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Report of the North-Western Working Group (NWWG)

24 April - 3 May 2007

ICES Headquarters

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Contents

1 Introduction

1.1 Terms of reference

2006/2/ACFM05 The **North-Western Working Group** [NWWG] (Chair: E. Hjörleifsson, Iceland) will meet at ICES Headquarters from 24 April - 3 May 2007 to: assess the status of and provide management options for 2008 for the following stocks

redfish in Subareas V, XII and XIV,

Greenland halibut in Subareas V and XIV,

cod in Subarea XIV, NAFO Subarea 1, and Division Va,

cod in Division Vb (including effort options)

saithe in Division Va,

saithe in Division Vb (including effort options)

haddock in Division Va,

haddock in Division Vb (including effort options)

Icelandic summer spawning herring

capelin in Subareas V and XIV;

for the stocks mentioned in a) perform the tasks described in C.Res. 2006/2/ACFM01. NWWG will report by 7 May 2007 to the attention of ACFM.

Below are the tasks described in C.Res. 2006/2/ACFM01.

The ACFM action plan highlights the need to develop advice based on long term considerations on a fisheries basis and within an ecosystem approach. It is recognized that the required integration of fisheries and ecosystem knowledge can best/only be achieved at the scientific level of the (regional) working groups. The following generic Terms of Reference specifies the tasks of assessment working groups in achieving the objectives of the action plan. The following Terms of Reference are generic, and each individual assessment group should prioritise them according to the detailed rolling planning developed by AMAWGC and to take account of regional developments.

WGNSSK, WGSSDS, WGHMM, WGMHSA, WGBFAS, WGNSDS, AFWG, HAWG, NWWG, WGNPBW and WGPAND will, in addition to the tasks listed by individual group in 2007:

1) set appropriate deadlines for submission of data. Data submitted after the deadline can be disregarded at the discretion of the WG Chair.

2) compile all relevant fisheries data, including data on different catch components (landings, discards, bycatch) and data on fishing effort. Data should be disaggregated by fisheries/fleets.

3) assess the state of the stocks according to the schedule for benchmark and update assessments as shown below.

4) provide specific information on possible deficiencies in the 2007 assessments and forecasts,

- • any major inadequacies in the data on landings, effort or discards;
- • any major expertise that was lacking
- • any major inadequacies in research vessel surveys data,

- • any major difficulties in model formulation or available software.

The consequences of these deficiencies for both the assessment of the status of the stocks and the projection should be clarified.

5) consider knowledge on important environmental drivers for stock productivity (based on input from e.g. WGRED and for the North Sea NORSEPP). If such drivers are considered important for management advice, incorporate such knowledge into assessment and prediction and comment on the consequences for long term targets of high yield and low risk.

6) consider existing knowledge of important impacts of fisheries on the ecosystem;

7) Evaluate existing management plans and develop options for management strategies including target and limit reference points. If mixed fisheries are considered important consider the consistency of target reference points and management strategies;

8) assess the influence of individual fleet activities on the stocks. For mixed fisheries, assess the technical interactions;

9) provide an overview of major regulatory changes (technical measures, TACs, effort control and management plans) and evaluate or assess their (potential) effects.

10) where misreporting and/or discarding is considered significant provide qualitative and where possible quantitative information, by fisheries and the describe the methods used to obtain the information and its influence on the assessment and predictions.

11) present an overview of the sampling on a national basis of the basic assessment data for the stocks considered according to the template that is supplied by the Secretariat

12) implement the roadmap for medium and long term strategy of the group as developed in AMAWGC.

1.2 NWWG 2007 work in relation to the the reference points

Due to unforeseen reasons the Saithe in Va was not assessed by the NWWG this year. All other stocks

The ToRs from the C.Res. 2ADFM01 where not addressed systematically for all stocks. The following points highlight the WG response to those terms of reference:

ToR1: Setting deadlines for submission of basic assessment data is generally not considered to be of importance within the North-Western working environment. The stocks where analytical assessments are done are for all practical purposes native fisheries. In these cases “The stock coordinator” is in principal also the supervisor of the national collection on commercial catch, participant in the scientific surveys, compiles individual measurement into suitable form for assessment purposes, performs the assessment, presents it to the group and writes up the report. For shared stocks a deadline has hetero forth not been set, but the working group concluded it may be appropriated to consider setting deadlines for data submission these stocks next year.

ToR2: Available information was compiled by the working group in the form appropriate for doing stock assessment.

ToR3: No stock was classified as a benchmark this year. Those on the update list that were dealt with by the working group were Faroe Platau cod, Faroe haddock, Icelandic cod and Icelandic haddock. The working group considered that the diagnostic from the SPALY settings for Faroe Platau cod, Faroe haddock and Icelandic cod did warrant a change in settings. However for the Icelandic haddock an alternative formulation was explored in detail and the results from that exercise may warrant a change in assessment formulation compared with that of last year. The Faroe saithe and Icelandic herring were under the exploratory umbrella, the assessment considered being indicative of stock trends but questions the use of point estimates from short term prediction as a basis of next years advice. Further progress on assessing the Greenland halibut within a Bayesian Stock Production framework were done at this meeting. The result from that analysis may, in combination with other information, be considered as guidance when formulating the advice.

ToR4: This ToR was addressed in within each stock section

ToR5: For the Faroe gadoid stocks it has been hypothesised for some time that there may be a linkage between environmental drivers (productivity index) and growth pattern, recruitment and fishing mortality patterns observed in some stocks. Although the observed correlation among different parameters gives the hypothesis credence, they have not been used directly in the assessment, let alone predictions.

ToR6: Although fisheries undoubtedly impacts on the ecosystem it was decided, to due time constraint, to addressed this issue formally at later meettings.

ToR7: The focus of the group was on re-evaluating existing reference points for the Faroese stocks as well as evaluating the long term harvesting goal relative to the limit reference points. The result of this work can be found in Section 2.1. Mixed fisheries are certainly of importance in the fisheries on the continental shelf in the North Western region. For the Icelandic shelf the main issue is that most of the stocks that fall under the “by catch” umbrella are not assessed by ICES. In the Faroese effort management system the control is not on the fishing mortalities on individual stock. In both cases factors controlling the observed fisheries behaviour may be outside the biological realm that the group is considered to be an expert in. Thus, a proper management evaluation in a mixed fisheries context thus calls for inclusion of additional experts from other fields.

TOr 8, 9 & 10: This ToR was only addressed briefly by the group and is given in the overview chapters of each region/stock. Again the issue on individual fleet activities is likely to be more complex than can be addressed by fisheries biologist alone. E.g. some observed patterns in the Icelandic fisheries are known to be more related to economy (size and condition of fish in different areas in relation to market demand) than conventional fisheries biological indices such as biomass catch rates. Misreporting of national stocks are probably not a major issue but are of some concern for shared stocks.

ToR11: The fisheries of most stocks in the North-West are truly national and information of sampling is given, as before, in individual stock section.

ToR12: This was not addressed during the working group meeting and needs thus to be taken up intersessionally. Recommendation

1.3 Recommendations

Stock	Assessment year	Assessment model	Survey at age							Catch at age					
			Tuning fleets	Year range for tuning	Age range for tuning	cpue-population model: Power	Survey-population model: Proportiona	q-platau	Time series weights	Separability model	Time variant selection	Selectivity platau	Shrinkage year range	Shrinkage age range	S.E for shrinkage
Faroe Plateau 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
			Spring survey	1994-2004	2-9	2	3-9	6+	None						
	2005	XSA	Summer survey	1996-2004	2-8		2-8	6+	None				5	5	2
			Spring survey	1994-2005	2-9		2-9	6+	None						
	2006	XSA	Summer survey	1996-2005	2-8		2-8	6+	None				5	5	2
			Spring survey	1994-2006	2-9		2-9	6+	None						
Faroe haddock	2003	XSA	Summer survey	1996-2002	1-8	1-2	3-8	6+	None				5	5	0.5
			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
			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
			Spring survey	1994-2005	1-5		1-5	None	None						
	2006	XSA	Summer survey	1996-2005	1-8		1-8	6+	None				5	5	0.5
			Spring survey	1994-2006	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
	2004	XSA	Cuba log books	1985-2003	3-11	3,4	5-11	9+	Yes				5	3	0.5
	2005	XSA	GLM log books	1995-2004	3-11		3-11	8+	None				5	3	2
	2006	XSA	GLM log books	1995-2004	3-11		3-11	8+	None				5	3	2
Icelandic saithe	2003	Camera	March survey	1985-2003	2-8		2-8	6+	None	parametric	Fixed	8+ platau			
	2004	Camera	March survey	1985-2004	2-8		2-8	6+	None	parametric	Fixed	8+ platau			
	2006	Camera	March survey	1985-2005	2-8		2-8	6+	None	parametric	Fixed	8+ platau			
	2005	Camera	March survey	1985-2006	2-8		2-8	6+	None	parametric	Fixed	8+ platau			
Icelandic cod	2003	ADCAM	March survey	1985-2003	1-10	1-5	6-10	None	None	parametric	RW	None			
	2004	ADCAM	March survey	1985-2004	1-10	1-5	6-10	None	None	parametric	RW	None			
	2005	ADCAM	March survey	1985-2005	1-10	1-5	6-10	None	None	parametric	RW	None			
	2005	ADCAM	March survey	1985-2005	1-10	1-5	6-10	None	None	parametric	RW	None			
Icelandic haddock	2003	ADCAM	March survey	1985-2003	1-9		1-9	None	None	parametric	RW	None			
	2004	ADCAM	March survey	1985-2004	1-9		1-9	None	None	parametric	RW	None			
	2005	ADCAM	March survey	1985-2005	1-9		1-9	None	None	parametric	RW	None			
	2006	ADCAM	March survey	1985-2006	1-9		1-9	None	None	parametric	RW	None			
Icelandic herring	2004	AMCI	Accustic survey	1981-2003	3-9		3-9	5+		parametric	RW	5+			
	2005	NO ANALYTICAL ASSESSMENT													
	2006	NFT ADAPT	Accustic survey	1981-2005											

Table 1.1. Input data, model name and configuration of the stocks that are analytically assessed by the NWWG.

2 Demersal Stocks in the Faroe Area (Division Vb and Sub-division 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. Number of licenses can be found in Table 2.1.3.

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 are often operated by part-time 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.

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. The spatial distribution is concentrated mainly in the year around closed areas to trawling (Figure 2.1.0). On average 92% of their catch is taken within the permanent exclusion zone for trawlers. During summer they also make a few trips to Icelandic waters.

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. This group, also called the deep-water trawlers, 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. The distribution of hauls by this fleet in 2000-2005 is shown in Figure 2.1.0.

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 (Figure 2.1.0).

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.

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 foreign 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 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 110 GRT, the jiggers, and the single trawlers less than 400 HP, 2) the pair trawlers and 3) the longliners greater than 110 GRT. The single trawlers 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 in order to minimize their cy-catches. One fishing day by longliners less than 110 GRT is considered equivalent to two fishing days for jiggers in the same gear category. Longliners less than 110 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 1998–2005 and Table 2.1.2 shows the number of allocated days inside the outer thick line (the "ring") 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 110 GRT are allowed to fish. The Faroe Bank shallower than 200 m is closed to trawling.

The fleet segmentation used to regulate the demersal fisheries in the Faroe Islands and the regulations applied are summarized in Table 2.1.3.

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 and 2006 NWWG meetings (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 and in the Faroe Bank channel 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). There is a positive relationship between primary production and the cod and haddock individual fish growth and recruitment 1-2 years later. The indices for primary production have been at or below average since 2002. Preliminary information indicate that primary production in 2007 might be above average. It should however be mentioned that the possible positive effect of this on the recruitment will not influence the fishery the first 2-3 years. In the section below on catchability analysis further effects of the primary production is 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 primary production seems to be negatively correlated with the catchability of longlines (Figure 2.1.3), suggesting that cod attack longline baits to a higher degree 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 primary production and fishing mortality (Fig. 2.1.4).

Also for haddock there seems to be similar relationship between primary production, growth, catchability and fishing mortality as for cod. The negative relationship between primary production and fishing mortality as shown in 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. For cod, the relationship is most clear for age 5 and older; for age 3 and 4, the relationship is less clear. 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 Faroe haddock on changes in 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 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 when periods with low primary production occur.

2.1.5 Summary of the 2007 assessment of Faroe Plateau cod, haddock and saithe

A summary of selected parameters from the 2007 assessment of Faroe Plateau cod, Faroe haddock and Faroe 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 0.18 and 0.25 over the period 1961 to 1989, 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 0.26 in 2006. 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 Reference points for Faroese stocks and evaluation of the Faroese management system

The NWWG has evaluated the relevance of existing reference points for Faroese demersal stocks on several occasions in recent years, mostly by investigating the development of fishing mortality and SSB and by doing medium term simulations. Except for the biomass reference points for Faroe Plateau cod, which are considered appropriate, the NWWG suggested changes to all other reference points and does so again in 2007 based on the guidelines provided in the report of the Study Group on Precautionary Reference Points for Advice on Fishery Management, held at ICES HQ from 24-26 February 2003 (SGPRP 2003) and the results of the current assessments. A summary of past work by the NWWG is also presented at the end of this section for background. Medium term simulations are not used in 2007 to evaluate the relevance of existing reference points. The inconsistency of fishing mortality reference points with the F experienced by the stocks will not be repeated. For a flavour of the inconsistencies between estimated F's and reference points, the reader is referred to the summary of previous reviews by the NWWG at the end of this section.

SGPRP 2003 provides useful background on the use and revision of reference points (page 2): "This concept of LIMIT and PA reference points implies that LIMIT and PA reference points have a very different status and should be revised according to different principles. Blim and Flim may be considered estimates of properties of nature (namely the reproductive capacity of a fish stock and its ability to sustain fishing) whereas the distance between LIMIT points and PA point (the distance between Blim and Bpa and between Flim and Fpa respectively) relate to our ability to measure the present spawning stock biomass and fishing mortality and are thus related to data quality and estimation methodology. Better data and improved estimation methods would therefore lead to more precise estimates of Blim and Flim (which may be unchanged, larger or lower) but a smaller interval between LIMIT and PA reference points, that is lower Bpa and higher Fpa values. Bpa and Fpa are also dependent on the acceptable probability that LIMIT points have been passed. The decision on the acceptable risk is not a science issue but should be decided by managers and stakeholders.

The LIMIT reference points will thus be constant as long as the overall natural regime is unchanged (but the estimates of these reference point may change as improved estimation methods and data are used) whereas the PA reference points and their estimates will change and should be revised whenever the assessment methodology, the quality of data or the perception of acceptable risk change. These changes in PA reference points can be in either direction. If the data available for the annual stock assessments deteriorate the interval between LIMIT and PA reference points will increase. The interval between LIMIT and PA reference points can conversely be reduced by investments and measures which ensure an improved data quality and thus an improvement in the precision of the annual stock assessments."

SGPRP 2003 highlighted the need to revise reference points, and it did make recommendations regarding the Faroese stocks that are consistent with subsequent work by the NWWG and with the current report. The process of revising reference points in ICES was not as rapid and effective as hoped for, partly because the attention shifted to the identification of target reference points in implementing resolutions of the Johannesburg Summit. The inappropriateness of existing reference points for Faroese stocks interferes with the credibility and usefulness of ICES advice. There is therefore a need to update the books, in order to increase the credibility and usefulness of ICES advice.

2.1.7 Faroe Plateau Cod

For Faroe Plateau cod, the existing biomass reference points (Blim=21 000t, Bpa=40 000t) are appropriate, but the fishing mortality reference (Flim=0.68, Fpa=0.35) points are not. SGPRP 2003 states that when Blim is available, Flim should be derived from Blim (page 14) "*by obtaining a value for the expected recruitment at Blim. The method is to measure the slope of the replacement line at Blim i.e R/Blim, and calculate the inverse, Blim/R. The equivalent fishing mortality derived from a curve of SSB/R against F will therefore be Flim.*".

A Ricker recruitment curve (Figure 2.4.7) with autocorrelated recruitment predicts 14500 recruits at the Blim of 21000t which provides Blim/R = 1.45 corresponding to a fishing mortality slightly above F=1.0 from the per-recruit calculations. Although this may seem high, the WG notes that the partial recruitment exerted on the stock is generally lower than the proportion mature at the same age as shown on Figure 2.4.8. For North Sea cod the partial recruitment at age are considerably higher than the proportion mature at the same age Figure 2.4.9. From Flim =1.0, Fpa could be proposed using the standard formula, assuming sigma of 0.40 Fpa = Flim*exp(-1.645*sigma) which implies Fpa = 0.50. This is consistent with the current assessment for Faroe Plateau cod where the median F since 1961 has been 0.48. Based on the current assessment, fishing mortality for Faroe Plateau cod is above Fpa.

2.1.8 Faroe haddock

WKREF 2007 endorsed the suggestion made in 2006 by the NWWG and in 2003 by SGPRP that Blim for haddock be set at 23 000t and further suggested that Bpa be set at 35 000t using Blim * exp(1.645*sigma), with sigma = 0.4 to account for high uncertainty in the assessment.

An alternate Ricker recruitment curve (Figure 2.4.10) where the SSB providing maximum recruitment was fixed at the average of the SSB that produced the four strongest year classes, predicts 17000 recruits at the Blim of 23000t which provides Blim/R = 1.36 corresponding to a fishing mortality slightly above F=1.0 from the per-recruit calculations. The WG suggests that Flim be set at 1.0 and that Fpa be set using the standard formula Fpa=Flim*exp(-1.645*sigma) where sigma would be 0.40 implying Fpa =0.50. This higher than the median average $F_{3-7} = 0.35$ for the period covered by the assessment. The WG notes that current fishing mortalities for Faroe haddock are considerably lower than Fpa and it would be prudent that they remain so. Fpa is not a target, it is the point where measures have to be taken to avoid reaching Flim.

2.1.9 Faroe saithe

For Faroe saithe, Figure 2.4.11 shows that recruitment is not impaired at 60 000t, the current Blim, on the contrary. Larger year classes appear to have been observed at lower SSB. Whether this is due to the influence of SSB on recruitment or of recruitment on subsequent SSB is besides the point: the current exercise aims at updating the reference points in a consistent manner. As suggested by SGPRP 2003, NWWG 2005 and NWWG 2006, Bloss for Faroe saithe should be interpreted as Bpa, not as Blim, that is Bpa = 60 000t. Blim could be arbitrarily set prudently lower at 45-50 000t until more stock and recruitment pairs are observed or it could be left undefined.

An alternate Ricker recruitment curve where the SSB providing maximum recruitment was fixed at the average of the four SSB that produced the strongest recruitment, predicts 41000 recruits at the Bpa of 60 000t which provides Blim/R = 1.45 corresponding to a fishing mortality slightly above F=1.0 from the per-recruit calculations. The WG considers that it would not be precautionary to set Fpa=1.0 and therefore suggests that Fpa for saithe be set at F = 0.50, the same value as for cod and haddock. The WG notes that, although the saithe assessment is uncertain, fishing mortality appears to have increased in recent years. If the increases continues, fishing mortality could reach Fpa in the not too distant future.

2.1.10 Study Group

The NWWG reiterates the suggestion made last year that 11 years "after the implementation of the effort management system, it would be appropriate to evaluate and suggest improvements to the system, including management measures to be taken when stocks approach or are under Blim. This could be done by a group of Faroese interested parties whose composition would be similar to that who originally designed the system, i.e. it should involve fishermen, fishery managers and fishery scientists. The improvements should also suggest how to monitor improvements in efficiency and how to adjust for them in a manner that will not ultimately lead to very few fishing days per individuals." This could be done by a Study Group prior to NWWG 2008.

2.1.11 Past reviews of reference points by NWWG

The rest of this section reviews the work done by the NWWG on the subject of reference points for Faroese stocks.

2.1.12 NWWG 2003

In 2003, for cod, the NWWG noted that "Over the period covered by the assessment, fishing mortality has been equal to or less than the proposed Fpa in only 6 of 40 years of available data. This suggests that Fpa = 0.35 may be overly conservative. The updated assessment indicates an Fmed = 0.48, F0.1 = 0.27 and Fmax = 0.48. Fpa could therefore be set in the order of Fmed = 0.48."

In the same year for haddock, the NWWG noted that "The SG on Precautionary Reference Points for Advice on Fishery Management (SGPRP – February 2003) suggested that Blim for Faroe haddock could be decreased to 20 000 t, considering that two strong year classes have been produced at SSB below Blim. The Working Group considers it premature to change Blim at this time. Of the 5 year classes produced at SSB below Blim, three were very small, and two very strong. The strong year classes are believed to be due to favourable environmental conditions, and there is no guarantee that similarly good environmental conditions would occur again should the SSB decrease below Blim.

The Flim and Fpa appear to be rather conservative. The fishing mortality has been above Flim during one third of the time series (14 of the 42 years), while it was above Fpa almost 70% of the time (29 out 42 years). Clearly, there is not a high probability that the stock will collapse at fishing mortality in the vicinity of Flim, particularly given the current high stock biomass. The average fishing mortality over the time period, F = 0.35 could therefore be considered as a candidate for Fpa, with an associated Flim, using Fpa e1.645̤assuming a sigma of about 0.30, giving Flim = 0.55."

In 2003, for saithe, the NWWG stated: "The current assessment (Table 2.5.5.5 and Figure 2.5.5.4) shows that fishing mortality has averaged 0.33 over the time period, that F has been above Flim in 13 out of 42 years (30%). Fishing mortality of F = 0.40 therefore does not appear to be associated with a high probability of stock collapse. Fishing mortality has been above Fpa every year except one since the 1980. Therefore, fishing mortalities in the order of 0.33, the average over the available time-series, do not appear associated with a high probability of stock collapse as implied by Flim. Given the history of the stock and the possible influence of changes in productivity on Faroese stocks, F = 0.33 could be considered as Fpa, with Flim derived using the usual formula of Flim = Fpae1.645x sigma where sigam could be 0.40 resulting in an Flim = 0.64, a value exceeded only once in the history of the fishery. The SG on Precautionary Reference Points for Advice on Fishery Management (SGPRP – February 2003) suggested that the existing Blim for Faroe saithe could be a candidate for Bpa instead.

2.1.13 NWWG 2005

The NWWG also addressed the subject in 2005. For biomass based reference points, it states: "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."

With respect to fishing mortality reference points, NWWG 2005 noted that "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 for haddock. 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."

Based on the material examined, NWWG 2005 concluded 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 sustain-able, 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 mature. 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."*

2.1.14 NWWG 2006

In 2006, NWWG 2006 noted that "in 2005, the NWWG made 100 year simulations using the results of the 2004 assessment and suggested that the biomass reference points for haddock and saithe, and the fishing mortality reference points for all three stocks be revised in accordance with the guidelines of the Study Group on Precautionary Reference Points for Advice on Fishery Management (SGPRP 2003, ICES CM 2003/ACFM:15), taking into account the results of the 100 year simulations. According to its Technical Minutes, the 2005 ACFM Review Group accepted the WG suggestions, with the exception of the Bpa for saithe which the WG suggested should be set at Bloss (the current Blim) given the shape of the stock and recruitment data pairs (the highest recruitment is observed at the lowest SSB). The reasons that led ACFM to reject the NWWG's proposals remain unclear, but the WG has attempted to address possible reasons. According to generic term of reference 2 of C.Res. 2005/2/ACFM01, the NWWG was asked to review reference points. This was done by scrutinising the results of the 100 year simulations done last year, by examining the stock and recruitment scatter plots from this year's assessment, and by investigating the dynamics of the three Faroese stocks."

Analysing the development of fishing mortality, NWWG 2006 noted: "During 1961 to 2005, the period covered by the assessment, the median F for cod was 0.47, F was less than Fpa in three years and over Flim in seven years. The saithe assessment covers the same period, and the median F was 0.35, F was less than Fpa in 18 years and above Flim in 17 years. During 1957 to 2005, the period covered by the haddock assessment, the median F was 0.29, F was less than Fpa in 13 years and above Flim in 18 years. Clearly, history shows that the current values used for Flim do not possess the characteristics of limit reference points since they have been breached on numerous occasions and productivity of the three stocks do not seem to have been impaired. Based on the history as depicted in the current assessment, the NWWG concludes that the median F's experienced by the Faroese demersal stocks over the period 1957/1961 to 2005 have been sustainable (F = 0.47 for cod, F = 0.29 for haddock, and F = 0.35 for saithe) and therefore that the current Flim's and associated Fpa's are not appropriate."

2.1.15 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 1998-06. 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
2005	21829	3123	6377
2006	19704	3440	5316
Average(98-06)	24568	2671	6601

Table 2.1.2. Number of allocated days for each fleet group since the new management scheme was adopted and number of licenses per fleet (by May 2006).

Fishing year	Group 1 Single trawlers > 400 HP	Group 2 Pair trawlers > 400 HP	Group 3 Longliners > 110 GRT	Group 4 Longliners and jiggers 15-110 GRT, single trawlers < 400 HP	Group 5 Longliners and jiggers < 15 GRT
1996/1997		8225	3040	9320	22000
1997/1998		7199	2660	9328	23625
1998/1999		6839	2527	8861	22444
1999/2000	Regulated by area	6839	2527	8861	22444
2000/2001	and by-catch	6839	2527	8861	22444
2001/2002	limitations	6839	2527	8861	22444
2002/2003		6771	2502	8772	22220
2003/2004		6636	2452	8597	21776
2004/2005		6536	2415	8468	21449
2005/2006		5752	3578	5603	21335
2006/2007		5752	3471	5435	20598
No. of licenses	12	29	25	65	593

	Fleet segment	Sub groups		Main regulation tools
1	Single trawlers > 400 HP	*none*		Bycatch quotas, area closures
2	Pair trawlers > 400 HP	*none*		Fishing days, area closures
3	Longliners > 110 GRT	*none*		Fishing days, area closures
4	Coastal vessels>15 GRT	4A	Trawlers 15-40 GRT	Fishing days
		4A	Longliners 15-40 GRT	Fishing days
		4B	Longliners>40 GRT	Fishing days
		4T	Trawlers>40 GRT	Fishing days
5	Coastal vessels <15 GRT	5A	Full-time fishers	Fishing days
		5B	Part-time fishers	Fishing days
6	Others		Gillnetters	Bycatch limitations, fishing depth, no. of nets
			Others	Bycatch limitations

Table 2.1.3. Main regulatory measures by fleet in the Faroese fisheries in Vb. The fleet capacity is fixed, based on among other things no. of licences. Number of licenses within each group (by May 2006) are as follows: 1: 12; 2:29; 3:25; 4A: 25; 4B: 21; 4T: 19; 5A:140; 5B: 453; 6: 8. These licenses have been fixed in 1997, but in group 5B a large number of additional licenses can be issued upon request.

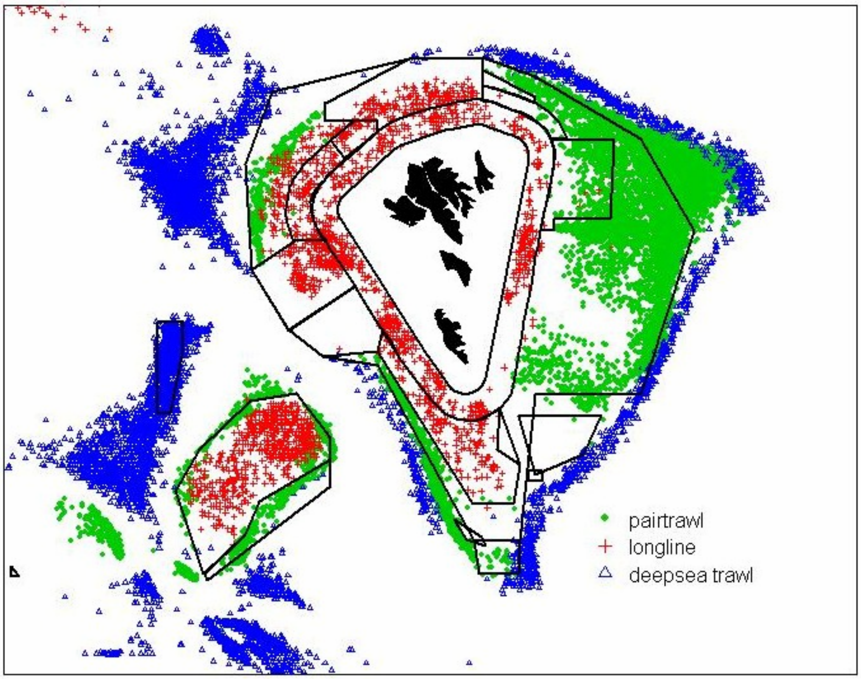
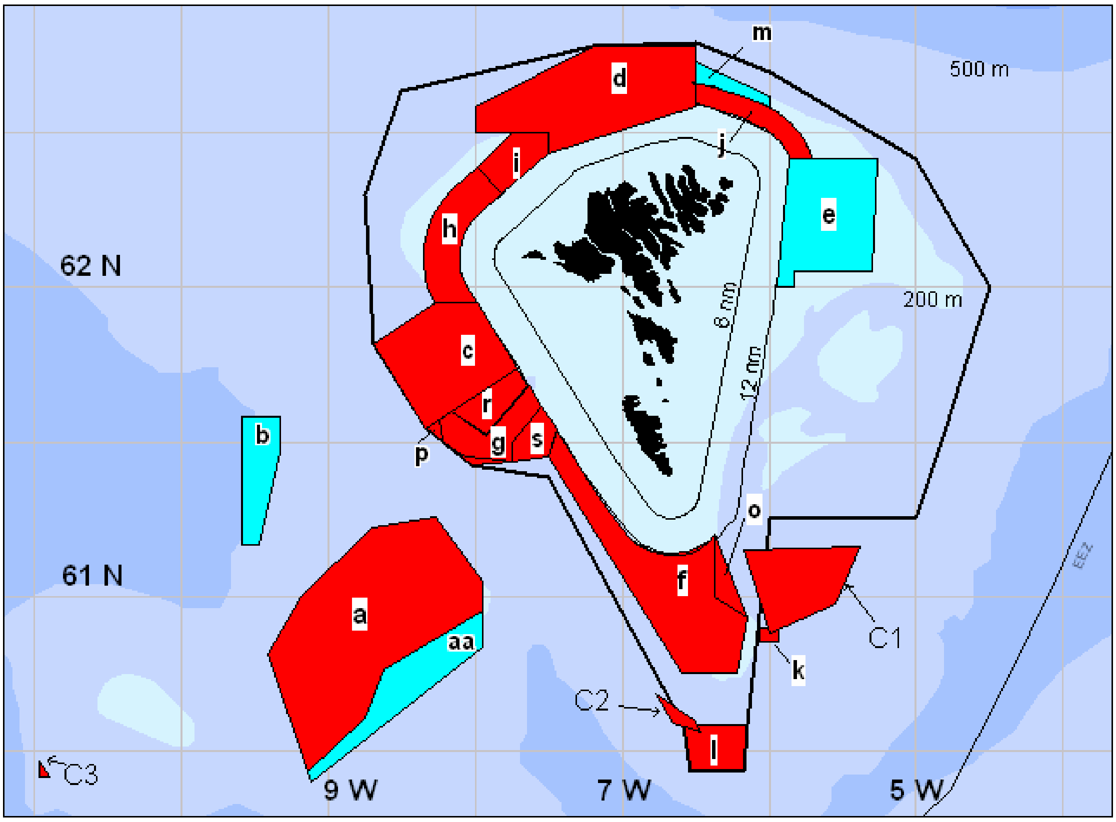


Figure 2.1.1. The 2000-2005 distribution of fishing activities by some major fleets.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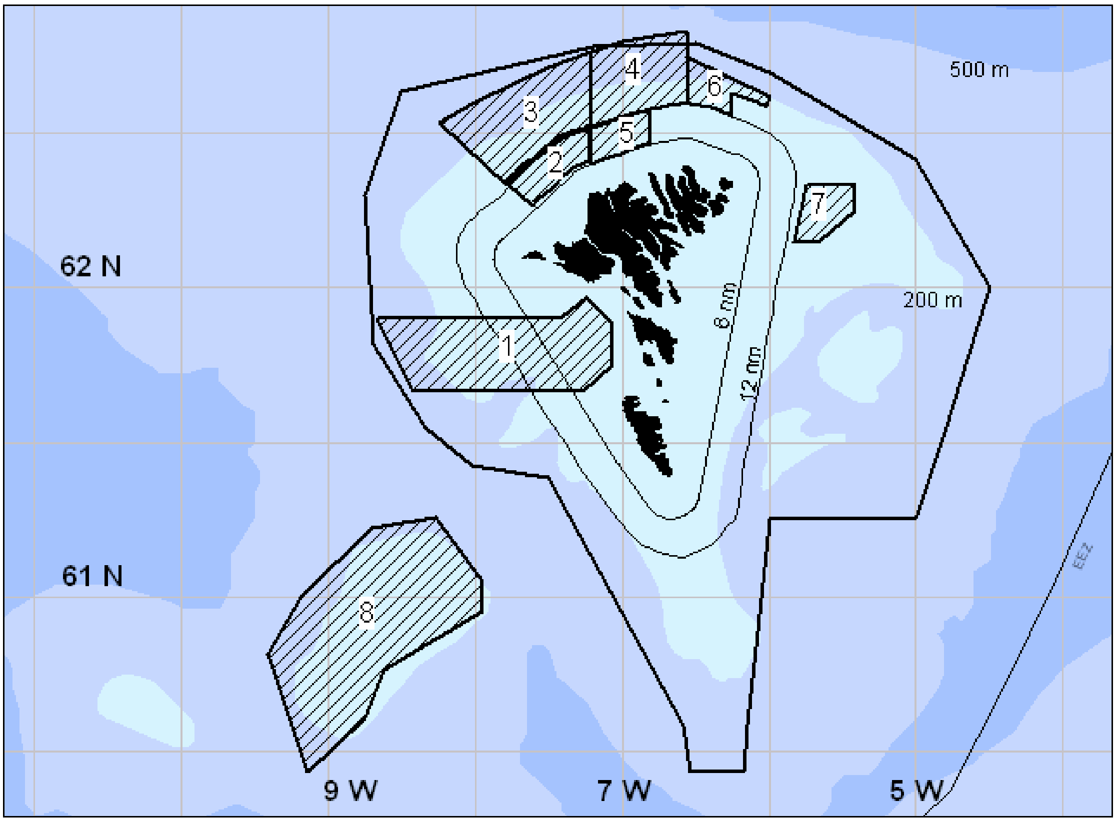
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7 W
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Exclusion zones for trawling

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
C1	1 jan - 31 des
C2	1 jan - 31 des
C3	1 jan - 31 des

Spawning closures

Area	Period
1	15 feb - 31 mar
2	15 feb - 15 apr
3	15 feb - 15 apr
4	1 feb - 1 apr
5	15 jan - 15 mai
6	15 feb - 15 apr
7	15 feb - 15 apr
8	1 mar - 1 may

Figure 2.1.2. Fishing area regulations in Division Vb. Allocation of fishing days applies to the area inside the outer thick line on the Faroe Plateau. Holders of effort quotas who fish outside this line can triple their numbers of days. Longliners larger than 110 GRT are not allowed to fish inside the inner thick line on the Faroe Plateau. If longliners change from longline to jigging, they can double their number of days. The Faroe Bank shallower than 200 m depths (a, aa) is regulated separate from the Faroe Plateau. It is closed to trawling and the longline fishery is regulated by individual day quotas.

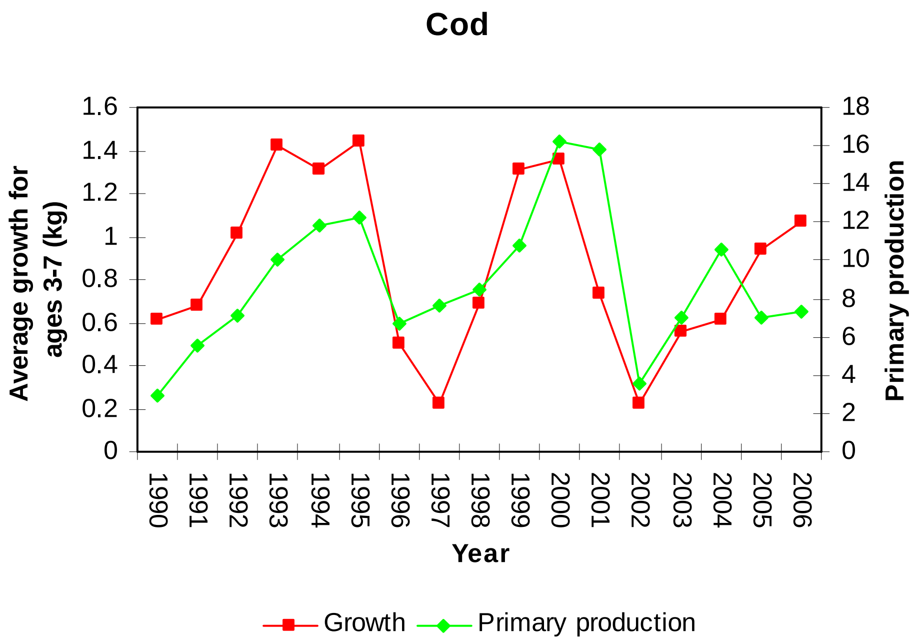

Figure 2.1.3 Faroe Plateau Cod. Relationship between primary production and growth of cod during the last 12 months.

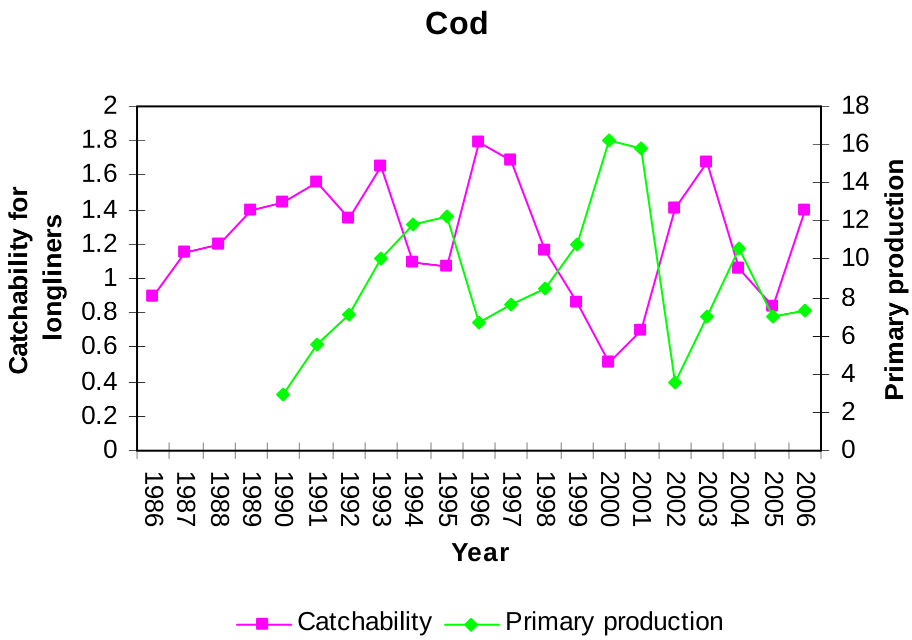

Figure 2.1.4. Faroe Plateau Cod. Relationship between long line catchability and primary production.

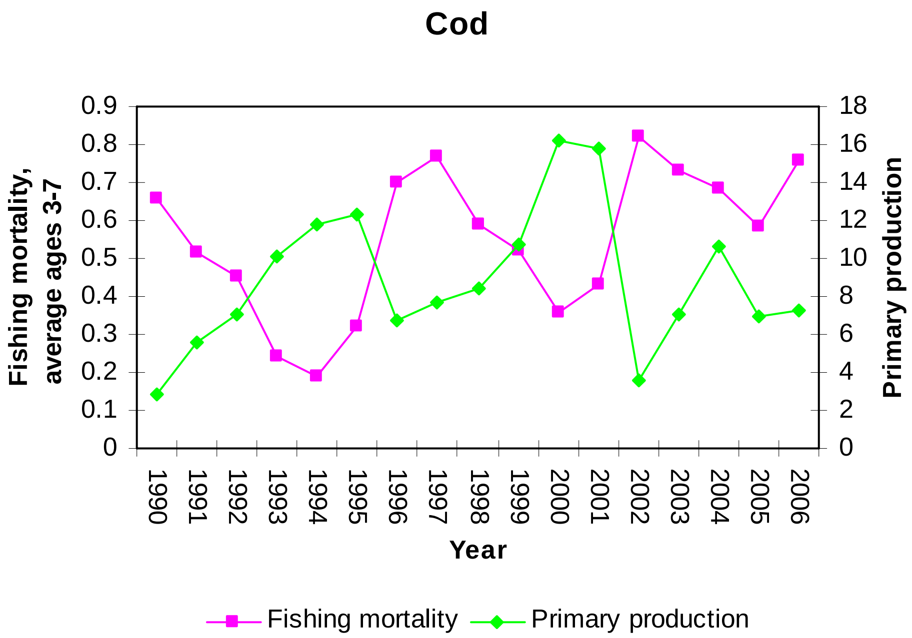

Figure 2.1.5. Faroe Plateau Cod. Relationship between fishing mortality and growth of cod during the last 12 months.

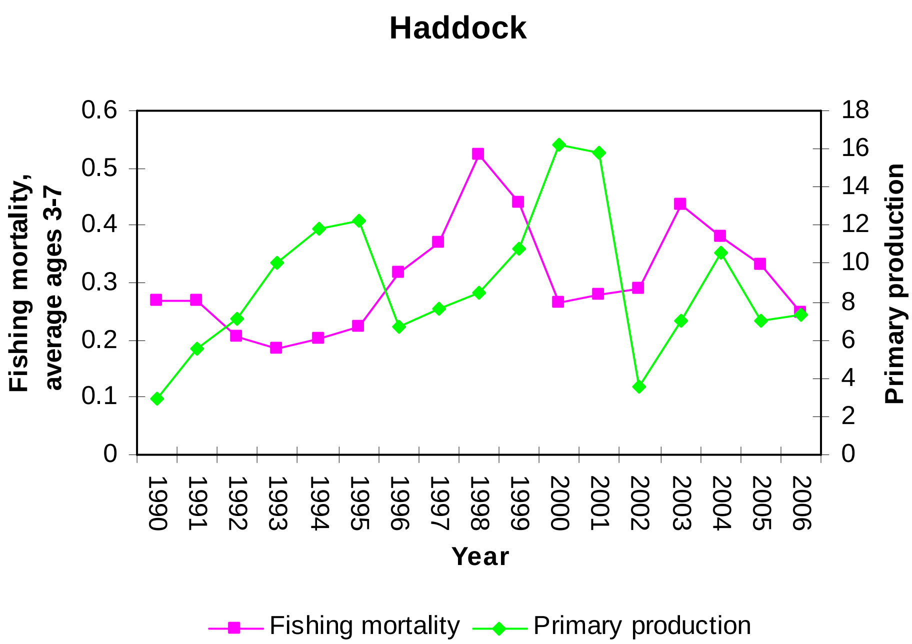

Figure 2.1.6. Faroe Haddock. Relationship between fishing mortality and growth of haddock during the last 12 months.

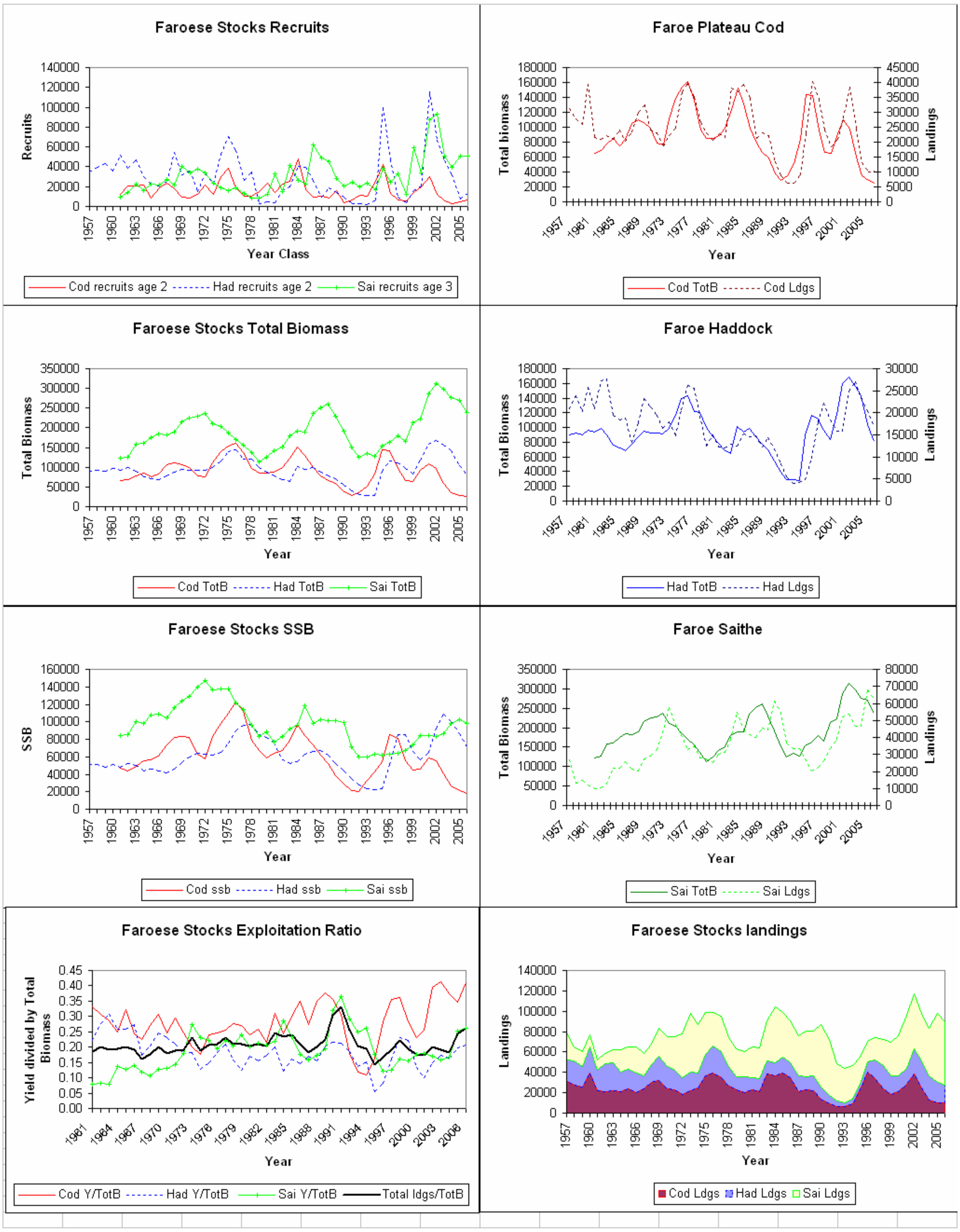

Figure 2.17. Faroe Plateau cod, Faroe haddock and Faroe saithe. 2007 stock summary. The Faroe saithe assessment is exploratory, recent estimates uncertain.

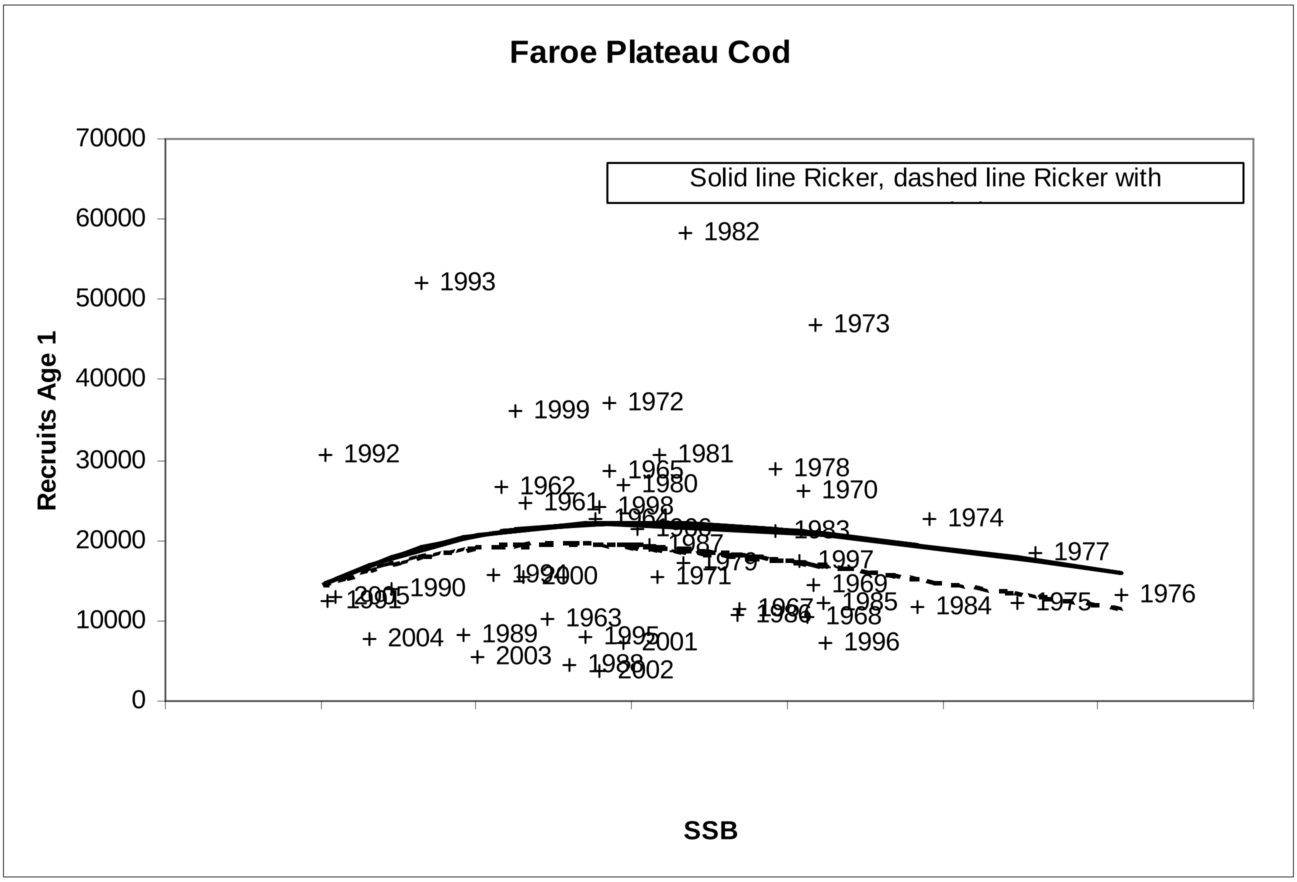

Figure 2.1.8. Ricker stock and recruitment relationship. Solid line is a normal fit, the dashed line assumes that recruitment is autocorrelated.

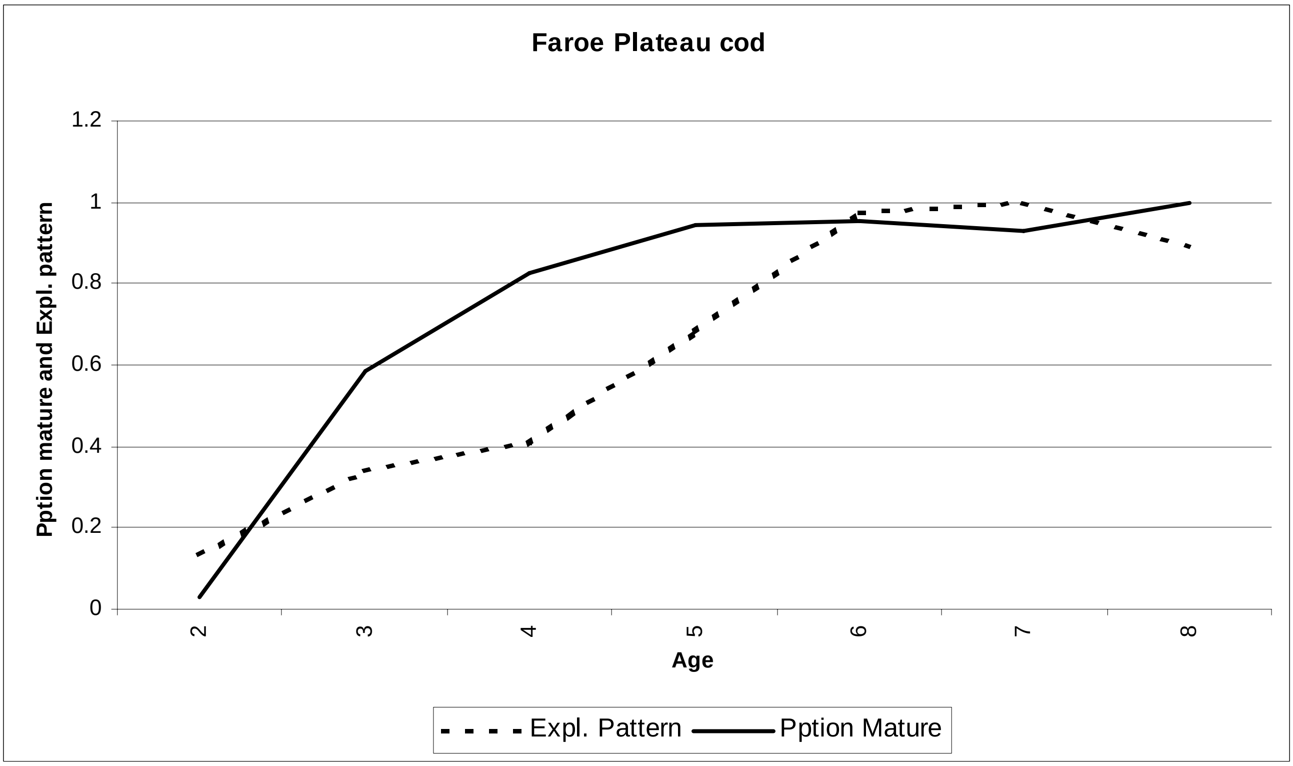

Figure 2.1.9 Exploitation pattern and proportion mature versus age for Faroe plateau cod. Faroe plateau cod matures at a faster rate than it becomes available to the fishery.

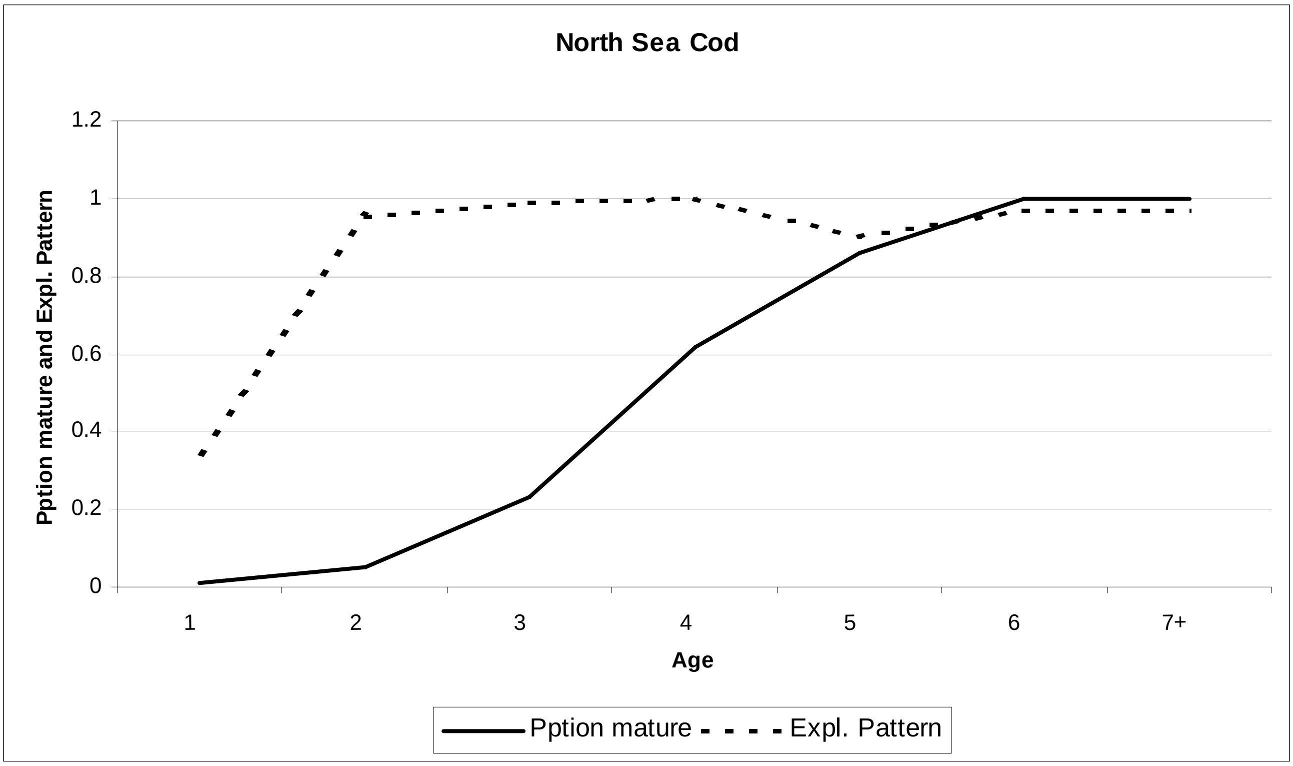

Figure 2.1.10. Exploitation pattern and proportion mature versus age for North Sea cod. North Sea cod becomes available to the fishery at a considerably faster rate than it matures.

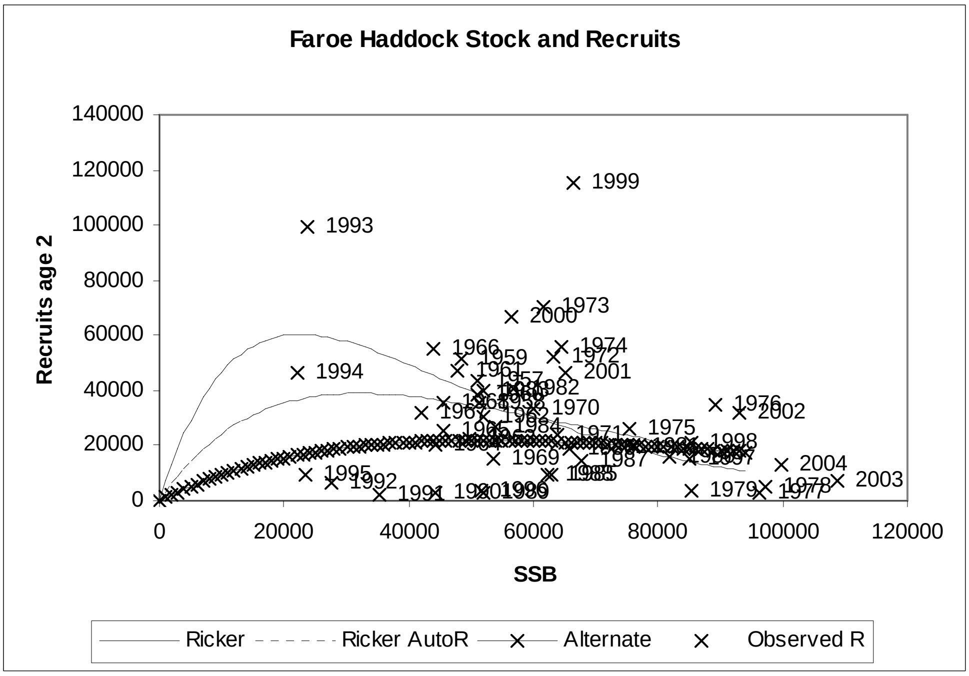

Figure 2.1.10. Ricker stock and recruitment relationships for Faroe haddock. The alternate formulation fixes the SSB where R is maximum, as the average SSB that produced the four strongest year classess.

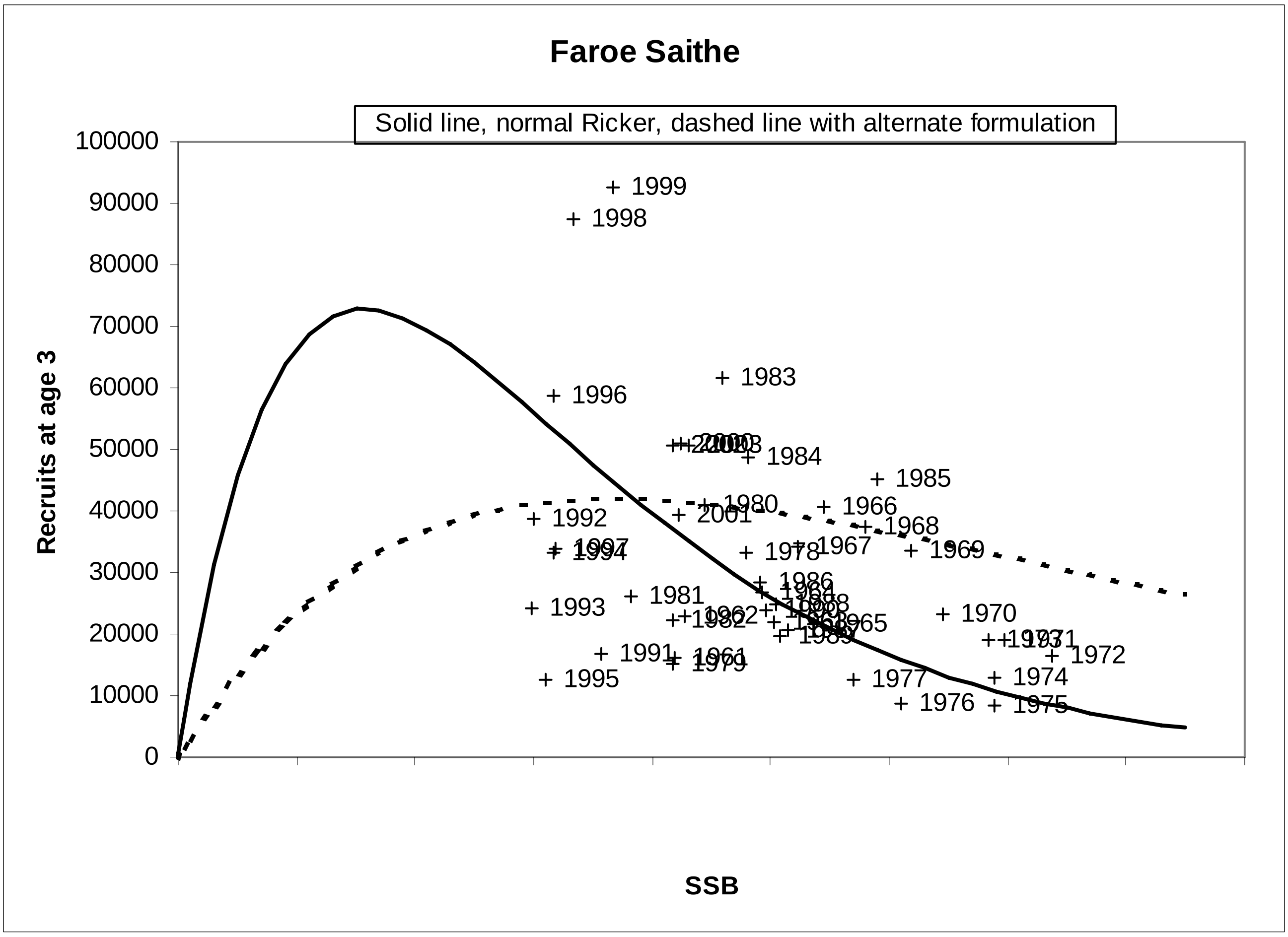

Figure 2.1.11. Ricker stock and recruitment relationships for Faroe saithe. The alternate formulation fixes the SSB where R is maximum, as the average SSB that produced the four strongest year classes.

2.2 Faroe Plateau Cod

Summary

Stock definition

Two cod stocks are distributed in the sub-division Vb1: The Faroe Plateau cod stock, which is distributed south of the Faroe-Icelandic ridge and Icelandic cod, which is distributed on the Faroe-Icelandic ridge.

Trends in landings

The catch has normally fluctuated between 20 and 40 kt. The landings in 1991-1994 and 2005-2006 were, however, less than, or around, 10 kt. The landings from the Faroe-Icelandic ridge (in 2003-2005 in the order of 4 kt) were excluded from the catch figures in the assessment.

Catch-at-age

The catch-at-age in 2006 was based on 18 000 length measurements, 4 000 otolith determinations and 19 000 length-weight measurements. The catch-at-age was calculated by 11 fleets and three seasons and eventually summed up. Exceptionally few medium-aged cod (ages 4-6) were caught in 2006.

Weight-at-age

The weight-at-age was obtained from the catch-at-age calculations (gutted weight scaled by 1.11 to obtain round weight). The weighs were increasing slightly from a low level in 2005.

Maturity-at-age

The maturity-at-age was obtained from the spring survey. All stations were pooled.

Groundfish surveys

Two groundfish surveys were used in the tuning of the XSA. A spring survey (March) with 100 fixed stations 1994-2007 and summer survey (August) 1996-2006 with 200 fixed stations (half of them being the same as in the spring survey).

Tuning and estimates of fishing mortality

Two commercial cpue series (longliners and pair-trawlers) were not used in the tuning, but were found to be in good agreement with the survey tuning series.

The spring survey pulled the XSA-estimates of stock numbers down while the summer survey pulled it up. Although both surveys suggested a low stock size, they differed in relative terms. The fishing mortality in 2006 was estimated at 0.76 while the stock biomass and SSB were 25 kt and 18 kt, respectively (amongst the lowest observed).

The XSA retrospective pattern showed that recruitment was overestimated while fishing mortality, stock biomass and spawning stock biomass differed little between the last three retrospective assessments.

Different measures of fishing mortality showed an increasing trend since the introduction of the effort management system in 1996.

Stock estimates and recruitment

Simulations by the NFT ADAPT software indicated that the XSA point estimate of SSB in 2006 was a slight underestimate.

There was a high probability (61%) that the fishing mortality in 2006 was above Flim.

The XSA results indicate that a number of recent year classes (YC 2001-2005) are weak.

Expaning the stock size back to 1906, using British trawler CPUEs, indicates that the stock biomass is amongst the lowest during a century.

Prediction of catch and biomass

Short term prediction

The short term prediction is very pessimistic, indicating SSB's below 13 kt in 2008-2009 and catches of 8 kt and 5 kt in 2007 and 2008, respectively.

Management considerations

The cod stock is on the lowest level during a century and furture recruitment is estimated to be low. In order to rebuild the stock it may be necessary to use other means than the number of fishing days.

Comments on the assessment

The quality of the input data was considered to be adequate. The stock assessement was considered to give a correct impression of the stock size and fishing mortality.

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 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.

Icelandic and Faroese tagging experiments suggest that the cod population on the Faroe-Icelandic ridge mainly belongs to the Icelandic cod stock. Faroese Fisheries Laboratory tagged about 24 000 cod in Faroese waters during 1997-2006 and about 6 000 have been recaptured so far. Of these one was caught on the Icelandic shelf and one on the Faroe-Icelandic ridge. In 2002 168 individuals were tagged on the Faroe-Icelandic rigde (Midbank). Eleven have been recaptured so far, 5 at Iceland, 4 on the Faroe-Icelandic ridge and 0 on the Faroe Plateau (2 had unknown recapture position).

The Marine Research Institute in Iceland tagged 25572 cod in Icelandic waters during 1997-2004 and 3708 were recaptured to April 2006. Of these only 13 individuals were recaptured on the Faroe-Icelandic ridge and none on the Faroe Plateau. The proportion of Icelandic tags reported from the Faroe-Icelandic ridge (13 out of 3708) is significantly higher than the proportion of Faroese tags recaptured on the Faroe-Icelandic ridge (1 out of 6000).

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. After a drop to about 20 000 tonnes in 2000 the catches increased again to about 40 000 tonnes in 2002, mainly caused by the 1998-1999 year classes, which were of average or above average strength, respectively. The index of primary production was high in 2000 and 2001, but decreased markedly in 2002-2003 and so did the recruitment in 2003-2005. The cod catches on the Faroe Plateau were only about 10 thousand tonnes in 2005 and 2006.

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

Since the introduction of the EEZ, the Faroe Plateau cod has almost entirely been exploited by the Faroese fishing fleets. In recent years, the longliners and the pair trawlers have usually taken most of the catches. Since the autumn in 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 reason was probably that their catches of redfish and Greenland halibut in deep waters were low.

A small part of the cod catches are not landed and not reported. It has been a long, legal, practice on Faroese vessels that small cod (ages 1-3) are dryed and used for private consumption. Recreational fishermen also fish legally a small quantum of small cod and use it for private consumption. The extent of this common practice is not known, but has been ongoing for several decades and it is not believed that there has been any time trend in it.

The nominal landings of cod (1986-2006) 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 2006, the catches were about 10 thousand tonnes, which is far below the long term average and also below the normal “downs” in the catches (20 thousand tonnes). The Faroese catches on the Faroe-Icelandic ridge, within the Faroese EEZ, were removed from the assessment-catches back to 1999 (Table 2.2.2.2 and 2.2.2.3). Table 2.2.2.4 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. The reason for this change was that the three-period splitup was considered to be in better agreement with biological cycles (the spawning period ends in April). 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. The number of samples in 2005 was not sufficient to allow the traditional three period splitup for all the fleets, and a two period splitup (January-June and July-December) was adopted for those fleets.

Landings-at-age were updated to account for a change in the nominal landings for 2004, and also to account for the changes by excluding the landings from the Faroe-Icelandic ridge 1999-2006. Landings-at-age for 2006 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 2006 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 2006.

Table 2.2.2.2. Samples of lengths, otoliths, and individual weights of Faroe Plateau cod in 2006.

Fleet	Size	Samples	Lengths	Otoliths	Weights
Open boats		16	1,136	294	1,033
Longliners	<100 GRT	62	6,175	1,259	6,791
Longliners	>100 GRT	62	5,445	1,074	7,314
Jiggers		7	1,038	359	440
Sing. trawlers	<400 HP	0	0	0	0
Sing. trawlers	400-1000 HP	8	291	180	1,214
Sing. trawlers	>1000 HP	5	593	59	0
Pair trawlers	<1000 HP	14	2,177	598	728
Pair trawlers	>1000 HP	24	2,309	539	2,344
Total		182	18,028	4,068	18,831

2.2.4 Weight-at-age

Mean weight-at-age data for 1961-2006 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 2006 showed a discrepancy of 0 %. The inclusion of ages 10+ in the assessment generally improved the SOP.

Figure 2.2.4.1 shows the mean weight-at-age for 1961 to 2006. For 2007-2009 the values used in the short term predictions are shown on this graph in order to put them in perspective with previous observations. The weights increased from 1998 to 2000, but have decreased since, although they appear to have increased in 2007. The expected weights in the commercial catches in 2007 (catch weights over the intire year: CW) were estimated by the weights in the commercial catches in January-February (Januar-February catch weights: JFW) or the weights in the spring survey (survey catch weights: SW). Linear regressions were made between CW and JFW for the years 1996-2006 and between the CW and the SW for the years 1996-2006 by each age. The correlation that was higher was chosen for prediction of the value in 2007.

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 - 2006) and shown in Figure 2.2.5.1 (1983 - 2006). The observed values in 2007 and the estimated values in 2008-2009 are also shown in order to put them in perspective with previous observations. 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 years 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 stratified mean catch of cod per unit effort in 1994-2007 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 and was low in 2005 and 2006. A calculation error in the 2006 index due to using the 2005 survey results for the spawning strata instead of the 2006 result was corrected, causing the total stock biomass estimated from XSA to decrease from 41 kt to 33 kt and the spawning stock biomass from 29 kt to 24 kt whereas the fishing mortality increased from 0.46 to 0.57 (when rerunning the 2006-assessment). 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 1996-2007.

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 stratified mean catch of cod per unit effort (kg/trawl hour) 1996-2006 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. 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 (15-26 cm for 2005 because of abnormally small 2 year old fish). Since the age length key was the same for all strata, a mean length distribution was calculated by stratum and the overall length distribution was calculated as the mean length distribution for all strata weighted by stratum area. Having this length distribution and the age length key, the number of fish at age per station was calculated, and scaled up to 200 stations. The tuning series are presented in Table 2.2.7.1.1.

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 in 2004 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 price differential between cod and saithe. These two cpue series are presented in Tables 2.2.7.1.2 and 2.2.7.1.3 although they were not used as tuning series.

Since the current assessment is an update assessment, the same procedure is followed as in the 2006 assessment: to use the two surveys for tuning and not the commercial series. The commercial series showed the same overall tendency as the surveys (Figure 2.2.7.1.1). As in the 2006 assessment, the ADAPT assessment package was used for comparison with the XSA. The XSA-run is presented in Table 2.2.7.1.4. and the results are shown in the Table 2.2.7.1.5 (fishing mortality at age), Table 2.2.7.1.6 (population numbers at age) and Table 2.2.7.1.7 (summary table).

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), 1995 and 2004-2006 (actually 2005-2007). For the summer survey there was a year effect in 2003-2006. In addition there seemingly is an effect of year class. Even though both survey indices for 2006 were low, they differed much in relative terms, giving low, but in relative terms quite different, estimates of survivors (Table 2.2.7.1.4).

The results from the retrospective analysis of the XSA (Figure 2.2.7.1.3) show that there has been a tendency to overestimate recruitment whereas the estimates of fishing mortality, stock biomass and spawning stock biomass have differed little.

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 recruitment while the estimates of SSB and fishing mortality are surprisingly close given the absence of any shrinkage.

The estimated fishing mortalities are shown in Tables 2.2.7.1.5 and 2.2.7.1.7 and Figure 2.2.7.1.5. The average F for age groups 3 to 7 in 2006 (F3-7) is estimated at 0.76, considerably higher than Fpa = 0.35 and Flim = 0.68.

The F3-7 (Figure 2.2.7.1.6) 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 2.2.7.1.7: weighting by stock numbers, stock biomasses or catch weights. All measures of fishing mortality show, however, that the fishing mortality has increased since the introduction of the effort management system in 1996 and that there have been regular oscillations around this increasing trend. The fishing mortality in 2006 was amongst the highest observed.

2.2.7.2 Stock estimates and recruitment

The stock size in numbers is given in Table 2.2.7.1.6. A summary of the XSA, with recruitment, biomass and fishing mortality estimates is given in Table 2.2.7.1.7 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 point estimate of F and SSB from the XSA assessment. The XSA point estimate of F and SSB falls below the cloud of bootstrapped pairs of F and SSB’s, contrary what was found in the 2006-assessment. The XSA fishing mortality is slightly above the bootstrapped F’s while the SSB is clearly below the bootstrapped SSB’s. This indicates that the XSA-run is more pessimistic that the ADAPT results. From the NFT Adapt results, there is a 68% probability that the Faroe cod 2006 SSB was less than Blim = 21 000t and there is a 100% probability that it was less than Bpa = 40 000t. There is a 100% probability that F 3-7 is higher than the target exploitation rate F = 0.45, a 100% probability that it is higher than the existing Fpa = 0.35, and 61% probability that it is higher than the existing Flim.

The assessment shows the poor recruitment for the 1984 to 1991 year classes, and the strong 1992 and 1993 year classes. Due to the continuous poor recruitment from 1984 to 1991 and the high fishing mortalities, the spawning stock biomass declined steadily from 1983 to 1992 when it was the lowest on record at 20 000 t. It increased sharply to above 80 000 t in 1996 and 1997 before declining to about 45 000 t in 1999. The spawning stock biomass increased to 59 000 t in 2001 but dropped to about 18 000 t in 2006 which is the lowest value observed during the assessment period from 1961-2006. The 2002 year class is amongst the lowest observed and the 2003-2004 year classes are also weak according to the XSA run. The estimate of the 2005 year class relies solely on the spring survey estimate in 2007 (shifted to 2006 in the tuning) and is also low.

In order to put the stock estimates in 2006 into a wider perspective, we have estimated the stock biomass back to 1906. A cpue series (tonnes per million tonn-hours) for British trawlers 1924-1972 was available from the data presented in Jákupsstovu and Reinert (1994). The cpue series was also used, and explained, in Jones (1966). There was an overlap between the cpue series and the stock assessment for the years 1961-1972. It was assumed that the british trawlers caught relatively few 2-year-old fish, and that their cpue reflected the abundance of age 3+. Another cpue series (cwts per day of absence from port) was available for British steam trawlers 1906-1925. The overlap was two years (1924 and 1925) and the 1906-1925 series was scaled to the 1924-1972 series. The results are presented in Figure 2.2.7.2.3. There was a decreasing trend in biomass from around 100 thousand tonnes to around 80 tonnes prior to World War II, and since then a decreasing trend from around 100 thousand tonnes to around 50 thousand tonnes. The biomass in 2006 was the lowest during the entire period.

2.2.8 Prediction 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 2005-2007 year classes were estimated as the average of the 2001-2004 year classes. Estimates of stock size (ages 3+) were taken directly from the XSA stock numbers. The exploitation pattern was estimated as the average fishing mortality for 2004-2006 and rescaled to the level in 2006. The weights at age in the catches in 2007 were estimated from the commercial catches in January-February or the spring survey (ages 2-5 years). Regression analyses were made between weights in January-February (or March), and the weights during the whole year 1996-2006. The weights in the catches in 2007 were predicted from the regressions. The weights in the catches in 2008-2009 were set to the values in 2007. The proportion mature in 2007 was set to the 2007 values from the spring groundfish survey, and for 2008-2009 to the average values for 2005-2007.

Table 2.2.8.1.2 shows that the landings in 2007 are expected to be 8 000 tonnes (the landings from the Faroe-Icelandic ridge should be added to this figure in order to get the total Faroese landings within the Vb1 area). The spawning stock biomass is expected to be 13 000 tonnes in 2007, 12 000 tonnes in 2008 and eventually 12 000 tonnes in 2009. The current short term prediction is therefore very pessimistic. The contribution of the various year-classes to the SSB in 2008 and 2009 is shown in Figure 2.2.8.1.1. It shows that the incoming year-classes (YC 2003-YC 2006) dominate the SSB.

The same impression of the future stock development was obtained when using same procedure as in the 2006-assessment, *i.e.* YC 2004 = 6363000 and YC2005 = 1574000 obtained from the XSA-results and YC 2006 and YC 2007 = 13516000 set to the geometric mean during the whole assessment period 1961-2006. The SSB was predicted to be 10 000 tonnes in 2008 and 16 000 tonnes in 2009.

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

No such projections are included in this years report.

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, weights at age, and the proportion mature were set to the average values for 2000-2006.

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 0.12 and F_{max} as 0.25. The present average fishing mortality (F3-7) in 2006 of 0.75 is considerably higher than F_{max} = 0.25 and much above F_{med} = 0.35.

2.2.9 Management considerations

The current assessment shows that the spawning stock biomass in 2006 was below Blim of 21 000 tonnes and that it is expected to stay as low as about 13 000 tonnes in 2008-2009. The catch in 2007-2008 is predicted to be less than 8 000 tonnes, which is as low as the catch in 1991-1993. The decrease in the stock is due to a combination of poor recruitment since 2002 and high fishing mortality. The low recruitment is believed to be a result of poor primary production since 2002. High primary production in 2007 (the signs by 2. May are positive, but the final estimate will be available by July 2007) and onwards could produce stronger recruitment than have been assumed in the assessment.

Biomass estimates of Faroe Plateau cod reconstructed back in time (Figure 2.2.7.2.3) show that the biomass fluctuated around 100 000 tonnes during the period 1906-1957, around 80 000 tonnes during 1958-1987 and eventually around 60 000 tonnes since 1988. The catches fluctuated between 20 000 and 40 000 tonnes, except in 1990-1994 and 2004-2006. Similar catches from smaller biomasses imply that the exploitation rates have increased.

There has been a long held view on the Faroe Islands that the cod stock is very resilient to exploitation and that a collapse in the fishery is nearly impossible – people bear in mind the rapid recovery of the cod stock during 1994-1996. The collapse in the fisheries during 1991-1994 has been regarded as an exceptional event. Figure 2.2.7.2.3 indicates that, although more resilient than many other cod stocks in the North Atlantic, Faroe Plateau cod does show a decreasing trend since World War II. This trend is likely caused by a combination of environmental factors and fishing effort, but the contribution from each of these two factors is unknown. While there is no direct information about environmental condition for cod such as the primary production index to evaluate possible environmental changes prior to 1990, there are reasons to believe that the fishing effort has increased during the period.

The catchability hypothesis presented in the overview section for Faroese stocks states that the fishing mortality is high when the primary production is low and *vice versa*. The primary production has been low, or average, since 2002 and the high fishing mortality in 2005-2006 were therefore expected. If the primary production stays average or low in 2007 or 2008 fishing mortality may remain high and the cod stock may be reduced even further than estimated in the prediction as a result of poor recruitment and high fishing mortality. If, on the other hand, the primary production is high in 2007 and 2008 then the cod stock may recover rapidly.

Although the extremely low cod stock biomass is a serious problem for the Faroese fisheries sector it may not cause as intense a crisis as occurred in the early 1990s because the biomass of the other two important demersal fish stocks, haddock and saithe, are higher than they were in the early 1990s.

Given the very poor state of the cod stock the WG considers that measure should be taken to reduce fishing mortality significantly in 2007. This is would require a substantial reduction in the number of fishing days in 2007/2008. A small reduction in the number of days is unlikely to have a detectable effect because the price of cod is higher than for the other two groundfish species and because the use of snail-baits in the longline fishery close to land has probably increased fishing efficiency. Area closures may therefore be necessary in order to reduce fishing mortality on the cod stock.

The continued high fishing mortality on cod also questions some of the underlying assumptions in the effort management system. The system assumes that the fleets would concentrate on abundant species, but, as mentioned earlier, fishing effort directed on cod has remained high because the price is higher than for haddock and especially saithe. Another assumption was that the fishing mortality could be regulated by the number of fishing days. While the average fishing mortality is undoubtedly related to fishing effort, as indicated in the overview section, short term fluctuations in fishing mortality may depend as much or more upon natural processes than on the number of fishing days. Given the current very low cod stock extra means are necessary to protect that stock.

As indicated above, a substantial reduction in the number of fishing days would be required to reduce the fishing mortality on cod. Other means, such as area closures would also be necessary and may actually be more effective.

2.2.10 Comments on the assessment

Misreporting is not believed to be a problem under the current effort management system. The total catch figures (in sub-divisions Vb1+Vb2) are believed to be accurate although there may be some minor problems when allocating the catches between the two sub-divisions.

The sampling of the catches for length measurements, otolith readings and length-weight relationships is considered to be adequate.

The quality of the tuning data is considered high. The same research vessel has been used all the time and the gear as well as sampling procedures of the catch have remained the same. The only exception may be the otolith sampling during 1994-1996 when larger otolith samples were collected from fewer hauls than during the other years (1997 to present).

New or changed things compared to last years report: the ages 10+ were included in the catch-at-age and treated as a plus group in the XSA-run. The other assessment settings were the same as last year.

The quality of the assessment is believed to be high – in the sense that there seems to be no doupt that the stock size is amongst the lowest observed during a century. There was a good agreement between the survey indicies (although they differed somewhat in relative terms) and when compared to the commercial tuning series.

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Table 2.2.2.1. Faroe Plateau (Sub-division Vb1) COD. Nominal catches (tonnes) by countries, 1986-2006, 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	2005	2006 *
Denmark	-							
Faroe Islands	19,156		29,762	40,602	30,259	17,540	13,556	11,603
France	- *	1	9 [2]	20	14	2		4
Germany	39	2	9	6	7	3 [2]		1 [2]
Iceland	-	-	-	5	-			
Norway	450	374	531 *	573	447	414	201	47
Greenland	-	-	-	29 [2]	-			
Portugal						1		
UK (E/W/NI)[2]	51	18	50	42	15	15	24	
UK (Scotland)[1]	-	-	-	-	-	-	-	-
United Kingdom								[1]
Total	19,696	395	30,361	41,277	30,742	17,975	13,781	11,655

* 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) 1986-2006, 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	2005	2006 *
Officially reported	19,696	395	30,361	41,277	30,742	17,975	13,781	11,655
Faroese catches in Vb1		21,793 *						
Correction of Faroese catches in Vb1 [1]			-1,766	-2,409	-1,795	-1,041	-804	-688
Faroese catch on the Faroe-Icelandic ridge	-1,600	-1,400	-700	-600	-4,700	-4,000	-4,200	-800
Greenland[2]						35		
France[2]						2		
Catches reported as Vb2:								
UK (E/W/NI)	-	-	-	-	-	-		
UK (Scotland)	210	245	288	218	254	244		
United Kingdom				-	-	-	1,129	279
Used in the assessment	18,306	21,033	28,183	38,486	24,501	13,215	9,906	10,446

*) 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. Estimate of the landings from the Faroe-Icelandic ridge. The landings were estimated from total landings by the single trawlers larger thant 1000 HP (ST>1000 HP) and the proportion of the catch taken on the Faroe-Icelandic ridge (obtained from logbooks).

Year	Total landings in tonnes from ST>1000HP	Round weight (x1.11)	Ratio on the Icelandic ridge (logbooks)	Tonnes from the Icelandic ridge (rounded)
1991	329	365	0.23	100
1992	196	218	0.51	100
1993	179	199	0.38	100
1994	449	498	0.02	0
1995	862	957	0.05	0
1996	667	740	0.06	0
1997	985	1093	0.15	200
1998	1359	1508	0.13	200
1999	2074	2302	0.7	1600
2000	2515	2792	0.49	1400
2001	1649	1831	0.37	700
2002	2267	2516	0.26	600
2003	4492	4986	0.94	4700
2004	3826	4247	0.94	4000
2005	3933	4365	0.95	4200
2006	1097	1217	0.63	800

Table 2.2.2.4. Faroe Plateau (sub-division Vb1) COD. The landings of Faroese fleets (in percents) of total catch. Note that the catches on the Faroe-Icelandic ridge (mainly belonging to single trawlers > 1000 HP) are included in this table, but excluded in the XSA-run.

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.weight
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
2005	3.7	27.5	5.1	0.8	5.4	2.4	28.1	1.7	6.4	18.8	0.0	0.0	15,472
2006	6.2	35.0	3.2	0.2	7.1	1.6	12.9	2.5	6.6	24.7	0.0	0.0	8,636
Average	**4.2**	**24.7**	**6.1**	**1.0**	**9.7**	**4.6**	**8.1**	**9.1**	**12.9**	**18.9**	**0.5**	**0.1**	

Table 2.2.3.1. Faroe Plateau COD. Catch in numbers at age per fleet in 2006. 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 (scaling)	Catch-at-age
2	103	60	613	91	0	5	3	2	4	96	0	201	1178
3	47	35	594	73	0	12	9	10	19	168	0	197	1164
4	13	8	192	39	0	13	22	14	31	81	0	85	498
5	36	9	344	43	0	12	22	13	32	73	0	120	704
6	40	5	283	56	0	15	37	18	50	199	1	146	850
7	15	1	86	20	0	6	16	8	22	119	1	60	354
8	3	0	11	4	0	1	3	2	7	36	1	12	80
9	0	0	0	0	0	0	1	1	1	5	0	2	10
10+	0	0	0	0	0	0	0	0	0	2	0	1	3
Sum	257	118	2123	326	0	64	113	68	166	779	3	824	4841
G.weight	430	115	3085	623	0	141	418	218	583	2176	22	1600	9411

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 1961-2006.

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

YEAR,	1961,	1962,	1963,	1964,	1965,	1966,
AGE						
1,	0,	0,	0,	0,	0,	0,
2,	3093,	4424,	4110,	2033,	852,	1337,
3,	2686,	2500,	3958,	3021,	3230,	970,
4,	1331,	1255,	1280,	2300,	2564,	2080,
5,	1066,	855,	662,	630,	1416,	1339,
6,	232,	481,	284,	350,	363,	606,
7,	372,	93,	204,	158,	155,	197,
8,	78,	94,	48,	79,	48,	104,
9,	29,	22,	30,	41,	63,	33,
+gp,	0,	0,	0,	0,	0,	0,
0 TOTALNUM,	8887,	9724,	10576,	8612,	8691,	6666,
TONSLAND,	21598,	20967,	22215,	21078,	24212,	20418,
SOPCOF %,	91,	94,	96,	98,	113,	109,

YEAR,	1967,	1968,	1969,	1970,	1971,	1972,	1973,	1974,	1975,	1976,
AGE										
1,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
2,	1609,	1529,	878,	402,	328,	875,	723,	2161,	2584,	1497,
3,	2690,	3322,	3106,	1163,	757,	1176,	3124,	1266,	5689,	4158,
4,	860,	2663,	3300,	2172,	821,	810,	1590,	1811,	2157,	3799,
5,	1706,	945,	1538,	1685,	1287,	596,	707,	934,	2211,	1380,
6,	847,	1226,	477,	752,	1451,	1021,	384,	563,	813,	1427,
7,	309,	452,	713,	244,	510,	596,	312,	452,	295,	617,
8,	64,	105,	203,	300,	114,	154,	227,	149,	190,	273,
9,	27,	11,	92,	44,	179,	25,	120,	141,	118,	120,
+gp,	0,	0,	0,	0,	0,	0,	97,	91,	150,	186,
0 TOTALNUM,	8112,	10253,	10307,	6762,	5447,	5253,	7284,	7568,	14207,	13457,
TONSLAND,	23562,	29930,	32371,	24183,	23010,	18727,	22228,	24581,	36775,	39799,
SOPCOF %,	102,	106,	109,	99,	123,	125,	101,	101,	97,	97,

YEAR,	1977,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,	1986,
AGE										
1,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
2,	425,	555,	575,	1129,	646,	1139,	2149,	4396,	998,	210,
3,	3282,	1219,	1732,	2263,	4137,	1965,	5771,	5234,	9484,	3586,
4,	6844,	2643,	1673,	1461,	1981,	3073,	2760,	3487,	3795,	8462,
5,	3718,	3216,	1601,	895,	947,	1286,	2746,	1461,	1669,	2373,
6,	788,	1041,	1906,	807,	582,	471,	1204,	912,	770,	907,
7,	1160,	268,	493,	832,	487,	314,	510,	314,	872,	236,
8,	239,	201,	134,	339,	527,	169,	157,	82,	309,	147,
9,	134,	66,	87,	42,	123,	254,	104,	34,	65,	47,
+gp,	9,	56,	38,	18,	55,	122,	102,	66,	80,	38,
0 TOTALNUM,	16599,	9265,	8239,	7786,	9485,	8793,	15503,	15986,	18042,	16006,
TONSLAND,	34927,	26585,	23112,	20513,	22963,	21489,	38133,	36979,	39484,	34595,
SOPCOF %,	70,	100,	98,	106,	104,	100,	97,	97,	95,	96,

YEAR,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,
AGE										
1,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
2,	257,	509,	2237,	243,	192,	205,	120,	573,	2615,	351,
3,	1362,	2122,	2151,	2849,	451,	455,	802,	788,	2716,	5164,
4,	2611,	1945,	2187,	1481,	2152,	466,	603,	1062,	2008,	4608,
5,	3083,	1484,	1121,	852,	622,	911,	222,	532,	1012,	1542,
6,	812,	2178,	1026,	404,	303,	293,	329,	125,	465,	1526,
7,	224,	492,	997,	294,	142,	132,	96,	176,	118,	596,
8,	68,	168,	220,	291,	93,	53,	33,	39,	175,	147,
9,	69,	33,	61,	50,	53,	30,	22,	23,	44,	347,
+gp,	26,	25,	9,	26,	24,	34,	25,	16,	49,	47,
0 TOTALNUM,	8512,	8956,	10009,	6490,	4032,	2579,	2252,	3334,	9202,	14328,
TONSLAND,	21391,	23182,	22068,	13487,	8750,	6396,	6107,	9046,	23045,	40422,
SOPCOF %,	96,	101,	98,	99,	106,	102,	102,	101,	101,	99,

YEAR,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	2005,	2006,
AGE										
1,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
2,	200,	455,	1185,	2091,	3912,	2080,	678,	101,	494,	1178,
3,	1278,	745,	993,	2637,	3759,	7288,	2128,	693,	592,	1164,
4,	6710,	1558,	799,	782,	2101,	3374,	4572,	1266,	877,	498,
5,	3731,	5140,	1107,	426,	367,	1673,	1927,	2111,	1122,	704,
6,	657,	1529,	2225,	674,	367,	470,	640,	738,	823,	850,
7,	639,	159,	439,	809,	718,	533,	177,	241,	204,	354,
8,	170,	118,	59,	104,	437,	413,	91,	65,	41,	80,
9,	51,	28,	17,	7,	36,	290,	115,	42,	19,	10,
+gp,	120,	25,	7,	1,	6,	7,	20,	37,	30,	3,
0 TOTALNUM,	13556,	9757,	6831,	7531,	11703,	16128,	10348,	5294,	4202,	4841,
TONSLAND,	34304,	24005,	18306,	21033,	28183,	38486,	24501,	13215,	9906,	10446,
SOPCOF %,	101,	103,	101,	104,	100,	100,	100,	100,	100,	100,

1

Table 2.2.4.1. Faroe Plateau COD. Catch weight at age 1961-2006.

YEAR,	1961,	1962,	1963,	1964,	1965,	1966,
AGE						
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	1.0800,	1.0000,	1.0400,	.9700,	.9200,	.9800,
3,	2.2200,	2.2700,	1.9400,	1.8300,	1.4500,	1.7700,
4,	3.4500,	3.3500,	3.5100,	3.1500,	2.5700,	2.7500,
5,	4.6900,	4.5800,	4.6000,	4.3300,	3.7800,	3.5100,
6,	5.5200,	4.9300,	5.5000,	6.0800,	5.6900,	4.8000,
7,	7.0900,	9.0800,	6.7800,	7.0000,	7.3100,	6.3200,
8,	9.9100,	6.5900,	8.7100,	6.2500,	7.9300,	7.5100,
9,	8.0300,	6.6600,	11.7200,	6.1900,	8.0900,	10.3400,
+gp,	10.2700,	10.2700,	10.8200,	14.3900,	11.1100,	11.6500,
0 SOPCOFAC,	.9068,	.9444,	.9573,	.9824,	1.1262,	1.0905,

YEAR,	1967,	1968,	1969,	1970,	1971,	1972,	1973,	1974,	1975,	1976,
AGE										
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.9600,	.8800,	1.0900,	.9600,	.8100,	.6600,	1.1100,	1.0800,	.7900,	.9400,
3,	1.9300,	1.7200,	1.8000,	2.2300,	1.8000,	1.6100,	2.0000,	2.2200,	1.7900,	1.7200,
4,	3.1300,	3.0700,	2.8500,	2.6900,	2.9800,	2.5800,	3.4100,	3.4400,	2.9800,	2.8400,
5,	4.0400,	4.1200,	3.6700,	3.9400,	3.5800,	3.2600,	3.8900,	4.8000,	4.2600,	3.7000,
6,	4.7800,	4.6500,	4.8900,	5.1400,	3.9400,	4.2900,	5.1000,	5.1800,	5.4600,	5.2600,
7,	6.2500,	5.5000,	5.0500,	6.4600,	4.8700,	4.9500,	5.1000,	5.8800,	6.2500,	6.4300,
8,	7.0000,	7.6700,	7.4100,	10.3100,	6.4800,	6.4800,	6.1200,	6.1400,	7.5100,	6.3900,
9,	11.0100,	10.9500,	8.6600,	7.3900,	6.3700,	6.9000,	8.6600,	8.6300,	7.3900,	8.5500,
+gp,	10.6900,	9.2800,	14.3900,	9.3400,	10.2200,	11.5500,	7.5700,	7.6200,	8.1700,	13.6200,
0 SOPCOFAC,	1.0224,	1.0598,	1.0851,	.9943,	1.2264,	1.2481,	1.0134,	1.0134,	.9709,	.9653,

YEAR,	1977,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,	1986,
AGE										
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.8700,	1.1120,	.8970,	.9270,	1.0800,	1.2300,	1.3380,	1.1950,	.9050,	1.0990,
3,	1.7900,	1.3850,	1.6820,	1.4320,	1.4700,	1.4130,	1.9500,	1.8880,	1.6580,	1.4590,
4,	2.5300,	2.1400,	2.2110,	2.2200,	2.1800,	2.1380,	2.4030,	2.9800,	2.6260,	2.0460,
5,	3.6800,	3.1250,	3.0520,	3.1050,	3.2100,	3.1070,	3.1070,	3.6790,	3.4000,	2.9360,
6,	4.6500,	4.3630,	3.6420,	3.5390,	3.7000,	4.0120,	4.1100,	4.4700,	3.7520,	3.7860,
7,	5.3400,	5.9270,	4.7190,	4.3920,	4.2400,	5.4420,	5.0200,	5.4880,	4.2200,	4.6990,
8,	6.2300,	6.3480,	7.2720,	6.1000,	4.4300,	5.5630,	5.6010,	6.4660,	4.7390,	5.8930,
9,	8.3800,	8.7150,	8.3680,	7.6030,	6.6900,	5.2160,	8.0130,	6.6280,	6.5110,	9.7000,
+gp,	10.7200,	12.2290,	13.0420,	9.6680,	10.0000,	6.7070,	8.0310,	10.9810,	10.9810,	8.8150,
0 SOPCOFAC,	.7012,	.9965,	.9843,	1.0584,	1.0408,	1.0030,	.9695,	.9685,	.9491,	.9625,

YEAR,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,
AGE										
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	1.0930,	1.0610,	1.0100,	.9450,	.7790,	.9890,	1.1550,	1.1940,	1.2180,	1.0160,
3,	1.5170,	1.7490,	1.5970,	1.3000,	1.2710,	1.3640,	1.7040,	1.8430,	1.9860,	1.7370,
4,	2.1600,	2.3000,	2.2000,	1.9590,	1.5700,	1.7790,	2.4210,	2.6130,	2.6220,	2.7450,
5,	2.7660,	2.9140,	2.9340,	2.5310,	2.5240,	2.3120,	3.1320,	3.6540,	3.9250,	3.8000,
6,	3.9080,	3.1090,	3.4680,	3.2730,	3.1850,	3.4770,	3.7230,	4.5840,	5.1800,	4.4550,
7,	5.4610,	3.9760,	3.7500,	4.6520,	4.0860,	4.5450,	4.9710,	4.9760,	6.0790,	4.9780,
8,	6.3410,	4.8960,	4.6820,	4.7580,	5.6560,	6.2750,	6.1590,	7.1460,	6.2410,	5.2700,
9,	8.5090,	7.0870,	6.1400,	6.7040,	5.9730,	7.6190,	7.6140,	8.5640,	7.7820,	5.5930,
+gp,	9.8110,	8.2870,	9.1560,	8.6890,	8.1470,	9.7250,	9.5870,	8.7960,	8.6270,	7.4820,
0 SOPCOFAC,	.9642,	1.0061,	.9774,	.9897,	1.0600,	1.0202,	1.0225,	1.0141,	1.0108,	.9940,

YEAR,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	2005,	2006,
AGE										
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.9010,	1.0040,	1.0500,	1.4160,	1.1640,	1.0170,	.8200,	1.0370,	.9860,	.8390,
3,	1.3410,	1.4170,	1.5860,	2.1700,	2.0760,	1.7680,	1.3620,	1.1540,	1.3730,	1.3040,
4,	1.9580,	1.8020,	2.3500,	3.1870,	3.0530,	2.8050,	2.1270,	1.6930,	1.7600,	1.9880,
5,	3.0120,	2.2800,	2.7740,	3.7950,	3.9760,	3.5290,	3.3290,	2.3630,	2.2930,	2.3860,
6,	4.1580,	3.4780,	3.2140,	4.0480,	4.3940,	4.0950,	4.0920,	3.8300,	3.1380,	3.3300,
7,	4.4910,	5.4330,	5.4960,	4.5770,	4.8710,	4.4750,	4.6700,	5.1910,	5.2870,	4.6910,
8,	5.3120,	5.8510,	8.2760,	8.1820,	5.5630,	4.6500,	6.0000,	6.3260,	8.2850,	7.6350,
9,	6.1720,	7.9700,	9.1290,	11.8950,	7.2770,	6.2440,	6.7270,	7.6560,	8.7030,	9.5240,
+gp,	7.0560,	8.8020,	10.6520,	13.0090,	12.3940,	7.4570,	6.8100,	9.5730,	9.5170,	11.9900,
0 SOPCOFAC,	1.0108,	1.0279,	1.0142,	1.0428,	1.0027,	1.0006,	1.0002,	1.0011,	1.0039,	1.0035,

Table 2.2.5.1. Faroe Plateau (sub-division Vb1) COD. Proportion mature at age 1983-2006. From 1961-1982 the average from 1983-1996 is used.

YEAR	1961	1962	1963	1964	1965	1966
AGE						
1	.0000	.0000	.0000	.0000	.0000	.0000
2	.1700	.1700	.1700	.1700	.1700	.1700
3	.6400	.6400	.6400	.6400	.6400	.6400
4	.8700	.8700	.8700	.8700	.8700	.8700
5	.9500	.9500	.9500	.9500	.9500	.9500
6	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
8	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
+gp	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

YEAR	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
AGE										
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
+gp	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

YEAR	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
AGE										
1	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
2	.1700	.1700	.1700	.1700	.1700	.1700	.0300	.0700	.0000	.0000
3	.6400	.6400	.6400	.6400	.6400	.6400	.7100	.9600	.5000	.3800
4	.8700	.8700	.8700	.8700	.8700	.8700	.9300	.9800	.9600	.9300
5	.9500	.9500	.9500	.9500	.9500	.9500	.9400	.9700	.9600	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	.9600
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	.9400
9	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
+gp	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

YEAR	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
AGE										
1	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
2	.0000	.0600	.0500	.0000	.0000	.0600	.0300	.0500	.0900	.0400
3	.6700	.7200	.5400	.6800	.7200	.5000	.7300	.3300	.3500	.4300
4	.9100	.9000	.9800	.9000	.8600	.8200	.7800	.8800	.3300	.7400
5	1.0000	.9700	1.0000	.9900	1.0000	.9800	.9100	.9600	.6600	.8500
6	1.0000	1.0000	1.0000	.9600	1.0000	1.0000	.9900	1.0000	.9700	.9400
7	1.0000	1.0000	1.0000	.9800	1.0000	1.0000	1.0000	.9600	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
+gp	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

YEAR	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
AGE										
1	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
2	.0000	.0000	.0200	.0200	.0700	.0400	.0000	.0000	.0500	.0400
3	.6400	.6200	.4300	.3900	.4700	.3700	.2900	.5100	.6600	.5900
4	.9100	.9000	.8800	.6900	.8600	.7600	.7900	.7800	.9000	.8000
5	.9700	.9900	.9800	.9200	.9400	.9700	.8800	.9200	.9300	.9900
6	1.0000	.9900	1.0000	.9900	1.0000	.9300	.9800	.8900	.9800	.9900
7	1.0000	1.0000	1.0000	1.0000	1.0000	.9700	1.0000	.8700	.9200	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
+gp	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

1

Table 2.2.7.1.1. 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 2006
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
 200  616.5    735.1    872.1   1166.3   756     142.5   44.8
 200  978.4    684.2    349.3    312     256.6   123     28.2
SPRING SURVEY (shifted back to december)
1993 2006
1 1 0.9 1.0
1 8
 100   567.8    335.1     906.5     504.7     128.9    186.1    28.5     0.1
 100   706      785.9    1453.4    1480.1    1179      284     349      48.6
 100   393.6   3975      3606.1    1768.2    1314.2    403.6    79.6   161.3
 100    90.7    935.7    5474      2309.5     328.8    223.9    57.8     5.2
 100    76.2    424.4    1548.5    4857.6    1126.2     81.7    40.5    34.8
 100   530.1    644.9     972.5    1204.4    2047.4    250      25.1    13.3
 100   288.8   1402.2     735.7     436.6     502.1    829.6    63.4     3.1
 100   874.1   2282.9    1953.5     448.8     320.4    572.5   128       3.9
 100   345.9   4193.7    2789.9    1544.1     323.2    225.7   174.1   128.1
 100   79.1     720.2    4343.4    1350.6     548.9     63.3    48.2    36.9
 100   426.8    450.2     786.3    1198.8     297.7     65.8    21.9    11.8
 100   293.4    400.4    1100.5    1409.9     837.9    139.7    14       3.8
 100   129.7    144.5     166.1     340.7     281.1     92.1    15.2     3.9
 100    40.5    255.7     270.6     148.3     164.1    102.9    37.5    14.3
```

Table 2.2.7.1.2. Faroe Plateau (sub-division Vb1) COD. Pairtrawler abundance index (number of individuals per 1000 fishing hours). This series was not used in the tuning of the XSA.

Year	Stand. effort	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10
1985	1000	332	8712	5134	2308	918	1108	400	142	93
1986	1000	211	3288	12317	4777	2043	544	333	98	88
1987	1000	77	1313	3584	5438	1944	515	112	90	21
1988	1000	73	1707	2067	1942	2962	713	265	47	42
1989	1000	137	991	2061	1616	1409	1343	339	97	26
1990	1000	31	2130	2282	1409	720	444	444	76	31
1991	1000	12	245	1562	956	525	291	199	92	34
1992	1000	25	366	694	1993	807	366	151	63	63
1993	1000	78	1551	2081	942	1258	472	136	99	78
1994	1000	497	1615	2182	2679	763	939	211	141	35
1995	1000	1142	3129	5199	3864	1930	434	517	162	83
1996	1000	407	13198	12929	4454	2764	667	17	269	43
1997	1000	38	1201	10428	8738	1569	795	165	0	104
1998	1000	27	1082	2611	5887	3666	554	306	57	0
1999	1000	363	2195	2423	2577	4579	1565	96	39	0
2000	1000	2749	3509	1920	959	1232	1331	186	0	0
2001	1000	3298	7725	3205	642	351	899	407	14	8
2002	1000	497	6856	5154	1362	272	203	132	211	9
2003	1000	61	1652	5102	2866	679	107	56	73	10
2004	1000	0	307	1622	3809	2321	745	149	39	80
2005	1000	57	489	797	2470	2113	510	124	45	12
2006	1000	124	588	986	1020	1579	707	208	43	7

Table 2.2.7.1.3. Faroe Plateau (sub-division Vb1) COD. Longliner abundance index (number of individuals per 100000 hooks). This series was not used in the tuning of the XSA.

Year	Stand. effort	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9
1986	100000	0	0	350	1094	460	241	66	44	22
1987	100000	0	22	65	390	693	346	173	65	43
1988	100000	0	67	501	484	451	601	184	83	33
1989	100000	0	555	538	514	285	334	334	98	24
1990	100000	0	60	632	328	244	162	141	141	25
1991	100000	0	38	125	770	263	138	81	63	38
1992	100000	0	70	185	185	343	132	62	35	18
1993	100000	7	20	550	537	184	332	84	44	20
1994	100000	41	720	921	460	287	91	164	64	36
1995	100000	0	403	1022	589	403	241	72	156	42
1996	100000	0	44	1357	1325	530	729	319	97	220
1997	100000	0	25	289	1994	1272	285	279	84	36
1998	100000	25	139	218	366	1373	460	63	37	12
1999	100000	4	473	258	191	214	461	133	33	8
2000	100000	74	507	638	123	58	114	184	34	5
2001	100000	10	1058	767	403	62	83	208	159	21
2002	100000	1	519	1988	778	421	156	174	117	132
2003	100000	0	142	655	1554	684	253	70	42	72
2004	100000	2	18	88	320	513	201	67	30	19
2005	100000	0	10	36	89	188	204	74	21	10
2006	100000	2	136	239	115	105	282	170	50	7

Table 2.2.7.1.4. Faroe Plateau (sub-division Vb1) COD. SPALY run (with age 10+ included).

```
Lowestoft VPA Version 3.1

   24/04/2007  20:53

 Extended Survivors Analysis

 COD FAROE PLATEAU (ICES SUBDIVISION Vb1)                 COD_ind_Surveys10.txt

 CPUE data from file Surveys.TXT

 Catch data for  46 years. 1961 to 2006. Ages  1 to  10.

      Fleet,            First, Last, First, Last, Alpha,  Beta
                    ,    year, year,  age ,  age
 SUMMER SURVEY       ,   1996, 2006,   2,     8,   .600,   .700
 SPRING SURVEY (shift,   1993, 2006,   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   40 iterations

1


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


 Fishing mortalities
    Age,  1997,  1998,  1999,  2000,  2001,  2002,  2003,  2004,  2005,  2006

      1,  .000,  .000,  .000,  .000,  .000,  .000,  .000,  .000,  .000,  .000
      2,  .035,  .089,  .096,  .125,  .158,  .201,  .136,  .036,  .127,  .229
      3,  .149,  .176,  .284,  .319,  .345,  .491,  .326,  .201,  .308,  .496
      4,  .411,  .273,  .290,  .380,  .455,  .600,  .666,  .328,  .421,  .463
      5,  .833,  .647,  .318,  .247,  .307,  .822,  .852,  .763,  .546,  .721
      6, 1.046, 1.052,  .656,  .326,  .350,  .828,  .907,  .991,  .788, 1.116
      7, 1.400,  .789, 1.061,  .530,  .698, 1.361,  .898, 1.136,  .849,  .994
      8, 1.331, 1.169,  .785,  .790,  .618, 1.234,  .929, 1.058,  .579, 1.022
      9,  .942,  .822,  .495,  .190,  .712, 1.182, 1.761, 1.992, 1.113,  .266


1
```

Table 2.2.7.1.4. (Cont'd)

XSA population numbers (Thousands)

YEAR	AGE 1	2	3	4	5	6	7	8	9
1997	7.24E+03	6.46E+03	1.02E+04	2.20E+04	7.29E+03	1.12E+03	9.37E+02	2.55E+02	9.24E+01
1998	1.75E+04	5.92E+03	5.11E+03	7.21E+03	1.19E+04	2.60E+03	3.22E+02	1.89E+02	5.52E+01
1999	2.41E+04	1.43E+04	4.44E+03	3.51E+03	4.49E+03	5.11E+03	7.42E+02	1.20E+02	4.81E+01
2000	3.62E+04	1.97E+04	1.07E+04	2.74E+03	2.15E+03	2.67E+03	2.17E+03	2.10E+02	4.47E+01
2001	1.54E+04	2.97E+04	1.42E+04	6.35E+03	1.53E+03	1.37E+03	1.58E+03	1.05E+03	7.81E+01
2002	7.19E+03	1.26E+04	2.07E+04	8.26E+03	3.30E+03	9.22E+02	7.92E+02	6.44E+02	4.62E+02
2003	3.82E+03	5.89E+03	8.46E+03	1.04E+04	3.71E+03	1.19E+03	3.30E+02	1.66E+02	1.53E+02
2004	5.58E+03	3.13E+03	4.21E+03	5.00E+03	4.37E+03	1.30E+03	3.92E+02	1.10E+02	5.37E+01
2005	7.77E+03	4.57E+03	2.47E+03	2.82E+03	2.95E+03	1.67E+03	3.94E+02	1.03E+02	3.13E+01
2006	1.92E+03	6.36E+03	3.29E+03	1.49E+03	1.51E+03	1.40E+03	6.21E+02	1.38E+02	4.73E+01

Estimated population abundance at 1st Jan 2007

0.00E+00	1.57E+03	4.14E+03	1.64E+03	7.66E+02	6.02E+02	3.75E+02	1.88E+02	4.07E+01

Taper weighted geometric mean of the VPA populations:

1.58E+04	1.35E+04	1.02E+04	6.46E+03	3.57E+03	1.74E+03	7.80E+02	3.09E+02	1.27E+02

Standard error of the weighted Log(VPA populations) :

.6996	.6238	.6088	.5817	.5389	.5577	.6169	.7111	.8243

1

Log catchability residuals.

Fleet : SUMMER SURVEY

Age	1993	1994	1995	1996
1	No data for this fleet at this age			
2	99.99	99.99	99.99	-.53
3	99.99	99.99	99.99	.05
4	99.99	99.99	99.99	.16
5	99.99	99.99	99.99	.69
6	99.99	99.99	99.99	.23
7	99.99	99.99	99.99	.34
8	99.99	99.99	99.99	-.13

Age	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1	No data for this fleet at this age									
2	-.16	-.01	-1.24	-.24	.29	.79	-.37	.41	.43	.63
3	-.30	-.67	.44	-.50	-.01	.52	-.36	.04	.51	.27
4	.27	-.63	-.17	.02	.06	.05	.06	-.14	.28	.03
5	-.04	.27	-.68	-.77	-.09	.14	-.32	.47	.44	-.10
6	-.13	.66	.16	-.58	-.52	-.28	-.66	.33	.74	.05
7	.02	-.32	.57	.07	-.25	-.35	-1.33	.17	.55	.04
8	-.25	.15	.44	-.25	-.05	-.41	-1.02	.25	.56	.09

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	-7.5191	-6.6894	-6.3475	-6.1777	-6.1850	-6.1850	-6.1850
S.E(Log q)	.5901	.4156	.2514	.4637	.4803	.5335	.4411

Table 2.2.7.1.4. (Cont'd)

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,	1.29,	-.817,	7.06,	.46,	11,	.78,	-7.52,
3,	1.08,	-.450,	6.50,	.77,	11,	.47,	-6.69,
4,	.96,	.403,	6.44,	.92,	11,	.25,	-6.35,
5,	.87,	.611,	6.44,	.71,	11,	.42,	-6.18,
6,	.78,	.976,	6.47,	.68,	11,	.37,	-6.19,
7,	.83,	.755,	6.28,	.69,	11,	.45,	-6.23,
8,	1.29,	-1.221,	6.48,	.66,	11,	.55,	-6.24,

1

Fleet : SPRING SURVEY (shift

Age	1993,	1994,	1995,	1996
1 ,	-.13,	-.44,	.17,	-.61
2 ,	-.81,	-.86,	.27,	-.01
3 ,	-.56,	.04,	.09,	.06
4 ,	-.48,	.06,	.62,	.02
5 ,	-.56,	.78,	.38,	-.11
6 ,	-.59,	.82,	.43,	-.15
7 ,	-.38,	.41,	.07,	-.22
8 ,	-4.77,	.69,	.09,	-1.60

Age	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	2005,	2006
1 ,	-.69,	.36,	-.56,	.14,	.06,	-.65,	1.67,	.92,	-.23,	.00
2 ,	-.11,	.45,	.34,	.54,	.77,	-.09,	.14,	.56,	-.75,	-.42
3 ,	-.09,	.17,	.13,	.26,	.35,	.56,	-.41,	.51,	-.75,	-.37
4 ,	.28,	-.13,	-.41,	-.05,	.41,	.15,	-.13,	.44,	-.32,	-.47
5 ,	.28,	.21,	-.53,	-.31,	.09,	.35,	-.36,	.43,	-.47,	-.18
6 ,	-.10,	.19,	.33,	.30,	.05,	-.37,	-.50,	.24,	-.62,	-.02
7 ,	-.29,	-.28,	.07,	-.80,	-.02,	.02,	-.33,	-.73,	-.92,	-.34
8 ,	.80,	-.02,	-1.38,	-1.71,	.01,	-.16,	-.24,	-.83,	-1.20,	.23

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,	-8.2754,	-6.9939,	-6.0729,	-5.8113,	-5.7730,	-5.9418,	-5.9418,	-5.9418,
S.E(Log q),	.6597,	.5396,	.3929,	.3521,	.4179,	.4210,	.4621,	1.6063,

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,	1.27,	-1.092,	7.98,	.57,	14,	.83,	-8.28,
2,	.91,	.499,	7.20,	.71,	14,	.51,	-6.99,
3,	.82,	1.588,	6.61,	.87,	14,	.31,	-6.07,
4,	.80,	2.040,	6.38,	.89,	14,	.25,	-5.81,
5,	.81,	1.333,	6.21,	.80,	14,	.33,	-5.77,
6,	.97,	.128,	5.98,	.61,	14,	.43,	-5.94,
7,	.88,	.849,	6.24,	.80,	14,	.33,	-6.21,
8,	.57,	1.618,	6.12,	.54,	14,	.76,	-6.66,

1

Table 2.2.7.1.4. (Cont'd)

```
 Terminal year survivor and F summaries :

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

 Year class = 2005

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,
Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SUMMER SURVEY       ,         1.,   .000,       .000,    .00,   0,  .000,     .000
 SPRING SURVEY (shift,      1574.,   .683,       .000,    .00,   1, 1.000,     .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,
      1574.,       .68,      .00,    1,    .000,   .000

1
 Age  2   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       ,      7758.,   .616,       .000,    .00,   1,  .317,     .129
 SPRING SURVEY (shift,      2938.,   .432,       .091,    .21,   2,  .645,     .310

   F shrinkage mean  ,      7546.,   2.00,,,,                        .038,     .132

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      4143.,       .35,      .27,    4,    .777,   .229


 Age  3   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       ,      2262.,   .356,       .073,    .21,   2,  .406,     .382
 SPRING SURVEY (shift,      1285.,   .297,       .396,   1.33,   3,  .572,     .599

   F shrinkage mean  ,      2636.,   2.00,,,,                        .022,     .336

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      1642.,       .23,      .23,    6,   1.009,   .496

1
 Age  4   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       ,       920.,   .232,       .150,    .65,   3,  .511,     .398
 SPRING SURVEY (shift,       631.,   .233,       .424,   1.82,   4,  .477,     .539

   F shrinkage mean  ,       698.,   2.00,,,,                        .012,     .498

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
       766.,       .16,      .21,    8,   1.293,   .463
```

Table 2.2.7.1.4. (Cont'd)

```
 Age  5   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       ,       653.,   .214,       .121,    .57,   4,  .486,     .681
 SPRING SURVEY (shift,       555.,   .212,       .170,    .80,   5,  .498,     .765

   F shrinkage mean  ,       675.,   2.00,,,,                        .016,     .664

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
       602.,       .15,      .10,   10,    .644,   .721


1
 Age  6   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       ,       390.,   .212,       .148,    .70,   5,  .464,    1.089
 SPRING SURVEY (shift,       350.,   .208,       .146,    .70,   6,  .510,    1.161

   F shrinkage mean  ,       650.,   2.00,,,,                        .027,     .781

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
       375.,       .15,      .10,   12,    .638,  1.116


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

 Year class = 1999

 Fleet,                  Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                   Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SUMMER SURVEY       ,       251.,   .274,       .132,    .48,   6,  .431,     .823
 SPRING SURVEY (shift,       149.,   .256,       .156,    .61,   7,  .531,    1.147

   F shrinkage mean  ,       187.,   2.00,,,,                        .038,    1.000

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
       188.,       .20,      .12,   14,    .600,   .994


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

 Year class = 1998

 Fleet,                  Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                   Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SUMMER SURVEY       ,        48.,   .306,       .086,    .28,   7,  .619,     .915
 SPRING SURVEY (shift,        28.,   .289,       .210,    .73,   8,  .324,    1.271

   F shrinkage mean  ,        50.,   2.00,,,,                        .056,     .893

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
        41.,       .24,      .11,   16,    .472,  1.022


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

Table 2.2.7.1.4. (Cont'd)

```
 Year class = 1997

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,
Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SUMMER SURVEY       ,        41.,   .319,       .158,     .50,   7,  .646,     .197
 SPRING SURVEY (shift,        19.,   .292,       .194,     .66,   8,  .301,     .391

   F shrinkage mean  ,         6.,   2.00,,,,                          .053,     .873

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
        30.,       .25,      .17,   16,    .690,   .266
```

Table 2.2.7.1.5. Faroe Plateau (sub-division Vb1) COD. Fishing mortality at age.

Run title : COD FAROE PLATEAU (ICES SUBDIVISION Vb1)   COD_ind_Surveys10.txt

At 24/04/2007 20:55

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR,	1961,	1962,	1963,	1964,	1965,	1966,
AGE						
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.3346,	.2701,	.2534,	.1086,	.1209,	.0829,
3,	.5141,	.4982,	.4138,	.2997,	.2518,	.1969,
4,	.4986,	.4838,	.5172,	.4523,	.4498,	.2552,
5,	.5737,	.7076,	.5124,	.5229,	.5622,	.4499,
6,	.4863,	.5569,	.5405,	.5659,	.6604,	.5016,
7,	.9566,	.3662,	.4879,	.6677,	.5305,	.9680,
8,	.8116,	.6826,	.3269,	.3531,	.4345,	.8520,
9,	.6715,	.5641,	.4806,	.5164,	.5318,	.6106,
+gp,	.6715,	.5641,	.4806,	.5164,	.5318,	.6106,
0 FBAR 3- 7,	.6059,	.5226,	.4944,	.5017,	.4909,	.4743,

YEAR,	1967,	1968,	1969,	1970,	1971,	1972,	1973,	1974,	1975,	1976,
AGE										
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.0789,	.1010,	.1099,	.0530,	.0309,	.0464,	.0657,	.0816,	.0774,	.0933,
3,	.2389,	.2318,	.3063,	.2081,	.1337,	.1476,	.2322,	.1568,	.3193,	.1723,
4,	.2687,	.3949,	.3806,	.3654,	.2225,	.2070,	.3048,	.2046,	.4359,	.3665,
5,	.3442,	.5339,	.4180,	.3409,	.3845,	.2497,	.2813,	.2953,	.4134,	.5568,
6,	.5779,	.4472,	.5709,	.3709,	.5572,	.6058,	.2526,	.3797,	.4544,	.5167,
7,	.5203,	.7132,	.5118,	.6559,	.4651,	.4686,	.3722,	.5330,	.3504,	.7619,
8,	1.0438,	.3331,	.8457,	.4208,	.7528,	.2464,	.3259,	.3052,	.4485,	.6429,
9,	.5556,	.4882,	.5499,	.4339,	.4800,	.3578,	.3091,	.3457,	.4235,	.5738,
+gp,	.5556,	.4882,	.5499,	.4339,	.4800,	.3578,	.3091,	.3457,	.4235,	.5738,
0 FBAR 3- 7,	.3900,	.4642,	.4375,	.3882,	.3526,	.3358,	.2886,	.3139,	.3947,	.4749,

1

YEAR,	1977,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,	1986,
AGE										
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.0481,	.0588,	.0433,	.0544,	.0523,	.0586,	.0992,	.1073,	.0658,	.0247,
3,	.3036,	.1896,	.2623,	.2391,	.2877,	.2227,	.4673,	.3712,	.3545,	.3547,
4,	.4748,	.4291,	.4309,	.3695,	.3409,	.3602,	.5585,	.5791,	.5077,	.6229,
5,	.7532,	.4289,	.5049,	.4337,	.4369,	.3887,	.6411,	.6610,	.6136,	.7035,
6,	.7333,	.4851,	.4906,	.5182,	.5644,	.4047,	.7836,	.4534,	.9237,	.8260,
7,	1.1138,	.5968,	.4480,	.4119,	.6940,	.6926,	1.0780,	.4761,	1.1084,	.8404,
8,	.7776,	.5674,	.6903,	.6437,	.5015,	.5526,	.9417,	.4792,	1.3206,	.5411,
9,	.7783,	.5054,	.5170,	.4790,	.5115,	.4834,	.8088,	.5341,	.9045,	.7135,
+gp,	.7783,	.5054,	.5170,	.4790,	.5115,	.4834,	.8088,	.5341,	.9045,	.7135,
0 FBAR 3- 7,	.6757,	.4259,	.4273,	.3945,	.4648,	.4138,	.7057,	.5082,	.7016,	.6695,

YEAR,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,
AGE										
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.0291,	.0670,	.1688,	.0760,	.0323,	.0201,	.0132,	.0255,	.0702,	.0306,
3,	.2210,	.3533,	.4428,	.3371,	.1973,	.0999,	.1019,	.1128,	.1617,	.1927,
4,	.4758,	.5646,	.7623,	.6320,	.4617,	.3219,	.1864,	.1906,	.4647,	.4521,
5,	.4855,	.5499,	.7639,	.7851,	.6017,	.3615,	.2497,	.2494,	.2802,	.8093,
6,	.5563,	.7750,	.9652,	.7027,	.7299,	.6440,	.2133,	.2170,	.3601,	.9055,
7,	.4900,	.8001,	1.0629,	.8412,	.5754,	.8484,	.4491,	.1689,	.3278,	1.1354,
8,	.6228,	.8655,	1.1069,	1.1254,	.7128,	.4379,	.5241,	.3303,	.2528,	.8921,
9,	.5303,	.7179,	.9425,	.8257,	.6218,	.5270,	.3265,	.8831,	.7752,	1.1931,
+gp,	.5303,	.7179,	.9425,	.8257,	.6218,	.5270,	.3265,	.8831,	.7752,	1.1931,
0 FBAR 3- 7,	.4457,	.6086,	.7994,	.6596,	.5132,	.4552,	.2401,	.1877,	.3189,	.6990,

YEAR,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	2005,	2006,	FBAR **-**
AGE											
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.0348,	.0887,	.0958,	.1247,	.1575,	.2010,	.1361,	.0363,	.1273,	.2289,	.1309,
3,	.1488,	.1758,	.2840,	.3190,	.3447,	.4914,	.3259,	.2009,	.3078,	.4956,	.3348,
4,	.4115,	.2730,	.2901,	.3796,	.4552,	.6000,	.6661,	.3285,	.4215,	.4626,	.4042,
5,	.8330,	.6468,	.3181,	.2474,	.3075,	.8224,	.8520,	.7632,	.5463,	.7214,	.6770,
6,	1.0458,	1.0523,	.6556,	.3264,	.3501,	.8280,	.9068,	.9911,	.7881,	1.1163,	.9652,
7,	1.4004,	.7886,	1.0606,	.5299,	.6976,	1.3614,	.8984,	1.1363,	.8487,	.9943,	.9931,
8,	1.3314,	1.1694,	.7854,	.7904,	.6180,	1.2341,	.9290,	1.0581,	.5790,	1.0222,	.8864,
9,	.9423,	.8222,	.4954,	.1899,	.7117,	1.1818,	1.7613,	1.9922,	1.1134,	.2661,	1.1239,
+gp,	.9423,	.8222,	.4954,	.1899,	.7117,	1.1818,	1.7613,	1.9922,	1.1134,	.2661,	
0 FBAR 3- 7,	.7679,	.5873,	.5217,	.3605,	.4310,	.8206,	.7298,	.6840,	.5825,	.7580,	

1

Table 2.2.7.1.6. Faroe Plateau (sub-division Vb1) COD. Stock number at age.

Run title : COD FAROE PLATEAU (ICES SUBDIVISION Vb1) COD_ind_Surveys10.txt

At 24/04/2007 20:55

Terminal Fs derived using XSA (With F shrinkage)

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

YEAR,	1961,	1962,	1963,	1964,	1965,	1966,
AGE						
1,	25227,	24782,	26668,	10100,	22676,	28643,
2,	12019,	20654,	20290,	21834,	8269,	18566,
3,	7385,	7042,	12907,	12893,	16037,	5999,
4,	3747,	3616,	3503,	6986,	7823,	10207,
5,	2699,	1863,	1825,	1710,	3639,	4085,
6,	666,	1245,	752,	895,	830,	1698,
7,	668,	335,	584,	358,	416,	351,
8,	155,	210,	190,	294,	151,	200,
9,	66,	56,	87,	112,	169,	80,
+gp,	0,	0,	0,	0,	0,	0,
0 TOTAL,	52630,	59804,	66807,	55183,	60009,	69829,

YEAR,	1967,	1968,	1969,	1970,	1971,	1972,	1973,	1974,	1975,	1976,
AGE										
1,	21475,	11390,	10514,	14569,	26041,	15356,	37229,	46803,	22687,	12208,
2,	23451,	17582,	9325,	8608,	11928,	21320,	12573,	30480,	38319,	18575,
3,	13990,	17744,	13012,	6840,	6684,	9469,	16664,	9639,	23000,	29035,
4,	4034,	9020,	11522,	7843,	4548,	4788,	6689,	10816,	6747,	13683,
5,	6475,	2525,	4976,	6447,	4456,	2981,	3187,	4037,	7217,	3572,
6,	2133,	3757,	1212,	2682,	3754,	2483,	1901,	1969,	2460,	3908,
7,	842,	980,	1967,	561,	1516,	1760,	1109,	1209,	1103,	1279,
8,	109,	410,	393,	965,	238,	779,	902,	626,	581,	636,
9,	70,	31,	240,	138,	519,	92,	499,	533,	378,	304,
+gp,	0,	0,	0,	0,	0,	0,	400,	342,	476,	466,
0 TOTAL,	72579,	63439,	53161,	48654,	59683,	59029,	81153,	106456,	102968,	83665,

YEAR,	1977,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,	1986,
AGE										
1,	13128,	18318,	28803,	17100,	27026,	30727,	58326,	21146,	11608,	12102,
2,	9995,	10748,	14997,	23582,	14000,	22127,	25157,	47753,	17313,	9503,
3,	13853,	7799,	8298,	11759,	18286,	10878,	17085,	18652,	35119,	13272,
4,	20010,	8372,	5282,	5226,	7579,	11228,	7128,	8767,	10535,	20172,
5,	7765,	10190,	4463,	2811,	2957,	4413,	6412,	3339,	4022,	5192,
6,	1676,	2993,	5433,	2206,	1491,	1564,	2449,	2765,	1411,	1783,
7,	1909,	659,	1509,	2723,	1076,	694,	854,	916,	1439,	459,
8,	489,	513,	297,	789,	1477,	440,	284,	238,	466,	389,
9,	274,	184,	238,	122,	339,	732,	207,	91,	121,	102,
+gp,	18,	154,	103,	52,	150,	348,	200,	174,	146,	81,
0 TOTAL,	69116,	59930,	69423,	66369,	74382,	83151,	118104,	103841,	82180,	63055,

YEAR,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,
AGE										
1,	10599,	19436,	4481,	8151,	13923,	12341,	30765,	52100,	15711,	7887,
2,	9909,	8678,	15913,	3669,	6674,	11399,	10104,	25188,	42656,	12863,
3,	7591,	7880,	6644,	11004,	2784,	5290,	9147,	8164,	20104,	32557,
4,	7621,	4982,	4531,	3494,	6432,	1871,	3920,	6763,	5971,	14002,
5,	8859,	3877,	2319,	1731,	1520,	3318,	1110,	2663,	4577,	3072,
6,	2103,	4463,	1832,	885,	646,	682,	1893,	708,	1699,	2831,
7,	639,	987,	1683,	571,	359,	255,	293,	1252,	467,	971,
8,	162,	321,	363,	476,	202,	165,	89,	153,	866,	275,
9,	185,	71,	110,	98,	127,	81,	87,	43,	90,	550,
+gp,	69,	53,	16,	50,	57,	91,	98,	30,	99,	73,
0 TOTAL,	47738,	50749,	37893,	30129,	32722,	35493,	57507,	97064,	92239,	75082,

YEAR,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	2005,	2006,	2007,	GMST 61-**	AMST 61-**
AGE													
1,	7236,	17518,	24080,	36230,	15422,	7193,	3820,	5578,	7771,	1923,	0,	16838,	20162,
2,	6458,	5925,	14343,	19715,	29662,	12627,	5889,	3128,	4567,	6363,	1574,	14092,	16677,
3,	10214,	5106,	4439,	10670,	14249,	20746,	8456,	4208,	2469,	3292,	4143,	10818,	12559,
4,	21983,	7206,	3506,	2736,	6350,	8265,	10391,	4998,	2818,	1486,	1642,	6804,	7838,
5,	7294,	11927,	4490,	2148,	1532,	3298,	3714,	4370,	2946,	1514,	766,	3660,	4206,
6,	1120,	2596,	5114,	2675,	1373,	922,	1186,	1297,	1668,	1397,	602,	1754,	2049,
7,	937,	322,	742,	2174,	1580,	792,	330,	392,	394,	621,	375,	797,	955,
8,	255,	189,	120,	210,	1048,	644,	166,	110,	103,	138,	188,	323,	410,
9,	92,	55,	48,	45,	78,	462,	153,	54,	31,	47,	41,	134,	187,
+gp,	214,	49,	20,	6,	13,	11,	26,	46,	48,	14,	39,		
0 TOTAL,	55804,	50893,	56902,	76609,	71308,	54960,	34132,	24180,	22817,	16795,	9370,		

1

Table 2.2.7.1.7. 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	110713	83547	22228	0.2661	0.2886
1974	30480	139266	98434	24581	0.2497	0.3139
1975	38319	153663	109565	36775	0.3356	0.3947
1976	18575	161260	123077	39799	0.3234	0.4749
1977	9995	136211	112057	34927	0.3117	0.6757
1978	10748	96227	78497	26585	0.3387	0.4259
1979	14997	85112	66722	23112	0.3464	0.4273
1980	23582	85037	58886	20513	0.3484	0.3945
1981	14000	88410	63560	22963	0.3613	0.4648
1982	22127	98960	67031	21489	0.3206	0.4138
1983	25157	123245	78539	38133	0.4855	0.7057
1984	47753	152130	96760	36979	0.3822	0.5082
1985	17313	131202	84766	39484	0.4658	0.7016
1986	9503	99223	73661	34595	0.4697	0.6695
1987	9909	78302	62191	21391	0.344	0.4457
1988	8678	66064	52065	23182	0.4452	0.6086
1989	15913	58647	38299	22068	0.5762	0.7994
1990	3669	37912	28971	13487	0.4655	0.6596
1991	6674	28554	20950	8750	0.4177	0.5132
1992	11399	35557	20599	6396	0.3105	0.4552
1993	10104	50886	32887	6107	0.1857	0.2401
1994	25188	83727	42317	9046	0.2138	0.1877
1995	42656	144096	54005	23045	0.4267	0.3189
1996	12863	142249	84967	40422	0.4757	0.699
1997	6458	96827	81545	34304	0.4207	0.7679
1998	5925	66116	55757	24005	0.4305	0.5873
1999	14343	64951	44941	18306	0.4073	0.5217
2000	19715	91053	46108	21033	0.4562	0.3605
2001	29662	109873	59005	28183	0.4776	0.431
2002	12627	97626	55907	38486	0.6884	0.8206
2003	5889	59413	40185	24501	0.6097	0.7298
2004	3128	35438	26316	13215	0.5022	0.684
2005	4567	28514	21843	9906	0.4535	0.5825
2006	6363	25436	17878	10446	0.5843	0.758
Arith. Mean	19496	88937	61655	23929	0.4021	0.5106
0 Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

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

Age	Stock size 2007	Source
2	4987	Average of R in 2003-2006
3	4143	XSA-output
4	1642	XSA-output
5	766	XSA-output
6	602	XSA-output
7	375	XSA-output
8	188	XSA-output
9	41	XSA-output
10+	39	XSA-output

	Recr.	Source
YC2004	6363	XSA-output
YC2005	4987	Average of R in 2003-2006
YC2006	4987	Average of R in 2003-2006
YC2007	4987	Average of R in 2003-2006

	Maturity			Exploitation pattern (rescaled to 2006 level)			Weights		
	Observed	Av. 05-07	Av. 05-07	Av. 04-06	Av. 04-06	Av. 04-06		As 2007	As 2007
Age	2007	2008	2009	2007	2008	2009	2007	2008	2009
2	0	0.03	0.03	0.1470	0.1470	0.1470	1.016	1.016	1.016
3	0.47	0.57	0.57	0.3760	0.3760	0.3760	1.386	1.386	1.386
4	0.78	0.83	0.83	0.4540	0.4540	0.4540	2.088	2.088	2.088
5	0.91	0.94	0.94	0.7604	0.7604	0.7604	2.759	2.759	2.759
6	0.99	0.99	0.99	1.0841	1.0841	1.0841	3.624	3.624	3.624
7	0.97	0.96	0.96	1.1155	1.1155	1.1155	4.477	4.477	4.477
8	1	1	1	0.9957	0.9957	0.9957	5.158	5.158	5.158
9	1	1	1	1.2624	1.2624	1.2624	7.378	7.378	7.378
10+	1	1	1	1.2624	1.2624	1.2624	10.515	10.515	10.515

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

MFDP version 1
Run: Man2
Index file 26/4-2007
Time and date: 13:34 27/04/2007
Fbar age range: 3-7

2007

Biomass	SSB	FMult	FBar	Landings
21894	12767	1.0000	0.7580	7855

2008					**2009**	
Biomass	**SSB**	**FMult**	**FBar**	**Landings**	**Biomass**	**SSB**
20113	12089	0.0000	0.0000	0	27581	18825
.	12089	0.0750	0.0569	654	26792	18106
.	12089	0.1500	0.1137	1276	26042	17424
.	12089	0.2250	0.1706	1868	25328	16777
.	12089	0.3000	0.2274	2432	24647	16162
.	12089	0.3750	0.2843	2970	23999	15578
.	12089	0.4500	0.3411	3484	23381	15022
.	12089	0.5250	0.3980	3974	22791	14493
.	12089	0.6000	0.4548	4442	22228	13989
.	12089	0.6750	0.5117	4890	21690	13509
.	12089	0.7500	0.5685	5318	21176	13051
.	12089	0.8250	0.6254	5728	20684	12615
.	12089	0.9000	0.6822	6120	20214	12198
.	12089	0.9750	0.7391	6496	19763	11800
.	12089	1.0500	0.7959	6857	19331	11420
.	12089	1.1250	0.8528	7203	18917	11056
.	12089	1.2000	0.9096	7535	18520	10708
.	12089	1.2750	0.9665	7854	18139	10375
.	12089	1.3500	1.0233	8160	17773	10056
.	12089	1.4250	1.0802	8455	17422	9751
.	12089	1.5000	1.1370	8739	17084	9458

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).

	Exploit. pattern	Weights	Prop. mature
Age	Average 2000-2006 Not rescaled	Average 2000-2006	Average 2000-2006
2	0.1445	1.0399	0.03
3	0.355	1.6011	0.47
4	0.4734	2.3733	0.80
5	0.6086	3.0959	0.94
6	0.7581	3.8468	0.97
7	0.9238	4.8231	0.97
8	0.8901	6.6631	1.00
9	1.0309	8.2899	1.00
10+	1.0309	10.1071	1.00

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: YLD2
Time and date: 19:33 01/05/2007
Yield per results

FMult	Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNosJan	SSBJan	SpwnNosSpwn	SSBSpwn
0.0000	0.0000	0.0000	0.0000	5.5167	24.4516	3.9137	22.1958	3.9137	22.1958
0.0750	0.0468	0.1731	0.8997	4.6550	17.2517	3.0680	15.0394	3.0680	15.0394
0.1500	0.0936	0.2771	1.2598	4.1384	13.3461	2.5664	11.1739	2.5664	11.1739
0.2250	0.1404	0.3483	1.4106	3.7853	10.9322	2.2274	8.7971	2.2274	8.7971
0.3000	0.1871	0.4011	1.4702	3.5237	9.3097	1.9793	7.2091	1.9793	7.2091
0.3750	0.2339	0.4425	1.4876	3.3193	8.1521	1.7876	6.0837	1.7876	6.0837
0.4500	0.2807	0.4762	1.4852	3.1534	7.2882	1.6338	5.2497	1.6338	5.2497
0.5250	0.3275	0.5043	1.4737	3.0150	6.6201	1.5069	4.6098	1.5069	4.6098
0.6000	0.3743	0.5284	1.4582	2.8969	6.0884	1.3999	4.1046	1.3999	4.1046
0.6750	0.4211	0.5493	1.4416	2.7945	5.6551	1.3080	3.6962	1.3080	3.6962
0.7500	0.4678	0.5676	1.4250	2.7045	5.2949	1.2282	3.3596	1.2282	3.3596
0.8250	0.5146	0.5840	1.4090	2.6245	4.9904	1.1579	3.0774	1.1579	3.0774
0.9000	0.5614	0.5987	1.3939	2.5527	4.7292	1.0955	2.8373	1.0955	2.8373
0.9750	0.6082	0.6121	1.3797	2.4879	4.5024	1.0396	2.6307	1.0396	2.6307
1.0500	0.6550	0.6242	1.3665	2.4288	4.3033	0.9892	2.4508	0.9892	2.4508
1.1250	0.7018	0.6354	1.3541	2.3747	4.1270	0.9435	2.2929	0.9435	2.2929
1.2000	0.7485	0.6456	1.3426	2.3249	3.9695	0.9018	2.1529	0.9018	2.1529
1.2750	0.7953	0.6552	1.3317	2.2789	3.8279	0.8637	2.0281	0.8637	2.0281
1.3500	0.8421	0.6640	1.3215	2.2362	3.6997	0.8286	1.9160	0.8286	1.9160
1.4250	0.8889	0.6723	1.3118	2.1964	3.5830	0.7961	1.8148	0.7961	1.8148
1.5000	0.9357	0.6800	1.3027	2.1593	3.4762	0.7661	1.7230	0.7661	1.7230

Reference point	F multiplier	Absolute F
Fbar(3-7)	1.0000	0.6238
FMax	0.3973	0.2478
F0.1	0.1903	0.1187
F35%SPR	0.2703	0.1686
Flow	0.162	0.101
Fmed	0.5645	0.3521
Fhigh	1.3543	0.8448

Weights in kilograms

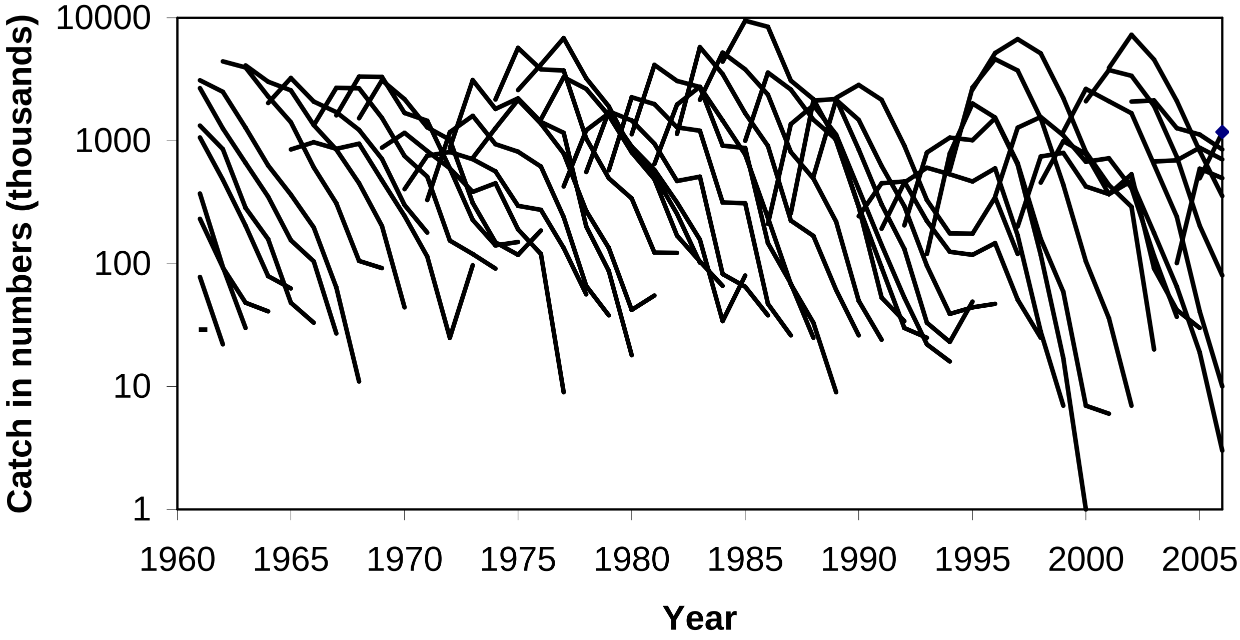


Figure 2.2.3.1. Faroe Plateau (sub-division VB1) COD. Catch in numbers.

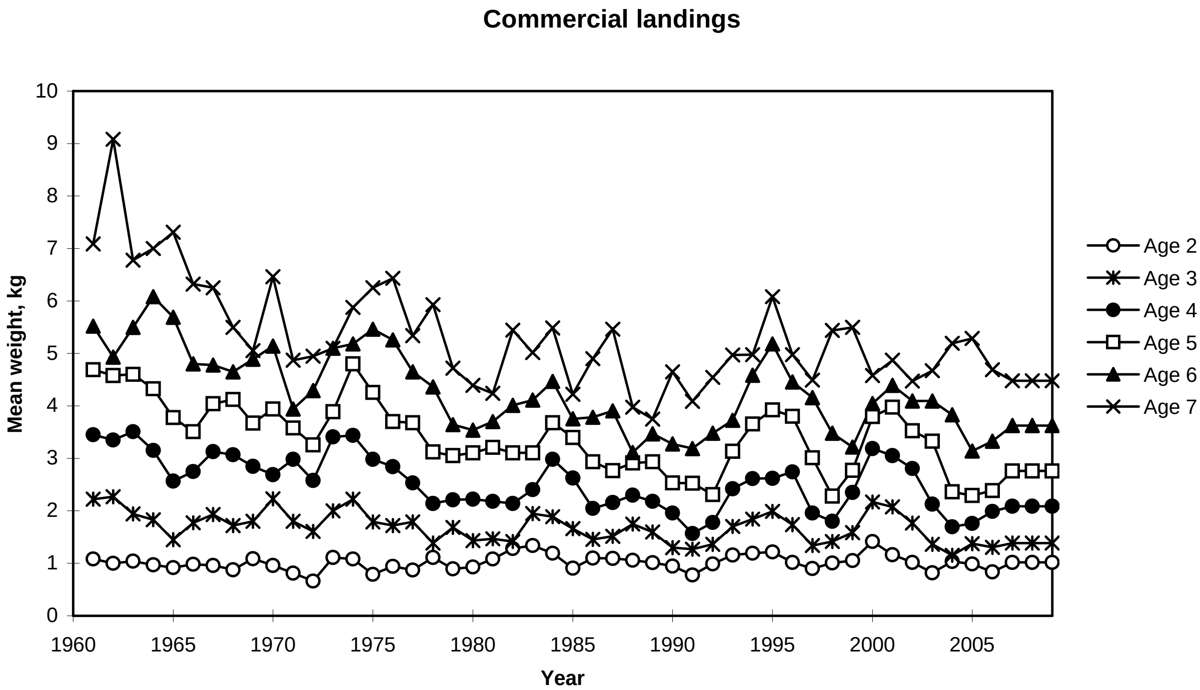


Figure 2.2.4.1. Faroe Plateau (sub-division VB1) COD. Mean weight at age 1961-2006. The estimated weights in 2007 are also shown. The weights in 2008 and 2009 are set to the 2007 value.

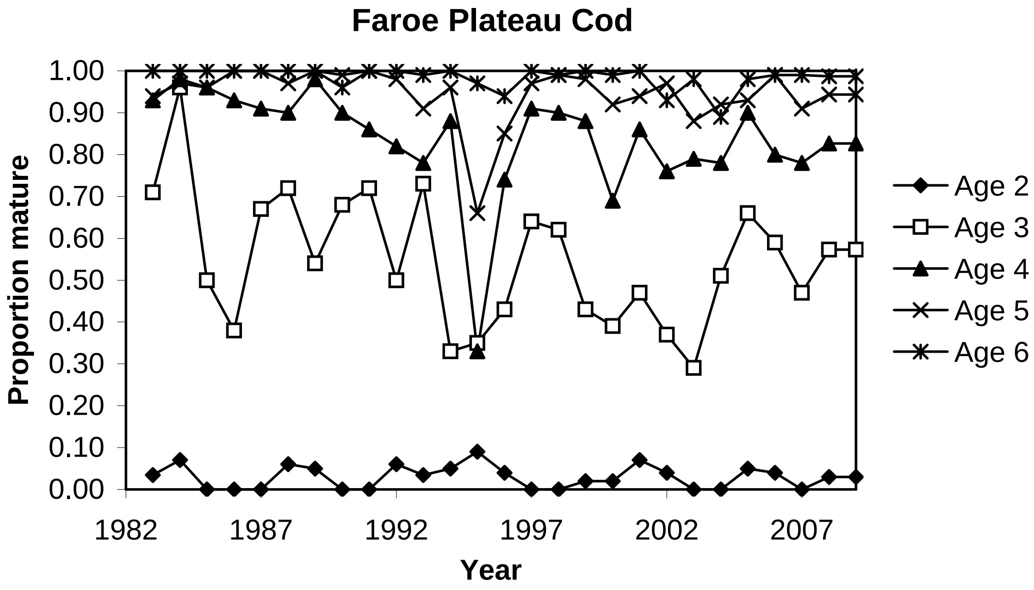


Figure 2.2.5.1. Faroe Plateau (sub-division VB1) COD. Proportion mature at age as observed in the spring groundfish survey. The values in 2008 and 2009 are estimated as the average of the 2005-2007 values.

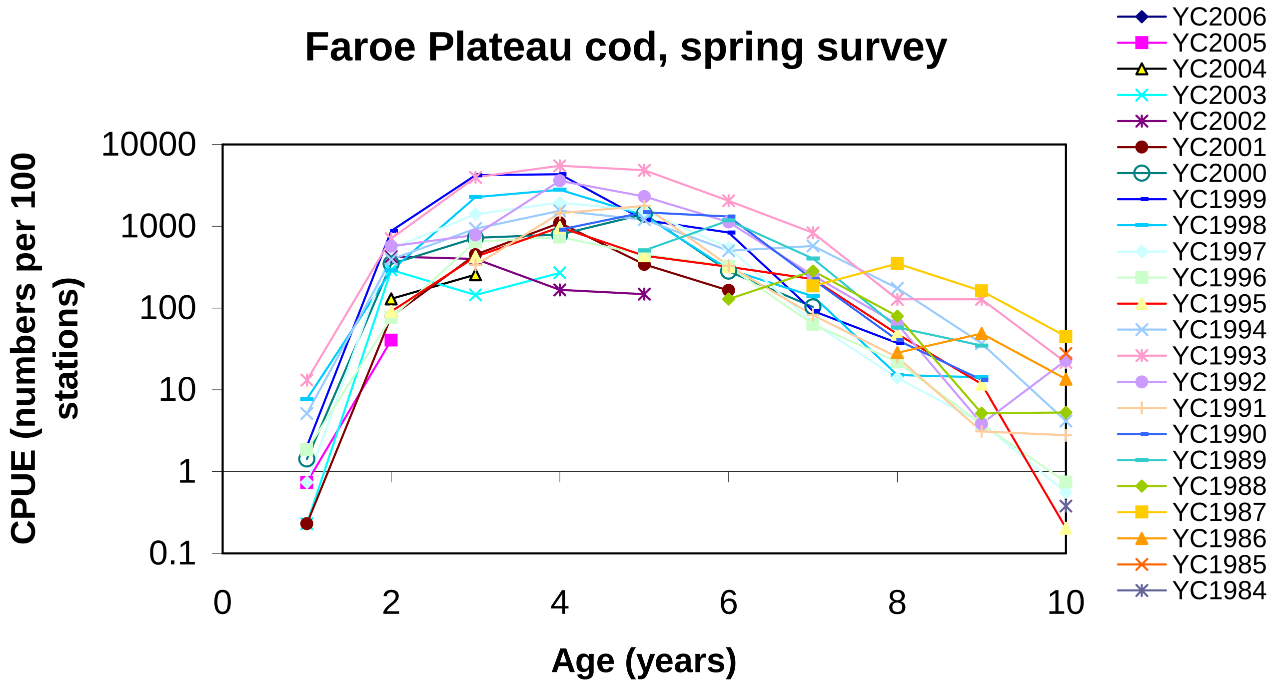


Figure 2.2.6.1. Faroe Plateau (sub-division VB1) COD. Catch curves from the spring groundfish survey.

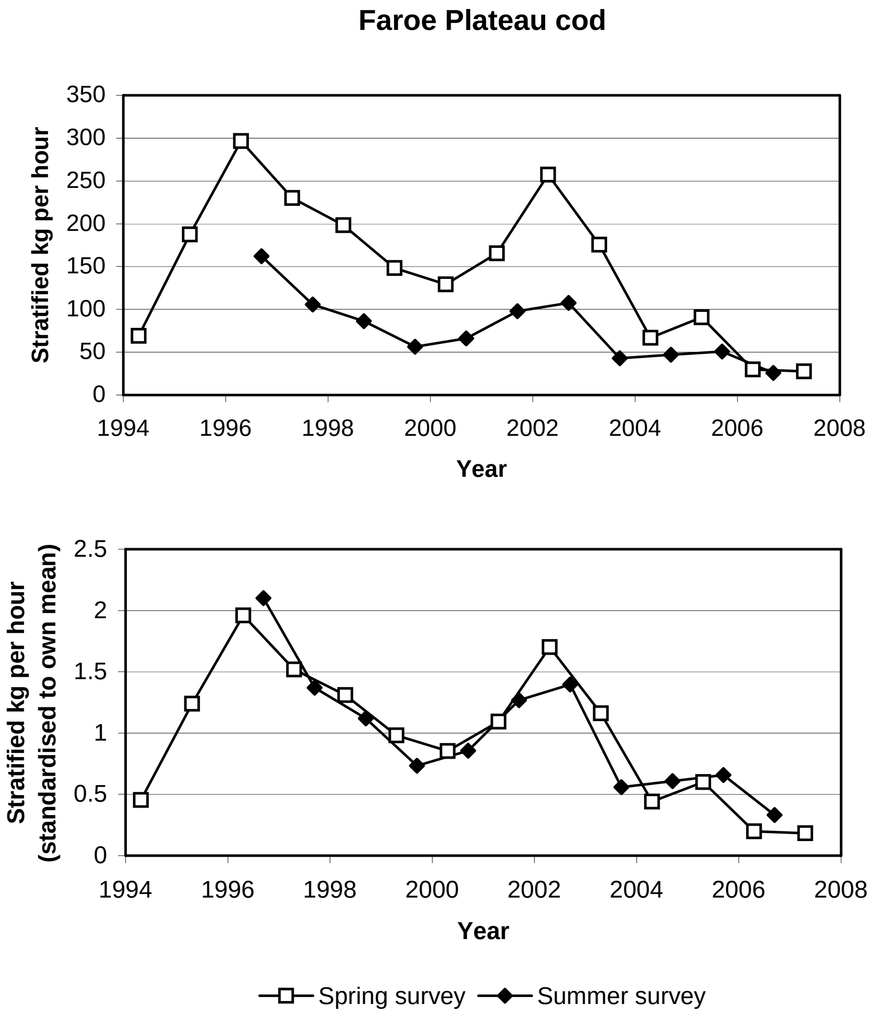


Figure 2.2.6.2. Faroe Plateau (sub-division VB1) COD. Stratified kg/hour in the spring and summer surveys.

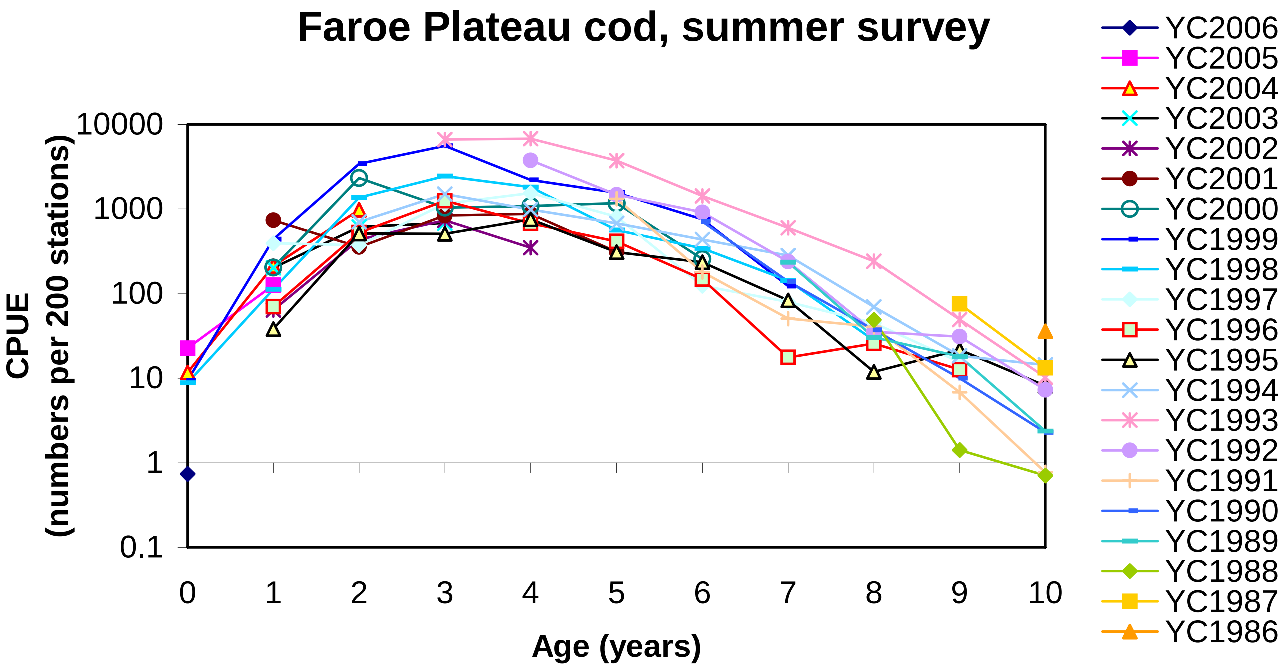


Figure 2.2.6.3. Faroe Plateau (sub-division VB1) COD. Catch curves from the summer groundfish survey.

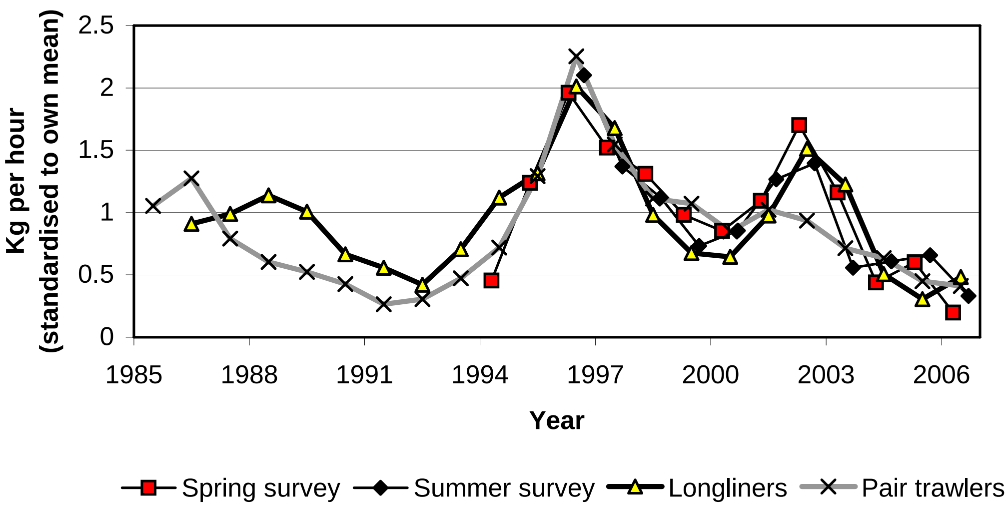


Figure 2.2.7.1.1. Faroe Plateau (sub-division VB1) COD. Standardised catch per unit effort for pair trawlers and longliners. The two surveys are shown as well.

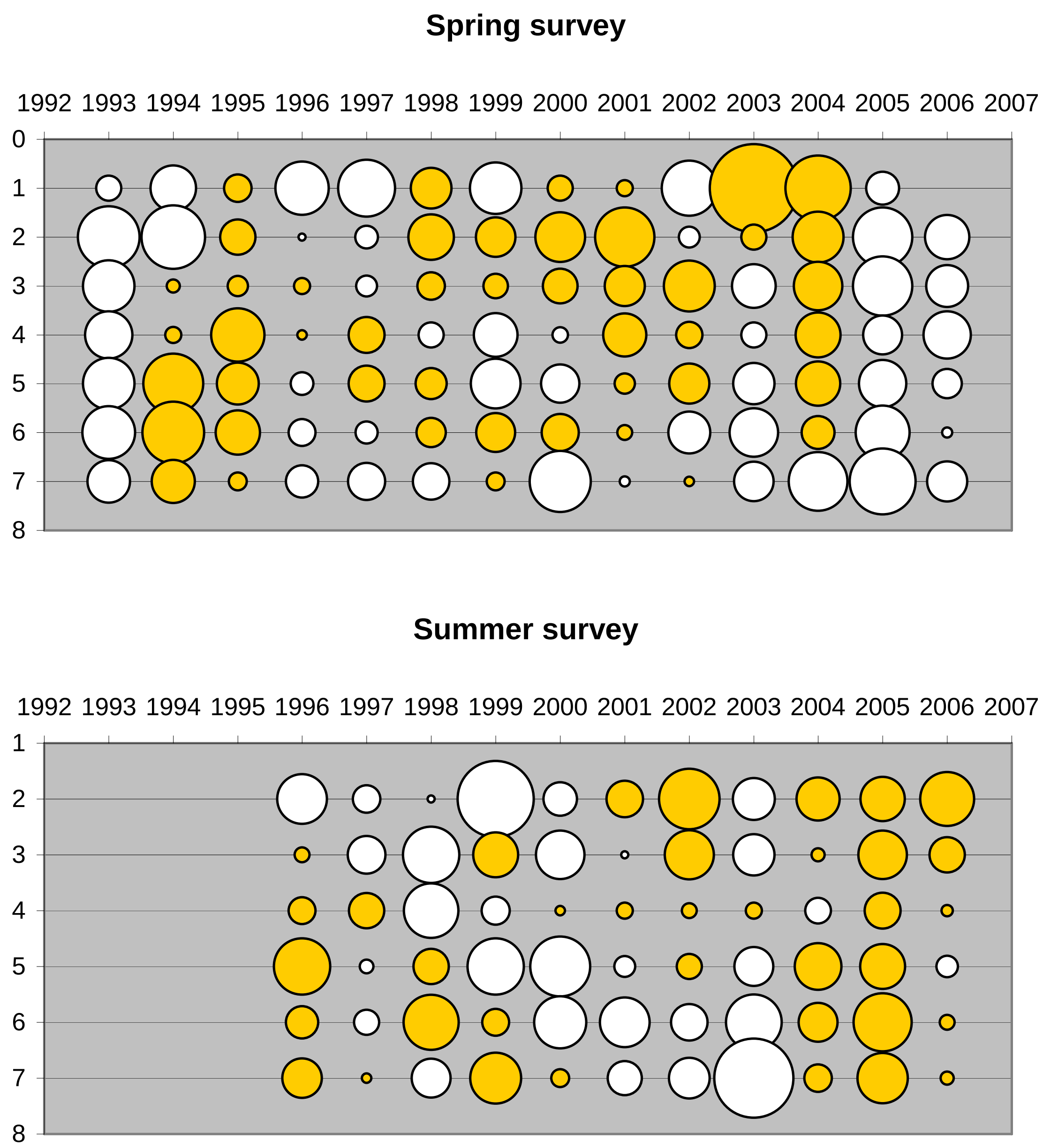


Figure 2.2.7.1.2. Faroe Plateau (sub-division VB1) COD. Log catchability residuals for the spring and summer survey. The residuals for age 8 are not presented because some values were off scale. White bubbles indicate negative residuals.

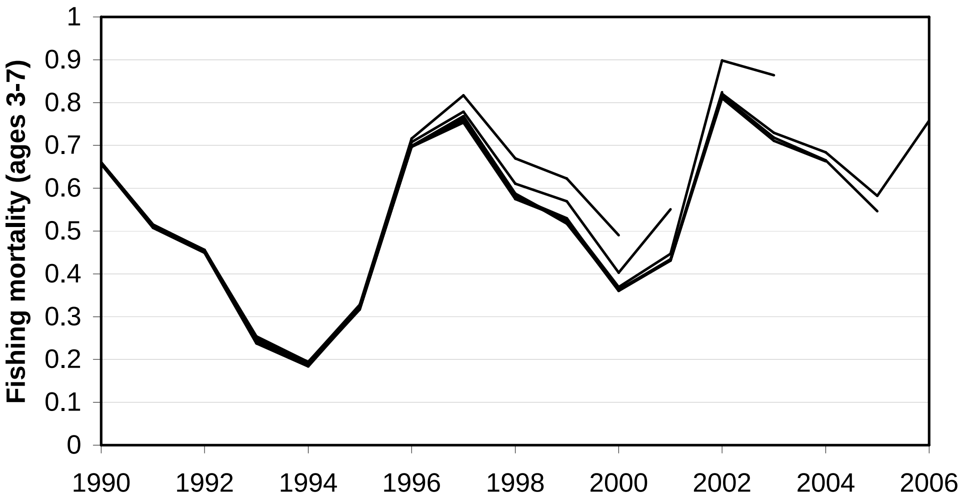


Figure 2.2.7.1.3. Faroe Plateau (sub-division VB1) COD. Results from the XSA retrospective analysis.

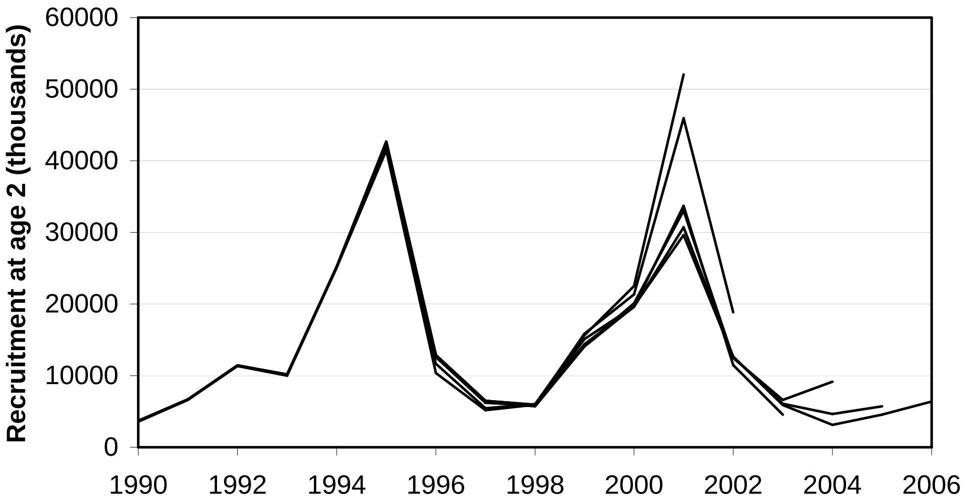


Figure 2.2.7.1.3. Faroe Plateau (sub-division VB1) COD. Results from the XSA retrospective analysis. Continued.

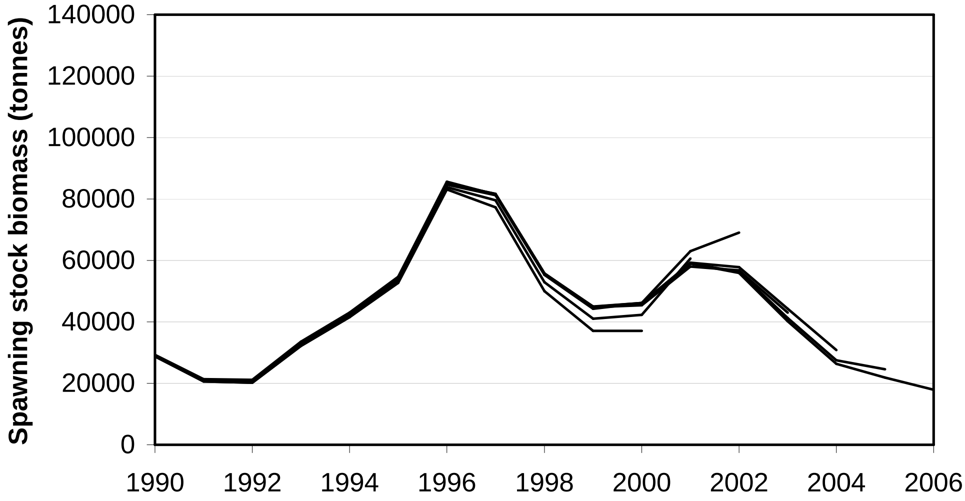


Figure 2.2.7.1.3. Faroe Plateau (sub-division VB1) COD. Results from the XSA retrospective analysis. Continued.

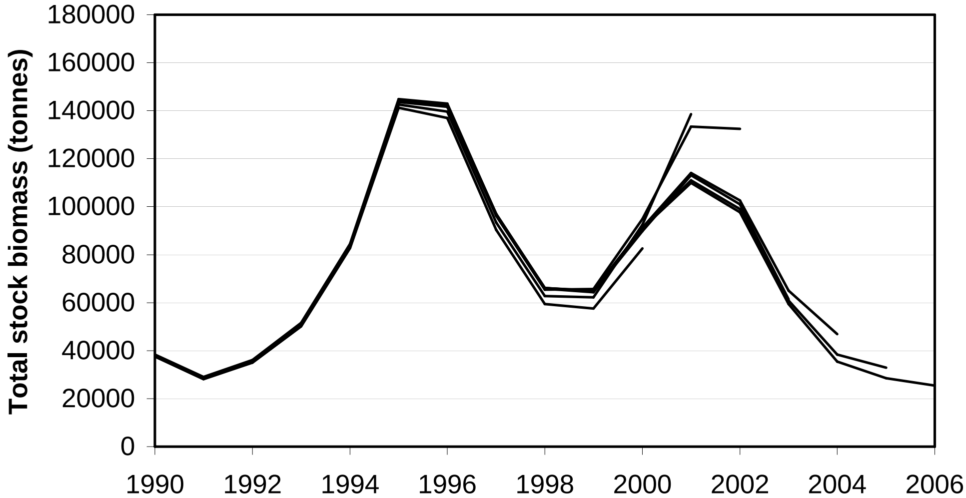


Figure 2.2.7.1.3. Faroe Plateau (sub-division VB1) COD. Results from the XSA retrospective analysis. Continued.

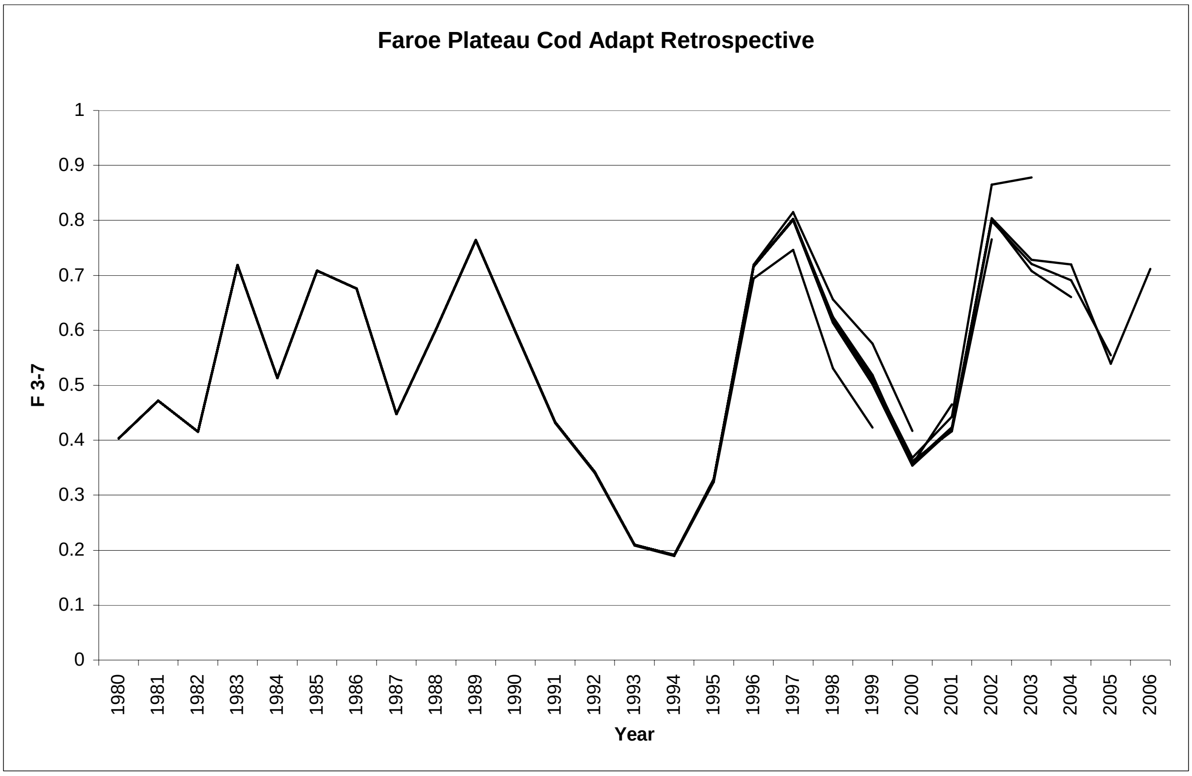


Figure 2.2.7.1.4. Retrospective pattern from the ADAPT calibrated with the summer and the spring surveys ages 2 to 8.

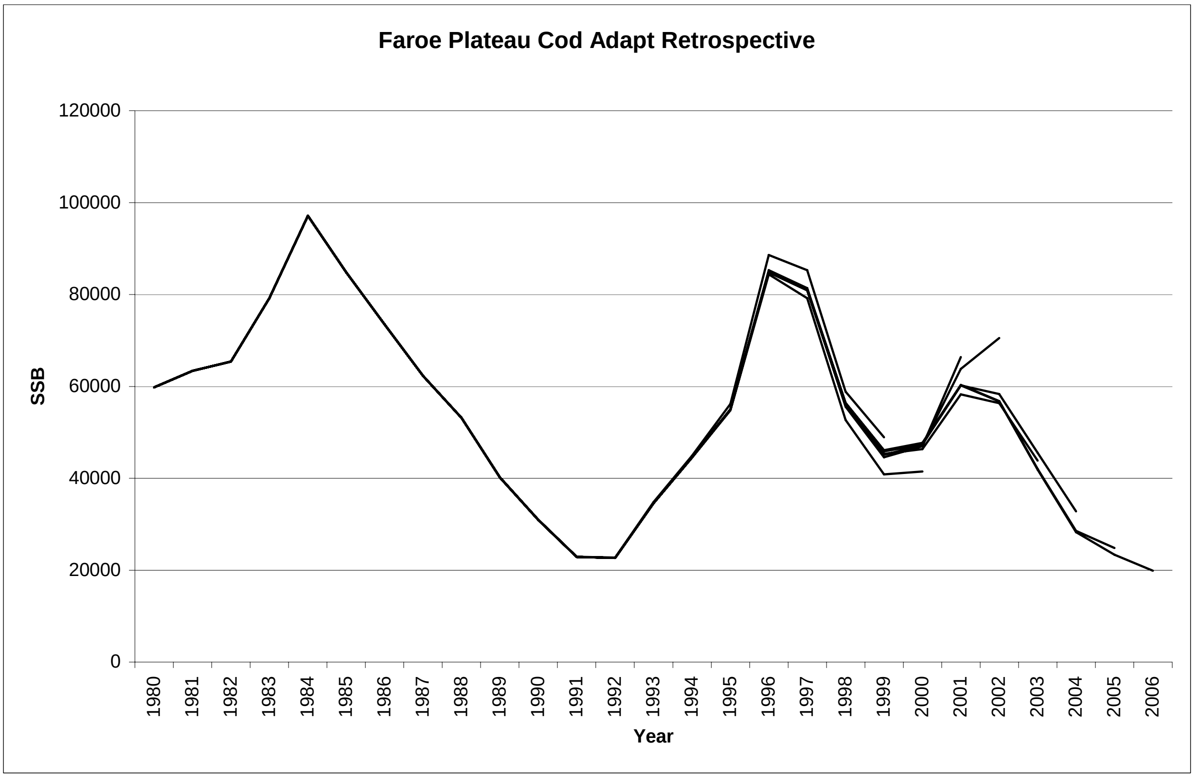


Figure 2.2.7.1.4. Retrospective pattern from the ADAPT calibrated with the summer and the spring surveys ages 2 to 8. Continued.

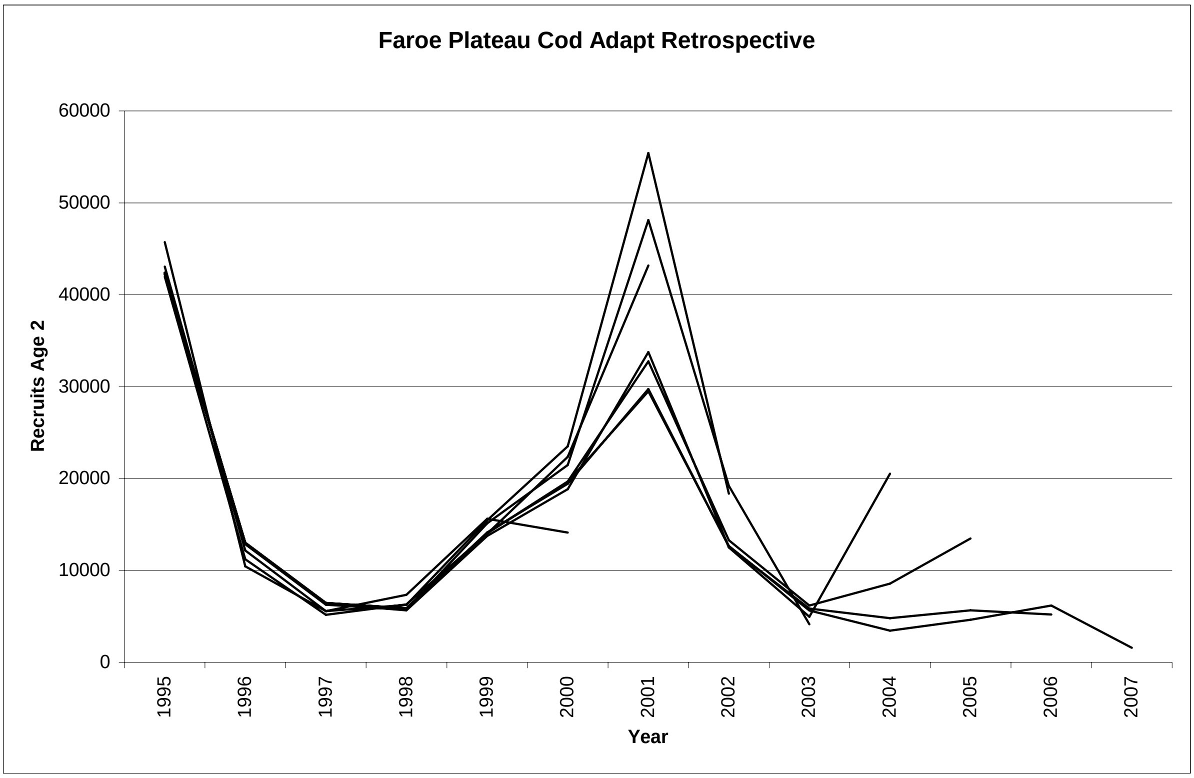


Figure 2.2.7.1.4. Retrospective pattern from the ADAPT calibrated with the summer and the spring surveys ages 2 to 8. Continued.

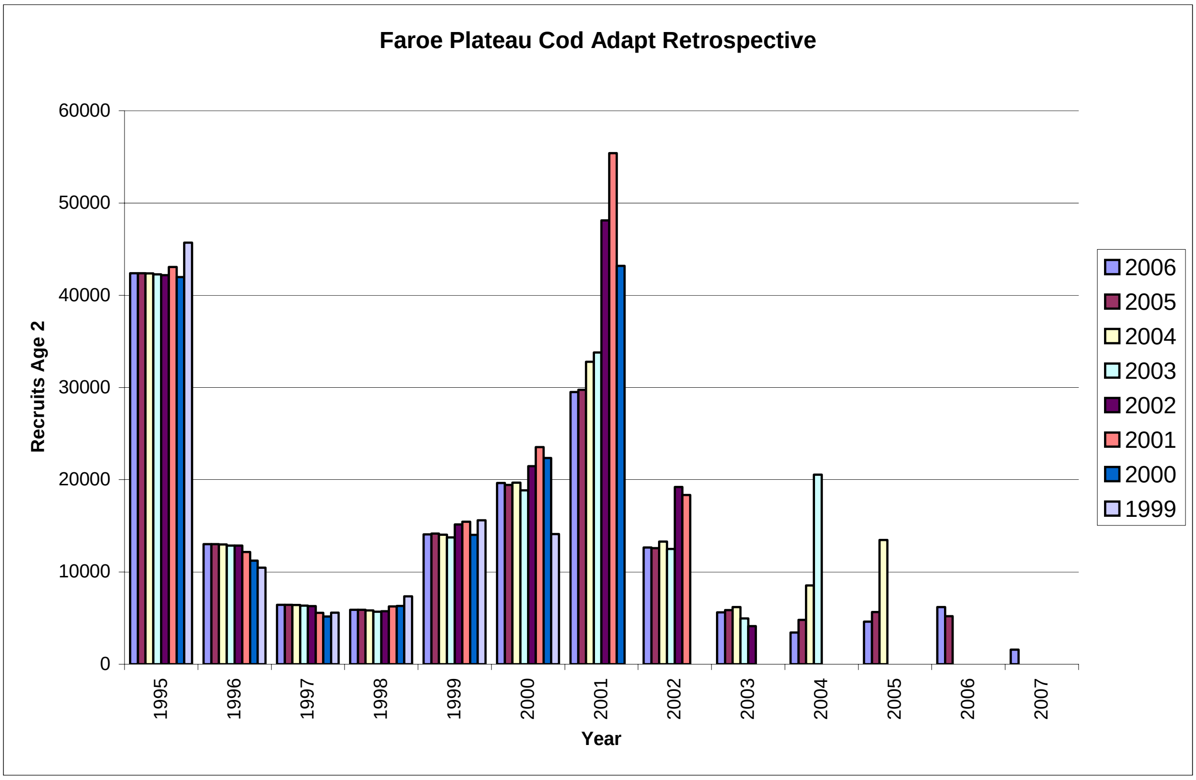
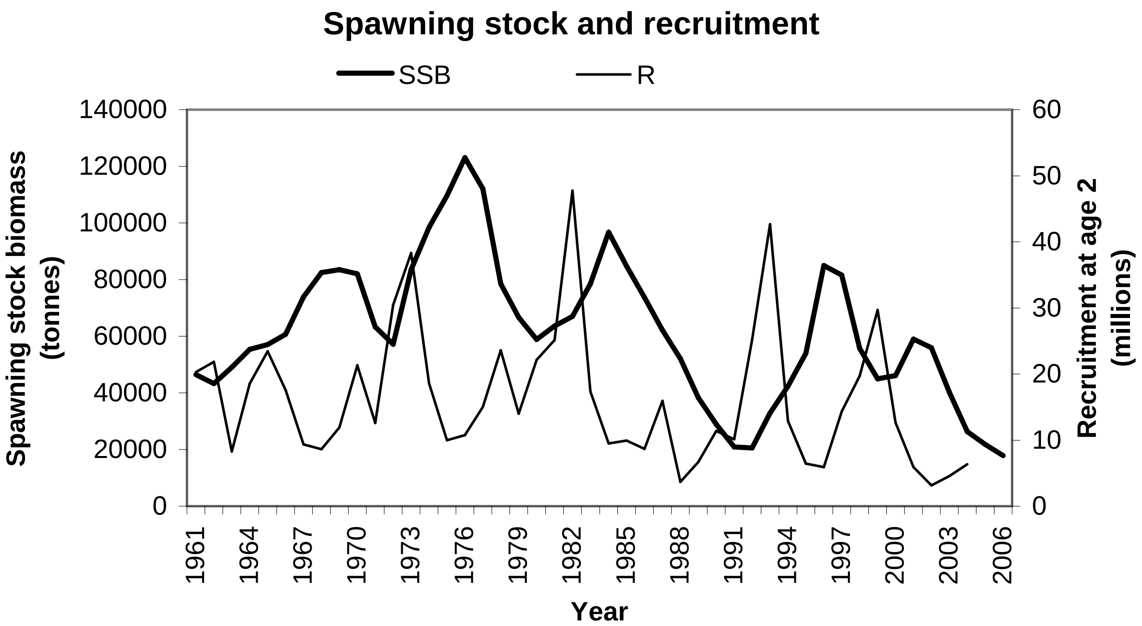


Figure 2.2.7.1.4. Retrospective pattern from the ADAPT calibrated with the summer and the spring surveys ages 2 to 8. The figure should be read from right to left for each year to get the impression of how the perception of recruitment has changed with time. Continued.



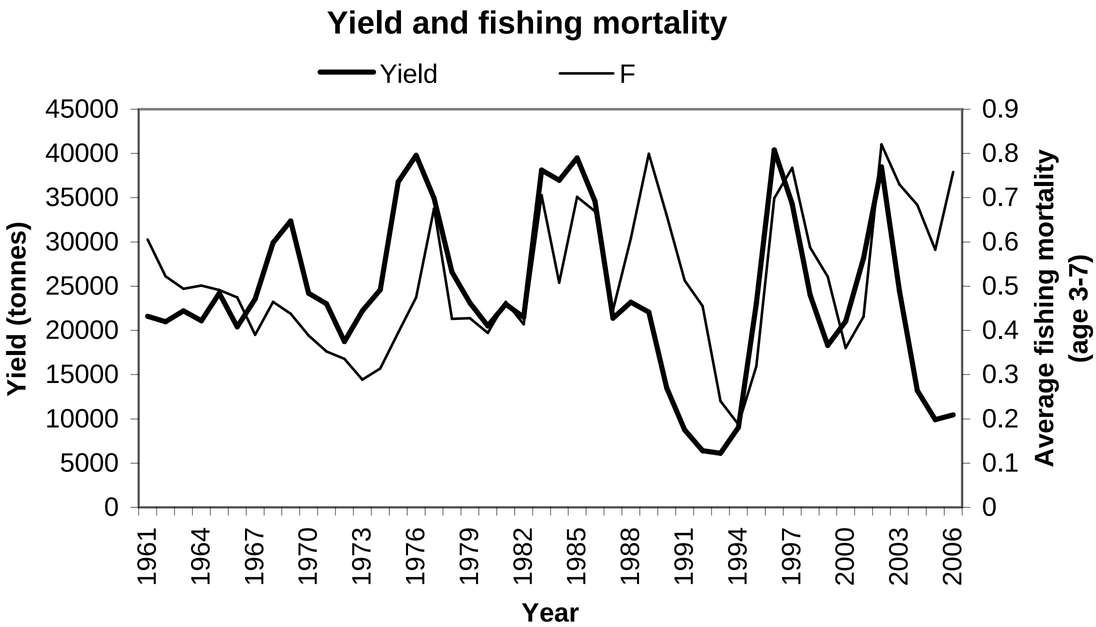


Figure 2.2.7.1.5. Faroe Plateau (sub-division VB1) COD. Yield and fishing versus year. Spawning stock biomass (SSB) and recruitment (year class) versus year.

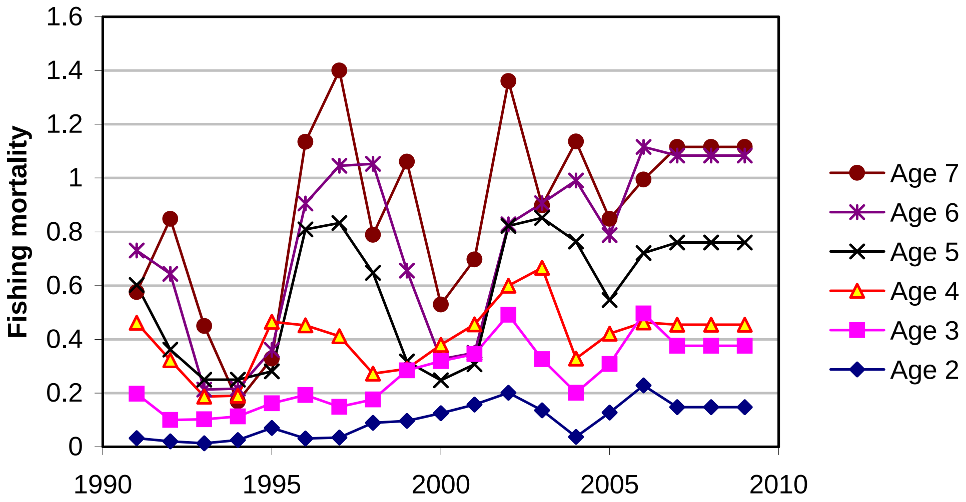


Figure 2.2.7.1.6. Faroe Plateau (sub-division VB1) COD. Fishing mortalities by age. The F-values in 2007-2009 are set to the average values in 2004-2006 rescaled to the 2006 level.

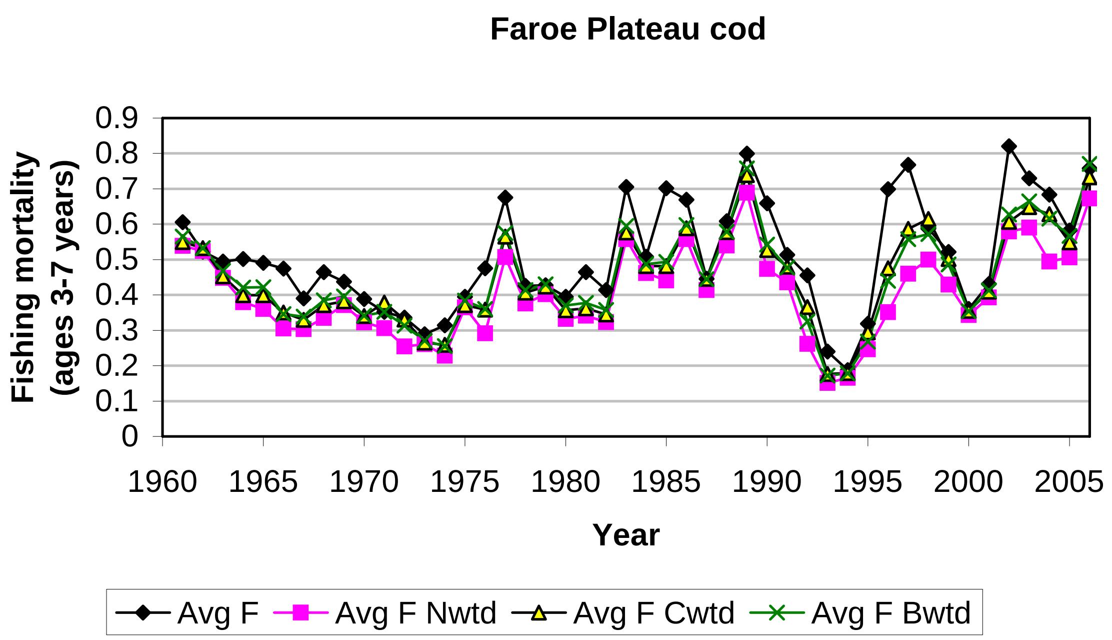


Figure 2.2.7.1.7. Faroe Plateau (sub-division VB1) COD. Different measures of fishing mortality: straight arithmetic average (Avg F), weighted by stock numbers (Nwtd), weighted by stock biomass (Bwtd) or weighted by catch (Cwtd).

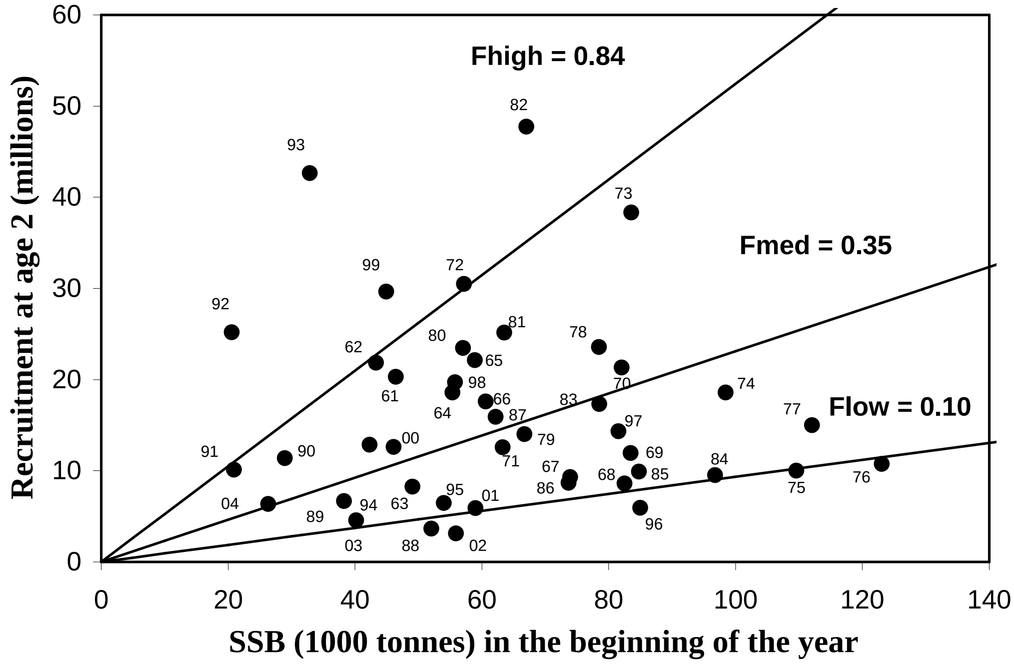


Figure 2.2.7.2.1. Faroe Plateau (sub-division VB1) COD. Spawning stock – recruitment relationship 1961-2004. Years are shown at each data point.

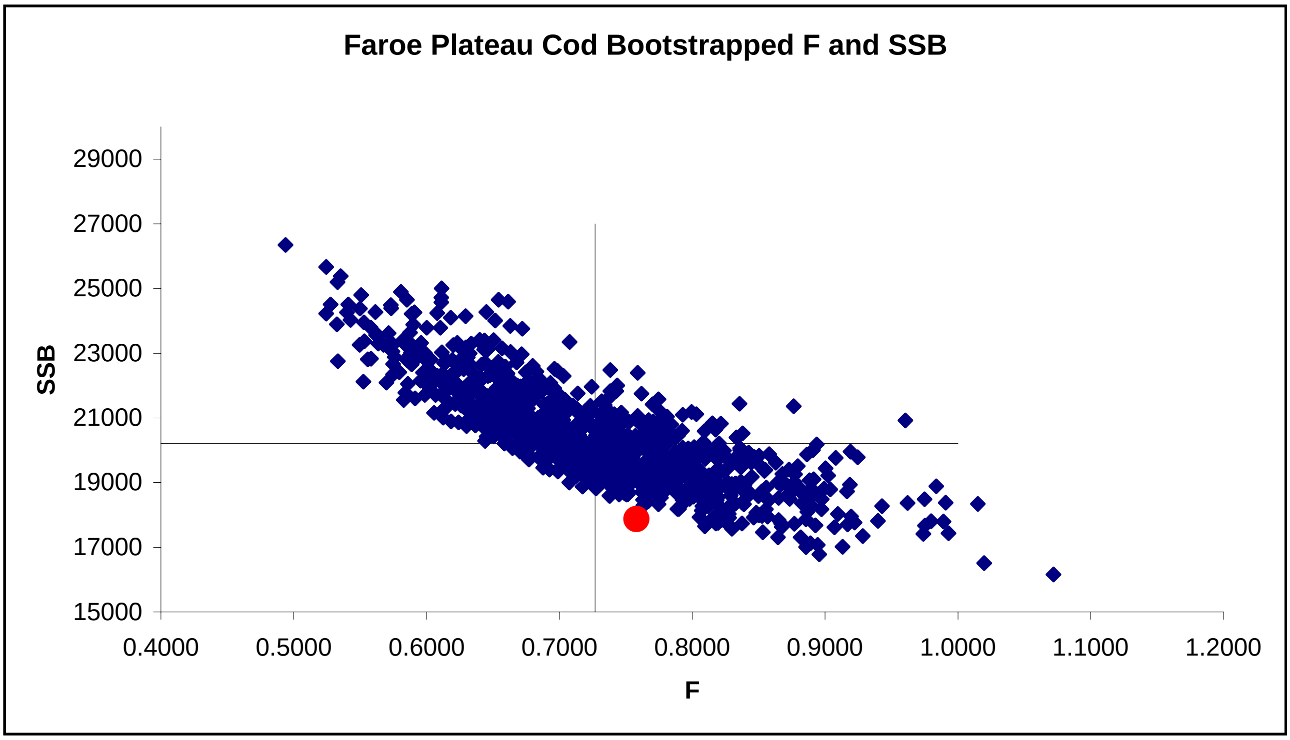


Figure 2.2.7.2.2. F and SSB's for 2006 from a 1000 bootstraps of the ADAPT with the two surveys. The XSA estimate is shown as a red point.

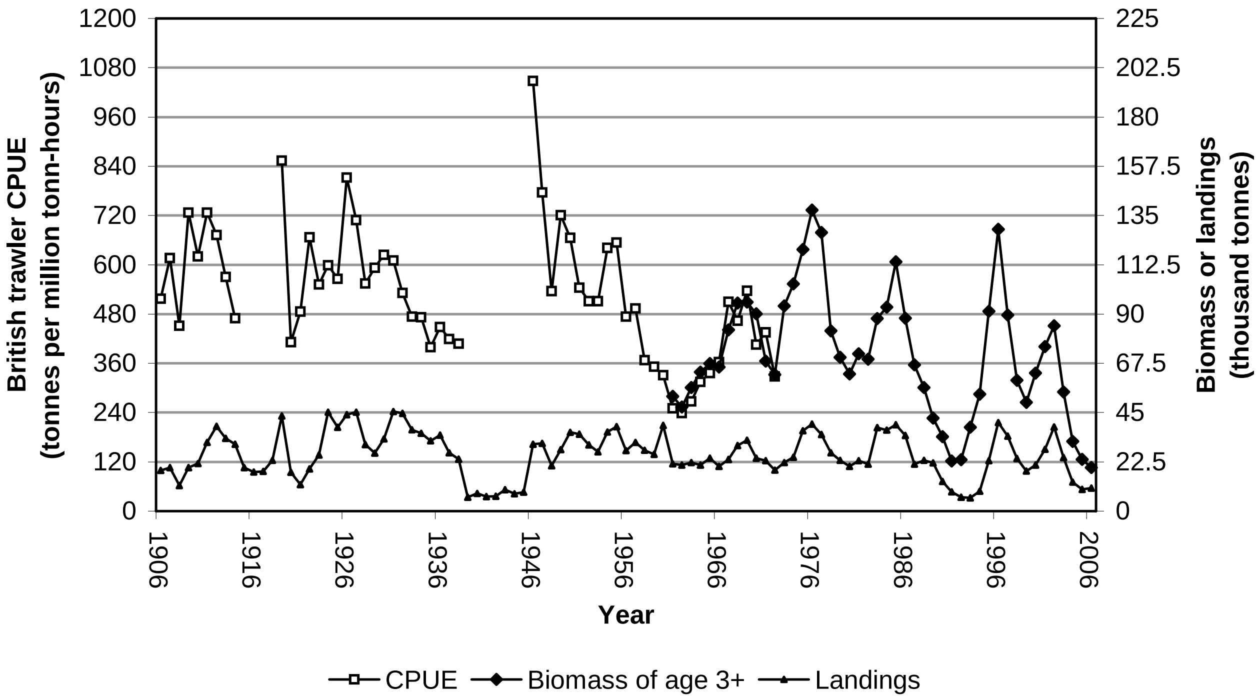


Figure 2.2.7.2.3. Faroe Plateau Cod. Stock development 1906-2006 based on cpues from british steam trawlers (1906-1925: cwts per days of absence from port), cpues from british trawlers (1924-1972: tonnes per million tonn hours) and the XSA-estimates (1961-2006: absolute biomass). The 1906-1925 series was scaled to the 1924-1972 series and the CPUEs refer to the first (left) axis while the XSA-estimates refer to the second axis.

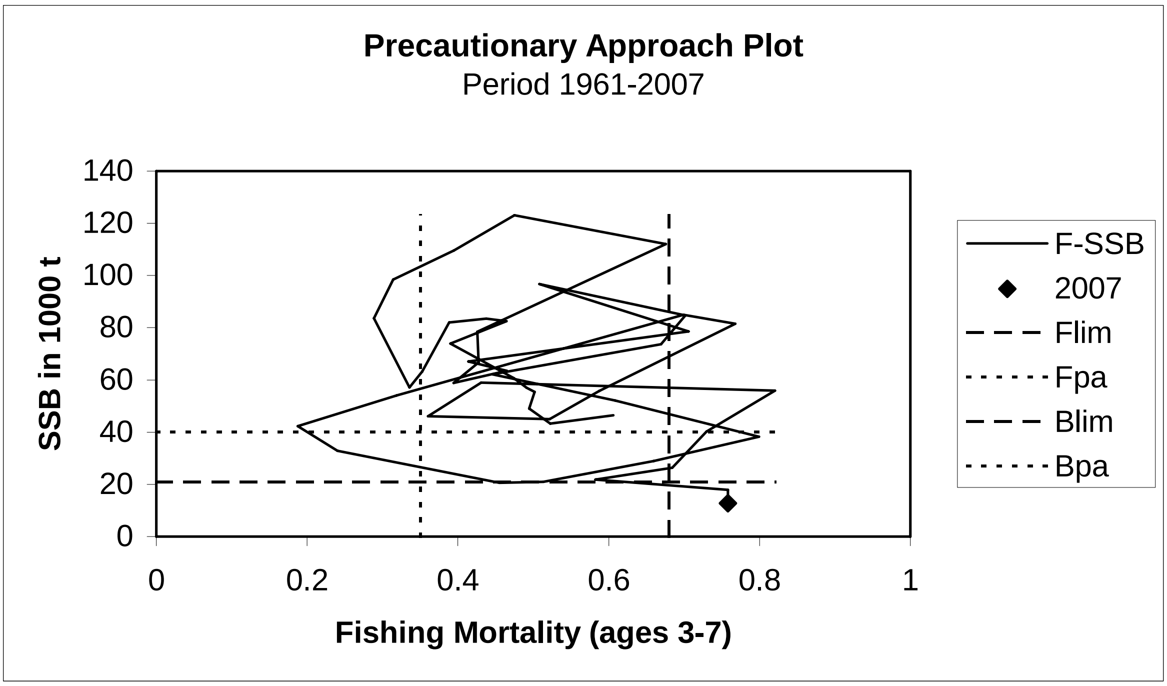
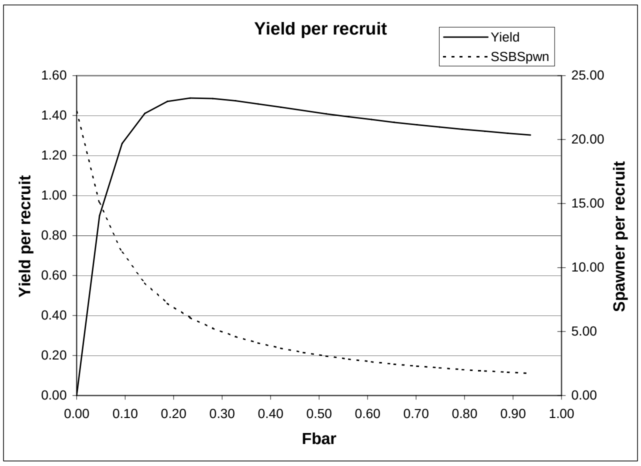
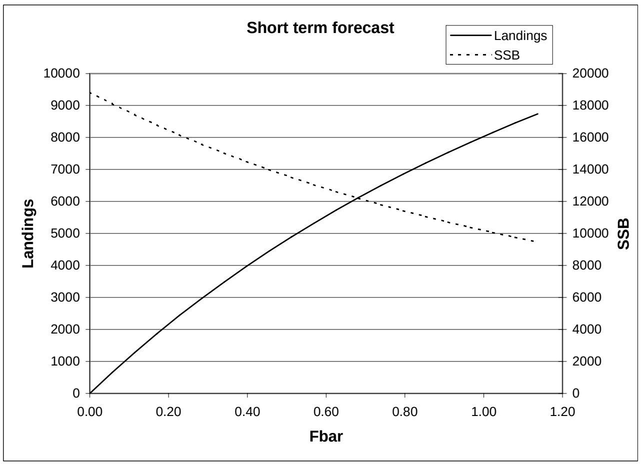


Figure 2.2.8.2.1. Faroe Plateau (sub-division VB1) COD. Spawning stock biomass versus fishing mortality 1961-2007.





MFYPR version 1
Run: YLD2
Time and date: 19:33 01/05/2007

Reference point	F multiplier	Absolute F
Fbar(3-7)	1.0000	0.6238
FMax	0.3973	0.2478
F0.1	0.1903	0.1187
F35%SPR	0.2703	0.1686
Flow	0.1620	0.1010
Fmed	0.5645	0.3521
Fhigh	1.3543	0.8448

Weights in kilograms

MFDP version 1
Run: Man2
Index file 26/4-2007
Time and date: 13:34 27/04/2007
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 2008 for cod, haddock, and saithe in Division Vb as these stocks are under effort control

(2) compile all relevant fisheries data, including data on different catch components (landings, discards, bycatch) and data on fishing effort .

(4) provide specific information on possible deficiencies in the 2007 assessments including any major inadequacies in the data on landings, effort or discards; any major expertise that was lacking; any major inadequacies in research vessel surveys data; any major difficulties in model formulation or available software.

(9) provide an overview of major regulatory changes (technical measures, TACs, effort control and management plans) and evaluate or assess their (potential) effects.

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

2.3.1 Trends in landings and effort

[ToR 2] Total nominal catches of the Faroe Bank cod from 1987 to 2006 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 and 2003. 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 2006 landings were estimated at 1 000t about 300 t less than in 2005 (Figure 2.3.1.1). Longline fishing effort increased substantially in 2003 and although it decreased in 2004 and 2005 the latter remains the second highest fishing effort observed since 1988 (Figure 2.3.1.1).

Due to uncertainty in the number of fishing days allocated to the small category of longliners the actual effort in 2006 may be higher than shown. Most of the Faroese catch has been taken by large (57%) and small longliners (17%)(Table 2.3.1.2).

[ToR 4] There may be problems with the landing figures for Faroe Bank. The vessels may fish on both the Faroe Plateau and the Faroe Bank during the same trip. The catches of cod on Faroe Bank are sometimes reported on the landing slips and only the 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 do not fill out logbooks and may not sell 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 2] The total fishing ban during the spawning period, (1 March to 1 May) introduced in 2005 was continued in 2006 and 2007.

2.3.2 Stock assessment

[ToR 11] Biological samples have been taken from commercial landings since 1974 (the 2006 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.

[ToR 4] Technical problems related to the SURBA assessment software have impeded the use of this tool in the present assessment year. One reason for this might have been the poor internal consistency in the age-disaggregated indices (Figure 2.3.2.1b)

Table 2.3.2.1. Samples of lengths, otoliths, and individual weights of Faroe Bank cod in 2006.

Fleet	Size	Samples	Length	Otoliths	Weights
Longliners	>100 GRT	13	2,434	240	2,165
Total		13	2,434	240	2,165

[ToR 11] 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 2004 and 2005. 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. The 2007 index is 58 kg per tow, which is the lowest since 1994 and very similar to the 2006 summer index (30 kg per tow). The low abundances in the latter are pronounced across all age groups (Figure 2.3.2.1a). The agreement between the summer and spring index is good during 1996 to 2001 and in 2006, 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 – 2002 (lengths 26 – 45 cm), corresponding to good recruitment of 2 years old in the spring surveys from 2001 to 2003 (40 – 60 cm). The spring index shows poor recruitment in 2006 and 2007 reflecting the weak year classes observed in the summer survey since 2004.

The recruitment can be estimated by simply counting the number of fish in length groups in the surveys. In the spring index, recruitment was estimated as total number of fish below 60 cm (2-year old) and in the summer index as number of fish below 45 cm (1-year old). Figure 2.3.2.4 shows a fairly good correlation between spring and summer survey recruitment. According to the summer index the recruitment of 1 year old has been good from 2000 to 2002, while the recruitment has been relatively poor from 2003 to 2006.

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. The ratio of landings to the survey indices provides an exploitation ratio, 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 (Figure 2.3.2.5). The exploitation ratio increased in 2006 with respect to 2005 and it remains higher than average.

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 not 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. 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 and/or by tagging of the different boxes.

[Tor 9] The effort was extremely high in 2003 and is still fairly high in 2004 and 2005 (Fig. 2.3.1.1). An exploitation ratio can be calculated via the catches and cpue from the surveys. The very high effort since 2003, results in extremely high exploitation ratios. Even though there might be uncertainties in the catches, there is no doubt that the exploitation rate is very high and may not be sustainable. The surveys are at a near lowest observed. Fishing on the Bank should be closed until the surveys confirm the stock has recovered. The working group suggests that recovery would be confirmed when indices are above average in both the spring (456.7 kg/hr) and the summer surveys (170.6 kg/hr).

[ToR b] The recruitment of the 2001 years class seems to be good, while there are indications of bad recruitment of the 2002 to 2005 year classes.

2.3.5 Annex

Stock definition

The Faroe Bank cod is distributed in the South-West of the Faroe Bank. Inside the 200 m depth contour, the Faroe Bank covers an area of about 45 × 90 km and its shallowest part is less than 100 m deep. The cod stock on the Bank is regarded as an independent stock displaying a higher growth rate than that of cod in the Plateau. Tagging experiments show that exchanges between the two cod stocks are negligible. The stock spawns from March to May with the main spawning in the first-half of April in the shallow waters of the Bank (<200 m). The eggs and larvae are kept on the Bank by an anti-cyclonic circulation. The juveniles descend to the bottom of the Bank proper in July. No distinct nursery areas have been found on the Bank. It is anticipated that the juveniles are widely distributed on the Bank, finding shelter in areas difficult to access by fishing gear (Jákupsstovu, 1999).

References

Jákupsstovu, 1999. The Fisheries in Faroese waters. Fleets, Activities, distribution and potential conflicts of interest with an off-shore oil industry.

Table 2.3.1.1. Faroe Bank (sub-division Vb2) cod. Nominal catches (tonnes) by countries 1986-2006 as officially reported to ICES. From 1992 the catches by Faroe Islands and Norway are used in the assessment.

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Faroe Islands	3409	2960	1270	289	297	122	264	717	561	2051
Norway	23	94	128	72	38	32	2	8	40	55
UK (E/W/NI)	-	-	-	-	-	+	1	1	- [2]	- [2]
UK (Scotland)	47	37	14	205	90	176	118	227	551 [3]	382
United Kingdom										
Total	3479	3091	1412	566	425	330	385	953	1152	2488
Used in assessment				289	297	154	266	725	601	2106

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Faroe Islands	3459	3092	1001		1094	1840	5957	3607	1270	996 *
Norway	135	147	88	49	51	25	72	18	37	10 *
UK (E/W/NI)	- [2]	- [2]	-	-	-	-	-	-		
UK (Scotland)	277	265	210	245	288	218	254	-		
United Kingdom			-	-	-	-	-	259 [3]	329 [3]	279 [3]
Total	3871	3504	1299	294	1433	2083	6283	3884	1636	1285
Correction of Faroese catches in Vb2					-65	-109	-353	-214	-75	-59
Used in assessment	3594	3239	1089	1194	1080	1756	5676	3411	1232	947

* Preliminary

[1] Includes Vb1.

[2] Included in Vb1.

[3] Reported as Vb.

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

Year	Open boats	LL<100	ST<400	Gillnet	Jiggers	ST<1000	ST>1000	PT<1000	PT>1000	LL>100	io
1992	0.0	8.0	0.0	0.0	16.0	7.0	7.0	11.0	40.0	11.0	0.0
1993	0.0	9.3	16.9	0.0	4.6	6.3	0.0	5.5	26.6	30.4	1.3
1994	0.5	8.8	31.2	2.6	5.1	8.1	6.4	2.8	20.0	12.6	2.0
1995	1.0	3.6	3.6	0.4	23.0	0.2	9.5	11.1	16.0	31.5	0.0
1996	2.3	1.2	3.2	0.1	24.3	5.0	1.6	23.9	36.7	1.5	0.1
1997	0.4	1.9	0.4	1.5	11.4	4.5	3.4	16.9	38.4	21.2	0.0
1998	0.1	3.8	0.5	1.3	5.7	3.1	10.1	12.8	32.4	29.8	0.4
1999	0.4	10.5	0.1	1.7	17.9	1.8	3.0	0.1	0.9	63.6	0.1
2000	0.3	5.9	0.3	0.0	1.3	0.0	9.3	17.7	51.2	14.0	0.0
2001	4.1	9.2	2.3	0.5	4.8	2.9	9.2	12.6	26.9	27.3	0.2
2002	10.3	3.5	0.0	0.0	0.3	0.0	1.5	5.9	33.4	45.3	0.0
2003	2.3	16.8	0.0	0.0	3.5	0.0	1.3	0.0	16.3	59.6	0.0
2004	2.6	11.7	8.1	2.3	4.3	1.8	33.5	3.4	10.7	21.7	0.0
2005	1.5	10.3	0.0	16.8	6.1	0.5	2.0	2.8	14.3	45.5	0.0
2006	4.2	16.6	0.0	0.4	16.2	0.0	1.5	2.8	0.7	56.9	0.0

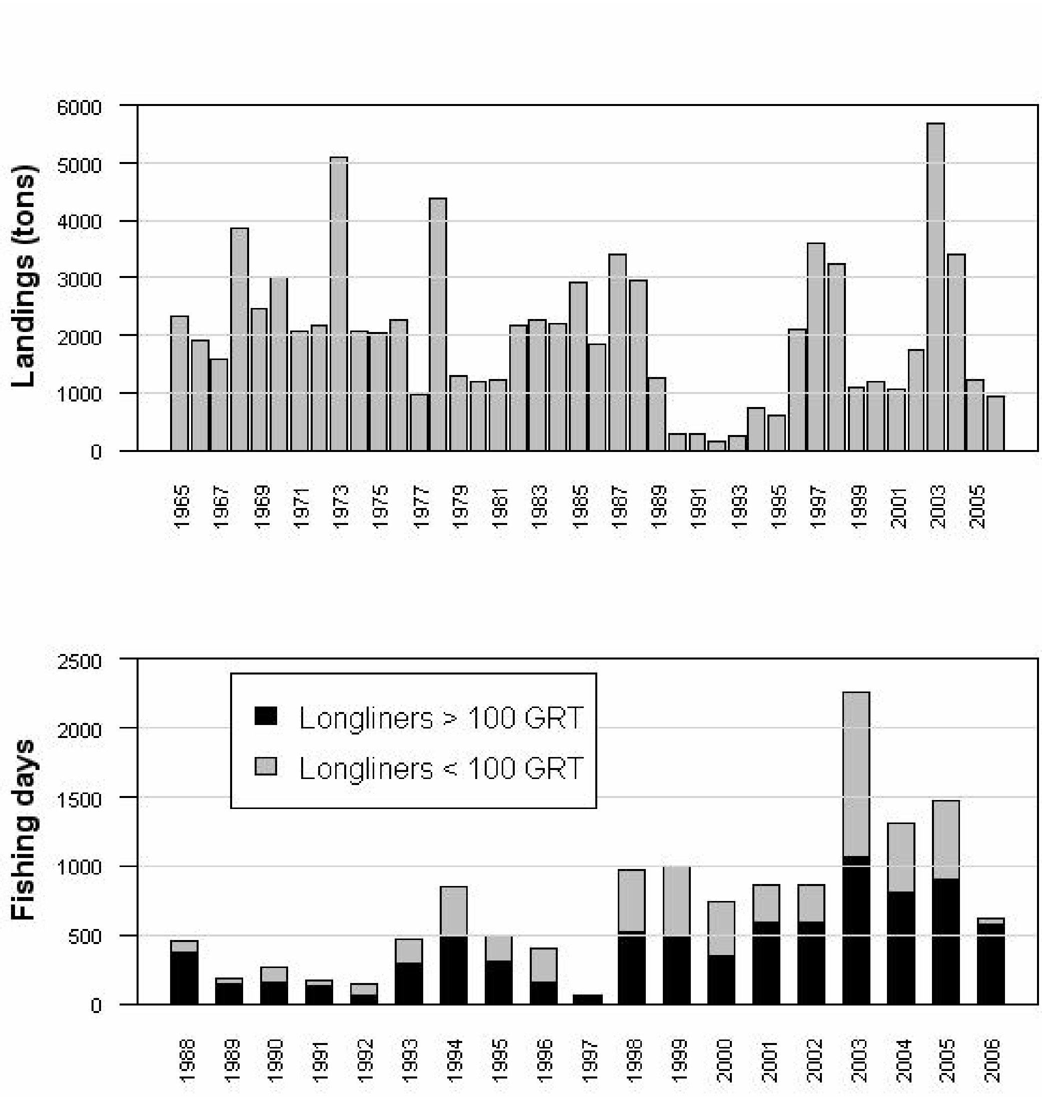


Figure 2.3.1.1. Faroe Bank (sub-division Vb2) cod. Reported landings 1965-2006. Since 1992 only catches from Faroese and Norwegian vessels are considered to be taken on Faroe Bank. Lower plot: fishing days 1988-2006 for long line gear type in the Faroe Bank (exerted).

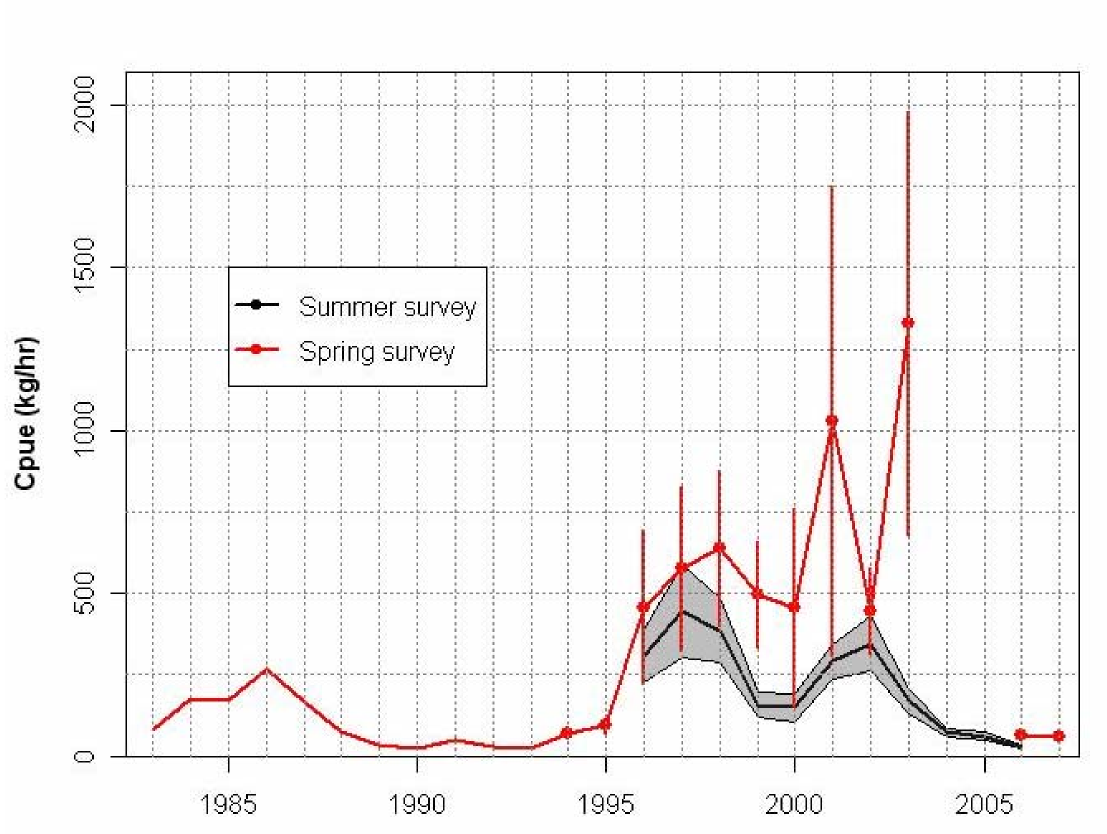
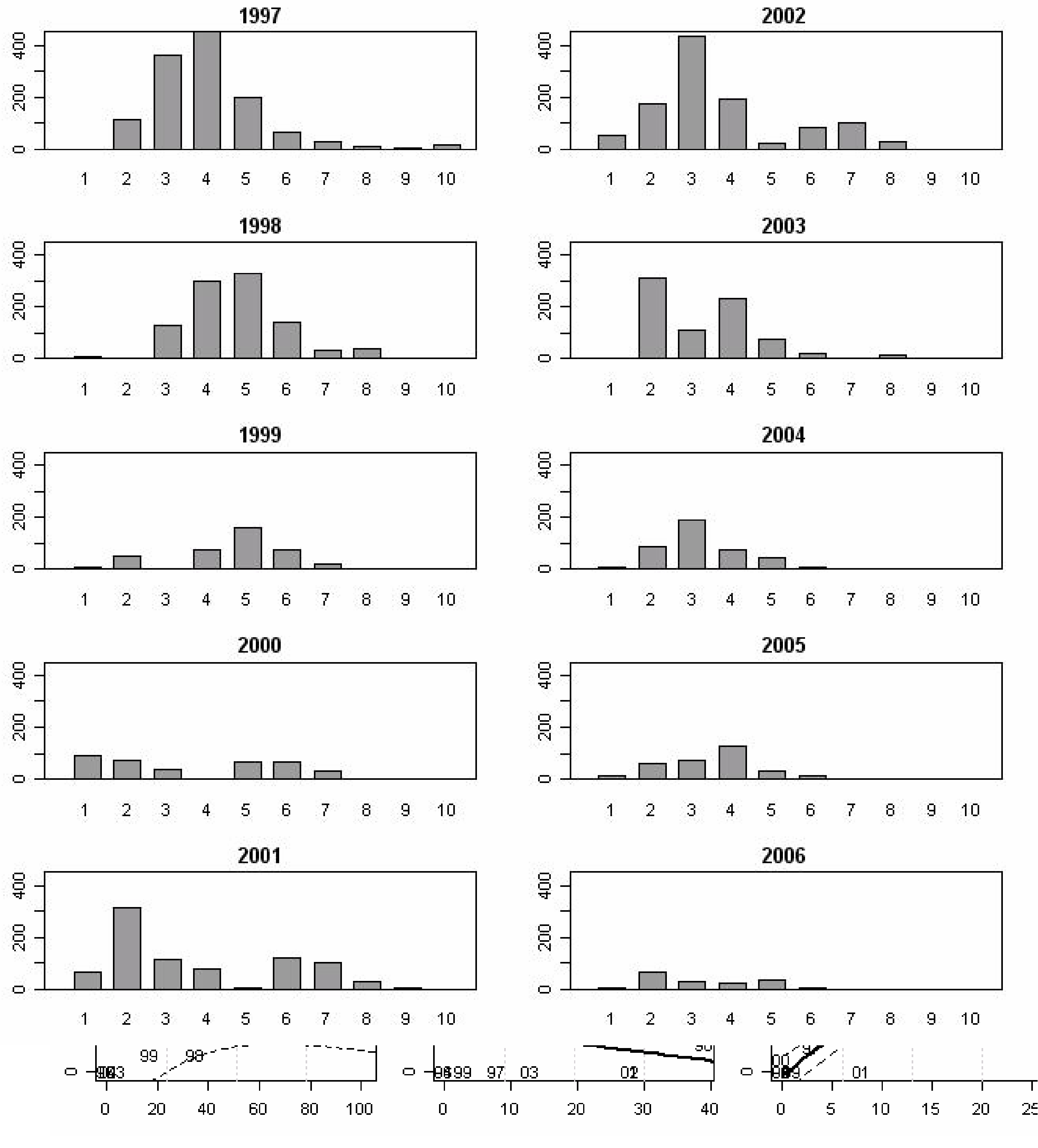


Figure 2.3.2.1. Faroe Bank (sub-division Vb2) cod. Catch per unit of effort in the spring groundfish survey and summer survey. Vertical bars and shaded areas show the standard error in the estimation of indexes.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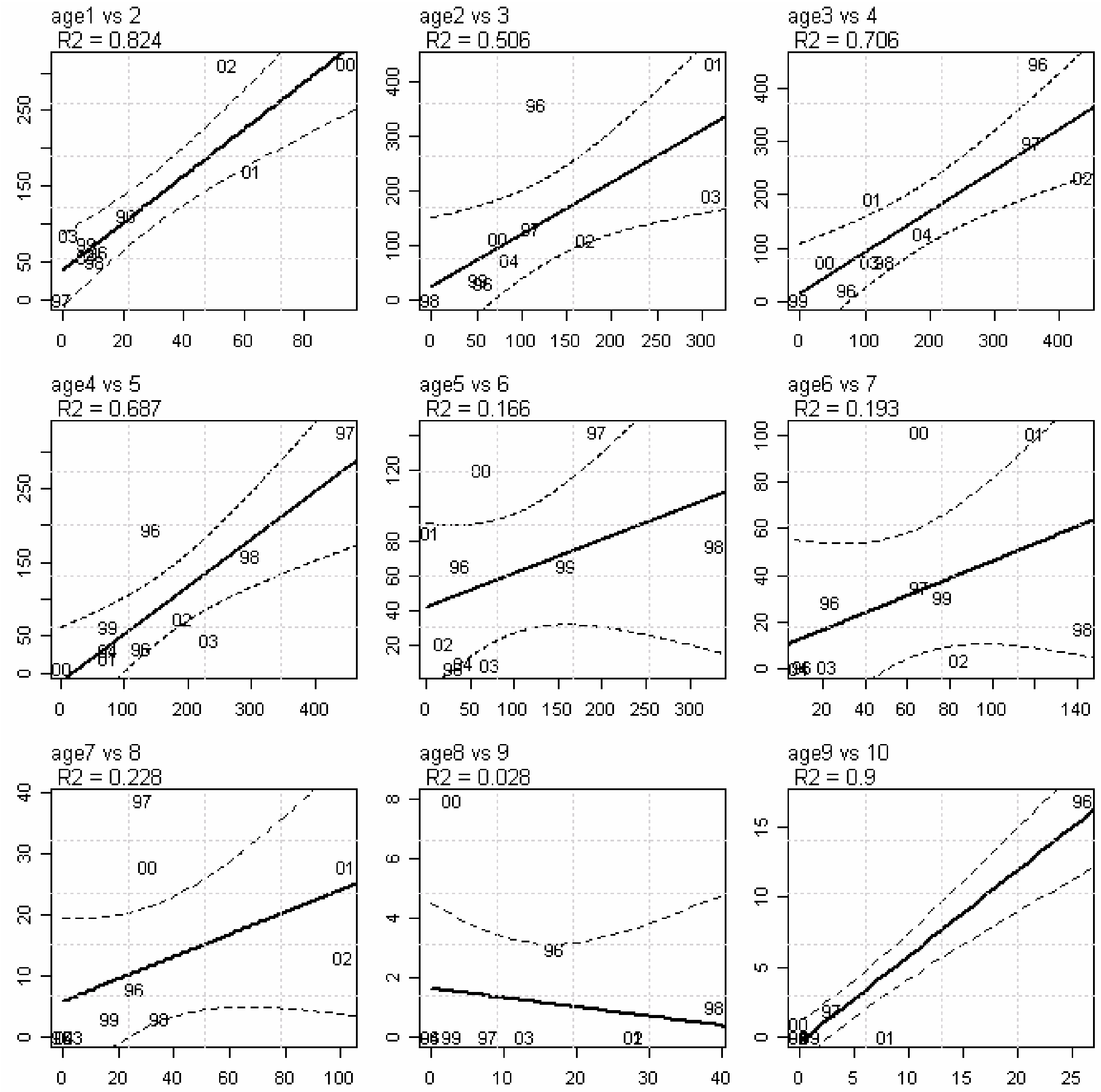

Figure 2.3.2.1b. Faroe Bank (sub-division Vb2) cod. Indices from the summer index plotted against indices of the same year class one year later.

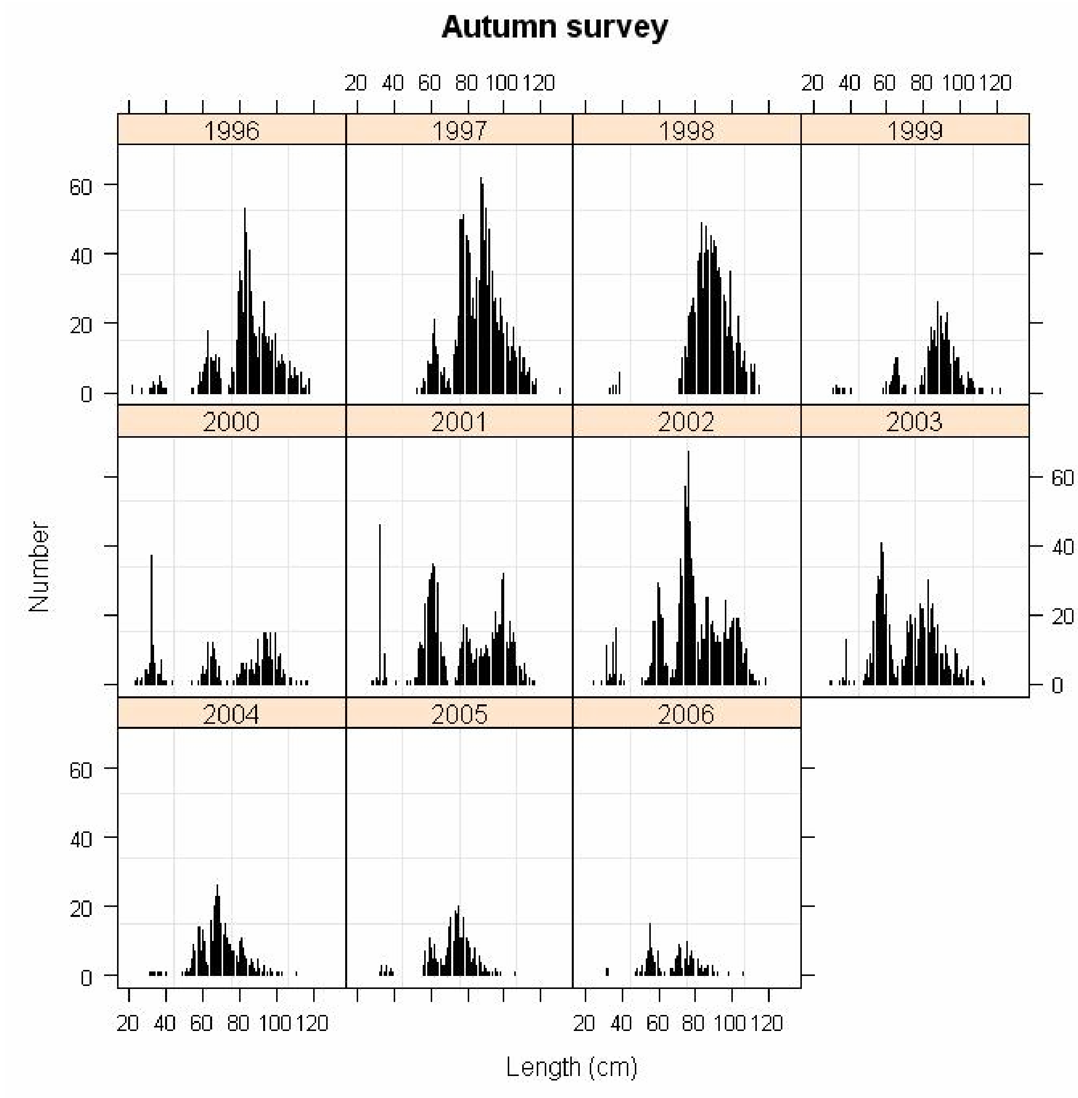

Figure 2.3.2.2. Faroe Bank (sub-division Vb2) cod. Length distributions in the autumn survey.

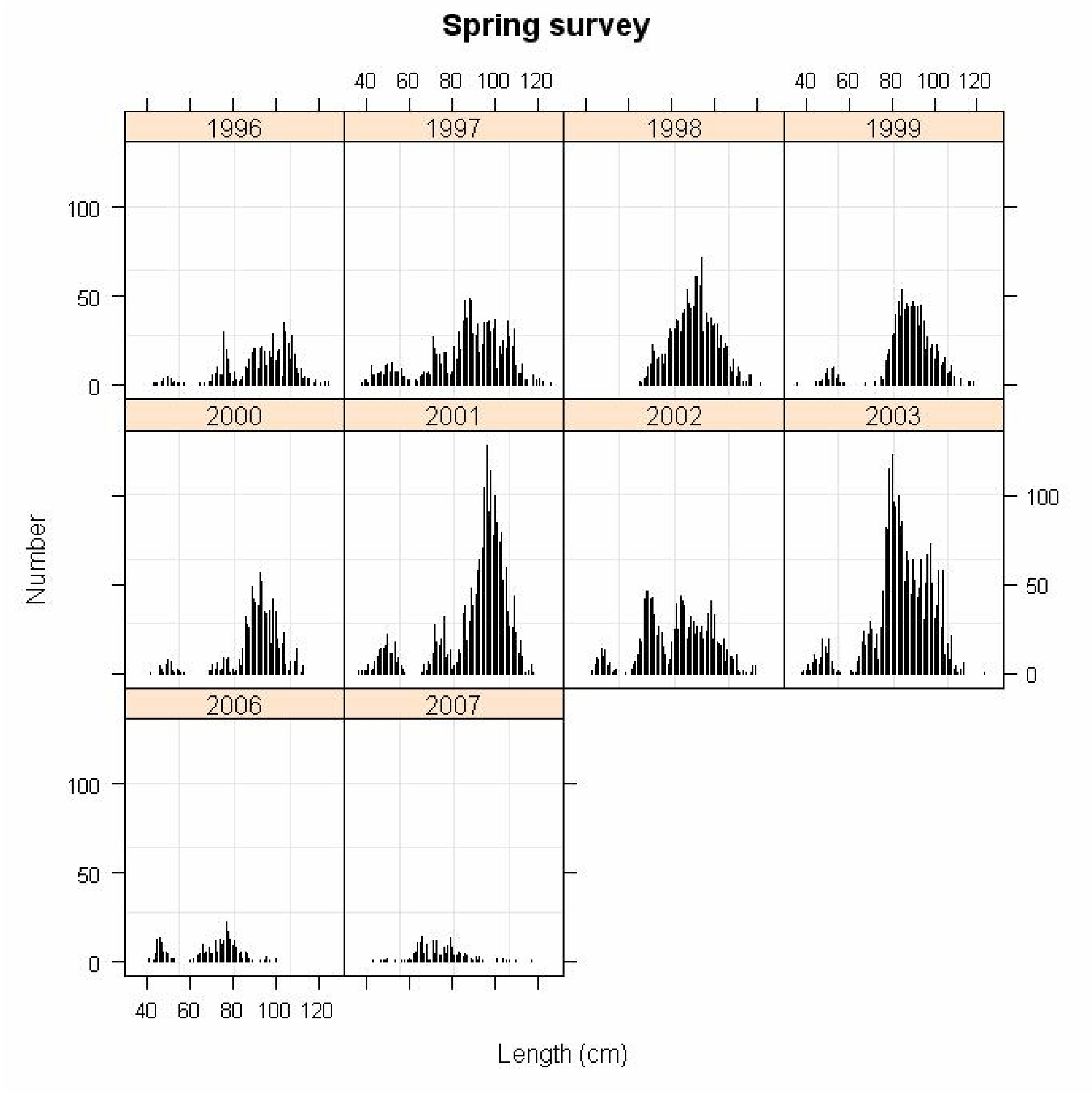

Figure 2.3.2.3. Faroe Bank (sub-division Vb2) cod. Length distributions in the spring survey.

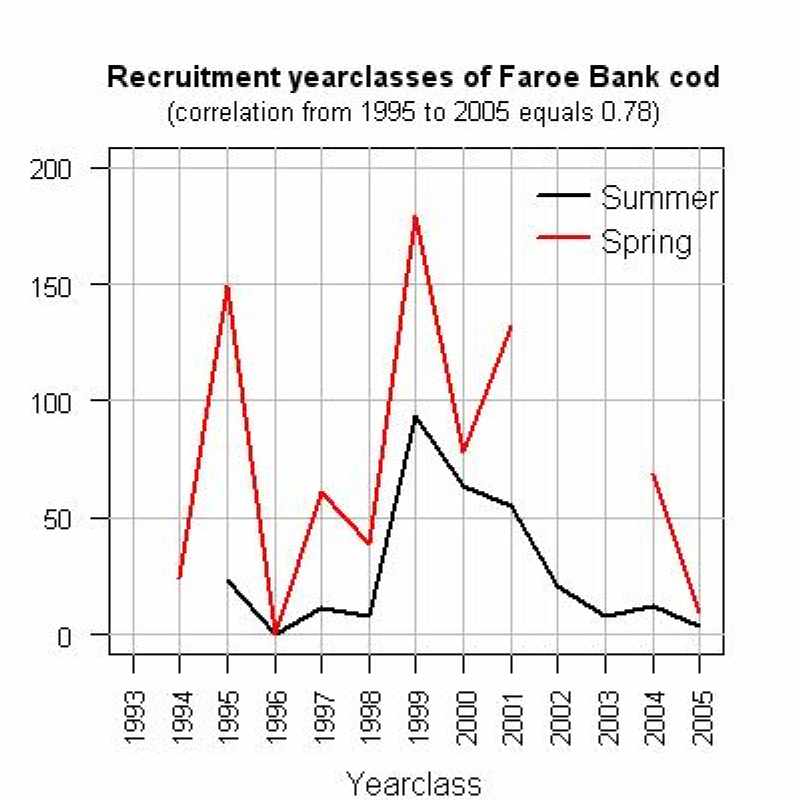

Figure 2.3.2.4. Estimated recruitment from surveys. In summer surveys the 1 year old recruitment is estimated. In spring surveys the recruitment of 2 year old is estimated.

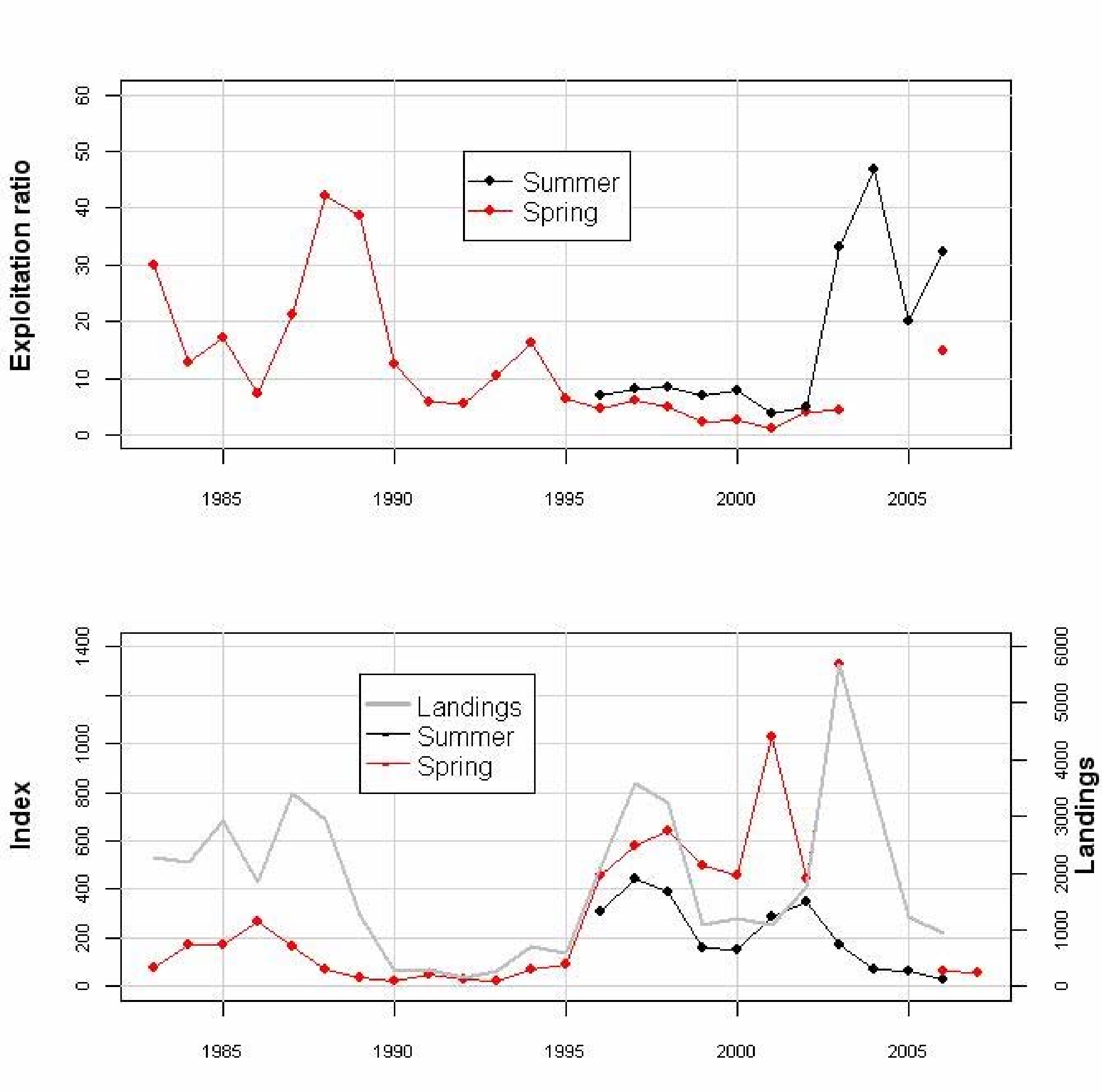

Figure 2.3.2.5. Faroe Bank (Sub-division Vb2) cod. Exploitation ratio (ratio of landings to survey interpreted as an index of exploitation rate). Lower plot: Landings and cpue (kg/hr) in spring and summer survey.

2.4 Faroe Haddock

Executive summary

Being an update assessment, the only changes compared to last year are additions of new data from 2006 and some minor revisions of the landings data for 2004 and 2005 with corresponding revisions of the catch@age data. The main assessment tool is XSA tuned with 2 research vessel bottom trawl surveys. ADAPT has also been applied using the same input data as for the XSA mostly to evaluate the uncertainties in the assessment. The results are in line with those from 2006, showing a declining SSB mainly due to poor recruitment and individual fish growth. SSB is still above B_{pa} but is predicted to be close to it in 2009. Fishing mortality in 2006 is estimated at F_{pa} and landings are at the long term average of 17 000 t.

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. Haddock does not form as dense spawning aggregations as 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 some individuals from 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. Figures 2.1.9-2.4.10 show the age-aggregated distribution by year as seen in the two regular groundfish surveys in the area.

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 27 000 t in 2003; they have declined since and amounted in 2006 to about 17 000t which is around the average since 1957. Most of the landings are taken from the Faroe Plateau; the landings from the Faroe Bank (Sub-Division Vb2) in 2006 were about 1 300 t (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 in 2007 may be smaller than those in 2006.

Faroese vessels have taken almost the entire catch since the late 1970s (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 2006 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 months of the year until the end of the spawning time in April, stayed low during the summer and increased again in late autumn. On the Faroe Bank, the monthly landings in the first half of 2006 were high as usual except for March and April reflecting a closure of the Bank during the spawning time (1 March – 1 May). As compared to recent years, the landings for rest of the year were low and dominated by the pairtrawlers.

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 2006 is shown in Table 2.4.4 and was at the same level as in 2005.

As has been the practise in the past, samples from each fleet category were disaggregated by season (Jan-Apr, May-Aug and Seep-Dec) and then raised by the catch proportions to give the 2006 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 although from time to time a few small year classes are disturbing this consistency, 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 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. No estimates of discards of haddock are available. However, since almost no quotas are used in the management of this stock, the incitement to discard in order to high grade the catches should be low. Moreover there is a ban on discarding. The landings statistics is therefore regarded as being adequate for assessment purposes.

2.4.4 Weight-at-age

Mean weight-at-age data are provided for the Faroese fishery (Table 2.4.6). Figure 2.4.5 shows the mean weights-at-age in the landings for age groups 2-7 since 1976. During the period, weights have shown cyclical changes, and have decreased during the most recent years to very low values in 2006. 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 1982–2007. 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).

2.4.6 Assessment

This assessment is an update of the 2006 assessment, with exactly the same settings of the XSA. The only changes are minor revisions of recent landings according to revised data and corresponding revisions of the c@age input file. All other input files (VPA and tuning fleets) are the same except for the addition of the 2006 data.

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 they are not used directly for tuning of the VPA due to changes in catchability caused by e.g. productivity variations in the area (see Faroe Plateau cod), to a different behaviour of the fleets after the introduction of the management system and in years when haddock prices are low as compared to cod the fleets apparently 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. The distribution of fishing activities by year for some major fleets (selected vessels) can be seen in chapter 2.1.1; the data are based on logbooks. These are mixed fisheries and not directly targeting haddock. It is not possible to show the fishing activities for the longliners below 100 GRT because this fleet is not obliged to keep logbooks. The age-aggregated cpue series for longliners and pair trawlers are presented in Figure 2.4.7. In general the two series show the same trends although in some periods the two series are conflicting; this has been explained by variations in catchability of the longlines due to the above mentioned changes in productivity of the ecosystem (see chapter 2.1).

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). The distribution of haddock catches in the surveys are shown in Figure 2.4.9 (spring surveys 1994-2007) and Figure 2.4.10 (summer surveys 1996-2006). Biomass estimates (kg/hour) are available for both series since they were initiated (Figure 2.4.8), and in general, there is a good agreement between them. Age disaggregated data are available for the whole summer series, but due to problems with the database (see earlier reports), age disaggregated data for the spring survey are only available since 1994. The calculation of indices at age is based on age-length keys and a smoother is applied. This is a useful method but by analyzing the number of otoliths for the youngest ages and comparing it with the length distributions some artifacts may be introduced because the smoothing can assign wrong ages to some lengths, especially for the youngest and oldest specimen. As last year the length distributions have been used more directly for calculation of indices at age for ages 0-3. LN(numbers at age) for the surveys are presented in Figures 2.4.11-2.4.12 and show consistent patterns. Further analysis of the performances of the two series are shown in figures 2.4.13 – 2.4.15. In general 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).

A spaly run, with the same settings of the XSA as in 2006 and tuned with the two surveys combined (Table 2.4.8), with 2006 data included and some minor revisions of recent catch figures (Table 2.4.9), gave almost identical 2005 estimates as the 2006 assessment (Section 2.4.10). The log q residuals for the two surveys are shown in Figure 2.4.16.

The retrospective pattern for fishing mortality, recruitment and spawning stock biomass of this XSA is shown in Figure 2.4.17. The recent estimates are consistent with each other. 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 and consequently they will create problems for estimation of the stock (see the 2005 NWWG report); this is not a problem for the time being.

Results. The fishing mortalities from the final XSA run are given in Table 2.4.10 and in Figure 2.4.18. 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 0.25 in 2006.

2.4.6.2 Stock estimates and recruitment

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 in Figure 2.4.18A and B. In 2.4.18A existing reference points are included whereas 2.4.18B includes the revised reference points. According to this assessment, the spawning stock biomass has shown big changes in recent years. It decreased from 68 000 t in 1987 to 22 000 t in 1994, increased again to 85 000 t in 1997 and 1998, decreased to 56 000 t in 2000 and has increased since to 109 000 t in 2003; the 2006 point estimate is 72 000t. 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. The 1999 YC is now confirmed being the highest on record at age 2 (115 mio.), the YC's from 2000 and 2001 are estimated well above average and the 2002 YC slightly above average. All more recent YC's are estimated or predicted to be small.

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 estimated in the same way as last year and given in Tables 2.4.13-14. All year classes up to 2005 are from the final VPA, the 2006 year class at age 2 is estimated from the 2007 XSA applying a natural mortality of 0.2 in a forward calculation of the numbers using basic VPA equations. The YC 2007 at age 2 in 2009 is estimated as the geometric mean of the 2-year-olds in 1980-2008. This period has been selected, because the recruitment in earlier years was more stable and not characteristic for the recent years.

The exploitation pattern used in the prediction was derived from averaging the 2004–2006 fishing mortality matrices from the final VPA and rescaled to the 2006 value. The same exploitation pattern was used for all three years.

The mean weight@age have been declining in recent years to low values but from inspection of Figure 2.4.5 they are not expected to decline further. The mean weight-at-age for ages 2-10 in 2007-2009 was therefore simply set equal to the observed weights in 2006. This is in line with what was done last year, see the 2006 report for argumentations).

The maturity ogive for 2007 is based on samples from the Faroese Groundfish Spring Survey 2007 and the ogives in 2008-2009 are estimated as the average of the smoothed 2004-2007 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 1977–2006 period. The maturity ogives are averages for the years 1982-2006. 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 2.4.20. $\mathbf{F}_{max}$ and $\mathbf{F}_{0.1}$ are indicated here as 0.61 and 0.15, respectively. From Figure 2.4.19, showing the recruit/spawning stock relationship, and from Table 2.4.17, $\mathbf{F}_{med}$, and $\mathbf{F}_{high}$ were calculated at 0.32 and 2.03, 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 was above this value (Figure 2.4.19) 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 2004 Working Group 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 were 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 $\mathbf{B}_{lim}$. However, the 2006 NWWG showed analyses indicating that B_{lim} could be set at 23 000 t and B_{pa} using the standard formula and a sigma of 0.40 set at 35 000 t. This was supported by the WKREF workshop in Gdynia 2007. In section 2.1 this is further analysed and commented upon.

2.4.7.3 Projections of catch and biomass

2.4.7.3.1 Short-term prediction

Given the stability in the allocation of fishing days, it should not be unrealistic to assume fishing mortalities in 2007 as the average of some recent years, here the average of F(2004-2006) scaled to the values in 2006; 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 for most fleets was only reduced marginal for the fishing year 1 Sept 2006 – 31 Aug 2007 and for pairtrawlers there was no change as compared to the year before. The landings in 2007 are then predicted to be about 17 000 t, and continuing with this fishing mortality will result in 2008 landings of about 14 000 t. The SSB will decrease to 62 000 t in 2007, 48 000 t in 2008, and to 36 000 t in 2009. The results of the short-term prediction are shown in Table 2.4.15 and in Figure 2.4.20. The contribution by year-classes to the age composition of the predicted 2008 and 2009 SSB's is shown in Figure 2.4.23. The contributions to the SSB's of new predicted incoming year-classes are minor.

2.4.8 Medium-term projections

No such projections are presented in this years report.

2.4.9 Management considerations

Management of haddock also need to take into account measures for cod and saithe.

2.4.10 Comments on the assessment

2.4.10.1 Data considerations

Misreporting is not believed to be a problem under the current effort management system and 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.

The sampling of the catches for length measurements, otolith readings and length-weight relationships is considered to be adequate.

The quality of the tuning data is considered high. The same research vessel has been used all the time and the gear as well as sampling procedures of the catch have remained the same.

2.4.10.2 Assessment quality

As explained previously in the report, this assessment is an update of the 2006 assessment. The only changes are minor revisions of recent landings according to revised data and corresponding revisions of the c@age input file. All other input files (VPA and tuning fleets) are the same except for the addition of the 2006 data. Following differences in the 2005 estimates were observed as compared to last year:

ASSESSMENT YEAR	RECRUITMENT AGE 2 IN 2005	EXPLOITABLE BIOMASS IN 2005	SPAWNING STOCK BIOMASS IN 2005	FISHING MORTALITY (F_{3-7}) IN 2005
2006	7 400 000	104 000 t	86 000 t	0.33
2007	7 300 000	105 000 t	88 000 t	0.35

As in 2005-06, 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 2.4.21 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(3-7). The XSA results fall almost in the middle of the cloud of bootstrapped ADAPT results.

Figure 2.4.21 shows the retrospective pattern of the ADAPT. It is comparable with the XSA retro.

2.4.10.3 Response to technical minutes

As explained in the Overview chapter, the WG again proposes to revise the biomass reference points; proposed values are given in the overview. This was supported by the WKREF workshop in Gdynia 2007.

Table 2.4.1 Faroe Plateau (Sub-division Vb1) HADDOCK. Nominal catches (tonnes) by countries 1982-2006, I.e. Working Group estimates in Vb1.

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[4,5]	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 #	2005 [2]	2006 [2]
Faroe Islands	3,675	4,549	9,152	16,585	19,135	16,643	13,620 [8]	13,457 [8]	20,776 [8]	21,615	18,995	18,172	15,374
France[1]					2 [2,]	- [2]	6	8 [7]	2	4	1 [5]	+	6 [5]
Germany		5	-	-		33	1	2	6	1	6		1 [5]
Greenland						*30* [6]	*22* [6]	*0* [6]	*4* [6]				+ [8]
Iceland									4				
Norway	22	28	45	45 [2]	71	411	355	257 [2]	227	265	229	212	56
Russia											16		
Spain											49		
UK (Engl. and Wales)	31	23	5	22	30 [1]	59 [7]	19 [7]	4 [7]	11 [7]	14 [7]	8 [7]	1 [7]	
UK (Scotland)[11]	-	-	…	…	…					185 [7]	186 [7]	126 [7]	
United Kingdom													107 [1]
Total	3,728	4,605	9,202	16,652	19,238	17,176	14,023	13,728	21,030	22,084	19,490	18,511	15,544
Working Group estimate[4,5,8]	4,252	4,948	9,642	17,924	22,210	18,482	15,821	15,890	24,933	27,128	23,287	20,455	16,848

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

2) Preliminary data

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

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

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

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

7) Reported as Division Vb.

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

9) Included in Vb2

10) Includes 14 reported as Vb

Table 2.4.2 Faroe Bank (Sub-division Vb2) HADDOCK. Nominal catches (tonnes) by countries,
1982-2006, I.e. Working Group estimates 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
France1	-	-	-	-	-	-	-	-	-	-	-	-
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	2005	2006 [2]
Faroe Islands	353	303	338	1,133	2,810	1,110	1,565 [5]	1,948	3,698	4,804	3,594	2,444	1,303
France1	-	-	-	-								+	
Norway	1	1	40	4	60	3	48	66	28	54	17	45	1
UK (Engl. and Wales)	+	... [1]	… [1]	… [1]	… [1]	[1]	[1]	[1]		[1]	[1]	[1]	[4]
UK (Scotland)3	170	39	62	135	102	193	185	148	177	[4]	[1]	[4]	[4]
Total	524	343	440	1,272	2,972	1,306	1,798	2,162 1	3,903	5,044	3,797 2	1,944	1,304

1) Catches included in Sub-division Vb1.

2) Provisional data

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

4) Reported as Division Vb.

5) Provided by the NWWG

Table 2.4.3 Total Faroese landings of haddock from Division Vb 1985-2006 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	2005	2006
Open boats	7	7	11	2	3	2	3	2	1	1	1	2	2	2	2	1	2	3	4	4	4	6
Longliners < 100GRT	39	39	39	49	58	60	56	46	24	18	23	28	31	30	23	24	29	31	34	40	41	47
Longliners > 100GRT	13	12	13	19	18	18	18	22	25	25	38	36	38	40	40	36	38	34	42	42	43	36
Otter board trawlers < 1000HP	7	5	7	6	4	4	3	3	11	10	12	13	9	8	7	9	7	6	4	3	3	1
Otterboard trawlers > 1000HP	8	5	2	2	2	2	2	1	1	3	2	2	3	3	7	5	5	11	3	1	1	2
Pairtrawlers < 1000HP	19	20	17	11	7	5	7	11	13	10	8	7	6	5	6	7	6	4	4	2	2	2
Pairtrawlers > 1000HP	6	10	9	9	6	8	11	14	22	29	16	13	12	12	14	19	12	10	8	7	4	5
Nets	0	0	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	1	0
Other gears	0	1	1	2	1	1	1	1	3	3	0	0	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	16328	11962

Table 2.4.4

Catch at age

Age	Vb1 Open Boats	Vb1 LLiners < 100GRT	Vb1 LLiners > 100GRT	Vb1 OB. trawl. < 1000HP	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	Vb Foreign Trawlers	Vb1 Foreign LLiners	Vb2 Foreign LLiners	Vb Total
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	34	138	16	1	0	0	0	69	243	0	0	0	0	0	0	0	243
3	35	232	55	2	3	4	8	97	434	1	1	0	2	1	1	0	438
4	205	1106	470	20	37	28	65	538	2461	31	7	0	38	15	6	0	2520
5	205	1510	900	34	85	50	154	873	3740	78	15	0	93	34	11	0	3879
6	214	1812	1569	44	94	48	198	897	5077	165	25	0	191	38	20	0	5326
7	144	1118	862	31	55	32	134	631	3032	129	26	0	155	22	11	0	3220
8	4	22	50	2	3	2	10	34	119	11	2	0	13	1	1	0	134
9	3	33	10	0	0	0	0	4	59	3	0	0	3	0	0	0	62
10	0	0	2	0	0	0	0	1	3	1	0	0	1	0	0	0	4
11	1	3	16	1	0	0	1	4	28	3	0	0	3	0	0	0	31
12	1	4	11	0	0	1	2	9	24	2	1	0	4	0	0	0	28
13	0	0	4	0	0	0	0	1	6	1	0	0	1	0	0	0	6
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total no.	845	5979	3964	135	279	167	572	3157	15226	424	78	1	503	112	51	1	15891
Catch, t.	768	5540	3919	126	256	161	546	3113	14429	495	99	1	596	103	50	1	15179

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 t Pair Trawl. = Pair trawlers

Sampling	Vb1 Open Boats	Vb1 LLiners < 100GRT	Vb1 LLiners > 100GRT	Vb1 OB. trawl. < 1000HP	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 trawlers	Vb2 Others	Vb2 All Faroese Fleets	Vb Foreign Trawlers	Vb1 Foreign LLiners	Vb2 Foreign LLiners	Vb Total
No. samples	11	53	74	5	6	16	33	0	198	16	1	0	17	0	0	0	215
No. lengths	2324	12330	16931	984	631	3978	7461	0	44639	3300	205	0	3505	0	0	0	48144
No. weights	1093	6128	9525	60	0	563	2145	0	19514	2631	0	0	2631	0	0	0	22145
No. ages	179	840	1560	984	0	420	480	0	4463	120	205	0	325	0	0	0	4788

Table 2.4.5 Faroe haddock. Catch number-at-age

At 18/04/2007 16:27

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

YEAR,	1957,	1958,	1959,	1960,	1961,	1962,	1963,	1964,	1965,	1966,
AGE										
0,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
1,	45,	116,	525,	854,	941,	784,	356,	46,	39,	90,
2,	4133,	6255,	3971,	6061,	7932,	9631,	13552,	2284,	1368,	1081,
3,	7130,	8021,	7663,	10659,	7330,	13977,	8907,	7457,	4286,	3304,
4,	8442,	5679,	4544,	6655,	5134,	5233,	7403,	3899,	5133,	4804,
5,	1615,	3378,	2056,	2482,	1937,	2361,	2242,	2360,	1443,	2710,
6,	894,	1299,	1844,	1559,	1305,	1407,	1539,	1120,	1209,	1112,
7,	585,	817,	721,	1169,	838,	868,	860,	728,	673,	740,
8,	227,	294,	236,	243,	236,	270,	257,	198,	1345,	180,
9,	94,	125,	98,	85,	59,	72,	75,	49,	43,	54,
+gp,	58,	105,	47,	28,	13,	22,	23,	7,	8,	9,
0 TOTALNUM,	23223,	26089,	21705,	29795,	25725,	34625,	35214,	18148,	15547,	14084,
TONSLAND,	20995,	23871,	20239,	25727,	20831,	27151,	27571,	19490,	18479,	18766,
SOPCOF %,	89,	90,	90,	88,	88,	89,	89,	101,	94,	109,

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

YEAR,	1967,	1968,	1969,	1970,	1971,	1972,	1973,	1974,	1975,	1976,

Run title : FAROE HADDOCK (ICES DIVISION Vb) HAD1_IND

AGE										
0,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
1,	70,	49,	95,	57,	55,	43,	665,	253,	94,	40,
2,	1425,	5881,	2384,	1728,	717,	750,	3311,	5633,	7337,	4396,
3,	2405,	4097,	7539,	4855,	4393,	3744,	8416,	2899,	7952,	7858,
4,	2599,	2812,	4567,	6581,	4727,	4179,	1240,	3970,	2097,	6798,
5,	1785,	1524,	1565,	1624,	3267,	2706,	2795,	451,	1371,	1251,
6,	1426,	1526,	1485,	1383,	1292,	1171,	919,	976,	247,	1189,
7,	631,	923,	1224,	1099,	864,	696,	1054,	466,	352,	298,
8,	197,	230,	378,	326,	222,	180,	150,	535,	237,	720,
9,	52,	68,	114,	68,	147,	113,	68,	68,	419,	258,
+gp,	13,	12,	20,	10,	102,	95,	11,	147,	187,	318,
0 TOTALNUM,	10603,	17122,	19371,	17731,	15786,	13677,	18629,	15398,	20293,	23126,
TONSLAND,	13381,	17852,	23272,	21361,	19393,	16485,	18035,	14773,	20715,	26211,
SOPCOF %,	101,	102,	108,	102,	97,	96,	97,	97,	117,	107,

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

YEAR,	1977,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,	1986,
AGE										
0,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
1,	0,	0,	1,	0,	0,	0,	0,	25,	0,	0,
2,	255,	32,	1,	143,	74,	539,	441,	1195,	985,	230,
3,	4039,	1022,	1162,	58,	455,	934,	1969,	1561,	4553,	2549,
4,	5168,	4248,	1755,	3724,	202,	784,	383,	2462,	2196,	4452,
5,	4918,	4054,	3343,	2583,	2586,	298,	422,	147,	1242,	1522,
6,	2128,	1841,	1851,	2496,	1354,	2182,	93,	234,	169,	738,
7,	946,	717,	772,	1568,	1559,	973,	1444,	42,	91,	39,
8,	443,	635,	212,	660,	608,	1166,	740,	861,	61,	130,
9,	731,	243,	155,	99,	177,	1283,	947,	388,	503,	71,
+gp,	855,	312,	74,	86,	36,	214,	795,	968,	973,	712,
0 TOTALNUM,	19483,	13104,	9326,	11417,	7051,	8373,	7234,	7883,	10773,	10443,
TONSLAND,	25555,	19200,	12424,	15016,	12233,	11937,	12894,	12378,	15143,	14477,
SOPCOF %,	98,	99,	104,	100,	109,	92,	106,	106,	106,	101,

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

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

YEAR,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,
AGE										
0,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
1,	0,	0,	0,	0,	0,	0,	43,	1,	0,	1,
2,	283,	655,	63,	105,	77,	40,	113,	277,	804,	326,
3,	1718,	444,	1518,	1275,	1044,	154,	298,	191,	452,	5234,
4,	3565,	2463,	658,	1921,	1774,	776,	274,	307,	235,	1019,
5,	2972,	3036,	2787,	768,	1248,	1120,	554,	153,	226,	179,
6,	1114,	2140,	2554,	1737,	651,	959,	538,	423,	132,	163,
7,	529,	475,	1976,	1909,	1101,	335,	474,	427,	295,	161,
8,	83,	151,	541,	885,	698,	373,	131,	383,	290,	270,
9,	48,	18,	133,	270,	317,	401,	201,	125,	262,	234,
+gp,	334,	128,	81,	108,	32,	162,	185,	301,	295,	394,
0 TOTALNUM,	10646,	9510,	10311,	8978,	6942,	4320,	2811,	2588,	2991,	7981,
TONSLAND,	14882,	12178,	14325,	11726,	8429,	5476,	4026,	4252,	4948,	9642,
SOPCOF %,	102,	97,	100,	102,	106,	106,	103,	100,	103,	100,

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

YEAR,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	2005,	2006,
AGE										
0,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
1,	0,	0,	9,	73,	19,	0,	0,	3,	0,	0,
2,	77,	106,	174,	1461,	4380,	1515,	133,	245,	85,	243,
3,	2913,	1055,	1142,	3061,	3128,	14039,	3443,	2023,	1671,	438,
4,	10517,	5269,	942,	210,	2423,	2879,	13579,	4841,	3852,	2520,
5,	710,	9856,	4677,	682,	173,	1200,	2229,	10510,	6753,	3879,
6,	116,	446,	6619,	2685,	451,	133,	951,	1172,	6127,	5326,
7,	123,	99,	226,	2846,	1151,	239,	163,	412,	542,	3220,
8,	93,	87,	26,	79,	1375,	843,	335,	90,	147,	134,
9,	220,	95,	20,	1,	17,	1095,	860,	167,	28,	62,
+gp,	516,	502,	192,	71,	18,	33,	935,	818,	154,	69,
0 TOTALNUM,	15285,	17515,	14027,	11169,	13135,	21976,	22628,	20281,	19359,	15891,
TONSLAND,	17924,	22210,	18482,	15821,	15890,	24933,	27128,	23287,	20455,	16848,
SOPCOF %,	103,	101,	100,	103,	100,	100,	100,	99,	100,	100,

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

Table 2 Catch weights at age (kg)

YEAR,	1957,	1958,	1959,	1960,	1961,	1962,	1963,	1964,	1965,	1966,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.2500,	.2500,	.2500,	.2500,	.2500,	.2500,	.2500,	.2500,	.2500,	.2500,
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,	.8937,	.8983,	.9034,	.8832,	.8832,	.8929,	.8915,	1.0111,	.9383,	1.0885,

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

Table 2 Catch weights at age (kg)

YEAR,	1967,	1968,	1969,	1970,	1971,	1972,	1973,	1974,	1975,	1976,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.2500,	.2500,	.2500,	.2500,	.2500,	.2500,	.2500,	.2500,	.2500,	.2500,
2,	.4700,	.4700,	.4700,	.4700,	.4700,	.4700,	.4700,	.4700,	.4700,	.4700,
3,	.7300,	.7300,	.7300,	.7300,	.7300,	.7300,	.7300,	.7300,	.7300,	.7300,
4,	1.1300,	1.1300,	1.1300,	1.1300,	1.1300,	1.1300,	1.1300,	1.1300,	1.1300,	1.1300,
5,	1.5500,	1.5500,	1.5500,	1.5500,	1.5500,	1.5500,	1.5500,	1.5500,	1.5500,	1.5500,
6,	1.9700,	1.9700,	1.9700,	1.9700,	1.9700,	1.9700,	1.9700,	1.9700,	1.9700,	1.9700,
7,	2.4100,	2.4100,	2.4100,	2.4100,	2.4100,	2.4100,	2.4100,	2.4100,	2.4100,	2.4100,
8,	2.7600,	2.7600,	2.7600,	2.7600,	2.7600,	2.7600,	2.7600,	2.7600,	2.7600,	2.7600,
9,	3.0700,	3.0700,	3.0700,	3.0700,	3.0700,	3.0700,	3.0700,	3.0700,	3.0700,	3.0700,
+gp,	3.5500,	3.5500,	3.5500,	3.5500,	3.5500,	3.5500,	3.5500,	3.5500,	3.5500,	3.5500,
0 SOPCOFAC,	1.0117,	1.0246,	1.0787,	1.0249,	.9688,	.9597,	.9690,	.9678,	1.1696,	1.0741,

Table 2 Catch weights at age (kg)

YEAR,	1977,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,	1986,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0000,	.0000,	.3000,	.0000,	.0000,	.0000,	.0000,	.3590,	.0000,	.0000,
2,	.3110,	.3570,	.3570,	.6430,	.4520,	.7000,	.4700,	.6810,	.5280,	.6080,
3,	.6330,	.7900,	.6720,	.7130,	.7250,	.8960,	.7400,	1.0110,	.8590,	.8870,
4,	1.0440,	1.0350,	.8940,	.9410,	.9570,	1.1500,	1.0100,	1.2550,	1.3910,	1.1750,
5,	1.4260,	1.3980,	1.1560,	1.1570,	1.2370,	1.4440,	1.3200,	1.8120,	1.7770,	1.6310,
6,	1.8250,	1.8700,	1.5900,	1.4930,	1.6510,	1.4980,	1.6600,	2.0610,	2.3260,	1.9840,
7,	2.2410,	2.3500,	2.0700,	1.7390,	2.0530,	1.8290,	2.0500,	2.0590,	2.4400,	2.5190,
8,	2.2050,	2.5970,	2.5250,	2.0950,	2.4060,	1.8870,	2.2600,	2.1370,	2.4010,	2.5830,
9,	2.5700,	3.0140,	2.6960,	2.4650,	2.7250,	1.9610,	2.5400,	2.3680,	2.5320,	2.5700,
+gp,	2.5910,	2.9200,	3.5190,	3.3100,	3.2500,	2.8560,	3.0400,	2.6860,	2.6860,	2.9220,
0 SOPCOFAC,	.9784,	.9947,	1.0380,	1.0017,	1.0870,	.9238,	1.0554,	1.0593,	1.0559,	1.0141,

Table 2 Catch weights at age (kg)

YEAR,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.3600,	.0000,	.0000,	.3600,
2,	.6050,	.5010,	.5800,	.4380,	.5470,	.5250,	.7550,	.7540,	.6660,	.5340,
3,	.8310,	.7810,	.7790,	.6990,	.6930,	.7240,	.9820,	1.1030,	1.0540,	.8580,
4,	1.1260,	.9740,	.9230,	.9390,	.8840,	.8170,	1.0270,	1.2540,	1.4890,	1.4590,
5,	1.4620,	1.3630,	1.2070,	1.2040,	1.0860,	1.0380,	1.1920,	1.4650,	1.7790,	1.9930,
6,	1.9410,	1.6800,	1.5640,	1.3840,	1.2760,	1.2490,	1.3780,	1.5930,	1.9400,	2.3300,
7,	2.1730,	1.9750,	1.7460,	1.5640,	1.4770,	1.4300,	1.6430,	1.8040,	2.1820,	2.3510,
8,	2.3470,	2.3440,	2.0860,	1.8180,	1.5740,	1.5640,	1.7960,	2.0490,	2.3570,	2.4690,
9,	3.1180,	2.2480,	2.4240,	2.1680,	1.9300,	1.6330,	1.9710,	2.2250,	2.4900,	2.7770,
+gp,	2.9330,	3.2950,	2.5140,	2.3350,	2.1530,	2.1260,	2.2400,	2.4230,	2.6780,	2.5820,
0 SOPCOFAC,	1.0197,	.9695,	1.0025,	1.0195,	1.0635,	1.0554,	1.0320,	.9969,	1.0331,	1.0043,

Table 2 Catch weights at age (kg)

YEAR,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	2005,	2006,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0000,	.0000,	.2780,	.2800,	.2800,	.0000,	.0000,	.3670,	.0000,	.0000,
2,	.5190,	.6220,	.5040,	.6610,	.6080,	.5840,	.5710,	.5740,	.5380,	.4750,
3,	.7710,	.8460,	.6240,	.9360,	.9400,	.8570,	.7150,	.7700,	.6490,	.6010,
4,	1.0660,	1.0160,	.9740,	1.1660,	1.3740,	1.4050,	1.0080,	.8870,	.7970,	.7680,
5,	1.7990,	1.2830,	1.2200,	1.4830,	1.7790,	1.7990,	1.5370,	1.1590,	1.0200,	.9110,
6,	2.2700,	2.0800,	1.4900,	1.6160,	1.9710,	1.9740,	1.9110,	1.6380,	1.2450,	1.1260,
7,	2.3400,	2.5560,	2.4560,	1.8930,	2.1190,	2.3010,	2.0910,	1.8700,	1.8430,	1.3740,
8,	2.4750,	2.5720,	2.6580,	2.8210,	2.3730,	2.3700,	2.3010,	2.4380,	2.0610,	2.1580,
9,	2.5010,	2.4520,	2.5980,	3.7490,	2.7500,	2.6260,	2.4060,	2.3570,	2.2630,	2.2110,
+gp,	2.6760,	2.7530,	2.9530,	3.1960,	3.9660,	3.1300,	2.5350,	2.4170,	2.5790,	2.5690,
0 SOPCOFAC,	1.0250,	1.0106,	.9973,	1.0349,	.9960,	1.0010,	1.0040,	.9928,	.9988,	.9985,

1

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

Run title : FAROE HADDOCK (ICES DIVISION Vb) HAD1_IND

At 18/04/2007 16:27

Table 5 Proportion mature at age

YEAR,	1957,	1958,	1959,	1960,	1961,	1962,	1963,	1964,	1965,	1966,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.0600,	.0600,	.0600,	.0600,	.0600,	.0600,	.0600,	.0600,	.0600,	.0600,
3,	.4800,	.4800,	.4800,	.4800,	.4800,	.4800,	.4800,	.4800,	.4800,	.4800,
4,	.9100,	.9100,	.9100,	.9100,	.9100,	.9100,	.9100,	.9100,	.9100,	.9100,
5,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
6,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
7,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
8,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
9,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
+gp,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,

Table 5 Proportion mature at age

YEAR,	1967,	1968,	1969,	1970,	1971,	1972,	1973,	1974,	1975,	1976,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.0600,	.0600,	.0600,	.0600,	.0600,	.0600,	.0600,	.0600,	.0600,	.0600,
3,	.4800,	.4800,	.4800,	.4800,	.4800,	.4800,	.4800,	.4800,	.4800,	.4800,
4,	.9100,	.9100,	.9100,	.9100,	.9100,	.9100,	.9100,	.9100,	.9100,	.9100,
5,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
6,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
7,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
8,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
9,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
+gp,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,

Table 5 Proportion mature at age

YEAR,	1977,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,	1986,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.0600,	.0600,	.0600,	.0600,	.0600,	.0800,	.0800,	.0800,	.0300,	.0300,
3,	.4800,	.4800,	.4800,	.4800,	.4800,	.6200,	.6200,	.7600,	.6200,	.4300,
4,	.9100,	.9100,	.9100,	.9100,	.9100,	.8900,	.8900,	.9800,	.9600,	.9500,
5,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	.9900,
6,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
7,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
8,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
9,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
+gp,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,

Table 5 Proportion mature at age

YEAR,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.0500,	.0500,	.0200,	.0800,	.1600,	.1800,	.1100,	.0500,	.0300,	.0300,
3,	.3200,	.2400,	.2200,	.3700,	.5800,	.6500,	.5000,	.4200,	.4700,	.4700,
4,	.9100,	.8900,	.8700,	.9000,	.9300,	.9100,	.8500,	.8600,	.9100,	.9300,
5,	.9800,	.9800,	.9900,	1.0000,	1.0000,	1.0000,	.9700,	.9600,	.9600,	.9800,
6,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	.9900,	.9900,	.9900,	1.0000,
7,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
8,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
9,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
+gp,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,

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

```
Table  5    Proportion mature at age
YEAR,         1997,    1998,    1999,    2000,    2001,    2002,    2003,    2004,    2005,    2006,

AGE
  0,          .0000,   .0000,   .0000,   .0000,   .0000,   .0000,   .0000,   .0000,   .0000,   .0000,
  1,          .0000,   .0000,   .0000,   .0000,   .0000,   .0000,   .0000,   .0000,   .0000,   .0000,
  2,          .0100,   .0100,   .0100,   .0200,   .0900,   .0800,   .0700,   .0000,   .0100,   .0000,
  3,          .4700,   .3600,   .3500,   .3600,   .5400,   .4900,   .4500,   .3500,   .3400,   .6400,
  4,          .9100,   .8700,   .8600,   .8700,   .9300,   .9700,   .9700,   .9400,   .9100,   .9700,
  5,         1.0000,   .9900,   .9900,   .9900,  1.0000,  1.0000,   .9900,   .9900,   .9900,  1.0000,
  6,         1.0000,  1.0000,  1.0000,  1.0000,  1.0000,  1.0000,  1.0000,  1.0000,  1.0000,  1.0000,
  7,         1.0000,  1.0000,  1.0000,  1.0000,  1.0000,  1.0000,  1.0000,  1.0000,  1.0000,  1.0000,
  8,         1.0000,  1.0000,  1.0000,  1.0000,  1.0000,  1.0000,  1.0000,  1.0000,  1.0000,  1.0000,
  9,         1.0000,  1.0000,  1.0000,  1.0000,  1.0000,  1.0000,  1.0000,  1.0000,  1.0000,  1.0000,
 +gp,        1.0000,  1.0000,  1.0000,  1.0000,  1.0000,  1.0000,  1.0000,  1.0000,  1.0000,  1.0000,
1
```

Table 2.4.8 Faroe haddock. 2007 tuning file.

```
FAROE Haddock (ICES SUBDIVISION VB)       COMB-SURVEY-SPALY-REV07-jr.txt
102
SUMMER SURVEY
1996 2006
1 1 0.6 0.7
1 8
200   42362.00 38050.46 60866.49   1138.05   210.25   286.72  238.48  416.44
200    6851.83 12379.93 24184.20  47016.45   852.22   177.11   81.49  163.30
200   18825.00  2793.18  2545.32  14600.59 18399.09   285.78   89.61   73.64
200   24115.03  9521.26  5553.74   1548.70  8698.75  9829.62  204.06    7.89
200  161583.90 18837.41  7340.20    371.40  1301.41  4638.88 5699.14   85.81
200   98708.03 96675.44 11962.07   4424.74   174.57   629.27 2615.71 3209.95
200   89340.23 52092.34 57922.78   5538.84  1909.63   162.47  395.07 1256.27
200   47450.28 36196.89 22847.00  35941.83  3962.64   621.93  101.63  428.87
200    9049.95 33653.00 15117.67  16561.09 16561.09   885.34  185.66   24.20
200   14574.15  7694.99 12936.61  16513.01 11635.42 11963.56  517.84   36.46
200    3484.57  9591.77  2004.49   8969.12  8908.60  6973.94 3364.52  125.74
SPRING SURVEY SHIFTED
1993 2006
1 1 0.95 1.0
0 6
100  16009.60   1958.70    216.70    338.10    172.80   305.30    399.60
100  35395.20  19462.60    702.20    216.60    150.70    48.80    141.10
100   6611.80  33206.50  19338.50    663.10     98.20    73.90     56.00
100    371.70   8095.00  15618.00  25478.90    628.10   146.10     37.00
100   3481.60   1545.80   3353.40  10120.10  12687.60   336.20      9.90
100   4459.50   6739.70    112.20   1517.30   4412.30  3139.20     48.70
100  25964.40   8354.40   4858.70    198.10    443.90  1669.60   1940.70
100  25283.30  36311.20   3384.70   1056.60     26.70   106.60    427.70
100  21111.90  17809.30  25760.60   1934.70    684.90    40.60    101.70
100   9391.10  22335.10  13272.70  12734.40    776.10   230.10     19.30
100   1823.10  16068.30  10327.10   7487.70  11212.50   487.50     79.10
100   5798.80   6022.70   7742.00   6165.00   4565.90  4912.80    238.60
100    705.50   6284.80   1574.60   4457.00   3250.40  3267.50   1577.20
100   1173.20   1891.90   4313.40   1010.00   3511.30  3712.50   2874.90
```

Table 2.4.9 Faroe haddock 2007 xsa.

Lowestoft VPA Version 3.1

18/04/2007 16:25

Extended Survivors Analysis

FAROE HADDOCK (ICES DIVISION Vb) HAD1_IND

CPUE data from file D:\vpa\vpa2007\vpa\input-files\comb-survey-spaly-rev07-jr.txt

Catch data for 50 years. 1957 to 2006. Ages 0 to 10.

Fleet,	First, year,	Last, year,	First, age ,	Last, age	Alpha,	Beta
SUMMER SURVEY ,	1996,	2006,	1,	8,	.600,	.700
SPRING SURVEY SHIFTE,	1993,	2006,	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 35 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,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	2005,	2006
0,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000
1,	.000,	.000,	.000,	.001,	.000,	.000,	.000,	.000,	.000,	.000
2,	.009,	.032,	.012,	.080,	.043,	.026,	.003,	.009,	.013,	.021
3,	.089,	.169,	.553,	.313,	.245,	.188,	.074,	.061,	.074,	.085
4,	.210,	.230,	.225,	.181,	.438,	.374,	.281,	.142,	.158,	.153
5,	.467,	.312,	.329,	.252,	.223,	.404,	.559,	.366,	.302,	.237
6,	.528,	.609,	.357,	.318,	.263,	.268,	.659,	.656,	.377,	.416
7,	.550,	1.292,	.732,	.256,	.219,	.217,	.615,	.680,	.742,	.349
8,	.351,	1.004,	1.880,	.618,	.188,	.247,	.536,	.850,	.552,	.404
9,	.464,	.743,	.665,	.302,	.255,	.225,	.428,	.565,	.711,	.477

Table 2.4.9 Faroe haddock 2007 xsa (cont.).

XSA population numbers (Thousands)

YEAR	AGE 0	1	2	3	4	5	6	7	8	9
1997	2.32E+04	4.58E+03	9.23E+03	3.79E+04	6.13E+04	2.10E+03	3.12E+02	3.21E+02	3.47E+02	6.55E+02
1998	3.14E+04	1.90E+04	3.75E+03	7.48E+03	2.84E+04	4.06E+04	1.08E+03	1.51E+02	1.52E+02	2.00E+02
1999	1.72E+05	2.57E+04	1.56E+04	2.97E+03	5.17E+03	1.85E+04	2.44E+04	4.81E+02	3.39E+01	4.55E+01
2000	9.91E+04	1.41E+05	2.11E+04	1.26E+04	1.40E+03	3.38E+03	1.09E+04	1.39E+04	1.89E+02	4.24E+00
2001	6.89E+04	8.12E+04	1.15E+05	1.59E+04	7.55E+03	9.56E+02	2.15E+03	6.48E+03	8.85E+03	8.36E+01
2002	4.75E+04	5.64E+04	6.64E+04	9.04E+04	1.02E+04	3.99E+03	6.26E+02	1.35E+03	4.26E+03	6.00E+03
2003	1.10E+04	3.89E+04	4.62E+04	5.30E+04	6.13E+04	5.75E+03	2.18E+03	3.92E+02	8.93E+02	2.73E+03
2004	1.93E+04	9.01E+03	3.19E+04	3.77E+04	4.03E+04	3.79E+04	2.69E+03	9.23E+02	1.74E+02	4.28E+02
2005	4.28E+03	1.58E+04	7.37E+03	2.59E+04	2.91E+04	2.86E+04	2.15E+04	1.14E+03	3.83E+02	6.08E+01
2006	5.93E+03	3.50E+03	1.29E+04	5.96E+03	1.97E+04	2.03E+04	1.73E+04	1.21E+04	4.45E+02	1.81E+02

Estimated population abundance at 1st Jan 2007

, 0.00E+00, 4.85E+03, 2.87E+03, 1.04E+04, 4.48E+03, 1.38E+04, 1.31E+04, 9.35E+03, 6.99E+03, 2.44E+02,

Taper weighted geometric mean of the VPA populations:

, 2.83E+04, 2.43E+04, 2.08E+04, 1.62E+04, 1.10E+04, 6.39E+03, 3.65E+03, 1.93E+03, 8.94E+02, 4.20E+02,

Standard error of the weighted Log(VPA populations) :

, 1.0566, 1.0369, 1.0000, .9766, .9764, .9738, .9632, .9831, 1.1251, 1.4092,

Log catchability residuals.

Fleet : SUMMER SURVEY

Age	1993	1994	1995	1996
0	No data for this fleet at this age			
1	99.99	99.99	99.99	1.09
2	99.99	99.99	99.99	-.06
3	99.99	99.99	99.99	.20
4	99.99	99.99	99.99	-.33
5	99.99	99.99	99.99	-.08
6	99.99	99.99	99.99	.25
7	99.99	99.99	99.99	.00
8	99.99	99.99	99.99	-.07

Age	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
0	No data for this fleet at this age									
1	.17	-.24	-.30	-.10	-.04	.23	-.03	-.23	-.31	-.24
2	.44	-.14	-.35	.08	-.01	-.09	-.11	.20	.19	-.15
3	.04	-.54	1.42	.09	.30	.11	-.36	-.44	-.21	-.60
4	.49	.10	-.44	-.59	.37	.25	.26	-.18	.15	-.07
5	.06	.07	.12	-.13	-.90	.19	.65	.07	-.04	-.01
6	.47	-.24	.02	.05	-.36	-.48	-.13	.01	.35	.06
7	-.32	1.01	.31	-.03	-.07	-.40	-.26	-.47	.39	-.36
8	.17	.62	.46	.31	-.20	-.37	.31	-.72	-1.30	-.31

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	-4.9356	-5.3054	-5.5994	-5.7836	-5.8288	-5.8641	-5.8641	-5.8641
S.E(Log q)	.4048	.2135	.5643	.3507	.3625	.2917	.4417	.5743

Table 2.4.9 Faroe haddock 2005 xsa (cont.).

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,	1.02,	-.188,	4.82,	.89,	11,	.44,	-4.94,
2,	1.03,	-.435,	5.16,	.96,	11,	.23,	-5.31,
3,	1.17,	-.886,	4.87,	.76,	11,	.67,	-5.60,
4,	.83,	2.927,	6.41,	.97,	11,	.22,	-5.78,
5,	.92,	1.233,	6.08,	.96,	11,	.32,	-5.83,
6,	.98,	.383,	5.91,	.97,	11,	.30,	-5.86,
7,	1.13,	-1.296,	5.72,	.92,	11,	.48,	-5.88,
8,	1.11,	-.856,	5.94,	.87,	11,	.64,	-5.96,

Fleet : SPRING SURVEY SHIFTED

Age	1993,	1994,	1995,	1996
0 ,	-.61,	.94,	.89,	-1.09
1 ,	-.39,	-.83,	.46,	.67
2 ,	-.43,	-.53,	.01,	.55
3 ,	.03,	.02,	-.20,	.64
4 ,	-.19,	-.05,	.01,	.58
5 ,	-.17,	-.96,	-.12,	1.17
6 ,	.50,	-.23,	-.13,	.07
7 ,	No data for this fleet at this age			
8 ,	No data for this fleet at this age			

Age	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	2005,	2006
0 ,	-.28,	-.33,	-.27,	.25,	.44,	.00,	-.18,	.42,	-.18,	.00
1 ,	-.09,	-.04,	-.13,	-.36,	-.52,	.07,	.11,	.59,	.07,	.38
2 ,	.63,	-1.84,	.48,	-.12,	.18,	.05,	.14,	.23,	.10,	.56
3 ,	.49,	.29,	-.45,	-.46,	-.15,	-.06,	-.17,	-.03,	.03,	.03
4 ,	.62,	.36,	-.24,	-1.79,	.02,	-.22,	.57,	-.04,	-.04,	.42
5 ,	.76,	-.12,	.05,	-1.07,	-.80,	-.32,	.21,	.45,	.26,	.67
6 ,	-.49,	-.06,	.26,	-.48,	-.35,	-.77,	-.23,	.66,	.20,	1.05
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,	-6.0304,	-5.4075,	-6.0446,	-6.1289,	-6.4038,	-6.5469,	-6.8553,
S.E(Log q),	.5540,	.4338,	.6344,	.3084,	.6011,	.6557,	.4988,

Table 2.4.9 Faroe haddock 2005 xsa (cont.).

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,	.93,	.622,	6.34,	.86,	14,	.53,	-6.03,
1,	1.22,	-2.016,	4.36,	.87,	14,	.48,	-5.41,
2,	.81,	1.833,	6.77,	.88,	14,	.47,	-6.04,
3,	.93,	1.290,	6.38,	.96,	14,	.28,	-6.13,
4,	.82,	2.212,	6.88,	.93,	14,	.43,	-6.40,
5,	.92,	.671,	6.70,	.86,	14,	.62,	-6.55,
6,	.84,	2.142,	7.02,	.94,	14,	.37,	-6.86,

1

Terminal year survivor and F summaries :

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

Year class = 2006

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 SHIFTE,	4855.,	.573,	.000,	.00,	1,	1.000,	.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
4855.,	.57,	.00,	1,	.000,	.000

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

Year class = 2005

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
SUMMER SURVEY ,	2261.,	.423,	.000,	.00,	1,	.411,	.000
SPRING SURVEY SHIFTE,	3390.,	.354,	.274,	.77,	2,	.589,	.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
2869.,	.27,	.20,	3,	.755,	.000

1

Table 2.4.9 Faroe haddock 2005 xsa (cont.).

```
Age  2   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       ,      8460.,   .245,       .078,    .32,   2,  .537,     .026
SPRING SURVEY SHIFTE,     13783.,   .311,       .146,    .47,   3,  .332,     .016

  F shrinkage mean  ,     11693.,    .50,,,,                         .131,     .019

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
    10379.,       .18,      .12,    6,    .653,   .021


Age  3   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       ,      4272.,   .226,       .208,    .92,   3,  .443,     .089
SPRING SURVEY SHIFTE,      5176.,   .223,       .155,    .70,   4,  .457,     .074

  F shrinkage mean  ,      2878.,    .50,,,,                         .100,     .129

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
     4484.,       .15,      .12,    8,    .805,   .085


1
Age  4   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       ,     14228.,   .192,       .084,    .44,   4,  .497,     .149
SPRING SURVEY SHIFTE,     15459.,   .210,       .066,    .31,   5,  .413,     .138

  F shrinkage mean  ,      7051.,    .50,,,,                         .091,     .280

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
    13815.,       .14,      .09,   10,    .640,   .153
```

Table 2.4.9 Faroe haddock 2005 xsa (cont.).

Age 5 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 ,	13094.,	.172,	.090,	.52,	5,	.531,	.237
SPRING SURVEY SHIFTE,	14953.,	.201,	.106,	.53,	6,	.376,	.211
F shrinkage mean ,	7754.,	.50,,,,				.093,	.373

Weighted prediction :

Survivors,	Int,	Ext,	N,	Var,	F
at end of year,	s.e,	s.e,	,	Ratio,	
13110.,	.13,	.08,	12,	.640,	.237

1

Age 6 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 ,	8846.,	.153,	.049,	.32,	6,	.563,	.435
SPRING SURVEY SHIFTE,	10599.,	.191,	.211,	1.11,	7,	.330,	.375
F shrinkage mean ,	8530.,	.50,,,,				.106,	.448

Weighted prediction :

Survivors,	Int,	Ext,	N,	Var,	F
at end of year,	s.e,	s.e,	,	Ratio,	
9354.,	.12,	.09,	14,	.745,	.416

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

Year class = 1999

Fleet,	Estimated,	Int,	Ext,	Var,	N,	Scaled,	Estimated
,	Survivors,	s.e,	s.e,	Ratio,	,	Weights,	F
SUMMER SURVEY ,	7528.,	.157,	.107,	.68,	7,	.596,	.327
SPRING SURVEY SHIFTE,	7480.,	.199,	.116,	.58,	7,	.261,	.329
F shrinkage mean ,	4512.,	.50,,,,				.143,	.498

Weighted prediction :

Survivors,	Int,	Ext,	N,	Var,	F
at end of year,	s.e,	s.e,	,	Ratio,	
6986.,	.13,	.08,	15,	.652,	.349

1

Table 2.4.9 Faroe haddock 2005 xsa (cont.).

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

Year class = 1998

Fleet,	Estimated,	Int,	Ext,	Var,	N,	Scaled,	Estimated
,	Survivors,	s.e,	s.e,	Ratio,	,	Weights,	F
SUMMER SURVEY ,	264.,	.204,	.118,	.58,	8,	.546,	.378
SPRING SURVEY SHIFTE,	277.,	.215,	.156,	.73,	7,	.150,	.363
F shrinkage mean ,	198.,	.50,,,,				.304,	.478

Weighted prediction :

Survivors,	Int,	Ext,	N,	Var,	F
at end of year,	s.e,	s.e,	,	Ratio,	
244.,	.19,	.08,	16,	.432,	.404

Age 9 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 ,	60.,	.195,	.205,	1.05,	8,	.446,	.660
SPRING SURVEY SHIFTE,	74.,	.212,	.093,	.44,	7,	.127,	.563
F shrinkage mean ,	152.,	.50,,,,				.428,	.313

Weighted prediction :

Survivors,	Int,	Ext,	N,	Var,	F
at end of year,	s.e,	s.e,	,	Ratio,	
92.,	.23,	.18,	16,	.767,	.477

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

Run title : FAROE HADDOCK (ICES DIVISION Vb) HAD1_IND

At 18/04/2007 16:27

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR,	1957,	1958,	1959,	1960,	1961,	1962,	1963,	1964,	1965,	1966,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0010,	.0024,	.0132,	.0150,	.0219,	.0149,	.0106,	.0018,	.0017,	.0032,
2,	.1394,	.1939,	.1066,	.2074,	.1875,	.3232,	.3801,	.0876,	.0691,	.0610,
3,	.3707,	.4378,	.3860,	.4599,	.4162,	.5866,	.5639,	.3723,	.2354,	.2370,
4,	.6163,	.5737,	.4782,	.6926,	.4209,	.5980,	.7261,	.5193,	.4767,	.4515,
5,	.3909,	.5386,	.4195,	.5260,	.4387,	.3480,	.5591,	.5369,	.3678,	.5006,
6,	.4380,	.6346,	.6458,	.6591,	.5879,	.6706,	.4026,	.6107,	.5882,	.5421,
7,	.6340,	.9504,	.9184,	1.2130,	.9483,	1.0499,	1.2493,	.3375,	.9618,	.9128,
8,	.5599,	.7839,	.8206,	.9667,	.8742,	.9736,	1.1139,	1.2027,	2.3618,	.7509,
9,	.5321,	.7028,	.6625,	.8198,	.6600,	.7351,	.8185,	.6472,	.9619,	.6373,
+gp,	.5321,	.7028,	.6625,	.8198,	.6600,	.7351,	.8185,	.6472,	.9619,	.6373,
0 FBAR 3- 7,	.4900,	.6270,	.5696,	.7101,	.5624,	.6506,	.7002,	.4753,	.5260,	.5288,

Table 8 Fishing mortality (F) at age

YEAR,	1967,	1968,	1969,	1970,	1971,	1972,	1973,	1974,	1975,	1976,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0012,	.0014,	.0024,	.0033,	.0015,	.0016,	.0114,	.0033,	.0015,	.0014,
2,	.0641,	.1261,	.0860,	.0551,	.0526,	.0253,	.1677,	.1266,	.1230,	.0908,
3,	.1873,	.2647,	.2363,	.2528,	.1936,	.4225,	.4320,	.2172,	.2650,	.1877,
4,	.2971,	.3483,	.5320,	.3344,	.4186,	.2853,	.2391,	.3730,	.2412,	.3810,
5,	.2997,	.2847,	.3330,	.3639,	.2754,	.4516,	.3143,	.1279,	.2116,	.2216,
6,	.5406,	.4540,	.4975,	.5561,	.5560,	.1495,	.2703,	.1714,	.0957,	.2871,
7,	.6906,	.8367,	.8277,	.8739,	.8385,	.6720,	.1951,	.2134,	.0859,	.1601,
8,	.6634,	.5851,	1.0631,	.5430,	.4224,	.4066,	.2907,	.1433,	.1599,	.2538,
9,	.5022,	.5057,	.6566,	.5386,	.5061,	.3957,	.2633,	.2067,	.1595,	.2621,
+gp,	.5022,	.5057,	.6566,	.5386,	.5061,	.3957,	.2633,	.2067,	.1595,	.2621,
0 FBAR 3- 7,	.4031,	.4377,	.4853,	.4762,	.4564,	.3962,	.2901,	.2206,	.1799,	.2475,

Table 8 Fishing mortality (F) at age

YEAR,	1977,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,	1986,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0000,	.0000,	.0002,	.0000,	.0000,	.0000,	.0000,	.0006,	.0000,	.0000,
2,	.0108,	.0010,	.0004,	.0325,	.0237,	.0383,	.0251,	.0329,	.0279,	.0096,
3,	.1128,	.0547,	.0457,	.0285,	.1373,	.4614,	.1914,	.1164,	.1690,	.0936,
4,	.1814,	.1664,	.1255,	.2024,	.1312,	.3706,	.3476,	.3890,	.2385,	.2483,
5,	.5272,	.2114,	.1912,	.2748,	.2110,	.2913,	.3494,	.2167,	.3467,	.2588,
6,	.7245,	.3818,	.1408,	.2134,	.2263,	.2772,	.1380,	.3330,	.4153,	.3577,
7,	.3903,	.5758,	.2720,	.1701,	.2003,	.2521,	.2987,	.0851,	.2079,	.1568,
8,	.3787,	.4967,	.3301,	.3951,	.0919,	.2263,	.3098,	.2924,	.1716,	.5162,
9,	.4436,	.3688,	.2129,	.2525,	.1728,	.2851,	.2903,	.2647,	.2775,	.3093,
+gp,	.4436,	.3688,	.2129,	.2525,	.1728,	.2851,	.2903,	.2647,	.2775,	.3093,
0 FBAR 3- 7,	.3872,	.2780,	.1550,	.1778,	.1812,	.3305,	.2650,	.2281,	.2755,	.2230,

Table 8 Fishing mortality (F) at age

YEAR,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0060,	.0000,	.0000,	.0001,
2,	.0334,	.0391,	.0048,	.0123,	.0286,	.0166,	.0708,	.0488,	.0090,	.0078,
3,	.0921,	.0674,	.1197,	.1270,	.1628,	.0736,	.1655,	.1644,	.1049,	.0745,
4,	.1834,	.1850,	.1349,	.2188,	.2615,	.1750,	.1815,	.2567,	.3126,	.3634,
5,	.2611,	.2349,	.3298,	.2306,	.2158,	.2620,	.1824,	.1459,	.3054,	.4177,
6,	.3065,	.3043,	.3176,	.3530,	.3126,	.2562,	.1933,	.2066,	.1810,	.3778,
7,	.4724,	.2068,	.5127,	.4175,	.3971,	.2622,	.1940,	.2316,	.2175,	.3503,
8,	.5820,	.2364,	.3851,	.4563,	.2632,	.2253,	.1545,	.2373,	.2436,	.3168,
9,	.3634,	.2347,	.3381,	.3373,	.2917,	.2373,	.1819,	.2166,	.2533,	.3172,
+gp,	.3634,	.2347,	.3381,	.3373,	.2917,	.2373,	.1819,	.2166,	.2533,	.3172,
0 FBAR 3- 7,	.2631,	.1997,	.2829,	.2694,	.2700,	.2058,	.1833,	.2010,	.2243,	.3167,

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

Table 8 Fishing mortality (F) at age

YEAR,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	2005,	2006,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0000,	.0000,	.0004,	.0006,	.0003,	.0000,	.0000,	.0004,	.0000,	.0000,
2,	.0093,	.0318,	.0124,	.0798,	.0429,	.0255,	.0032,	.0085,	.0128,	.0210,
3,	.0888,	.1693,	.5528,	.3126,	.2448,	.1882,	.0745,	.0611,	.0741,	.0847,
4,	.2104,	.2297,	.2247,	.1813,	.4382,	.3736,	.2806,	.1425,	.1585,	.1528,
5,	.4666,	.3120,	.3285,	.2520,	.2231,	.4044,	.5592,	.3657,	.3023,	.2372,
6,	.5282,	.6092,	.3572,	.3184,	.2634,	.2675,	.6585,	.6563,	.3774,	.4155,
7,	.5501,	1.2924,	.7323,	.2555,	.2186,	.2169,	.6145,	.6795,	.7423,	.3486,
8,	.3509,	1.0041,	1.8798,	.6182,	.1885,	.2466,	.5357,	.8496,	.5516,	.4041,
9,	.4636,	.7432,	.6647,	.3022,	.2547,	.2253,	.4284,	.5647,	.7108,	.4767,
+gp,	.4636,	.7432,	.6647,	.3022,	.2547,	.2253,	.4284,	.5647,	.7108,	.4767,
0 FBAR 3- 7,	.3688,	.5225,	.4391,	.2640,	.2776,	.2901,	.4375,	.3810,	.3309,	.2478,

1

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

Run title : FAROE HADDOCK (ICES DIVISION Vb) HAD1_IND

At 18/04/2007 16:27

Terminal Fs derived using XSA (With F shrinkage)

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

YEAR,	1957,	1958,	1959,	1960,	1961,	1962,	1963,	1964,	1965,	1966,
AGE										
0,	64927,	54061,	77651,	58761,	71715,	45400,	33843,	30192,	37948,	81925,
1,	47944,	53158,	44261,	63576,	48109,	58715,	37170,	27709,	24719,	31070,
2,	35106,	39212,	43417,	35763,	51279,	38537,	47362,	30110,	22644,	20203,
3,	25440,	25003,	26445,	31954,	23796,	34806,	22837,	26515,	22585,	17302,
4,	20280,	14377,	13213,	14717,	16517,	12850,	15850,	10638,	14961,	14613,
5,	5517,	8965,	6632,	6706,	6028,	8877,	5786,	6278,	5182,	7604,
6,	2786,	3055,	4284,	3570,	3245,	3182,	5132,	2708,	3005,	2937,
7,	1377,	1472,	1326,	1839,	1512,	1476,	1332,	2809,	1204,	1366,
8,	585,	598,	466,	433,	448,	480,	423,	313,	1641,	377,
9,	252,	274,	224,	168,	135,	153,	148,	114,	77,	127,
+gp,	154,	227,	106,	54,	29,	46,	45,	16,	14,	21,
0 TOTAL,	204367,	200401,	218024,	217540,	222812,	204522,	169929,	137402,	133981,	177545,

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

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

YEAR	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
AGE										
0	47769	53240	23137	49624	35420	78976	104882	83656	39145	52391
1	67075	39110	43589	18943	40629	28999	64660	85870	68492	32049
2	25356	54853	31976	35602	15458	33214	23704	52338	70075	55991
3	15563	19470	39588	24023	27585	12007	26515	16411	37753	50734
4	11176	10566	12234	25591	15275	18609	6443	14094	10813	23715
5	7617	6798	6106	5884	14997	8229	11455	4153	7947	6956
6	3774	4622	4187	3583	3348	9323	4289	6849	2992	5266
7	1398	1800	2403	2084	1682	1572	6573	2680	4725	2226
8	449	574	638	860	712	596	657	4428	1772	3550
9	146	189	262	180	409	382	325	402	3141	1237
+gp	36	33	45	26	281	319	52	865	1396	1515
0 TOTAL	180359	191254	164166	166400	155795	192226	249554	271746	248251	235628

Terminal Fs derived using XSA (With F shrinkage)

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

YEAR	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
AGE										
0	4158	7381	5211	23645	29327	60947	59118	39698	14184	28179
1	42894	3404	6043	4267	19359	24011	49899	48401	32502	11613
2	26203	35118	2787	4947	3493	15850	19658	40854	39605	26611
3	41864	21223	28724	2281	3921	2793	12489	15696	32367	31535
4	34427	30621	16451	22465	1815	2798	1442	8444	11438	22380
5	13265	23511	21226	11881	15024	1303	1582	834	4685	7378
6	4563	6410	15581	14354	7390	9960	797	913	550	2712
7	3235	1810	3583	11081	9493	4825	6180	569	536	297
8	1553	1793	833	2235	7654	6362	3070	3754	428	356
9	2255	871	893	490	1232	5716	4154	1844	2294	295
+gp	2614	1109	424	424	250	947	3464	4573	4410	2937
0 TOTAL	177031	133251	101756	98070	98958	135514	161854	165580	143000	134293

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

YEAR	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
AGE										
0	21631	14165	4497	4001	2724	9652	148201	69541	13766	5590
1	23071	17710	11598	3682	3276	2230	7902	121336	56935	11271
2	9508	18889	14500	9495	3014	2682	1826	6431	99341	46615
3	21579	7528	14872	11814	7679	2398	2160	1393	5014	80606
4	23512	16113	5762	10803	8519	5342	1824	1499	967	3696
5	14295	16024	10963	4122	7106	5370	3672	1246	949	579
6	4663	9015	10372	6454	2680	4689	3383	2505	881	573
7	1553	2810	5444	6181	3713	1605	2971	2283	1668	602
8	208	793	1871	2669	3333	2043	1011	2004	1483	1099
9	174	95	512	1042	1385	2098	1335	709	1294	952
+gp	1202	673	310	414	139	843	1223	1699	1448	1591
0 TOTAL	121396	103815	80701	60678	43568	38952	175508	210645	183748	153173

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

YEAR	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
AGE											
0	23249	31433	172078	99126	68947	47520	11006	19311	4280	5929	0
1	4577	19035	25736	140886	81157	56449	38906	9011	15811	3504	4855
2	9227	3747	15585	21062	115282	66429	46216	31853	7375	12945	2869
3	37870	7485	2972	12602	15922	90421	53016	37718	25858	5961	10379
4	61259	28370	5173	1400	7548	10206	61328	40291	29051	19658	4484
5	2104	40638	18459	3383	956	3987	5751	37924	28607	20299	13815
6	312	1080	24354	10881	2153	626	2179	2691	21540	17311	13110
7	321	151	481	13950	6479	1354	392	923	1143	12091	9354
8	347	152	34	189	8846	4263	893	174	383	445	6986
9	655	200	46	4	84	5998	2728	428	61	181	244
+gp	1523	1043	432	299	88	180	2940	2072	330	199	193
0 TOTAL	141445	133334	265349	303783	307462	287434	225355	182398	134438	98525	66289

Table 2.4.12 Faroe haddock. Stock summary of the VPA 2007.

Run	title	FAROE	HADDOCK	(ICES	DIVISION	Vb)	HAD1_IND
At	18/04/2007		18:08				
Table	16		Summary	(without	SOP	correction)	
Terminal	Fs	derived	using	XSA	(With	F	shrinkage)
	Recruits Age 0	Recruits Age 2	Total Biomass	Total SSB	Landings	Yield/SSB	FBAR(3-7)
1957	64927	35106	90264	51049	20995	0.4113	0.49
1958	54061	39212	92975	51409	23871	0.4643	0.627
1959	77651	43417	89969	48340	20239	0.4187	0.5696
1960	58761	35763	96422	51101	25727	0.5035	0.7101
1961	71715	51279	93296	47901	20831	0.4349	0.5624
1962	45400	38537	98262	52039	27151	0.5217	0.6506
1963	33843	47362	90204	49706	27571	0.5547	0.7002
1964	30192	30110	75561	44185	19490	0.4411	0.4753
1965	37948	22644	71884	45605	18479	0.4052	0.526
1966	81925	20203	68774	44027	18766	0.4262	0.5288
1967	47769	25356	77101	42086	13381	0.3179	0.4031
1968	53240	54853	87972	45495	17852	0.3924	0.4377
1969	23137	31976	94880	53584	23272	0.4343	0.4853
1970	49624	35602	92145	59959	21361	0.3563	0.4762
1971	35420	15458	92934	63923	19393	0.3034	0.4564
1972	78976	33214	91511	63137	16485	0.2611	0.3962
1973	104882	23704	98983	61626	18035	0.2927	0.2901
1974	83656	52338	116889	64636	14773	0.2286	0.2206
1975	39145	70075	138926	75412	20715	0.2747	0.1799
1976	52391	55991	143653	89234	26211	0.2937	0.2475
1977	4158	26203	121075	96400	25555	0.2651	0.3872
1978	7381	35118	120624	97268	19200	0.1974	0.278
1979	5211	2787	99549	85440	12424	0.1454	0.155
1980	23645	4947	87686	81948	15016	0.1832	0.1778
1981	29327	3493	79018	75899	12233	0.1612	0.1812
1982	60947	15850	68364	56852	11937	0.21	0.3305
1983	59118	19658	64040	51867	12894	0.2486	0.265
1984	39698	40854	100898	53905	12378	0.2296	0.2281
1985	14184	39605	94218	62732	15143	0.2414	0.2755
1986	28179	26611	98872	65799	14477	0.22	0.223
1987	21631	9508	88041	67582	14882	0.2202	0.2631
1988	14165	18889	77860	62239	12178	0.1957	0.1997
1989	4497	14500	70198	52096	14325	0.275	0.2829
1990	4001	9495	54203	44160	11726	0.2655	0.2694
1991	2724	3014	39341	35193	8429	0.2395	0.27
1992	9652	2682	29648	27493	5476	0.1992	0.2058
1993	148201	1826	29326	23735	4026	0.1696	0.1833
1994	69541	6431	27998	22125	4252	0.1922	0.201
1995	13766	99341	90521	23329	4948	0.2121	0.2243
1996	5590	46615	116871	51612	9642	0.1868	0.3167
1997	23249	9227	111109	85016	17924	0.2108	0.3688
1998	31433	3747	96011	85383	22210	0.2601	0.5225
1999	172078	15585	83374	66307	18482	0.2787	0.4391
2000	99126	21062	117312	56409	15821	0.2805	0.264
2001	68947	115282	159397	65280	15890	0.2434	0.2776
2002	47520	66429	168570	92928	24933	0.2683	0.2901
2003	11006	46216	156007	108674	27128	0.2496	0.4375
2004	19311	31853	142902	99849	23287	0.2332	0.381
2005	4280	7375	103784	86405	20455	0.2367	0.3309
2006	5929	12945	81300	71776	16848	0.2347	0.2478
Arith.							
Mean	43463	30387	93614	61203	17174	0.2898	0.3582
Units	(Thousands)	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

Table 2.4.13 Management option tables INPUT DATA FAROE HADDOCK

Stock size

The yearclasses at age 2 up to 2005 included are derived from the final 2007 XSA.
The yearclass 2006 at age 2 is estimated from the 2007 XSA
applying a natural mortality of 0.2 in forward calculations of the numbers using standard VPA equations
The yearclass 2007 at age 2 in 2009 is estimated as the geomean of the yearclasses since 1980

	Age0	Age1	Age2
YC2005	4280	3504	2869
YC2006	5929	4855	3975
YC2007			
0.818731			

Age	2007	2008	2009
2	2869	3975	13251
3	10379		
4	4484		
5	13815		
6	13110		
7	9354		
8	6986		
9	244		
10+	193		

Predicted values rounded

Year	age 2	Geomean(1980-2008)
1980	4947	
1981	3493	
1982	15850	
1983	19658	
1984	40854	
1985	39605	
1986	26611	
1987	9508	
1988	18889	13251
1989	14500	
1990	9495	
1991	3014	
1992	2682	
1993	1826	
1994	6431	
1995	99341	
1996	46615	
1997	9227	
1998	3747	
1999	15585	
2000	21062	
2001	115282	
2002	66429	
2003	46216	
2004	31853	
2005	7375	
2006	12945	
2007	2869	
2008	3975	
2009	13251	

Proportion mature at age

Age	2007	2008	2009		2005	2006	2007	Avg(05-07)
2	0.02	0.01	0.01		0.01	0.01	0.02	0.01
3	0.42	0.39	0.39		0.34	0.42	0.42	0.39
4	0.91	0.91	0.91		0.91	0.91	0.91	0.91
5	1.00	1.00	1.00		0.99	1.00	1.00	1.00
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 2008-2009 is estimated as the average of the maturity at age 2005-2007

Catch/stock weights at age

Age	2007	2008	2009
2	0.475	0.475	0.475
3	0.601	0.601	0.601
4	0.768	0.768	0.768
5	0.911	0.911	0.911
6	1.126	1.126	1.126
7	1.374	1.374	1.374
8	2.158	2.158	2.158
9	2.211	2.211	2.211
10+	2.569	2.569	2.569

Prediction using 2006 mean catch weight at age from the 2007 assessment

	2006
2	0.475
3	0.601
4	0.768
5	0.911
6	1.126
7	1.374
8	2.158
9	2.211
10+	2.569

Exploitation pattern

Age	2007	2008	2009
2	0.0109	0.0109	0.0109
3	0.0568	0.0568	0.0568
4	0.1172	0.1172	0.1172
5	0.2337	0.2337	0.2337
6	0.3742	0.3742	0.3742
7	0.4571	0.4571	0.4571
8	0.4661	0.4661	0.4661
9	0.4524	0.4524	0.4524
10+	0.4524	0.4524	0.4524
Avg3-7	0.2478	0.2478	0.2478

2004	2005	2006	Average F for 2004-06		Age	Rescaled to Fbar2006 Average F for 2004-06
0.0085	0.0128	0.021	2	0.0141	2	0.0109
0.0611	0.0741	0.0847	3	0.0733	3	0.0568
0.1425	0.1585	0.1528	4	0.1513	4	0.1172
0.3657	0.3023	0.2372	5	0.3017	5	0.2337
0.6563	0.3774	0.4155	6	0.4831	6	0.3742
0.6795	0.7423	0.3486	7	0.5901	7	0.4571
0.8496	0.5516	0.4041	8	0.6018	8	0.4661
0.5647	0.7108	0.4767	9	0.5841	9	0.4524
0.5647	0.7108	0.4767	10+	0.5841	10+	0.4524
0.381	0.3309	0.2478	Fbar(3-7)	0.3199	Fbar(3-7)	0.2478

The exploitation pattern is estimated from the average fishing mortality matrix 2004-2006 from the final VPA in 2007 (re-scaled to 2006)

Table 2.4.14 **Faroe haddock. Management option table - Input data**

MFDP version 1
Run: man07
Time and date: 11:58 4/20/2007
Fbar age range: 3-7

2007

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
2	2869	0.2	0.02	0	0	0.475	1.09E-02	0.475
3	10379	0.2	0.42	0	0	0.601	5.68E-02	0.601
4	4484	0.2	0.91	0	0	0.768	0.117155	0.768
5	13815	0.2	1	0	0	0.911	0.23369	0.911
6	13110	0.2	1	0	0	1.126	0.374131	1.126
7	9354	0.2	1	0	0	1.374	0.457054	1.374
8	6986	0.2	1	0	0	2.158	0.466063	2.158
9	244	0.2	1	0	0	2.211	0.452355	2.211
10	193	0.2	1	0	0	2.569	0.452355	2.569

2008

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
2	3975	0.2	0.01	0	0	0.475	1.09E-02	0.475
3	.	0.2	0.39	0	0	0.601	5.68E-02	0.601
4	.	0.2	0.91	0	0	0.768	0.117155	0.768
5	.	0.2	1	0	0	0.911	0.23369	0.911
6	.	0.2	1	0	0	1.126	0.374131	1.126
7	.	0.2	1	0	0	1.374	0.457054	1.374
8	.	0.2	1	0	0	2.158	0.466063	2.158
9	.	0.2	1	0	0	2.211	0.452355	2.211
10	.	0.2	1	0	0	2.569	0.452355	2.569

2009

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
2	13251	0.2	0.01	0	0	0.475	1.09E-02	0.475
3	.	0.2	0.39	0	0	0.601	5.68E-02	0.601
4	.	0.2	0.91	0	0	0.768	0.117155	0.768
5	.	0.2	1	0	0	0.911	0.23369	0.91
6	.	0.2	1	0	0	1.126	0.374131	1.126
7	.	0.2	1	0	0	1.374	0.457054	1.374
8	.	0.2	1	0	0	2.158	0.466063	2.158
9	.	0.2	1	0	0	2.211	0.452355	2.211
10	.	0.2	1	0	0	2.569	0.452355	2.569

Input units are thousands and kg - output in tonnes

Table 2.4.15 Faroe haddock. Management option table - Results

MFDP version 1
Run: man07
Index file 19/04/2007
Time and date: 11:58 4/20/2007
Fbar age range: 3-7

2007				
Biomass	**SSB**	**FMult**	**FBar**	**Landings**
67355	62092	1	0.2478	17039

2008					2009	
Biomass	**SSB**	**FMult**	**FBar**	**Landings**	**Biomass**	**SSB**
51636	48360	0	0	0	58632	51076
.	48360	0.1	0.0248	1657	56775	49221
.	48360	0.2	0.0496	3249	54994	47442
.	48360	0.3	0.0743	4778	53285	45736
.	48360	0.4	0.0991	6247	51647	44099
.	48360	0.5	0.1239	7658	50075	42529
.	48360	0.6	0.1487	9015	48567	41023
.	48360	0.7	0.1734	10318	47120	39578
.	48360	0.8	0.1982	11570	45731	38192
.	48360	0.9	0.223	12774	44399	36861
.	48360	1	0.2478	13931	43121	35585
.	48360	1.1	0.2725	15044	41894	34360
.	48360	1.2	0.2973	16114	40716	33184
.	48360	1.3	0.3221	17143	39585	32055
.	48360	1.4	0.3469	18132	38500	30972
.	48360	1.5	0.3716	19084	37458	29932
.	48360	1.6	0.3964	19999	36457	28933
.	48360	1.7	0.4212	20880	35496	27974
.	48360	1.8	0.446	21728	34573	27053
.	48360	1.9	0.4707	22543	33687	26169
.	48360	2	0.4955	23329	32836	25320

Input units are thousands and kg - output in tonnes

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

MFYPR version 1
Run: ypr07a
Index file 19/04/2007
Time and date: 15:32 4/20/2007
Fbar age range: 3-7

Age	M	Mat	PF	PM	SWt	Sel	CWt
2	0.2	0.06	0	0	0.553	0.0109	0.553
3	0.2	0.46	0	0	0.802	0.0568	0.802
4	0.2	0.91	0	0	1.075	0.1172	1.075
5	0.2	0.99	0	0	1.409	0.2337	1.409
6	0.2	1.00	0	0	1.729	0.3741	1.729
7	0.2	1.00	0	0	2.031	0.4571	2.031
8	0.2	1.00	0	0	2.274	0.4661	2.274
9	0.2	1.00	0	0	2.497	0.4524	2.497
10	0.2	1.00	0	0	2.819	0.4524	2.819

Weights in kilograms

Table 2.4.17 Faroe haddock. Long-term Prediction - Results

MFYPR version 1
Run: ypr07a
Time and date: 15:32 4/20/2007
Yield per results

FMult	Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNosJan	SSBJan	SpwnNosSpwn	SSBSpwn
0	0	0	0	5.5167	8.6677	4.062	7.7165	4.062	7.7165
0.1	0.0248	0.1009	0.2104	5.0141	7.3489	3.5605	6.3986	3.5605	6.3986
0.2	0.0496	0.1715	0.3432	4.663	6.45	3.2104	5.5007	3.2104	5.5007
0.3	0.0743	0.224	0.4316	4.4023	5.7996	2.9507	4.8513	2.9507	4.8513
0.4	0.0991	0.2648	0.4929	4.1999	5.3078	2.7492	4.3604	2.7492	4.3604
0.5	0.1239	0.2977	0.5366	4.0372	4.9231	2.5876	3.9767	2.5876	3.9767
0.6	0.1487	0.3248	0.5686	3.903	4.6139	2.4544	3.6685	2.4544	3.6685
0.7	0.1734	0.3478	0.5924	3.7899	4.36	2.3422	3.4155	2.3422	3.4155
0.8	0.1982	0.3675	0.6104	3.6928	4.1474	2.2461	3.2039	2.2461	3.2039
0.9	0.223	0.3847	0.6243	3.6082	3.9668	2.1624	3.0242	2.1624	3.0242
1	0.2478	0.3998	0.635	3.5335	3.8111	2.0887	2.8694	2.0887	2.8694
1.1	0.2725	0.4134	0.6433	3.4669	3.6753	2.0231	2.7346	2.0231	2.7346
1.2	0.2973	0.4256	0.6499	3.407	3.5557	1.9641	2.6159	1.9641	2.6159
1.3	0.3221	0.4367	0.6551	3.3526	3.4494	1.9106	2.5105	1.9106	2.5105
1.4	0.3469	0.4469	0.6592	3.3029	3.3541	1.8619	2.4161	1.8619	2.4161
1.5	0.3716	0.4562	0.6624	3.2572	3.2681	1.8171	2.331	1.8171	2.331
1.6	0.3964	0.4649	0.665	3.2149	3.1899	1.7757	2.2537	1.7757	2.2537
1.7	0.4212	0.473	0.667	3.1756	3.1184	1.7374	2.1832	1.7374	2.1832
1.8	0.446	0.4805	0.6685	3.139	3.0528	1.7016	2.1184	1.7016	2.1184
1.9	0.4707	0.4875	0.6697	3.1046	2.9922	1.6682	2.0587	1.6682	2.0587
2	0.4955	0.4942	0.6706	3.0723	2.936	1.6367	2.0034	1.6367	2.0034

Reference point	F multiplier	Absolute F
Fbar(3-7)	1	0.2478
FMax	2.456	0.6085
F0.1	0.6077	0.1506
F35%SPR	1.1273	0.2793
Fhigh	8.2027	2.0323
Fmed	1.2761	0.3162
Flow	-99	0

Weights in kilograms

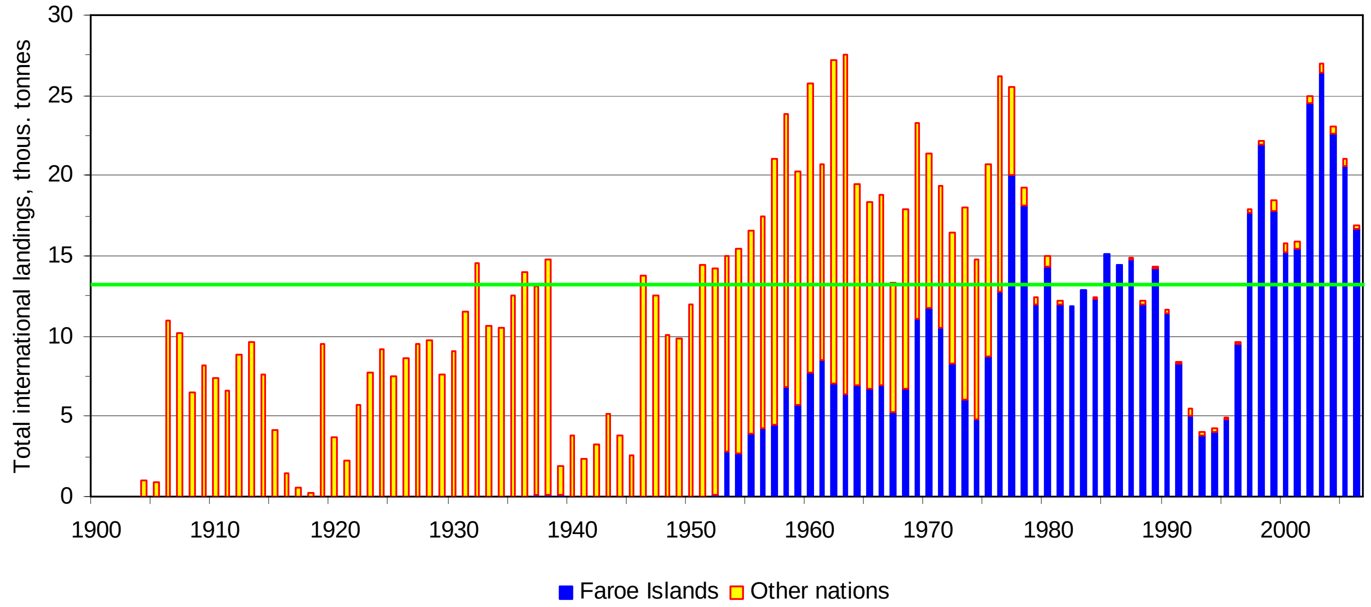


Figure 2.4.1. Haddock in ICES Division Vb. Landings by all nations 1904-2006.

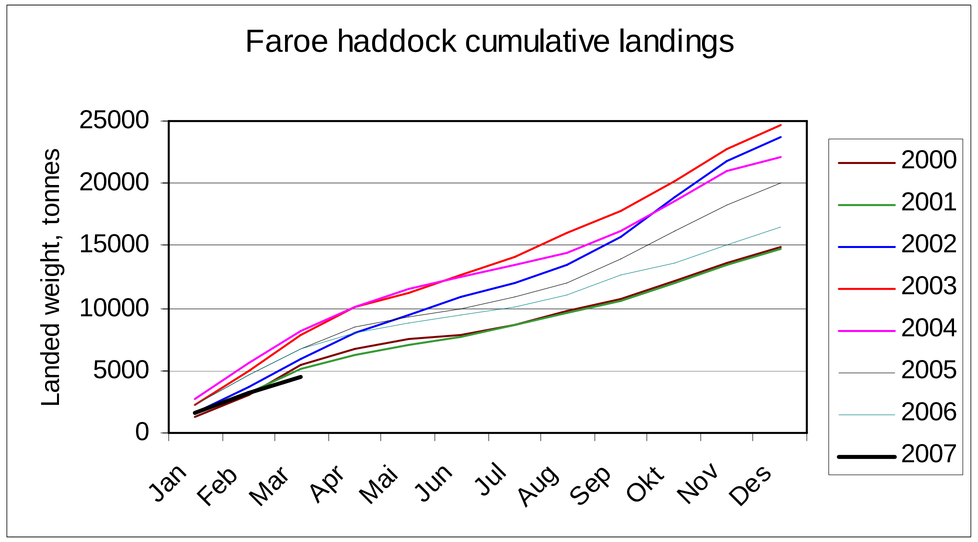


Figure 2.4.2. Faroe haddock. Cumulative Faroese landings from Vb.

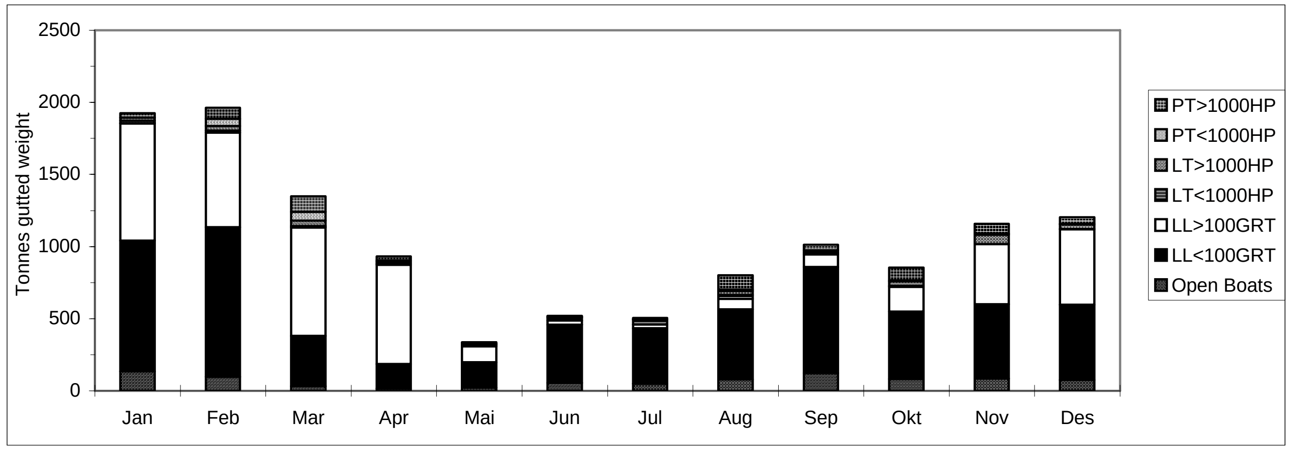


Figure 2.4.3.A. Faroese landings of haddock from Vb1 in 2006 by fleet. Tonnes ungutted weight.

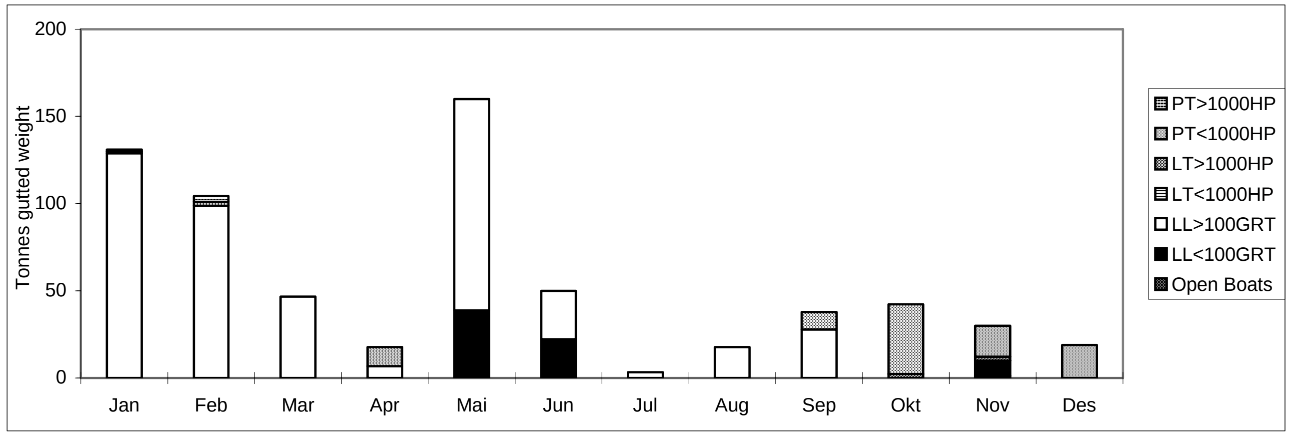


Figure 2.4.3.B. Faroese landings of haddock from Vb2 in 2006 by fleet. Tonnes ungutted weight.

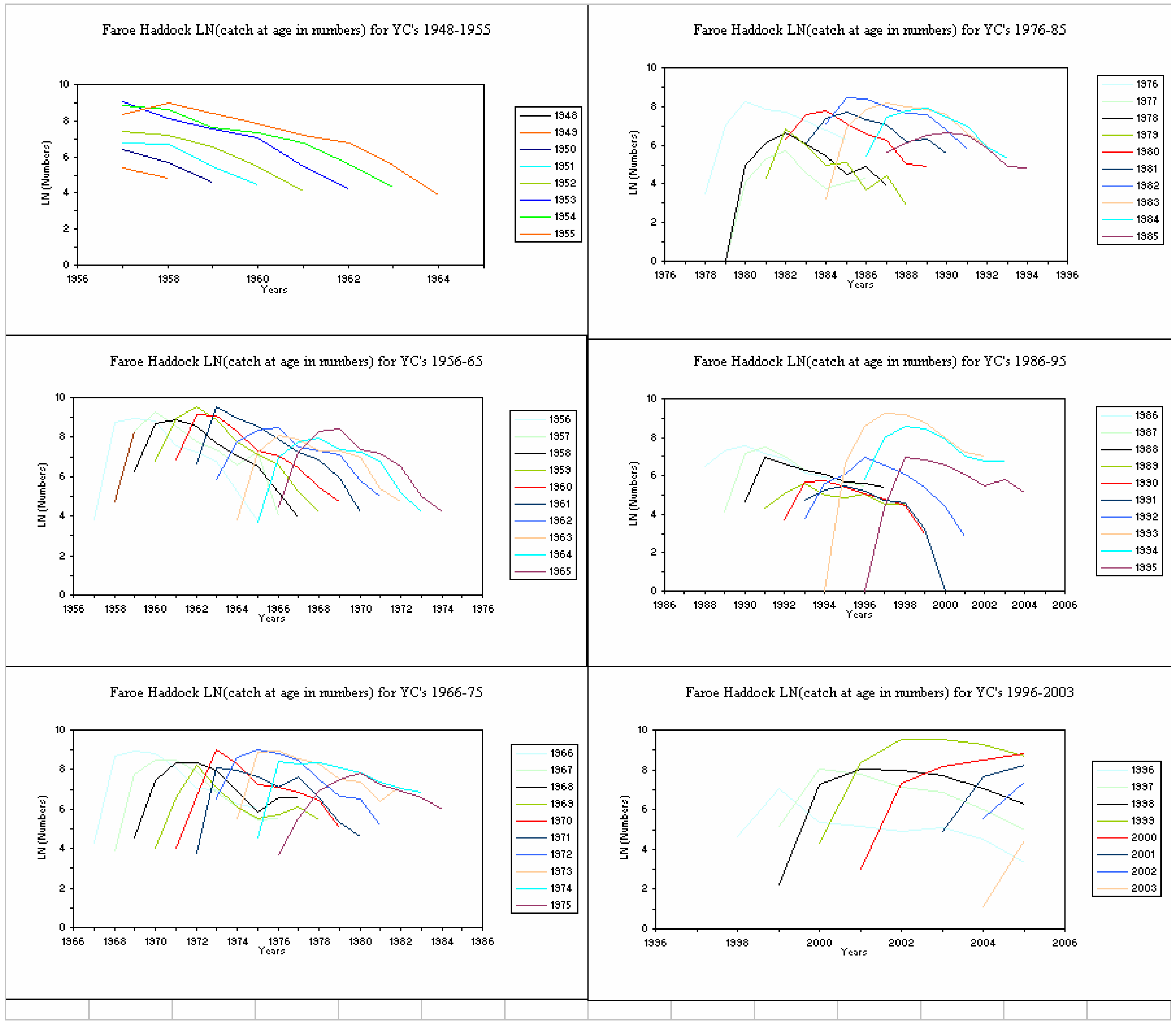


Figure 2.4.4. Faroe haddock. LN(catch@age in numbers) for YC's 1953 onwards.

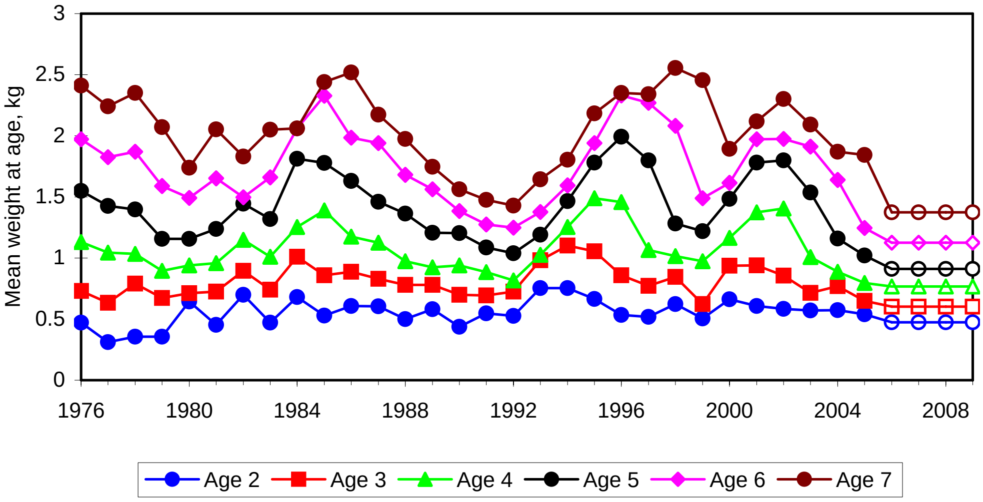
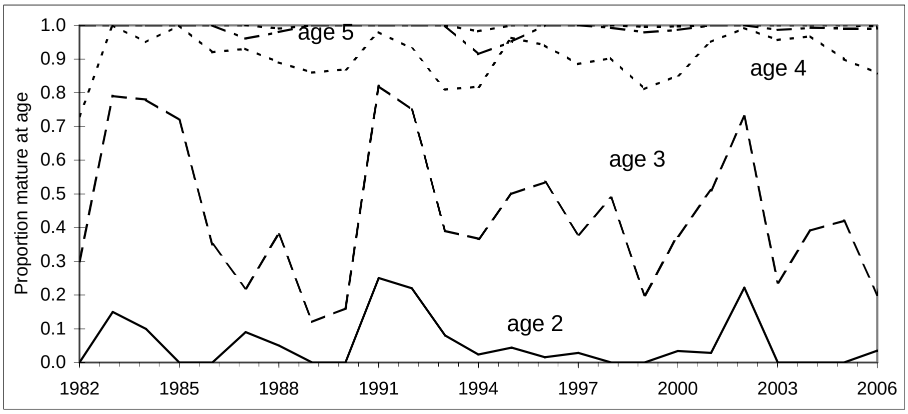
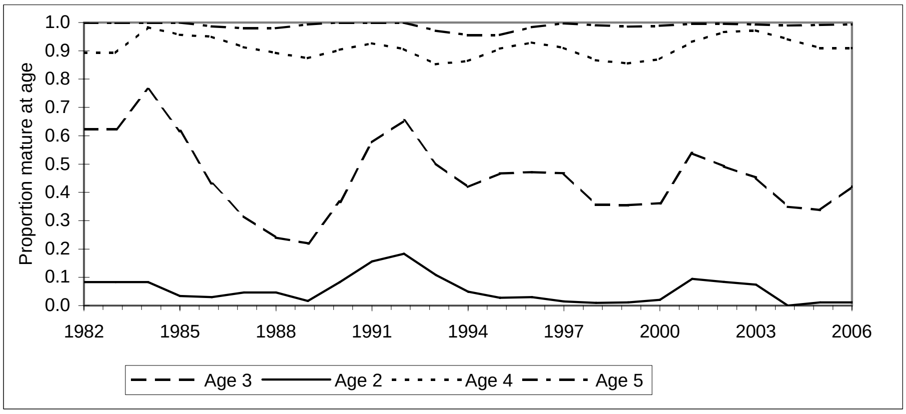


Figure 2.4.5. Faroe haddock. Mean weight at age (2-7). 2006-2008 are predicted values used in the short term prediction (open symbols).



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



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

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

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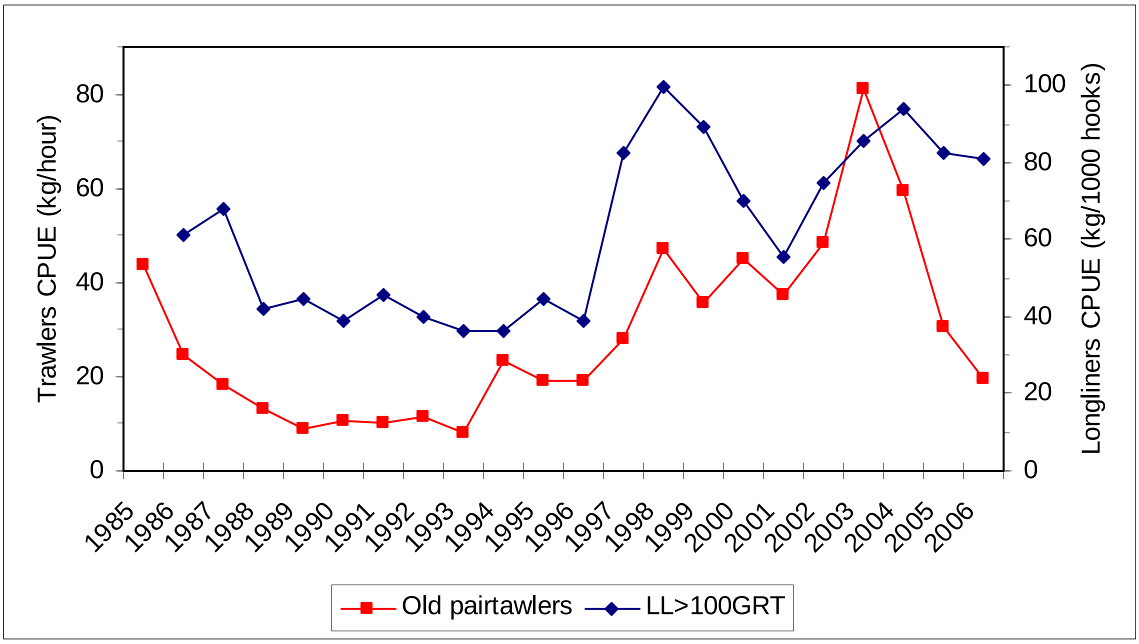


Figure 2.4.7. Pair trawlers > 1000HP and longliners > 100 HP.

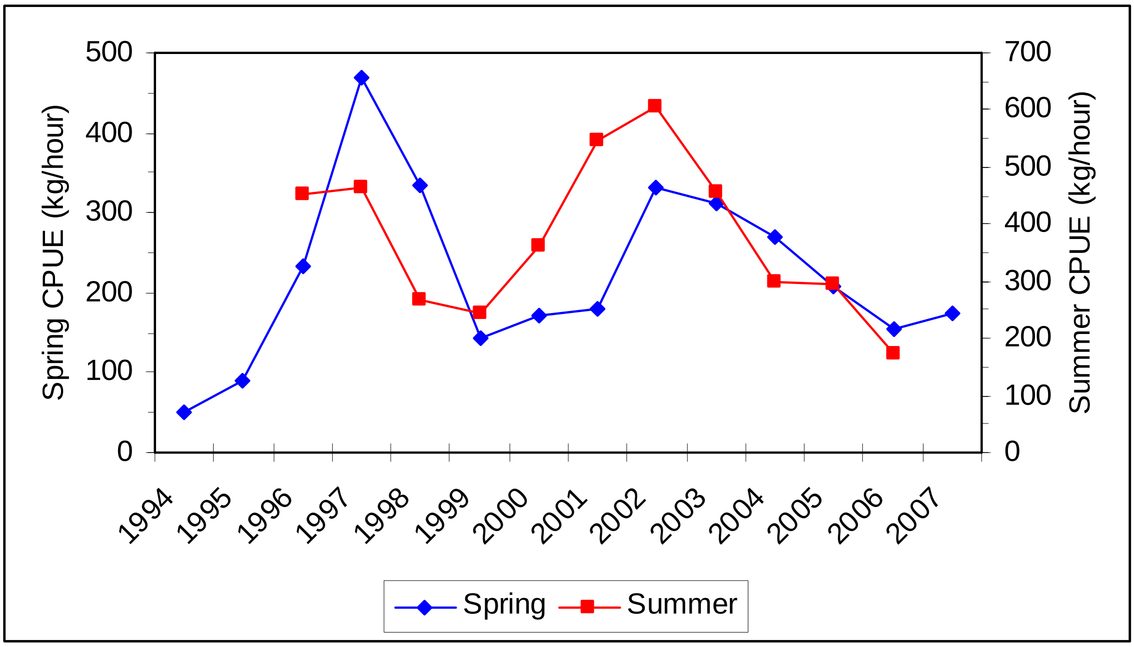
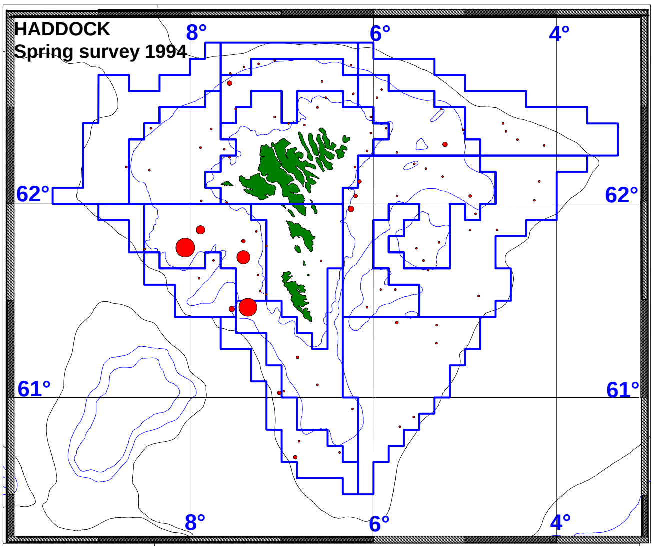


Figure 2.4.8. Faroe haddock. CPUE (kg/trawlhour) in the spring and summer surveys.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Spring survey 1994
8°
6°
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62°
62°
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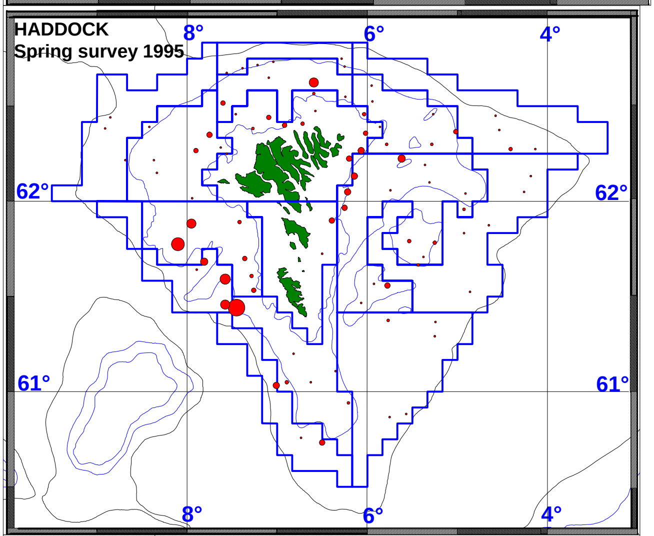
61°
8°
6°
4°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Spring survey 1995
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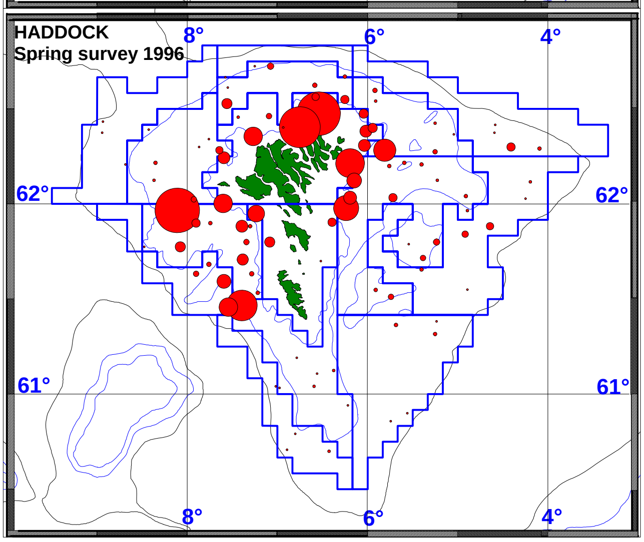
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Spring survey 1996
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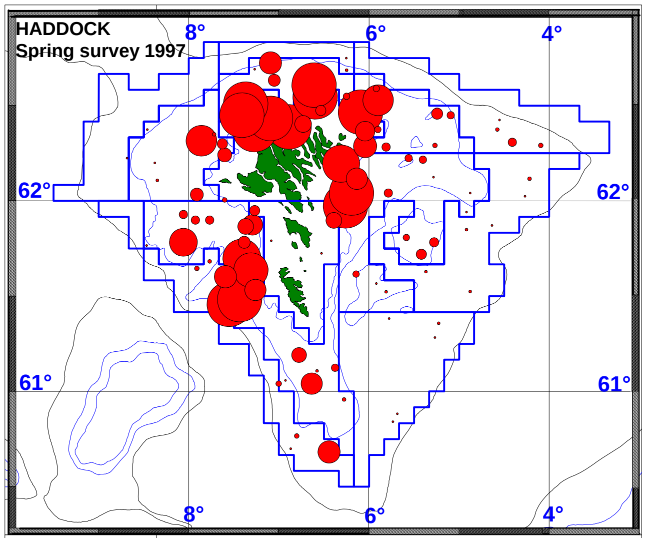
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Spring survey 1997
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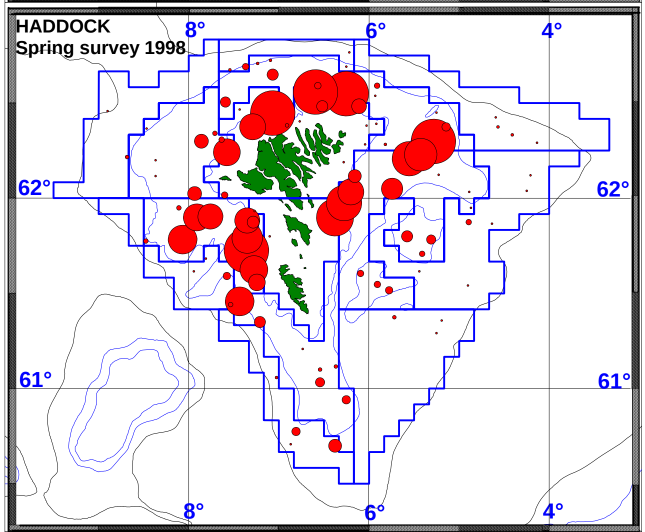
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Spring survey 1998
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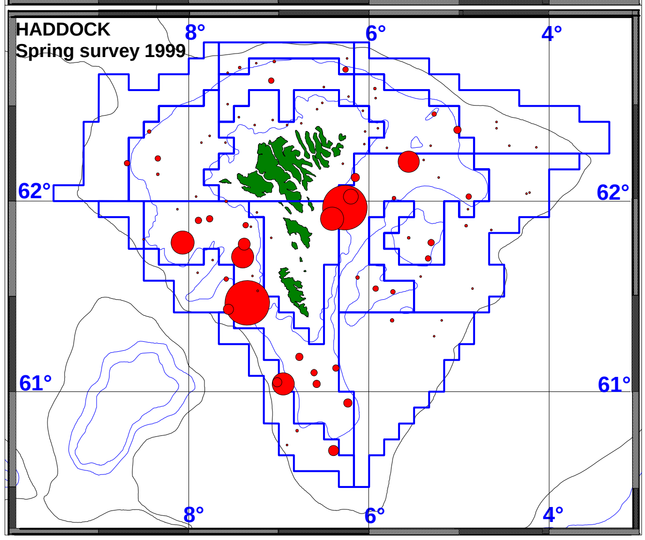
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Spring survey 1999
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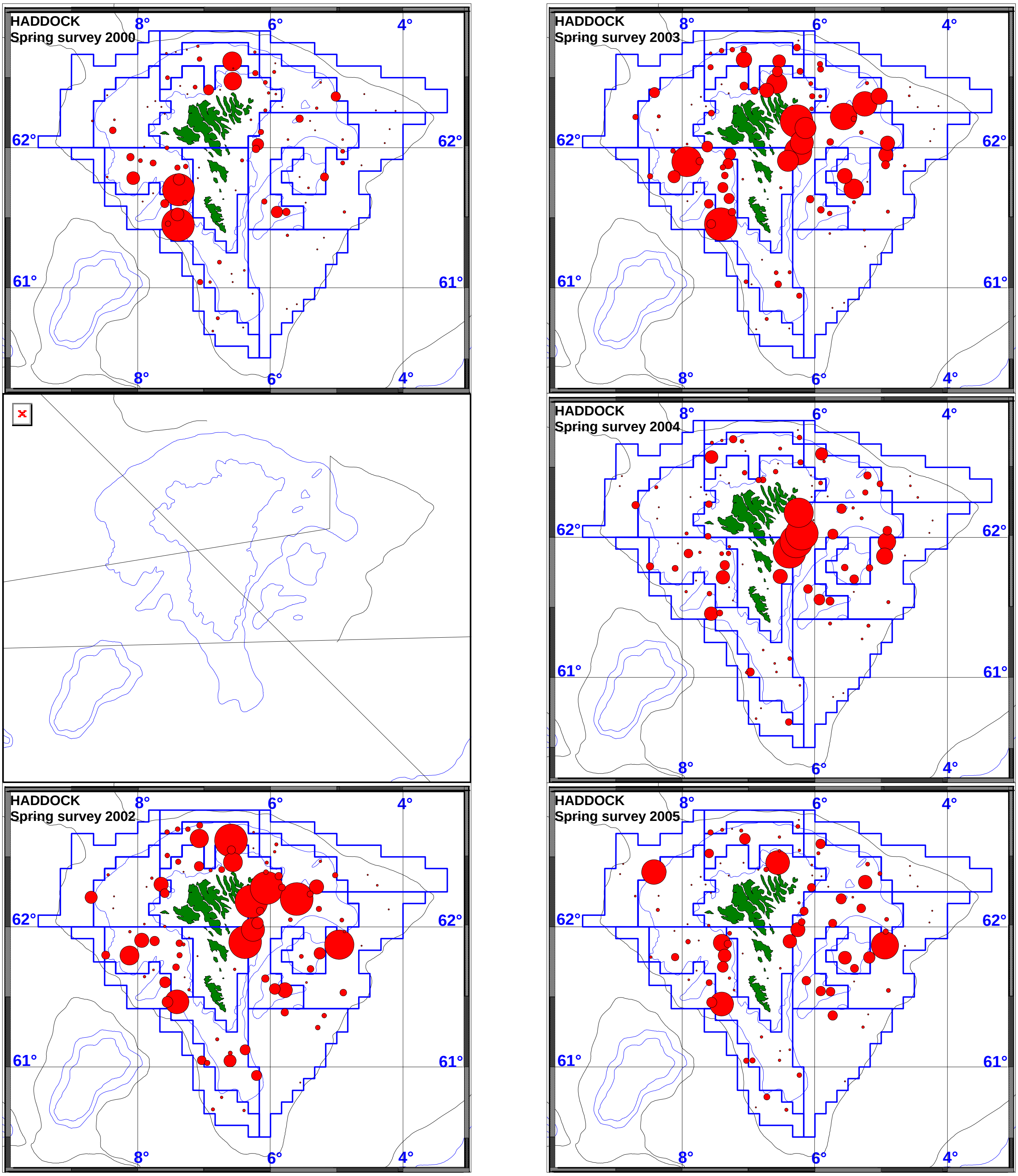
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Spring survey 2000
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Spring survey 2003
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Spring survey 2004
HADDOCK
Spring survey 2002
HADDOCK
Spring survey 2005

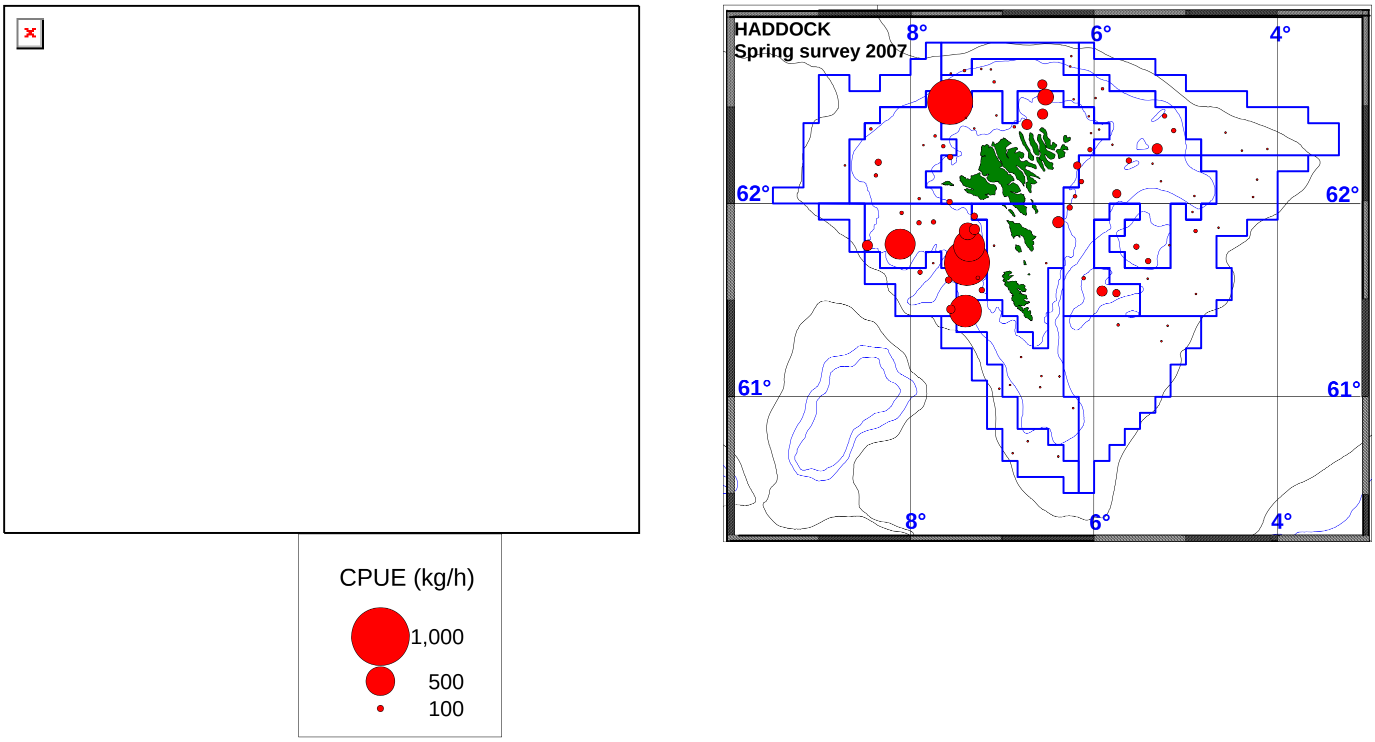
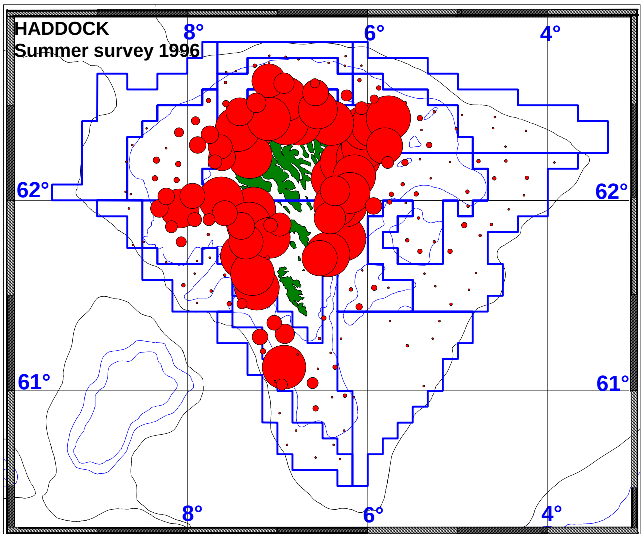


Figure 2.4.9. Distribution of Faroe haddock catches by year in the spring surveys.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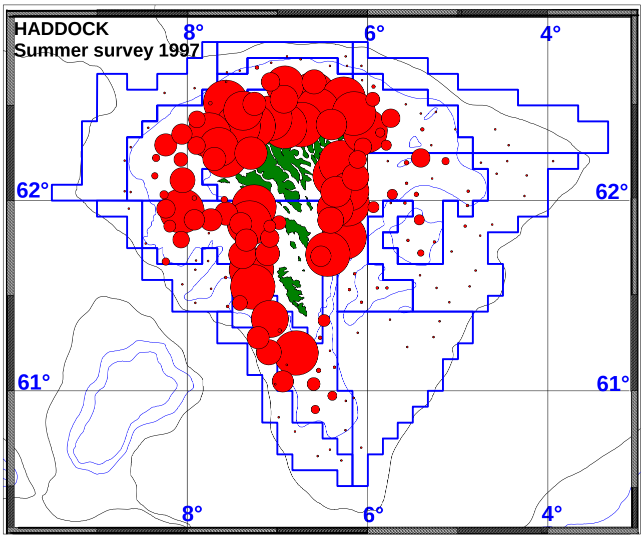
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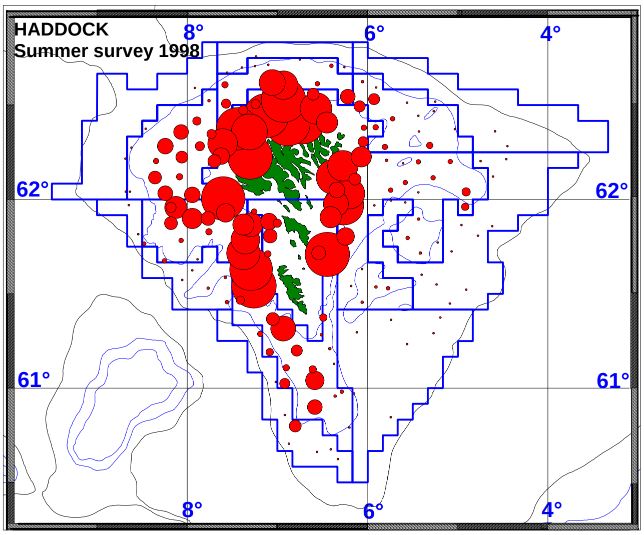
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Summer survey 1998
8°
6°
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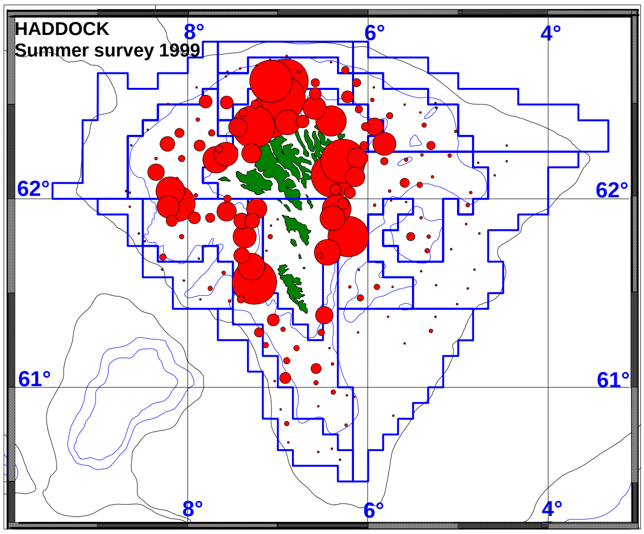
8°
6°
4°


HADDOCK
Summer survey 1999
8°
6°
4°
62°
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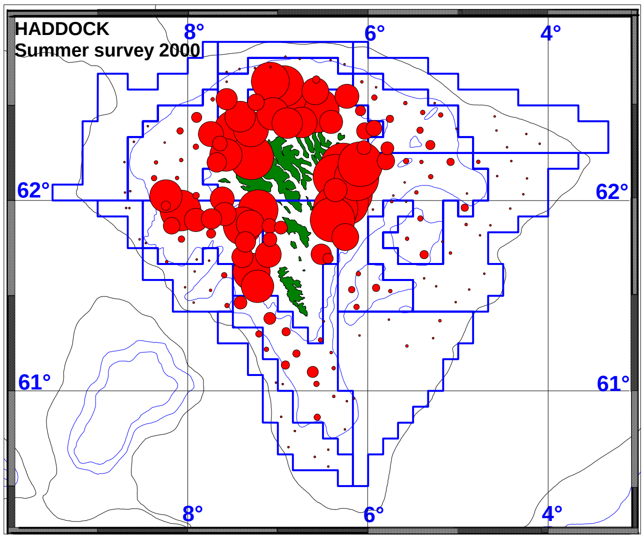
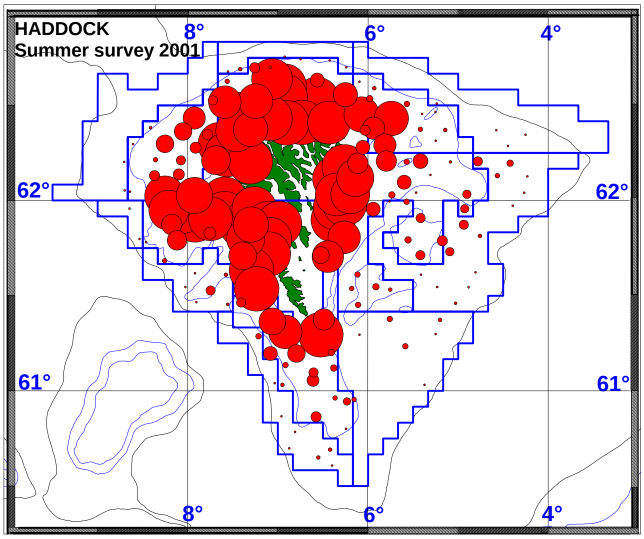
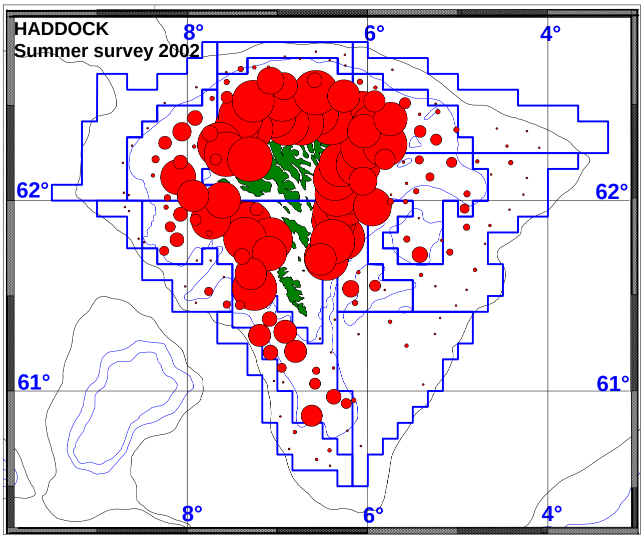
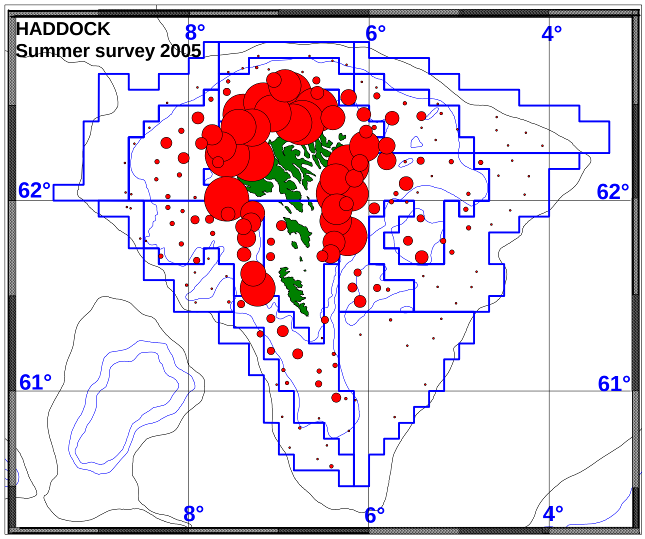
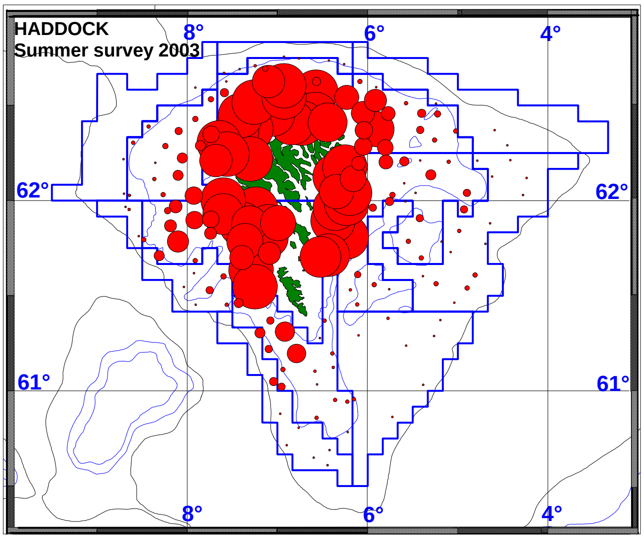
61°
61°
8°
6°
4°

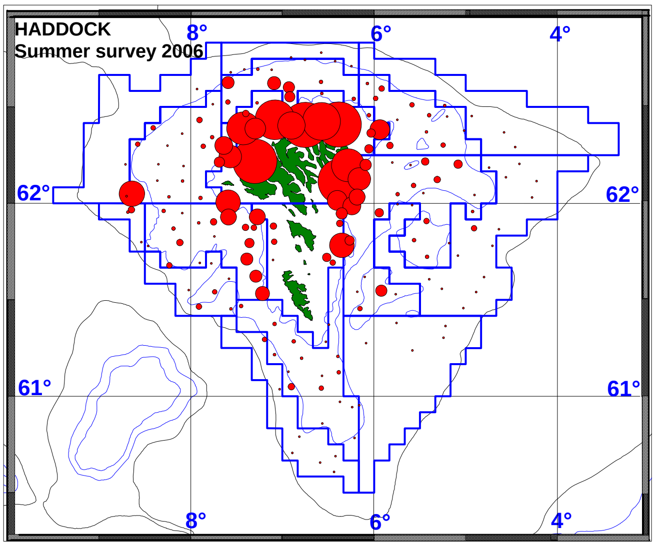

HADDOCK
Summer survey 2000
8°
6°
4°
62°
62°
61°
61°
8°
6°
4°

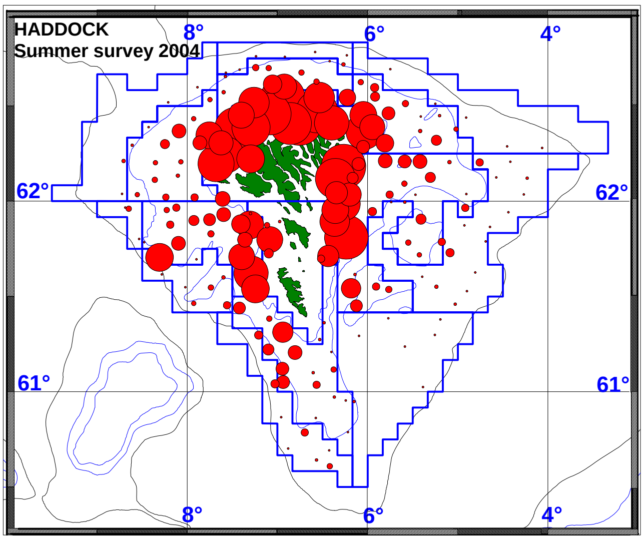

HADDOCK
Summer survey 2001
8°
6°
4°
62°
62°
61°
61°
8°
6°
4°











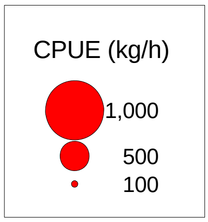


Figure 2.4.10. Distribution of Faroe haddock catches by year in the summer surveys.

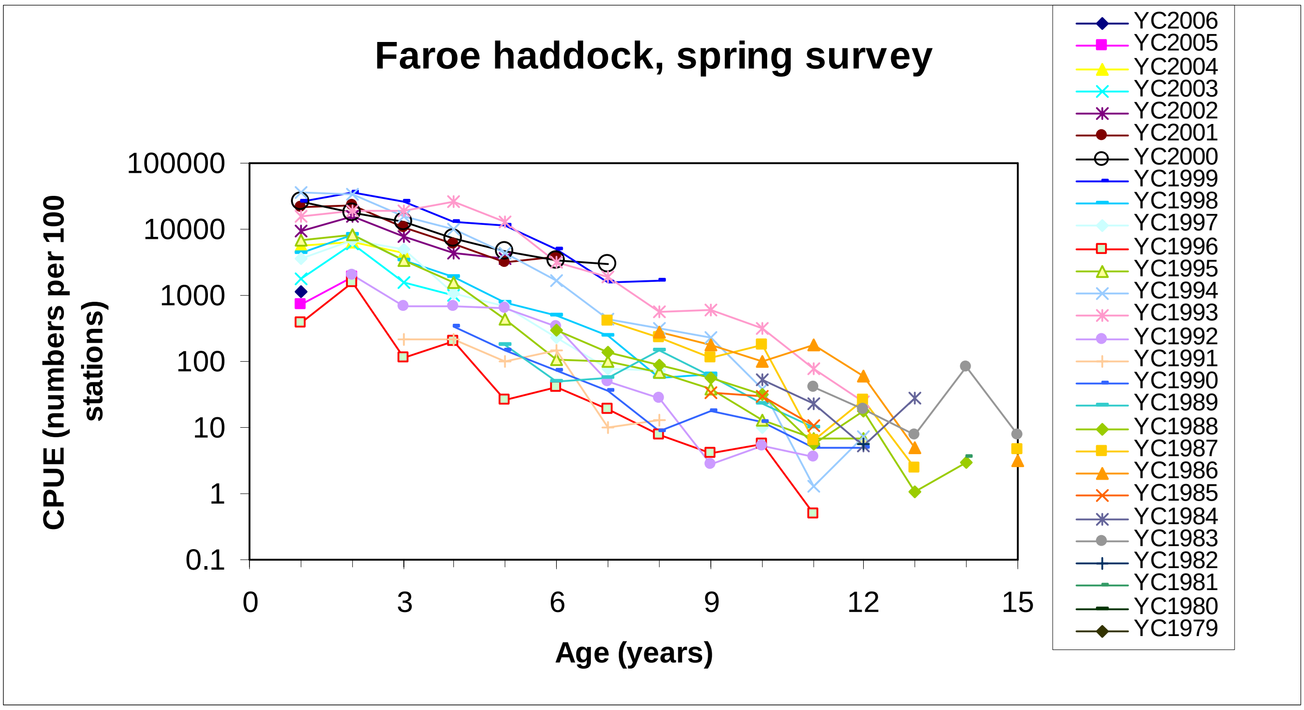


Figure 2.4.11. Faroe haddock. LN (c@age in numbers) in the spring survey.

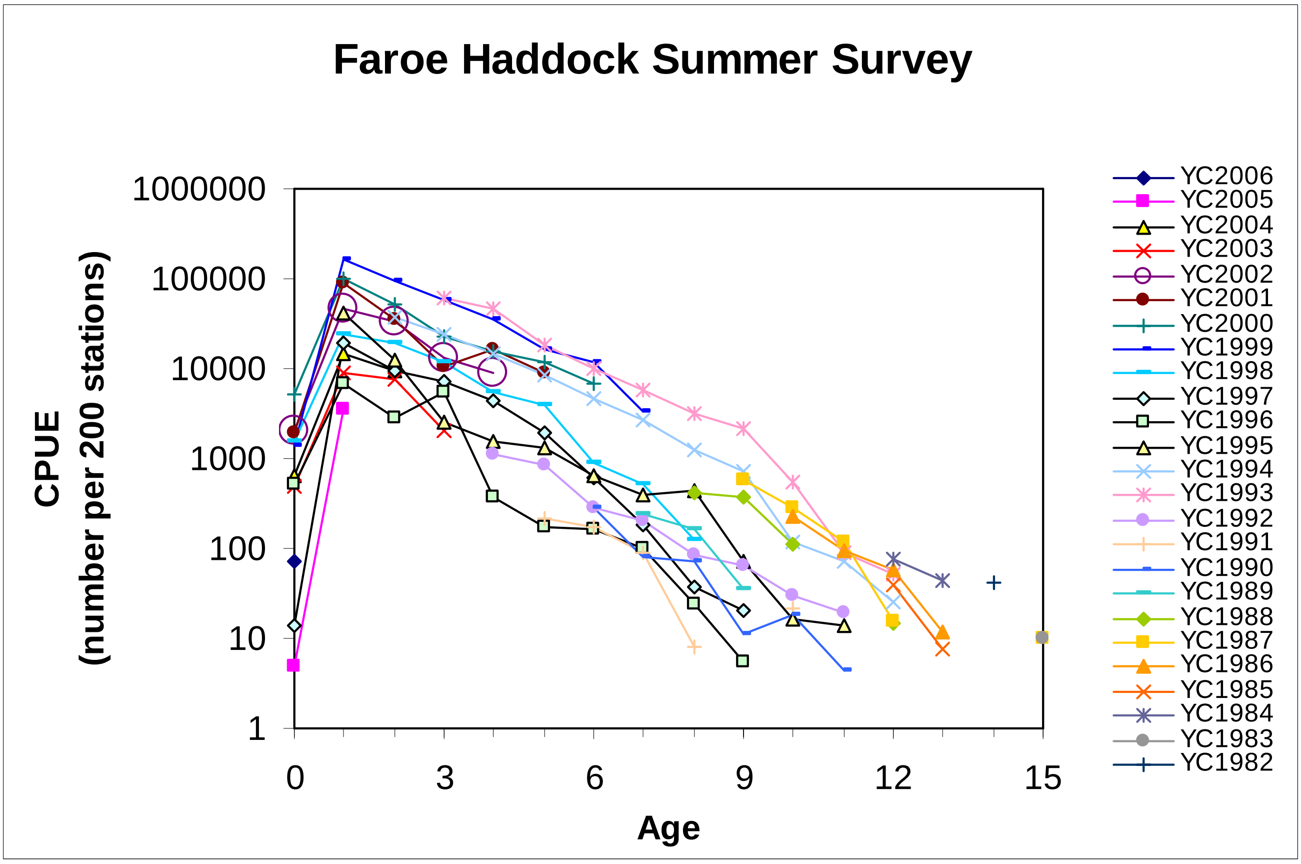


Figure 2.4.12. Faroe haddock. LN (c@age in numbers) in the summer survey.

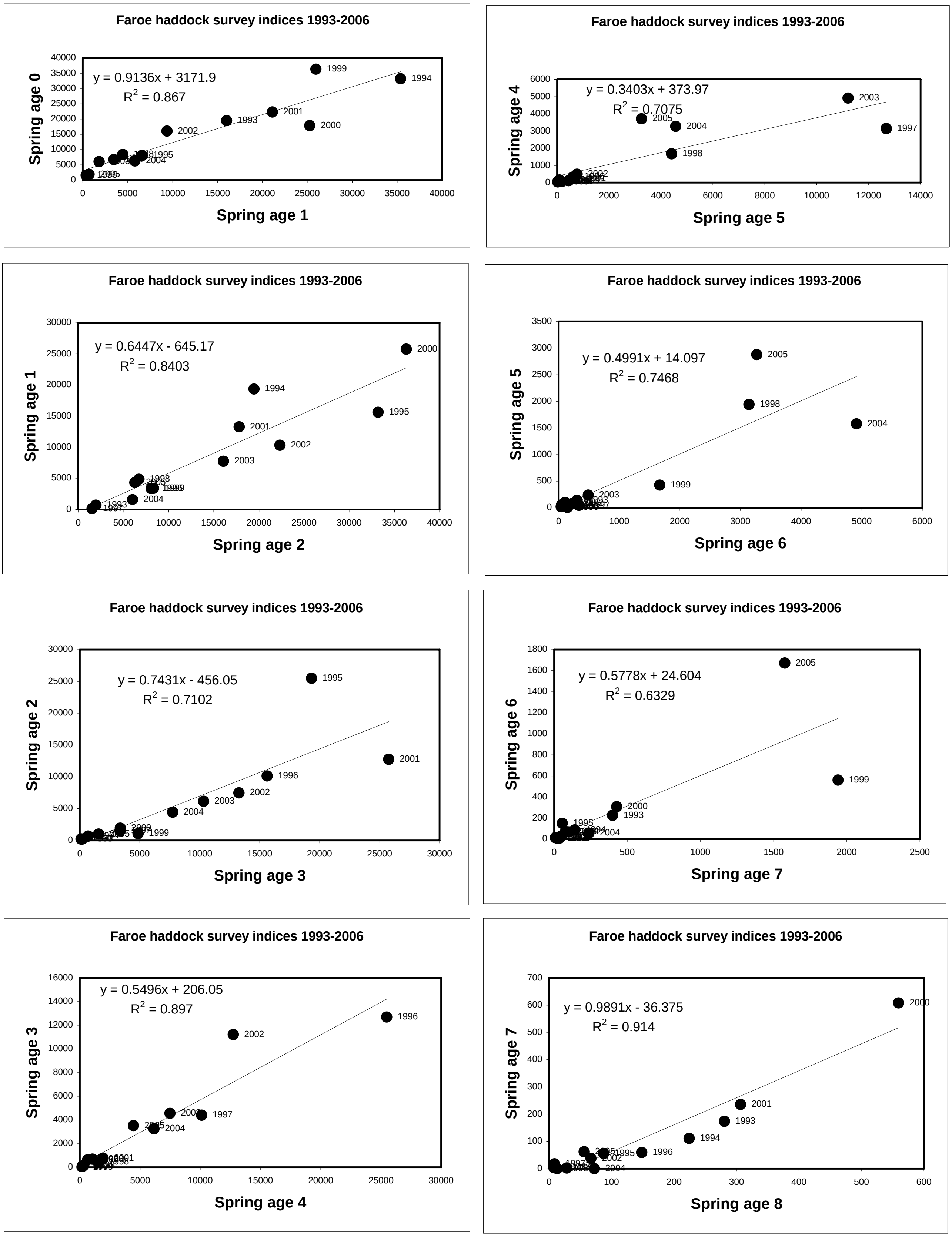


Figure 2.4.13. Faroe haddock. Comparison between spring survey indices at age and the indices of the same YC one year later.

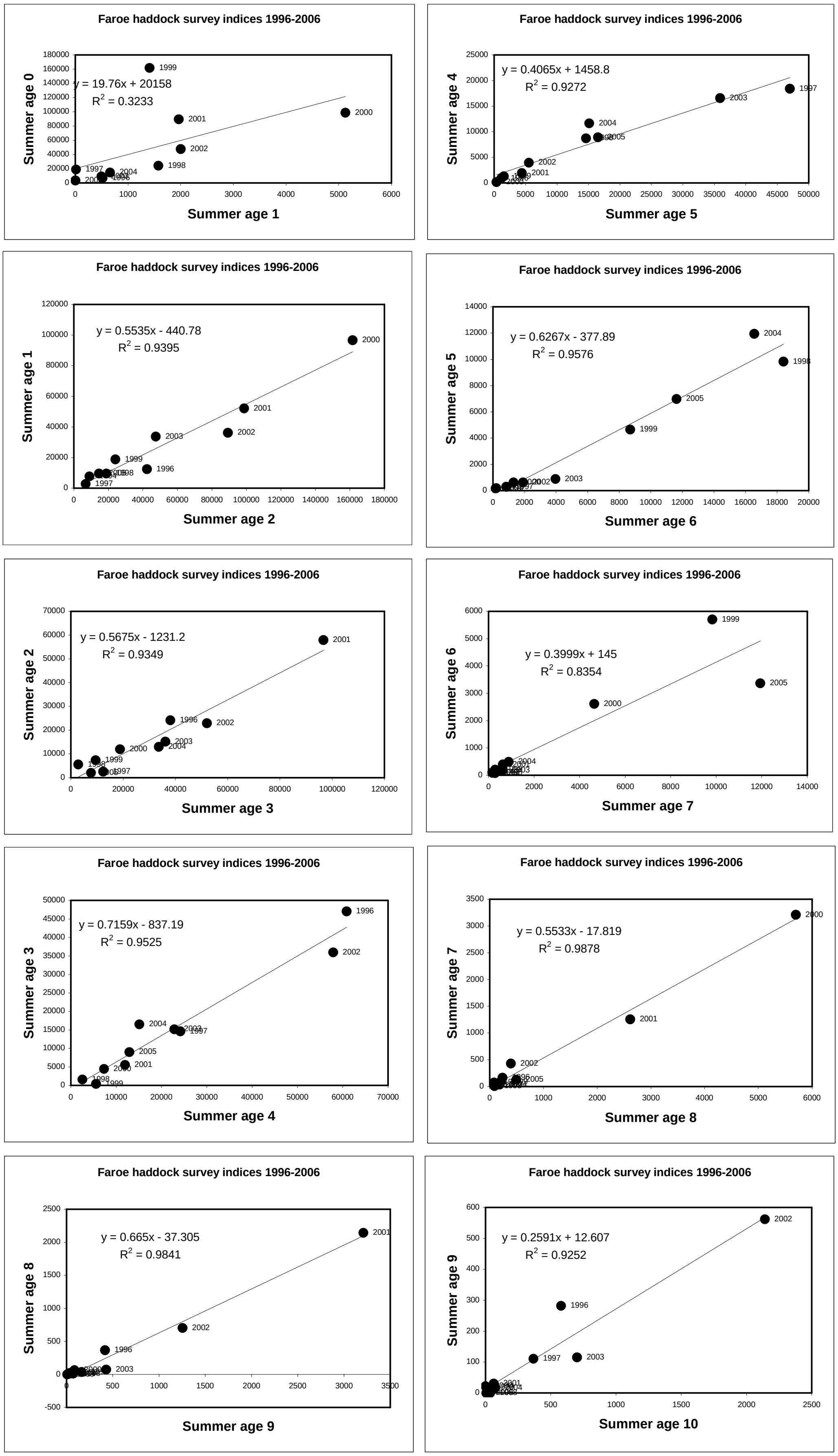


Figure 2.4.14. Faroe haddock. Comparison between summer survey indices at age and the indices of the same YC one year later.

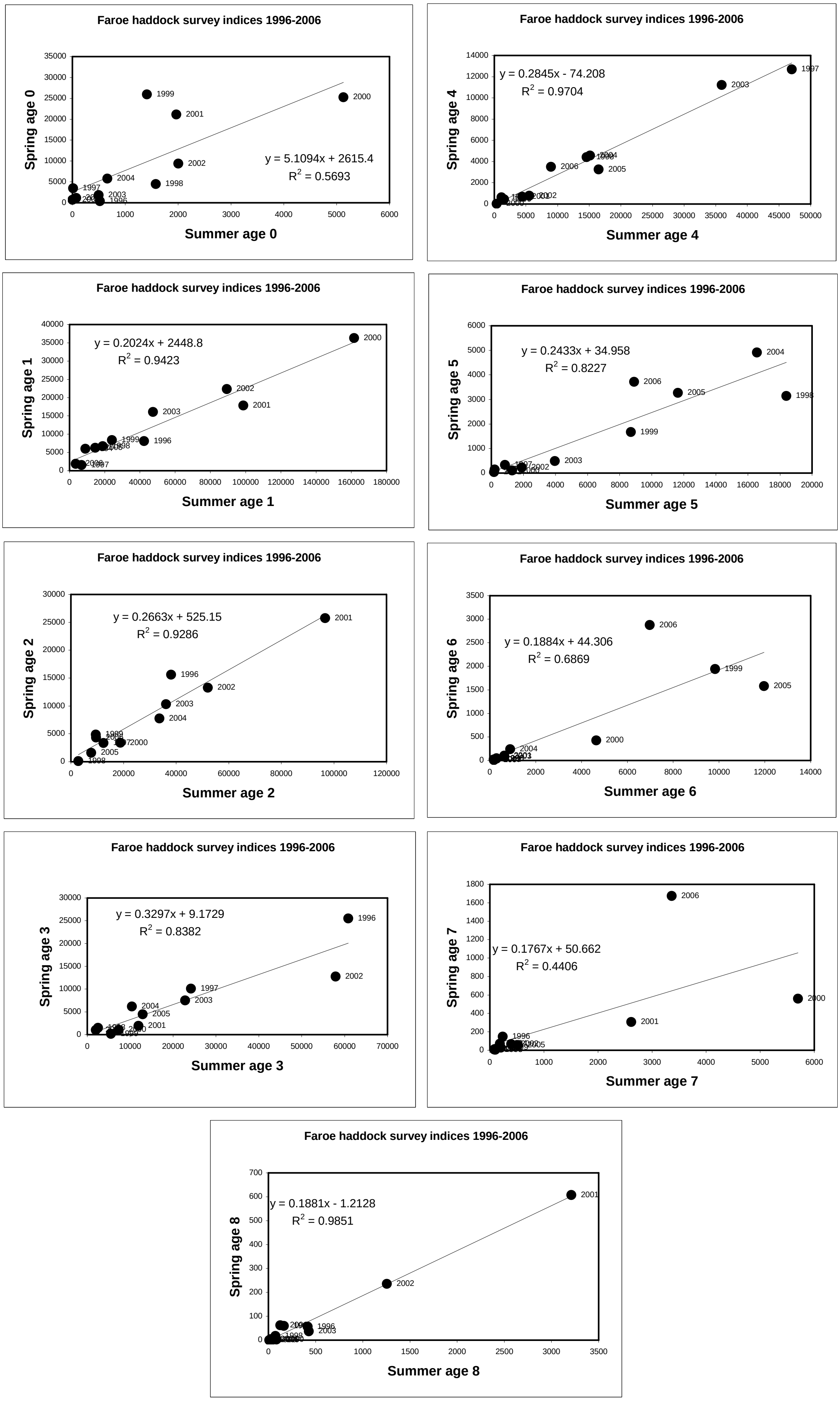
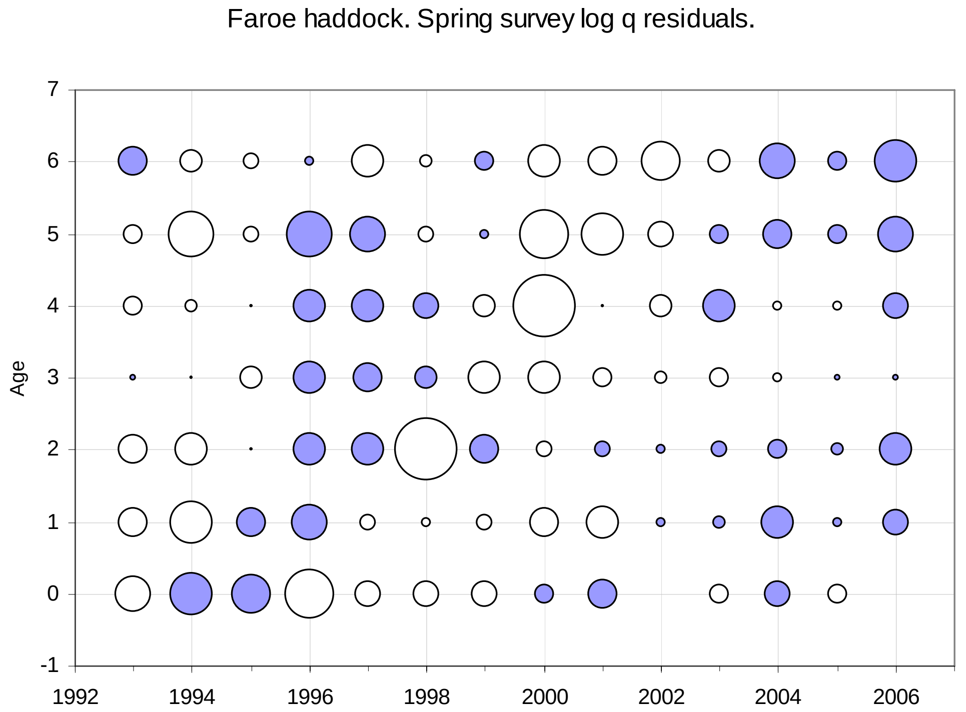


Figure 2.4.15. Faroe haddock. Comparison between indices at age from the spring and summer surveys.



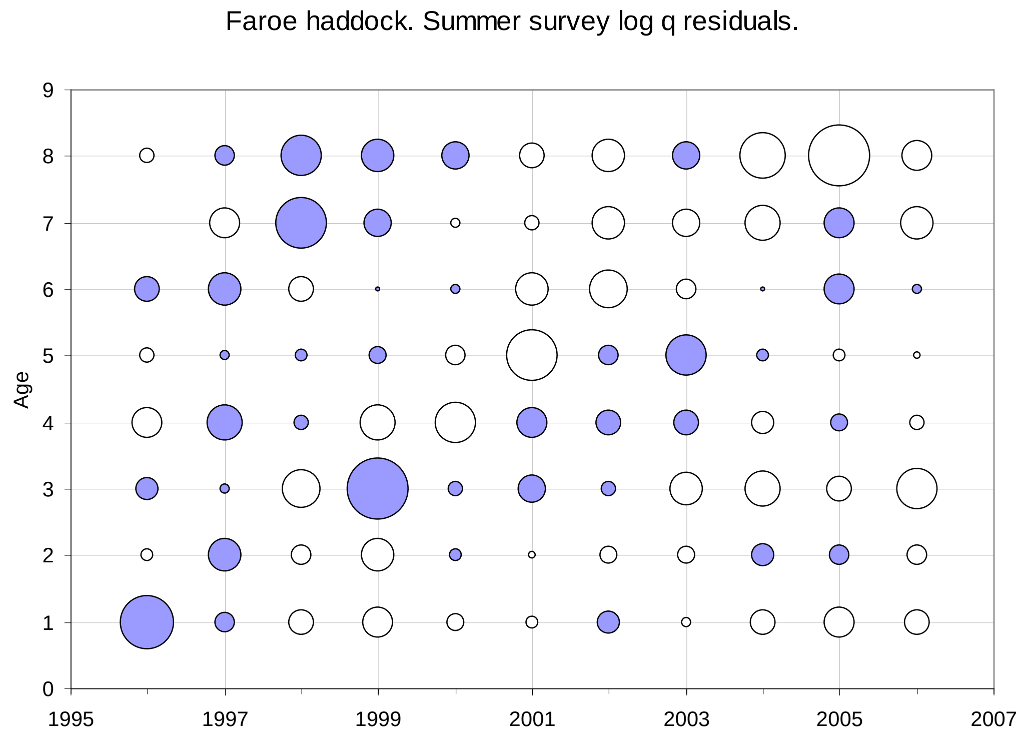


Figure 2.4.16. Faroe haddock survey log q residuals.

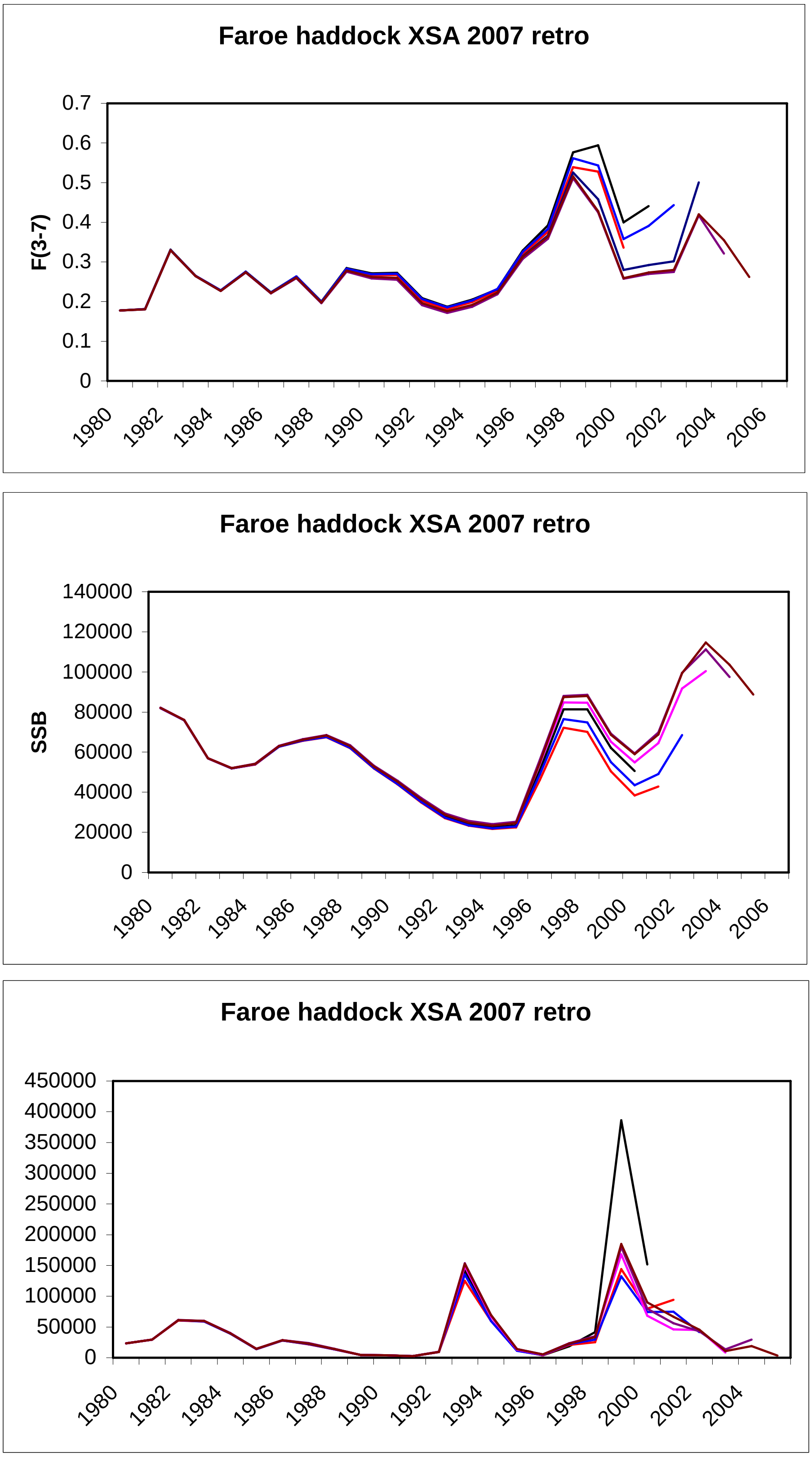


Figure 2.4.17. Faroe haddock. Retrospective analysis on the 2007 XSA.

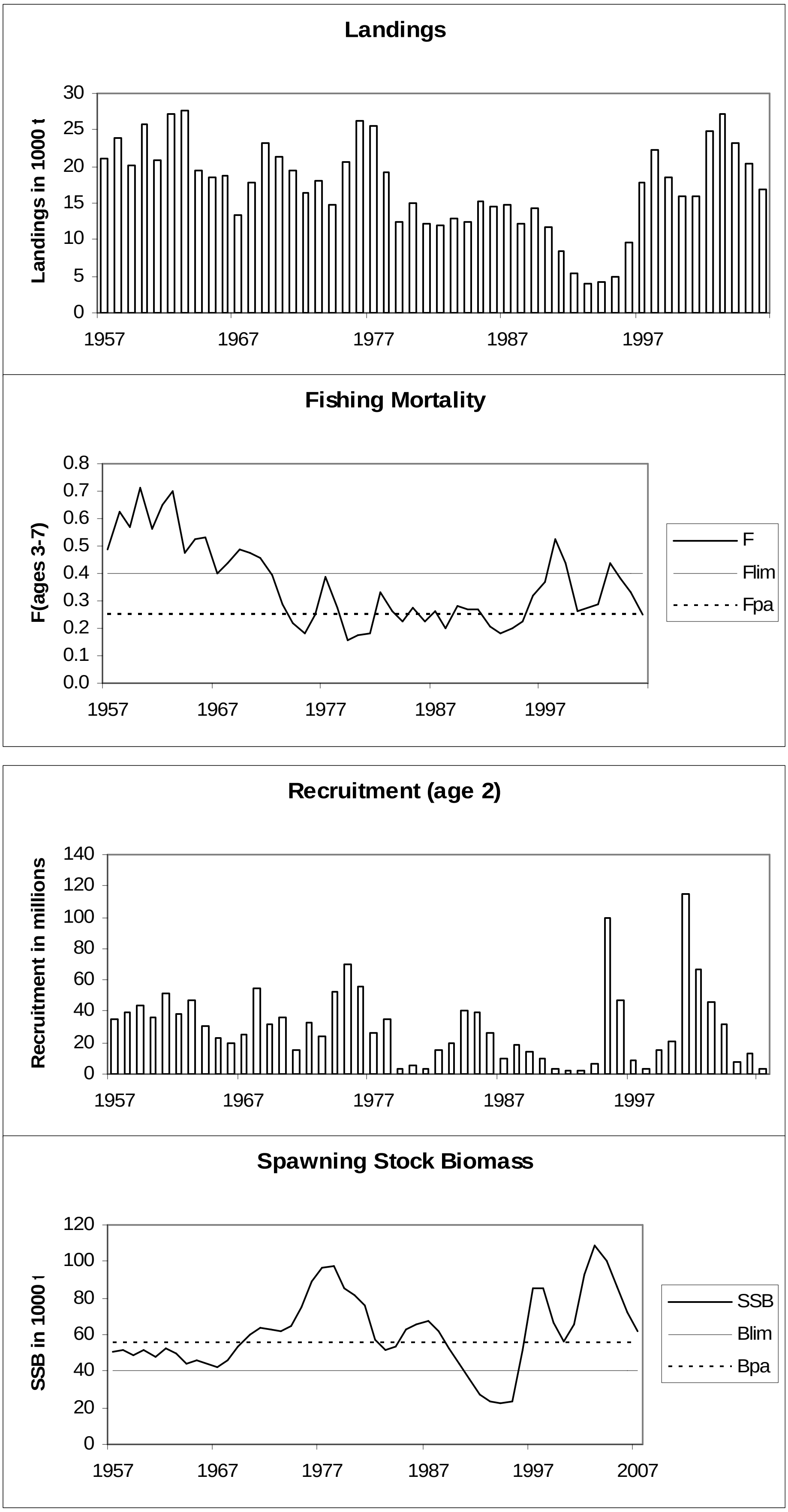


Figure 2.4.18A. Faroe haddock (Division Vb) standard graphs from the 2007 assessment.

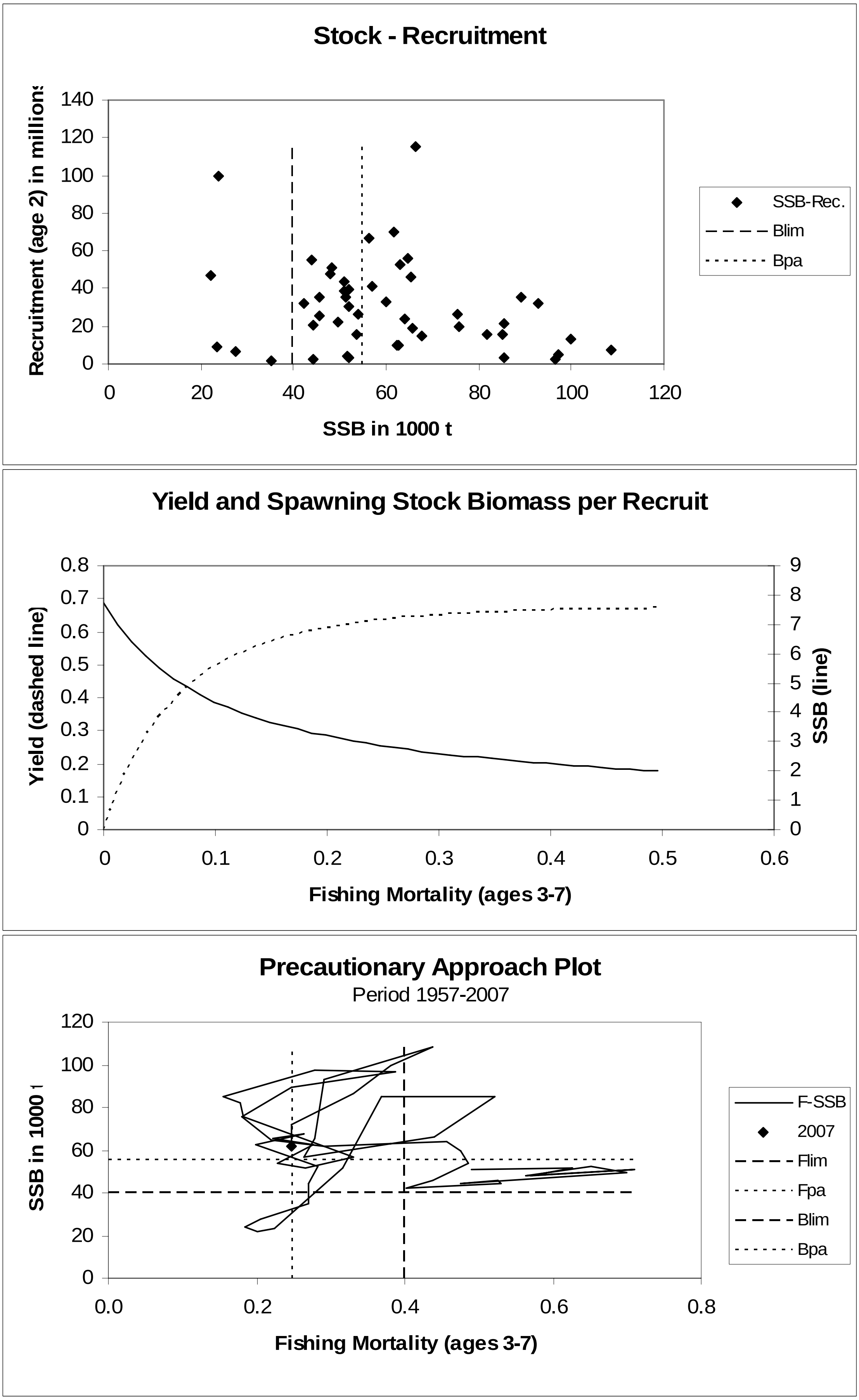


Figure 2.4.18A (cont.). Faroe haddock (Division Vb) standard graphs from the 2007 assessment.

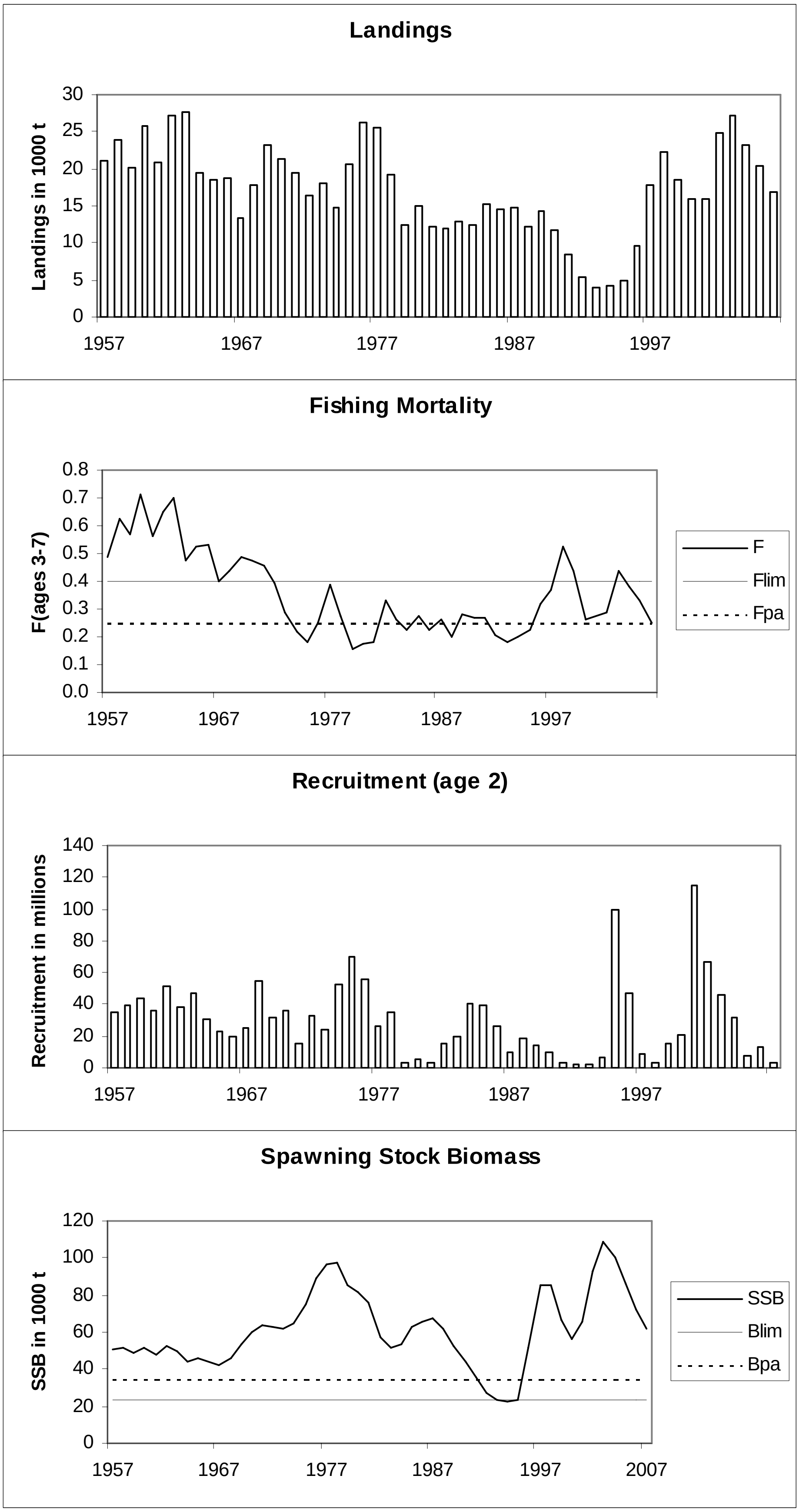


Figure 2.4.18B. Faroe haddock (Division Vb) standard graphs from the 2007 assessment.

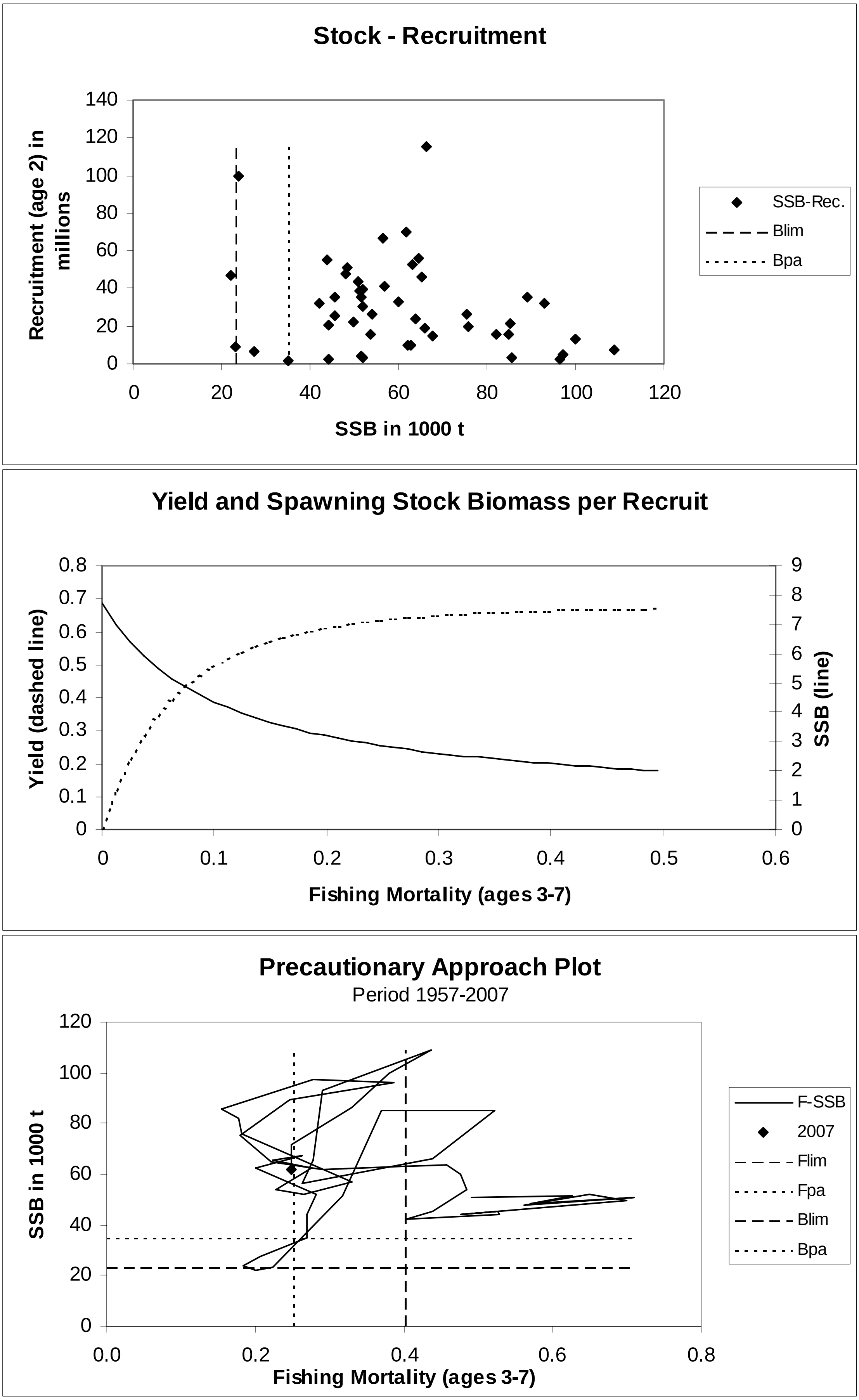


Figure 2.4.18B (cont.). Faroe haddock (Division Vb) standard graphs from the 2007 assessment.

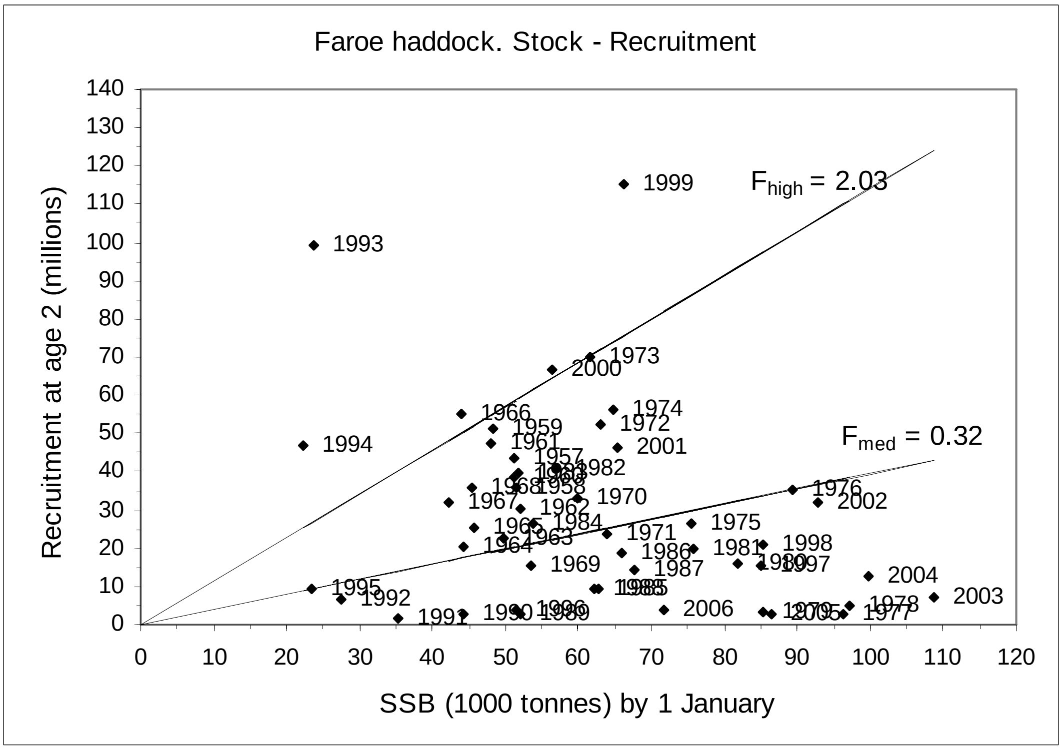
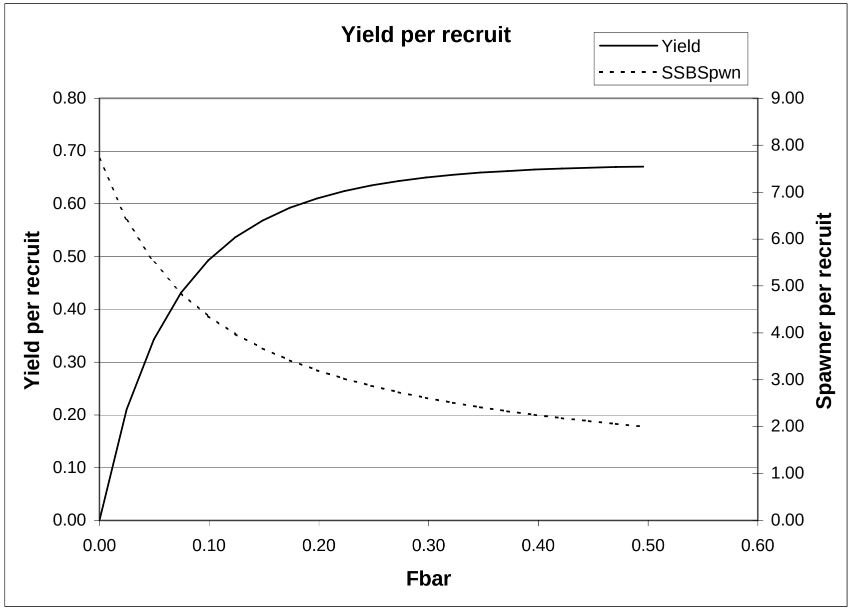
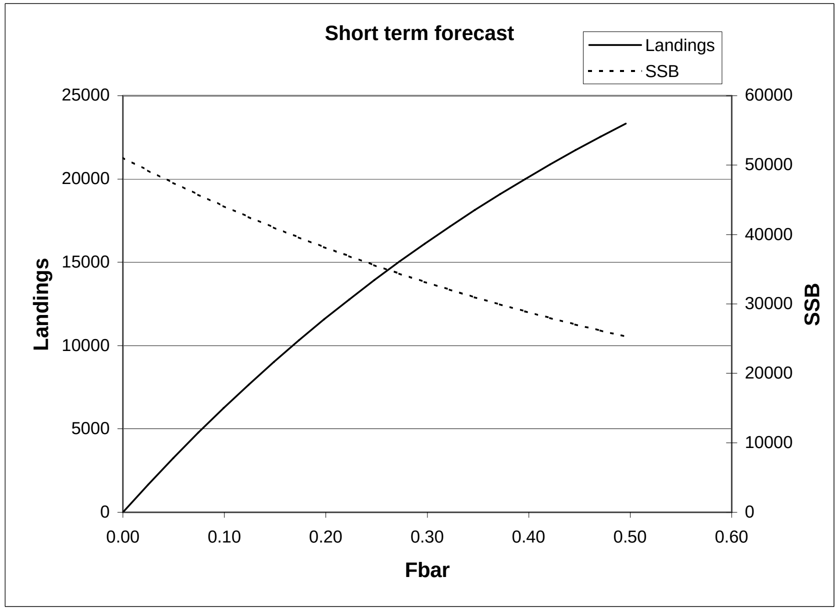


Figure 2.4.19. Faroe haddock. SSB-R plot.





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Run: ypr07a
Time and date: 15:32 4/20/2007

Reference point	F multiplier	Absolute F
Fbar(3-7)	1	0.2478
FMax	2.456	0.6085
F0.1	0.6077	0.1506
F35%SPR	1.1273	0.2793
Fhigh	8.2027	2.0323
Fmed	1.2761	0.3162
Flow	-99	

Weights in kilograms

MFDP version 1
Run: man07
Index file 19/04/2007
Time and date: 11:58 4/20/2007
Fbar age range: 3-7

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Figure 2.4.20. Faroe haddock. Prediction output.

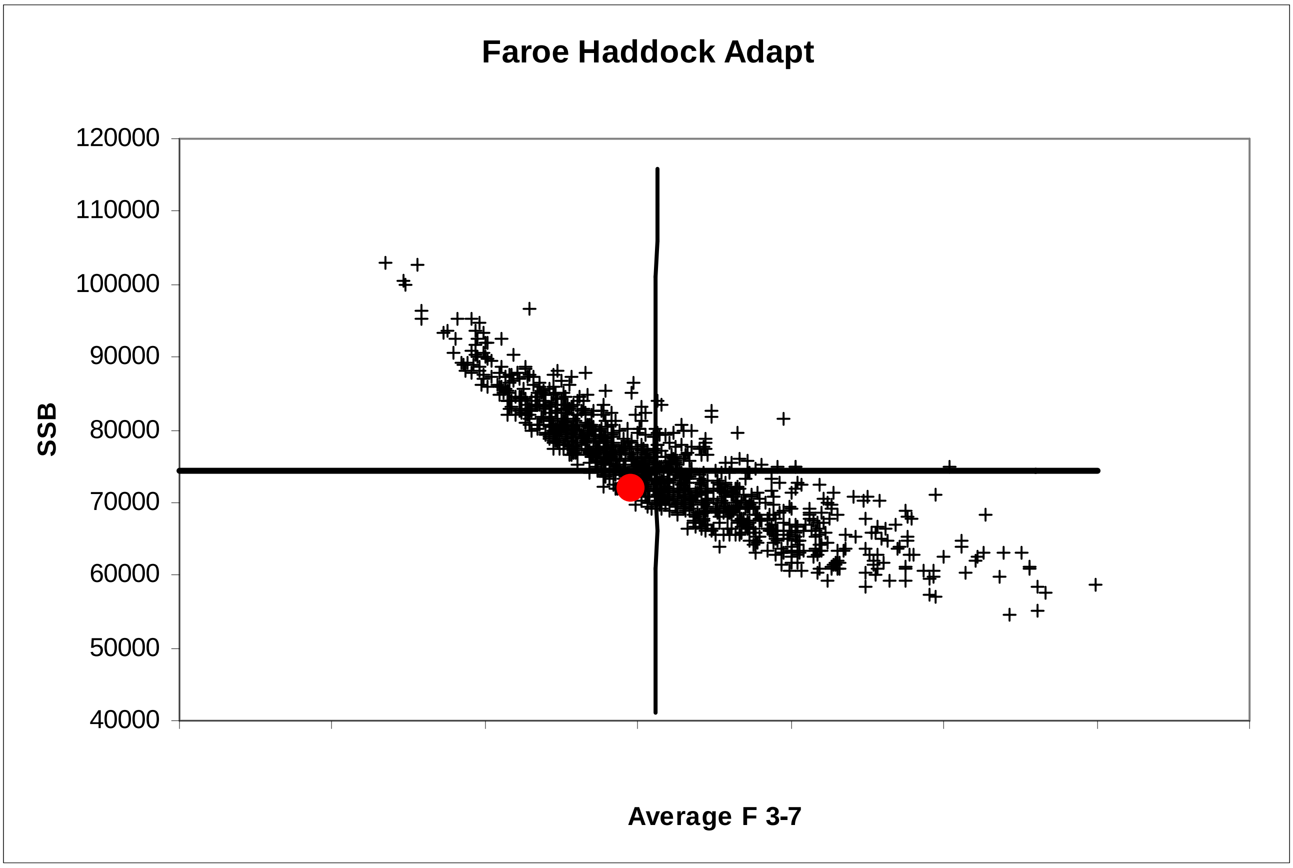


Figure 2.4.21. The F's and SSB's from a 1000 bootstraps of the ADAPT. Inserted are the point values of F and SSB from the accepted XSA.

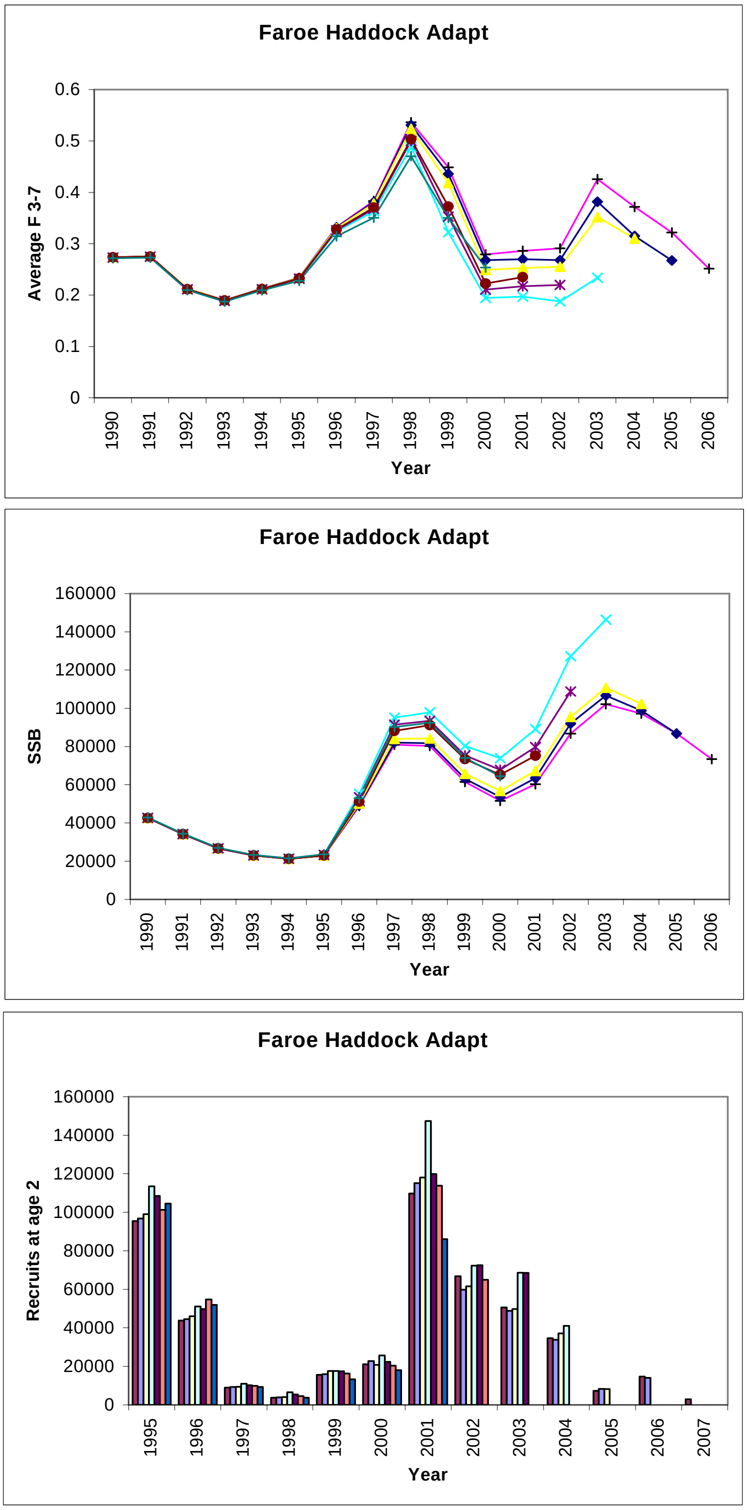
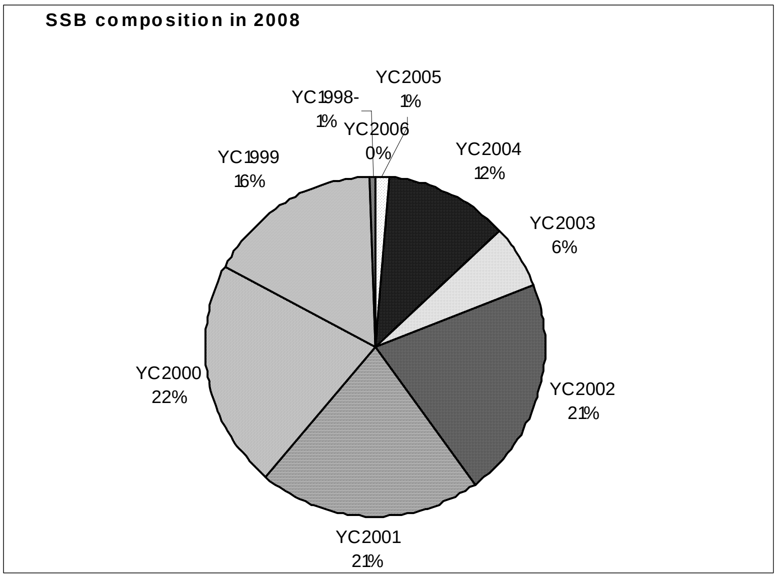


Figure 2.4.22. Faroe haddock. The ADAPT retrospective patterns.



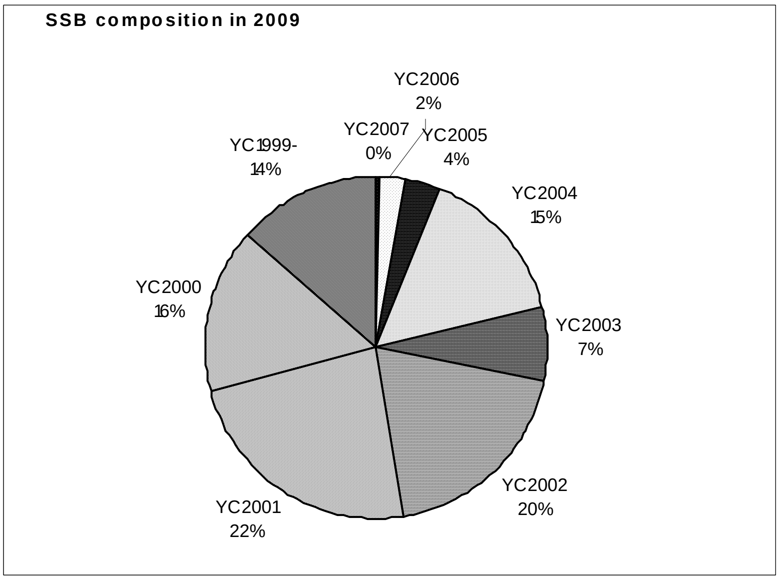


Figure 2.4.23. Faroe haddock. Projected composition of the number by year-classes in the SSB's in 2008 and 2009.

2.5 Faroe saithe

Summary

The 2006 assessment was rejected by the review group. The 2007 Faroe saithe analytical assessment is an exploratory assessment with technical issues to be resolved. The XSA is still used as the main assessment method and the results are compared with those from ADAPT calibrated with the same data as XSA, Xcam model (exploratory model setup in excel) and iterative cohort model (also in excel) which do not use tuning fleets.

The working group concludes that the XSA assessment is useful to indicate stock trends but that recent year classes are probably underestimated because of changes in catchability (q) due to slower growth. The Faroe saithe biomass is estimated to be above average in 2006, but it is expected to decline slightly below average in 2007 and 2008.

For Faroe saithe, the highest recruitment has been observed at the lowest SSB. This suggests that Bloss should be used as Bpa, not Blim. The working group recommends that Bpa for saithe be set at Bloss = 60 000t and that Blim be set at an arbitrarily lower value (45-50 000t) until more stock and recruitment data pairs are observed below Bloss. Fishing mortality reference points consistent with these new biomass reference points are suggested.

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) but declined to 46 100 t in 2004. In 2005 landings were 68 000 tonnes, the highest catch recorded since 1961 and in 2006 the second highest catch recorded on 62 500 tonnes.

Since the introduction of the 200 miles EEZ in 1977, the saithe fishery has been prosecuted mostly by Faroese vessels. The principal fleet consists of large pair trawlers (>1000 HP), which have a directed fishery for saithe, accounting for about 60% of the reported landings in 1993-2005 (Table 2.5.1.2). The smaller pair trawlers (<1000 HP) and larger single trawlers have a more mixed fishery and they account for about 10-20% of the total landings of saithe in 1997-2006. Jiggers only account for about 2% of the total landings in the last five years.

Catches used in the assessment are presented in Table 2.5.1.1. These include foreign catches that have been reported to the Faroese Authorities but not officially reported to ICES. Catches in that part of Sub-division IIa, which lies immediately north of the Faroes, have also been included. Little discarding is thought to occur in this fishery.

2.5.2 Catch at age

Catch at age is based on length, weight and otoliths 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 2006 was similar to that in 2005 (Table 2.5.2.2).

2.5.3 Weight at age

Mean weights at age have varied by a factor of about 2 during 1961-2006. 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 decrease since. Weights at age for 2006 are the lowest since 1991.

The catchability (q) is calculated as the catch per unit of effort at age in the tuning series divided with the stock number at age. Catchability (q) may change as a result of changes of weight at age given the high variability in the weight at age for saithe. There appears to be a relationship between weight at age and catchability at age 3 ($P<0.05$) (Figure 2.5.3.2). This may have an effect on the assessment that saithe at age 3 is underestimated in the tuning when weight at age are low. The SOP for weight at age in 2006 was 100%.

2.5.4 Maturity at age

Maturity at age data from the spring survey is available from 1983 onward (Steingrund, 2003). Due to poor sampling in 1988 the proportion mature for that year was calculated as the average of the two adjacent years. A model was used 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 the 2005 assessment. The decreasing trend in weights at age caused the predicted maturities to decline when the observed maturities did not. The working group examined various smoothers and decided to use a three years running average to predict the maturity at age for 1983-2006. (Table 2.5.4.1 and Figure 2.5.4.1). For 1961 to 1982, the average maturity at age for 1983 to 1996 was used. The proportion mature for most ages has been slightly increasing in resent years. A comparison of XSA SSB output with different maturity input showed little variation of SSB (ICES C.M. 2006/ACFM:26).

2.5.5 Stock assessment

2.5.5.1 Tuning and estimation of fishing mortality

The 2005 Faroe saithe assessment was a benchmark assessment, where several different settings and combinations of tuning series were run in the XSA (WD 16, 2005). Due to technical issues discovered by the NWWG in 2006 the review group in that year concluded that the modelling setup set up in 2005 should not have been adopted. This year’s assessment is an exploratory assessment, but the technical issues related to changes in catchability to changes in growth have not yet been resolved (see section 2.5.8).

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 pair trawler series. The series extends back to 1985 and consists of data from 8-10 pair trawlers greater than 1000 HP which have specialized 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 (1995-2005) information for each haul was supplied and only those hauls where saithe contributed to more than 50% of the total catches were used. Figure 2.5.5.1 shows a map of the distribution of saithe hauls from the pair trawlers tuning fleet in 2006.

A systematic check of the age based indices from the different pairs of the commercial series showed that there were differences between the pairs (ICES C.M. 2005/ACFM:21), especially in 2004. A GLM model using data from each haul was used to standardize the CPUE-data

(WD 37, 2005). The fitted CPUE values have been estimated for the period 1995-2006 including year, month, pair, and statistical square as explanatory variables (Figure 2.5.5.2). There is a difference in the results from the GLM model if it is done in the statistical program SPSS or R. This year's model was done in R and it shows a lower difference between the original data than the SPSS model did. The different pairs of trawlers are described in the appendix.

The survey series were updated with the traditional stratification and with no stratification, but these were not used in 2007 assessment until the appropriate treatment of the survey data has been found. 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 tapered weighting. These settings are also used for the 2007 assessment. The tunings 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. Log catchability residuals are relatively random in recent years (Figure 2.5.5.3).

Comparisons between different models (Xcam model, iterative cohort model, ADAPT and XSA) show different results (Figure 2.5.8.1). The Xcam model and the iterative cohort model do not use tuning data. The fishing mortality shows good relationship to 2005. The recruitment for the two last years is set to 50000 in the Xcam and iterative cohort model. The recruitment from the Xcam and iterative cohort model are higher in 2004 than the results from the other two. This likely reason for this is discussed further below. The 2005 and 2006 SSB are higher from the models that not use the tuning serie.

The 2007 XSA Faroe saithe assessment was calibrated with a commercial cpue index of age groups 3 to 11 derived from a subset of the pair trawler fleet. The calibration assumed a proportional relationship between stock size and cpue indices (CPUEa = Ua = qa Na), estimated independently for age groups 3 to 7 but jointly for age groups 8 to 11. The XSA average catchability coefficient calculated relative to age groups 8 to 11 are plotted relative to the age groups 8-11 in figure 2.5.8.2.

Figure 2.5.8.2 shows that the mean catchability of age group 6 is estimated to be about 6-7 fold higher than that of age group 4. Weights at age in the tuning fleet show that an age 6 saithe in 1995 weighed about 3 kg while an age 4 saithe weighed slightly more than 2 kg. In 2006, an age 6 saithe weighed about the same as an age 2 saithe 11 years earlier, that is slightly more than 2 kg. Catchability is a function of fish size and fish availability to the fleet. Given these drastic changes in the weights at age the assumption of constant q with age is not valid since it will give and underestimation in the population numbers entering the fisheries, particularly at partially recruited ages. This pattern is also reflected in the historical underestimation of this stock. The working group thus concludes that the assessment is useful to indicate stock trends but that recent year classes are probably underestimated.

The median SSB from ADAPT is higher than the point estimate from XSA and the ADAPT median fishing mortality is correspondingly lower (Figure 2.5.5.5). The XSA point estimates do fall in the cloud of the 1000 bootstrap combinations of SSB and F (Figure 2.5.5.4). The working group accepted the XSA calibrated with the CPUE from the GLM-model, with some comments (see chapter 2.5.8).

Retrospective analysis of the average fishing mortality from the XSA for age groups 4-8 (Figure 2.5.5.6 a) shows a tendency to overestimate F in the last years. This implies that biomass was correspondingly underestimated (Figure 2.5.5.6 b). With respect to recruitment, the analysis indicated an underestimate (Figure 2.5.5.6 c). The fishing mortalities for 1961-2006 are presented in Table 2.5.5.3 and in Figure 2.5.5.7. The average fishing mortality for age groups 4-8 was 0.53 in 2006.

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 2.5.5.8). The 1998 year class (87 millions) and the 1999 year class (93 millions) are the largest in the available time series and the 1998 year class can be seen in the modal length progression in the summer survey from 1999 (Figure 2.5.5.9). 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 2.5.5.10). The SSB has increased since 1996 to above 100 000t in 2005 with the maturation of the 1992, 1994, 1996, 1998 and 1999 yearclasses but in 2006 the SSB decreased to 98 000 t. The relation between stock and recruitment (Figure 2.5.5.11) shows that the highest recruitment has been observed at the lowest SSBs. While the spawning stock biomass graph shows three cycles of decreasing magnitude, that of total biomass (Figure 2.5.5.12) shows three cycles of increasing magnitude. This could be due to higher exploitation rates since the early 1990s.

2.5.6 Prediction of catch and biomass

2.5.6.1 Input data

The assessment is exploratory and the prediction is used to compare the results with previous years assessment to evaluate relative changes given similar input dat. 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 2003 year class are from the final VPA run whereas values for the 2004-2006 year classes are the geometric mean of the 1977 to 2003 year classes. A correlation between mean weight at age from the landings and mean weight at age from the spring survey and an arithmetic mean for 2004-2006 was tried to get a prediction of 2007 mean weight at age. Because the results from this showed an increase in weight in 2007, the 2006 values were used for 2007-2009 weights (Table 2.5.6.1). In the long term prediction (yield per recruit) mean weights for 1961-2006 were used. The value of natural mortality is 0.2.

In the short term prediction the average of 2006-2007 proportion mature values from the spring survey were used for 2007. For 2008 and 2009 the average for 2005-2007 was used. In the long term prediction the average of smoothed values for 1983-2007 was used.

For all three years in the short term prediction the average exploitation pattern in the final VPA for 2004-2006, unscaled to Fbar (ages 4-8) in 2006 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 2002-2006 (as suggested from ACFM, 2004).

2.5.6.2 Biological reference points

The assessment is exploratory and the results is used to compare with previous years assessment. Yield per recruit and spawning stock biomass per recruit curves are presented in Figure 2.5.6.1. Compared to the 2006 average fishing mortality of 0.53 in age groups 4-8, $\mathbf{F}_{max}$ is 0.45, $\mathbf{F}_{0.1}$ is 0.14, $\mathbf{F}_{med}$ is 0.35 and $\mathbf{F}_{high}$ is 1.04 (Table 2.5.6.3, Figure 2.5.6.1 and Figure 2.5.6.2).

Yield and spawning biomass per Recruit F-reference points:

	Fish Mort Ages 4-8	Yield/R	SSB/R
Average last 3 years	0.45	1.50	2.98
Fmax	0.45	1.50	3.00
F0.1	0.14	1.31	7.20
Fmed	0.35	1.49	3.66

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

The assessment is exploratory and the results are used to compare with previous years assessment. Results from predictions with management option are presented in Table 2.5.6.3. Catches at status quo F would be 46 800 t in 2007 and 43 900 t in 2008. The spawning stock biomass would be about 85 000 tonnes in 2007 and about 75 000 in 2008 above the suggested Bpa =60 000t.Results from the yield per recruit estimates are shown in Table 2.5.6.4 and Figure 2.5.6.1. A projection of catch in number by year classes in 2006 and weight composition in SSB by year classes in 2008 is presented in Figure 2.5.6.4. The catch in 2007 is predicted to rely on the four most recent year classes (86%). In 2008 the five year classes from 2003 to 1999 are expected to contribute about 20% each of the SSB.

2.5.7 Management considerations

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

The spawning stock biomass is about $\mathbf{B}_{pa}$ and is expected to reduce to 75 000 t at status quo fishing mortality, due to poor recruitment in the short term.

2.5.8 Comments on the assessment

2.5.8.1 Data consideration

The XSA settings are the same as in the 2006 assessment, but the tuning fleets had to be changed due to replacement of vessels in the commercial pair trawlers. 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, but this needs further investigation once an appropriate stratification scheme has been identified.

The 2007 assessment indicates that the point estimator of biomass is higher than in the 2006 assessment (2005 SSB = 70 600t compared to 98 400t) and the fishing mortality has increased to 0.53.

2.5.8.2 Assessment quality

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 overlap occurs with other vessels.

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.

2.5.8.3 Response to technical minutes

Technical minutes suggested that a length based assessment should be attempted. This will be further investigated with Bormicon for next year's meeting, time permitting.

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.

Bycatch has been mentioned in the latest technical minutes and below is some information on bycatch and that it will be closed areas and mandatory use of sorting grid in the blue whiting fishery from 2007.

<u>Bycatch</u>

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 subarea Vb was 468 thousand tonnes in 2003 (ICES, 2004) and only small percentages of bycatch 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 in the blue whiting fisheries 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 was made in 2004 to estimate the by-catch of saithe in Faroese waters (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.

In May-June 2006 an observer measured the bycatch of saithe on the Faroese Blue whiting vessel "Atlantic Navigator", that fished in the area northwest of the Faroe Islands (Fiskiveiðieftirlitið, 2006). The bycatch of saithe was estimated at 0.49 % of the total catch, which corresponds to 2500 tonnes (the landings of saithe in 2006 were 62539 tonnes). The highest bycatch in a single haul was 7.35% whereas most values were considerably lower (Figure 2.5.8.3). The length varied normally between 50 and 70 cm, the average length being 60.5 cm (Figure 2.5.8.4). The ages ranged between 3 and 13 years, the majority being between 5 and 9 years old (mode: 7 years). These results indicate that Scenario 1 is more likely than Scenario 2 (see below) and that the bycatch issue is a minor problem in the saithe assessment.

The Faroese Ministry of Fisheries and Maritime Affairs announced 9. March 2007 that a sorting grid was mandatory from 15. April 2007 in the area west- and north-west of the Faroe

Islands (Area 2) whereas the grid was not mandatory in the deepwater areas north-east (Area 1) and south of the Faroe Islands (Area 3) (Kunngerð no. 18, 2007, Figure 2.5.8.5). No Blue whiting trawling was allowed in the shallow areas covering the Faroe Plateau and the three banks south-west of Faroe Islands (Figure 2.5.8.5).

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

		Scenario 1	Scenario 2
Total blue whiting catch in Vb (tonnes) in 2005		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). In December 2002 two pair of the trawlers left the fleet and in 2005 the last two pair ended their fishing days.

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 pairtrawlers in Faroe waters since the 1986 fishing cod, haddock and saithe, but have in later years been mainly targeting for saithe. They are fishing for greater argentine (silver smelt) a few summer months per year. 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. In August 2006 these two trawlers switched owners again and they are now called "Navarin" and "Borgarin", but they still fish mainly for saithe around the Faroes.

The data on which the tuning series are based origin from all available logbooks 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).

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Table 2.5.1.1. Saithe in the Faroes (Division Vb). Nominal catches (tonnes round weight) by countries, 1989-2006, as officially reported to ICES.

Country	1989	1990	1991	1992	1993	1994	1995	1996	1997
Denmark	-	2	-	-	-	-	-	-	-
Estonia	-	-	-	-	-	-	-	-	16
Faroe Islands	43,624	59,821	53,321	35,979	32,719	32,406	26,918	19,267	21,721
France [3]	-	-	-	120	75	19	10	12	9
Germany	-	-	32	5	2	1	41	3	5
German Dem.Rep.	9	-	-	-	-	-	-	-	-
German Fed. Rep.	20	15	-	-	-	-	-	-	-
Greenland	-	-	-	-	-	-	-	-	-
Ireland	-	-	-	-	-	-	-	-	-
Netherlands	22	67	65	-	-	-	-	-	
Norway	51	46	103	85	32	156	10	16	67
Portugal	-	-	-	-	-	-	-	-	-
UK (Eng. & W.)	-	-	5	74	279	151	21	53	-
UK (Scotland)	9	33	79	98	425	438	200	580	460
USSR/Russia [2]	-	30	-	12	-	-	-	18	28
Total	43,735	60,014	53,605	36,373	33,532	33,171	27,200	19,949	22,306
Working Group estimate [4,5]	44,477	61,628	54,858	36,487	33,543	33,182	27,209	20,029	22,306

Country	1998	1999	2000	2001	2002	2003	2004	2005	2006 [1]
Denmark	-	-	-	-	-	-	-	-	34
Estonia	-	-	-	-	-	-	-	-	-
Faroe Islands	25,995	32,439		49,676	55,165	47,933	48,222	71,496	65,965
France	17	-	273	934	607	370	147		161
Germany	-	100	230	667	422	281	186	1	49
Greenland	-	-	-		442	-			
Irland	-	-	-	5	-	-	-	-	-
Norway	53	160	72	60	77	62	82	82	35
Portugal	-	-	-	-	-	-	5	-	-
Russia	-	-	20	1	10	32	71		104
UK (E/W/NI)	19	67	32	80	58	89	85	32	
UK (Scotland)	337	441	534	708	540	610	748	4,322	
United Kingdom									1099
Total	26,421	33,207	1,161	52,131	57,321	49,377	49,546	75,933	67,413
Working Group estimate [4,5,6,7]	26,421	33,207	39,020	51,786	53,546	46,555	46,355	67,972	62,539

[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 2001-2006 catches from Faroe Islands, as stated from Faroese coastal guard service, are corrected in order to be consistent with procedures used previous years.

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 1985-2006 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 >1000 HP	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	43624
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	59821
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	53321
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	35979
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	32719
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	32406
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	26918
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	19267
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	21721
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	25995
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	32439
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	37859
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	49676
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	51028
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	44338
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	44605
2005	0.2	0.1	4.4	0.0	2.4	0.2	12.7	20.6	59.2	0.2	0.0	0.0	66134
2006	0.2	0.4	0.3	0.0	3.9	0.1	19.8	20.6	54.1	0.6	0.0	0.0	61018
Average	0.3	0.2	0.6	0.1	6.2	2.0	16.1	20.2	53.5	0.2	0.6	0.1	41143

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

Age	Jiggers	Single trawlers >1000 HP	Pair trawlers <1000 HP	Pair trawlers >1000HP	Others	Total Faroese fleet	Foreign fleet	Total Division Vb
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
2	0	43	0	0	0	63	10	73
3	21	572	93	140	6	1242	132	1374
4	114	1225	404	1176	47	4425	282	4707
5	212	1048	965	2410	76	7029	241	7270
6	172	714	1185	2584	66	7045	164	7210
7	246	834	1452	3700	90	9435	192	9627
8	102	273	531	1376	32	3453	63	3515
9	23	52	44	268	7	587	12	599
10	11	30	44	85	3	257	7	264
11	1	3	2	14	1	29	1	30
12	0	0	1	5	0	11	0	11
13	0	0	4	3	0	12	0	12
14	0	1	0	1	0	5	0	5
15	0	0	0	0	0	0	0	0
Total No.	902	4794	4726	11762	327	33592	1103	34696
Catch, t.	1705	7337	8773	22456	620	61018	1521	62539

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

Table 2.5.2.2. Saithe in the Faroes (Division Vb). Sampling intensity in 2000-2006.

Year		Jiggers	Single trawlers >1000 HP	Pair trawlers <1000 HP	Pair trawlers >1000 HP	Others	Total	Amount sampled pr tonnes landed (%)
2000	**Lengths**	2443	2429	9910	28724		43506	10.7
	Otoliths	300	301	1019	2816		4436	
	Weights	300	241	959	2816		4316	
2001	**Lengths**	1788	4388	5613	30341		42130	7.7
	Otoliths	180	450	480	3237		4347	
	Weights	180	420	420	3177		4197	
2002	**Lengths**	1197	9235	5049	30761		46242	5.8
	Otoliths	120	1291	422	3001		4834	
	Weights	120	420	240	2760		3540	
2003	**Lengths**		4959	6393	34812	1388	47552	7.0
	Otoliths		719	960	3719	180	5578	
	Weights		420	239	2999		3658	
2004	**Lengths**	916	2665	3455	35609	1781	44426	6.0
	Otoliths	180	180	240	3537	240	4377	
	Weights	180	120	120	3357	1364	5141	
2005	**Lengths**	1048	4266	6183	32046	1564	45107	4.0
	Otoliths	120	413	690	2760	240	4223	
	Weights	340	385	791	3533	1564	6613	
2006	**Lengths**	1059	7979	8115	23082	1139	41374	3.8
	Otoliths	180	598	1138	2096	60	4072	
	Weights	180	60	1620	5678	812	8350	

Table 2.5.2.3. Saithe in the Faroes (Division Vb). Catch number at age (thousands) from the commercial fleet.

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

YEAR	1961	1962	1963	1964	1965	1966
AGE						
3	183	562	614	684	996	488
4	379	542	340	1908	850	1540
5	483	617	340	1506	1708	1201
6	403	495	415	617	965	1686
7	216	286	406	572	510	806
8	129	131	202	424	407	377
9	116	129	174	179	306	294
10	82	113	158	150	201	205
11	45	71	94	100	156	156
+gp	82	105	274	174	285	225
TOTALNUM	2118	3051	3017	6314	6384	6978
TONSLAND	9592	10454	12693	21893	22181	25563
SOPCOF %	108	93	96	99	92	98

YEAR	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
AGE										
3	595	614	1191	1445	2857	2714	2515	3504	2062	3178
4	796	1689	2086	6577	3316	1774	6253	4126	3361	3217
5	1364	1116	2294	1558	5585	2588	7075	4011	3801	1720
6	792	1095	1414	1478	1005	2742	3478	2784	1939	1250
7	1192	548	1118	899	828	1529	1634	1401	1045	877
8	473	655	589	730	469	1305	693	640	714	641
9	217	254	580	316	326	1017	550	368	302	468
10	190	128	239	241	164	743	403	340	192	223
11	97	89	115	86	100	330	215	197	193	141
+gp	140	187	190	132	100	210	186	265	298	287
TOTALNUM	5856	6375	9816	13462	14750	14952	23002	17636	13907	12002
TONSLAND	21319	20387	27437	29110	32706	42663	57431	47188	41576	33065
SOPCOF %	104	102	97	96	109	100	120	113	116	107

YEAR	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
AGE										
3	1609	611	287	996	411	387	2483	368	1224	1167
4	2937	1743	933	877	1804	4076	1103	11067	3990	1997
5	2034	1736	1341	720	769	994	5052	2359	5583	4473
6	1288	548	1033	673	932	1114	1343	4093	1182	3730
7	767	373	584	726	908	380	575	875	1898	953
8	708	479	414	284	734	417	339	273	273	1077
9	498	466	247	212	343	296	273	161	103	245
10	338	473	473	171	192	105	98	52	38	104
11	272	407	368	196	92	88	98	65	26	67
+gp	330	535	691	786	1021	902	540	253	275	158
TOTALNUM	10781	7371	6371	5641	7206	8759	11904	19566	14592	13971
TONSLAND	34835	28138	27246	25230	30103	30964	39176	54665	44605	41716
SOPCOF %	104	100	102	99	96	96	100	100	94	94

YEAR	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
AGE										
3	1581	866	451	294	1030	521	1316	690	398	297
4	5793	2950	5981	3833	5125	4067	2611	3961	1019	1087
5	3827	9555	5300	10120	7452	3667	4689	2663	3468	1146
6	2785	2784	7136	9219	5544	2679	1665	2368	1836	1449
7	990	1300	793	5070	3487	1373	858	746	1177	1156
8	532	621	546	477	1630	894	492	500	345	521
9	333	363	185	123	405	613	448	307	241	132
10	81	159	83	61	238	123	245	303	192	77
11	43	27	55	60	128	63	54	150	104	64
+gp	97	60	39	79	118	108	52	49	117	82
TOTALNUM	16062	18685	20569	29336	25157	14108	12430	11737	8897	6011
TONSLAND	40020	45285	44477	61628	54858	36487	33543	33182	27209	20029
SOPCOF %	96	99	97	98	99	105	102	102	102	103

YEAR	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
AGE										
3	344	163	322	811	1125	302	330	76	453	1374
4	832	1689	655	2830	2452	8399	2432	2011	2948	4707
5	2440	1934	3096	1484	8437	5962	11152	8544	9487	7270
6	1767	3475	2551	4369	2155	9786	3994	8762	16605	7210
7	1335	1379	4113	2226	3680	862	4287	2125	7097	9627
8	624	683	915	2725	1539	1280	417	1807	842	3515
9	165	368	380	348	1334	465	419	265	809	599
10	71	77	147	186	293	362	304	293	32	264
11	29	32	24	56	90	33	91	146	102	30
+gp	100	73	69	25	56	45	43	112	30	28
TOTALNUM	7707	9873	12272	15060	21161	27496	23469	24141	38405	34624
TONSLAND	22306	26421	33207	39020	51786	53546	46555	46355	67972	62539
SOPCOF %	100	102	102	102	100	100	100	100	100	100

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

Table 2 Catch weights at age (kg)

YEAR	1961	1962	1963	1964	1965	1966
AGE						
3	1.4300	1.2730	1.2800	1.1750	1.1810	1.3610
4	2.3020	2.0450	2.1970	2.0550	2.1250	2.0260
5	3.3480	3.2930	3.2120	3.2660	2.9410	3.0550
6	4.2870	4.1910	4.5680	4.2550	4.0960	3.6580
7	5.1280	5.1460	5.0560	5.0380	4.8780	4.5850
8	6.1550	5.6550	5.9320	5.6940	5.9320	5.5200
9	7.0600	6.4690	6.2590	6.6620	6.3210	6.8370
10	7.2650	6.7060	8.0000	6.8370	7.2880	7.2650
11	7.4970	7.1500	7.2650	7.6860	8.0740	7.6620
+gp	9.3399	9.0237	8.8589	8.5591	8.9035	9.2233
SOPCOFAC	1.0779	.9342	.9590	.9933	.9220	.9769

YEAR	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
AGE										
3	1.2730	1.3020	1.1880	1.2440	1.1010	1.0430	1.0880	1.4300	1.1140	1.0880
4	1.7800	1.7370	1.6670	1.4450	1.3160	1.4850	1.4610	1.5250	1.6580	1.6760
5	2.5340	2.0360	2.3020	2.2490	1.8180	2.0550	1.5820	2.2070	2.2600	2.8780
6	3.5720	3.1200	2.8530	2.8530	2.9780	2.8290	2.2490	2.5000	3.1200	3.0810
7	4.3680	4.0490	3.6730	3.5150	3.7020	3.7910	3.6870	3.1200	3.5570	4.2870
8	5.3130	5.1830	5.0020	4.4180	4.2710	4.1750	4.3850	4.6010	4.0960	4.3520
9	5.8120	6.2380	5.7140	5.4440	5.3880	4.8080	5.1280	5.5590	5.1280	4.7900
10	6.5540	7.5200	6.4050	5.7330	5.9720	5.2940	5.2760	5.7140	6.0940	5.9120
11	7.8060	8.0490	6.5540	6.6620	6.4900	6.9480	6.7270	6.2590	7.1960	6.6190
+gp	8.1494	9.0925	8.0870	8.5844	8.0047	7.5146	8.0307	8.0104	8.5982	7.8941
SOPCOFAC	1.0357	1.0194	.9663	.9634	1.0935	1.0043	1.2006	1.1296	1.1607	1.0680

YEAR	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
AGE										
3	1.2230	1.4930	1.2200	1.2300	1.3100	1.3370	1.2080	1.4310	1.4010	1.7180
4	1.6410	2.3240	1.8800	2.1200	2.1300	1.8510	2.0290	1.9530	2.0320	1.9860
5	2.6600	3.0680	2.6200	3.3200	3.0000	2.9510	2.9650	2.4700	2.9650	2.6180
6	3.7900	3.7460	3.4000	4.2800	3.8100	3.5770	4.1430	3.8500	3.5960	3.2770
7	4.2390	4.9130	4.1800	5.1600	4.7500	4.9270	4.7240	5.1770	5.3360	4.1860
8	5.5970	4.3680	4.9500	6.4200	5.2500	6.2430	5.9010	6.3470	7.2020	5.5890
9	5.3500	5.2760	5.6900	6.8700	5.9500	7.2320	6.8110	7.8250	6.9660	6.0500
10	5.9120	5.8320	6.3800	7.0900	6.4300	7.2390	7.0510	6.7460	9.8620	6.1500
11	6.8370	6.0530	7.0200	7.9300	7.0000	8.3460	7.2480	8.6360	10.6700	9.5360
+gp	7.7085	7.5756	8.6262	9.2153	8.9618	10.0411	10.0547	10.0976	11.9501	10.2181
SOPCOFAC	1.0442	1.0049	1.0248	.9937	.9564	.9632	.9997	.9991	.9415	.9419

YEAR	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
AGE										
3	1.6090	1.5000	1.3090	1.2230	1.2400	1.2640	1.4080	1.5030	1.4560	1.4320
4	1.8350	1.9750	1.7350	1.6330	1.5680	1.6020	1.8600	1.9510	2.1770	1.8750
5	2.3950	1.9780	1.9070	1.8300	1.8640	2.0690	2.3230	2.2670	2.4200	2.4960
6	3.1820	2.9370	2.3730	2.0520	2.2110	2.5540	3.1310	2.9360	2.8950	3.2290
7	4.0670	3.7980	3.8100	2.8660	2.6480	3.0570	3.7300	4.2140	3.6510	3.7440
8	5.1490	4.4190	4.6670	4.4740	3.3800	4.0780	4.3940	4.9710	5.0640	4.9640
9	5.5010	5.1150	5.5090	5.4240	4.8160	5.0120	5.2090	5.6570	5.4400	6.3750
10	6.6260	6.7120	5.9720	6.4690	5.5160	6.7680	6.5400	5.9500	6.1670	6.7450
11	6.3430	9.0400	6.9390	6.3430	6.4070	7.7540	8.4030	6.8910	7.0800	7.4660
+gp	10.2439	9.3369	9.9364	8.2869	7.7285	8.2297	8.0501	9.1086	7.5392	7.9806
SOPCOFAC	.9620	.9928	.9698	.9811	.9938	1.0506	1.0169	1.0240	1.0205	1.0319

YEAR	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
AGE										
3	1.4760	1.3880	1.3740	1.4770	1.3300	1.1420	1.1230	1.1430	1.1480	1.1260
4	1.7830	1.7110	1.7120	1.6060	1.5900	1.4600	1.3040	1.3330	1.3250	1.2180
5	2.0320	1.9540	1.9050	2.0770	1.7850	1.6520	1.6140	1.4500	1.5160	1.4620
6	2.7780	2.4050	2.3960	2.3600	2.5860	1.9690	1.9770	1.7890	1.6720	1.7900
7	3.5980	3.3000	2.8450	2.9770	3.0590	3.1300	2.5320	2.5600	2.0870	2.0350
8	4.7660	4.2200	4.1240	3.4800	3.8710	3.5890	3.9700	3.1590	2.9750	2.4360
9	5.9820	4.9990	5.2560	4.8510	4.3740	4.5130	4.8340	4.1540	3.7900	3.8610
10	7.6580	6.3910	5.5260	5.2680	5.5650	5.1380	5.4990	5.1670	6.0870	4.2220
11	7.8820	6.6650	6.9560	6.5230	6.7030	6.4220	6.0990	6.0150	6.1340	5.1490
+gp	9.2453	8.4847	8.5237	5.9024	6.9076	7.5192	6.9154	6.3209	6.7283	6.4461
SOPCOFAC	.9994	1.0221	1.0182	1.0154	1.0017	1.0004	1.0012	1.0038	.9999	.9969

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

Table 5 Proportion mature at age

YEAR	1961	1962	1963	1964	1965	1966
AGE						
3	.0400	.0400	.0400	.0400	.0400	.0400
4	.2600	.2600	.2600	.2600	.2600	.2600
5	.5700	.5700	.5700	.5700	.5700	.5700
6	.8200	.8200	.8200	.8200	.8200	.8200
7	.9100	.9100	.9100	.9100	.9100	.9100
8	.9800	.9800	.9800	.9800	.9800	.9800
9	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
11	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

YEAR	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
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	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
AGE										
3	.0400	.0400	.0400	.0400	.0400	.0400	.0000	.0300	.0400	.1100
4	.2600	.2600	.2600	.2600	.2600	.2600	.2800	.2500	.3700	.3100
5	.5700	.5700	.5700	.5700	.5700	.5700	.6300	.5600	.7100	.5500
6	.8200	.8200	.8200	.8200	.8200	.8200	.9900	.9400	.9200	.8600
7	.9100	.9100	.9100	.9100	.9100	.9100	1.0000	.9800	.9800	.9800
8	.9800	.9800	.9800	.9800	.9800	.9800	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
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	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
AGE										
3	.1100	.1000	.0300	.0000	.0000	.0000	.0100	.0400	.0400	.0200
4	.3200	.2200	.2000	.2000	.1600	.1700	.1500	.1800	.1400	.1300
5	.5900	.5200	.5700	.5500	.4400	.4700	.5100	.6600	.6500	.5900
6	.8300	.7500	.6700	.6800	.7000	.7800	.8300	.8600	.8600	.8000
7	.9700	.9100	.8300	.8000	.8300	.8900	.9400	.9600	.9500	.9400
8	.9700	.9200	.9200	.9400	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
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	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
AGE										
3	.0000	.0100	.0300	.0300	.0200	.0000	.0000	.0000	.0000	.0000
4	.1300	.1600	.2000	.2100	.2000	.1800	.1500	.1300	.1700	.2200
5	.4300	.3700	.3500	.3600	.3600	.4100	.3700	.3800	.3500	.4000
6	.6400	.5400	.5200	.6200	.6000	.6000	.5100	.5500	.5600	.6200
7	.8700	.7900	.7400	.7600	.7500	.7300	.6700	.7100	.7100	.7800
8	.9900	.9700	.9200	.9300	.9100	.9400	.8700	.8700	.8500	.8800
9	1.0000	.9700	.9700	.9600	.9700	.9700	.9900	.9900	.9700	.9600
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 2006

1 1 0 1

3 11

10486	91	349	1118	457	283	95	46	37	27
7126	99	306	262	358	161	90	43	41	22
9621	76	205	571	389	295	128	28	13	4
10562	46	281	492	637	313	139	73	17	5
14675	89	249	794	1031	1035	418	97	42	6
12740	205	741	432	1278	631	759	91	50	15
14105	315	742	2554	602	958	386	319	66	15
12673	58	1741	1736	3016	228	299	108	77	11
8735	50	528	2321	839	800	70	75	44	13
8532	15	428	1818	1828	370	272	40	42	19
9360	73	463	1573	2829	1219	125	113	3	17
7835	52	440	902	967	1384	515	100	32	5

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

Lowestoft VPA Version 3.1

24/04/2007 15:11

Extended Survivors Analysis

FAROE SAITHE (ICES Division Vb) SAI_IND

CPUE data from file D:\Stovnsmeting\Ices2007\XSA\allpairGLM3-11.DAT

Catch data for 46 years. 1961 to 2006. Ages 3 to 12.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
All pair (GLM) >1000	1995	2006	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 25 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	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
3	.011	.014	.006	.027	.014	.004	.007	.002	.010	.030
4	.048	.072	.073	.068	.106	.141	.036	.055	.107	.136
5	.116	.151	.182	.237	.294	.403	.282	.172	.394	.413
6	.327	.241	.305	.422	.643	.660	.521	.375	.590	.596
7	.505	.461	.499	.477	.776	.581	.694	.588	.599	.843
8	.536	.529	.643	.743	.727	.689	.626	.726	.490	.685
9	.700	.715	.643	.543	1.075	.501	.506	1.124	.875	.799
10	.667	.862	.713	.775	1.355	1.020	.733	.826	.366	.815
11	.779	.738	.735	.662	1.176	.504	.786	1.006	.789	.704

XSA population numbers (Thousands)

	AGE								
YEAR	3	4	5	6	7	8	9	10	11
1997	3.33E+04	1.95E+04	2.46E+04	6.99E+03	3.72E+03	1.66E+03	3.62E+02	1.61E+02	5.92E+01
1998	1.27E+04	2.70E+04	1.53E+04	1.80E+04	4.13E+03	1.84E+03	7.96E+02	1.47E+02	6.78E+01
1999	5.89E+04	1.02E+04	2.06E+04	1.07E+04	1.16E+04	2.13E+03	8.86E+02	3.19E+02	5.10E+01
2000	3.38E+04	4.79E+04	7.78E+03	1.40E+04	6.48E+03	5.75E+03	9.18E+02	3.81E+02	1.28E+02
2001	8.74E+04	2.70E+04	3.67E+04	5.02E+03	7.54E+03	3.29E+03	2.24E+03	4.36E+02	1.44E+02
2002	9.27E+04	7.05E+04	1.99E+04	2.24E+04	2.16E+03	2.84E+03	1.30E+03	6.26E+02	9.22E+01
2003	5.11E+04	7.56E+04	5.01E+04	1.09E+04	9.47E+03	9.91E+02	1.17E+03	6.47E+02	1.85E+02
2004	3.95E+04	4.15E+04	5.97E+04	3.09E+04	5.28E+03	3.87E+03	4.34E+02	5.76E+02	2.54E+02
2005	5.05E+04	3.22E+04	3.22E+04	4.12E+04	1.74E+04	2.40E+03	1.53E+03	1.15E+02	2.07E+02
2006	5.06E+04	4.10E+04	2.37E+04	1.78E+04	1.87E+04	7.83E+03	1.20E+03	5.24E+02	6.56E+01

Table 2.5.5.2. (Continued)

Estimated population abundance at 1st Jan 2007

0.00E+00	4.02E+04	2.93E+04	1.29E+04	8.01E+03	6.58E+03	3.23E+03	4.43E+02	1.90E+02

Taper weighted geometric mean of the VPA populations:

2.63E+04	1.98E+04	1.32E+04	7.81E+03	4.21E+03	2.20E+03	1.15E+03	6.12E+02	3.25E+02

Standard error of the weighted Log(VPA populations) :

.5720	.6009	.6278	.6259	.6030	.5762	.6425	.8196	.9924

Log catchability residuals.

Fleet : All pair (GLM) >1000

Age	1995	1996
3	.27	1.21
4	.60	-.04
5	.83	-.21
6	.00	.08
7	.31	-.22
8	.24	.41
9	.16	.64
10	-.39	1.47
11	.01	.08

Age	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
3	.32	.70	-.51	1.03	.40	-1.25	-.43	-1.35	-.11	-.26
4	-.27	-.36	.16	-.15	.34	.36	-.58	-.16	.10	.00
5	-.67	-.41	-.55	-.02	.14	.52	.20	-.25	.24	.17
6	-.25	-.84	-.14	.00	.27	.50	.26	-.05	.10	.05
7	-.03	-.19	-.33	-.12	.18	.01	.21	.00	-.09	.25
8	-.16	-.27	.40	.19	-.04	-.05	-.11	-.04	-.54	-.04
9	-.08	.00	-.18	-.18	.30	-.37	-.25	.39	-.03	.24
10	-.05	.29	.04	.20	.47	.24	-.10	.03	-1.29	-.06
11	-.18	-.20	-.07	.04	.03	-.01	-.04	.13	.05	.11

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	-15.4732	-13.3397	-12.1170	-11.5564	-11.3452	-11.2346	-11.2346	-11.2346	-11.2346
S.E(Log q)	.8121	.3344	.4396	.3304	.2040	.2749	.3033	.6319	.1059

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	6.77	-2.189	43.28	.01	12	4.74	-15.47
4	1.29	-1.408	14.20	.70	12	.41	-13.34
5	1.05	-.221	12.23	.65	12	.48	-12.12
6	1.02	-.115	11.59	.80	12	.35	-11.56
7	.99	.079	11.33	.93	12	.21	-11.35
8	1.07	-.551	11.49	.85	12	.30	-11.23
9	1.23	-1.300	12.20	.76	12	.36	-11.18
10	.97	.084	11.03	.53	12	.64	-11.16
11	.91	2.296	10.67	.99	12	.08	-11.24

Terminal year survivor and F summaries :

Age 3 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
All pair (GLM) >1000	30966.	.845	.000	.00	1	.844	.039

Table 2.5.5.2. (Continued)

```
  F shrinkage mean       166217.    2.00                           .156      .007

 Weighted prediction :

 Survivors         Int       Ext     N     Var      F
 at end of year    s.e       s.e           Ratio
     40214.        .78       .66     2     .851    .030

 Age  4   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
 All pair (GLM) >1000      28900.    .322        .039     .12    2   .971      .137

  F shrinkage mean        45636.    2.00                           .029      .089

 Weighted prediction :

 Survivors         Int       Ext     N     Var      F
 at end of year    s.e       s.e           Ratio
     29283.        .32       .06     3     .192    .136

 Age  5   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
 All pair (GLM) >1000      12732.    .264        .306    1.16    3   .973      .417

  F shrinkage mean        18040.    2.00                           .027      .311

 Weighted prediction :

 Survivors         Int       Ext     N     Var      F
 at end of year    s.e       s.e           Ratio
     12854.        .26       .25     4     .948    .413

 Age  6   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       7997.    .214        .097     .45    4   .975      .597

  F shrinkage mean         8638.    2.00                           .025      .563

 Weighted prediction :

 Survivors         Int       Ext     N     Var      F
 at end of year    s.e       s.e           Ratio
      8013.        .21       .08     5     .388    .596

 Age  7   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       6523.    .183        .187    1.03    5   .975      .848

  F shrinkage mean         9446.    2.00                           .025      .653

 Weighted prediction :

 Survivors         Int       Ext     N     Var      F
 at end of year    s.e       s.e           Ratio
      6584.        .19       .17     6     .905    .843
```

Table 2.5.5.2. (Continued)

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

Year class = 1998

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
All pair (GLM) >1000	3229.	.169	.061	.36	6	.980	.686
F shrinkage mean	3420.	2.00				.020	.658

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
3233.	.17	.05	7	.322	.685

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

Year class = 1997

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
All pair (GLM) >1000	444.	.166	.147	.89	7	.977	.798
F shrinkage mean	423.	2.00				.023	.824

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
443.	.17	.13	8	.799	.799

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

Year class = 1996

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
All pair (GLM) >1000	191.	.199	.052	.26	8	.950	.812
F shrinkage mean	173.	2.00				.050	.869

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
190.	.21	.05	9	.224	.815

Age 11 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	27.	.203	.150	.74	9	.972	.702
F shrinkage mean	23.	2.00				.028	.774

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
27.	.20	.14	10	.684	.704

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

Table 8 Fishing mortality (F) at age

YEAR	1961	1962	1963	1964	1965	1966
AGE						
3	.0226	.0465	.0307	.0478	.0495	.0250
4	.0556	.0863	.0358	.1260	.0772	.1007
5	.0994	.1208	.0716	.2198	.1588	.1492
6	.1219	.1401	.1115	.1797	.2137	.2326
7	.0933	.1192	.1634	.2213	.2216	.2784
8	.0852	.0752	.1157	.2566	.2424	.2536
9	.0972	.1150	.1355	.1424	.2983	.2770
10	.0915	.1295	.2012	.1658	.2355	.3346
11	.0916	.1069	.1514	.1891	.2601	.2900
+gp	.0916	.1069	.1514	.1891	.2601	.2900
0 FBAR 4- 8	.0911	.1083	.0996	.2007	.1827	.2029

YEAR	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
AGE										
3	.0248	.0320	.0328	.0479	.0885	.0935	.1271	.2293	.1505	.2055
4	.0518	.0910	.1452	.2547	.1480	.0728	.3227	.3170	.3595	.3704
5	.1217	.0954	.1719	.1538	.3579	.1649	.4582	.3543	.5442	.3153
6	.1388	.1357	.1684	.1597	.1404	.2985	.3486	.3276	.2891	.3431
7	.2564	.1345	.2000	.1536	.1262	.3286	.2919	.2297	.1957	.2048
8	.2615	.2183	.2094	.1943	.1118	.2995	.2425	.1770	.1752	.1767
9	.2269	.2182	.3063	.1656	.1244	.3759	.1982	.1960	.1183	.1664
10	.2903	.2027	.3289	.2008	.1213	.4600	.2496	.1809	.1485	.1202
11	.2609	.2141	.2831	.1877	.1196	.3810	.2312	.1854	.1479	.1550
+gp	.2609	.2141	.2831	.1877	.1196	.3810	.2312	.1854	.1479	.1550
0 FBAR 4- 8	.1660	.1350	.1790	.1832	.1769	.2329	.3328	.2811	.3127	.2821

YEAR	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
AGE										
3	.1478	.0837	.0374	.0926	.0137	.0285	.0693	.0158	.0628	.0211
4	.2977	.2367	.1776	.1536	.2415	.1832	.1061	.4954	.2365	.1384
5	.4251	.2881	.2890	.2023	.1957	.2031	.3628	.3457	.5026	.4547
6	.4140	.1915	.2780	.2299	.4379	.4822	.4647	.5670	.2914	.7610
7	.3664	.2001	.3213	.3217	.5551	.3197	.4953	.6363	.5660	.4051
8	.2537	.4119	.3572	.2549	.6322	.5383	.5283	.4648	.4139	.7498
9	.2026	.2642	.3871	.3127	.5592	.5697	.8445	.5171	.3183	.8256
10	.1740	.3017	.4698	.5104	.5211	.3288	.3717	.3691	.2172	.6204
11	.2111	.3279	.4075	.3617	.5757	.4826	.5865	.4537	.3184	.7391
+gp	.2111	.3279	.4075	.3617	.5757	.4826	.5865	.4537	.3184	.7391
0 FBAR 4- 8	.3514	.2657	.2846	.2325	.4125	.3453	.3914	.5018	.4021	.5018

YEAR	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
AGE										
3	.0366	.0215	.0177	.0159	.0470	.0299	.0633	.0465	.0114	.0137
4	.1385	.0887	.2021	.2044	.4160	.2641	.2055	.2747	.0898	.0391
5	.4267	.3555	.2276	.6216	.7732	.5995	.5545	.3344	.4126	.1382
6	.5760	.6403	.4934	.7833	.8596	.7181	.6077	.6109	.4070	.3020
7	.4616	.5872	.3741	.8064	.7966	.5312	.5293	.6118	.7158	.4883
8	.4164	.5968	.5273	.4054	.6672	.4803	.3664	.6863	.6474	.8334
9	.5476	.5629	.3524	.2120	.7308	.5723	.4738	.4114	.8692	.5543
10	.7302	.5537	.2370	.1865	.8168	.5098	.4733	.6945	.4922	.7777
11	.5695	.5760	.3747	.2694	.7455	.5250	.4410	.6026	.5453	.2996
+gp	.5695	.5760	.3747	.2694	.7455	.5250	.4410	.6026	.5453	.2996
0 FBAR 4- 8	.4038	.4537	.3649	.5642	.7025	.5186	.4527	.5036	.4545	.3602

YEAR	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	FBAR **-**
AGE											
3	.0115	.0143	.0061	.0269	.0143	.0036	.0072	.0021	.0100	.0304	.0142
4	.0482	.0717	.0735	.0675	.1059	.1412	.0362	.0550	.1065	.1358	.0991
5	.1159	.1510	.1820	.2369	.2935	.4032	.2822	.1721	.3944	.4133	.3266
6	.3274	.2405	.3046	.4217	.6427	.6604	.5214	.3752	.5902	.5956	.5204
7	.5054	.4608	.4994	.4772	.7759	.5806	.6943	.5883	.5987	.8429	.6766
8	.5362	.5293	.6431	.7426	.7266	.6895	.6257	.7256	.4904	.6850	.6337
9	.6997	.7154	.6428	.5433	1.0747	.5012	.5057	1.1238	.8746	.7986	.9323
10	.6668	.8616	.7131	.7747	1.3551	1.0199	.7330	.8257	.3656	.8145	.6686
11	.7790	.7378	.7347	.6617	1.1758	.5038	.7860	1.0061	.7891	.7041	.8331
+gp	.7790	.7378	.7347	.6617	1.1758	.5038	.7860	1.0061	.7891	.7041	
0 FBAR 4- 8	.3066	.2907	.3405	.3892	.5089	.4950	.4319	.3833	.4360	.5345	

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

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

YEAR	1961	1962	1963	1964	1965	1966
AGE						
3	9047	13663	22431	16192	22803	21830
4	7739	7241	10678	17809	12638	17769
5	5643	5993	5438	8435	12854	9578
6	3881	4183	4349	4145	5543	8979
7	2680	2813	2977	3185	2835	3665
8	1746	1999	2044	2070	2090	1860
9	1384	1313	1518	1491	1311	1343
10	1036	1028	958	1085	1059	797
11	568	774	740	641	753	685
+gp	1032	1141	2147	1111	1367	981
0 TOTAL	34757	40149	53279	56164	63254	67486

YEAR	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
AGE										
3	26879	21515	40798	34136	37285	33607	23282	18897	16306	18911
4	17432	21468	17059	32325	26640	27941	25059	16786	12301	11485
5	13154	13552	16048	12079	20514	18811	21271	14859	10010	7030
6	6755	9536	10085	11064	8480	11742	13059	11014	8536	4756
7	5826	4814	6816	6978	7721	6033	7133	7545	6498	5234
8	2272	3691	3445	4569	4899	5572	3556	4361	4910	4375
9	1182	1432	2429	2288	3080	3587	3381	2285	2991	3374
10	833	771	942	1464	1587	2227	2016	2271	1537	2176
11	467	510	515	555	981	1151	1151	1286	1551	1085
+gp	670	1067	846	848	977	727	990	1722	2386	2199
0 TOTAL	75468	78355	98986	106306	112165	111398	100899	81025	67026	60624

YEAR	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
AGE										
3	12940	8415	8633	12451	33330	15223	40985	25976	22214	61762
4	12607	9138	6337	6808	9293	26916	12113	31309	20934	17080
5	6492	7664	5905	4344	4781	5976	18349	8919	15620	13529
6	4199	3475	4704	3621	2905	3218	3993	10452	5168	7737
7	2763	2273	2349	2917	2356	1535	1627	2054	4854	3162
8	3492	1568	1523	1395	1731	1107	913	812	890	2256
9	3002	2218	850	872	885	753	529	441	418	482
10	2339	2007	1395	473	523	414	349	186	215	249
11	1580	1609	1215	714	232	254	244	197	105	142
+gp	1907	2100	2263	2840	2549	2579	1330	760	1107	330
0 TOTAL	51320	40467	35173	36435	58584	57976	80432	81105	71525	106727

YEAR	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
AGE										
3	48651	45075	28489	20651	24791	19548	23713	16773	38663	24204
4	49510	38401	36121	22917	16642	19365	15533	18224	13108	31294
5	12177	35294	28771	24161	15294	8988	12175	10355	11336	9810
6	7029	6507	20250	18760	10625	5779	4041	5725	6069	6143
7	2959	3235	2808	10123	7018	3682	2307	1802	2545	3307
8	1726	1527	1472	1582	3700	2591	1772	1113	800	1018
9	873	932	688	712	863	1555	1312	1006	459	343
10	173	413	435	396	471	340	718	669	546	157
11	109	68	195	281	269	170	167	366	273	273
+gp	244	150	137	367	245	289	160	118	304	348
0 TOTAL	123452	131602	119366	99949	79918	62308	61899	56150	74103	76898

YEAR	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	GMST	61-**AMST
61-**													
AGE													
3	33333	12664	58858	33831	87361	92717	51072	39470	50540	50636	0	25554	29986
4	19548	26979	10221	47897	26965	70507	75637	41516	32247	40968	40214	19259	23075
5	24638	15252	20561	7776	36654	19858	50127	59726	32171	23734	29283	12809	15677
6	6995	17964	10737	14032	5023	22376	10864	30949	41169	17755	12854	7379	8760
7	3719	4128	11564	6482	7535	2163	9465	5281	17411	18681	8013	3938	4517
8	1662	1837	2132	5746	3293	2840	991	3870	2401	7833	6584	2131	2473
9	362	796	886	918	2239	1304	1167	434	1534	1204	3233	1142	1402
10	161	147	319	381	436	626	647	576	115	524	443	637	853
11	59	68	51	128	144	92	185	254	207	66	190	341	520
+gp	201	152	145	56	88	124	86	192	60	60	51		
TOTAL	90678	79987	115472	117247	169738	212607	200240	182269	177853	161461	100864		

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

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	126463	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	181652	104635	21319	.2037	.1660
1968	21515	189804	115962	20387	.1758	.1350
1969	40798	215031	123796	27437	.2216	.1790
1970	34136	224448	129143	29110	.2254	.1832
1971	37285	228426	139501	32706	.2344	.1769
1972	33607	237049	147569	42663	.2891	.2329
1973	23282	210528	136683	57431	.4202	.3328
1974	18897	204074	137612	47188	.3429	.2811
1975	16306	187422	137888	41576	.3015	.3127
1976	18911	169752	122019	33065	.2710	.2821
1977	12940	156337	114099	34835	.3053	.3514
1978	8415	137401	96028	28138	.2930	.2657
1979	8633	113051	83560	27246	.3261	.2846
1980	12451	124853	88946	25230	.2837	.2325
1981	33330	142243	76332	30103	.3944	.4125
1982	15223	150259	83378	30964	.3714	.3453
1983	40985	179313	91811	39176	.4267	.3914
1984	25976	190450	96213	54665	.5682	.5018
1985	22214	190249	118137	44605	.3776	.4021
1986	61762	235809	98217	41716	.4247	.5018
1987	48651	250728	102893	40020	.3889	.4038
1988	45075	260968	101027	45285	.4482	.4537
1989	28489	229550	101423	44477	.4385	.3649
1990	20651	192726	99089	61628	.6219	.5642
1991	24791	150297	71466	54858	.7676	.7025
1992	19548	124705	59906	36487	.6091	.5186
1993	23713	133831	59693	33543	.5619	.4527
1994	16773	127443	63449	33182	.5230	.5036
1995	38663	153265	62156	27209	.4378	.4545
1996	24204	163159	63393	20029	.3159	.3602
1997	33333	180579	63706	22306	.3501	.3066
1998	12664	164784	66744	26421	.3959	.2907
1999	58858	212956	73308	33207	.4530	.3405
2000	33831	223078	84710	39020	.4606	.3892
2001	87361	287071	84632	51786	.6119	.5089
2002	92717	313275	83386	53546	.6421	.4950
2003	51072	297184	86023	46555	.5412	.4319
2004	39470	275692	98293	46355	.4716	.3833
2005	50540	270015	102761	67972	.6615	.4360
2006	50636	238079	98406	62539	.6355	.5345
Arith. Mean	30881	192251	96792	36051	.3874	.3424
0 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: 15:29 27/04/2007
Fbar age range: 4-8

2007

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	32657	0.2	0.00	0	0	1.126	0.01	1.126
4	40214	0.2	0.26	0	0	1.218	0.10	1.218
5	29283	0.2	0.37	0	0	1.462	0.33	1.462
6	12854	0.2	0.64	0	0	1.790	0.52	1.790
7	8013	0.2	0.78	0	0	2.035	0.68	2.035
8	6584	0.2	0.87	0	0	2.436	0.63	2.436
9	3233	0.2	0.95	0	0	3.861	0.93	3.861
10	443	0.2	1.00	0	0	4.222	0.67	4.222
11	190	0.2	1.00	0	0	5.149	0.83	5.149
12	51	0.2	1.00	0	0	6.446	0.83	6.446

2008

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	32657	0.2	0.00	0	0	1.126	0.01	1.126
4.		0.2	0.22	0	0	1.218	0.10	1.218
5.		0.2	0.37	0	0	1.462	0.33	1.462
6.		0.2	0.61	0	0	1.790	0.52	1.790
7.		0.2	0.76	0	0	2.035	0.68	2.035
8.		0.2	0.87	0	0	2.436	0.63	2.436
9.		0.2	0.96	0	0	3.861	0.93	3.861
10.		0.2	1.00	0	0	4.222	0.67	4.222
11.		0.2	1.00	0	0	5.149	0.83	5.149
12.		0.2	1.00	0	0	6.446	0.83	6.446

2009

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	32657	0.2	0.00	0	0	1.126	0.01	1.126
4.		0.2	0.22	0	0	1.218	0.10	1.218
5.		0.2	0.37	0	0	1.462	0.33	1.462
6.		0.2	0.61	0	0	1.790	0.52	1.790
7.		0.2	0.76	0	0	2.035	0.68	2.035
8.		0.2	0.87	0	0	2.436	0.63	2.436
9.		0.2	0.96	0	0	3.861	0.93	3.861
10.		0.2	1.00	0	0	4.222	0.67	4.222
11.		0.2	1.00	0	0	5.149	0.83	5.149
12.		0.2	1.00	0	0	6.446	0.83	6.446

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: sai2
Index file 27/4/2007
Time and date: 15:45 27/04/2007
Fbar age range: 4-8

Age	M	Mat	PF	PM	SWt	Sel	CWt
3	0.2	0.020	0	0	1.300	0.01	1.300
4	0.2	0.200	0	0	1.776	0.10	1.776
5	0.2	0.490	0	0	2.362	0.33	2.362
6	0.2	0.710	0	0	3.063	0.55	3.063
7	0.2	0.850	0	0	3.889	0.66	3.889
8	0.2	0.950	0	0	4.798	0.64	4.798
9	0.2	0.990	0	0	5.615	0.76	5.615
10	0.2	1.000	0	0	6.359	0.75	6.359
11	0.2	1.000	0	0	7.199	0.76	7.199
12	0.2	1.000	0	0	8.473	0.76	8.473

Weights in kilograms

Table 2.5.6.3. Saithe in the Faroes (Division Vb). Prediction with management option

MFDP version 1a
Run: sai1
Index file 27/4/2007
Time and date: 15:29 27/04/2007
Fbar age range: 4-8

2007				
Biomass	**SSB**	**FMult**	**FBar**	**Landings**
199578	84865	1	0.4513	46789

2008					2009	
Biomass	**SSB**	**FMult**	**FBar**	**Landings**	**Biomass**	**SSB**
181238	75141	0	0	0	212137	103742
.	75141	0.1	0.0451	5496	206172	99051
.	75141	0.2	0.0903	10704	200530	94634
.	75141	0.3	0.1354	15642	195188	90475
.	75141	0.4	0.1805	20326	190129	86556
.	75141	0.5	0.2256	24772	185335	82861
.	75141	0.6	0.2708	28995	180790	79377
.	75141	0.7	0.3159	33007	176479	76089
.	75141	0.8	0.361	36822	172388	72986
.	75141	0.9	0.4061	40451	168503	70055
.	75141	1	0.4513	43905	164812	67285
.	75141	1.1	0.4964	47194	161304	64668
.	75141	1.2	0.5415	50328	157968	62192
.	75141	1.3	0.5866	53316	154793	59850
.	75141	1.4	0.6318	56166	151771	57633
.	75141	1.5	0.6769	58887	148893	55534
.	75141	1.6	0.722	61484	146150	53544
.	75141	1.7	0.7672	63966	143534	51659
.	75141	1.8	0.8123	66339	141039	49871
.	75141	1.9	0.8574	68608	138658	48174
.	75141	2	0.9025	70780	136385	46564

Input units are thousands and kg - output in tonnes

Table 2.5.6.4. Saithe in the Faroes (Division Vb). Yield per recruit, summary table.

MFYPR version 2a
Run: sai2
Time and date: 15:45 27/04/2007
Yield per results

FMult	Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNosJan	SSBJan	SpwnNosSpwn	SSBSpwn
0.0	0.0000	0.0000	0.0000	5.5167	21.9702	3.2918	17.8707	3.2918	17.8707
0.1	0.0456	0.1602	0.7897	4.7194	16.1847	2.5154	12.1573	2.5154	12.1573
0.2	0.0912	0.2542	1.1382	4.2522	13.0428	2.0676	9.0815	2.0676	9.0815
0.3	0.1368	0.3171	1.3094	3.9409	11.1008	1.7744	7.2002	1.7744	7.2002
0.4	0.1824	0.3626	1.3990	3.7162	9.7945	1.5666	5.9499	1.5666	5.9499
0.5	0.2281	0.3974	1.4476	3.5447	8.8609	1.4109	5.0682	1.4109	5.0682
0.6	0.2737	0.4251	1.4744	3.4086	8.1625	1.2896	4.4179	1.2896	4.4179
0.7	0.3193	0.4479	1.4890	3.2972	7.6209	1.1922	3.9210	1.1922	3.9210
0.8	0.3649	0.4670	1.4964	3.2038	7.1884	1.1121	3.5303	1.1121	3.5303
0.9	0.4105	0.4834	1.4996	3.1241	6.8349	1.0449	3.2158	1.0449	3.2158
1.0	0.4561	0.4976	1.5003	3.0550	6.5401	0.9877	2.9577	0.9877	2.9577
1.1	0.5017	0.5101	1.4993	2.9943	6.2902	0.9382	2.7422	0.9382	2.7422
1.2	0.5473	0.5213	1.4974	2.9404	6.0753	0.8951	2.5598	0.8951	2.5598
1.3	0.5930	0.5313	1.4950	2.8921	5.8882	0.8570	2.4033	0.8570	2.4033
1.4	0.6386	0.5404	1.4921	2.8484	5.7236	0.8232	2.2678	0.8232	2.2678
1.5	0.6842	0.5487	1.4891	2.8087	5.5775	0.7929	2.1492	0.7929	2.1492
1.6	0.7298	0.5562	1.4860	2.7724	5.4468	0.7655	2.0446	0.7655	2.0446
1.7	0.7754	0.5632	1.4829	2.7389	5.3289	0.7407	1.9516	0.7407	1.9516
1.8	0.8210	0.5697	1.4798	2.7080	5.2219	0.7180	1.8683	0.7180	1.8683
1.9	0.8666	0.5758	1.4768	2.6793	5.1243	0.6972	1.7934	0.6972	1.7934
2.0	0.9122	0.5814	1.4739	2.6524	5.0348	0.6781	1.7255	0.6781	1.7255

Reference p	F multiplier	Absolute F
Fbar(4-8)	1.000	0.456
FMax	0.983	0.449
F0.1	0.300	0.137
F35%SPR	0.372	0.170
Flow	0.216	0.099
Fmed	0.764	0.349
Fhigh	2.272	1.036

Weights in kilograms

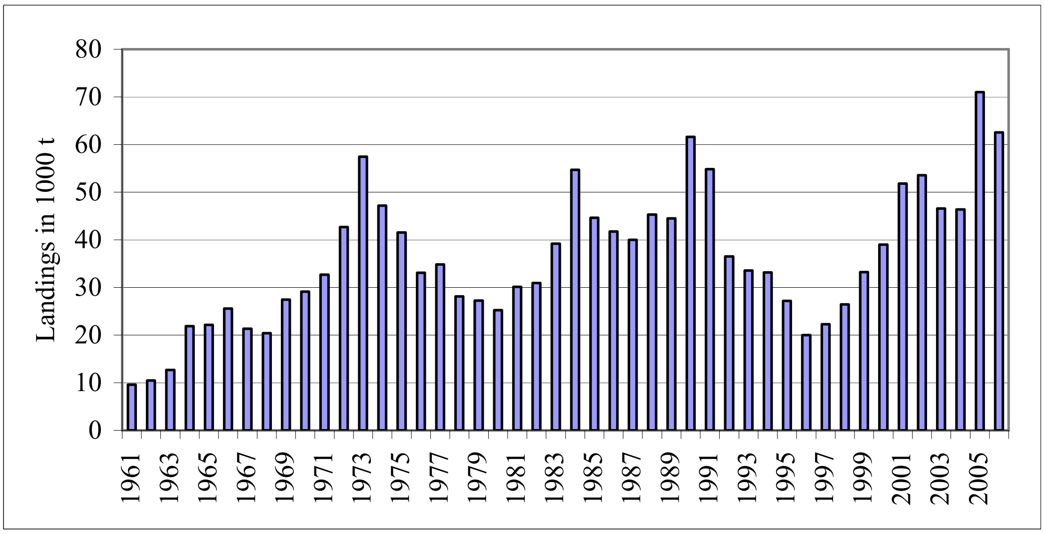


Figure 2.5.1.1. Saithe in the Faroes (Division Vb). Landings in 1000 tonnes.

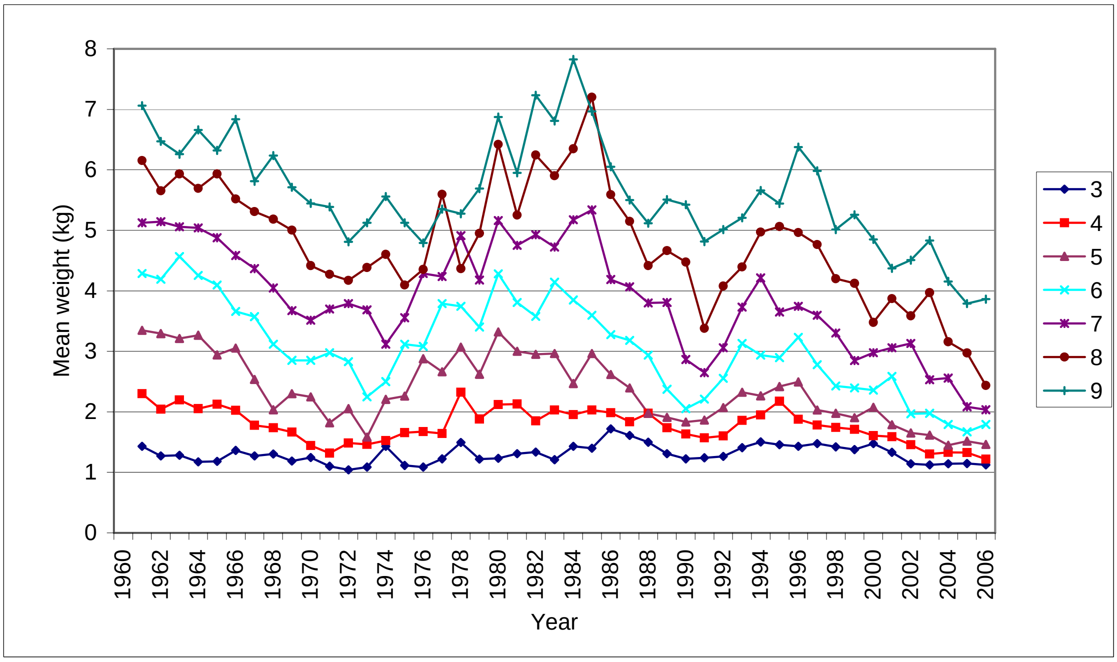


Figure 2.5.3.1. Saithe in the Faroes (Division Vb). Mean weight at age (kg) in the commercial catches for the period 1961-2006.

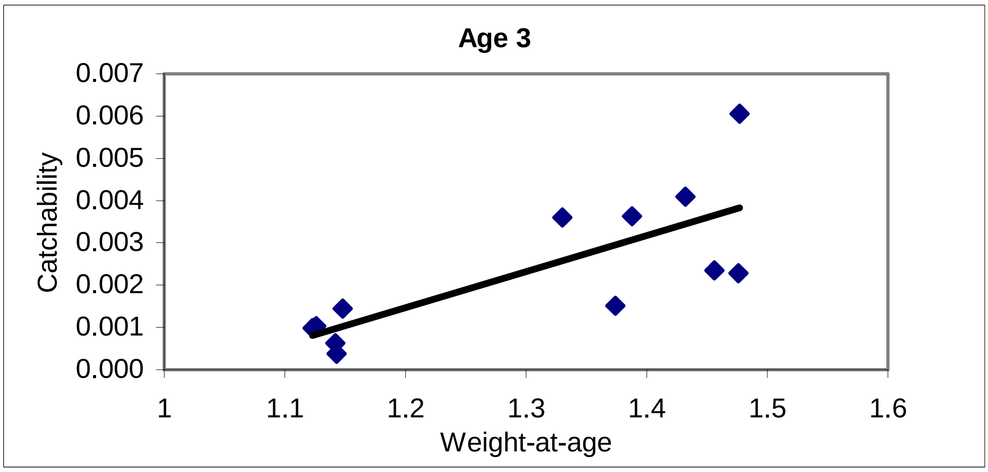
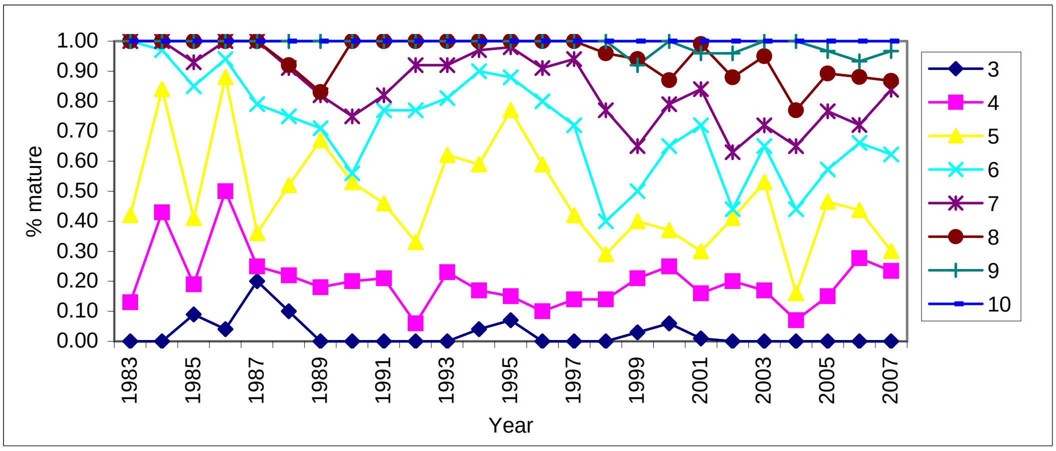


Figure 2.5.3.2. Saithe in the Faroes (Division Vb). Relation between weight at age and catchability for age 3.



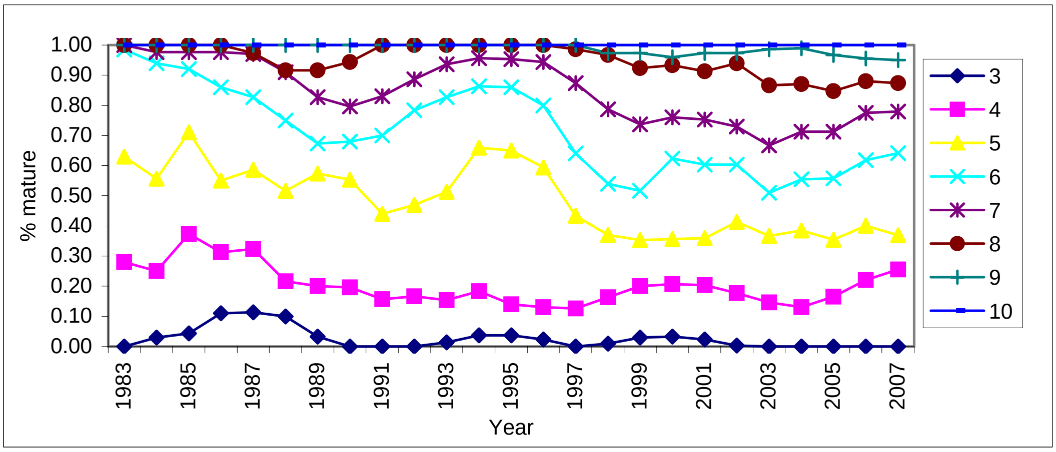


Figure 2.5.4.1. Saithe in the Faroes (Division Vb). Observed (upper figure) and three years running average (lower figure) proportion mature at age from the spring survey for the period 1983-2006. 2007 value is predicted.

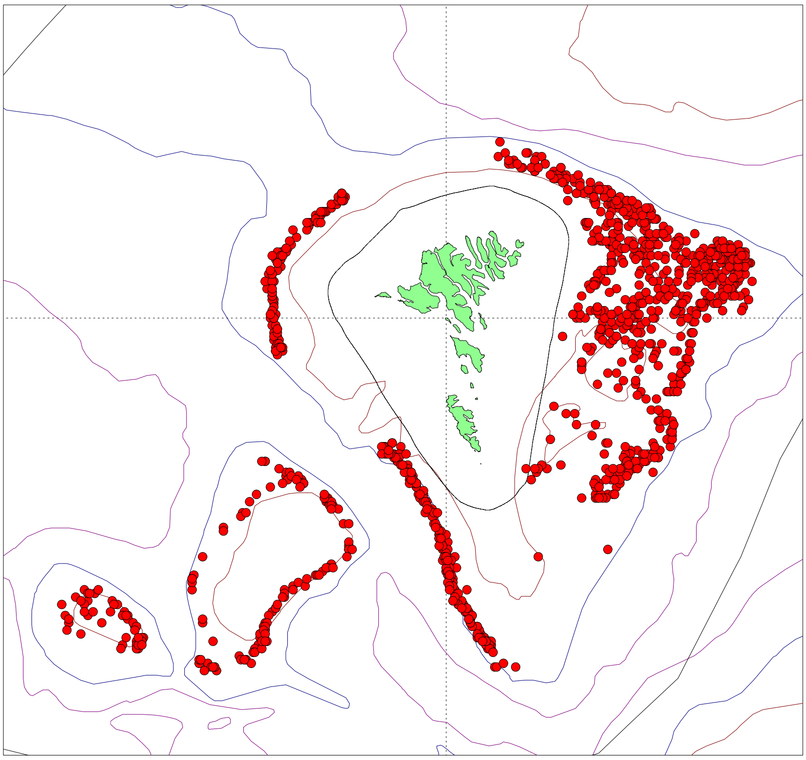


Figure 2.5.5.1. Saithe in the Faroes (Div. Vb). Start position of all saithe hauls from the pair trawlers, which are used in the pair trawler tuning series.

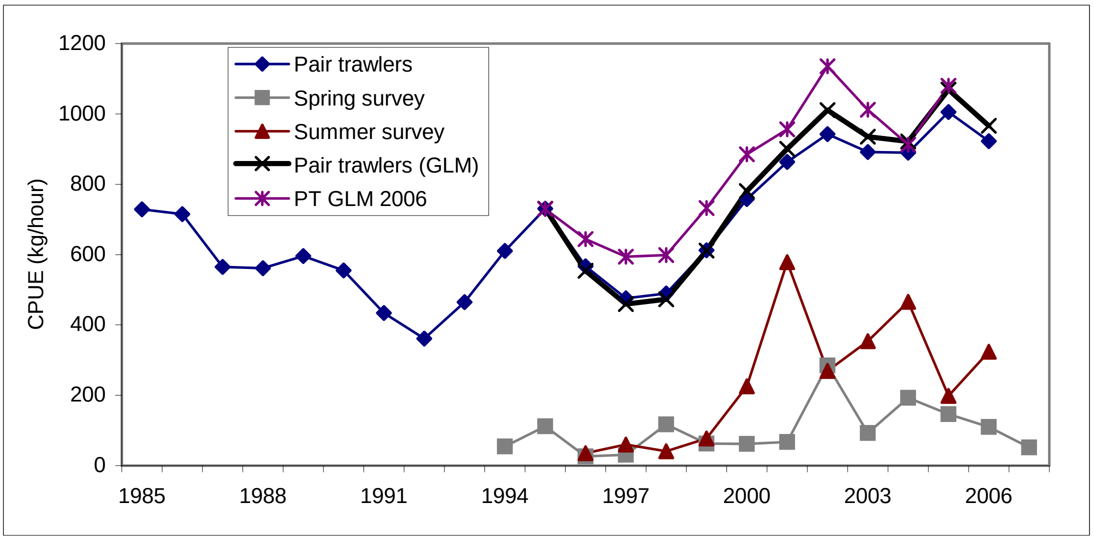


Figure 2.5.5.2. CPUE (kg/hour) from the commercial pair trawlers, spring- and summer survey. Pair trawlers (GLM)- glim modelled cpue from R (used in this years XSA) and PT GLM 2006-glim modelled from SPSS.

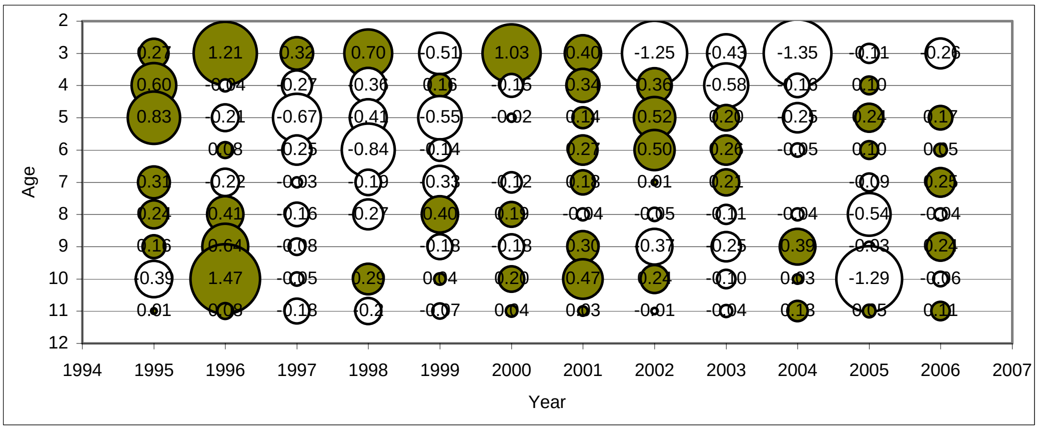


Figure 2.5.5.3. Saithe in the Faroes (Division Vb). Log catchability residuals for age groups 3 -11 from XSA.

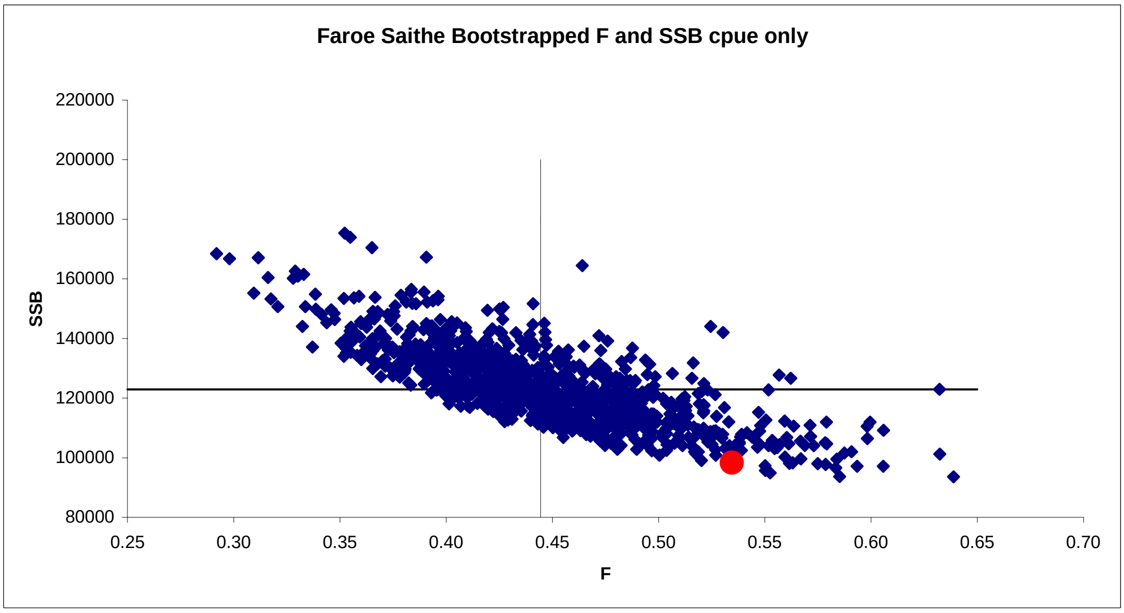
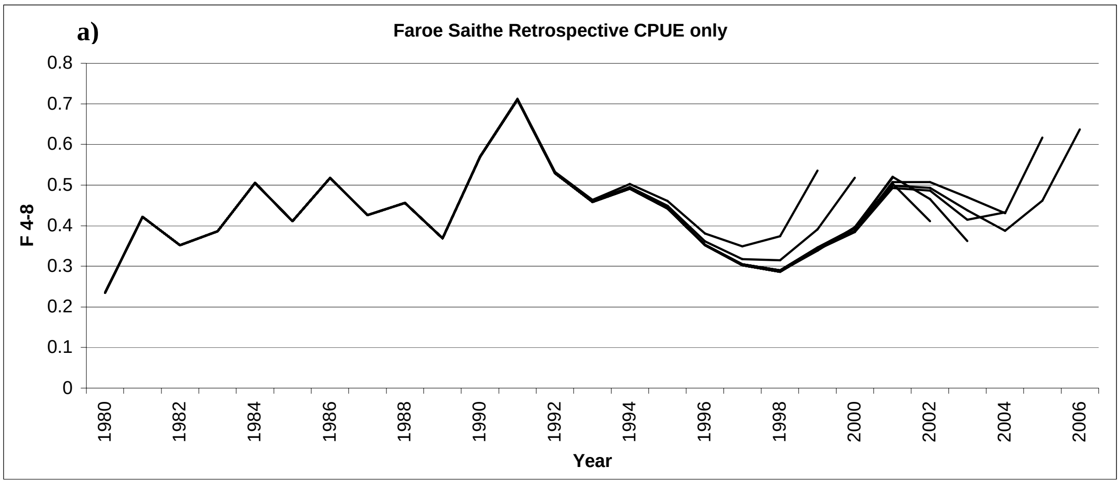
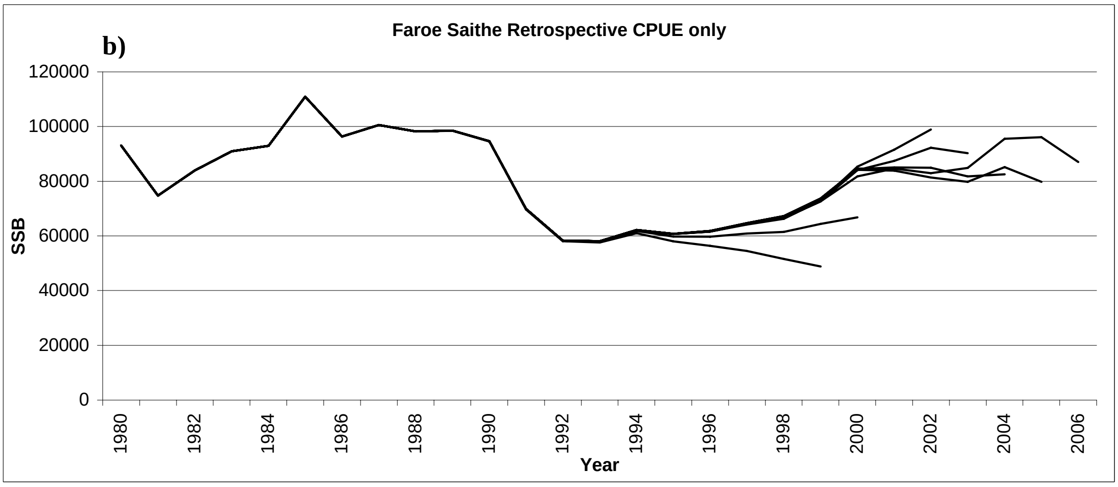


Figure 2.5.5.4. Saithe in the Faroes (Division Vb). Bootstrapped SSB and F on the pair trawler fleet ages 3-11 and the output from XSA on the pair trawlers (red dot). Vertical and horizontal lines show the median F and SSB respectively.





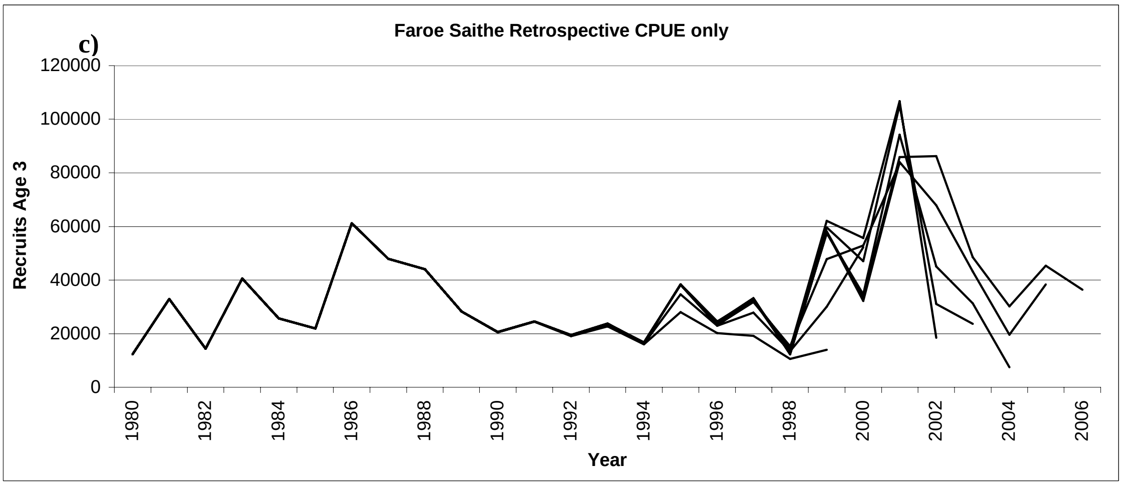
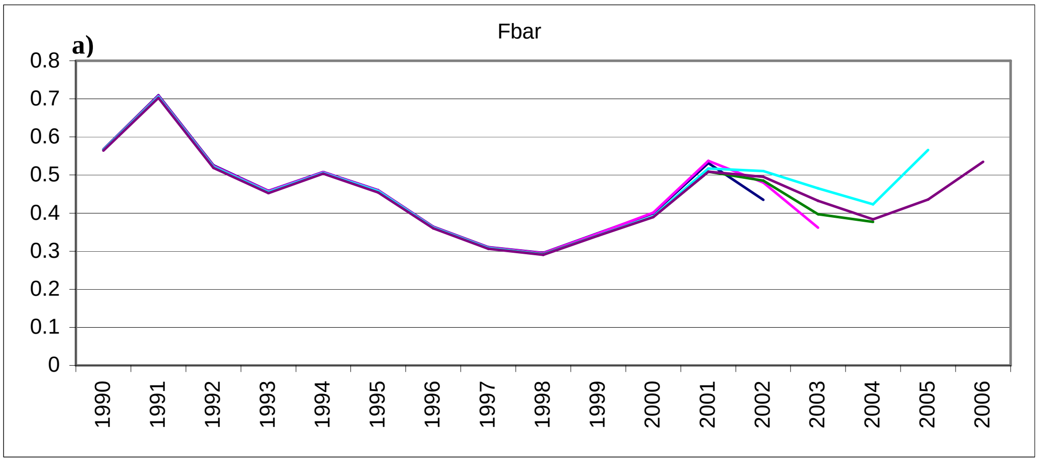
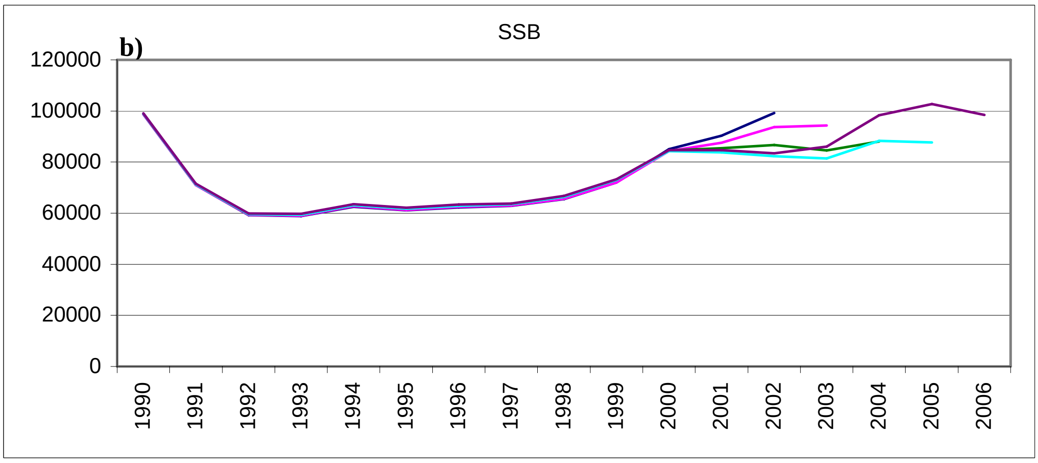


Figure 2.5.5.5. Saithe in the Faroes (Division Vb). Retrospective analysis from Adapt of a) average fishing mortality of age groups 4-8, b) spawning stock biomass of age groups 4-8 and c) recruits (age 3).





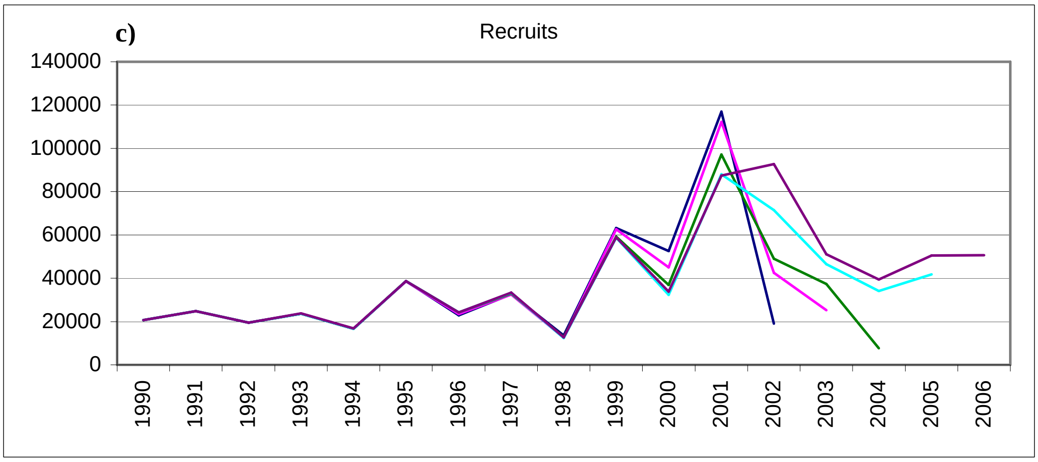


Figure 2.5.5.6. Saithe in the Faroes (Division Vb). Retrospective analysis from XSA for the years 2002-2006 for a) average fishingmortality of age groups 4-8, b) spawning stock biomass of age groups 4-8 and c) average recruitment for age 3.

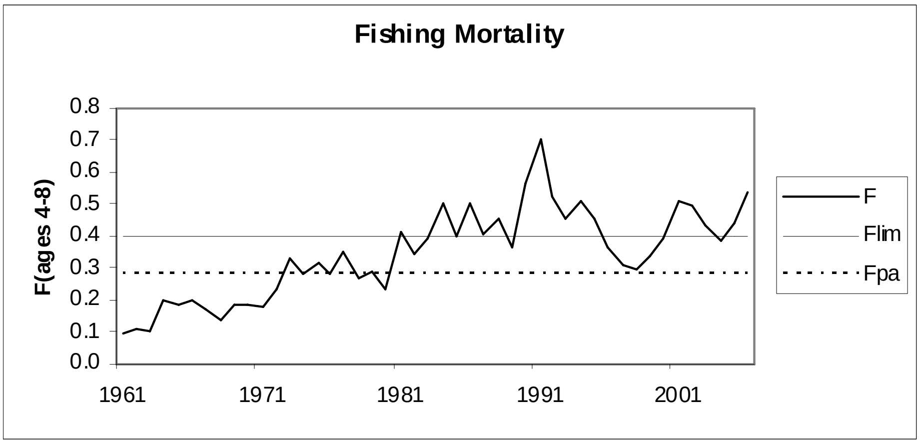


Figure 2.5.5.7. Saithe in the Faroes (Division Vb). Fishing mortality (average F ages 4-8).

Figure 2.5.5.8. Saithe in the Faroes (Division Vb). Recruitment at age 3 (millions).

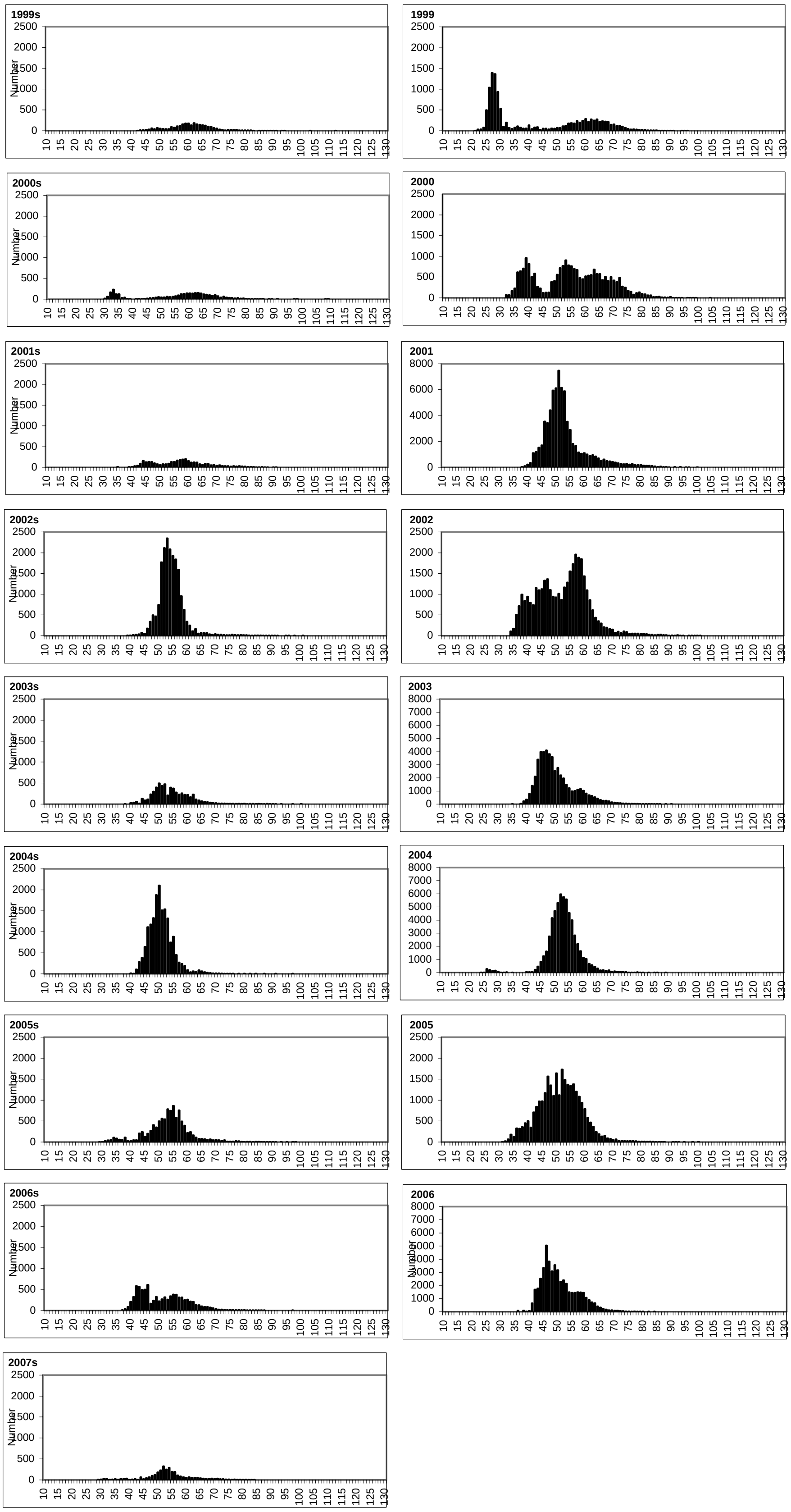


Figure 2.5.5.9. Saithe in the Faroes (Division Vb). Length distribution from spring (s) and summer survey 1999-2007. NB! Different scale for year 2001, 2003, 2004 and 2006 summer survey.

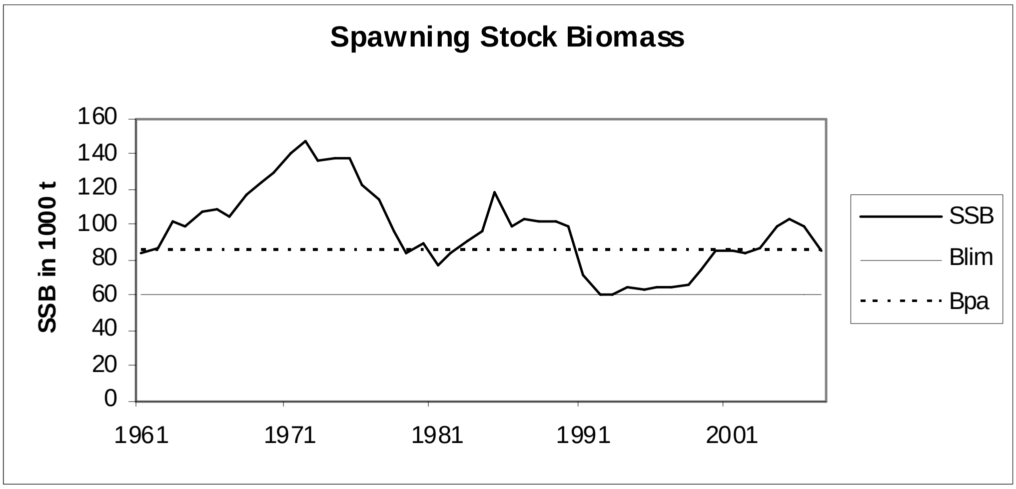


Figure 2.5.5.10. Saithe in the Faroes (Division Vb). Spawning stock biomass (1000 tonnes). 2006 is predicted value.

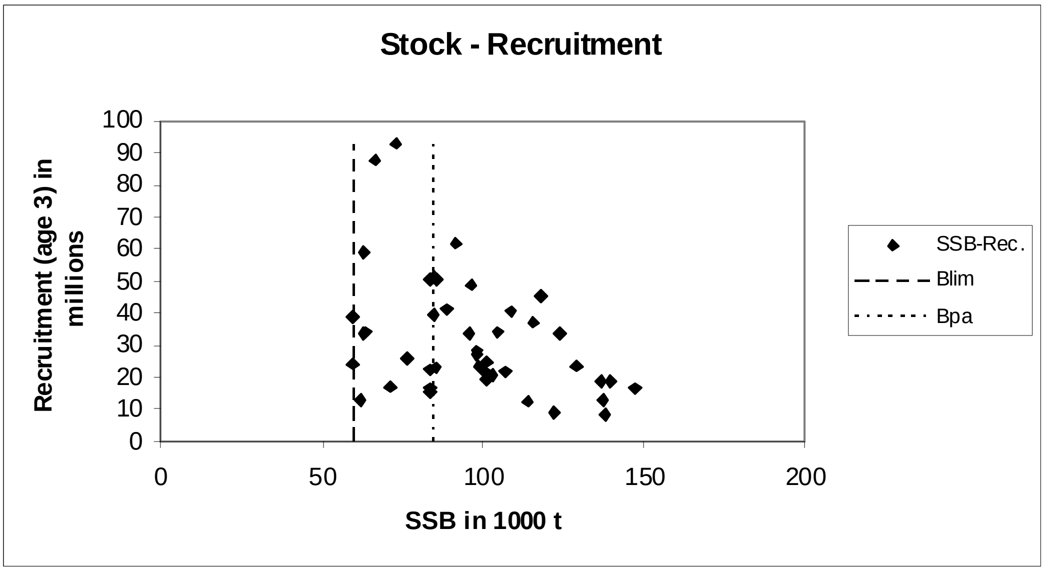


Figure 2.5.5.11. Saithe in the Faroes (Division Vb). Stock-Recruitment plot.

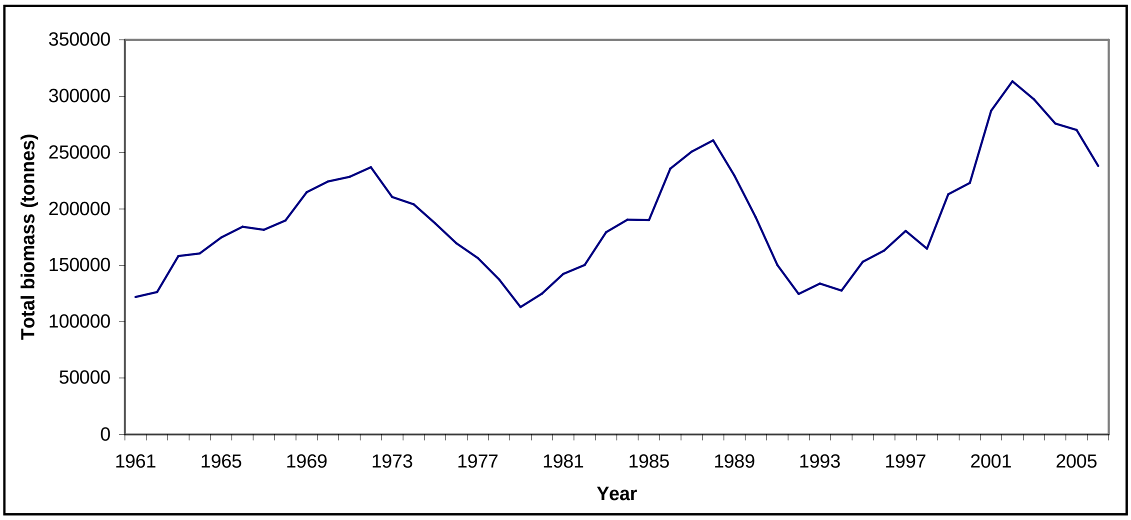


Figure 2.5.5.12. Saithe in the Faroes (Division Vb). Total biomass (1000 tonnes).

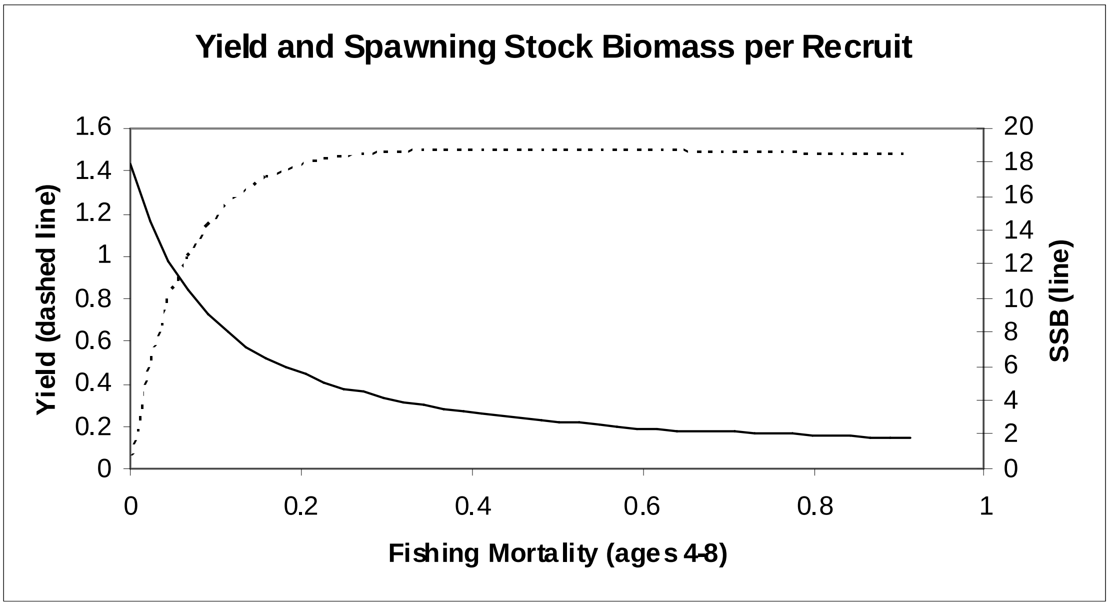


Figure 2.5.6.1. Saithe in the Faroes (Division Vb). Fish stock summary.

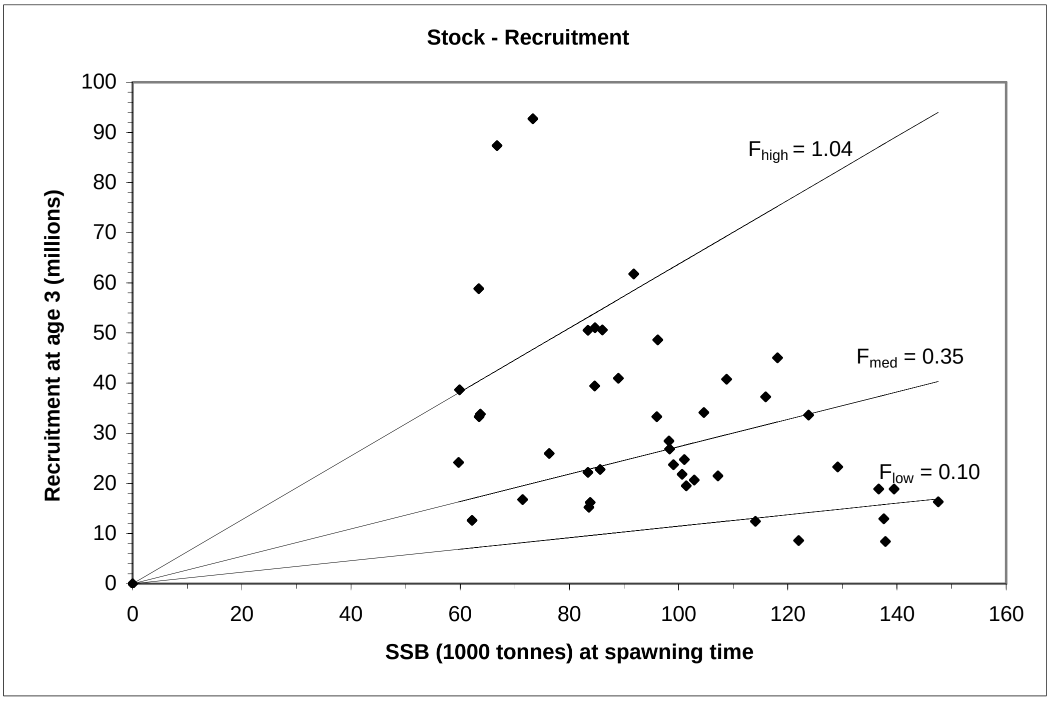


Figure 2.5.6.2. Saithe in the Faroes (Division Vb). Stock- recruitment.

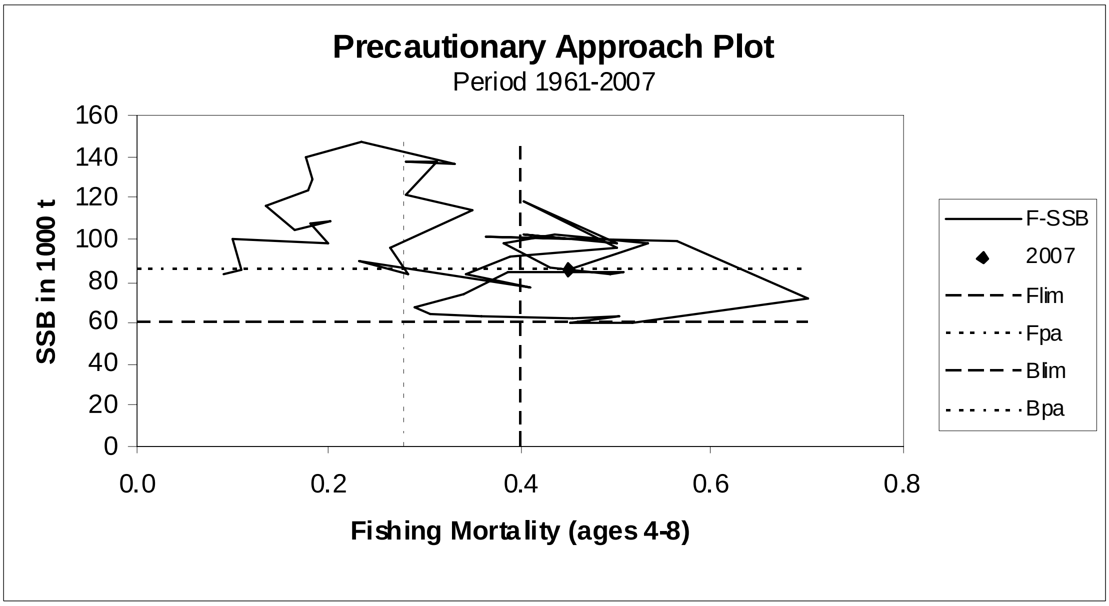
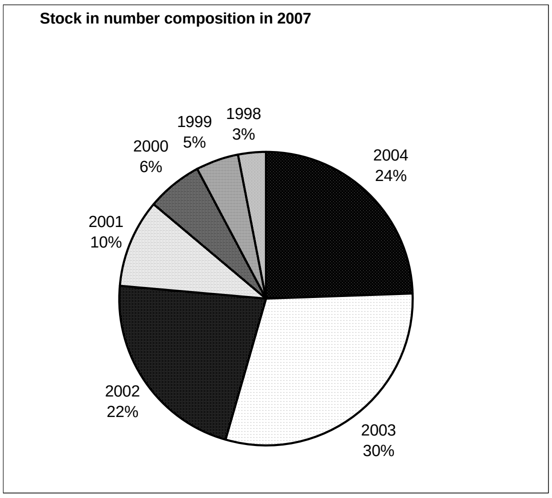


Figure 2.5.6.3. Saithe in the Faroes (Division Vb). Precautionary approach plot, period 1961-2007. The history of the stock/fishery in relation to the four reference points.



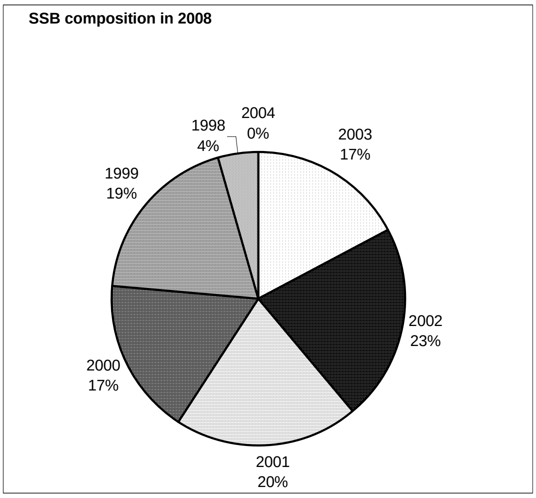


Figure 2.5.6.4. Saithe in the Faroes (Division Vb). Projected composition in number by year classes in the catch in 2007 (left figure) and the composition in SSB in 2008 by year classes (right figure).

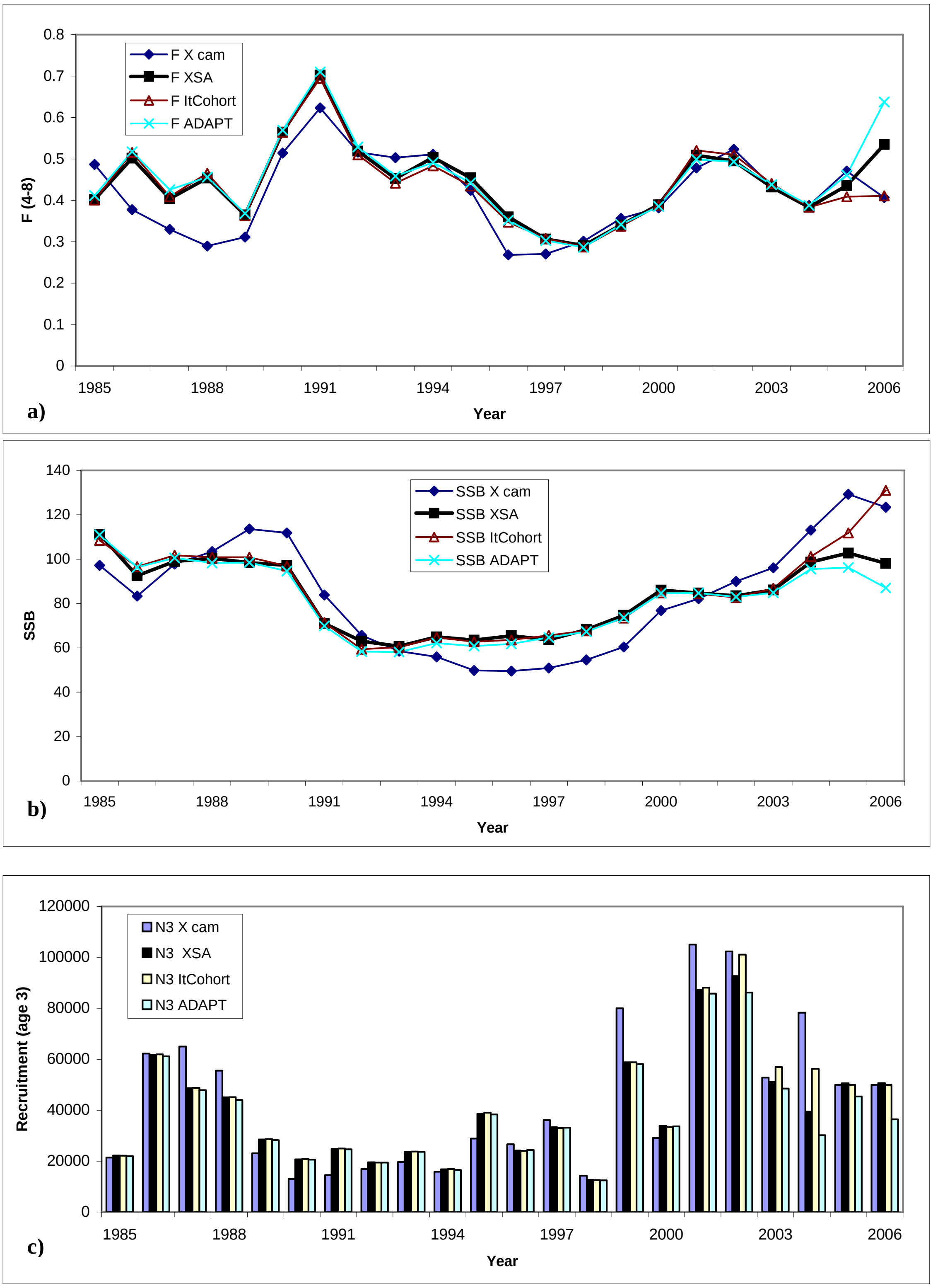


Figure 2.5.8.1. Saithe in the Faroes (Division Vb). Comparison on results from X cam model, iterative cohort model, adapt and XSA for a) fishing mortality (F age 4-8), b) spawning stock biomass and c) recruitment (age 3).

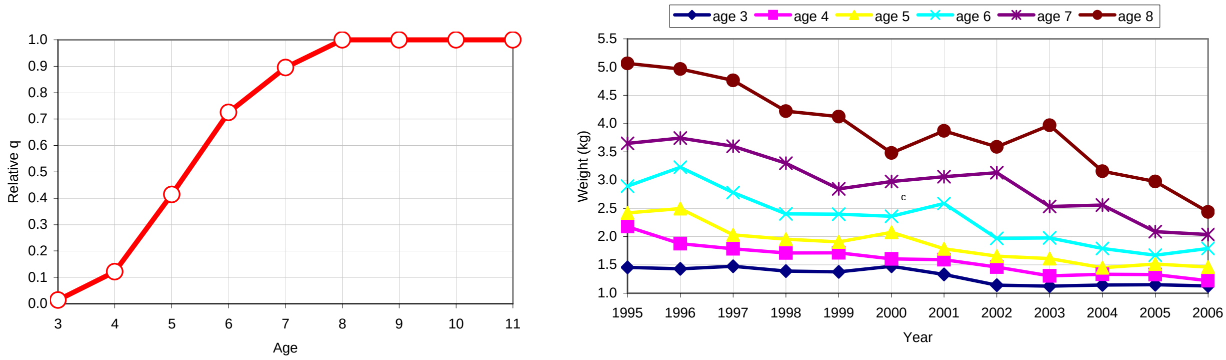


Figure 2.5.8.2. Saithe in the Faroes (Division Vb). Relative mean q at age and (left figure) and weight at age over the XSA tuning window (right figure).

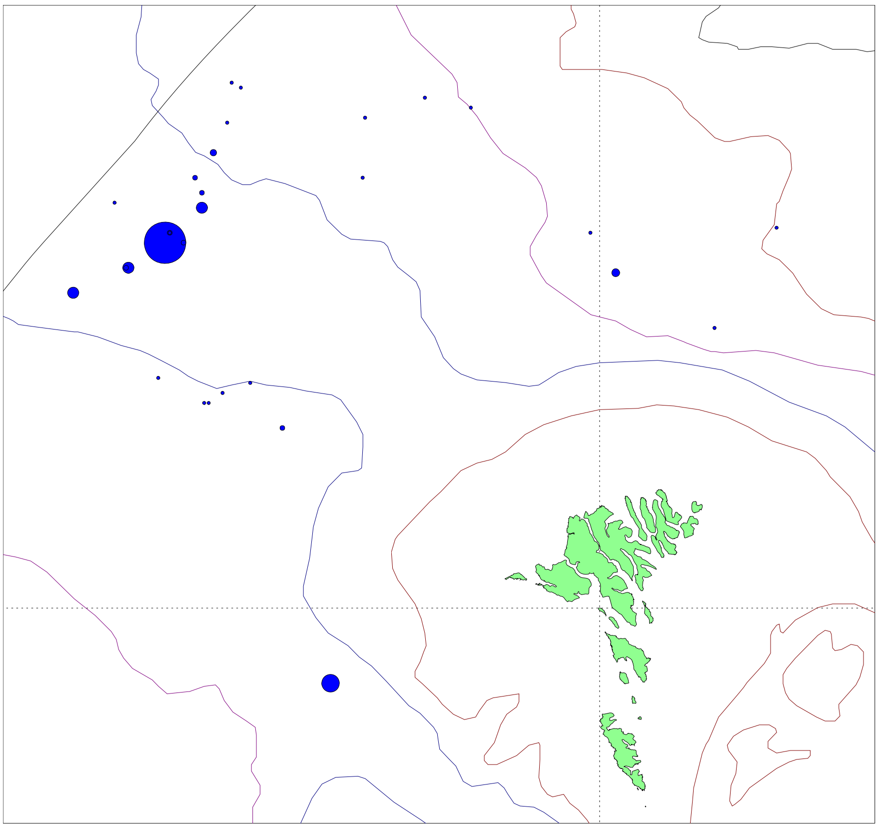


Figure 2.5.8.3. Saithe in the Faroes (Division Vb). Locations and the proportion of bycatch of saithe in Faroese screenings on board the factory trawler "Atlantic Navigator" in May-June 2006.

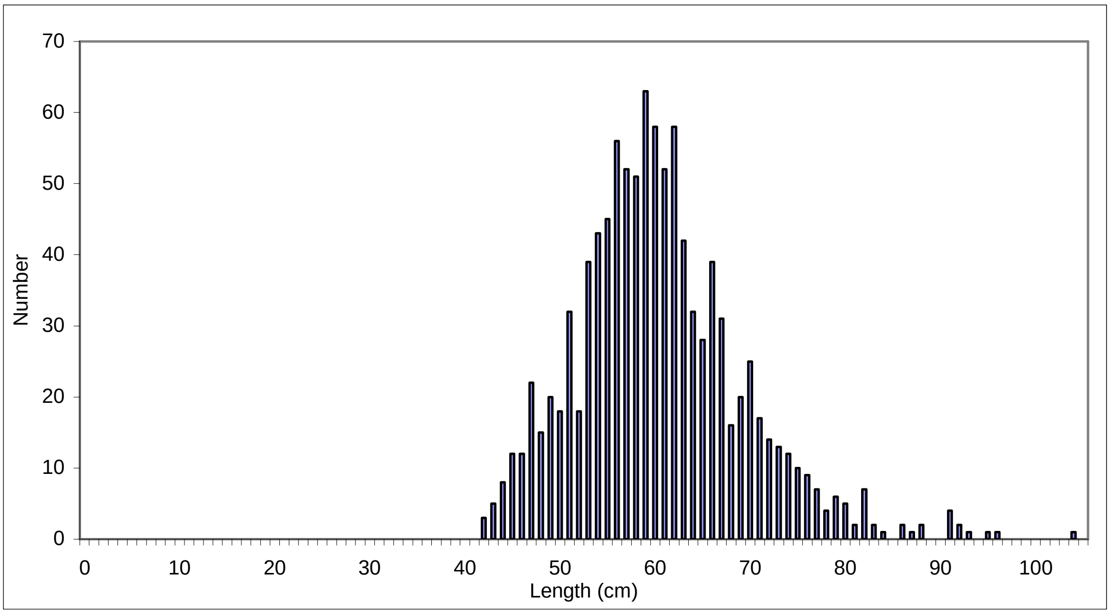


Figure 2.5.8.4. Saithe in the Faroes (Division Vb). Length distribution (numbers) of saithe taken as bycatch in the blue whiting fishery in May/June 2006.

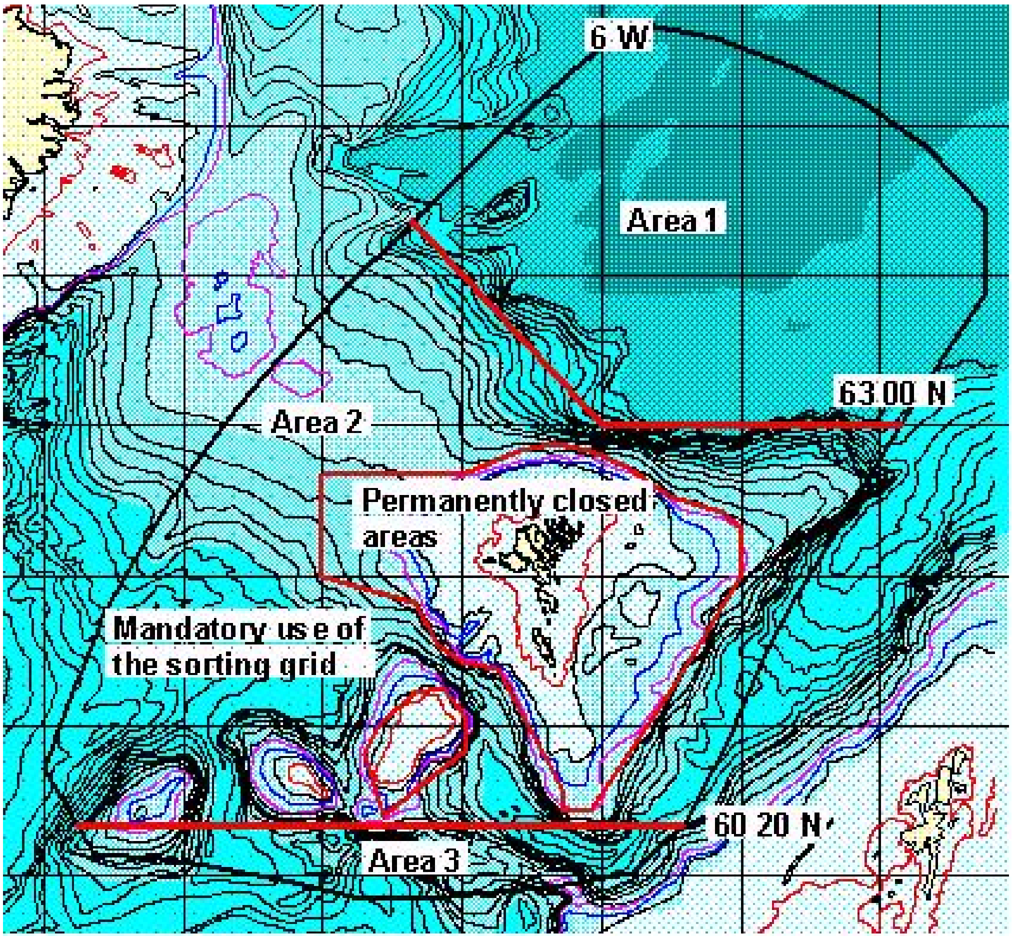


Figure 2.5.8.5. Saithe in the Faroes (Division Vb). Area restriction for the blue whiting fishery in the Faroese zone (Kunngerð nr. 18, 2007).

3 Stocks in Icelandic waters

3.1 Overview of fisheries and some recent ecosystem observation

This section gives a very broad and general overview of the fishery, fleet, species composition and some bycatch analysis of the commercially landed species as well as management measures in the Icelandic Exclusive Economic Zone. The zone covers a number of different ICES statistical regions. These include parts of IIa2, Va1, Va2, Vb1b, XIIa4, XIVa and XIVb2. A geographical distribution of the total catches of the Icelandic fleet in the major ICES areas in the Icelandic EEZ and accessible adjacent waters are given in figure 3.1.1. Although the Icelandic EEZ covers quite a number of different areas, in practice, the Icelandic landings of different species are generally reported as catches/landings in Va.

In addition, some up to date information are provided on environmental information from Icelandic waters. That information is meant to complement the information already available in the WGRED report.

3.1.1 The fleets and fisheries in Icelandic EEZ waters

Only Icelandic vessels are considered in the following analysis since they constitute the largest operational players in Icelandic waters. Few trawlers and longliners of other nationalities operate in the Icelandic region principally targeting deep-sea redfish, tusk, ling and Atlantic halibut, with some bycatch of gadoids species. Additionally some limited pelagic fishery of foreign boats on capelin, herring and blue whiting also takes place in Icelandic waters.

The data sources used in this section are centralized electronic landings, boat, log book and discard databases. Landings of species by each boat and gear are effectively available electronically in real time (end of day of landing). Log-book statistics are generally available in a centralized database 1-2 months after the day of fishing operation. The electronic data base is available to fisheries scientists, the logbook data alone counting in 2005 for a total of 189.266 individual hauls/sets.

The Icelandic fishing fleet can be 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 ability to catch pelagic fishes at greater depths than previously possible. 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. The total recorded landings of the Icelandic fleets in 2005 amounted to 2.0 million tonnes where pelagic fishes amounted to 1.5 million tonnes. Spatial distributions of the catches are shown in figure 3.1.1. Detailed information of landings by species and gear type are given in Table 3.1. Spatial overviews of the removal of the some important species by different gear are given in figures 3.1.2. – 3.1.5.

A simple categorization of boats among the different fisheries types is impossible as many change gear depending on fish availability in relation to season, quota status of the individual companies, fish availability both in nature and on the quota exchange market, market price, etc. E.g. larger trawl vessels may operate both on demersal species using bottom trawls as well as using purse seine and pelagic trawls on pelagic species. Total number of vessels within each fleet category as of May 2005 is thus limited to the broad categories given below:

Type	No. vessels[1)]	Gear type used
Trawlers	63	Pelagic and bottom trawl
Decked vessels > 100 t	172	Purse seine, longline, trawl, gillnet
Decked vessels < 100 t	680	Gillnet, longline, danish seine, trawl, jiggers
Undecked vessels > 5 gt	290	jiggers, longline
Total	1205	

[1)]Source: Statistic Iceland - Statistical series 2007: 28. February 2007

The 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 haddock and a number of other species are also target. 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 other 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 of secondary importance.
- Boats using Danish seine. (20-300 GRT) Cod, haddock and variety of flatfishes, e.g. plaice, dab, lemon sole and witch are the target species of this fleet.

Although different fleets may be targeting the main species the spatial distribution of effort may different. In general the can be observed that the bottom trawl fleet is fishing in deeper waters than the long line fleet (Figures 3.1.6 and 3.1.7).

The pelagic fisheries targeting capelin, herring and blue whiting is almost exclusively carried out by larger vessels. The fisheries in Icelandic waters for capelin and herring are carried out using both purse seine and pelagic trawl while that of blue whiting is exclusively carried out with pelagic trawl. In addition to this a significant the pelagic fisheries of Icelandic vessels occurs in distant waters, both on the Atlanto-Scandian herring and on blue whiting.

3.1.2 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. Below is a short account of the main feature of the management system.

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. Since 2006/2007 fishing season, all boats operate under the TAC system.

With some minor exceptions it is required by law to land all catches. Consequently, no minimum landing size is in force. To prevent fishing of small fish various measures such as mesh size regulation and closure of fishing areas are in place (see below).

FLEXIBILITY WITHIN THE SYSTEM: Within this system individual boat owners have substantial flexibility in exchanging quota, both among vessels within individual company as well as among different companies. The latter can be done via temporary or permanent transfer of quota. In addition, some flexibility is allowed by individual boats with regard to transfer allowable catch of one species to another. These measures, which can be acted on more or less instantaneously, are likely to result in lesser initiative to discards and misreporting than can be expected if individual boats are restricted by strict TAC measures alone. They may however result in fishing pressures of individual species to be different than intended under the single species TAC allocation.

MESH SIZE REGULATIONS: 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 minimum mesh size of 135 is allowed in the codend in all trawl fisheries not using "Polish cover" and in the Danish seine fisheries. 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.

REAL TIME AREA CLOSURE: 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.

PERMANENT AREA CLOSURES: 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.

TEMPORARY AREA CLOSURES: The major spawning grounds of cod, plaice and wolfish are closed during the main spawning period of these species. The general objectives of these measures, which were in part initiated by the fishermen, are to reduce fishing during the spawning activity of these species.

3.1.3 Discards and misreporting

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 discard rate for cod has been less than 1-2% of the reported landings over the time investigated (Figure 3.1.8). The discard estimates for haddock are somewhat higher ranging between 2-6% annually. Discarding of saithe and golden redfish has been neglible over time period of investigation.

Estimates of discards of cod and haddock in 2006 by individual fleets are given in table 3.1.2. These relatively low discard rates compared to what is generally assumed to be a side effect of a TAC system may be a result of the various measures, including the flexibility within the Icelandic ITQ system (see above). Since the time series of discards is relatively short it is not included in the assessments.

All catch that is brought ashore must by law be weighted by a licensed body. The monitoring and enforcement is under the realm of the Directorate of Fisheries. Under the TAC system there are known incentives for misreporting, both with regards to the actual landings statistics as well as with regards to the species recorded. This results in bias in the landings data but detailed quantitative estimates of how large the bias may be, is not available to the NWWG. Verbal information from the Directorate of Fisheries, partly based on investigation comparing export from fish processing plants with the amount of fish weighted in the landing process indicate that this bias may be of the order of single digit percentages and not in double digits.

3.1.4 Mixed fisheries issues

A number of species caught in Icelandic waters are caught in fisheries targeting only one species, with very little bycatch. These include the pelagic fisheries on herring, capelin and blue whiting (see however below), the Greenland halibut fishery in the west and southeast of Iceland and the S. mentella fishery. Advice given for these stocks should thus not influence the advice of other stocks.

Other fisheries, particularly demersal fisheries may be classified as more mixed, where a target species of e.g. cod, haddock, saithe or S. marinus may be caught in a mixture with other species in the same haul/setting (Figure 3.1.8). Fishermen can however have a relatively good control of the relative catch composition of the different species. E.g. the saithe fishery along the shelf edge is often in the same areas as the redfish fisheries: Fleets are often targeting at redfish during daytime and saithe 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. Small differences in the location of setting are also known to affect the catch composition. This has for example been documented in the long line fisheries in Faxabay, where in adjacent areas cod catches and wolfish catches are know to consistently dominate the catches in individual setting. There are however numerous species in Icelandic waters that can be classified as “bycatch species” in some fisheries. E.g. in the bottom trawl fisheries 75 % of the annual plaice yield is caught in hauls where plaice is minority of the catches. In a proper fisheries based advice taking mixed fisheries issues into account, such stocks may have a greater influence on the advice on the main stocks that are currently assessed by ICES than fisheries linkage among the latter.

In the pelagic fisheries catch other than the targeted species is considered rare. In some cases juveniles of other species are caught in significant numbers. When observers are on board or when fishermen themselves provide voluntary information, the fishing areas have in such cases been closed for fishing, temporarily or permanently. By catch of adults of other species in the blue whiting fishery have been estimated (Pálsson 2005).

3.1.5 Recent observation on the ecosystem

The information provide in this paragraph include the most recent measurements of salinity and temperature measurements in western and northern waters. 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 (Figure 3.1.10). These are very large changes for Atlantic water in this area. Off central N-Iceland a similar trend is observed. 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. (Figure 3.1.11)

It appears that these changes have had considerable effects on the fish fauna of the Icelandic ecosystem. Species which are at or near their northern distribution limit in Icelandic waters have increased in abundance in recent years (Fig. 3.1.13). 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. The semi-pelagic blue whiting has lately been found and fished in E-Icelandic water in far larger quantities than ever before.

On the other hand, coldwater species like Greenland halibut and northern shrimp have become scarcer. 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 (Figure 3.1.13 and 3.1.14). The change in availability of capelin in the traditional grounds may however have had an effect on the growth rate of various predators, as is reflected in low weight of cod in recent years.

There is one demersal stock, 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 improvements 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.

3.1.6 References

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Table 3.1.1 Overview of the 2005 landings of fish and shrimp caught in Icelandic waters by the Icelandic fleet categorized by gear type in 2005. 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.

SPECIES	BOTTOM TR.	DANISH SEINE	GILLNET	JIGGERS	LONGLINE	PEL TRAWL	PURSE SEINE	SHRIMP TR.	TOTAL
40	2030	0	0	0	0	0	0	0	2030
Angler, monkfish	996	379	1407	1	14	0	0	0	2798
Atlantic wolffish, catfish	7329	1568	78	3	5872	11	0	0	14861
Black scabbard fish	19	0	0	0	0	0	0	0	19
Blueling, European ling	1259	118	9	0	108	7	0	0	1500
Cod, Atlantic cod	90142	12803	31245	2094	65222	448	16	58	202028
dab	20	2079	12	0	3	0	0	0	2113
Deepwater redfish	16636	0	1	0	0	538	1	0	17176
Greater argentine,	4395	0	0	0	0	87	0	0	4482
Greenland halibut	11246	0	1587	0	11	182	2	6	13033
Greenland shark	40	0	10	0	0	0	0	0	50
haddock	54407	10702	1418	70	28331	714	0	16	95658
Halibut, Atlantic halibut	225	54	32	3	194	4	0	0	512
lemon sole	933	1652	1	0	0	9	0	0	2596
ling	1509	253	512	3	2012	8	0	0	4296
Long rough dab	120	753	0	0	3	0	0	0	876
Lumpsucker, lumpfish	0	0	3	0	0	0	0	0	4
megrim	42	106	0	0	0	0	0	0	148
Norway haddock	4	0	0	0	0	0	0	0	4
Orange roughy	8	0	0	0	0	0	0	0	8
others	47	0	0	0	0	0	0	0	47
Pel. Redfish	3194	0	0	0	0	12811	0	0	16005
plaice	1714	3944	165	0	60	8	0	0	5891
porbeagle	0	0	0	0	0	0	0	0	0
Rabbitfish (rat fish)	0	0	0	0	0	0	0	0	0
Redfish, golden redfish	42277	1031	84	33	747	807	0	2	44981
Roughhead grenadier	5	0	0	0	0	0	0	0	5
Roundnose grenadier,	76	0	0	0	0	1	0	0	76
sailray	1	0	0	0	19	0	0	0	20
Saith, pollock	58847	1379	2998	814	602	1638	0	0	66278
shagreen ray	4	1	0	0	11	0	0	0	16
skate	67	44	10	0	43	0	0	2	166
spotted wolffish, leopardfish	1656	14	11	0	1542	9	0	1	3233
spurdog, spiny dogfish	4	12	38	0	22	0	0	0	76
starry ray, thorny skate	148	258	55	0	186	2	0	0	648
tusk, torsk, cusk	117	0	19	14	3336	0	0	0	3486
whiting	513	63	6	1	188	5	0	0	777
witch, witch flounder	359	1967	0	0	0	0	0	0	2327
other	2357	7	83	1	0	29	0	0	2478
Shrimp	0	0	0	0	0	0	0	8659	8659
Atlantic mackerel	238		59	36		362462			362795
blue whiting						265887			265887
capelin						188516	415993		604509
herring, Atlantic herring	17					180619	84042		264678
Grand Total	303000	39187	39845	3073	108526	1014802	500055	8745	2017233

Table 3.1.2.. Estimates of discard of cod and haddock in the Icelandic fisheries in 2006. Source: Ólafur K. Pálsson, Eyþór Björnsson, Guðmundur Jóhannesson, Ari Arason, og Þórhallur Ottesen 2007. Discards in demersal Icelandic fisheries 2006. Marine Research Institute, report series (manuscript for printing).

		Landings	Discards		
		(tonnes)	Numbers (thous.)	Weight(Tonnes)	% Weight
COD	Long line	71033	931	588	0.83
	Gill net	23371	184	418	1.79
	Hand line	5729	108	118	2.05
	Danish Seine	10358	52	36	0.35
	Bottom trawl	80096	821	899	1.12
	Total	**190587**	**2096**	**2059**	**1.08**
HADDOCK	Long line	36216	1256	791	2.18
	Danish Seine	12700	360	166	1.30
	Botnvarpa	45495	2536	1495	3.29
	Total	**94411**	**4152**	**2452**	**2.60**

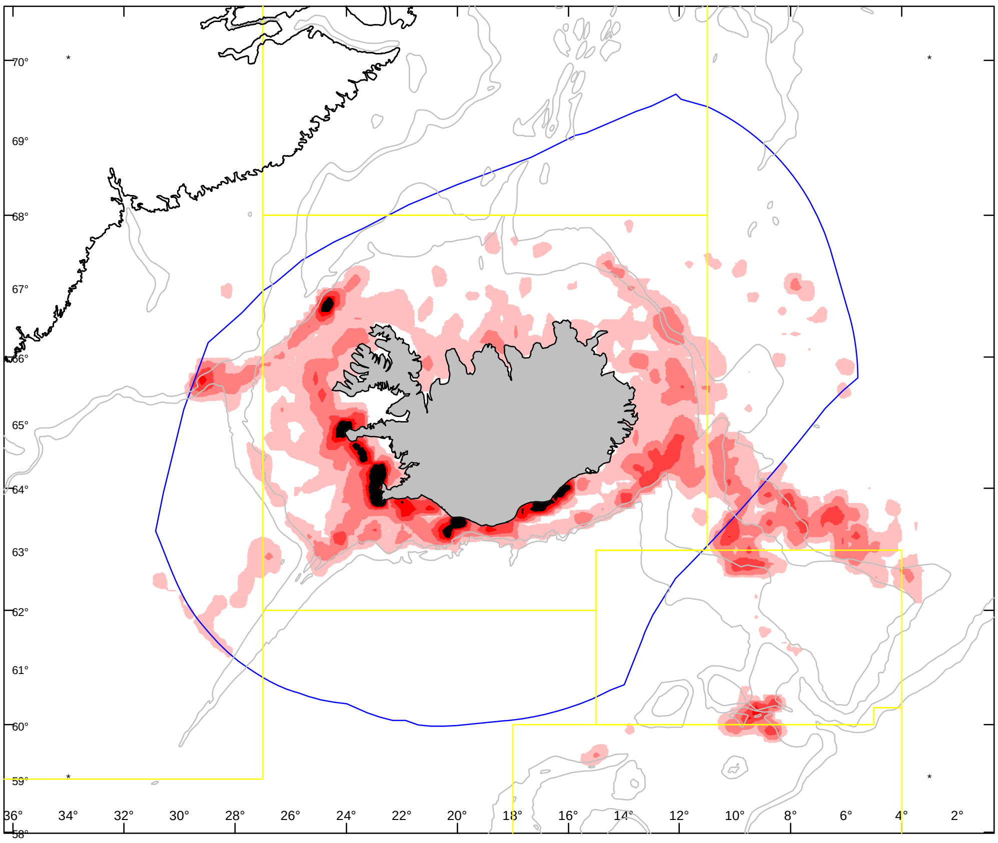


Figure 3.1.1. Distribution of total catch of all species by the Icelandic fishing fleet in Icelandic EEZ and adjacent waters in 2006. The Icelandic EEZ is shown as a red line, regular thin lines show major ICES areas and contour lines indicate 500 and 1000 m depth.

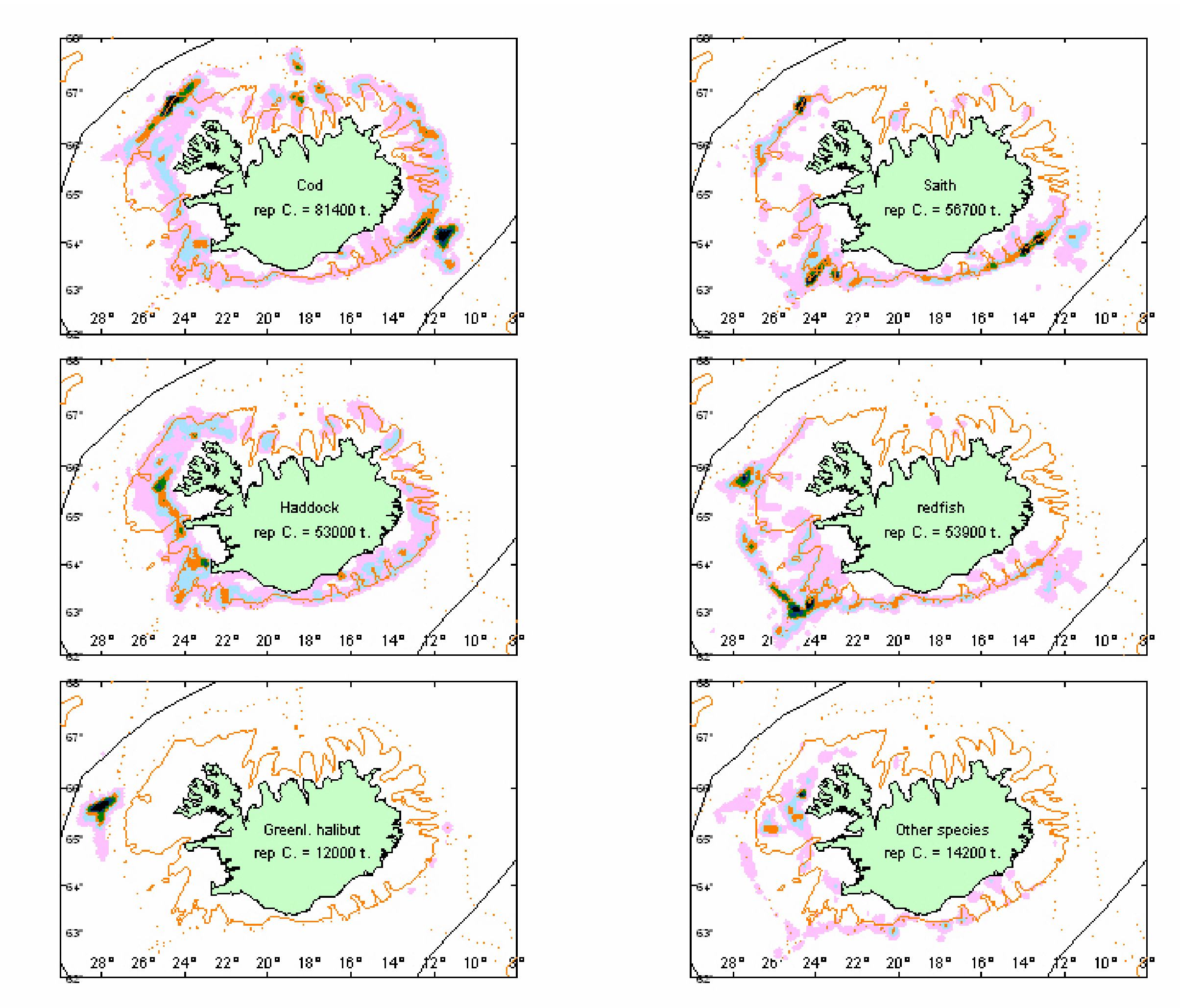


Figure 3.1.2 Location of catches of cod, saithe, haddock, redfish, Greenland halibut and others caught with bottom trawl 2005.

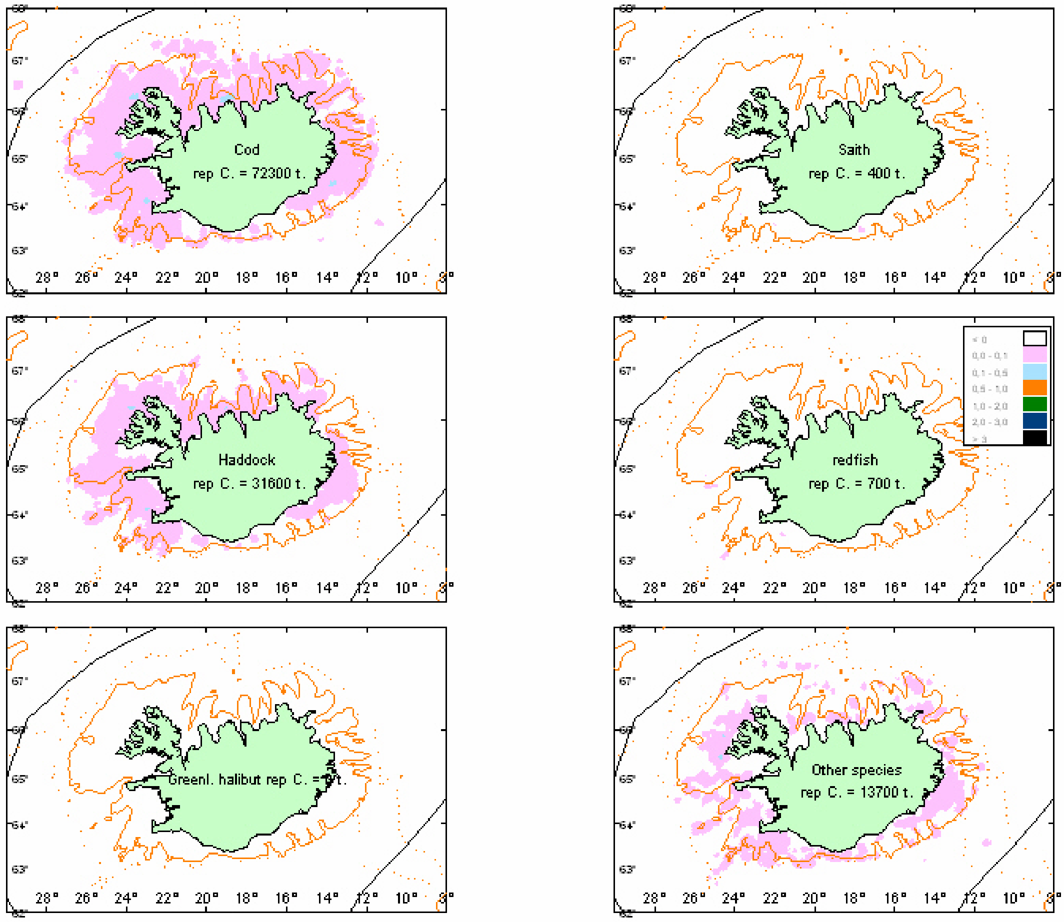


Figure 3.1.3 Location of catches of cod, saithe, haddock, redfish, Greenland halibut and others caught with long-line in 2005.

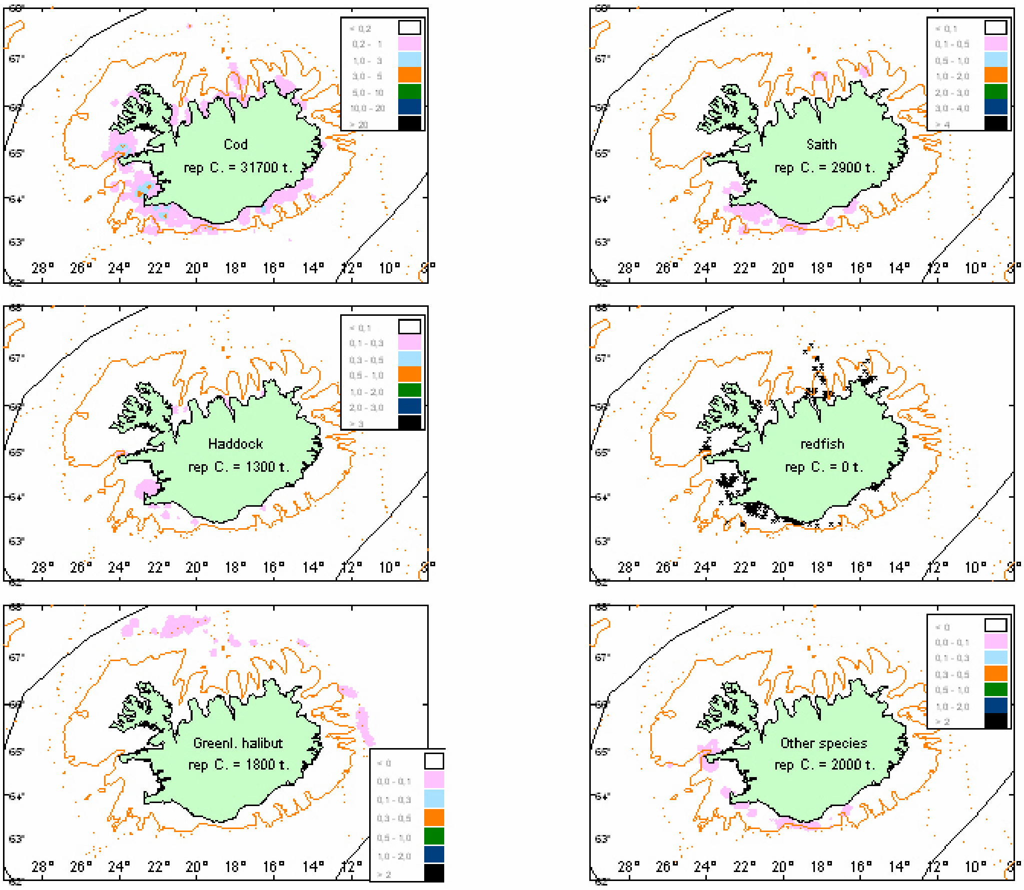


Figure 3.1.4 Location of catches of cod, saithe, haddock, redfish, Greenland halibut and others caught with gillnets in 2005.

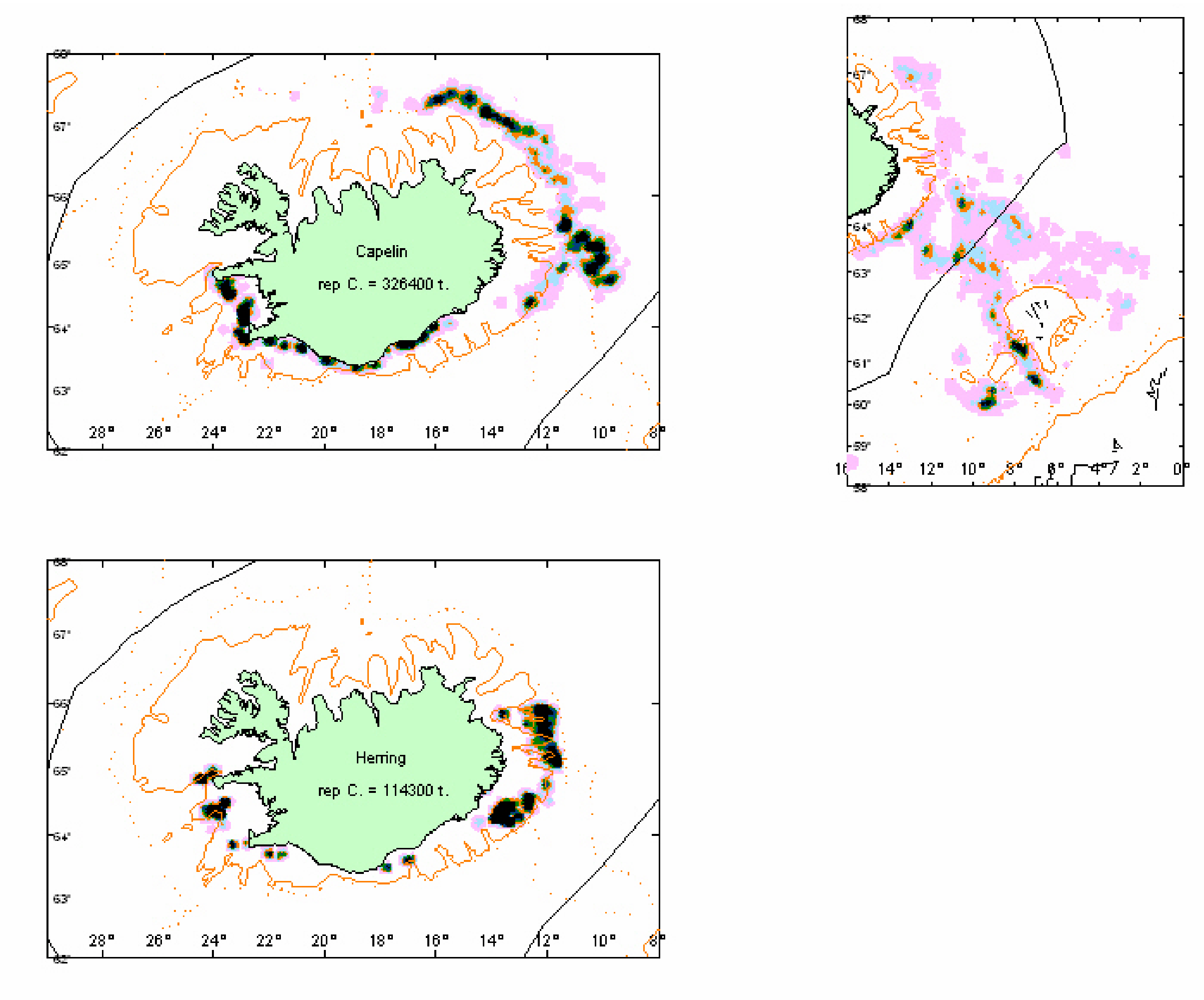


Figure 3.1.5. Location of catches of capelin, Icelandic spring spawning herring and blue whiting with purse seine and pelagic trawls in 2005.

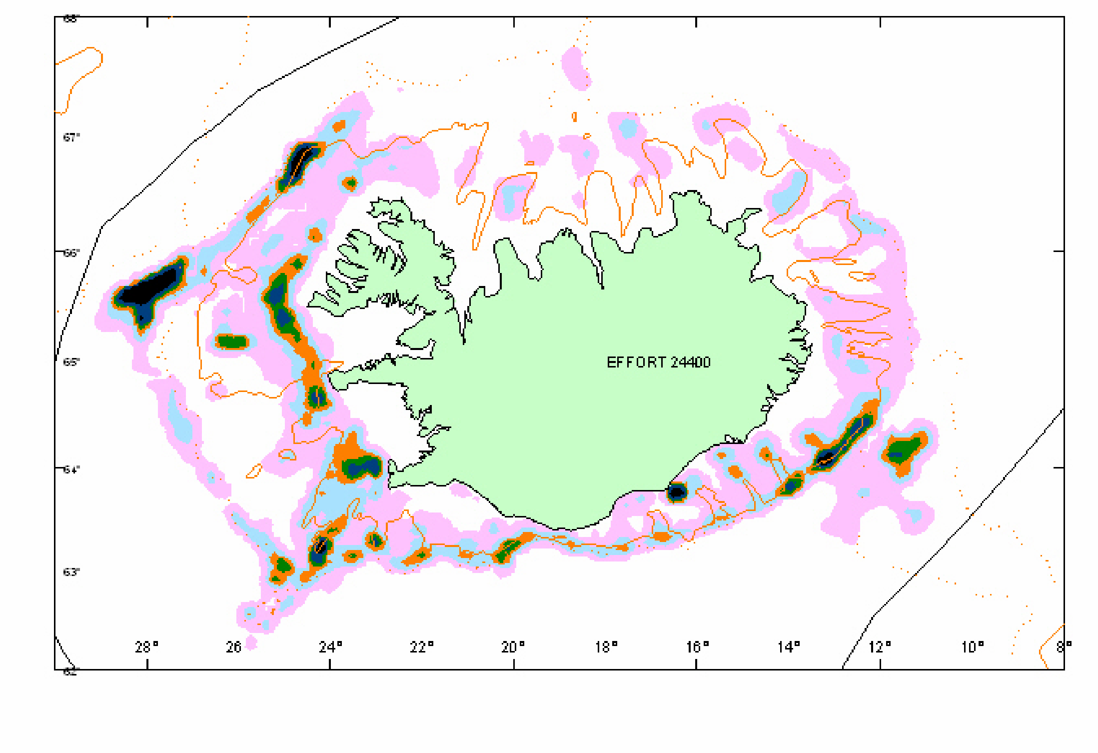


Figure 3.1.6. Effort of the trawler fleet in 2005. The dark colours show the areas of the greatest fishing effort to be off the southeast to the west coast and off Northwest Iceland.

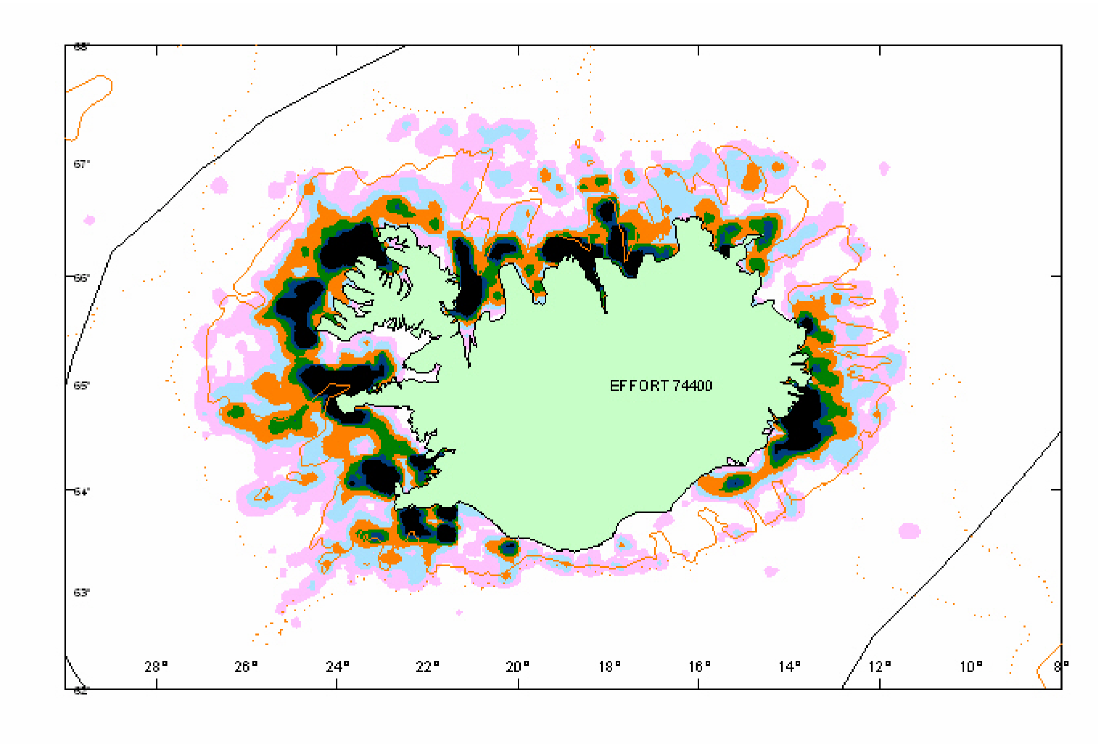


Figure 3.1.7. Effort in the longline fleet in 2005. The dark colours show the areas of the greatest fishing effort to be off the northwest and west coast but fishing is also concentrated along the entire southwest and south coast. The main targeted species for longline fishing are cod, haddock, catfish and tusk.

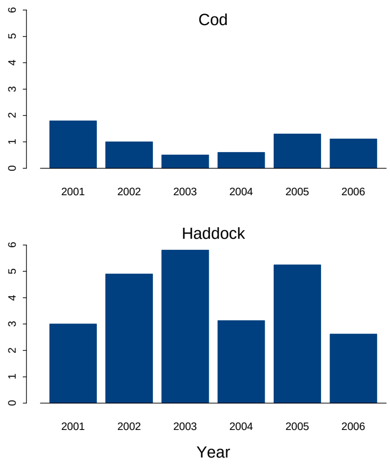


Figure 3.1.8. Estimates of discard percentage by weight, all gears combined for cod and haddock. Source: Ólafur K. Pálsson, Eyþór Björnsson, Guðmundur Jóhannesson, Ari Arason, og Þórhallur Ottesen 2007. Discards in demersal Icelandic fisheries 2006. Marine Research Institute, report series (manuscript for printing).

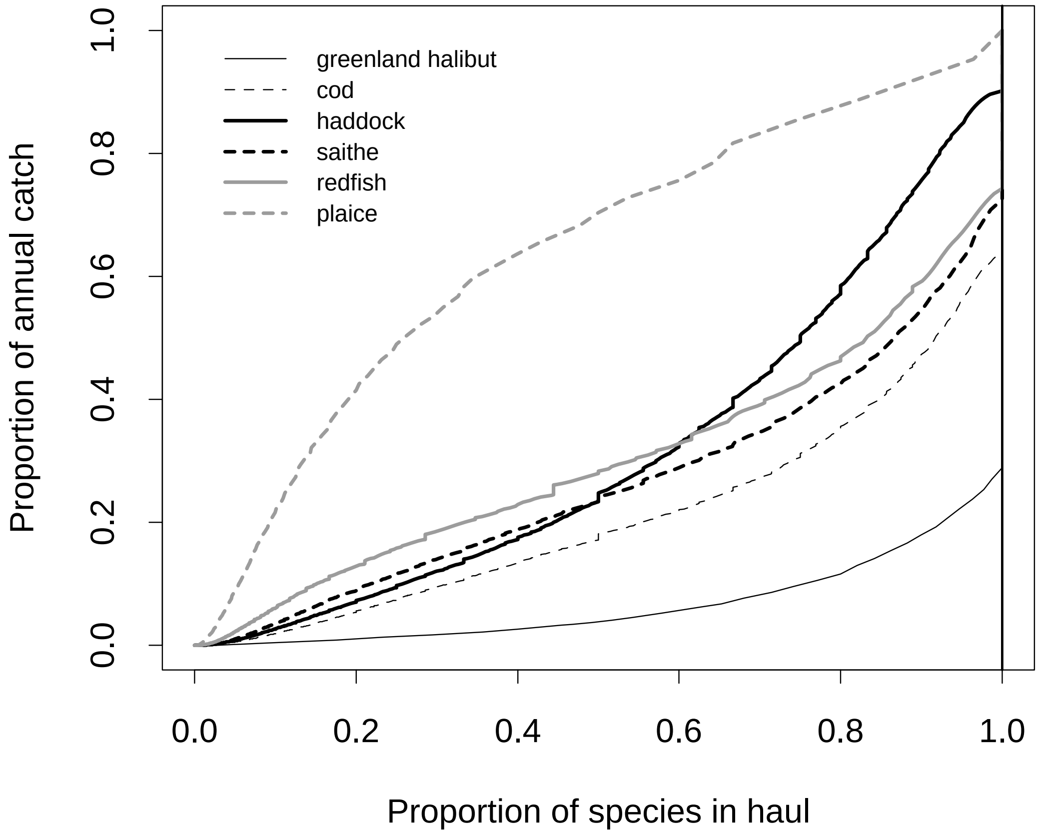


Figure 3.1.9. Cumulative plot for bottom trawl in 2004. An example describes this probably best. Looking at the figure above it can be seen from the dashed lines that 30% of the catch of haddock comes from hauls where haddock is less than 50% of the total catch while only 4% of the catch of greenland 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.

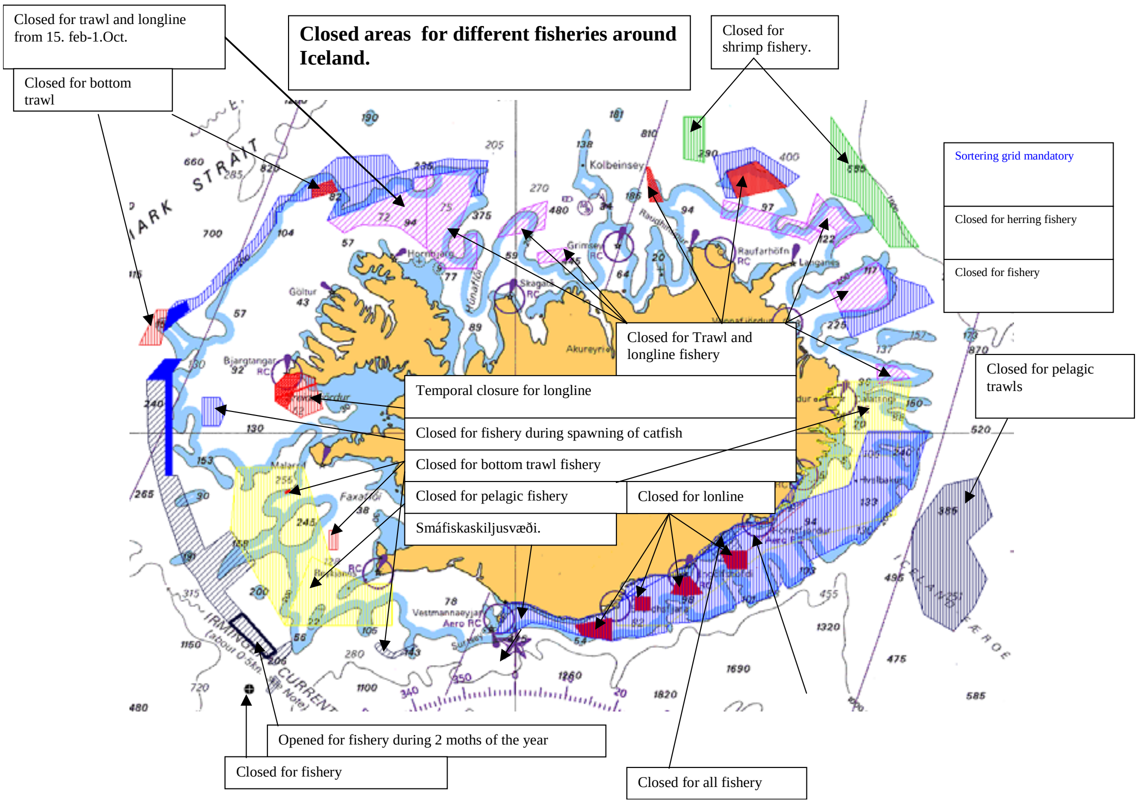


Figure 3.1.10. Overview of closed areas around Iceland. The boxes are of different nature and can be closed for different time period and gear type.

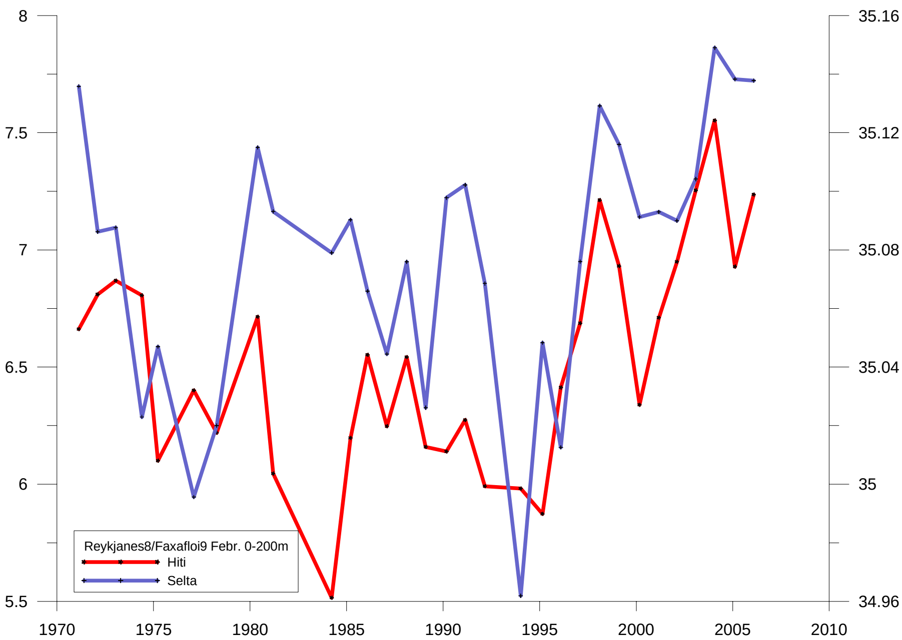


Figure 3.1.11 Changes of temperature and salinity west of Iceland 1970-2006.

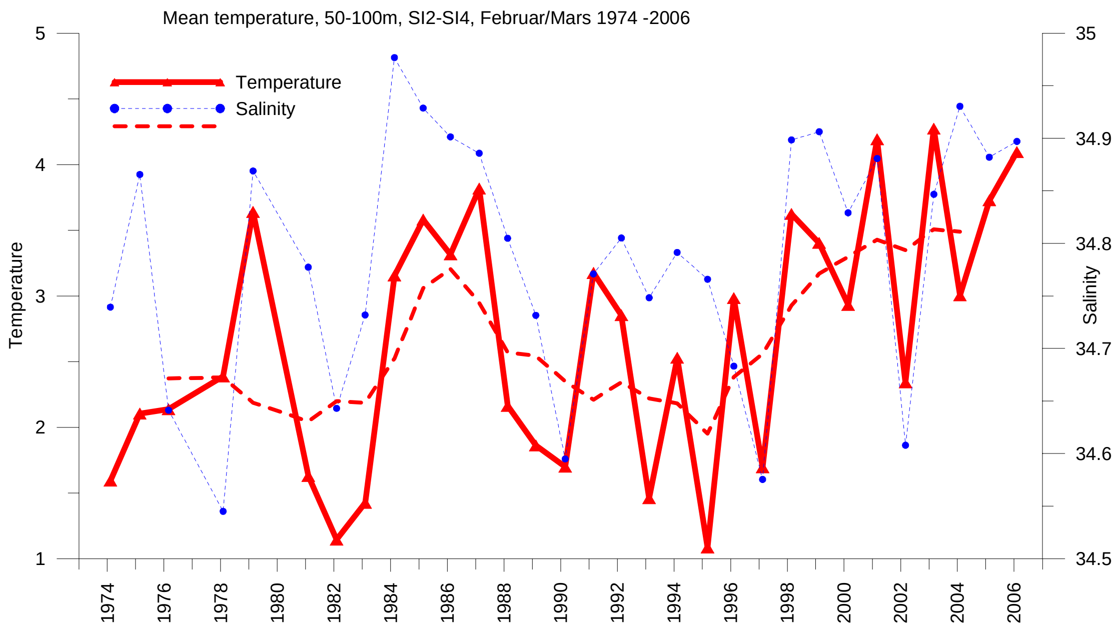


Figure 3.1.12 Changes of temperature and salinity off central North-Iceland 1970-2006.

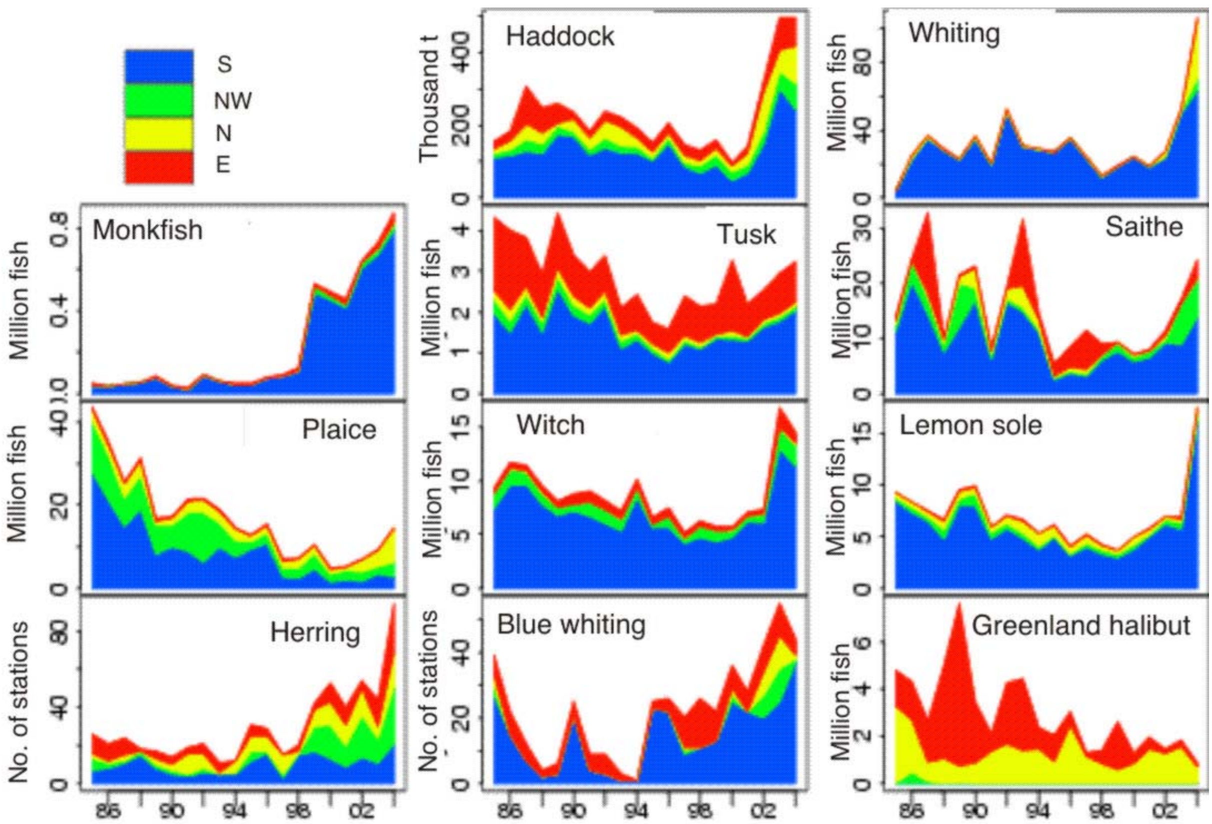


Figure 3.1.13. Changes of indices of abundance and geographical distribution of several fish stocks in Icelandic waters, 1985 – 2005 (based on the spring groundfish survey). The denotations S, NW, N and E beside the color code shown in the top left corner stand for South-, Northwest-, North- and East-Iceland in that order.

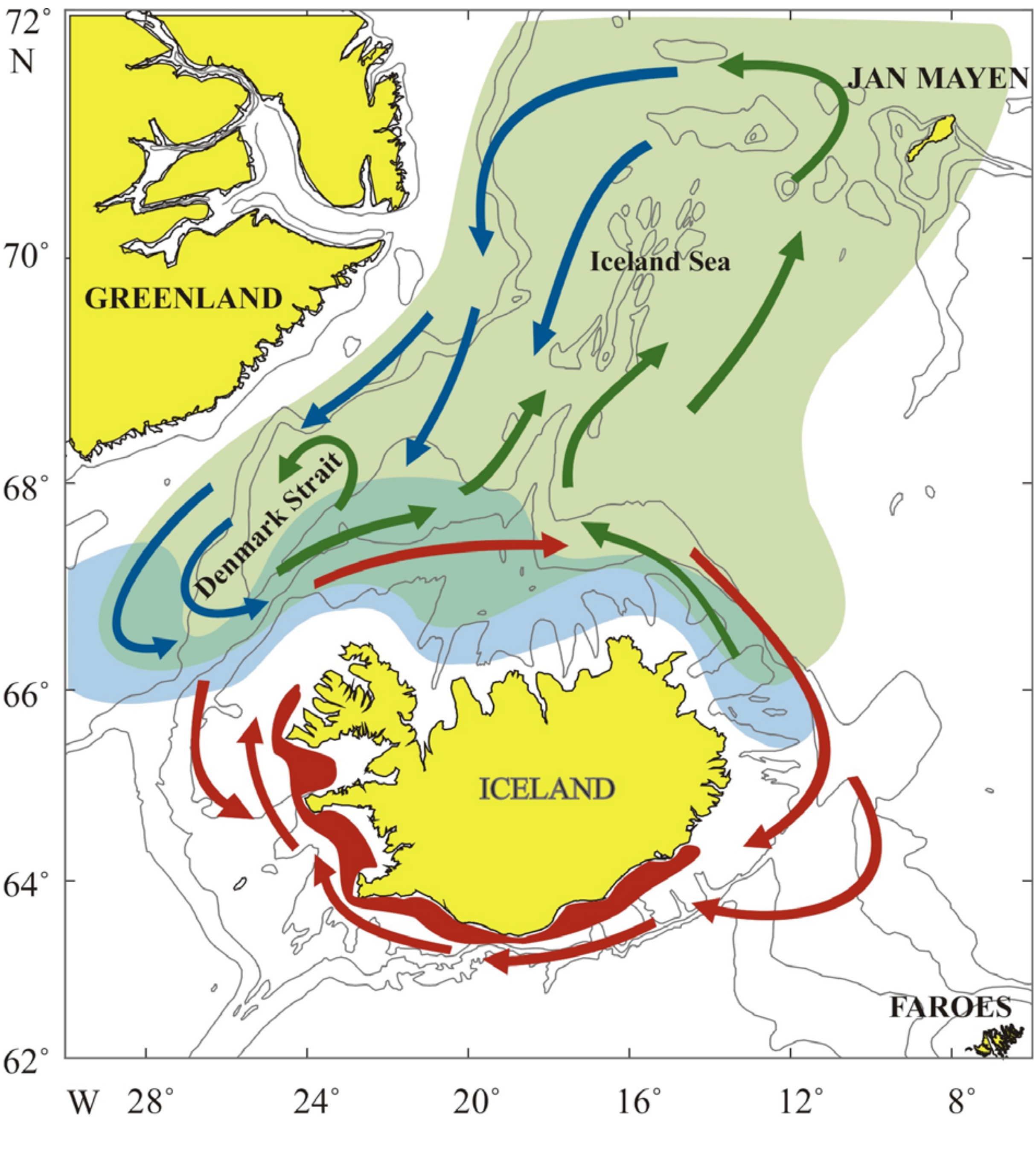


Figure 3.1.14. Distribution and migrations of capelin in the Iceland/East-Greenland/Jan Mayen area before 2001. Red: Spawning grounds; Green: Adult feeding area; Blue: Distribution and feeding area of juveniles; Green arrows: Adult feeding migrations; Blue arrows: Return migrations; Red arrows: Spawning migrations; Depth contours are 200, 500 and 1000 m (Vilhjalmsson 2002)

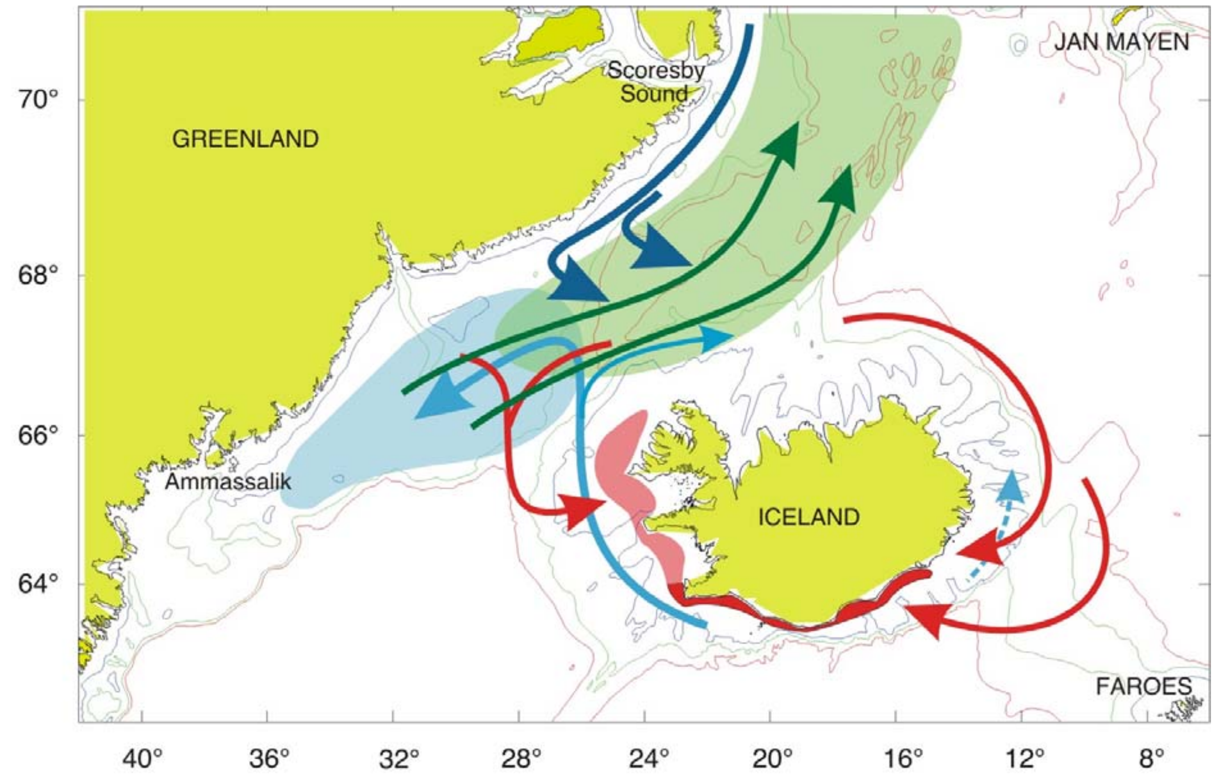


Figure 3.1.15. Likely changes of distribution and migration routes of capelin in the Iceland/Greenland/Jan Mayen area in the last 3-4 years. Green: Feeding area; Light blue: Juvenile area; Red area: Main spawning grounds; Lighter red colour: Lesser importance of W-Iceland spawning areas; Light blue arrows: Larval drift; Dark green arrows: Feeding migrations; Dark blue arrows: Return migrations; Red arrows: Spawning migrations. Depth contours are 200, 500 and 1000 m.

3.2 Icelandic saithe

The Icelandic saithe was not assessed by the NWWG in 2007

3.3 Icelandic cod

3.3.1 Summary

3.3.1.1 Input data

The total reported landings in 2006 were 196 thos. tonnes compared to 204 estimated by the working group last year.

The landings at age in 2006 were in good accordance with last years projections.

Mean weight at age in landings were observed lower than predicted by the working group last year but a decrease is also observed in survey weights. Survey weights have been decreasing continuously since 2001.

Total biomass survey index in spring survey 2007 was observed about 17% lower compared to last year but with similar measurement error (CV) as in 2006.

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 (ADCAM), as in previous years, was adopted as a point estimate for forward projections.

3.3.1.3 Changes in assessment results

In present assessment the estimated reference biomass (B4+) in the beginning of 2007 is 649 thous. tonnes compared to 747 thous. tonnes in last year assessment. The reference biomass in 2006 was estimated at 756 thous. tonnes in last year's assessment but in the current assessment at 675 thous. tonnes.

The year classes 2001-2004 were estimated 61, 164, 127 and 87 millions respectively in last years assessment compared to 64, 155, 123 and 80 in the current assessment.

Retrospective pattern of recruitment estimates in recent years, both historical and analytical, show constant downward revision.

3.3.1.4 Comments

Medium term projections based on current HCR indicate that the reference biomass (B4+) will most likely stay around the same low level in coming years but a moderate increase in SSB is seen.

The situation now with 3 of the 6 recent year classes estimated poor (2001, 2003 and 2004) and 2002, 2005 and 2006 year classes below longterm average raises concerns about the size of the spawning stock in 2010 when those year classes will become a large part of the spawning stock.

3.3.2 Input data

In this section a brief description of input data is given which is relevant for this year assessment. In section "3.1.7. Icelandic cod (Quality handbook)" a more detailed description concerning routine input data and analysis proceadure is given.

3.3.2.1 Fisheries dependent data

3.3.2.1.1 Catch: Landings, discards and misreporting

The landings of Icelandic cod declined more or less continuously from over 550 000 tonnes in 1955 to around 250 000 tonnes in 1993 (Table 3.3.1 and Fig. 3.3.1). The two most recent pulses in catches, around 1980 and 1990 were a result of the relatively large cohorts of 1973, 1983 and 1984, which partly immigrated from Greenlandic waters. With the uptake of the catch rule in 1994 the landings were limited to just over 150 thousand tones in 1994 to 1996 but have remained around 200 thousand tones in the last 5 years.

The main changes in landings by gear is the continued increase in longline catches, specially in the north and a subsequent decrease in gillnet catches along the south coast. Proportion of catches from bottom trawls and Danish seine has not changed significantly since 2000 but a considerable decrease has occurred in landings from handlines (figure 3.3.2). Since a ban on using a 9 inch mesh was implemented in the gillnet fishery in 2005 the main part of landings from the gillnet fishery has come from 8 inch mesh (figure 3.3.3.).

The Marine Research Institute has been giving advice on catch restriction of Icelandic cod since 1973 but the fisheries remained unregulated until 1984. The cod landings were regulated by a mixture of TAC and effort restriction in the period 1984 to 1990, In 1990 the landings were regulated by ITQ for all boats larger than 15 GRT with a mixture of effort and ITQ restrictions for the smaller boats. Since 2005 the catch of cod has been regulated by ITQ's only. Prior to the uptake of the catch rule the TAC was in general set higher than the advice. Landings generally exceeded the TAC since no account was taken of catches caught under the effort regime.

According to data presented to the working group last year around 4 thous. tonnes of Faroes annual landings in 2003-2005 were caught at the Faroe-Icelandic-ridge. In 2006 the landings were around 800 tonnes These landings were regarded as taken from the Icelandic cod stock and subtracted from the Faroese landings and added to the Icelandic landings. This is supported by results of tagging experiments conducted in Iceland and Faroe Islands (see section Faroe plateau cod) and observed distributional pattern of catches from logbooks. On the basis of preliminary sensitivity analysis conducted during the working group meeting in 2006 (WD-31) it was decided not to take these landings into account in this year assessment but is now included. See section "3.1.5. Assessment deficiencies, data gaps and research priorities".

A large project which aim is to estimate discards for some of the main species in the Icelandic fishery has been conducted since 2001 (Pálsson et al 2002). Estimated cod discards have been in the range of 0.4-1.8% of landings, lowest in 2003, 0.4%, and highest in 2001, 1.8%. In 2005 discard is estimated to have been 1.1% compared to 0.6% in 2004. The observed annual difference in discard estimates are though most likely within the precision of the estimates.

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). This by-catch is included in the estimated annual landings for 2004.

At the meeting no information was available about by-catch of Icelandic cod in 2006..

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 current sampling protocol for estimating the age composition of the cod has been in effect since 1991 and is described in detail in section 3.3.7. The data samples comprising the age-length keys for 2006 are given in the table below.

Gear	Area	Season	No. length samples	No. length measured	No. age samples	No. aged	Catches (tonnes)
Longline	South	Jan-May	259	22362	19	1132	22593
Gillnet	South	Jan-May	381	21709	20	1266	18258
Handlines*	South	Jan-May	9	990	0	0	1083
Danish seine	South	Jan-May	144	7773	8	500	5706
Bottom trawl	South	Jan-May	62	10009	20	1020	14053
Longline	North	Jan-May	142	28633	12	647	16617
Gillnet	North	Jan-May	420	8410	3	564	3133
Handlines*	North	Jan-May	13	1697	0	0	464
Danish seine	North	Jan-May	12	1983	1	51	677
Bottom trawl	North	Jan-May	135	16035	23	1357	21923
Longline	South	June-Dec	51	7870	4	662	4901
Gillnet	South	June-Dec	19	1983	2	147	2263
Handlines	South	June-Dec	84	680	2	179	1122
Danish seine	South	June-Dec	22	2390	4	325	1489
Bottom trawl	South	June-Dec	18	2941	6	650	2898
Longline	North	June-Dec	252	52332	15	1097	30567
Gillnet**	North	June-Dec	4	485	0	0	232
Handlines	North	June-Dec	47	7329	1	63	2495
Danish seine	North	June-Dec	23	3219	1	50	2282
Bottom trawl	North	June-Dec	251	45991	27	2034	43457

*In handlines where there are no age-samples age-length keys from long lines from the same area and season are used. **For gillnets where there are no length-age keys the keys from longlines were used.

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. Minor updates were done to the landings at age data for they years 2003 to 2005 to account for updated information of landings by foreign vessels. In the past two decades age groups 7 and younger have generally accounted for more than 90% of the landings in numbers. The catch composition in 2006 was in general agreement with that predicted in last years assessment. The 2000 year class was as in 2005 the most prominent in the landings. The contribution of age group 5 is only 13% in 2006 confirming the poor size of the 2001 year class.

3.3.2.1.4 Mean weight at age in the landings

The mean weight at age in the landings (table 3.3.5 and figure 3.3.7a) have been declining in the last 5 years and are in 2006 close to the historical low of the time series, being about 8 to 25% below the long term average in age groups 4 to 9. Some of this decrease in mean weight at age can be attributed to changes in fishing practices. As described above there has been a shift from gillnets in the south to longlines in the north. Gillnets used to focus on large spawning cod along the south coast but now much of the older fish is caught on longlines along the north coast were cod is traditionally much smaller at a given age. The weights at age in the landings are used to calculate the "reference biomass" B4+ used in the Harvest Control Rule.

3.3.2.1.5 Logbooks

Trends in unstandardised CPUE indices and effort from the commercial fleets since 1991 are 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 but has again increased from 2004. An increase has been observed in bottom trawl in 2001- 2004 but the CPUE in 2006 is observed about the same level as in 2004-2005. In longliners CPUE was again at similar levels as in 2006.

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

An annual bottom trawl groundfish spring survey that was initiated in 1985 has been the principal tuning fleet in the assessment of the cod stock in recent years (details of the survey design are given in section 3.3.7.3). A subset of 162 spring survey stations have been taken annually in the fall since 1995. Details of both surveys and methods for calculation of indices is given in section 3.3.7.3.

The total biomass index of the two surveys (Figure 3.3.10) show a continued decrease since 2004. The decrease appears greater in the March survey than in the October survey. Age based indices are quite low and there are hardly any distinct ageclasses except for age 5 or the 2002 cohort. In all the assessment models used, the indices are combined by simple summation (Table 3.3.8 and figure 3.3.11). The total biomass index from the survey is presented in figure 3.3.10.

The following analysis was conducted to check if there are different trends in the spring and the fall groundfish survey: Within suvey and for each age group the indices in each year were standardized to the average over the years 1996-2006 (Sa,y = Ua,y / Ua,avg). The ratio of the standardized indices for each survey was then calculate and plotted (Figure 3.3.28). The analysis indicates that the efficiency/catchabilty in the two surveys is changing, with the fall survey showing an increase in catchability relative to the fall survey.

3.3.2.2.2 Mean weight at age in survey

The calculated annual mean weight at age in the spring survey show similar pattern as the weights in landings although survey weights for age 3 to 5 are always considerably lower than the weights of these agegroups from the catches (figure 3.3.7b).

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. Nevertheless the ratio between weights at age of sexually mature cod from the survey and commercial catches has been changing in recent years. It seems that weights at age from commercial catches has been decreasing at a faster rate than those from surveys. This is specially apparent for age 10, 11, and 12 but can be detected in agegroups 7 to 9 as well.

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.

Mean weights at age in the 2006 spring survey are at a historical low for ages 2 to 5 which is part of a continuous decreasing trend since 2001 for age groups 2 to 6. In age groups 7 and 8 a slight increase is observed compared to 2005 (figure 3.3.7b).

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. In recent years the quality of maturity data from commercial catches has decreased for various reasons as explained in the report last year and in NWWG-2005-WD23.

Proportion mature at age has in general been increasing in recent years (figure 3.3.6a) and age at 50% maturity in the 1983 to 2001 cohort has similarly been degreasing by approximately half a year. That is from little under 6.5 to about 6 years (figure 3.3.6b).

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

Catch curves for year classes 1982 to 2002 (figure 3.3.5a) show that the mortality of the older age groups has been on the order of 1.0, the cod becoming fully recruited to the fishery around age 5 and 6. The ln catch ratio (figure 3.3.5b) indicate that the mortality in the main age groups may have been lower in the last 10 years compared to the 10 years prior. Reduction in the catch ratio of the younger age groups may indicate that there may have been a decline in the targeting of younger fish. A Shepherd Nicholson model (Shepherd and Nicholson 1991) using landings at age data, gives a CV of approximately 0.2 for age groups 4-10. The Shepherd Nicholson model is a simple model for this purpose and particularly useful for obtaining a quick view of the inherent variability in the data due to its simplicity and ability to incorporate most of the structure in the data. The model is simply an analysis of variance of the logged survey catches in numbers using age, year and year class as factors. The model parameters are not all estimable but this is of no consequence when the emphasis is on the estimation of residual variance.

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.

Catch curves based on the spring survey indices for year classes 1981-2001 are presented in figure 3.3.12. The Shepherd Nicholson model gives a CV of approximately 0.24 for age groups 2-9 for the survey indices.

Figure 3.3.13 show plots of survey index for cod vs. the index of the same year class in the survey one year later. This type of plot should show good relationship if the survey is consistent, except when fishing effort varies much. The best relationship is between ages 3 and 4, age groups that are fully recruited to the survey but age 3 does usually have low fishing mortality.

In figure 3.3.14 the relationships between the survey indices and estimated stock in numbers for age groups 1-9 using 1985-2003 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) with random walk term that limits the interannual changes in fishing mortality between years (AC-base-rs). 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 $\boldsymbol{\rho}$ was estimated to be 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. All models assume that catchability in the survey is dependent on stock size for the youngest age groups. Additionally the autumn survey was used for tuning as well for the first time. In the XSA two runs were made, a) using both surveys and b) using only the autumn survey, but in TSA and ADCAM were only run on the autum survey indices.

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 2007 spring survey indices were moved three months back in time i.e. to end of December 2006. 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 **0.58.**

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, Figure 3.3.18 and WD#27). The results from corresponding retrospective analysis are presented in Figures 3.3.16-17. The terminal reference fishing mortality based on this run is **0.55**.

ADAPT

The ADAPT type model estimates the survivors in the beginning of the assessment years an backcalculates from there using Popes equation. The fishing mortality of the oldest age is the weighted mean of the fishing mortality of the two age groups 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 2007 are presented in Table 3.3.13. The terminal reference fishing mortality is estimated **0.60**.

X-CAM

A fixed separable CAEGIAN type of model using c@age for the years 1985-2006, 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 penalty added.

The estimated fishing mortality rates in 2006 and stock in numbers in 2007 are presented in Table 3.3.13 and Figures 3.3.19-3.3.20. The terminal reference fishing mortality is estimated **0.47**.

AD-CAM

The input parameters settings of the ADCAM 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 **0.59**.

Results from tuning with autumn survey

XSA using only the autumn survey estimates the terminal fishing mortality as 0.54 but as 0.55 when using both surveys. The TSA estimate is 0.41 and ADCAM is 0.53.

3.3.3.2 Final assessment

Comparison of the retrospective results from four models presented in 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 TSA 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 same models are presented in figure 3.3.18. All models show positive blocks in survey residuals in 1998 when catchabilty in survey is assumed to have been exceptionally high.

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 2007 from the different models are presented. The estimated stock in weight (4+) in the beginning of 2007 from the three models used are similar or in the range of 623-693 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 0.55-0.60 expect from the X-CAM, 047, which is reflecting the difference in the older ages. The estimated stock in numbers in the beginning of 2007 from all models are well within one standard error of the AD-AM model results (Figure 3.3.24).

All the models tested using the autumn survey for tuning predict a higher value of biomass (4+) in the beginning of 2007 than when using the spring survey and similarly lower terminal fishing mortalities. The biomass estimates from XSA are 747 thous. tonnes using the autumn survey and 721 thous. tonnes using both surveys compared to 688 thous. tonnes using only the spring survey. TSA predicts the biomass as 826 thous tonnes using the autumn survey compared to 623 thous. tonnes using the spring survey. TSA model estimated a negative trend (decreasing catchability) in the spring survey and a positive trend in the autumn survey. Neither trend was though statistically significant. A TSA run allowing for this gave about 700 thous tonnes (WD#27). The difference between the runs from ADCAM is smaller than from TSA, or 722 thous. tonnes using the autumn survey compared to 649 thous. tonnes using the spring survey.

The working group explored using both surveys in the assessment, but decided to base further work only on the assessment using the Spring survey because: 1) The cod assessment is an update assessment. 2) The biomass estimates from the ADCAM, TSA and XSA, using the spring survey only, are larger than the spring survey measurements as indicated by negative block in the residuals in the last year. This implies that the stock may actually be smaller than the current model estimates. 3) Using both surveys in the assessment framework would further complicate this potential problem as it gives approximately 50 thous. tonnes greater reference biomass (4+) in 2007 which exacerbates the potential overestimation using the Spring survey alone. 4) Analysis based on the survey indices directly as well as TSA analysis indicate that there may be different and conflicting catchability trends in the two surveys even though the catchability trends were not significantly different. 5) There has been a tendency by the working group to overestimate the cod stock, albeit in most years by a relatively small amount.

For the last four years the NWWG has concluded that the ADCAM modeling approach is the most appropriate since it provides stock and recruitment estimates within the same statistical and operational framework including probability profiles. Medium term projections are also a natural extension of this type of model approach. Furthermore the ADCAM 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 ADCAM run was adopted as a point estimate for forward projections. Those arguments are still valid and the results from the ADCAM run were also adopted this year as point estimate for forward projections. 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 2007 from the AD-CAM model is 649 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

The HCR is based on the stock biomass estimates using stock numbers multiplied by catch weights. Various attempts have been made at predicting catch weight by the working group in the historical past, that history being presented in the stock annex. In recent years the working group has overestimated the weights in the catches, resulting in somewhat higher target TAC than indended with the catch rule. Last year the catches in the prediction were taken from the relatively low weights observed in 2005. This year to predict catch weights at age in 2007 the relationship between historical mean weight at age from catches and survey are used, that is survey wights from 2007 are used to predict catch weights in 2007. The catch-survey relationships for age groups 3-10 were used but for the oldest ages (11-14) the relationship is weak and therfore a smoothed weight at age from the 2006 catches is used in the projections.

The exploitation pattern used for the short-term predictions was taken as the average of the years 2004–2006.

Based on the reported landings in the first month of the 2006/2007 fishing year and an assumption of the use of harvest control rule for the coming fishing year the expected catch in 2007 will be a around 195 000t corresponding to F=0.61. Since the average fishing mortility in the last three years is very similar to that estimated from a TAC constraint, an F-based projection in the assessment year would result in a similar projection of population numbers. A yield constraint has always been used for this stock since the yield forecasts based on TAC have historically been relatively good.

The size of the year classes 2002–2006 as estimated by the various models give all similar results expect for TSA giving 4-21% lower values compared to the ADCAM model, see Table 3.3.13. Retrospective pattern of recruitment estimates in recent years, both historical and analytical, show constant downward revision, see Figure 3.3.17B. This was noted by the working group but this trend could not be related to obvious model errors (NWWG 2006 WD-31) or explained by sound biological knowledge. The working group therefore decided to use the results from the AD-CAM model for recruitment prediction as in last year.

3.3.3.3.2 Short-term prediction results

Input data to the short term prediction and results from projections up to the year 2010 with different management options are presented in Table 3.3.19.

The resulting TAC according to the harvest control rule in the 2007/2008 fishing year will be 178 000t. The SSB will decline to about 186 000 t in 2008 and the resulting reference fishing mortality is about 0.59. The estimated age distribution of the catches and SSB in 2008 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 1985–2006 has been used as input (Table 3.3.20).

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 0.34 and 0.15 respectively. Yield per recruit at the F_{max}- is 1.80 kg. (Figure 3.3.25 Table 3.3.21).

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 curve with 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. Using data from 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 harvesting on mean length/weight at age by selection of the fastest growing individuals of incoming year classes is also an important but normally overlooked. Ignoring individual growth variation in a size selective fishery can lead to considerable overestimation of reference points such as $F_{0.1}$ and underestimation of yield achieved when harvesting at either $F_{0.1}$ or F_{max} (NWWG-2006 WD30)..

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.

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. For the fishing year 2006/2007 the TAC was based on the average of the last years TAC and 25% of the estimated refernce biomass B(4+) in the assessment year.

ICES has considered the 1995 harvest control rule to be consistent with the precautionary approach but taking into account the experienced implementation problems and the assessment errors and biases in recent 10 years ICES has suggested that the plan should be re-evaluated.

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 a 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 2006 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. Sexual maturity is fixed to the avergae of 2004-2006.

The results of the simulations are shown in figures 3.3.27-28. The results indicate that SSB and the catchable biomass 4+ will most likely stay around the same level in coming years but a slight decrease in fishing mortalities and yield is observed.

3.3.3.7 Harvest control rule scenarios

Medium term simulations were performed looking at the effects of applying HCR using the average of last years TAC and different fraction of the estimated reference biomass in the assessment year on the on the cumulative probability distribution of the size of spawning biomass in 2011. The relatively short time span is chosen as the dominating year classes in the reference biomass have already been measured in surveys.

The results are presented in figure 3.3.28. They indicate that if the currently used fraction (25%) will be applied the SSB in 2011 will be less than current estimate (shaded horzontal line at around 180 kt) with 40% probability. The fraction has to be less than 20% if the probabilty of increasing SSB in 2011 is higher than 90%.

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 and implementation error. 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 was partially adopted in spring 2006, that is the average part of the HCR was implemented without decreasing the proportion of reference biomass (B4+) taken.

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. Numerous 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.

3.3.4.2 Evaluation of management measures

Since the implementation of the catch rule in 1995 realised reference fishing mortalities have been in the range of 0.51-0.76, in last three years 0.59-0.62. The expected long-term fishing mortality by the application of catch rule was 0.4. The exploitation rate (Landings/B(4+) has been in the range of 26-40% since 1995 with an average of 31% which is about 25% higher than intended by the HCR. At present fishing mortality is high (F5-10 in the year 2006 about 0.6) and age 9 and younger fish account for 98% of the fishable biomass(4+) in 2007. Spawners at age 10 and older will constitute only to about 5% of the spawning stock biomass in 2008. Given the relatively high proportions of younger fish in both the fishable as well as in the spawning stock biomass and a relatively low recruitment in recent years a lower fishing mortalities than resulting from the catch control rule should be considered. Furthermore given that the present harvest control has consistently exceeded the aimed exploitation rate an alternative control rule should be considered.

The effects of technical measures have not been fully evaluated but preliminary evaluation on the effectiveness of the quick closure system have been conducted. 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 (Kristjánsson et. al. 2005). Tagging experiments within closed areas indicate that the closure system can be an important approach in reducing fishing mortalities on juvenile fish (Schopka et al 2006).

Cod in Greenland waters

In years of high recruitment a larval drift to Greenland is sometimes observed, resulting in a large year class at Greenland. In some other years an immigration of adult cod from Greenland has taken place, which has been taken into account in the assessment. Based on the present status of cod stocks in Greenland, no substantial immigration to Iceland can be expected in the near future but the are indication of that the relatively big 2003 year class presently found in Greenland waters is of Icelandic origin..

3.3.4.3 Comments on the assessment

1. Data consideration

No serious assessment deficiencies or data gaps have been revealed for stock in recent years expect for observed downward revision of recent year classes.

2. Assessment quality

The current assessment compared to last years assessment indicates an overestimation in 2006. Recent years assessments are however more consistent with previous years assessments compared to the assessments in 1998-2000 were substantial overestimation was observed. As in five 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 2006 was estimated at 756 thous. tonnes in last year's assessment, the current assessment estimate of biomass 4+ in 2006 is 675 thous. tonnes. Two thirds of this overestimate was due to the observed mean weight at age in the catches in 2006 were slightly higher than predicted, one third because overestimation in stock numbers.

The year classes 2002-2005 were estimated 164, 127, 87 and 174 millions respectively in last years assessment compared to 155, 123, 81 and 145 in the current assessment. Retrospective pattern of recruitment estimates in recent years, both historical and analytical, indicate persistent downward revision.

The situation now with 3 of the 6 recent year classes estimated poor (2001, 2003 and 2004) and 2002, 2005 and 2006 year classes below longterm average raises concerns about the size of the spawning stock in 2010 when those year classes will become a large part of the spawning stock.

3. Response to technical minutes

3.3.5 Ecosystem considerations

3.3.5.1 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) which 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).

Various factors affect the natural mortality of cod and several of these factors could change in magnitude in the future. The cod 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 whales and seals as a part of future natural mortality for the cod stock even though icelandic grey and harbour seals stocks have been reduced considerably in recent years.

3.3.5.2 Fishery effect on the ecosystem

Iceland has been involved in a European project which partly focuses on the effects of both anthropogenic and non-anthropogenic factors on exploited species in the North-east Atlantic, Icelandic EEZ included. In Icelandic waters there is a number of areas closed to fishing activities. They play an important role in protecting benthic and fish communities. Findings from a recent study show that closed areas can benefit several fish species such as cod. A large sampling program is being carried out to investigate benthic and fish communities within fishery regulated closed areas and on adjacent fishing grounds.

During the last few years there has been a decline in the Icelandic capelin stock and that might potentially have caused an increase in natural mortality in seabird populations around Iceland. It is possible that some of these changes are climate-driven but the effects of fishery induced mortality can not be ruled out.

3.3.5.3 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 aerial 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.

3.3.6 Icelandic cod (Quality handbook)

3.3.6.1 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 show no indication of significant emigration from Iceland to other areas. Nevertheless cod tagged in Iceland has been recaptured inside Faroes waters close to the EEZ line seperating Iceland and the Faroes islands.

3.3.6.2 Fisheries dependent data

3.3.6.2.1 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 by each gear type from each area, calculated daily ("real time proportional sampling scheme").

Catch in numbers at age

The Icelandic catch in numbers at age has since 1970 has been calculated by splitting the landings by 5 fleets, 2 areas and 2 seasons. The gears are longlines, bottom trawl, gillnets, handlines 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 they are to few to give reliable age-length 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 are estimated along with the catch in numbers. Before 1993 weighting of cod was relatively uncommon so length-weight relationships were based on limited 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 3.3.7a.

Mean weight at age have been shown to correlate well with the size of the capelin stock and therefore the capelin stock 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.

JUST MOVED FROM OTHER PART OF THE REPORT, PLACE AND CONTEXT NEEDS DOUBLE CHECKING Prior to 2004 the catch weights at age had been predicted from the weight at age of the same year class 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. In 2004 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). 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 in 2004 showed that for the assessment year no obvious pattern was observed in the residuals but for the following year an overestimation is observed in the most recent years. This was explained by the fact that the mean weight at age had been decreasing in two previous years but the linear model assumed an average growth. In 2005, a sensitivity analysis of using various models or methods to predict mean weight at age in the catches were presented (NWWG 2005, WD-30). The results indicated little 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 information were available about the capelin stock size the following 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 observed mean weight at age in the catches in 2005 are slightly higher than in 2004 and same is observed in SSB weights (survey) in 2006 compared to 2005. The mean weight at age in the survey in 2006 for ages 2-6 are lower than observed in 2005 but for ages 7 and 8 there is some increase. Nevertheless both survey and catch mean weights at age for the most important age groups, in terms of catches, are near or at historical low levels. This downward trend in mean weight at age in the Icelandic cod is propably be due to low abundance of capelin in recent years which is the most important prey of cod in Icelandic waters. In 2006 the proceadure from 2005 was repeated (NWWG 2006 WD-32)

3.3.6.2.2 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 are presented in Figures 3.3.9. 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.

3.3.6.3 Fisheries independent data

3.3.6.3.1 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 standardized 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.

3.3.6.4 Assessment input data

3.3.6.4.1 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 then combined. In all the assessment models used apart from TSA, the indices are combined by simple summation (Table 3.3.8 and figure 3.3.11) but for the TSA tuning is performed using the weighted geometric mean of the two area indices (Table3.3.9).

3.3.6.4.2 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.

3.3.6.5 Stock assessment model

3.3.6.5.1 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.

3.3.6.5.2 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).

3.3.6.5.3 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 2nd 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.

3.3.6.5.4 History of the Harvest Control Rule for the Icelandic cod stock

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 that would have been the TAC based on the original catch rule. For the fishing year 2001/2002 the modified rule resulted in 190 thousand tonnes compared to 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.

Table 3.3.1 Icelandic cod division Va. Nominal catches (tonnes) by contries 1997-2006 as officially reported to ICES.

Year	Belgium	Faeroe Islands	France	Germany	Germany, Fed. Rep. of	Greenland	Iceland	Norway	Poland	UK - Eng+Wales+N.Irl.	UK - England & Wales	UK - Scotland	UK	Sum	WG estimates	Difference
1973	1110	14207	-	.	6839	-	235184	268	-	.	121320	957		379885	369205	-10680
1974	1128	12125	203	.	5554	-	238066	171	1	.	115395	2144		374787	368133	-6654
1975	1269	9440	23	.	2266	-	264975	144	-	.	91000	1897		371014	364754	-6260
1976	956	8772	-	.	2970	-	280831	514	-	.	53534	786		348363	346253	-2110
1977	1408	7261	-	.	1598	-	329676	108	-	.	-	-		340051	340086	35
1978	1314	7069	-	.	-	-	319648	189	-	.	-	-		328220	329602	1382
1979	1485	6163	-	.	-	-	360077	288	-	.	-	-		368013	366462	-1551
1980	840	4802	-	.	-	-	429044	358	-	.	-	-		435044	432237	-2807
1981	1321	6183	-	.	-	-	461038	559	-	.	-	-		469101	465032	-4069
1982	236	5297	-	.	-	-	382297	557	-	.	-	-		388387	380068	-8319
1983	188	5626	-	.	-	-	293890	109	-	.	-	-		299813	298049	-1764
1984	254	2041	-	.	-	-	281481	90	-	.	2	-		283868	282022	-1846
1985	207	2203	-	.	-	-	322810	46	-	.	1	-		325267	323428	-1839
1986	226	2554	-	.	-	-	365852	1	-	.	-	-		368633	364797	-3836
1987	597	1848	-	.	-	-	389808	4	-	.	-	-		392257	389915	-2342
1988	365	1966	-	.	-	-	375741	4	-	.	-	-		378076	377554	-522
1989	309	2012	-	.	-	-	353985	3	-	-	.	-		356309	363125	6816
1990	260	1782	-	.	-	-	333348	-	-	-	.	-		335390	335316	-74
1991	548	1323	-	-	.	-	306697	-	-	-	.	-		308568	307759	-809
1992	222	883	-	-	.	-	266662	-	-	-	.	-		267767	264834	-2933
1993	145	664	-	-	.	-	251170	-	-	<0.5	.	-		251979	250704	-1275
1994	136	754	-	-	.	-	177919	-	-	-	.	-		178809	178138	-671
1995	-	739	-	-	.	-	168685	-	-	-	.	-		169424	168592	-832
1996	-	599	-	<0.5	.	-	181052	7	-	-	.	-		181658	180701	-957
1997	-	408	-	-	.	-	202745	-	-	-	.	-		203153	203112	-41
1998	-	1078	-	9	.	-	241545	-	-	-	.	-		242632	243987	1355
1999	-	1247	.	21	.	25	258658	85	-	12	.	4		260052	260147	95
2000	-	.	-	15	.	-	234362	60	-	10	.	<0.5		234447	235092	645
2001	-	1143	-	11	.	-	233875	65	-	15	.	5		235114	234229	-885
2002	-	1175	-	15	.	-	206987	73	-	19	.	13		208282	208487	205
2003	-	2118	-	88	.	-	200327	56	-	104	.	42		202735	207543	4808
2004	-	2737	-	113	.	-	220020	90	-	310	.	102		223372	226762	3390
2005	-	2310	.	177	.	.	206343	77	-	224	.	220		209351	213403	4052
2006	-	1606		37				78					19	1740	196077	194337

Table 3.3.2 Icelandic cod division Va. Landings (tonnes), effort, CPUE and percentage changes in effort and CPUE in 1991-2006 (with 1991 as 100%). Data is 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	572	77
1993	110757	176928.115	75	626	84
1994	65213	82757.61421	35	788	106
1995	55656	65477.64706	28	850	114
1996	63749	63621.75649	27	1002	134
1997	81202	74840.553	32	1085	146
1998	108424	84971.78683	36	1276	171
1999	123140	119437.4394	51	1031	138
2000	102094	124809.291	53	818	110
2001	96624	108444.4444	46	891	120
2002	85741	82206.13615	35	1043	140
2003	86992	75513.88889	32	1152	155
2004	94041	76518.30757	33	1229	165
2005	84959	72552.51921	31	1171	157
2006	80096	69588.18419	30	1151	154

Gillnet

Year	Catch	Effort	Effort % changes	Cpue	Cpue % changes
1991	58948	11099	100	5.31	100
1992	59712	10728	97	5.57	105
1993	56350	11272	102	5.00	94
1994	39821	8037	72	4.96	93
1995	31182	5425	49	5.75	108
1996	40807	6447	58	6.33	119
1997	45919	6454	58	7.12	134
1998	51004	8539	77	5.97	112
1999	47137	9437	85	5.00	94
2000	48018	9915	89	4.84	91
2001	53600	13333	120	4.02	76
2002	44162	11107	100	3.98	75
2003	37498	10468	94	3.58	67
2004	37296	11166	101	3.34	63
2005	32185	7998	72	4.02	76
2006	23371	5309	48	4.40	83

Long line

Year	Catch	Effort	Effort % changes	Cpue	Cpue % changes
1991	44711	2009	100	22.25	100
1992	42301	2017	100	20.97	94
1993	45938	2162	108	21.25	96
1994	35990	1633	81	22.04	99
1995	44584	1724	86	25.86	116
1996	39770	1476	73	26.94	121
1997	31276	830	41	37.68	169
1998	37244	979	49	38.05	171
1999	52658	1536	76	34.29	154
2000	49869	1706	85	29.24	131
2001	47120	1794	89	26.27	118
2002	42153	1401	70	30.09	135
2003	44662	1598	80	27.95	126
2004	57480	1835	91	31.33	141
2005	68632	2156	107	31.83	143
2005	71033	2211	110	32.12	144

Table 3.3.3 Icelandic cod division Va. Observed catch in numbers by year and age in millions in the 1955-2006 period and predicted catches for 2007-2009.

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	3.950	16.160	21.874	18.145	5.063	4.419	1.124	0.401	0.172	0.034	0.020	0.015
2004	1.778	19.184	25.003	17.384	9.926	2.734	2.023	0.481	0.126	0.062	0.014	0.005
2005	5.102	5.125	26.749	16.980	8.339	4.682	1.292	0.913	0.203	0.089	0.025	0.002
2006	3.258	12.884	8.438	22.041	10.418	4.523	2.194	0.497	0.336	0.067	0.027	0.002
2007	2.396	12.103	22.184	7.562	12.698	5.352	2.365	1.066	0.137	0.108	0.017	0.010
2008	3.631	6.729	15.058	15.822	3.854	5.597	2.219	0.885	0.329	0.046	0.033	0.005
2009	3.349	12.049	9.994	13.030	9.928	2.111	2.905	1.050	0.349	0.140	0.018	0.014

Table 3.3.4. Icelandic cod 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 Icelandic cod division Va. Observed mean weight at age in the landings in 1955-2006 and predictions for 2007-2009.

Year/age	3	4	5	6	7	8	9	10	11	12	13	14
1955	0.827	1.307	2.157	3.617	4.638	5.657	6.635	6.168	8.746	8.829	10.086	14.584
1956	1.080	1.600	2.190	3.280	4.650	5.630	6.180	6.970	6.830	9.290	10.965	12.954
1957	1.140	1.710	2.520	3.200	4.560	5.960	7.170	7.260	8.300	8.290	10.350	13.174
1958	1.210	1.810	3.120	4.510	5.000	5.940	6.640	8.290	8.510	8.840	9.360	13.097
1959	1.110	1.950	2.930	4.520	5.520	6.170	6.610	7.130	8.510	8.670	9.980	11.276
1960	1.060	1.720	2.920	4.640	5.660	6.550	6.910	7.140	7.970	10.240	10.100	12.871
1961	1.020	1.670	2.700	4.330	5.530	6.310	6.930	7.310	7.500	8.510	9.840	14.550
1962	0.990	1.610	2.610	3.900	5.720	6.660	6.750	7.060	7.540	8.280	10.900	12.826
1963	1.250	1.650	2.640	3.800	5.110	6.920	7.840	7.610	8.230	9.100	9.920	11.553
1964	1.210	1.750	2.640	4.020	5.450	6.460	8.000	9.940	9.210	10.940	12.670	15.900
1965	1.020	1.530	2.570	4.090	5.410	6.400	7.120	8.600	12.310	10.460	10.190	17.220
1966	1.170	1.680	2.590	4.180	5.730	6.900	7.830	8.580	9.090	14.230	14.090	17.924
1967	1.120	1.820	2.660	4.067	5.560	7.790	7.840	8.430	9.090	10.090	14.240	16.412
1968	1.170	1.590	2.680	3.930	5.040	5.910	7.510	8.480	10.750	11.580	14.640	16.011
1969	1.100	1.810	2.480	3.770	5.040	5.860	7.000	8.350	8.720	10.080	11.430	13.144
1970	0.990	1.450	2.440	3.770	4.860	5.590	6.260	8.370	10.490	12.310	14.590	21.777
1971	1.090	1.570	2.310	2.980	4.930	5.150	5.580	6.300	8.530	11.240	14.740	17.130
1972	0.980	1.460	2.210	3.250	4.330	5.610	6.040	6.100	6.870	8.950	11.720	16.000
1973	1.030	1.420	2.470	3.600	4.900	6.110	6.670	6.750	7.430	7.950	10.170	17.000
1974	1.050	1.710	2.430	3.820	5.240	6.660	7.150	7.760	8.190	9.780	12.380	14.700
1975	1.100	1.770	2.780	3.760	5.450	6.690	7.570	8.580	8.810	9.780	10.090	11.000
1976	1.350	1.780	2.650	4.100	5.070	6.730	8.250	9.610	11.540	11.430	14.060	16.180
1977	1.259	1.911	2.856	4.069	5.777	6.636	7.685	9.730	11.703	14.394	17.456	24.116
1978	1.289	1.833	2.929	3.955	5.726	6.806	9.041	10.865	13.068	11.982	19.062	21.284
1979	1.408	1.956	2.642	3.999	5.548	6.754	8.299	9.312	13.130	13.418	13.540	20.072
1980	1.392	1.862	2.733	3.768	5.259	6.981	8.037	10.731	12.301	17.281	14.893	19.069
1981	1.180	1.651	2.260	3.293	4.483	5.821	7.739	9.422	11.374	12.784	12.514	19.069
1982	1.006	1.550	2.246	3.104	4.258	5.386	6.682	9.141	11.963	14.226	17.287	16.590
1983	1.095	1.599	2.275	3.021	4.096	5.481	7.049	8.128	11.009	13.972	15.882	18.498
1984	1.288	1.725	2.596	3.581	4.371	5.798	7.456	9.851	11.052	14.338	15.273	16.660
1985	1.407	1.971	2.576	3.650	4.976	6.372	8.207	10.320	12.197	14.683	16.175	19.050
1986	1.459	1.961	2.844	3.593	4.635	6.155	7.503	9.084	10.356	15.283	14.540	15.017
1987	1.316	1.956	2.686	3.894	4.716	6.257	7.368	9.243	10.697	10.622	15.894	12.592
1988	1.438	1.805	2.576	3.519	4.930	6.001	7.144	8.822	9.977	11.732	14.156	13.042
1989	1.186	1.813	2.590	3.915	5.210	6.892	8.035	9.831	11.986	10.003	12.611	16.045
1990	1.290	1.704	2.383	3.034	4.624	6.521	8.888	10.592	10.993	14.570	15.732	17.290
1991	1.309	1.899	2.475	3.159	3.792	5.680	7.242	9.804	9.754	14.344	14.172	20.200
1992	1.289	1.768	2.469	3.292	4.394	5.582	6.830	8.127	12.679	13.410	15.715	11.267
1993	1.392	1.887	2.772	3.762	4.930	6.054	7.450	8.641	10.901	12.517	14.742	16.874
1994	1.443	2.063	2.562	3.659	5.117	6.262	7.719	8.896	10.847	12.874	14.742	17.470
1995	1.348	1.959	2.920	3.625	5.176	6.416	7.916	10.273	11.022	11.407	13.098	15.182
1996	1.457	1.930	3.132	4.141	4.922	6.009	7.406	9.772	10.539	13.503	13.689	16.194
1997	1.484	1.877	2.878	4.028	5.402	6.386	7.344	8.537	10.797	11.533	10.428	12.788
1998	1.230	1.750	2.458	3.559	5.213	7.737	7.837	9.304	10.759	14.903	16.651	18.666
1999	1.241	1.716	2.426	3.443	4.720	6.352	8.730	9.946	11.088	12.535	14.995	15.151
2000	1.308	1.782	2.330	3.252	4.690	5.894	7.809	9.203	10.240	11.172	13.172	17.442
2001	1.499	2.050	2.649	3.413	4.766	6.508	7.520	9.055	8.769	9.526	11.210	13.874
2002	1.294	1.926	2.656	3.680	4.720	6.369	7.808	9.002	10.422	13.402	9.008	16.893
2003	1.265	1.790	2.424	3.505	4.455	5.037	5.980	7.819	8.802	10.712	12.152	13.797
2004	1.257	1.771	2.323	3.312	4.269	5.394	5.872	7.397	10.808	11.569	13.767	12.955
2005	1.194	1.712	2.374	3.435	4.392	5.201	6.200	5.495	7.211	9.909	12.944	18.151
2006	1.070	1.614	2.185	3.052	4.347	5.177	5.382	5.769	6.258	5.688	7.301	15.412
2007	1.117	1.629	2.229	2.810	3.922	5.151	6.193	5.819	6.201	6.508	6.751	6.943
2008	1.117	1.629	2.229	2.810	3.922	5.151	6.193	5.819	6.201	6.508	6.751	6.943
2009	1.117	1.629	2.229	2.810	3.922	5.151	6.193	5.819	6.201	6.508	6.751	6.943

Table 3.3.6 Icelandic cod division Va. Mean weight at age in the spawning stock in 1955-2007 and predictions for 2008-2010.

Year/age	3	4	5	6	7	8	9	10	11	12	13	14
1955	0.645	1.019	1.833	3.183	4.128	5.657	6.635	6.168	8.746	8.829	10.086	14.584
1956	0.645	1.248	1.862	2.886	4.138	5.630	6.180	6.970	6.830	9.290	10.965	12.954
1957	0.645	1.334	2.142	2.816	4.058	5.960	7.170	7.260	8.300	8.290	10.350	13.174
1958	0.645	1.412	2.652	3.969	4.450	5.940	6.640	8.290	8.510	8.840	9.360	13.097
1959	0.645	1.521	2.490	3.978	4.913	6.170	6.610	7.130	8.510	8.670	9.980	11.276
1960	0.645	1.342	2.482	4.083	5.037	6.550	6.910	7.140	7.970	10.240	10.100	12.871
1961	0.645	1.303	2.295	3.810	4.922	6.310	6.930	7.310	0.750	8.510	9.840	14.550
1962	0.645	1.256	2.218	3.432	5.091	6.660	6.750	7.060	7.540	8.280	10.900	12.826
1963	0.645	1.287	2.244	3.344	4.548	6.920	7.840	7.610	8.230	9.100	9.920	11.553
1964	0.645	1.365	2.244	3.538	4.850	6.460	8.000	9.940	9.210	10.940	12.670	15.900
1965	0.645	1.193	2.184	3.599	4.815	6.400	7.120	8.600	12.310	10.460	10.190	17.220
1966	0.645	1.310	2.202	3.678	5.100	6.900	7.830	8.580	9.090	14.230	14.090	17.924
1967	0.645	1.420	2.261	3.579	4.948	7.790	7.840	8.430	9.090	10.090	14.240	16.412
1968	0.645	1.240	2.278	3.458	4.486	5.910	7.510	8.480	10.750	11.580	14.640	16.011
1969	0.645	1.412	2.108	3.318	4.486	5.860	7.000	8.350	8.720	10.080	11.430	13.144
1970	0.645	1.131	2.074	3.318	4.325	5.590	6.260	8.370	10.490	12.310	14.590	21.777
1971	0.645	1.225	1.964	2.622	4.388	5.150	5.580	6.300	8.530	11.240	14.740	17.130
1972	0.645	1.139	1.878	2.860	3.854	5.610	6.040	6.100	6.870	8.950	11.720	16.000
1973	0.645	1.108	2.100	3.168	4.361	6.110	6.670	6.750	7.430	7.950	10.170	17.000
1974	0.645	1.334	2.066	3.362	4.664	6.660	7.150	7.760	8.190	9.780	12.380	14.700
1975	0.645	1.381	2.363	3.309	4.850	6.690	7.570	8.580	8.810	9.780	10.090	11.000
1976	0.645	1.388	2.252	3.608	4.512	6.730	8.250	9.610	11.540	11.430	14.060	16.180
1977	0.645	1.491	2.428	3.581	5.142	6.636	7.685	9.730	11.703	14.394	17.456	24.116
1978	0.645	1.430	2.490	3.480	5.096	6.806	9.041	10.865	13.068	11.982	19.062	21.284
1979	0.645	1.526	2.246	3.519	4.938	6.754	8.299	9.312	13.130	13.418	13.540	20.072
1980	0.645	1.452	2.323	3.316	4.681	6.981	8.037	10.731	12.301	17.281	14.893	19.069
1981	0.645	1.288	1.921	2.898	3.990	5.821	7.739	9.422	11.374	12.784	12.514	19.069
1982	0.645	1.209	1.909	2.732	3.790	5.386	6.682	9.141	11.963	14.226	17.287	16.590
1983	0.645	1.247	1.934	2.658	3.645	5.481	7.049	8.128	11.009	13.972	15.882	18.498
1984	0.645	1.346	2.207	3.151	3.890	5.798	7.456	9.851	11.052	14.338	15.273	16.660
1985	0.485	1.375	1.750	2.709	3.454	6.372	8.207	10.320	12.197	14.683	16.175	19.050
1986	0.758	1.597	2.882	3.246	4.581	6.155	7.503	9.084	10.356	15.283	14.540	15.017
1987	0.576	1.584	2.423	3.522	4.905	6.257	7.368	9.243	10.697	10.622	15.894	12.592
1988	0.610	1.475	2.261	3.277	4.398	6.001	7.144	8.822	9.977	11.732	14.156	13.042
1989	0.673	1.494	2.338	3.429	4.686	6.892	8.035	9.831	11.986	10.003	12.611	16.045
1990	0.563	1.035	2.170	2.798	4.422	6.521	8.888	10.592	10.993	14.570	15.732	17.290
1991	0.686	1.283	2.039	2.747	3.397	5.680	7.242	9.804	9.754	14.344	14.172	20.200
1992	0.619	1.336	2.094	3.029	3.753	5.582	6.830	8.127	12.679	13.410	15.715	11.267
1993	0.708	1.363	2.309	3.235	4.109	6.054	7.450	8.641	10.901	12.517	14.742	16.874
1994	0.847	1.728	2.254	3.340	4.514	6.262	7.719	8.896	10.847	12.874	14.742	17.470
1995	0.745	1.635	2.345	3.186	4.489	6.416	7.916	10.273	11.022	11.407	13.098	15.182
1996	0.678	1.753	2.490	3.531	4.273	6.009	7.406	9.772	10.539	13.503	13.689	16.194
1997	0.670	1.347	2.267	3.746	5.245	6.386	7.344	8.537	10.797	11.533	10.428	12.788
1998	0.599	1.516	2.261	3.263	4.474	7.737	7.837	9.304	10.759	14.903	16.651	18.666
1999	0.711	1.467	1.932	2.996	3.961	6.352	8.730	9.946	11.088	12.535	14.995	15.151
2000	0.600	1.355	1.915	2.881	4.319	5.894	7.809	9.203	10.240	11.172	13.172	17.442
2001	0.661	1.550	2.071	2.694	4.131	6.508	7.520	9.055	8.769	9.526	11.210	13.874
2002	0.630	1.590	2.259	3.120	3.984	6.369	7.808	9.002	10.422	13.402	9.008	16.893
2003	0.900	1.338	2.215	2.988	4.169	5.037	5.980	7.819	8.802	10.712	12.152	13.797
2004	0.900	1.453	2.099	3.057	3.757	5.394	5.872	7.397	10.808	11.569	13.767	12.955
2005	0.900	1.119	1.897	2.963	3.874	5.201	6.200	5.495	7.211	9.909	12.944	18.151
2006	0.900	1.383	1.998	2.905	4.385	5.177	5.382	5.769	6.258	5.688	7.301	15.412
2007	0.900	1.264	2.022	2.580	4.078	5.151	6.193	5.819	6.201	6.508	6.751	6.943
2008	0.900	1.264	2.022	2.580	4.078	5.151	6.193	5.819	6.201	6.508	6.751	6.943
2009	0.900	1.264	2.022	2.580	4.078	5.151	6.193	5.819	6.201	6.508	6.751	6.943
2010	0.900	1.264	2.022	2.580	4.078	5.151	6.193	5.819	6.201	6.508	6.751	6.943

Table 3.3.7 Icelandic cod division Va. Maturity at age in 1955-2007 and predictions for 2008-2010.

Year/age	3	4	5	6	7	8	9	10	11	12	13	14
1955	0.019	0.022	0.033	0.181	0.577	0.782	0.834	0.960	1.000	1.000	1.000	1.000
1956	0.019	0.025	0.033	0.111	0.577	0.782	0.818	0.980	0.980	1.000	1.000	1.000
1957	0.019	0.026	0.043	0.100	0.549	0.801	0.842	0.990	1.000	1.000	1.000	1.000
1958	0.019	0.028	0.086	0.520	0.682	0.801	0.834	1.000	1.000	1.000	1.000	1.000
1959	0.019	0.029	0.070	0.535	0.772	0.818	0.834	0.990	1.000	1.000	1.000	1.000
1960	0.019	0.026	0.066	0.577	0.782	0.826	0.834	0.990	1.000	1.000	1.000	1.000
1961	0.019	0.025	0.053	0.450	0.772	0.818	0.834	0.990	0.990	1.000	1.000	1.000
1962	0.019	0.025	0.048	0.281	0.791	0.834	0.834	0.990	0.990	1.000	1.000	1.000
1963	0.019	0.025	0.048	0.237	0.706	0.834	0.849	1.000	1.000	1.000	1.000	1.000
1964	0.019	0.026	0.048	0.329	0.762	0.826	0.849	1.000	1.000	1.000	1.000	1.000
1965	0.019	0.025	0.045	0.354	0.751	0.826	0.842	1.000	1.000	1.000	1.000	1.000
1966	0.019	0.026	0.045	0.394	0.791	0.849	0.849	1.000	1.000	1.000	1.000	1.000
1967	0.019	0.028	0.051	0.341	0.772	0.842	0.849	1.000	1.000	1.000	1.000	1.000
1968	0.019	0.025	0.051	0.292	0.682	0.801	0.842	1.000	1.000	1.000	1.000	1.000
1969	0.019	0.028	0.043	0.227	0.682	0.801	0.842	1.000	1.000	1.000	1.000	1.000
1970	0.019	0.023	0.041	0.227	0.644	0.772	0.818	1.000	1.000	1.000	1.000	1.000
1971	0.019	0.025	0.037	0.074	0.657	0.706	0.772	0.979	0.994	0.982	0.993	1.000
1972	0.019	0.023	0.035	0.106	0.450	0.772	0.809	0.979	0.994	0.982	0.993	1.000
1973	0.022	0.028	0.163	0.382	0.697	0.801	0.834	0.996	0.996	1.000	1.000	1.000
1974	0.020	0.031	0.085	0.346	0.636	0.790	0.818	0.989	1.000	1.000	1.000	1.000
1975	0.020	0.035	0.118	0.287	0.715	0.809	0.839	1.000	1.000	1.000	1.000	1.000
1976	0.025	0.026	0.086	0.253	0.406	0.797	0.841	1.000	1.000	1.000	1.000	1.000
1977	0.019	0.024	0.060	0.382	0.742	0.817	0.842	1.000	1.000	1.000	1.000	1.000
1978	0.025	0.025	0.052	0.192	0.737	0.820	0.836	1.000	1.000	1.000	1.000	1.000
1979	0.019	0.021	0.053	0.282	0.635	0.790	0.836	0.919	1.000	1.000	1.000	1.000
1980	0.026	0.021	0.047	0.225	0.653	0.777	0.834	0.977	1.000	0.964	1.000	1.000
1981	0.019	0.022	0.030	0.090	0.448	0.751	0.811	0.962	0.988	1.000	1.000	1.000
1982	0.021	0.025	0.038	0.065	0.297	0.705	0.815	0.967	1.000	1.000	1.000	1.000
1983	0.019	0.030	0.047	0.116	0.264	0.530	0.715	0.979	0.985	1.000	1.000	1.000
1984	0.019	0.024	0.053	0.169	0.444	0.620	0.716	0.949	0.969	0.948	1.000	1.000
1985	0.000	0.021	0.185	0.412	0.495	0.735	0.572	1.000	1.000	1.000	1.000	1.000
1986	0.001	0.023	0.149	0.395	0.682	0.734	0.941	0.962	0.988	1.000	1.000	1.000
1987	0.002	0.033	0.093	0.360	0.490	0.885	0.782	1.000	0.979	1.000	1.000	1.000
1988	0.006	0.029	0.225	0.511	0.448	0.683	0.937	0.946	0.974	0.821	1.000	1.000
1989	0.008	0.025	0.142	0.372	0.645	0.652	0.634	0.991	1.000	0.903	0.859	1.000
1990	0.006	0.012	0.155	0.437	0.581	0.796	0.814	0.986	1.000	1.000	1.000	1.000
1991	0.000	0.055	0.149	0.369	0.637	0.790	0.682	0.842	1.000	1.000	1.000	1.000
1992	0.002	0.062	0.265	0.402	0.813	0.917	0.894	1.000	1.000	1.000	1.000	1.000
1993	0.006	0.085	0.267	0.464	0.693	0.801	0.843	0.968	1.000	1.000	1.000	1.000
1994	0.008	0.110	0.339	0.591	0.702	0.917	0.698	0.852	0.985	1.000	1.000	1.000
1995	0.005	0.109	0.384	0.528	0.752	0.787	0.859	1.000	1.000	1.000	1.000	1.000
1996	0.002	0.031	0.186	0.499	0.650	0.733	0.812	1.000	1.000	0.986	0.971	1.000
1997	0.006	0.037	0.246	0.424	0.685	0.787	0.804	0.932	1.000	0.913	1.000	1.000
1998	0.000	0.061	0.209	0.491	0.782	0.814	0.810	0.925	0.998	1.000	1.000	1.000
1999	0.012	0.044	0.239	0.516	0.649	0.835	0.687	0.988	1.000	1.000	1.000	1.000
2000	0.001	0.065	0.248	0.512	0.611	0.867	0.998	0.980	1.000	1.000	1.000	1.000
2001	0.004	0.043	0.261	0.589	0.750	0.742	0.862	0.987	1.000	1.000	1.000	1.000
2002	0.008	0.086	0.322	0.656	0.759	0.920	0.550	0.979	1.000	1.000	1.000	1.000
2003	0.005	0.046	0.218	0.524	0.870	0.798	0.860	0.998	1.000	1.000	1.000	1.000
2004	0.000	0.038	0.246	0.549	0.626	0.843	0.816	0.990	1.000	1.000	1.000	1.000
2005	0.006	0.109	0.282	0.495	0.791	0.814	0.951	0.990	1.000	1.000	1.000	1.000
2006	0.002	0.023	0.294	0.448	0.751	0.869	0.743	1.000	1.000	1.000	1.000	1.000
2007	0.012	0.032	0.159	0.500	0.693	0.795	0.862	0.960	0.924	1.000	1.000	1.000
2008	0.007	0.055	0.245	0.481	0.745	0.826	0.852	0.983	0.975	1.000	1.000	1.000
2009	0.007	0.055	0.245	0.481	0.745	0.826	0.852	0.983	0.975	1.000	1.000	1.000
2010	0.007	0.055	0.245	0.481	0.745	0.826	0.852	0.983	0.975	1.000	1.000	1.000

Table 3.3.8. Icelandic cod division Va. CPUE from the spring bottom trawl surveys in 1985-2007 as used in XSA and AD-CAM tuning. Sum of north and south (stratified mean) area indices.

year\age	1.00	2.00	3.00	4.00	5.00	6.00	7.00	8.00	9.00	10.00
1985	16.54	111.07	34.85	48.09	64.30	22.57	14.86	4.85	3.21	1.52
1986	15.08	60.56	95.56	22.43	21.23	26.36	6.64	2.48	0.83	0.74
1987	3.65	28.86	103.10	82.03	21.08	12.22	12.02	2.57	0.90	0.40
1988	3.44	7.36	71.69	101.61	66.75	7.81	5.88	6.14	0.58	0.25
1989	4.04	16.45	21.97	77.70	67.59	34.20	4.20	1.45	1.14	0.24
1990	5.56	11.79	26.15	14.07	26.97	32.38	14.22	1.51	0.53	0.42
1991	3.95	16.27	17.93	30.17	15.24	18.09	20.93	4.23	0.80	0.32
1992	0.72	17.13	33.26	18.87	16.27	6.54	5.70	5.11	1.29	0.22
1993	3.57	4.82	30.76	36.41	13.24	9.93	2.13	1.75	1.17	0.34
1994	14.38	15.01	8.97	26.66	21.90	5.77	3.62	0.70	0.48	0.43
1995	1.18	29.03	24.78	8.99	23.88	17.69	3.78	1.76	0.35	0.17
1996	3.72	5.48	42.60	29.44	12.84	14.62	13.99	3.81	1.05	0.19
1997	1.21	22.39	13.57	56.18	29.05	9.48	8.71	6.59	0.56	0.36
1998	8.06	5.56	29.98	16.06	61.77	28.33	6.51	5.20	3.05	0.66
1999	7.39	32.98	7.01	42.27	13.02	23.66	11.12	2.35	1.32	0.66
2000	18.79	27.90	54.74	6.94	30.00	8.28	8.18	4.14	0.51	0.30
2001	12.16	21.72	36.78	37.60	4.91	15.24	3.33	1.97	0.79	0.23
2002	0.92	38.07	41.12	40.16	36.16	7.10	8.33	1.49	0.72	0.30
2003	11.17	4.44	46.36	38.55	31.51	19.09	4.11	4.71	1.08	0.23
2004	6.57	24.58	7.91	61.65	34.96	24.81	14.44	2.82	2.88	0.47
2005	2.56	14.62	39.03	9.70	43.40	22.93	10.86	5.66	0.93	0.83
2006	8.79	6.53	22.55	38.49	10.86	27.75	10.06	3.52	1.38	0.23
2007	5.55	18.34	8.50	21.16	27.70	9.10	9.79	5.03	2.05	0.66

Y/a	0	1	2	3	4	5	6	7	8	9	10
1995	0.66	1.66	16.42	21.87	8.21	17.44	11.43	1.98	0.66	0.19	0.05
1996	0.28	5	3.31	18.68	14.1	5.86	8.17	6.26	1.49	0.29	0.09
1997	1.8	0.56	12.53	5.54	25.29	14.3	3.94	3.5	2.26	0.24	0.16
1998	6.11	5.77	2.35	14.46	7.28	16.76	16.73	5.2	2.28	1.26	0.2
1999	10.55	7.24	13.65	5.22	21.59	7.23	10.83	4.56	0.64	0.31	0.32
2000	3.45	3.91	10.35	13.3	3.46	11	3.65	2.9	1.3	0.43	0.36
2001	0.24	6.17	10.26	18.1	20.95	3.36	6.67	1.59	0.76	0.17	0.02
2002	0.79	0.76	12.33	17.5	28.44	20.04	6.91	5.96	1.33	0.75	0.07
2003	2.08	5.27	3.05	30.71	24.06	19.07	11.69	2.22	2.81	0.38	0.11
2004	0.36	3.48	15.41	6.68	30.27	20.09	12.83	7.98	1.94	1.71	0.23
2005	0.51	1.81	8.96	19.39	6.62	25.74	11.37	4.12	2	0.31	0.32
2006	0.37	4.03	4	14.23	22.52	8.41	15.88	6.85	2.33	1.13	0.17

Table 3.3.8. Icelandic cod division Va. CPUE from the autumn bottom trawl surveys in 1995-2006 as used in XSA and AD-CAM tuning. Sum of north and south (stratified mean) area indices.

Table 3.3.10. Icelandic cod division Va. XSA tuning diagnostics

Log catchability residuals.

Fleet : SMB. Tot

Age	1984	1985	1986
0	-0.19	0.28	0.33
1	0.1	-0.04	0.08
2	0.08	-0.16	0.06
3	0.29	-0.22	-0.26
4	0.15	-0.04	-0.13
5	0.26	0.03	0.06
6	0.64	-0.26	0.07
7	0.3	-0.27	-0.13
8	0.65	-0.45	-0.06

Age	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
0	-0.16	0.18	-0.21	-0.19	-0.3	-0.34	0.27	-0.24	-0.35	0
1	0.07	0.03	0.12	-0.25	-0.05	-0.04	-0.22	0.1	-0.14	-0.04
2	0.35	0.36	0	0.04	-0.13	0	-0.06	-0.23	0.06	0.02
3	0.04	0.38	0.04	0.05	0.06	-0.09	-0.05	-0.09	-0.14	0.19
4	-0.1	0	-0.09	0.19	-0.16	0.06	-0.19	0.12	0.23	-0.04
5	-0.56	0.17	-0.19	0.09	-0.2	-0.02	-0.32	0.02	0.1	0.06
6	0.24	-0.2	0.03	0.15	-0.16	-0.3	-0.11	-0.15	0.29	0.21
7	0.57	-0.01	-0.31	-0.21	-0.12	-0.05	-0.41	0.01	0.59	0.24
8	-0.34	0.57	0.15	0.16	-0.32	-0.28	0.08	-0.05	0.31	-0.44

Age	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
0	-0.04	0.01	0.4	0.07	-0.07	0.19	0.16	0.09	0.1	-0.03
1	0.1	0.11	0.12	-0.05	0.11	0.04	0.04	-0.01	-0.08	-0.09
2	-0.15	-0.14	0.16	0.02	0.05	-0.02	-0.01	0.04	-0.07	-0.29
3	0.06	0.01	-0.21	-0.08	0.06	-0.03	0.12	0.04	0	-0.16
4	0.41	-0.05	-0.08	-0.47	0.08	0.06	0.03	0.03	0.11	-0.13
5	0.31	0.16	-0.24	-0.19	-0.22	0.02	0.33	0.14	0.15	0.02
6	0.19	0.01	-0.06	-0.43	-0.08	-0.25	0.39	0.17	-0.12	-0.27
7	0.5	0.02	-0.05	-0.42	-0.38	0.12	0.12	0.24	-0.26	-0.09
8	0.47	0.21	-0.44	-0.53	-0.25	0.19	0.56	-0.03	-0.26	0.08

Table 3.3.11 Icelandic cod division Va. TSA-results

Estimated with catch-at-age 4-11 years 1985-2006,

Bottom trawl survey, spring, 1-9 years, 1985-2007

STOCK (million fish)

	1	2	3	4	5	6	7	8	9	10	11	Biom.
1985	193.1	286.1	111.9	118.3	113.1	42.7	18.9	8.2	4.68	2.00	0.43	891.
1986	155.6	209.6	260.8	103.7	72.1	65.9	20.1	7.7	3.07	1.63	0.72	831.
1987	78.2	156.5	226.2	255.6	69.4	31.8	27.8	6.8	2.53	1.03	0.52	1017.
1988	92.2	73.5	166.3	229.8	152.7	32.9	11.5	9.3	1.95	0.76	0.32	1060.
1989	84.4	97.2	74.3	154.9	156.6	73.7	11.6	3.5	2.23	0.51	0.21	1085.
1990	107.9	83.0	99.9	67.4	87.1	99.4	32.8	4.6	1.22	0.73	0.18	826.
1991	97.5	108.9	79.2	102.9	42.6	44.5	43.7	11.6	1.67	0.41	0.25	692.
1992	45.7	102.1	115.3	77.2	61.8	20.8	16.8	14.3	4.00	0.54	0.12	545.
1993	89.4	46.9	106.5	121.2	40.8	26.9	6.8	4.8	4.29	1.45	0.18	552.
1994	146.7	94.1	47.5	110.2	69.7	19.3	10.1	2.4	1.38	1.21	0.44	570.
1995	57.3	144.7	98.7	49.4	66.9	42.0	10.3	4.3	0.92	0.52	0.48	543.
1996	105.0	58.5	144.6	106.7	33.0	37.2	24.8	5.3	2.11	0.45	0.24	640.
1997	50.9	112.4	60.2	144.2	79.2	21.4	18.7	13.0	2.28	0.99	0.21	796.
1998	138.8	49.9	117.3	61.4	101.8	52.9	12.4	8.3	5.49	0.94	0.41	731.
1999	125.2	146.5	44.8	126.5	47.9	56.8	26.4	5.4	3.14	1.91	0.35	738.
2000	143.3	128.8	149.1	42.6	91.9	26.4	22.7	10.7	2.03	1.14	0.69	579.
2001	143.2	129.9	125.7	148.2	31.4	48.6	11.8	7.7	3.73	0.75	0.41	697.
2002	46.3	147.7	129.2	126.4	95.6	19.8	21.8	5.0	2.64	1.34	0.27	740.
2003	134.2	46.6	148.5	128.3	86.1	51.3	11.5	10.5	2.38	1.01	0.54	749.
2004	103.2	131.3	45.4	151.1	93.4	48.1	24.7	5.8	4.85	1.03	0.42	821.
2005	63.9	96.7	126.7	45.2	111.2	51.3	22.1	11.1	2.61	2.08	0.44	703.
2006	114.7	57.5	90.0	122.0	36.1	64.1	25.7	10.4	4.78	1.12	0.88	675.
2007	106.3	112.6	52.5	87.0	88.2	22.6	29.7	11.7	4.79	2.04	0.48	**623.**

Standard deviation of log(Stock)

2006	0.093	0.077	0.078	0.078	0.071	0.071	0.074	0.081	0.100	0.132	0.162	35.
2007	0.120	0.091	0.088	0.098	0.106	0.110	0.120	0.129	0.136	0.175	0.198	43.

(Migration 6 years in 1990 15.8)

Fishing mortality rates

	4	5	6	7	8	9	10	11	F-bar 5-10
1985	0.254	0.440	0.633	0.747	0.805	0.813	0.814	0.813	0.709
1986	0.246	0.507	0.731	0.896	0.932	0.923	0.924	0.924	0.819
1987	0.309	0.545	0.766	0.928	1.016	1.015	1.010	1.016	0.880
1988	0.211	0.518	0.865	1.026	1.109	1.096	1.078	1.078	0.949
1989	0.223	0.427	0.635	0.789	0.855	0.855	0.860	0.868	0.737
1990	0.224	0.434	0.660	0.814	0.863	0.866	0.866	0.870	0.751
1991	0.304	0.522	0.746	0.895	0.924	0.933	0.944	0.935	0.827
1992	0.362	0.629	0.868	0.985	0.985	0.940	0.954	0.967	0.894
1993	0.350	0.550	0.766	0.903	1.001	1.027	1.017	1.016	0.877
1994	0.266	0.384	0.513	0.632	0.705	0.708	0.705	0.707	0.608
1995	0.220	0.324	0.422	0.520	0.557	0.570	0.579	0.580	0.495
1996	0.162	0.288	0.436	0.532	0.591	0.599	0.603	0.602	0.508
1997	0.134	0.274	0.433	0.577	0.658	0.683	0.677	0.675	0.550
1998	0.149	0.326	0.533	0.689	0.753	0.779	0.772	0.767	0.642
1999	0.188	0.408	0.629	0.756	0.804	0.802	0.801	0.805	0.700
2000	0.188	0.414	0.634	0.797	0.842	0.838	0.838	0.838	0.727
2001	0.205	0.388	0.584	0.727	0.815	0.827	0.825	0.821	0.694
2002	0.175	0.322	0.470	0.599	0.669	0.714	0.706	0.701	0.580
2003	0.151	0.321	0.494	0.606	0.643	0.654	0.655	0.653	0.562
2004	0.153	0.333	0.504	0.609	0.655	0.652	0.655	0.653	0.568
2005	0.136	0.296	0.456	0.569	0.631	0.647	0.642	0.641	0.540
2006	0.125	0.290	0.473	0.593	0.640	0.651	0.648	0.646	0.549

Standard deviations of logF and F-bar (not log(F-bar))

2005	0.081	0.064	0.067	0.069	0.075	0.082	0.084	0.085	0.033
2006	0.090	0.076	0.081	0.083	0.089	0.097	0.098	0.098	0.042

Table 3.3.12a Icelandic cod division Va. AD Model Builder Statistical Catch at Age Model (AD-CAM) diagnostics and results.

Input data and estimated parameters:

- The model used catch data from 1955 to 2005 and survey data from 1985 – 2006. 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. Time trend 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.
- Catchability in the survey was dependent on stock size 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 2nd 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.

Residuals from catch at age (C_ay) and survey indices (U_ay)

Table 3.3.12b. Catch at age residuals

Year/age	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1955			-0.122	-0.208	0.077	0.114	0.208	-0.115	-0.164	0.132	-0.099	-0.451	-0.204	0.000
1956			-0.026	-0.047	0.027	-0.006	-0.135	-0.199	-0.006	0.007	0.176	0.095	0.229	0.220
1957			0.092	0.018	-0.015	0.168	-0.133	0.092	0.063	-0.148	-0.098	-0.112	-0.380	0.522
1958			0.153	0.176	-0.265	-0.072	0.059	0.079	0.133	-0.231	0.233	0.001	-0.226	0.394
1959			-0.214	0.211	0.260	-0.243	-0.218	-0.061	-0.070	0.279	-0.263	0.381	-0.229	-0.400
1960			0.100	-0.356	0.141	0.188	0.063	0.074	-0.025	-0.113	-0.041	0.034	-0.639	0.907
1961			0.051	0.040	-0.403	0.118	-0.016	0.272	0.202	-0.142	0.087	-0.191	-0.974	0.832
1962			0.090	-0.007	0.125	-0.243	0.117	-0.296	0.091	0.260	-0.064	0.034	-0.401	0.700
1963			-0.057	0.296	-0.174	0.013	-0.031	-0.070	-0.376	0.209	0.349	0.063	0.072	-0.615
1964			-0.128	-0.016	0.126	-0.252	-0.118	0.377	-0.103	-0.456	-0.012	0.266	-0.159	0.007
1965			-0.033	-0.115	0.084	0.162	-0.129	0.049	0.472	-0.482	-0.056	-0.509	-0.362	0.636
1966			-0.043	-0.043	-0.180	0.095	-0.070	0.123	-0.347	0.591	-0.828	0.278	0.008	1.058
1967			0.190	-0.130	0.023	-0.200	0.025	-0.372	0.490	0.046	0.671	-0.726	-0.837	-0.182
1968			0.035	-0.021	-0.273	-0.120	0.232	0.157	-0.417	0.367	-0.124	0.599	-0.658	0.656
1969			-0.090	-0.027	0.152	-0.011	0.052	-0.150	-0.326	-0.246	-0.041	-0.259	-0.811	-0.142
1970			-0.096	0.135	-0.053	-0.137	0.053	-0.162	0.477	-0.582	-0.119	0.244	0.292	0.453
1971			-0.104	0.071	0.090	0.176	-0.185	0.283	-0.170	0.054	-0.452	-0.022	0.121	0.361
1972			-0.166	-0.126	0.069	-0.034	0.117	-0.052	-0.103	0.293	-0.070	0.169	0.523	-2.760
1973			0.274	-0.021	-0.098	0.027	-0.005	-0.241	0.086	0.173	0.158	-0.196	-1.253	-2.091
1974			-0.160	0.209	-0.020	-0.177	-0.006	-0.003	-0.222	0.288	0.013	0.184	-0.436	0.810
1975			0.187	-0.073	0.040	-0.053	0.030	-0.152	-0.209	-0.005	0.407	-0.017	-0.122	0.098
1976			0.095	0.002	-0.169	0.077	-0.092	0.252	-0.157	-0.155	0.058	0.271	-0.232	0.245
1977			-0.399	-0.065	0.046	-0.092	0.126	0.053	0.307	0.029	-0.700	-0.479	-1.223	-2.486
1978			0.081	-0.013	0.036	-0.096	0.043	-0.206	0.120	-0.187	0.019	-0.053	0.528	1.207
1979			0.154	0.097	-0.216	0.100	-0.047	0.031	-0.314	-0.078	0.047	-0.148	0.405	-0.196
1980			0.212	0.006	0.081	0.060	-0.010	-0.092	0.123	-0.487	0.297	0.093	0.150	-1.084
1981			-0.303	-0.205	0.079	-0.133	0.070	0.087	0.018	0.325	-0.074	0.595	-0.022	1.171
1982			0.009	0.150	0.074	-0.057	-0.219	0.191	0.173	0.135	-0.228	-0.874	0.046	-0.856
1983			-0.320	-0.358	0.111	0.145	0.038	0.011	-0.041	-0.029	0.008	0.368	-0.199	0.593
1984			0.349	0.026	-0.058	-0.046	-0.098	-0.008	0.055	-0.133	-0.346	0.163	0.710	0.110
1985			0.050	0.183	-0.102	0.120	-0.106	-0.024	-0.148	0.140	0.039	-0.346	0.472	0.479
1986			0.132	-0.104	0.018	-0.015	0.171	-0.056	0.110	-0.216	0.091	0.054	-0.594	0.193
1987			-0.161	0.110	0.034	-0.157	0.060	0.031	-0.038	0.112	-0.374	-0.111	0.126	-0.284
1988			-0.082	-0.074	-0.062	0.159	-0.090	0.066	0.150	0.026	0.490	0.014	0.554	0.141
1989			-0.196	0.046	0.135	-0.079	0.007	-0.159	-0.331	-0.096	-0.016	0.514	-0.020	-1.386
1990			-0.003	-0.114	-0.097	0.004	0.026	0.104	-0.092	-0.231	0.299	0.107	-0.210	0.100
1991			0.091	0.044	-0.098	-0.057	0.084	-0.087	0.122	-0.084	-0.307	0.393	-0.568	0.142
1992			-0.227	0.103	0.055	0.056	0.098	-0.013	-0.061	-0.058	-0.742	-0.778	-0.566	-0.131
1993			0.251	0.052	-0.170	-0.050	-0.066	-0.129	0.056	0.482	0.533	-0.213	-0.966	0.468
1994			0.051	0.235	-0.122	-0.168	-0.056	0.075	-0.205	-0.136	0.450	0.544	0.548	-0.334
1995			0.268	-0.015	0.081	-0.025	-0.028	-0.129	-0.129	-0.301	-0.188	0.738	1.163	0.675
1996			0.002	-0.059	-0.145	0.079	0.045	0.040	0.106	0.169	-0.365	-0.398	0.635	0.016
1997			-0.137	0.017	-0.027	-0.094	-0.109	0.222	0.181	0.221	0.423	-0.748	-0.211	0.215
1998			-0.189	-0.144	0.074	0.077	0.034	-0.172	0.231	0.043	0.075	0.263	0.160	-0.686
1999			-0.079	0.021	0.076	0.038	0.080	-0.012	-0.268	-0.176	-0.206	-0.407	-0.426	-0.827
2000			0.140	-0.216	0.106	0.000	-0.005	0.105	0.033	-0.131	0.070	0.208	-0.064	0.053
2001			0.196	0.156	-0.130	-0.009	0.035	-0.198	0.051	0.270	0.002	0.212	-0.383	0.126
2002			-0.029	0.080	0.001	-0.039	-0.048	0.011	-0.219	0.211	0.297	-0.317	0.500	-0.949
2003			-0.269	-0.001	-0.009	-0.044	0.191	0.001	0.205	-0.397	0.019	0.138	0.194	0.628
2004			-0.068	0.024	0.061	-0.052	-0.105	0.276	-0.010	0.206	-0.526	-0.066	0.279	-0.259
2005			0.155	-0.138	0.052	-0.043	-0.142	-0.102	0.334	0.070	0.397	0.083	0.080	-0.699
2006			0.005	-0.073	-0.018	0.037	0.008	-0.070	-0.128	0.195	0.095	0.241	-0.057	-1.474

Table 3.3.12c. Survey at age residuals

Year/age	1	2	3	4	5	6	7	8	9	10
1985	-0.302	0.098	0.156	0.385	0.181	0.304	0.486	0.273	0.386	0.554
1986	0.444	-0.041	-0.396	-0.266	-0.101	0.027	-0.118	-0.250	-0.220	-0.075
1987	0.423	0.025	0.084	-0.391	-0.035	-0.048	0.092	-0.037	-0.053	0.009
1988	-0.325	0.023	0.439	0.163	-0.084	-0.321	0.119	0.463	-0.113	-0.127
1989	0.208	0.036	0.445	0.515	0.195	0.122	-0.118	-0.112	0.149	0.075
1990	-0.462	0.106	-0.009	-0.038	-0.162	-0.164	0.038	-0.133	-0.009	0.108
1991	-0.298	-0.430	0.022	0.088	0.207	0.063	0.182	-0.155	0.211	0.257
1992	-0.479	-0.004	-0.243	0.042	-0.134	-0.098	-0.122	-0.120	-0.107	0.022
1993	-0.588	-0.061	0.088	-0.077	0.010	-0.036	-0.195	-0.150	-0.243	-0.285
1994	0.497	-0.276	-0.067	0.018	-0.199	-0.283	-0.137	-0.191	-0.146	-0.127
1995	-0.384	0.114	-0.303	-0.160	0.115	0.022	-0.145	-0.046	-0.025	-0.243
1996	-0.680	-0.127	0.030	-0.182	0.145	-0.026	0.313	0.444	0.234	0.043
1997	-0.038	-0.066	0.064	0.237	-0.052	-0.007	0.000	0.300	-0.280	0.018
1998	-0.158	0.118	-0.253	0.045	0.505	0.303	0.155	0.234	0.493	0.467
1999	-0.051	0.128	-0.113	0.006	-0.076	0.096	0.066	0.031	0.006	0.050
2000	0.818	0.142	0.175	-0.267	-0.095	-0.164	-0.164	0.018	-0.199	-0.255
2001	0.123	-0.075	-0.033	-0.173	-0.502	-0.192	-0.297	-0.522	-0.333	0.021
2002	-0.103	0.167	0.055	0.032	0.015	-0.094	-0.124	-0.220	-0.403	-0.200
2003	0.397	0.071	-0.076	-0.051	-0.014	-0.094	-0.052	0.065	0.261	-0.479
2004	0.336	0.090	0.057	0.156	0.031	0.202	0.211	0.246	0.478	0.324
2005	0.249	0.027	0.066	0.028	0.025	0.096	0.032	0.060	0.137	0.202
2006	0.292	0.035	-0.059	-0.019	0.084	0.103	-0.105	-0.288	-0.325	-0.181
2007	0.011	-0.051	-0.206	-0.220	-0.180	0.038	-0.296	-0.052	0.055	-0.172

Table 3.3.13 Icelandic cod division Va. Comparison of results from various assessment methods using the spring groundfish survey.

Estimated fishing mortality rate in 2006:

Age	XSA	TSA	AD-CAM	ADAPT	X-CAM	Est 2006	Difference
3	0.03		0.03	0.03	0.04	0.03	-2.0%
4	0.12	0.13	0.13	0.12	0.15	0.13	2.1%
5	0.28	0.29	0.30	0.27	0.28	0.28	8.2%
6	0.48	0.47	0.47	0.48	0.41	0.41	13.0%
7	0.52	0.59	0.56	0.57	0.49	0.50	11.4%
8	0.58	0.64	0.63	0.57	0.55	0.57	9.9%
9	0.69	0.65	0.73	0.73	0.54	0.65	11.5%
10	0.84	0.65	0.85	0.97	0.53	0.70	18.1%
11	0.80	0.65	0.84	1.15	0.53	0.66	21.4%
12	1.06		0.88	1.78		0.67	23.9%
13	1.63		0.84	1.82		0.61	27.2%
14	1.10		0.84	1.08		0.61	27.2%
F(5-10)	**0.57**	**0.55**	**0.59**	**0.60**	**0.47**	**0.52**	

Estimated stock in numbers (millions) in 2007:

Age	XSA	TSA	AD-CAM	ADAPT	X-CAM	Est 2006	Difference
1	218.034	193.691	202.025	211.137	208.2284		
2	194.469	167.979	177.663	184.765	180.13102		
3	91.138	64.124	80.932	82.293	81.053	87.346	-7.9%
4	103.820	87.000	98.009	98.077	95.781	101.205	-3.3%
5	93.013	88.200	87.953	91.309	88.159	93.888	-6.7%
6	23.904	22.600	21.660	24.461	22.823	21.228	2.0%
7	32.239	29.700	31.611	32.550	35.821	35.070	-10.9%
8	13.713	11.700	12.211	12.397	14.369	13.762	-12.7%
9	5.164	4.790	4.916	5.288	6.166	5.598	-13.9%
10	1.987	2.040	2.050	1.858	2.913	2.363	-15.3%
11	0.343	0.480	0.270	0.274	1.087	0.316	-17.2%
12	0.248		0.207	0.140		0.256	-23.8%
13	0.032		0.033	0.012		0.044	-32.4%
14	0.006		0.019	0.005		0.028	-44.3%

Recruitment:

Yearcl.	XSA	TSA	AD-CAM	ADAPT	X-CAM	Est 2006	Difference
2002	162	149	155	159	158	166	-7.6%
2003	130	106	123	123	121	125	-1.1%
2004	91	64	81	82	81	86	-6.7%
2005	160	138	145	151	147	174	-19.3%
2006	176	130	135	142	140		

Estimated stock in weight (4+, Thous. tonnes) in 1991-2007

Year	XSA	TSA	AD-CAM	ADAPT	X-CAM	Est 2006	Difference
1993	588	552	589	588	607	590	0.0%
1994	585	570	574	585	595	574	0.0%
1995	563	543	553	563	573	553	0.0%
1996	688	640	668	688	678	668	0.0%
1997	805	796	783	805	805	784	-0.1%
1998	739	731	717	739	741	718	-0.1%
1999	751	738	730	750	749	730	0.0%
2000	603	579	588	602	606	586	0.3%
2001	697	697	693	694	707	691	0.2%
2002	729	740	729	725	739	727	0.4%
2003	746	749	740	737	755	735	0.6%
2004	820	821	807	812	841	815	-0.9%
2005	718	703	703	712	742	714	-1.6%
2006	703	675	675	694	721	756	-11.9%
2007	**688**	**623**	**649**	**670**	**693**	**747**	-15.1%

Table 3.3.13b. Comparison between ADCAM 2006 and 2007 estimates

ADCAM 2006 estimates

Age	Na,06	Na,07	Wa,06	Wa,07	Ba06	Ba07
1						
2						
3	127.211	88.000	1.193	1.193	152	105
4	130.625	101.351	1.709	1.709	223	173
5	34.359	93.883	2.377	2.377	82	223
6	64.264	21.126	3.440	3.440	221	73
7	27.396	34.692	4.399	4.399	121	153
8	11.928	13.551	5.211	5.211	62	71
9	5.473	5.497	6.211	6.211	34	34
10	0.769	2.317	5.496	5.496	4	13
11	0.593	0.309	7.213	7.213	4	2
12	0.102	0.254	9.946	9.946	1	3
13	0.061	0.044	12.947	12.947	1	1
14	0.020	0.026	18.147	18.147	0	0
				B4+ 2006 weights	**753**	**745**
				B4+ 2007 weights	702	691

ADCAM 2007 estimates

Age	Na,06	Na,07	Wa,06	Wa,07	Ba06	Ba07
1						
2						
3	123.269	80.929	1.070	1.117	132	90
4	122.658	97.997	1.614	1.629	198	160
5	35.877	87.928	2.185	2.229	78	196
6	61.839	21.649	3.052	2.810	189	61
7	26.205	31.588	4.347	3.922	114	124
8	11.298	12.203	5.177	5.151	58	63
9	5.219	4.912	5.382	6.193	28	30
10	0.774	2.048	5.769	5.819	4	12
11	0.585	0.269	6.258	6.201	4	2
12	0.098	0.207	5.688	6.508	1	1
13	0.055	0.033	7.301	6.751	0	0
14	0.017	0.019	15.412	6.944	0	0
				B4+ 2006 weights	725	700
				B4+ 2007 weights	**675**	**649**

ADCAM 2007 minus 2006 estimates

Age	Na,06	Na,07	Wa,06	Wa,07	Ba06	Ba07
1						
2						
3	-3.942	-7.071	-0.123	-0.076	-19.865	-14.551
4	-7.967	-3.354	-0.095	-0.080	-25.268	-13.527
5	1.518	-5.955	-0.192	-0.148	-3.280	-27.211
6	-2.425	0.522	-0.388	-0.630	-32.334	-11.834
7	-1.191	-3.104	-0.052	-0.477	-6.603	-28.737
8	-0.630	-1.348	-0.034	-0.060	-3.669	-7.751
9	-0.254	-0.585	-0.829	-0.018	-5.906	-3.722
10	0.005	-0.269	0.273	0.323	0.237	-0.818
11	-0.008	-0.040	-0.955	-1.012	-0.618	-0.559
12	-0.004	-0.048	-4.258	-3.438	-0.458	-1.187
13	-0.006	-0.011	-5.646	-6.196	-0.390	-0.345
14	-0.003	-0.007	-2.735	-11.203	-0.105	-0.343
				B4+	-78	-96
				Vegna þyndgar	-50	-51
				Vegna fjölda	-29	-45

Table 3.3.14 Icelandic cod division Va. Estimates of fishing mortality 1955-2006 using final F from AD-CAM using catch at age and spring trawl survey indices and predictions for 2007-2009.

Year/age	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1955			0.04	0.17	0.25	0.27	0.30	0.30	0.28	0.33	0.33	0.31	0.33	0.33
1956			0.05	0.18	0.25	0.26	0.29	0.30	0.30	0.34	0.36	0.34	0.33	0.33
1957			0.08	0.21	0.27	0.27	0.30	0.33	0.33	0.36	0.37	0.33	0.30	0.30
1958			0.11	0.25	0.30	0.29	0.32	0.37	0.40	0.44	0.45	0.39	0.33	0.33
1959			0.09	0.23	0.28	0.26	0.30	0.34	0.35	0.40	0.38	0.32	0.23	0.23
1960			0.10	0.23	0.29	0.29	0.34	0.40	0.43	0.48	0.48	0.39	0.27	0.27
1961			0.09	0.23	0.26	0.26	0.33	0.40	0.42	0.46	0.44	0.35	0.23	0.23
1962			0.11	0.25	0.28	0.26	0.35	0.42	0.47	0.51	0.49	0.38	0.24	0.24
1963			0.13	0.28	0.33	0.31	0.38	0.49	0.59	0.65	0.63	0.46	0.29	0.29
1964			0.13	0.29	0.37	0.36	0.43	0.57	0.74	0.81	0.84	0.61	0.39	0.39
1965			0.12	0.28	0.38	0.40	0.47	0.60	0.74	0.85	0.88	0.66	0.43	0.43
1966			0.09	0.25	0.34	0.38	0.49	0.62	0.78	0.92	1.01	0.79	0.53	0.53
1967			0.08	0.23	0.30	0.34	0.48	0.61	0.75	0.88	0.93	0.73	0.46	0.46
1968			0.08	0.25	0.34	0.41	0.58	0.77	1.04	1.20	1.36	1.08	0.74	0.74
1969			0.06	0.23	0.32	0.35	0.50	0.61	0.72	0.84	0.87	0.72	0.45	0.45
1970			0.07	0.27	0.39	0.43	0.55	0.65	0.76	0.89	0.95	0.80	0.52	0.52
1971			0.09	0.31	0.48	0.53	0.62	0.72	0.80	0.96	1.04	0.89	0.58	0.58
1972			0.09	0.30	0.48	0.55	0.65	0.73	0.79	0.96	1.06	0.92	0.61	0.61
1973			0.12	0.32	0.49	0.56	0.67	0.75	0.80	0.95	1.04	0.91	0.60	0.60
1974			0.11	0.32	0.50	0.58	0.70	0.83	0.92	1.06	1.18	1.03	0.70	0.70
1975			0.11	0.31	0.50	0.60	0.72	0.88	1.02	1.13	1.26	1.11	0.78	0.78
1976			0.07	0.26	0.43	0.55	0.70	0.85	0.95	1.01	1.07	0.95	0.66	0.66
1977			0.03	0.20	0.33	0.43	0.61	0.72	0.73	0.74	0.70	0.63	0.41	0.41
1978			0.03	0.17	0.28	0.35	0.53	0.60	0.55	0.55	0.49	0.45	0.28	0.28
1979			0.03	0.17	0.27	0.34	0.50	0.57	0.50	0.49	0.42	0.40	0.25	0.25
1980			0.03	0.17	0.31	0.39	0.54	0.62	0.56	0.55	0.47	0.44	0.30	0.30
1981			0.02	0.18	0.35	0.49	0.65	0.82	0.85	0.82	0.75	0.70	0.53	0.53
1982			0.03	0.19	0.39	0.56	0.70	0.90	0.96	0.87	0.75	0.68	0.52	0.52
1983			0.02	0.18	0.38	0.55	0.71	0.88	0.92	0.86	0.74	0.68	0.54	0.54
1984			0.04	0.20	0.38	0.53	0.67	0.81	0.76	0.71	0.60	0.57	0.44	0.44
1985			0.05	0.23	0.42	0.58	0.71	0.83	0.77	0.71	0.60	0.57	0.45	0.45
1986			0.06	0.26	0.52	0.71	0.83	0.96	0.88	0.77	0.66	0.63	0.50	0.50
1987			0.06	0.27	0.55	0.81	0.91	1.06	1.00	0.86	0.75	0.71	0.59	0.59
1988			0.05	0.26	0.52	0.79	0.92	1.10	1.09	0.95	0.88	0.85	0.74	0.74
1989			0.04	0.24	0.46	0.65	0.80	0.90	0.80	0.73	0.65	0.64	0.53	0.53
1990			0.05	0.25	0.47	0.66	0.79	0.86	0.75	0.69	0.62	0.62	0.50	0.50
1991			0.09	0.30	0.56	0.80	0.89	0.95	0.85	0.78	0.71	0.71	0.60	0.60
1992			0.10	0.32	0.59	0.86	0.93	1.01	0.90	0.81	0.75	0.73	0.63	0.63
1993			0.14	0.31	0.55	0.79	0.89	1.03	1.04	0.95	0.90	0.89	0.80	0.80
1994			0.09	0.24	0.38	0.53	0.68	0.76	0.72	0.71	0.65	0.66	0.57	0.57
1995			0.06	0.20	0.32	0.42	0.57	0.62	0.56	0.58	0.52	0.54	0.46	0.46
1996			0.04	0.16	0.28	0.41	0.56	0.62	0.58	0.60	0.55	0.56	0.48	0.48
1997			0.03	0.15	0.27	0.42	0.59	0.67	0.66	0.69	0.64	0.65	0.58	0.58
1998			0.03	0.15	0.33	0.51	0.67	0.78	0.84	0.86	0.82	0.83	0.77	0.77
1999			0.05	0.18	0.39	0.64	0.74	0.85	0.93	0.93	0.90	0.90	0.85	0.85
2000			0.06	0.18	0.39	0.62	0.75	0.87	0.97	0.99	0.96	0.97	0.93	0.93
2001			0.07	0.19	0.38	0.58	0.70	0.84	0.98	1.03	1.02	1.03	1.00	1.00
2002			0.04	0.17	0.34	0.49	0.61	0.71	0.83	0.90	0.87	0.89	0.85	0.85
2003			0.03	0.15	0.34	0.49	0.59	0.66	0.73	0.81	0.78	0.81	0.76	0.76
2004			0.03	0.15	0.34	0.52	0.60	0.67	0.75	0.83	0.80	0.83	0.78	0.78
2005			0.03	0.14	0.31	0.47	0.57	0.64	0.73	0.83	0.81	0.85	0.80	0.80
2006			0.03	0.13	0.30	0.47	0.56	0.63	0.73	0.85	0.84	0.88	0.84	0.84
2007			0.03	0.15	0.32	0.48	0.58	0.65	0.74	0.83	0.81	0.84	0.79	0.79
2008			0.03	0.12	0.27	0.40	0.49	0.55	0.62	0.70	0.68	0.71	0.67	0.67
2009			0.03	0.12	0.27	0.40	0.48	0.54	0.62	0.69	0.67	0.70	0.66	0.66

Table 3.3.15 Icelandic cod, division Va. Estimates of numbers at age in stock in 1955-2007 using final F from AD-CAM using catch at age and spring trawl survey indices and predictions for 2008-2009.

Year/age	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1955	254.594	186.679	152.002	217.646	211.955	115.411	36.0072	24.5308	12.9193	87.1777	9.16193	7.77063	8.07963	2.62637
1956	329.259	208.444	152.840	119.564	150.298	134.755	71.797	21.785	14.815	7.965	51.542	5.417	4.666	4.777
1957	431.378	269.575	170.659	118.917	81.587	95.879	85.171	43.983	13.161	9.028	4.624	29.533	3.166	2.733
1958	230.275	353.182	220.709	128.832	78.542	50.804	59.820	51.623	35.149	7.765	5.134	2.627	17.322	1.920
1959	287.698	188.533	289.161	161.175	82.276	47.548	31.100	35.431	51.601	19.329	4.093	2.693	1.459	10.230
1960	192.265	235.547	154.358	216.196	104.517	50.795	30.122	18.887	20.616	37.475	10.610	2.284	1.598	0.948
1961	264.833	157.413	192.850	114.276	140.206	63.728	31.067	17.590	10.390	10.997	19.037	5.396	1.269	0.996
1962	304.642	216.827	128.879	143.750	74.707	88.572	40.165	18.222	23.599	5.598	5.685	10.030	3.111	0.827
1963	322.940	249.420	177.523	94.380	91.839	46.152	55.715	23.257	9.764	12.113	2.743	2.857	5.619	2.002
1964	341.931	264.401	204.208	127.675	58.231	54.168	27.745	31.102	11.641	4.447	5.196	1.201	1.472	3.453
1965	477.827	279.950	216.473	147.438	78.194	32.866	30.928	14.709	14.397	4.547	1.619	1.845	0.534	0.816
1966	256.434	391.212	229.203	157.061	90.861	43.575	17.980	15.807	6.596	5.599	1.593	0.550	0.784	0.285
1967	369.404	209.950	320.297	170.796	99.798	52.885	24.358	9.010	6.947	2.474	1.834	0.476	0.205	0.376
1968	269.237	302.442	171.893	242.879	111.213	60.335	30.880	12.294	4.009	2.688	0.841	0.593	0.189	0.106
1969	281.404	220.433	247.619	130.337	155.390	64.696	32.938	41.226	4.683	1.165	0.662	0.177	0.164	0.074
1970	207.614	230.394	180.475	191.724	84.592	92.159	37.177	32.911	18.371	1.868	0.413	0.227	0.071	0.086
1971	407.500	169.980	188.631	137.952	119.868	46.917	49.277	17.539	14.062	7.030	0.627	0.131	0.083	0.034
1972	266.956	333.633	139.168	141.371	82.919	60.804	22.549	21.693	23.264	5.173	2.209	0.182	0.044	0.038
1973	389.218	218.565	273.155	104.385	85.594	42.025	28.623	9.642	8.562	8.631	1.621	0.626	0.060	0.020
1974	549.350	318.665	178.946	198.600	62.021	42.995	19.566	12.017	3.712	3.152	2.721	0.468	0.207	0.027
1975	213.706	449.769	260.901	130.803	117.522	30.826	19.802	7.957	4.281	1.210	0.897	0.684	0.136	0.084
1976	338.479	174.968	368.240	191.696	78.576	58.233	13.841	7.872	2.689	1.260	0.320	0.209	0.185	0.051
1977	364.184	277.123	143.251	282.143	121.225	41.941	27.457	5.652	2.746	0.852	0.375	0.090	0.066	0.078
1978	208.505	298.169	226.889	113.766	190.021	71.388	22.377	12.216	2.249	1.084	0.332	0.153	0.039	0.036
1979	210.078	170.709	244.120	180.767	78.276	117.456	41.020	10.835	5.474	1.065	0.512	0.167	0.080	0.024
1980	196.831	171.997	139.765	194.306	124.766	48.711	71.787	20.311	5.030	2.726	0.533	0.275	0.092	0.051
1981	347.558	161.151	140.820	111.254	133.551	75.210	27.107	47.156	8.939	2.355	1.291	0.273	0.145	0.056
1982	206.912	284.557	131.940	112.705	76.388	76.829	37.779	11.599	17.001	3.117	0.848	0.497	0.111	0.070
1983	205.671	169.405	232.975	105.085	76.148	42.164	36.029	15.357	3.861	5.307	1.064	0.328	0.206	0.054
1984	496.758	168.389	138.697	186.324	71.986	42.808	19.851	14.559	5.196	1.257	1.840	0.416	0.135	0.099
1985	393.547	406.711	137.865	109.257	124.881	40.467	20.682	8.285	5.325	1.992	0.507	0.827	0.193	0.071
1986	260.510	322.209	332.987	107.329	71.046	67.082	18.639	8.289	2.948	2.018	0.806	0.228	0.382	0.101
1987	129.800	213.288	263.802	256.304	67.585	34.719	26.963	6.687	2.609	1.001	0.761	0.340	0.100	0.189
1988	194.158	106.271	174.625	204.321	159.803	31.810	12.648	8.918	1.894	0.786	0.348	0.295	0.137	0.045
1989	155.531	158.963	87.008	136.393	129.179	77.569	11.849	4.124	2.418	0.523	0.249	0.119	0.104	0.053
1990	258.268	127.338	130.148	68.376	87.620	100.448	33.099	4.380	1.378	0.887	0.207	0.107	0.051	0.050
1991	203.558	211.452	104.256	101.320	43.562	44.891	42.608	12.303	1.520	0.533	0.364	0.092	0.047	0.025
1992	113.326	166.659	173.122	78.310	61.336	20.369	16.448	14.396	3.899	0.533	0.200	0.146	0.037	0.021
1993	226.646	92.783	136.449	127.917	46.518	27.770	7.067	5.339	4.307	1.295	0.193	0.078	0.057	0.016
1994	247.799	185.562	75.964	97.338	76.497	21.956	10.287	2.378	1.557	1.252	0.412	0.064	0.026	0.021
1995	127.752	202.880	151.925	56.914	62.522	42.682	10.597	4.273	0.907	0.619	0.505	0.176	0.027	0.012
1996	241.959	104.594	166.104	116.953	38.277	37.237	22.925	4.891	1.876	0.424	0.284	0.245	0.084	0.014
1997	102.039	198.099	85.635	131.171	81.523	23.673	20.279	10.706	2.151	0.862	0.190	0.134	0.114	0.042
1998	262.389	83.543	162.190	68.328	92.834	50.766	12.770	9.242	4.501	0.907	0.352	0.082	0.057	0.053
1999	238.630	214.826	68.399	129.017	47.919	54.820	24.839	5.365	3.482	1.598	0.315	0.127	0.029	0.022
2000	239.681	195.374	175.885	53.533	88.379	26.563	23.704	9.660	1.872	1.120	0.515	0.105	0.042	0.010
2001	276.260	196.234	159.958	135.772	36.472	48.894	11.714	9.188	3.329	0.582	0.342	0.161	0.033	0.014
2002	94.806	226.183	160.663	122.555	91.871	20.345	22.449	4.747	3.257	1.022	0.170	0.101	0.047	0.010
2003	230.736	77.621	185.183	126.026	84.963	53.423	10.251	9.985	1.919	1.166	0.340	0.058	0.034	0.016
2004	183.916	188.911	63.551	146.950	88.609	49.733	26.745	4.651	4.232	0.753	0.423	0.128	0.021	0.013
2005	120.736	150.578	154.667	50.312	103.438	51.417	24.314	12.037	1.954	1.641	0.268	0.156	0.046	0.008
2006	216.998	98.851	123.283	122.687	35.890	61.865	26.216	11.302	5.221	0.774	0.585	0.098	0.055	0.017
2007	202.025	177.663	80.932	98.009	87.953	21.660	31.611	12.211	4.916	2.050	0.270	0.207	0.033	0.019
2008	184.757	165.404	145.458	64.098	69.336	52.078	10.957	14.519	5.214	1.914	0.729	0.098	0.073	0.012
2009	190.128	151.266	135.422	115.812	46.412	43.227	28.441	5.517	6.877	2.286	0.777	0.303	0.040	0.031
2010	193.225	155.664	123.846	107.850	83.957	29.011	23.699	14.389	2.627	3.032	0.934	0.325	0.123	0.017

Table 3.3.16 Icelandic cod, division Va. Estimates of spawning stock biomass (SSB) by age in 1955-2007 using final F from AD-CAM using catch at age and spring trawl survey indices and predictions for 2008-2009.

Year/age	3	4	5	6	7	8	9	10	11	12	13	14	SSB
1955	1.766	4.501	11.454	58.310	72.678	90.372	59.398	420.401	65.259	56.289	66.367	31.194	937.989
1956	1.774	3.434	8.258	38.035	145.962	79.886	61.878	43.925	276.794	40.762	41.480	50.169	792.356
1957	1.976	3.775	6.679	23.698	160.907	173.042	64.646	51.871	30.665	198.635	27.011	29.672	772.576
1958	2.548	4.633	15.810	91.515	152.603	198.600	153.139	49.634	33.608	18.358	131.977	20.464	872.889
1959	3.345	6.485	12.719	89.221	100.104	146.517	228.797	107.249	27.596	19.047	12.409	98.276	851.765
1960	1.784	6.881	15.138	104.416	99.194	81.695	92.124	200.669	64.093	18.492	13.479	10.197	708.163
1961	2.230	3.400	15.212	96.189	98.858	72.558	46.785	60.796	10.896	36.949	10.655	12.366	466.893
1962	1.488	4.106	7.055	75.154	134.787	79.996	101.139	29.133	31.982	65.919	28.757	8.997	568.514
1963	2.047	2.745	8.675	31.753	147.009	102.972	46.720	64.418	15.930	19.825	46.238	19.191	507.521
1964	2.355	4.091	5.441	53.907	82.616	123.043	52.840	28.561	30.561	9.341	14.724	43.354	450.832
1965	2.498	3.974	6.645	35.350	88.859	56.855	57.560	24.810	12.458	13.427	4.222	10.897	317.554
1966	2.651	4.862	7.869	53.650	57.196	67.116	28.740	29.516	8.516	5.114	8.144	3.769	277.143
1967	3.710	6.199	10.154	55.550	73.572	43.067	30.765	13.045	10.179	3.233	2.227	4.711	256.410
1968	1.991	6.851	11.292	51.400	72.130	39.626	14.714	12.229	4.495	3.892	1.844	1.130	221.594
1969	2.873	4.701	12.369	41.740	79.055	141.104	18.633	6.206	3.626	1.203	1.441	0.743	313.694
1970	2.092	4.519	6.212	58.204	79.795	101.681	62.258	9.718	2.617	1.811	0.765	1.389	331.061
1971	2.182	3.801	7.358	7.396	106.615	44.335	39.341	26.119	3.084	0.899	0.876	0.424	242.430
1972	1.610	3.337	4.603	14.885	29.025	64.970	74.129	18.588	8.650	0.983	0.366	0.432	221.576
1973	3.650	2.908	24.690	40.933	64.124	32.279	30.945	35.012	6.940	3.072	0.434	0.240	245.225
1974	2.175	7.369	9.154	40.126	42.258	41.809	13.308	13.897	12.067	2.658	1.743	0.269	186.833
1975	3.172	5.688	27.521	23.311	49.566	27.828	15.879	5.759	4.128	3.746	0.901	0.605	168.103
1976	5.617	6.282	13.019	42.944	18.490	27.665	11.281	7.111	2.112	1.444	1.799	0.573	138.335
1977	1.666	9.272	15.481	48.077	78.939	21.264	11.937	5.535	2.991	0.913	0.901	1.467	198.442
1978	3.472	3.750	21.828	40.858	65.409	49.834	12.452	8.619	3.277	1.402	0.621	0.633	212.153
1979	2.839	5.344	8.280	100.143	100.966	42.916	28.499	6.855	5.234	1.769	0.909	0.410	304.164
1980	2.224	5.461	12.010	30.837	169.888	79.898	24.568	20.936	4.982	3.531	1.136	0.799	356.269
1981	1.638	2.905	6.708	16.147	35.972	137.022	35.517	13.723	9.630	2.374	1.338	0.793	263.767
1982	1.696	3.130	4.780	11.005	30.958	28.271	55.600	17.269	6.745	4.862	1.422	0.860	166.598
1983	2.710	3.621	5.998	10.498	25.182	28.842	11.923	26.663	7.718	3.144	2.410	0.735	129.445
1984	1.612	5.523	7.297	18.550	25.212	35.006	18.376	7.974	14.077	4.099	1.593	1.267	140.585
1985	0.000	2.879	34.642	36.236	25.603	25.645	16.466	13.971	4.422	8.787	2.391	1.042	172.084
1986	0.239	3.577	25.534	66.280	40.418	23.458	13.013	11.590	5.715	2.458	4.157	1.131	197.571
1987	0.288	12.134	12.628	32.949	43.602	22.150	8.875	5.852	5.307	2.446	1.137	1.712	149.081
1988	0.606	7.936	67.928	40.134	16.675	21.452	7.183	3.967	2.119	1.804	1.293	0.395	171.492
1989	0.444	4.639	36.371	77.610	25.143	11.915	7.988	3.431	2.086	0.751	0.830	0.634	171.842
1990	0.416	0.772	24.957	96.166	59.827	14.864	6.629	6.333	1.616	1.103	0.602	0.647	213.933
1991	0.000	6.441	10.956	34.117	62.542	34.686	4.764	2.886	2.401	0.893	0.479	0.366	160.531
1992	0.202	5.824	27.952	18.298	33.524	45.147	14.728	2.793	1.693	1.312	0.410	0.169	152.052
1993	0.545	13.322	23.797	31.355	13.630	15.686	15.702	6.561	1.304	0.607	0.550	0.177	123.235
1994	0.486	16.847	50.557	35.257	23.928	9.301	5.652	6.442	3.066	0.574	0.281	0.268	152.659
1995	0.536	9.313	49.490	60.287	27.337	15.629	4.487	4.587	4.127	1.471	0.272	0.142	177.678
1996	0.214	5.873	15.730	55.315	48.876	15.620	8.144	2.953	2.192	2.372	0.840	0.173	158.301
1997	0.327	6.058	40.409	31.611	55.408	38.247	8.803	4.684	1.433	0.986	0.860	0.391	189.215
1998	0.000	5.845	38.481	66.432	32.937	39.443	18.244	4.934	2.430	0.779	0.629	0.647	210.799
1999	0.553	7.671	19.107	66.734	45.705	18.645	12.722	9.572	2.167	0.982	0.277	0.209	184.344
2000	0.100	4.339	36.227	31.034	44.717	32.171	8.747	6.003	3.169	0.704	0.338	0.109	167.658
2001	0.400	8.318	17.051	62.187	26.389	29.273	12.854	3.031	1.755	0.894	0.216	0.111	162.477
2002	0.767	15.471	58.396	34.308	51.147	19.434	8.966	5.573	1.113	0.841	0.269	0.105	196.391
2003	0.791	7.179	35.909	68.784	28.227	28.631	6.611	5.868	1.963	0.403	0.272	0.150	184.790
2004	0.000	7.511	39.961	68.157	47.607	15.029	13.504	3.528	2.972	0.946	0.191	0.110	199.516
2005	0.792	5.694	48.692	62.352	57.091	36.724	7.752	5.712	1.251	0.982	0.383	0.094	227.519
2006	0.211	3.625	18.593	66.611	66.204	36.685	13.988	2.826	2.333	0.348	0.255	0.165	211.844
2007	0.829	3.673	24.821	23.048	68.140	35.790	17.513	7.317	1.000	0.858	0.146	0.088	183.222
2008	0.870	4.146	30.538	54.532	26.298	46.261	19.427	7.454	3.032	0.435	0.341	0.059	193.393
2009	0.810	7.493	20.455	45.316	68.386	17.620	25.693	8.928	3.243	1.342	0.186	0.148	199.619
2010	0.740	6.981	37.064	30.504	57.248	46.224	9.887	11.943	3.929	1.453	0.581	0.082	206.636

Table 3.3.17 Icelandic cod, division Va. Stock weight at age in stock in 1955-2006 using final F from AD-CAM using catch at age and spring trawl survey indices and predictions for 2006-2008.

Year/age	3	4	5	6	7	8	9	10	11	12	13	14	B4+
1955	125.706	284.463	457.187	417.442	167.001	138.771	85.720	537.712	80.130	68.607	81.491	38.303	2356.827
1956	165.067	191.302	329.153	441.996	333.857	122.647	91.554	55.516	352.030	50.322	51.163	61.880	2081.419
1957	194.551	203.348	205.599	306.812	388.380	262.138	94.366	65.540	38.379	244.825	32.773	36.002	1878.162
1958	267.058	233.186	245.050	229.128	299.098	306.638	233.389	64.372	43.687	23.219	162.138	25.141	1865.045
1959	320.969	314.291	241.070	214.918	171.672	218.609	341.085	137.816	34.835	23.351	14.565	115.353	1827.566
1960	163.619	371.857	305.190	235.687	170.489	123.710	142.454	267.568	84.560	23.387	16.136	12.206	1753.245
1961	196.707	190.841	378.556	275.944	171.799	110.993	71.999	80.388	142.776	45.918	12.489	14.495	1496.199
1962	127.590	231.438	194.986	345.430	229.746	121.358	159.293	39.521	42.868	83.051	33.906	10.609	1492.204
1963	221.904	155.727	242.454	175.378	284.701	160.936	76.551	92.179	22.573	25.995	55.738	23.133	1315.366
1964	247.092	223.431	153.731	217.754	151.210	200.918	93.127	44.199	47.854	13.138	18.645	54.900	1218.907
1965	220.802	225.580	200.958	134.422	167.320	94.135	102.505	39.104	19.925	19.301	5.442	14.045	1022.736
1966	268.168	263.862	235.331	182.141	103.023	109.071	51.646	48.037	14.477	7.825	11.046	5.113	1031.573
1967	358.733	310.849	265.463	215.083	135.430	70.187	54.466	20.853	16.668	4.804	2.919	6.174	1102.895
1968	201.115	386.178	298.051	237.116	155.636	72.656	30.110	22.796	9.044	6.865	2.763	1.693	1222.906
1969	272.381	235.910	385.367	243.902	166.009	241.582	32.782	9.729	5.776	1.781	1.875	0.966	1325.679
1970	178.670	278.000	206.403	347.439	180.680	183.974	115.004	15.636	4.330	2.794	1.030	1.871	1337.161
1971	205.608	216.585	276.895	139.813	242.934	90.324	78.468	44.291	5.345	1.468	1.226	0.589	1097.938
1972	136.385	206.402	183.250	197.613	97.637	121.695	140.515	31.552	15.173	1.630	0.517	0.607	996.591
1973	281.350	148.227	211.418	151.290	140.255	58.910	57.111	58.261	12.047	4.977	0.606	0.335	843.437
1974	187.893	339.606	150.710	164.240	102.524	80.033	26.542	24.460	22.285	4.575	2.563	0.395	917.932
1975	286.991	231.521	326.711	115.907	107.923	53.233	32.410	10.378	7.899	6.687	1.375	0.923	894.968
1976	497.124	341.219	208.226	238.755	70.171	52.976	22.184	12.111	3.693	2.390	2.594	0.827	955.146
1977	180.353	539.175	346.219	170.657	158.617	37.506	21.104	8.285	4.391	1.299	1.153	1.877	1290.283
1978	292.460	208.533	556.572	282.339	128.130	83.141	20.331	11.780	4.343	1.828	0.748	0.762	1298.506
1979	343.721	353.580	206.806	469.707	227.581	73.176	45.429	9.916	6.723	2.246	1.077	0.485	1396.726
1980	194.553	361.798	340.985	183.544	377.527	141.790	40.427	29.254	6.556	4.760	1.375	0.967	1488.982
1981	166.168	183.680	301.825	247.665	121.519	274.492	69.175	22.192	14.680	3.484	1.809	1.072	1241.594
1982	132.732	174.693	171.568	238.478	160.864	62.472	113.597	28.491	10.144	7.074	1.916	1.159	970.456
1983	255.108	168.031	173.236	127.376	147.575	84.171	27.215	43.137	11.718	4.579	3.271	0.998	791.307
1984	178.642	321.409	186.876	153.296	86.767	84.414	38.743	12.385	20.336	5.968	2.069	1.645	913.908
1985	193.976	215.346	321.693	147.705	102.913	52.791	43.699	20.562	6.182	12.136	3.115	1.357	927.498
1986	485.828	210.472	202.055	241.026	86.391	51.018	22.121	18.331	8.345	3.489	5.552	1.510	850.311
1987	347.163	501.331	181.533	135.196	127.157	41.842	19.224	9.254	8.142	3.610	1.583	2.384	1031.256
1988	251.111	368.799	411.653	111.938	62.352	53.514	13.530	6.932	3.475	3.461	1.934	0.591	1038.178
1989	103.191	247.281	334.574	303.684	61.735	28.419	19.431	5.145	2.986	1.187	1.306	0.857	1006.605
1990	167.891	116.513	208.798	304.759	153.052	28.562	12.249	9.391	2.281	1.556	0.805	0.865	838.831
1991	136.471	192.407	107.816	141.810	161.570	69.883	11.010	5.221	3.546	1.314	0.669	0.512	695.758
1992	223.154	138.452	151.438	67.054	72.270	80.357	26.630	4.328	2.540	1.958	0.582	0.240	545.850
1993	189.937	241.379	128.947	104.470	34.838	32.319	32.088	11.192	2.107	0.974	0.845	0.273	589.433
1994	109.617	200.809	195.986	80.338	52.638	14.893	12.021	11.138	4.464	0.827	0.387	0.370	573.870
1995	204.795	111.494	182.564	154.723	54.851	27.416	7.176	6.355	5.569	2.005	0.356	0.185	552.693
1996	242.014	225.719	119.883	154.198	112.836	29.391	13.890	4.139	2.993	3.310	1.144	0.228	667.730
1997	127.082	246.208	234.624	95.354	109.544	68.367	15.800	7.356	2.048	1.551	1.190	0.541	782.582
1998	199.494	119.574	228.185	180.677	66.571	71.505	35.272	8.435	3.792	1.216	0.953	0.981	717.160
1999	84.883	221.393	116.251	188.744	117.241	34.076	30.401	15.893	3.498	1.586	0.437	0.330	729.849
2000	230.058	95.396	205.923	86.382	111.170	56.935	14.618	10.306	5.271	1.175	0.554	0.178	587.908
2001	239.777	278.333	96.614	166.875	55.828	59.795	25.035	5.274	3.000	1.535	0.366	0.189	692.842
2002	207.898	236.041	244.008	74.871	105.961	30.231	25.428	9.197	1.776	1.354	0.425	0.165	729.457
2003	234.256	225.587	205.951	187.247	45.668	50.296	11.473	9.116	2.991	0.623	0.411	0.227	739.589
2004	79.883	260.248	205.839	164.715	114.172	25.087	24.848	5.574	4.570	1.478	0.292	0.168	806.993
2005	184.672	86.134	245.562	176.618	106.786	62.605	12.113	9.017	1.934	1.546	0.590	0.144	703.050
2006	131.913	198.017	78.419	188.810	113.961	58.512	28.100	4.467	3.662	0.557	0.400	0.258	675.163
2007	90.401	159.656	196.047	60.865	123.977	62.899	30.442	11.930	1.672	1.346	0.224	0.135	649.193
2008	162.477	104.415	154.550	146.340	42.972	74.786	32.293	11.140	4.519	0.641	0.494	0.085	572.235
2009	151.266	188.658	103.453	121.468	111.546	28.419	42.586	13.300	4.818	1.969	0.269	0.213	616.700
2010	138.336	175.688	187.141	81.522	92.949	74.115	16.268	17.645	5.792	2.114	0.831	0.117	654.181

Table 3.3.18 Icelandic cod, division Va. Landings ('000 tonnes), average fishing mortality of age groups 5 to 10, recruitment to the fishery at age 3, total stock biomass (Bio4+) ('000 tonnes) spawning stock biomass (SSB) at spawning time ('000 tonnes) and harvest ratio.

Year	Landings	F5-10	SSB	N3	B4+	Hratio old
1955	538	0.29	1137	152	2357	0.24
1956	481	0.29	963	153	2081	0.24
1957	452	0.31	937	171	1878	0.24
1958	509	0.35	1071	221	1865	0.27
1959	453	0.32	1032	289	1828	0.25
1960	465	0.37	887	154	1753	0.27
1961	375	0.36	568	193	1496	0.25
1962	387	0.38	704	129	1492	0.26
1963	410	0.46	649	178	1315	0.31
1964	434	0.55	603	204	1219	0.36
1965	394	0.58	430	216	1023	0.38
1966	357	0.59	376	229	1032	0.35
1967	345	0.56	337	320	1103	0.31
1968	381	0.72	305	172	1223	0.31
1969	406	0.56	413	248	1326	0.31
1970	471	0.61	449	180	1337	0.35
1971	453	0.68	343	189	1098	0.41
1972	399	0.69	325	139	997	0.40
1973	383	0.70	345	273	843	0.45
1974	375	0.76	268	179	918	0.41
1975	371	0.81	238	261	895	0.41
1976	348	0.75	189	368	955	0.36
1977	340	0.59	257	143	1290	0.26
1978	330	0.48	269	227	1299	0.25
1979	368	0.45	379	244	1397	0.26
1980	434	0.49	464	140	1489	0.29
1981	469	0.66	385	141	1242	0.38
1982	388	0.73	251	132	970	0.40
1983	300	0.72	188	233	791	0.38
1984	284	0.64	194	139	914	0.31
1985	325	0.67	231	138	927	0.35
1986	369	0.78	274	333	850	0.43
1987	392	0.86	215	264	1031	0.38
1988	378	0.90	233	175	1038	0.36
1989	356	0.72	225	87	1007	0.35
1990	335	0.70	286	130	839	0.40
1991	309	0.80	231	104	696	0.44
1992	268	0.85	223	173	546	0.49
1993	252	0.87	174	136	589	0.43
1994	179	0.63	191	76	574	0.31
1995	169	0.51	217	152	553	0.31
1996	182	0.51	198	166	668	0.27
1997	203	0.55	241	86	783	0.26
1998	243	0.66	278	162	717	0.34
1999	260	0.75	251	68	730	0.36
2000	236	0.76	230	176	588	0.40
2001	235	0.75	219	160	693	0.34
2002	209	0.65	248	161	729	0.29
2003	208	0.60	234	185	740	0.28
2004	227	0.62	254	64	807	0.28
2005	214	0.59	288	155	703	0.30
2006	196	0.59	273	123	675	0.29
2007	193	0.60	241	81	649	0.30
2008	158	0.51	243	145	572	0.28
2009	159	0.50	252	135	617	0.26
2010			259	124	654	

Table 3.3.19a. Icelandic cod division Va. Input values for the short term predictions

Mean weights in the stock and the catch

age\year	2006	2007	2008	2009	2010
3	1.070	1.117	1.117	1.117	1.117
4	1.614	1.629	1.629	1.629	1.629
5	2.185	2.229	2.229	2.229	2.229
6	3.052	2.810	2.810	2.810	2.810
7	4.347	3.922	3.922	3.922	3.922
8	5.177	5.151	5.151	5.151	5.151
9	5.382	6.193	6.193	6.193	6.193
10	5.769	5.819	5.819	5.819	5.819
11	6.258	6.201	6.201	6.201	6.201
12	5.688	6.508	6.508	6.508	6.508
13	7.301	6.751	6.751	6.751	6.751
14	15.412	6.943	6.943	6.943	6.943

Mean weights in the SSB

age\year	2006	2007	2008	2009	2010
3	0.900	0.900	0.900	0.900	0.900
4	1.383	1.264	1.264	1.264	1.264
5	1.998	2.022	2.022	2.022	2.022
6	2.905	2.580	2.580	2.580	2.580
7	4.385	4.078	4.078	4.078	4.078
8	5.177	5.151	5.151	5.151	5.151
9	5.382	6.193	6.193	6.193	6.193
10	5.769	5.819	5.819	5.819	5.819
11	6.258	6.201	6.201	6.201	6.201
12	5.688	6.508	6.508	6.508	6.508
13	7.301	6.751	6.751	6.751	6.751
14	15.412	6.943	6.943	6.943	6.943

Sexual maturity at spawning time:

age\year	2006	2007	2008	2009	2010
3	0.00	0.01	0.01	0.01	0.01
4	0.02	0.03	0.03	0.03	0.03
5	0.29	0.16	0.16	0.16	0.16
6	0.45	0.50	0.50	0.50	0.50
7	0.75	0.69	0.69	0.69	0.69
8	0.87	0.80	0.80	0.80	0.80
9	0.74	0.86	0.86	0.86	0.86
10	1.00	0.96	0.96	0.96	0.96
11	1.00	0.92	0.92	0.92	0.92
12	1.00	1.00	1.00	1.00	1.00
13	1.00	1.00	1.00	1.00	1.00
14	1.00	1.00	1.00	1.00	1.00

Selection pattern

age\year	2006	2007	2008	2009	2010
3	0.050	0.053	0.053	0.053	0.053
4	0.224	0.234	0.234	0.234	0.234
5	0.514	0.534	0.534	0.534	0.534
6	0.794	0.810	0.810	0.810	0.810
7	0.950	0.959	0.959	0.959	0.959
8	1.065	1.074	1.074	1.074	1.074
9	1.238	1.225	1.225	1.225	1.225
10	1.439	1.398	1.398	1.398	1.398
11	1.415	1.366	1.366	1.366	1.366
12	1.482	1.366	1.366	1.366	1.366
13	1.412	1.366	1.366	1.366	1.366
14	1.412	1.366	1.366	1.366	1.366

Natural Mortality

age\year	2006	2007	2008	2009	2010
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

Stock numbers

age\year	2006	2007	2008	2009	2010
3		80.932	145.46	135.42	123.85
4		98.009			
5		87.953			
6		21.660			
7		31.611			
8		12.211			
9		4.916			
10		2.050			
11		0.270			
12		0.207			
13		0.033			
14		0.019			

Prop. mort. before spawning

age\year	F	M
3	0.085	0.250
4	0.180	0.250
5	0.248	0.250
6	0.296	0.250
7	0.382	0.250
8	0.437	0.250
9	0.477	0.250
10	0.477	0.250
11	0.477	0.250
12	0.477	0.250
13	0.477	0.250
14	0.477	0.250

Table 3.3.19b. Icelandic cod, division Va. Output values for the short term prediction – ICES format

2007 B4+	SSB	Landings	Fbar
649	183	193	0.61

2008 B4+	Fmult	Fbar	SSB2008	Landings	2009 B4+	SSB
572	0.00	0.00	216	0	797	337
	0.10	0.10	209	36	756	299
	0.20	0.20	201	70	717	265
	0.30	0.30	194	101	682	235
	0.40	0.40	187	130	649	210
	0.50	0.50	180	156	619	187
	0.60	0.60	174	181	591	167
	0.70	0.70	168	204	565	150
	0.80	0.80	162	225	542	135
	0.90	0.90	156	245	519	121
	1.00	1.00	151	263	499	109
	1.10	1.10	146	280	479	99
	1.20	1.20	141	296	461	89
	1.30	1.30	136	311	445	81
	1.40	1.40	132	325	429	74
	1.50	1.50	127	338	414	67
	1.60	1.60	123	350	401	61
	1.70	1.70	119	361	388	56
	1.80	1.80	115	372	376	51
	1.90	1.90	112	382	365	47
	2.00	2.00	108	392	354	44

Table 3.3.19c. Icelandic cod division Va. Output value for the short term prediction – Domestic format.

Prognosis - Summary table

2007				2008				2009				2010			
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)*
195	649	182	0.614	100	570	206	0.299	100	662	252	0.255	100	748	301	0.218
				125	570	199	0.386	125	633	227	0.351	125	691	256	0.315
				152	570	192	0.489	150	602	201	0.473	166	630	205	0.508
				178	570	186	0.592	168	574	180	0.586	176	581	172	0.629
				200	570	179	0.690	200	548	156	0.798	200	518	130	0.917

Table 3.3.20 Icelandic cod, division Va. Input for long-term predictions.

2007

	Nat	Mat	PF	PM	swt	swl	cw	
Age	M	Mat	PF	PM	SWt	Sel	CW	
3	0.2	0.00	0.085	0.25	0.701	0.053	1.326	
4	0.2	0.05	0.18	0.25	1.444	0.234	1.850	
5	0.2	0.23	0.248	0.25	2.194	0.534	2.577	
6	0.2	0.48	0.296	0.25	3.121	0.810	3.542	
7	0.2	0.68	0.382	0.25	4.240	0.959	4.745	
8	0.2	0.81	0.437	0.25	6.103	1.074	6.103	
9	0.2	0.80	0.477	0.25	7.372	1.225	7.372	
10	0.2	0.97	0.477	0.25	8.861	1.398	8.861	
11	0.2	1.00	0.477	0.25	10.323		1.357	10.323
12	0.2	0.98	0.477	0.25	12.086		1.419	12.086
13	0.2	0.99	0.477	0.25	13.495		1.345	13.495
14	0.2	1.00	0.477	0.25	15.698		1.345	15.698
Unit	-	-	-	-	Kilograms		-	Kilograms

Table 3.3.21. Icelandic cod, division Va. Biological reference points.

	Fish Mort Ages 5-10	Yield/R	SSB/R
Average last 3 years	0.60	1.74	1.62
Fmax	0.33	1.79	3.37
F0.1	0.14	1.61	7.84
Fmed	0.66	1.73	1.41

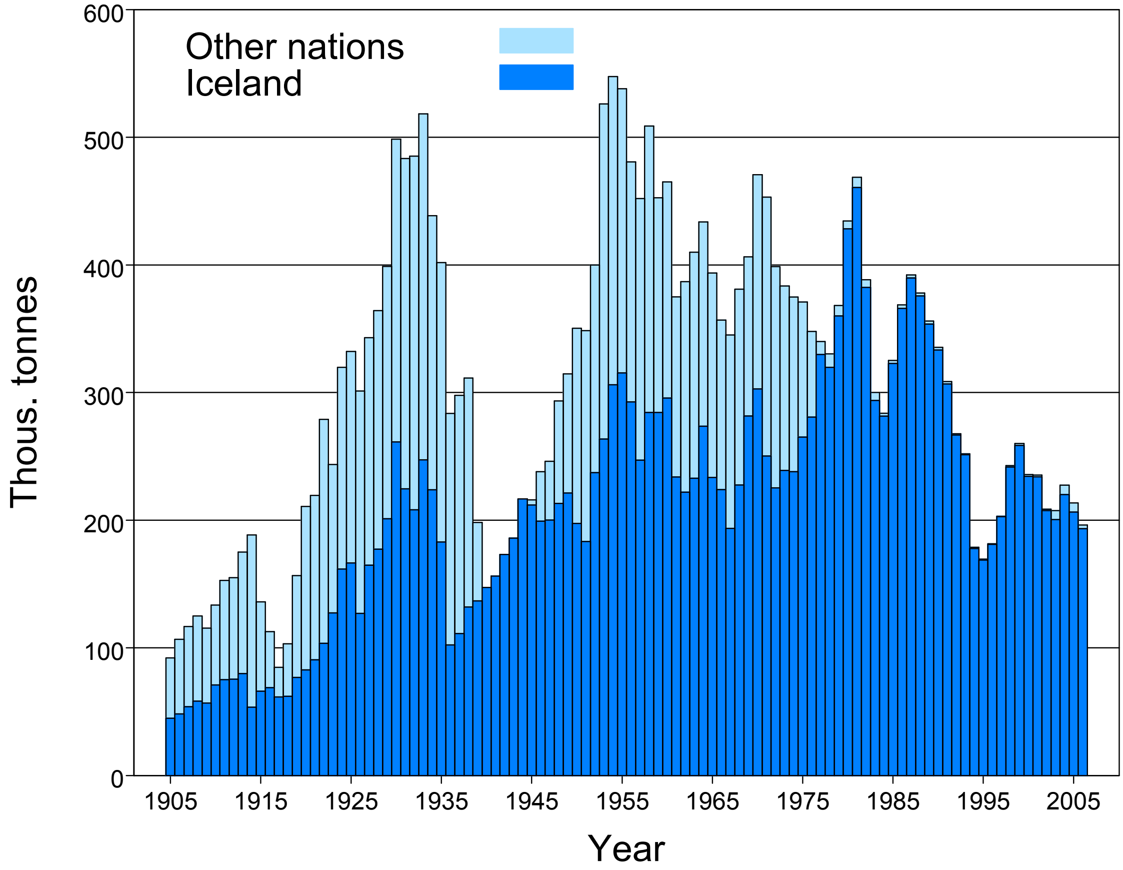
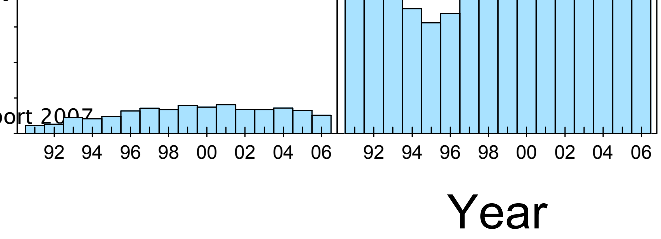


Figure 3.3.1 Nominal landings of Icelandic cod (Division Va) from 1905 to 2006.



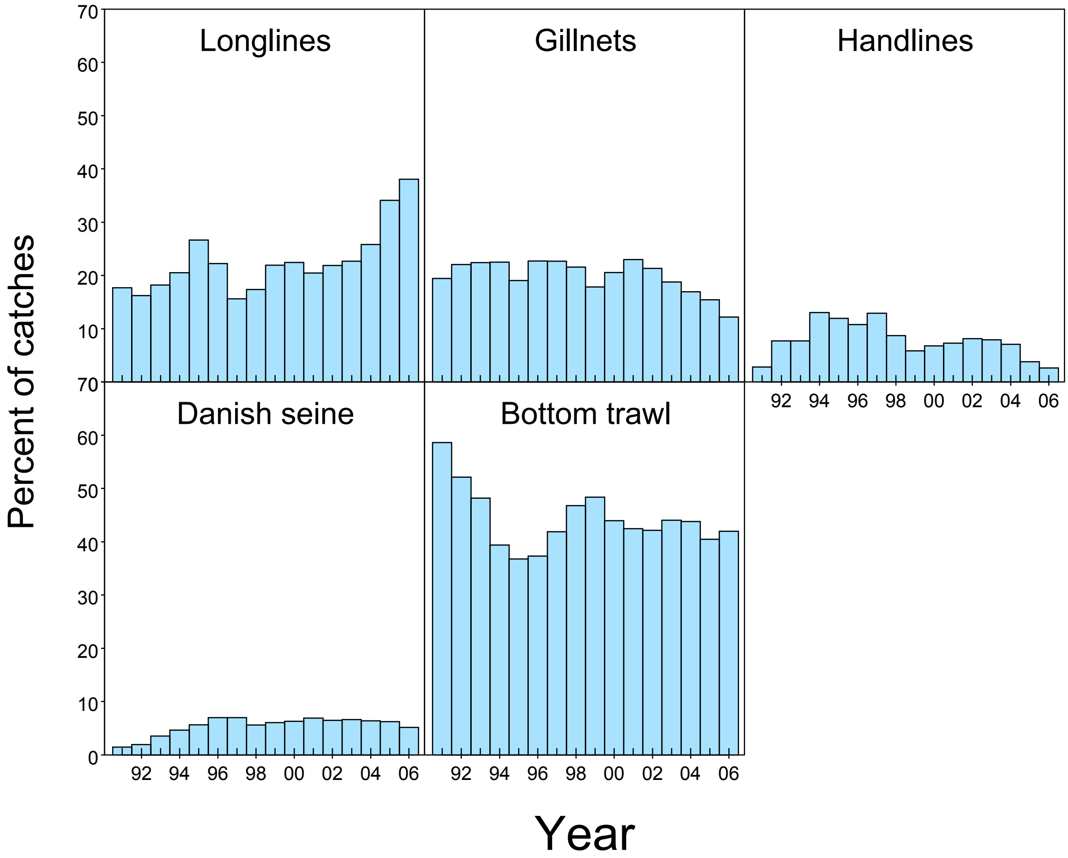


Figure 3.3.2 Landings by gear and year. Upper pictures in tonnes and lower in percentages.

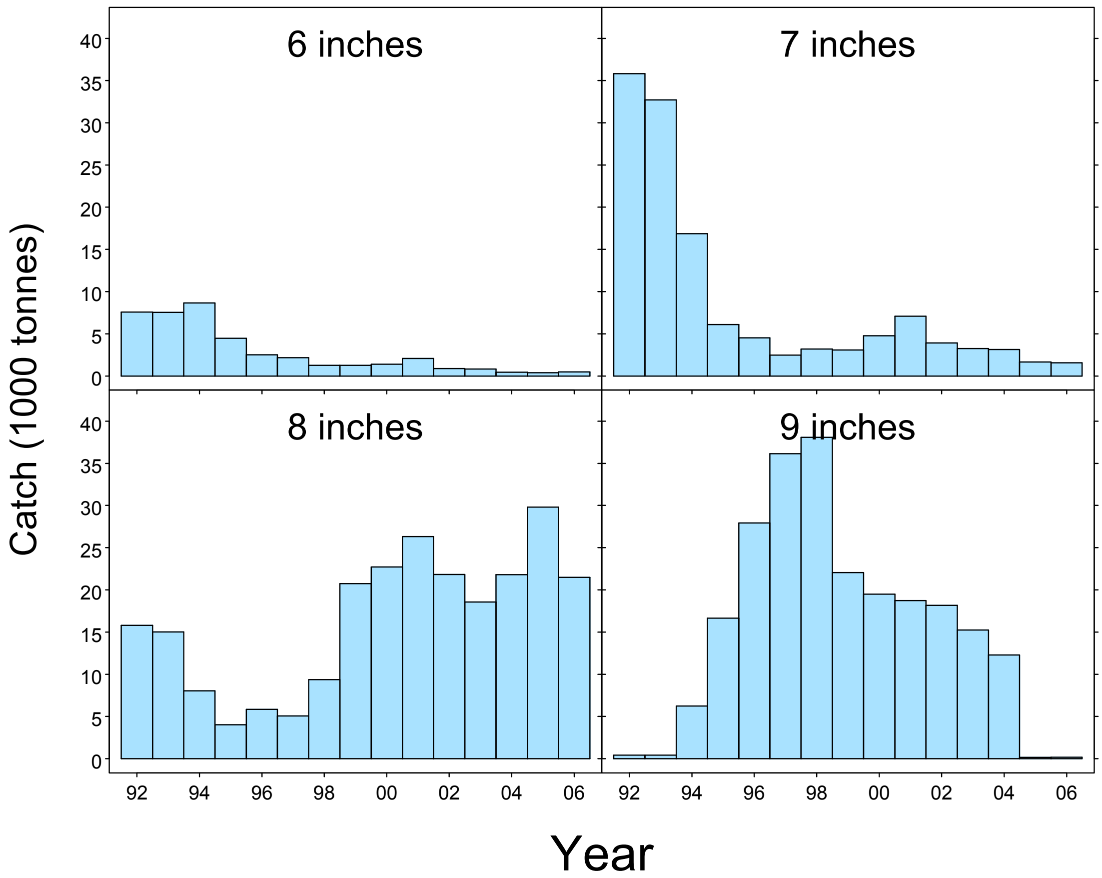


Figure 3.3.3.. Cod in division Va. Gillnet landings by mesh size and year.

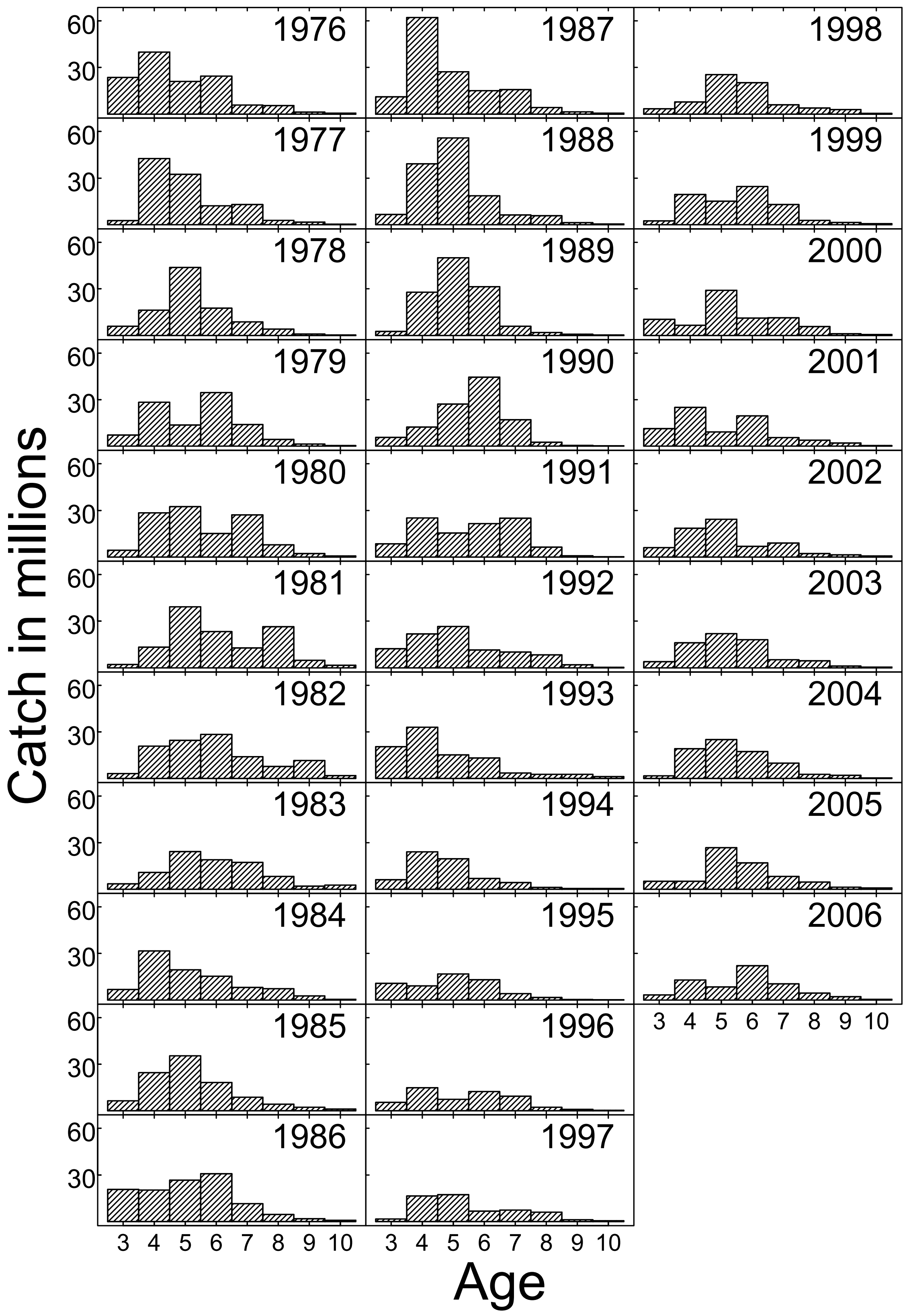


Figure 3.3.4 . Cod in division Va. Catch in numbers by year and age.

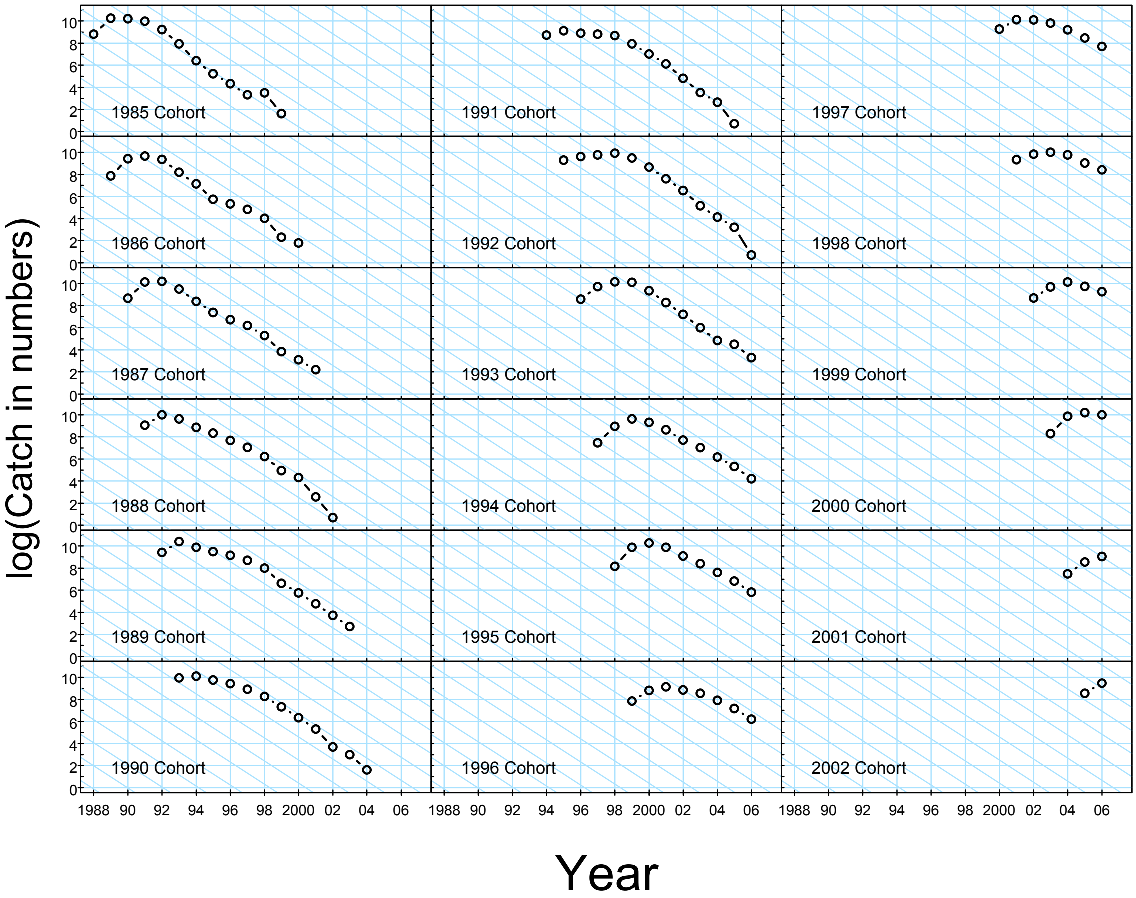


Figure 3.3.5a. Icelandic cod. Catch curves for each year class 1982-2002, age group 3 to 14. Diagonal lines correspond to a slope of 1.0.

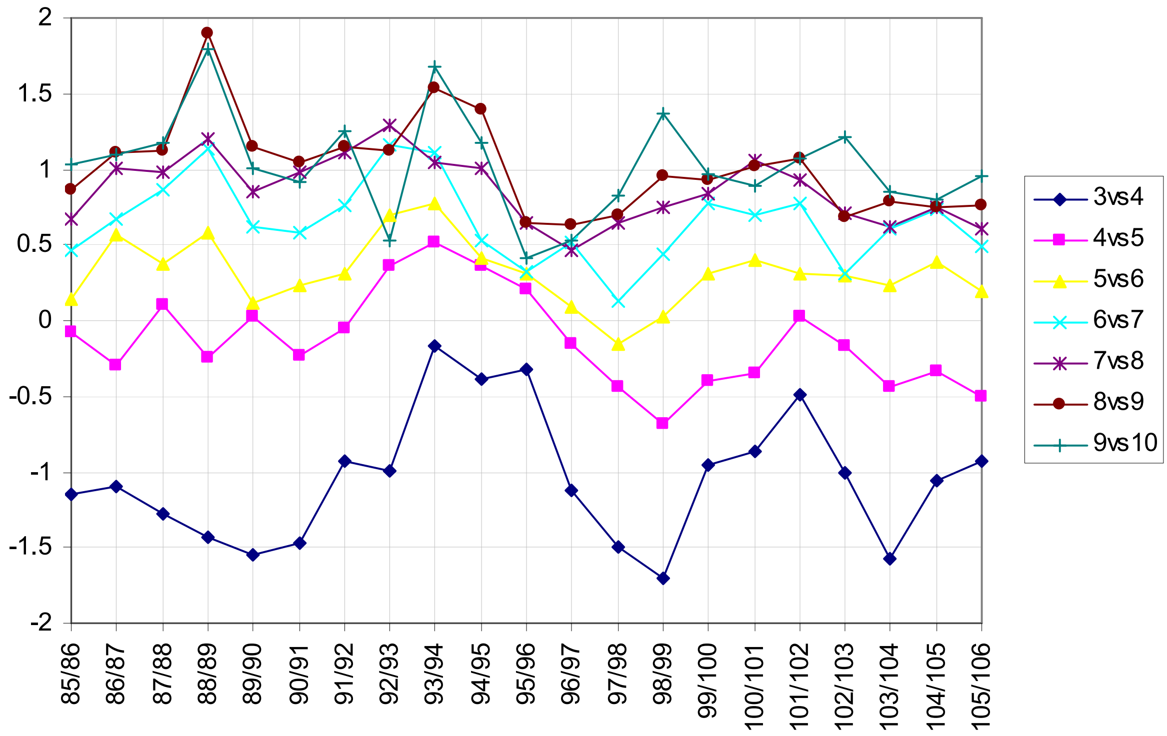


Figure 3.3.5b. Icelandic cod. Ln catch ratios for age groups 3 to 10 for the year 1985 to 2006.

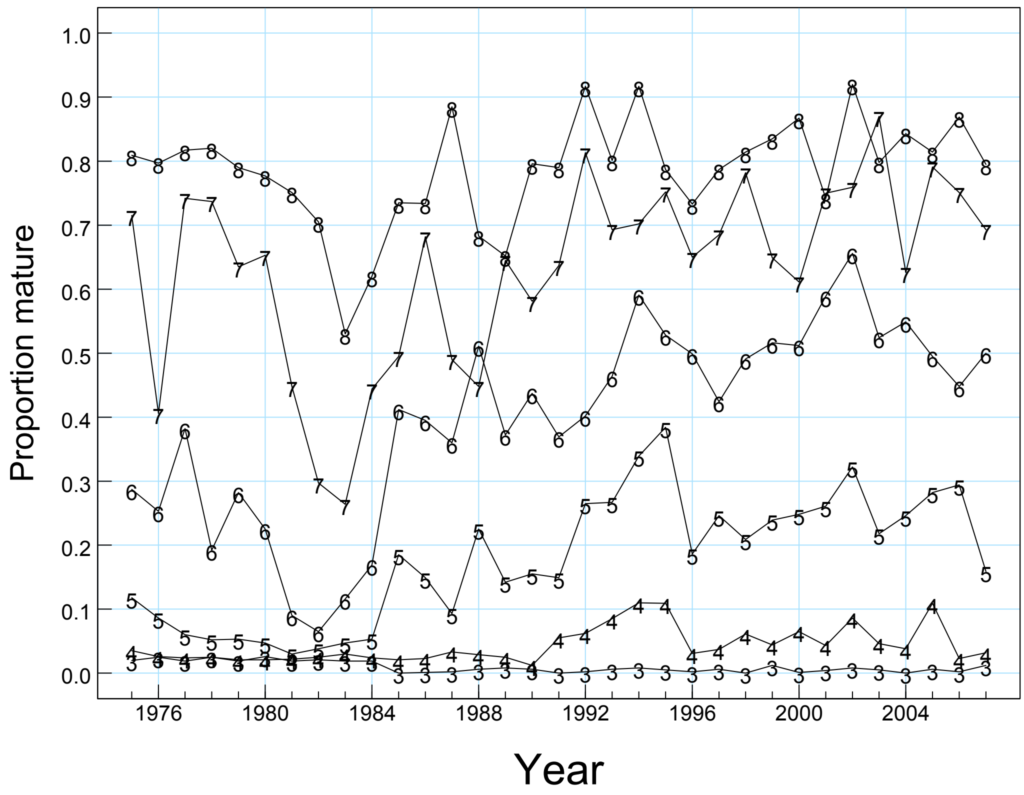


Figure 3.3.6a. Cod. Sexual maturity at age in the spring survey.

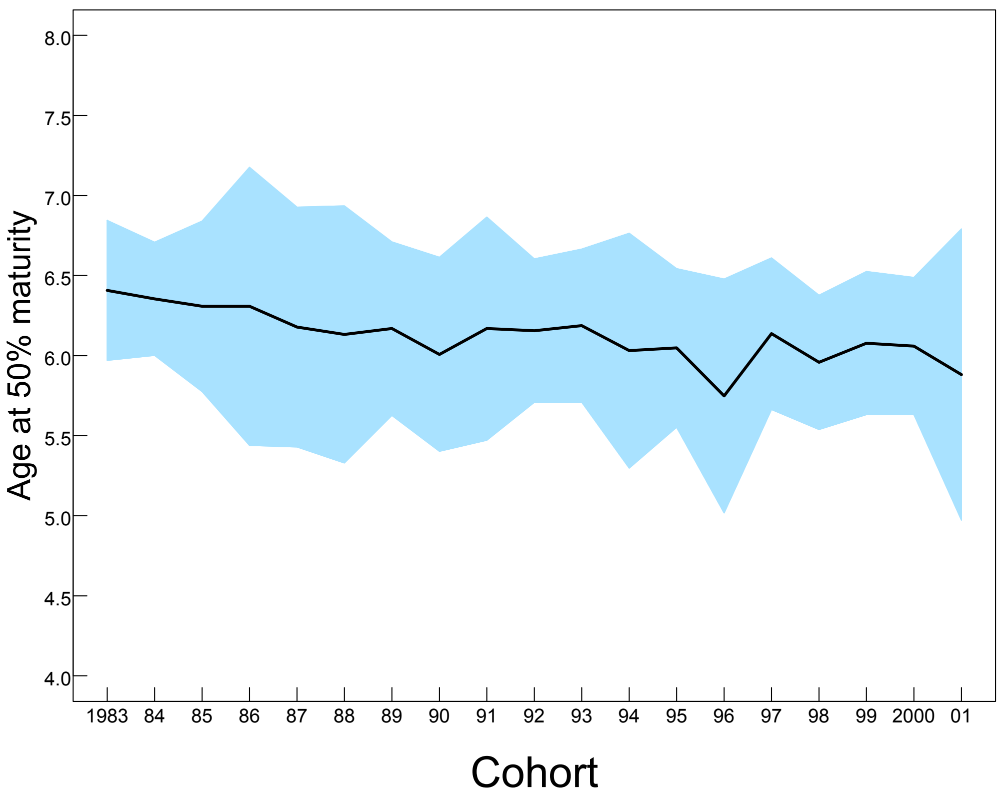


Figure 3.3.6b. Age at 50% maturity of Icelandic cod as estimated from a logistic regression (line). Shaded area represents 95% confidence intervals of the estimate.

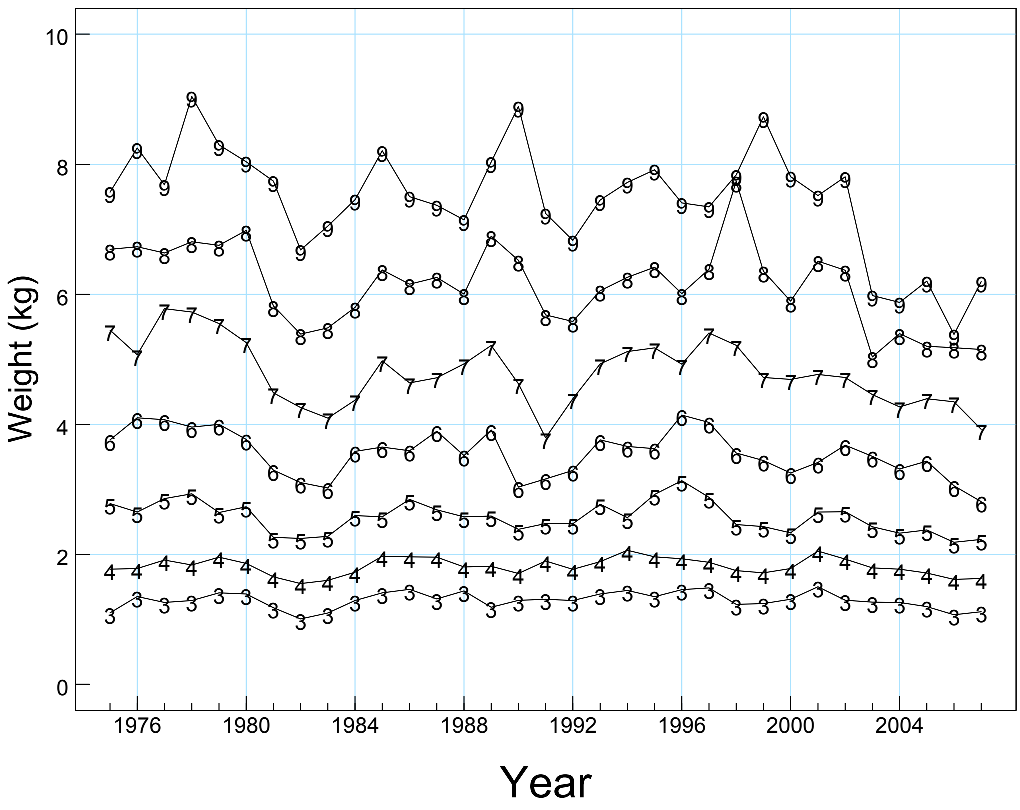


Figure 3.3.7a Cod in division Va. Mean weight at age in the catches.

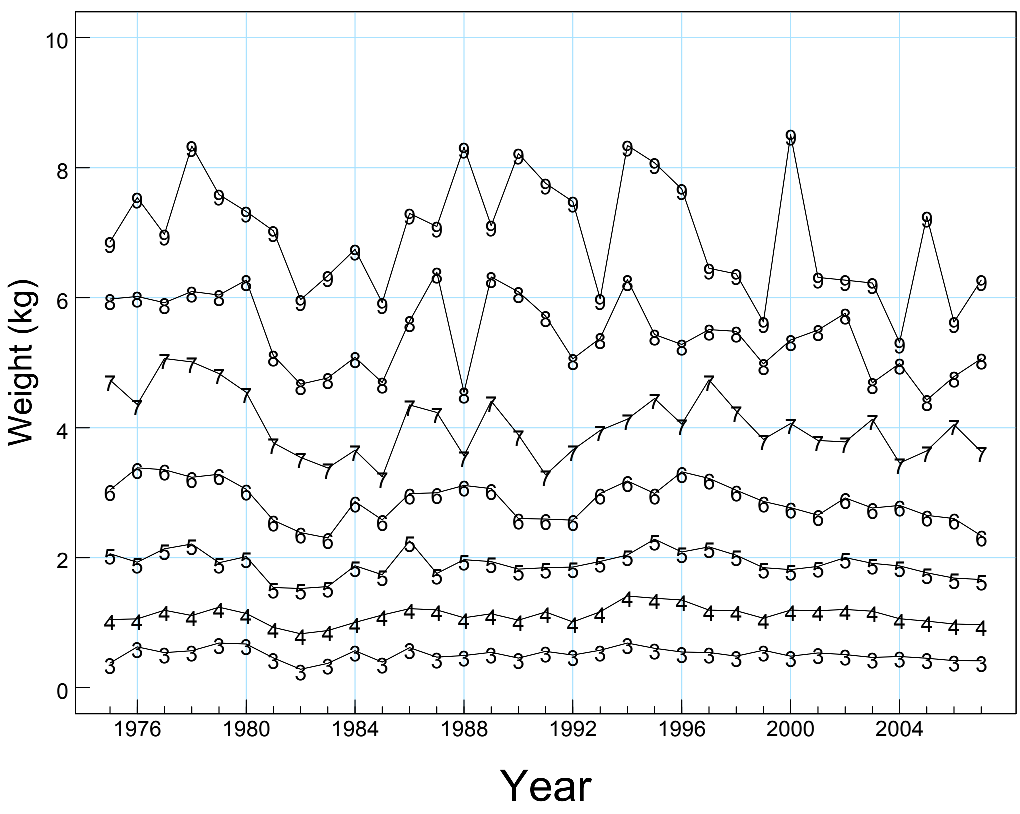


Figure 3.3.7b Cod in division Va. Mean weight at age in the March survey.

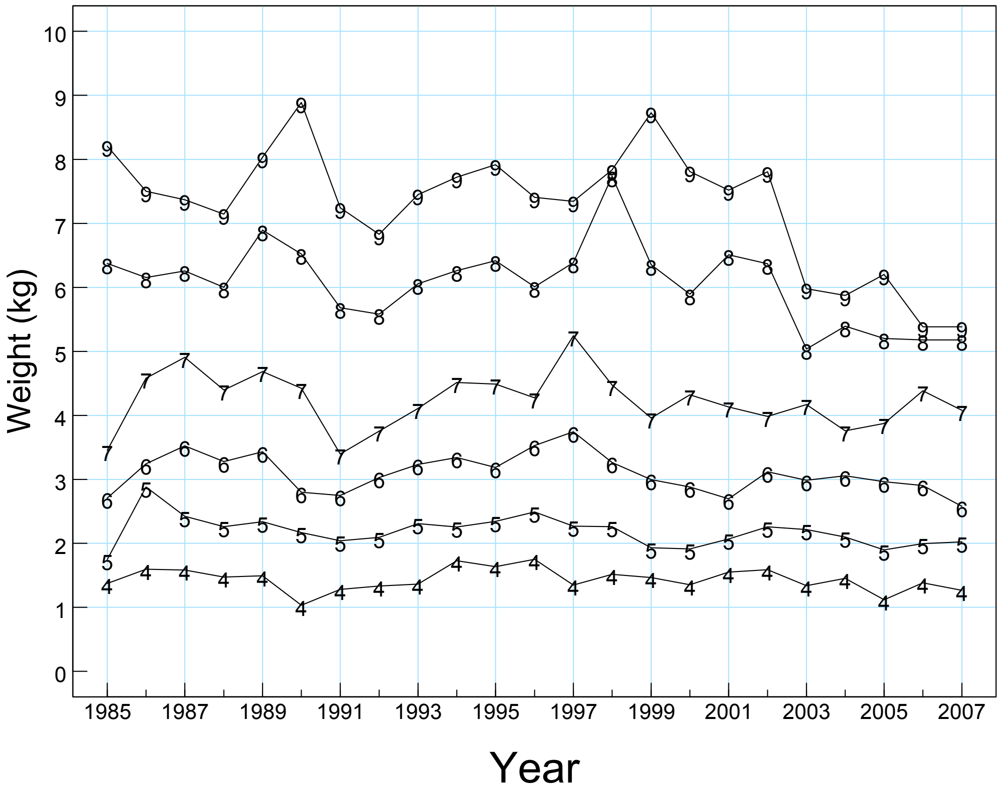


Figure 3.3.8 Cod in division Va. Mean weight at age in the SSB.

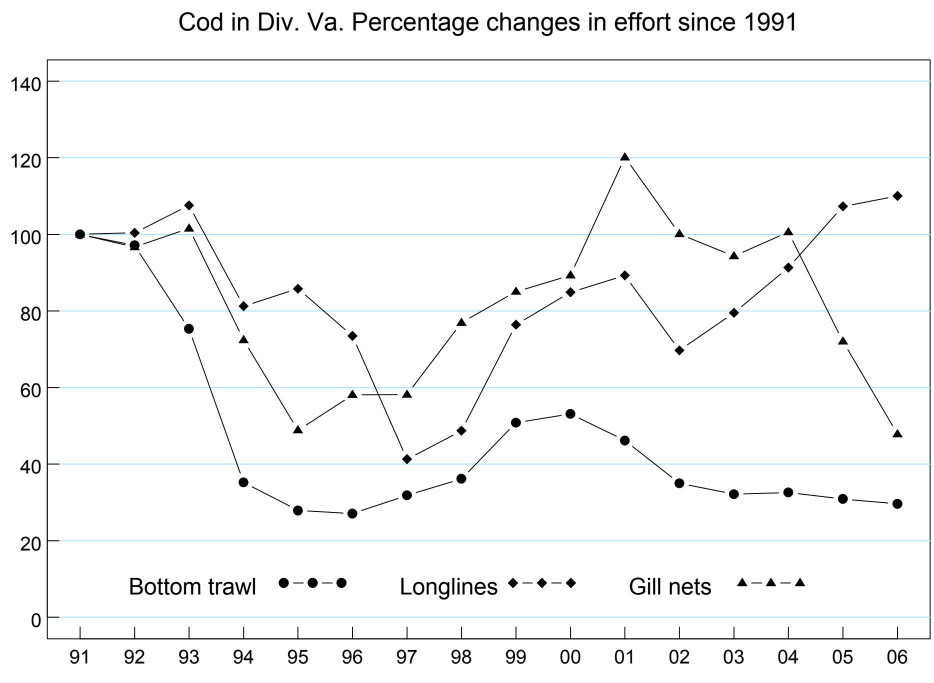


Figure 3.3.9.A. Cod at Iceland Division Va. Percentages changes in effort for the main geras since 1991.

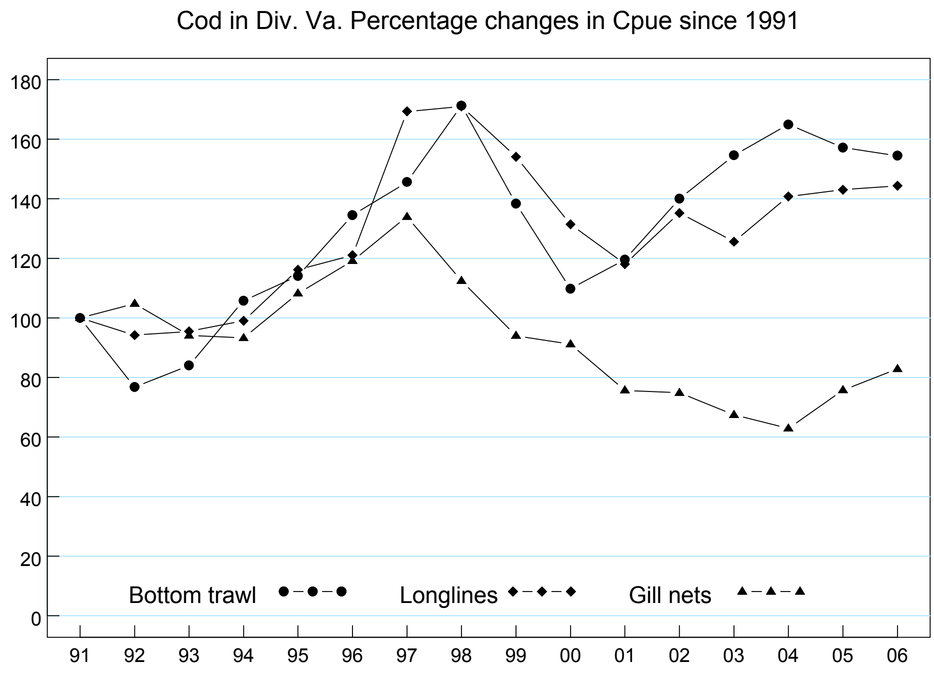


Figure 3.3.9.B. Cod at Iceland Division Va. Percentages changes in cpue for the main gears since 1991.

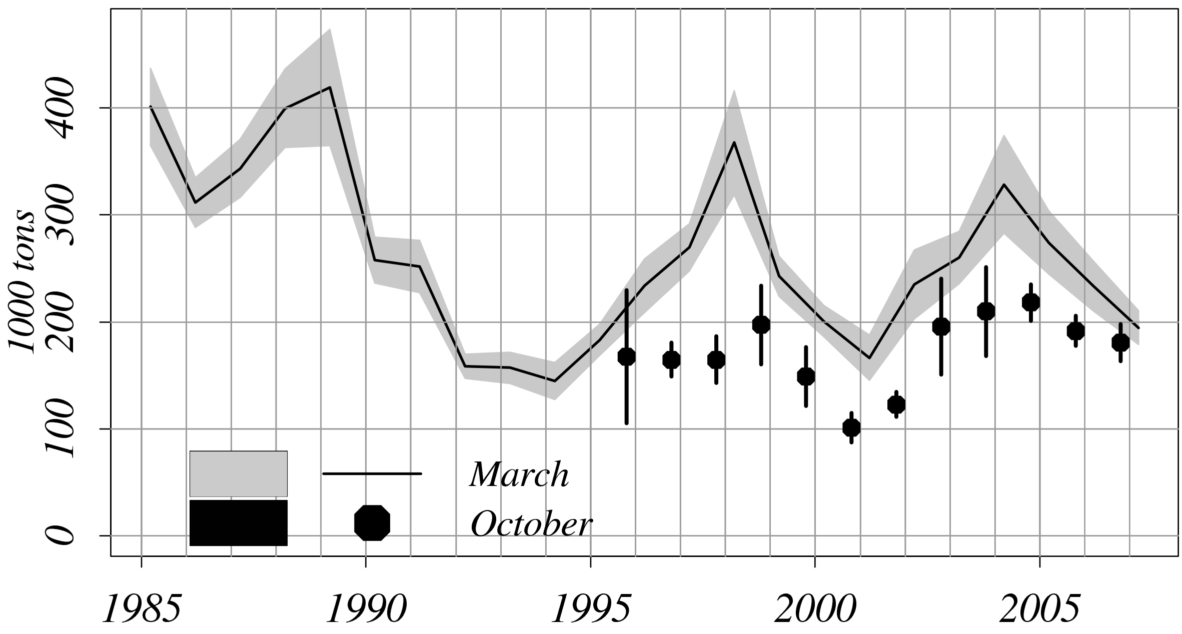


Figure 3.3.10. Cod in division Va. Total biomass index from the spring groundfish survey 1985-2006 and from the autumn survey 1996-2005.

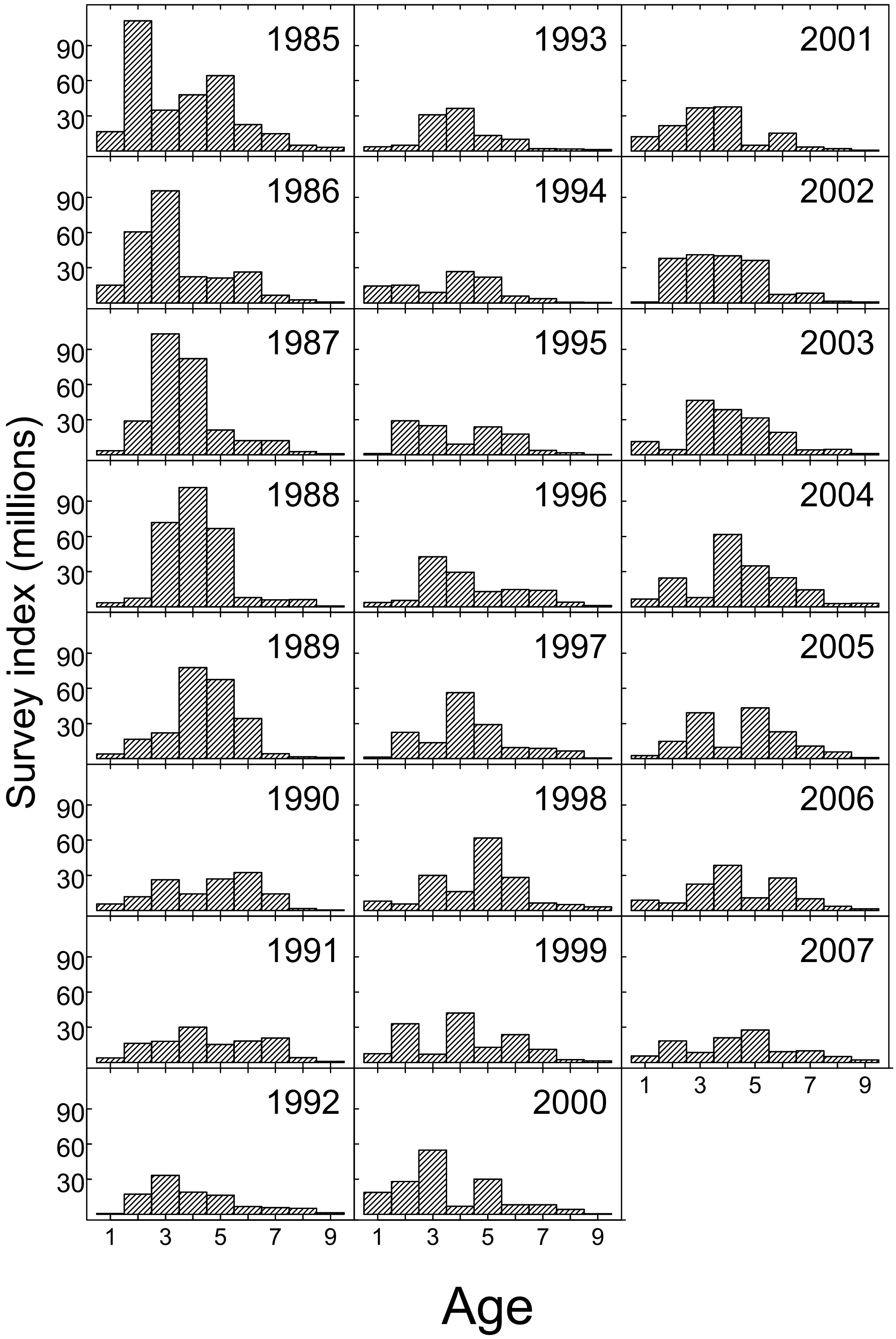


Figure 3.3.11. Cod in division Va. Survey indices from the March survey. Numbers by year and age.

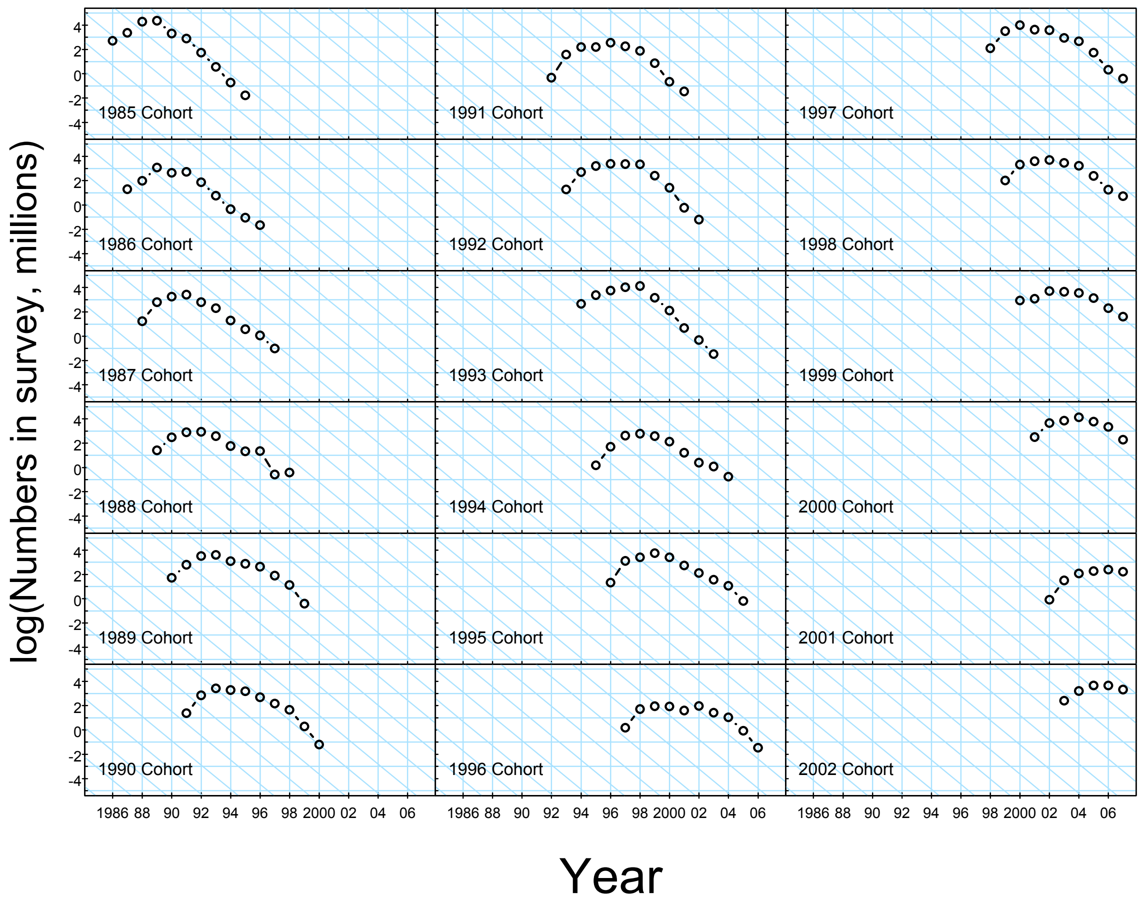


Figure 3.3.12a. Cod in division Va. Catch curves from the survey. The grey lines show Z=1

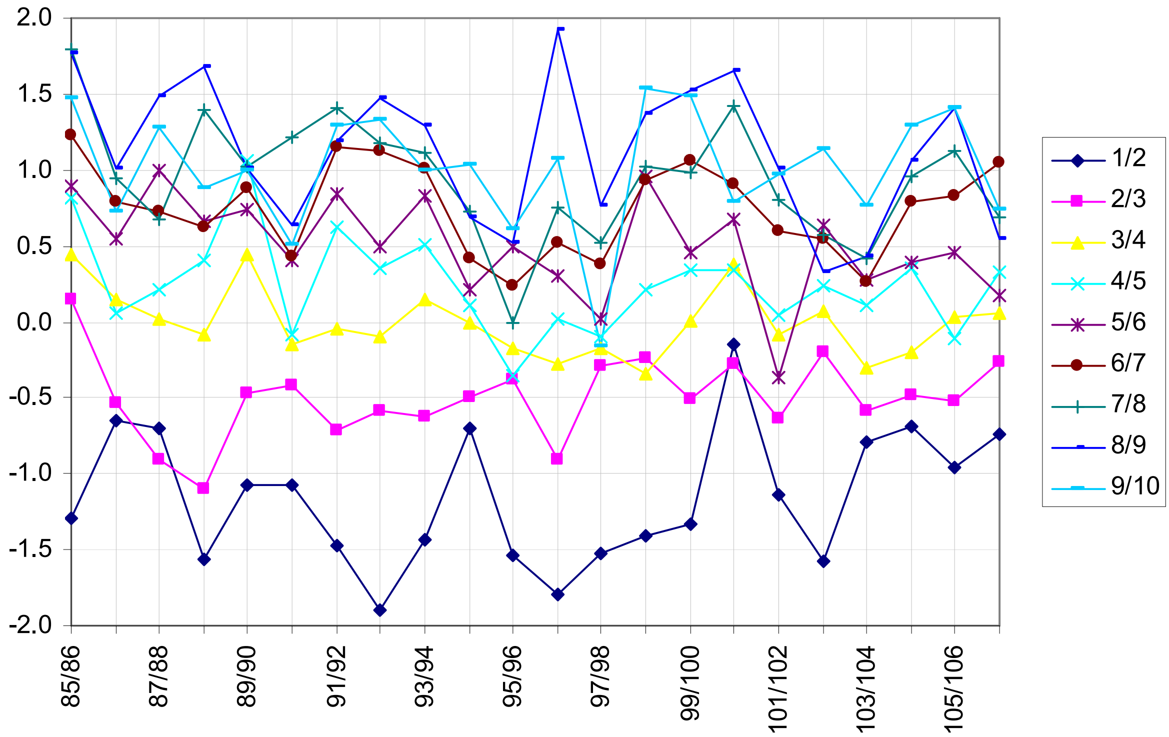


Figure 3.3.12b. Cod in division Va. Ln catch ratio of the spring ground fish survey indices.

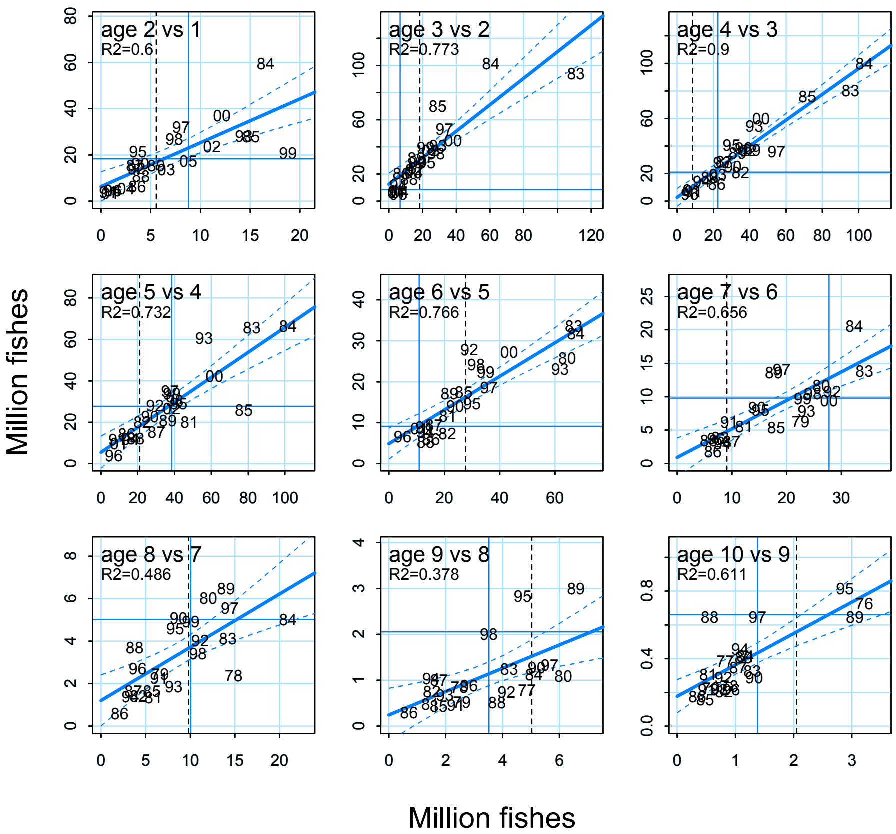


Figure 3.3.13. Cod in division Va. Indices from the groundfish survey vs. index of the same year class in survey a year later. The cross represents the last cohort age pair and the dotted vertical line is the value from the 2007 for the younger age in the pair plot.

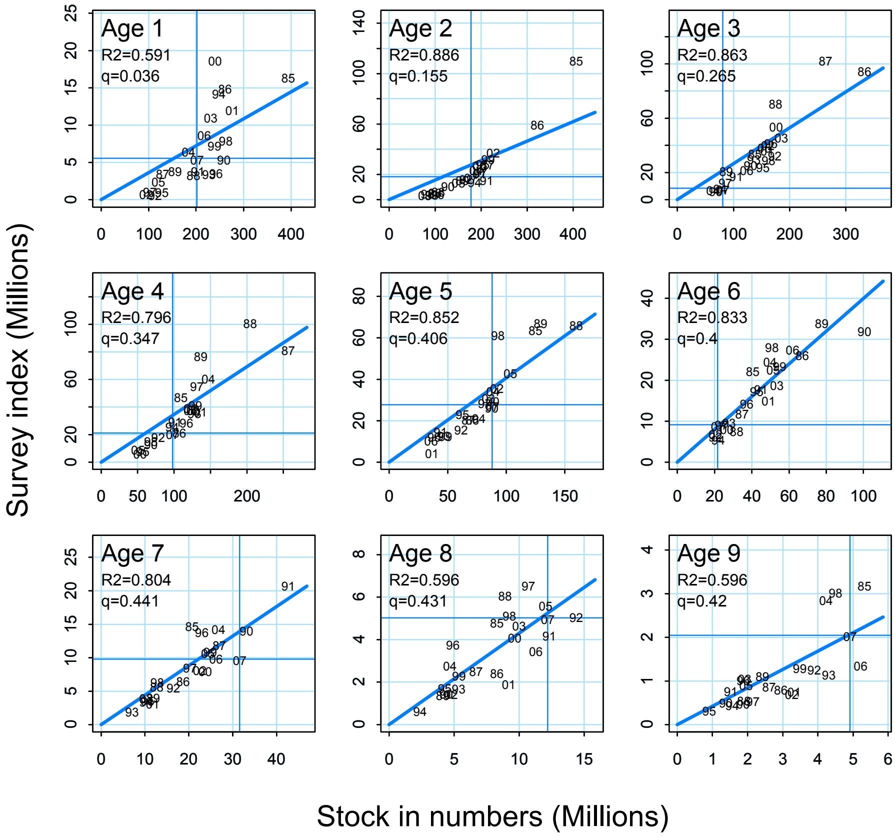


Figure 3.3.14. Cod in division Va. Survey indices vs. number in stock. Line fitted on original scale using 1985-2002 data.

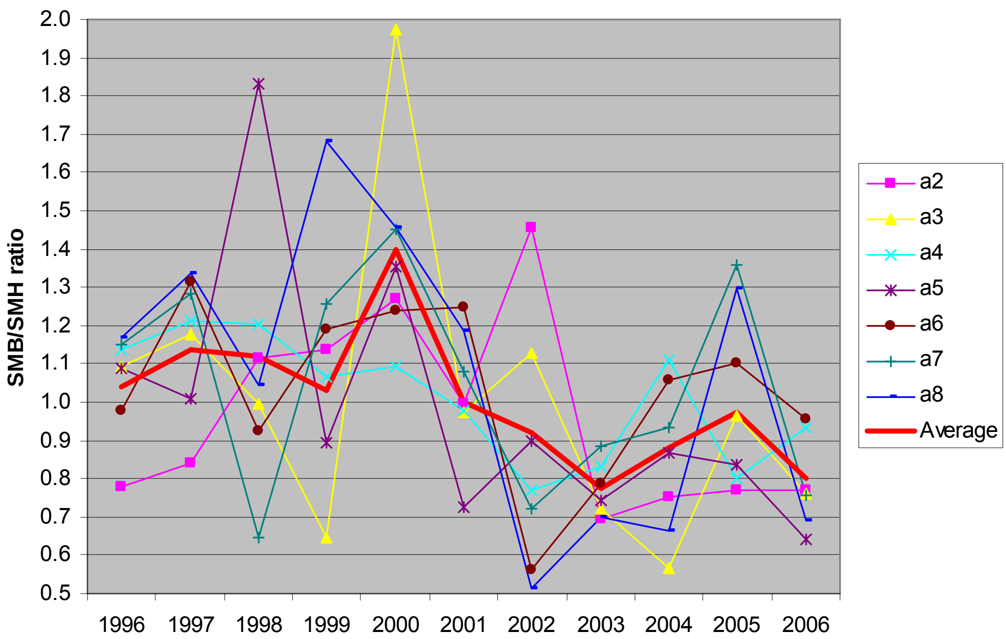


Figure x. The ratio of the standardized survey indices from the spring and the fall groundfish survey. Age groups 2 through 8 and a plain average of those age groups.

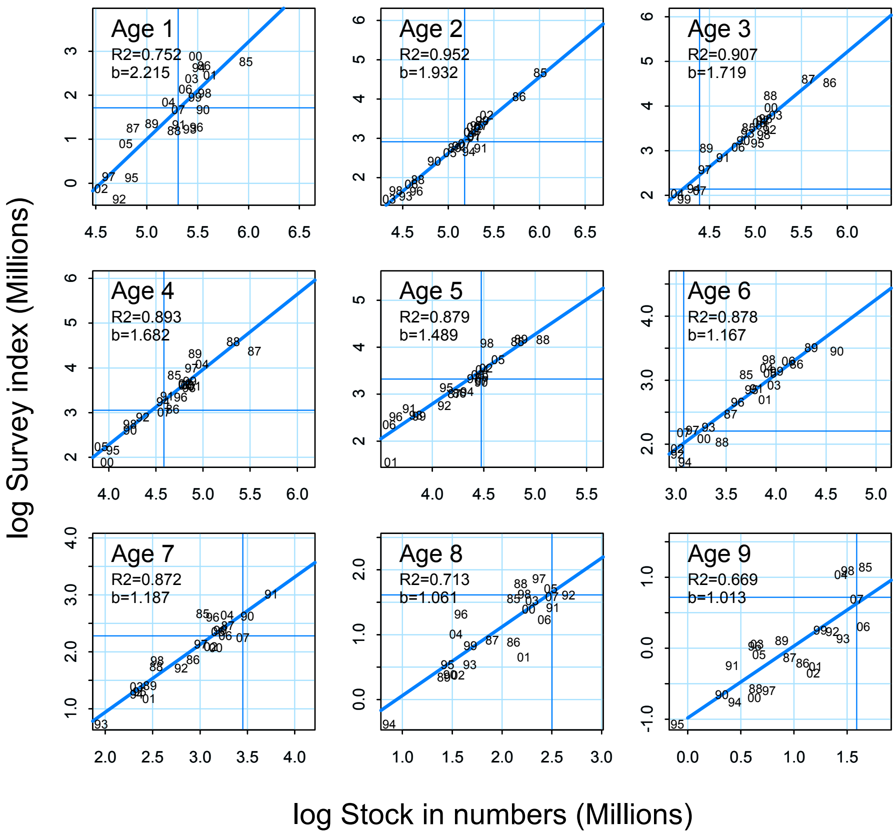


Figure 3.3.15. Cod in division Va. Survey indices vs. number in stock. Line fitted on log scale (power curve) using 1985-2002 data.

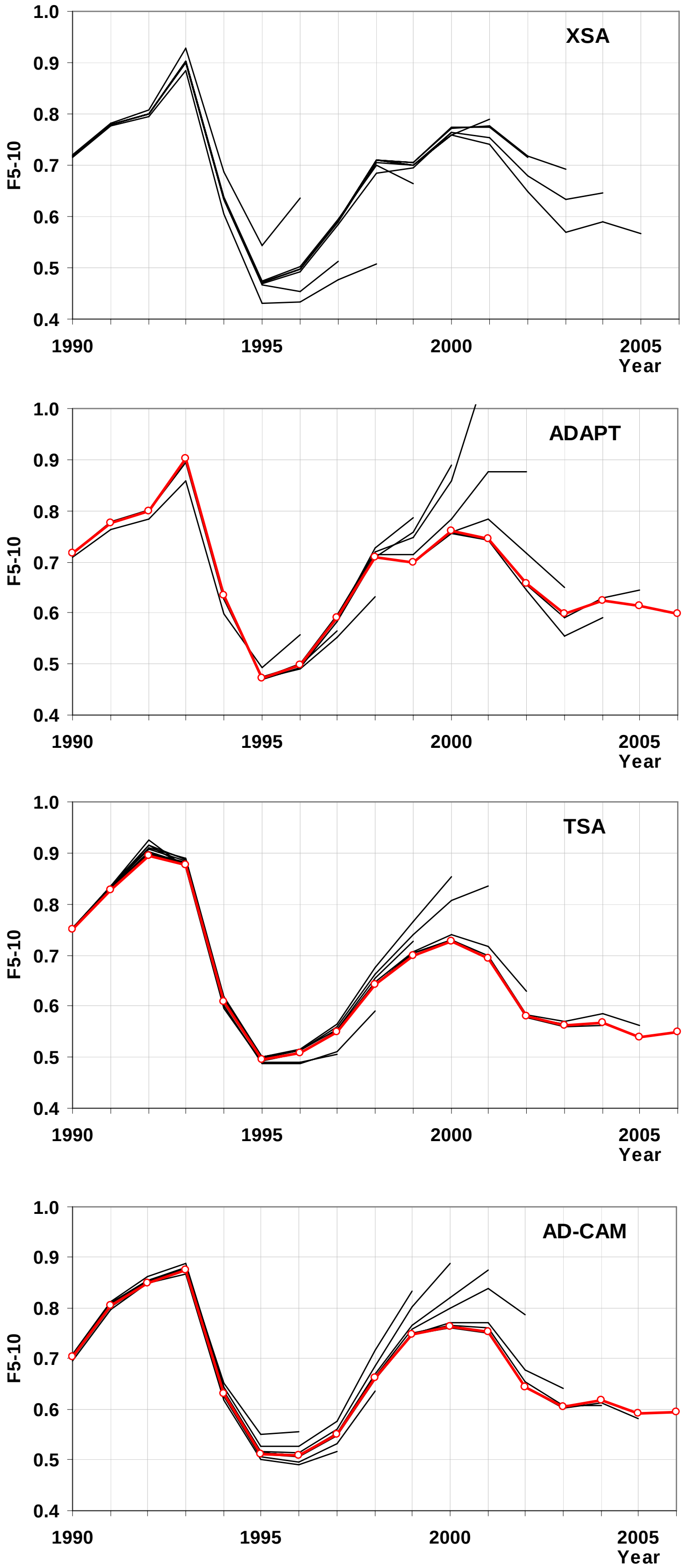


Figure 3.3.16. Retrospective pattern from four assessment runs. The figures show mean fishing mortality of ages 5 to 10.

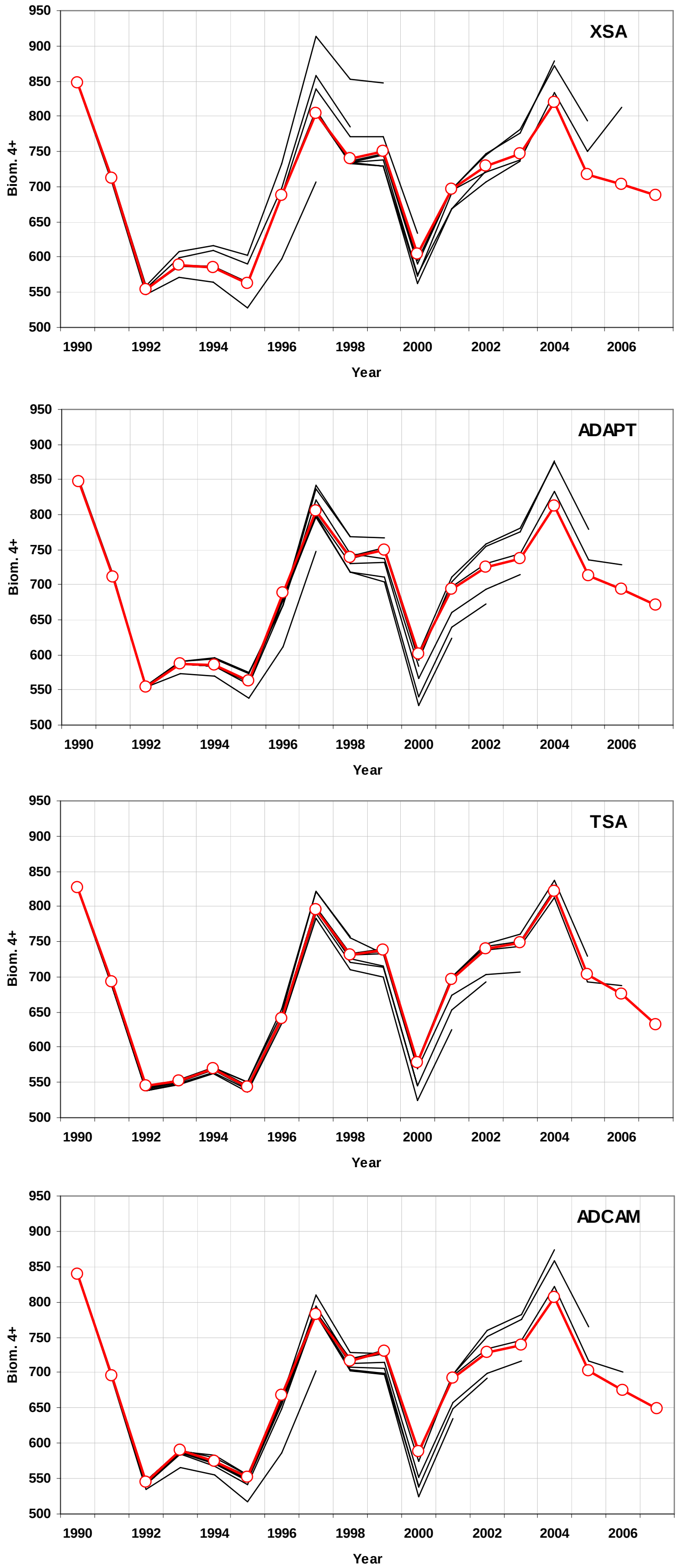


Figure 3.3.17. Retrospective patterns from four assessment runs. The figures show number of age 4 and older multiplied by the weight in the catches.

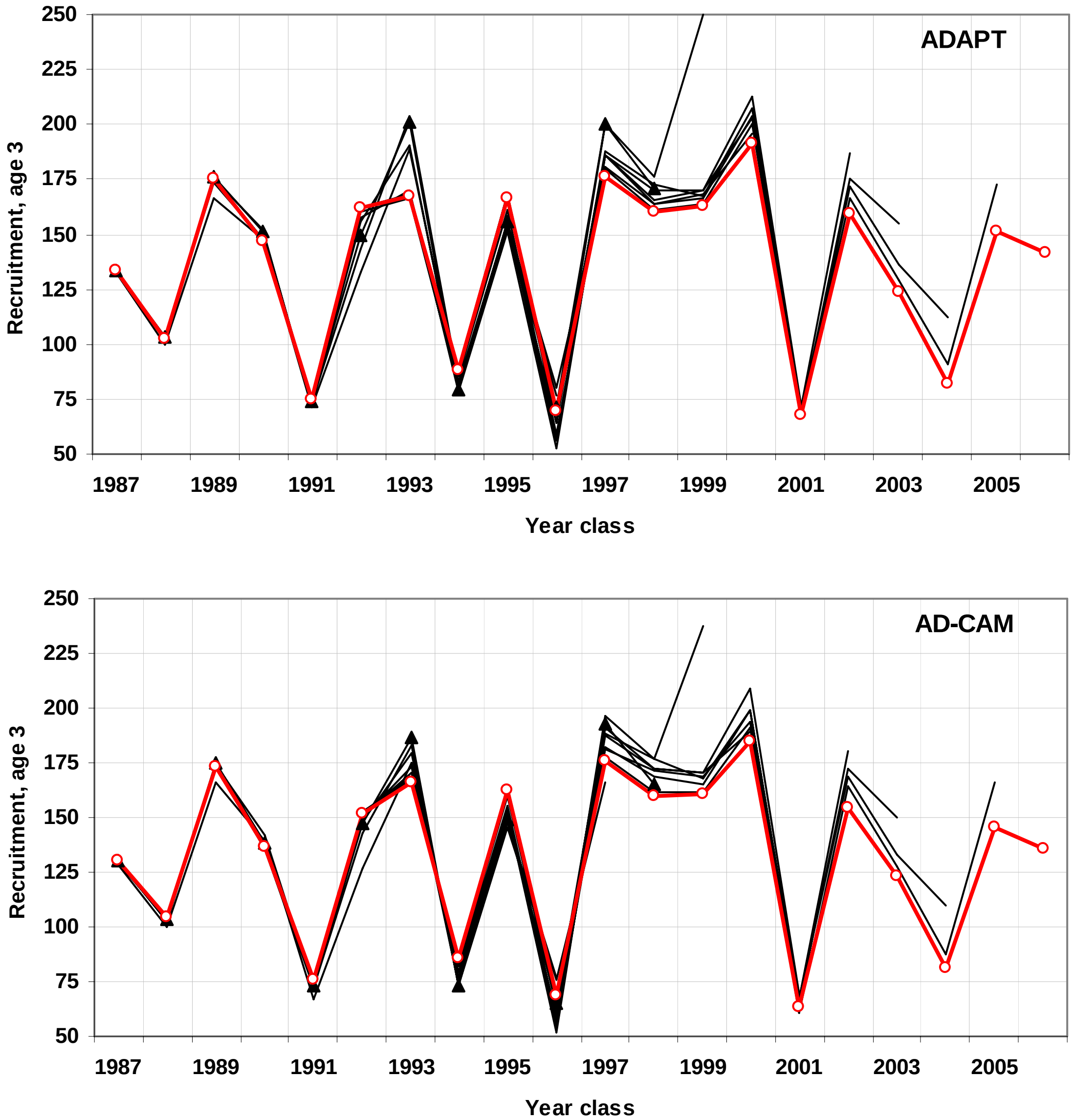


Figure 3.3.17B. Analytical recruitment retrospective pattern from ADAPT and ADCAM.

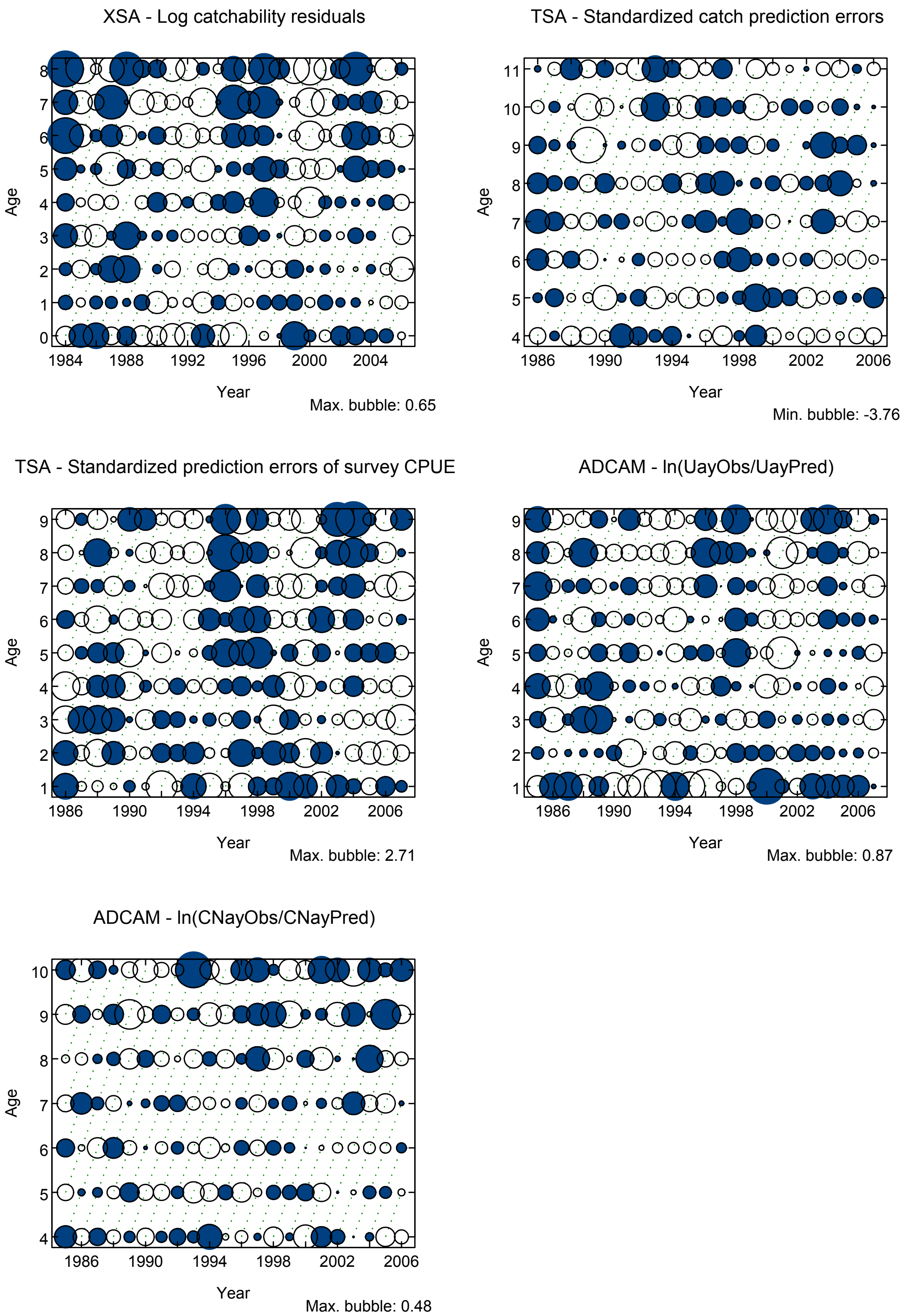


Figure 3.3.18. Residuals by year and age group from the various models. Solid symbols indicate positive values, open symbols indicate negative values. Bubble area is proportional to magnitude.

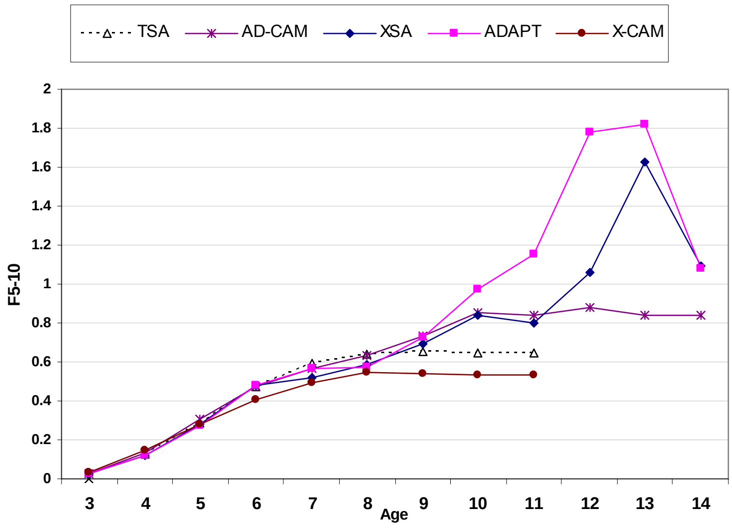


Figure 3.3.19. Comparison of estimated fishing mortalities in 2006 from different assessment runs.

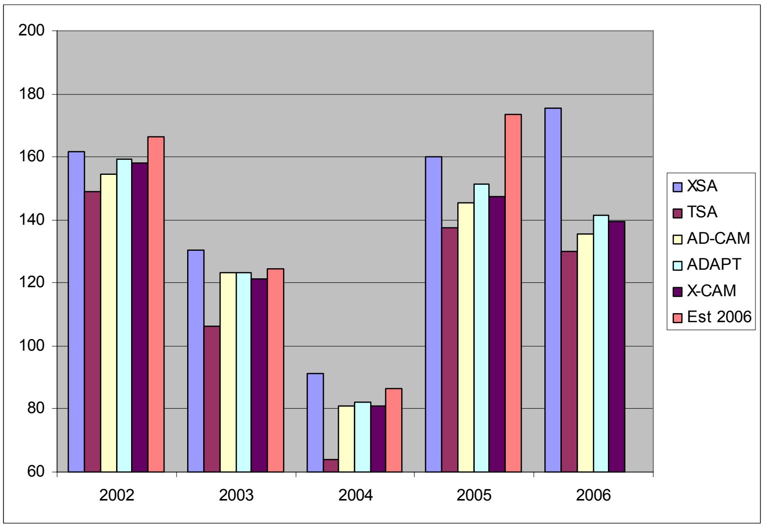


Figure 3.3.20. Comparison of estimated stock in numbers in 2007 from different assessment runs.

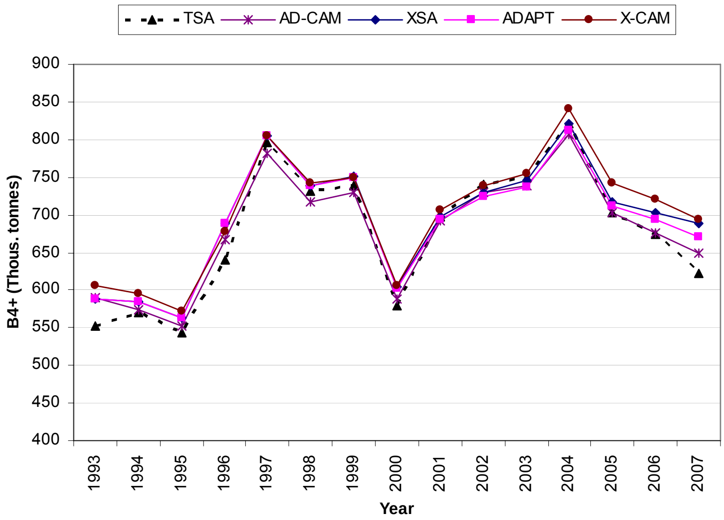


Figure 3.3.21. Estimated 4+ biomass from the various assessment models.

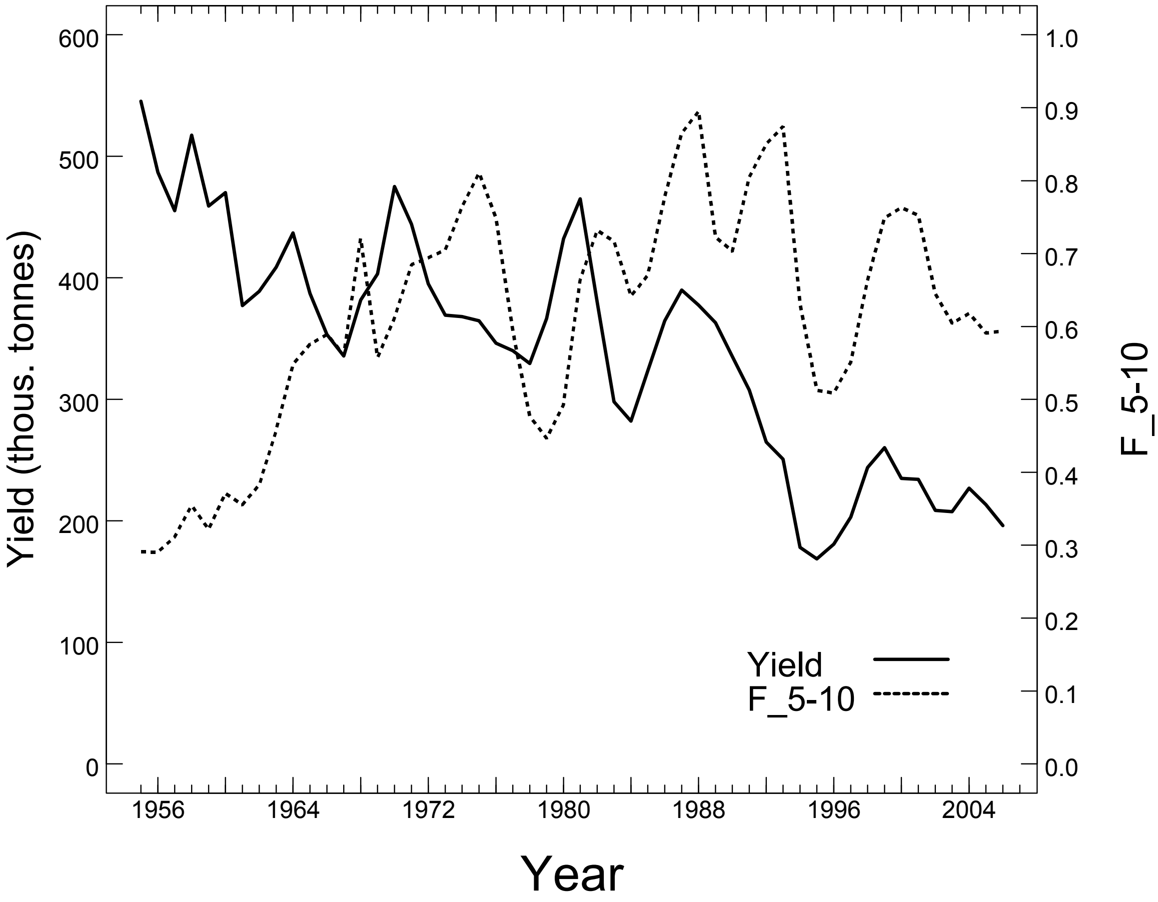


Figure 3.3.22A. Cod in division Va, Yield and average fishing mortality for agegroups 5 to 10 (F_5-10).

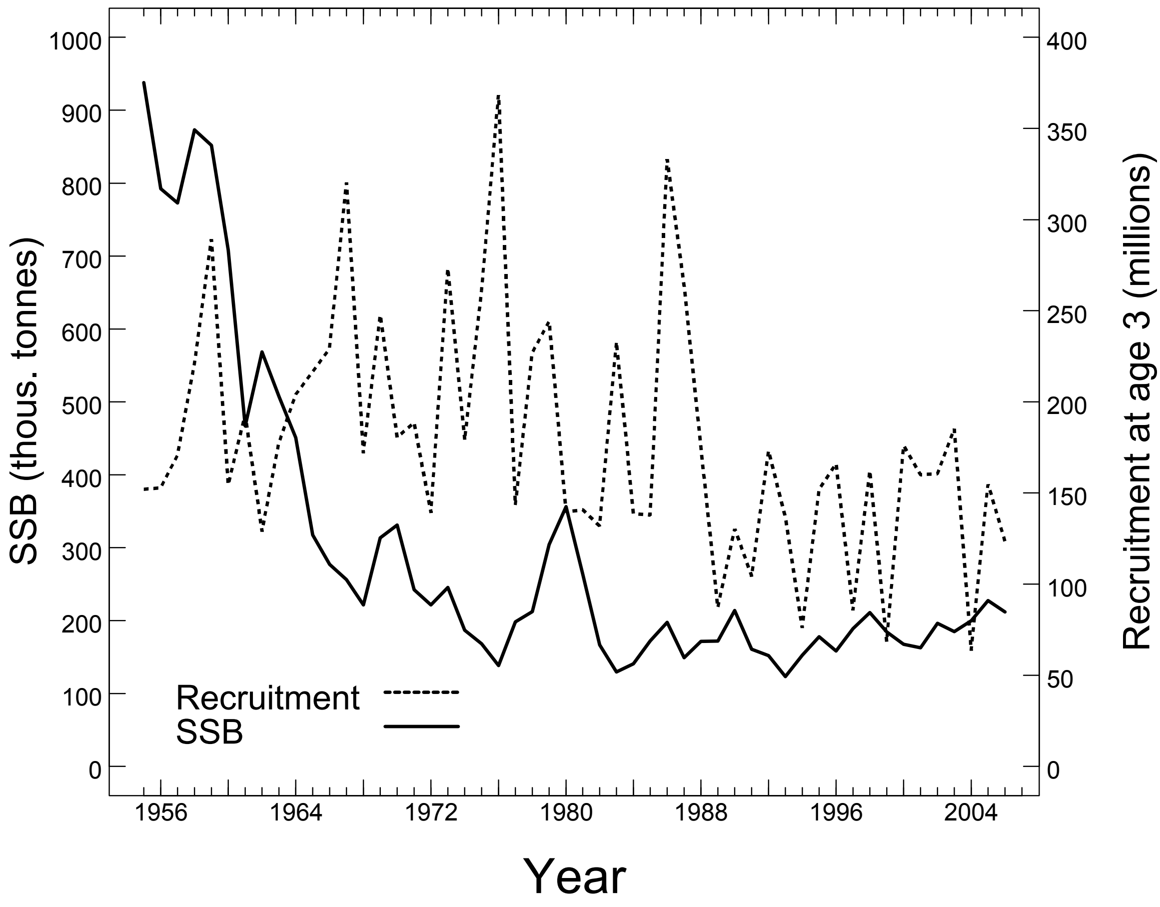


Figure 3.3.22B. Cod in division Va. Spawning stock biomass (SSB) and recruitment.

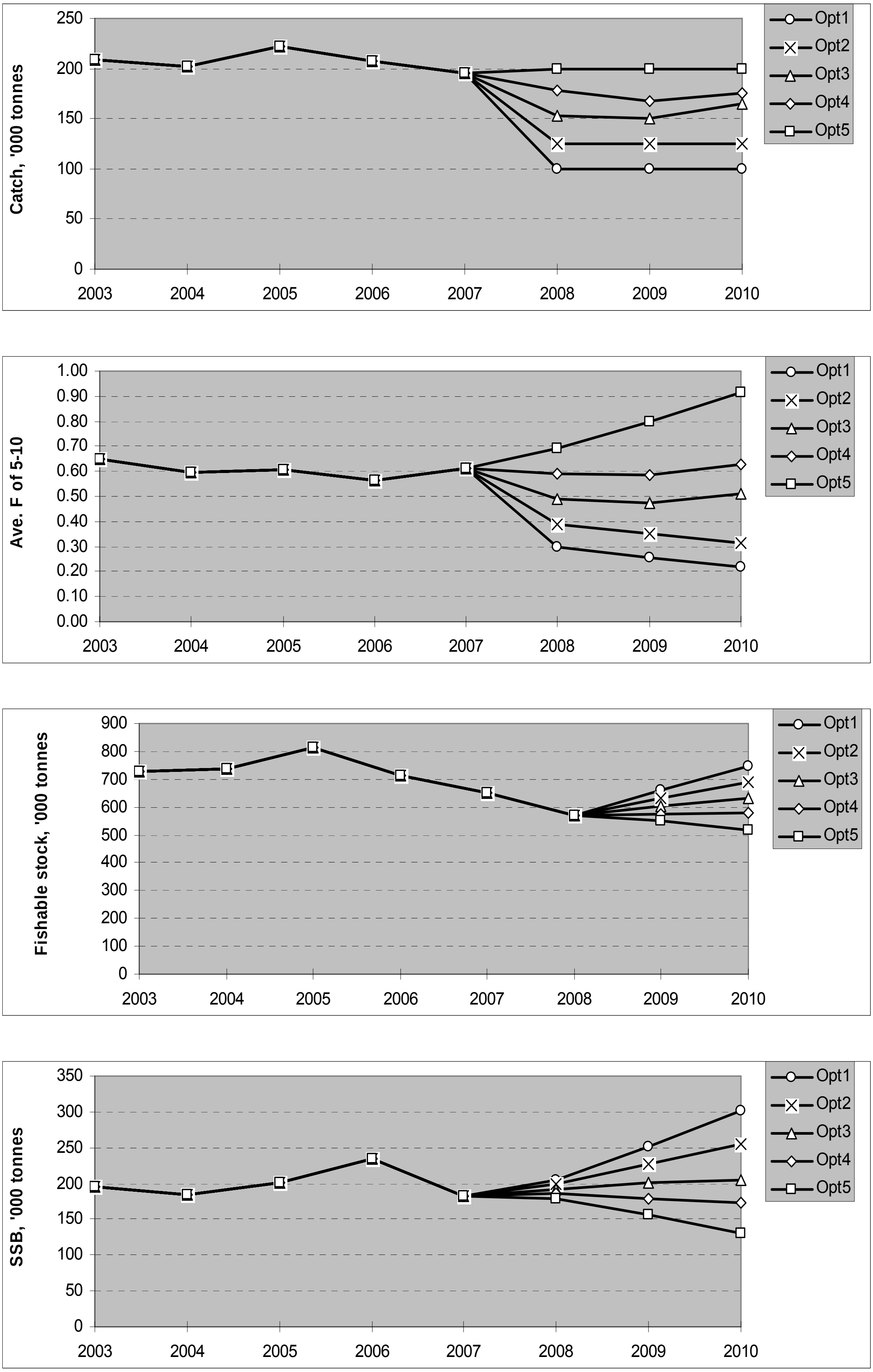
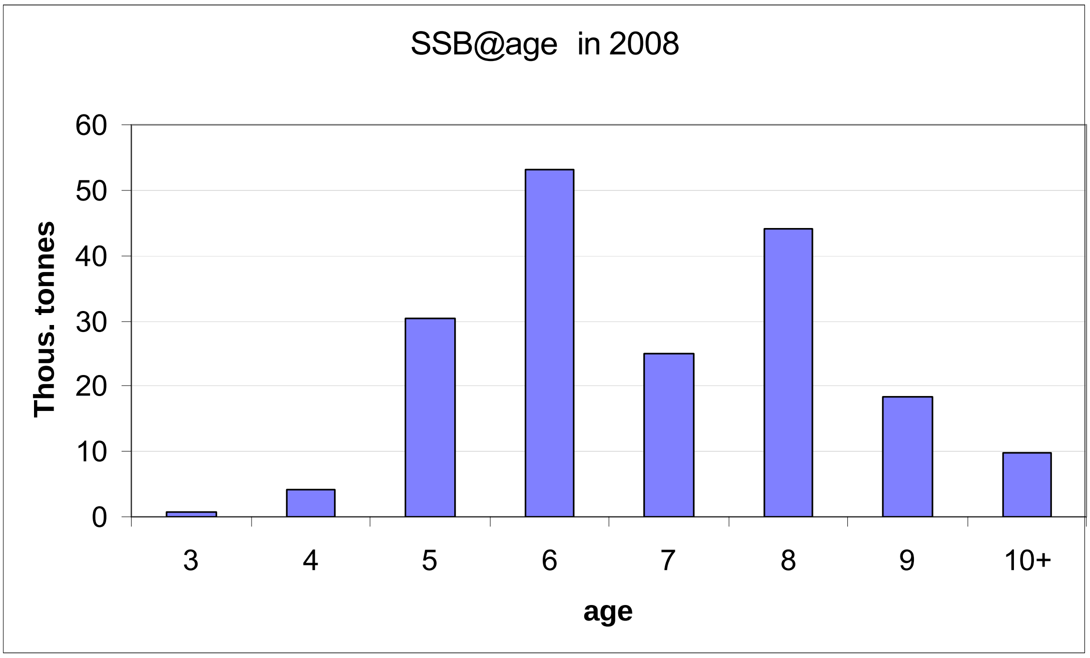


Figure 3.3.23a. Results of different management options.Opt4 corresponds to HCR.



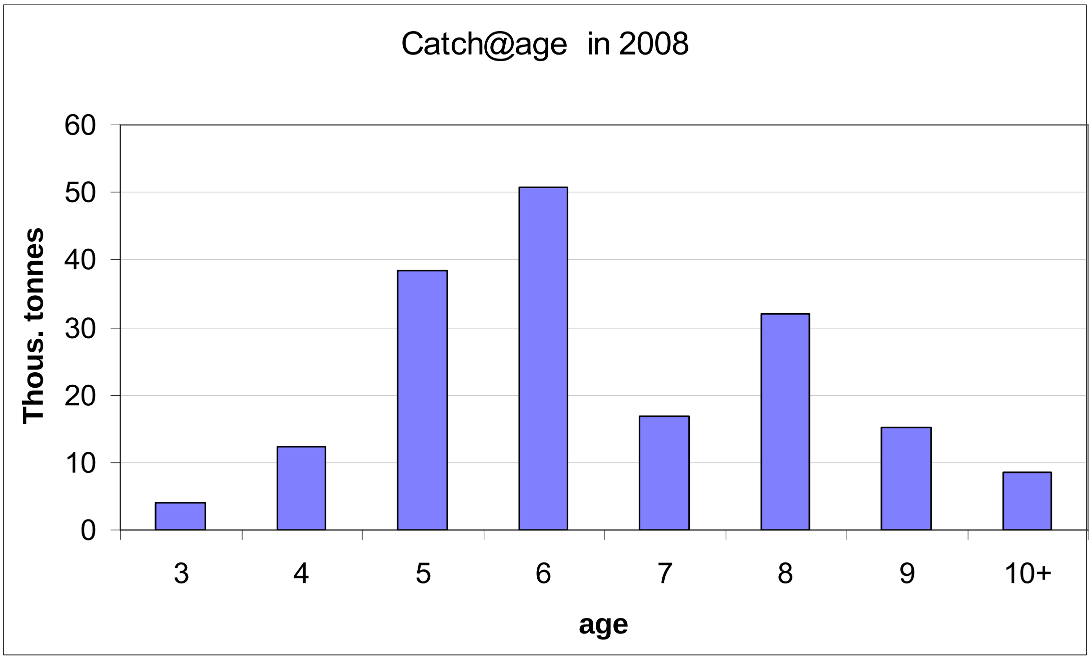


Figure 3.3.23B. Estimed age composition of the SSB and the catches in 2008.

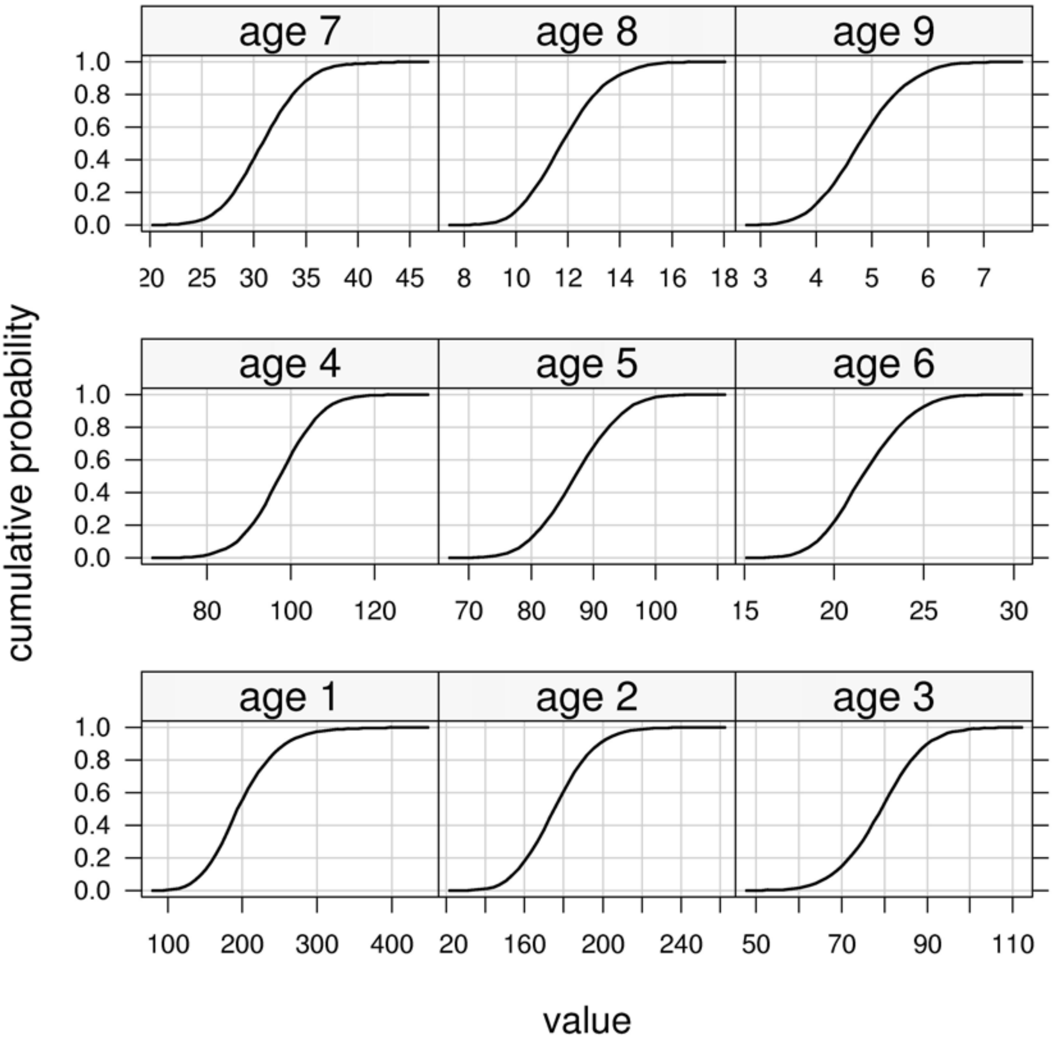


Figure 3.3.24.. Cod in division Va. Cumulative probability distribution of number in stock at the start of 2006.

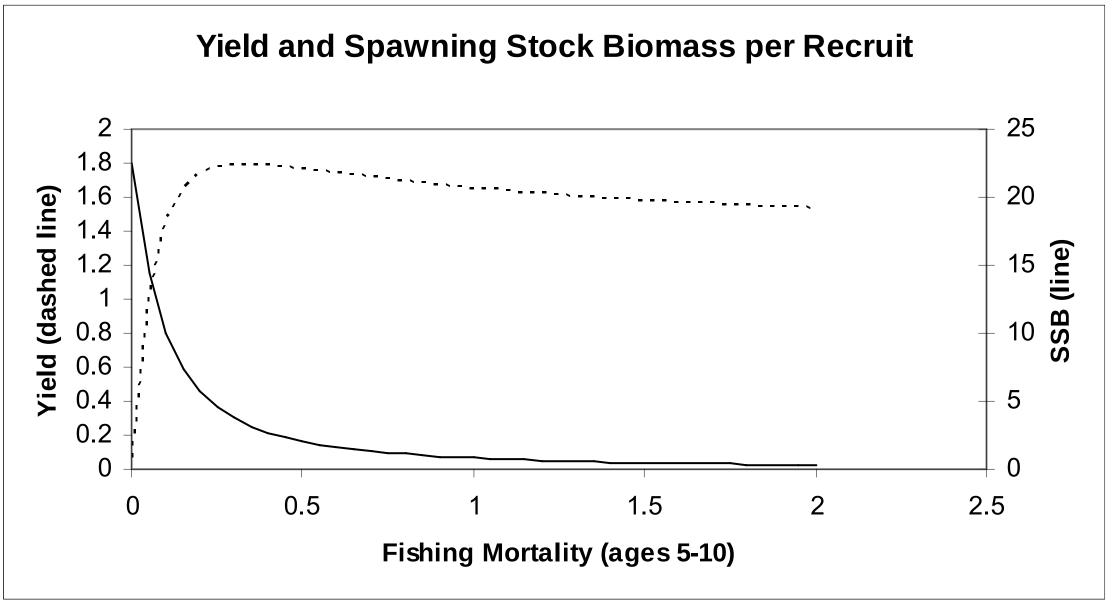


Figure 3.3.25 Yield per recruit

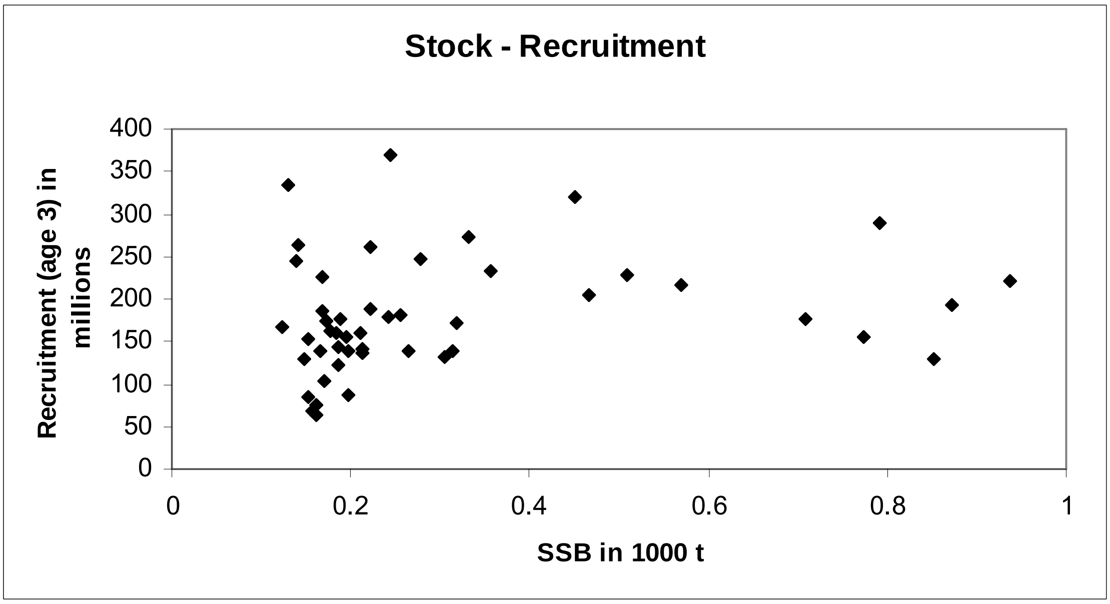


Figure 3.3.26 Spawning stock biomass and recruitment at age 3

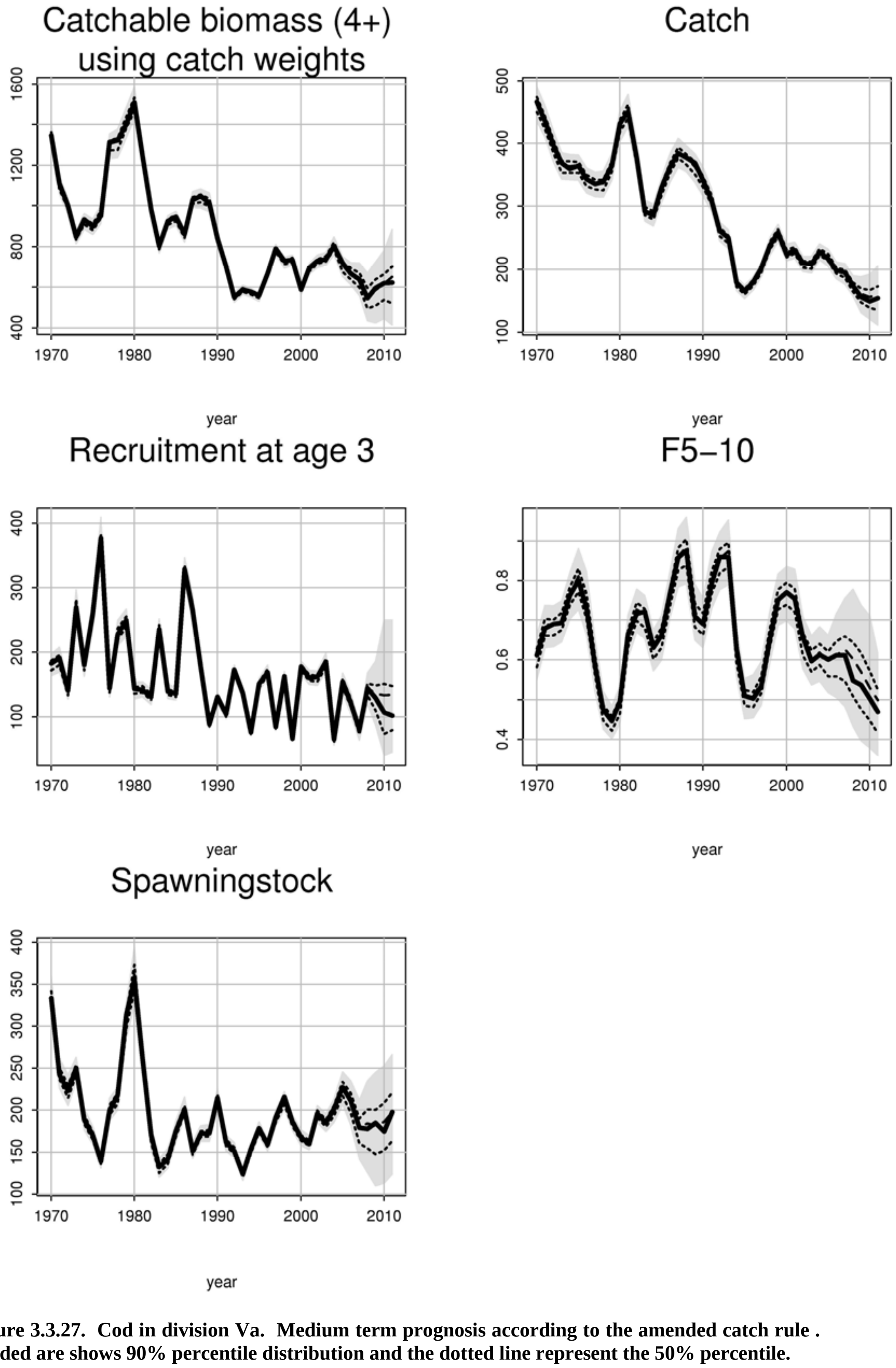


Figure 3.3.27. Cod in division Va. Medium term prognosis according to the amended catch rule . Shaded are shows 90% percentile distribution and the dotted line represent the 50% percentile.

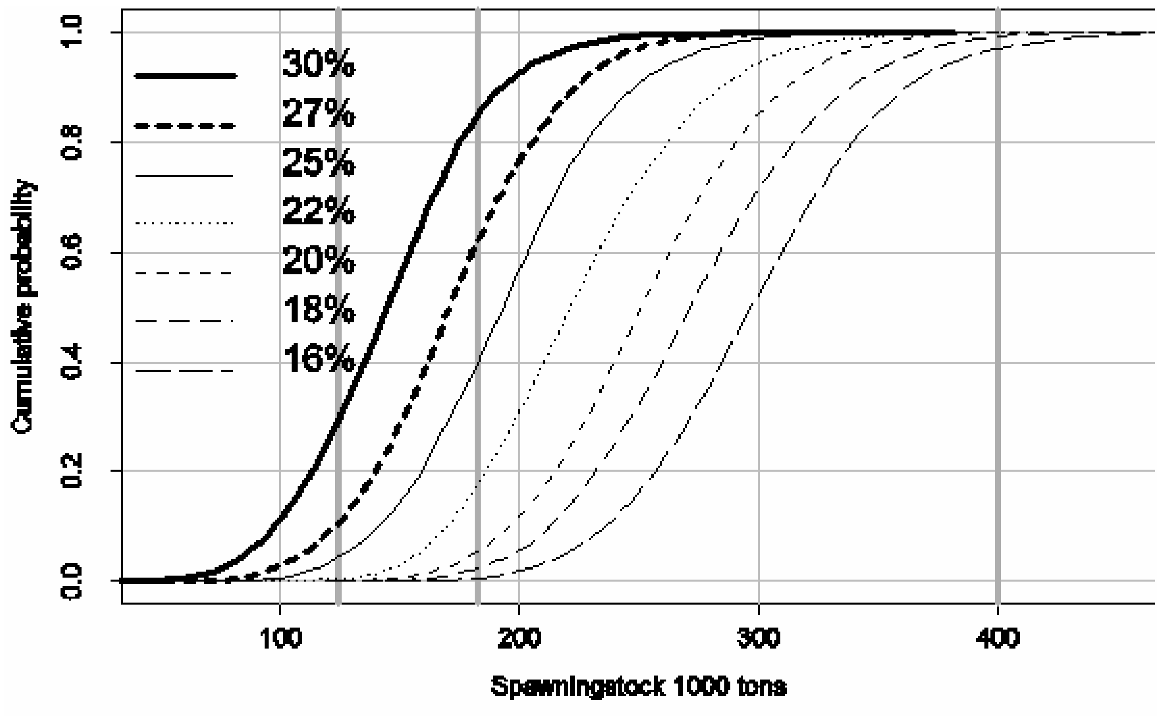


Figure 3.3.28. Cod in division Va. Cumulative probability of the size of the spawning stock biomass in 2011 according to different harvesting ratios (HCR).

3.4 Icelandic haddock

3.4.1 Executive summary.

There have been no changes in input data in the exception of addition of one year to the catch at age data and the surveys that are conducted in March and in October. Both surveys show a little decline but indicate that the stock is still very large due to good recruitment from year classes 1998-2003 and landings are currently at the highes level since early sixties or close to 100 kt.

Year classes 2004 – 2006 seem to be about average size.

Last years assessment was based on the March survey for tuning but it was noted that assessment based on the autumn survey seemed to indicate substantially less stock and recruitment. This year this difference between assessment of the stock based on the 2 surveys continued and it was decided to introduce a model run tuned with both the surveys.

Justifictation for this change are

- Less than predicted catches of age 3 and 4 in 2006.
- Landings in 2006 are well below prediction.
- Negative residuals of the March survey residuals in the final year of the assessment tuned with the March survey and positive residuals in the assessment tuned with the autumn survey. The run using both the surveys has close to zero average residuals for both the surveys in the final year .

In addition to using both the surveys the assessment was based on an Adapt type model instead of catch at age model (ADCAM) last year. The Adapt type model has better possibilities of estimating CV on each agegroup in both the surveys and as ADCAM has quite flexible selection pattern the resulting fishing mortalities are quite similar using the same data. 90% of the Adapt type is the same as in Adcam among it the survey part and the assessment is mostly survey driven.

Mean weight at age are currently at record low especially for the largest year class (2003). Prediction of growth last year succeeded reasonably well and the growth in 2006 is now estimated to be slightly better than in 2005 when it is the lowest on record.

Fisheries on Icelandic haddock are strongly size selective and last year a method was introduced where selection by age, catch weights and maturity at age are linked to stock weights (predicted for 2008). This procedure was repeated this year but the possibility of reducing the target F4-7 of 0.47 was considered but ages 4-7 is now a much smaller fish than in 2000 when the target F was proposed. It was estimated that the reference needed to be reduced to 0.35 based on size at age.

Depending on which assessment, reference fishing mortality and selection is used the proposed TAC for 2008 can be from the 95 th tonnes to 155 th tonnes as shown in the table below.

Assessment	March survey	Two surveys	March survey	Two surveys	March survey	Two surveys
Selection	Age based mean of last 5 years		Selection linked to mean weight at age in the stock.			
$F_{4\text{-}7}$ 2008	0.47		0.35		0.47	
Landings 2008	155	136	110	95	136	120

Discards has often been a problem in Icelandic haddock but is not expected to be an important issue in 2008 as year classes 2004-2006 are much smaller than year classes 1998 – 2003.

3.4.2 Introduction, trends in landings and fisheries

Icelandic haddock (*Melanogrammus aeglefinus*) is mostly limited to the Icelandic continental shelf but 0-group and juveniles from the stock are occasionally found in E Greenland waters. The species is found 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 north of Iceland. In warm periods the area inhabited by the stock in considerably larger than in cold period. Recent years have been relatively warm and all but one of the year classes from 1998-2003 ar estimated to be strong. The strong year classes of recent years have inhabited the waters north of Iceland as juveniles and there are even signals that at the moment substantial part of of the spawning might take place there. The good recruitment was probably due to favourable environmental conditions for haddock north of Iceland.

During the early sixties haddock landings were around 100 000 tonnes for six years (Figure 3.4.2.2) After that, landings have ranged 40 and 97 thousand tonnes highest in 2005 and 2006. Historically landings by foreign fleets accounted for up to half of the total landed catch. Since 1976 catches by foreign nations have been negligible except for the Faroese catches. Haddock landings are subject to fluctuations, reflecting great variability in stock biomass and recruitment.

The landings in 2006 were 97 thousand tonnes, similar to 2005. In last year the forecasted landings for the year 2006 were 110 thousand tonnes.

In 2006, 48% of landings were caught in demersal trawl, 13% in Danish seine, 38% on long line and 2% in gillnets. The share of bottom trawl has decreased in recent years but the share of longline and Danish seine is the highest on record(figures 3.4.2.1 and 3.4.2.3).

In recent years increasing percentage of the catches have been taken north of Iceland. (figures 3.4.2.4 and 3.4.5.13).

Discard is a larger problem in the Icelandic haddock fisheries than in other demersal fisheries in Icelandic waters. The discards have been estimated to be up to 50% of number caught and 22% of landings in 1997 (Pálsson 2003). In recent years discard of haddock has decreased, mostly due to reduced spatial overlap of the fisheries and recruitment. In 2005 the discards were estimated to be 5.2% of landings and 11% by number (Anon 2005). Most of the discard in 2005 took place in the bottom trawl fishery. Discard estimates for 2006 were not available when this report was written but compilation of comparison of catch in numbers based on sea and shore samples indicates that discard in 2006 was considerably less than in 2005. (figure 3.4.3.3) .Discards estimates are not used in calculations of catch in numbers by age. The effect on the current assessment is not substantial but historical recruitment estimates could be affected. The effect on assessment based on the autumn survey (1995-2005) is somewhat more questionable as period of highest discards (1996-1998) is approximately all within the autumn survey period. As described in Björnsson and Jónsson (2004) unreported of age 1 haddock caused by the fisheries could be a larger factor than discards but that is not a large issue in this assessment as year classes 2004-2006 are weak compared to earlier year classes. .

3.4.3 Catch at age

Catch at age for 2006 for the Icelandic fishery is provided in Table 3.4.3.1 and figure 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 2006 are given in the table 3.4.3.4

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. Catch in numbers was also compliled based on harbour samples only and sea samples only. One of the main problem with compiling catch in numbers is the difference between samples taken at sea and harbour samples. As discard of haddock is substantial (Pálsson 2003) the proportion of small haddock is considerably less in the harbour samples. This would not be a large problem if the catch in numbers are looked at as a time series except for the fact that proportion of sea samples vs. harbour samples might have changed in recent years. In 2006 the catch in number based on harbour samples was very similar to catch in numbers based on sea samples (figure 3.4.3.3)

The table below shows catch at age in 2006 in percent of number compared to last year's prediction showing that less than predicted was caught of the younger age groups and more of older age groups . Last year low mean weight at age was taken into account when modelling selection of the fisheries so the lack of younger age groups in the landings could indicate that the recruiting age year classes are smaller than estimated. Other factors like spatial distribution of the recruits outside the most important fishing areas could also be a factor.

AGE	2	3	4	5	6	7	8	9
Forecast %	0.62	21.9	35.9	7.11	22.8	8.5	2.9	0.33
Catch %	0.23	14.7	30.9	9.9	28.4	11.5	3.3	0.47

Figure 3.4.3.2 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 has decreased in the most recent years. The big 1976 year class is shown for comparison but the fishing mortality was low around 1980 so the 1976 year class did last for a long time in the fisheries sustaining substantial gillnet fishery in 1985 (3.4.4.1).. Figure 3.4.3.2 indicates that CV in these data is low. Shephard Nicholson model gives a CV of 26% for agegroups 3-8.

3.4.4 Weight and maturity at age

Mean weight at age in the catch is shown in table 3.4.4.2 and figure 3.4.4.2.

Mean weight at age in the stock for 1985–2007 is given in Table 3.4.4.1 and figure 3.4.4.1. 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 did not show any apparent trend but it seems like the large year classes (1990 and 1995) and sometimes the following year classes 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 was though above what is was for the 1990 and 1995 year classes until in 2006 when mean weight at age of all agegroups showed considerable declince compared to earlier year indicating slow growth in 2005. Mean weight at age in the 2007 survey is similar to what is was in the 2006 survey and the large 2003 year class has now as in 2006 the lowest mean weight at age on record. The data do indicate that growth of nearly all agegroups of haddock was slow in 2006 but it is though estimated to have been somewhat better than in 2005 (figure 3.4.7.1) . This slow growth could be a density dependent effect as the stock is now very large but there could be other explanations like lack of sandeel which has been observed in the last 3 years.

The catch weights show a similar drop in the early nineties as the stock weights but the reduction in recent years is not seen as clearly as the weights are only available till 2005 and weight at age of the recruiting year classes is to some extent controlled by the selection of the fisheries.

Maturity at age data are given in table 3.4.4.3 and figure 3.4.4.3. Maturity at age increased in the nineties compared to the eighties at the same time as mean weight at age decreased. In recent years maturity at age has been decreasing at the same time as mean weight at age has been decreasing. Maturity by size has though not changed much in recent years.

In tables 3.4.4.1 to 3.4.4.3 values used in prediction are highlighted and in figures 3.4.4.1 to 3.4.4.3 values used in prediction are shown by light grey bars.

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 figure 3.4.5.14 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 large increase between 2002 and 2005 but a little decrease since then. Both surveys give similar picture of devlepoment of the stock but the increase in biomass after 2002 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 due to relatively high catchability of age 1-3 haddock in the autumn survey.(figure 3.4.6.8) The catch curves and the plot of the abundance of same year class in the survey two adjacent year (figures 3.4.5.7 and 3.4.5.4) suggest that the March 2003 survey is an outlier for year classes 1998 and 1999 and the measurement error of the 2003 indices is fairly high (figure 3.4.5.2). Last three March and October surveys have been characterized by high indices with relatively low CV (figure 3.4.5.2), indicating high abundance and uniform 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 (figures 3.4.5.3 and 3.4.5.1) but they have increased much in both surveys. In short, looking at the total biomass both the surveys indicate large stock in recent years.

Indices of haddock above given size are given in table 3.4.5.19 and do not show as much increase in recent years due to slow growth of haddock. 45 cm is the minimum landings size of haddock (<30% must be below this size).

Age disaggregated indices from 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 to 2006 year classes seem to be considerably smaller than most recent year classes but if they are small or average sized in numbers depends on the reference period.

Figures 3.4.5.4 – 3.4.5.6 show the internal consistency of the March and the October survey as well as the consistency between the two surveys. The figure indicates that the consistency is very good but the dynamic range of the data is also very large, especially in age groups where the 2003 year class is included.

In figures 3.4.5.9 to 3.4.5.11 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 1985-2006. The plot for the March survey includes regression lines based on all data until 2003 and r^2 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 surveys indices are a good indicator of stock size and the relationship between survey indices and number in stock is close to linear for all age groups. Figure 3.4.5.9 does though indicate that ages 4 and 5 in the March survey in 2003 are outliers (as does figure 3.4.5.4) but that the most recent estimate (shown as intersection of dashed lines) are overestimates in the SPALY assessment calibrated with the March survey. Figure 3.4.5.11 indicates that indices from the autumn survey fit well with results from assessment based on the March survey, confirming what is seen in figure 3.4.5.6. Figure 3.4.5. shows indices from the March survey plotted on log scale against the SPALY run with a line of slope 1 (on log-log scale) fitted through the data. Compared to figure 3.4.5.9 the large 2003 year class is here close to the fitted line but in figure 3.4.5.9 it lies to the right of the line so fitting the data on log scale (as assessment models do) predicts this year class larger than fitting on ordinary scale.

The surveys indicate that in some recent years increasing proportion of the incoming year cohorts has been in the northern part of the survey area (figures 3.4.5.12, 3.4.5.13 and 3.4.5.14) where fishing effort has been relatively low. 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 the years 1999-2004 can explain why discards reduced in that period and the year classes became stronger in every new survey (Björnsson and Jónsson 2004). The March survey does indicate that spatial distribution of haddock could be changing again as small part of year classes 2005 and 2006 is in the north (figure 3.4.5.14).

CPUE from the commercial fleet is shown in figure 3.4.5.16. 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 a decrease between 2006 and 2007 but are still at relatively high level compared to the period before 2003. (It must be noted that the longline data are only comparable from 2000 onwards). The increase in CPUE after 2001 is though much smaller than observed in the surveys. Figure 3.4.5.17 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 displays a continuous increase in effort since the year 2000 for longlines and Danish seine and since 2002 for bottom trawl. Looking at the period 2000-2006 the trends in fishing mortality (figure 3.4.6.1) and effort are somewhat contradictory with effort increasing but fishing mortality decreasing.

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.
- Even distribution of haddock indicated by the surveys might reduce CPUE of commercial fisheries.
- The method used here before to calculate effort for figure 3.4.5.16 is conceptually wrong when landings are increasing.
- The assessment is an overestimate of the stock.
- Slow growth of haddock leads to F 4-7 underestimating effort changes in recent years (see chapter 3.4.7.1).

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 that the fishery does not quite follow change in spatial location of the stock (figure 3.4.5.13). 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 3.4.5.18 and 3.4.5.19. Figure

3.4.5.18 indicates that number caught, calculated in this way are not very far from official catch in numbers and Figure 3.4.5.19 that fishing mortality (by bottom trawl) might have been decreasing in recent years until 2005 when it stabilizes. This is in line with figure 3.4.2.1 which shows that the increase in haddock fisheries in recent years has mostly been taken by longliners .

3.4.6 Stock Assessment and recruitment estimates

As in recent years the assessment this year was based on a number of different models, and settings. Most of the models 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 that has now been conducted for 12 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 #34.

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 year 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 2008 assuming F4-7 =0.35 in 2008 and 105 000 TAC constraint in 2007 is shown for some of the models.

Summary of results from different assessment models.

	F4-7 2006	Biom 3+ 2007	Std.Er in 3+ bio	N7-2007	N5-2007	N4-2007	F 2007 105kt	Tac 2008
XSA March survey 2-9*	0.47	337		25.7	81.4	267.2		
TSA March survey*	0.53	305	34	17.9	63.7	251.6		
Adapt March survey	0.65	343	37	18.2	77.4	309		
Last years spaly ADCAM *	0.616	336	31	17.1	75.0	298.6	0.42	112
Adapt Autumn survey 1-9	0.68	245	27	16.3	51.4	207.9		
Adcam Autumn surve 1-9	0.68	235	22	14.5	49.7	197.4	0.63	68
Adapt both surveys	0.65	300	25	17.7	64.7	261.4	0.48	95
Last years SPALY assessmement using data available 2006		322		17.2	77.7	289	0.44	

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

In addition to the stock assessment models the RTC3 model was used for estimating recruitment. The TSA model has changed from last year so now estimation of stock size and recruitment is done in the same program.

Recruitment age 2 (million)

Year class	Last years asessment	RTC3 March survey	Adapt AUtums urvey	XSA MARCH SURVEY age 1+	ADCAM Spaly	ADAPT 2 surveys	TSA March survey	TSA Oct survey
2002	204	210	143	193	186	167	159	
2003	466	428	325	441	461	405	380	
2004	83	76	47	69	72	65	66	
2005	65	60	53	57	57	57	53	
2006		66		56	68	56	55	

***numbers are geometric mean**

The results vary widely but 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. Those contradictory results are somewhat surprising if figure 3.4.5.11 is investigated but the figure shows indices from the autumn survey vs. stock estimate from the March survey.

The results from the SPALY ADCAM run from last year are shown in Figures 3.4.6.1 to 3.4.6.5 and results from a run based on the autumn survey are shown in figures 3.4.5.6 to 3.4.5.8.

Recruitment of haddock was much above average from year classes 1998 – 2003 (figure 3.4.5.14) and fishing mortality decreased until 2004 but increased again in 2005 and 2006. Two years ago the use of inertia factors was questioned as fishing mortality had been decreasing for a number of years. This year that issue could be also important as fishing mortality seems to be increasing again. Linking certain age group with the same agegroup few years ago might though be questionable as the mean size at age had decreased.

As in last years assessment the stock is outside historical range (range of the tuning series) and the stock assessment can be looked at as an extrapolation. This applies especially to the 2003 year class whose size is estimated to be more than twice the size of any year class seen since the late fifties. Features like stock size dependent catchability could in this case be affecting the abundance in the surveys even though they have not been noted before.

The discrepancy between assessment based on the autumn survey and the March suvey is a concern. There are indications in figure 3.4.6.1 and 3.4.6.4 that most age groups in the March survey 2007 are above model predictions and figures 3.4.6.6 and 3.4.6.7 indicate that results from the autumn survey 2006 are above model predictions. Comparison of figures 3.4.5.9 and 3.4.5.10 regarding year class 2003 at age 4 indicate that the estimate of its strength could be dependent upon the type of scale used (log or ordinary). In addition the fact that less than expected was caught of the 2002 and 2003 year classes in 2006, in spite of reasonably correct weight prognosis could indicate that these age groups are less abundant than last years assessment indicated. That the landings in 2006 were below prediction could also be an indicator that the stock size is below predictions. The result of these considerations was to use a model based on both the surveys as basis for prediction.

In addition to using both the surveys the assessment was based on an Adapt type model instead of catch at age model (ADCAM) last year. The Adapt type model has better possibilities of estimating CV on each agegroup in both the surveys and as ADCAM has quite flexible selection pattern the resulting fishing mortalities are quite similar using the same data. 90% of the code Adapt type model is the same as in Adcam, among it the survey part but the assessment of Icelandic haddock is mostly survey driven.

The main feature of the Adapt type model are.

- Back calculations using Popes approximation. Age range 1-9 with age 9 not a plus group. Fishing mortality of age 9 assumed to be mean of ages 8 and 7.
- 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 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 all age groups in both surveys is estimated .
- Correlation of the residuals of different age groups in the surveys is estimated and the residuals assumed to follow a multivariate normal distribution. The correlation between different ages i and j is |i-j|. where is the estimated correlation coefficient. The estimated correlation coefficient for the March survey is 0.57 but the Autumn survey 0.58 indicating more year blocks in the March survey. Residuals for ages 1 and 2 are assumed uncorrelated with the rest.
- Catchability in survey was independent of stock size for all ages. (See figures 3.4.5.9 and 3.4.5.11 for justification)

There are a number of possible reasons for the some possible explanations for the year blocks in the March survey.

- 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 while residuals of ages 1 and 2 are assumed to be uncorrelated with the rest in the Adapt model. Modelling of the correlation of survey residuals has in earlier assessment explained most of the differences between results from ADCAM and TSA based on the March survey compared to XSA. In 2007 the TSA model gives somewhat lower estimates than the other assessment models based on the March survey and the results are closer to the results from Adapt using both the surveys for tuning (see table above).

Results from the selected run are shown in figures 3.4.6.9 – 3.4.6.11. Figure 3.4.6.11 shows the estimated catchablity and CV of the surveys but the weight given to each age group are inversely proportional to square of the CV. The model was also run with the March survey data limited to the years 1995 – 2007 to see if the length of the series affected the estimated CV's in the survey. The result was that it limiting the series to 1995-2007 did not affect the results much.

Figure 3.4.6.12 shows the calculated and observed survey biomass for single survey runs based on the March and the autumn survey and run using both the surveys. (The biomasses for the autumn survey are calculated using mean weight at age from the March survey so they are an underestimate of the "real survey biomass"). The figure shows that in the run using both the surveys the observed and predicted survey biomass agree for both the surveys in the most recent year but are quite far off in some earlier years, especially in 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, figures 3.4.4.1 to 3.4.4.4 and tables 3.4.6.2 and 3.4.7.2. As may be seen in the figures weight at age in the stock (survey) is very low in 2007 as it was in 2006 and the predicted weights in coming years are also very low.

Prediction of weight at age in the stock, weight at age in the catches, maturity at age and selection is described in working paper #19 last year. To summarize the findings of working paper #19 the stock weights are predicted forward in time starting with the weights from the March survey 2007 and a model where growth was predicted as a function of weight at age and a year effect.

$$\log \frac{W_{a+1,t+1}}{W_{a,t}} = \alpha + \beta \log W_{a,t} + \delta_{year}$$

Figure 3.4.7.1 shows the estimated year effect indicating slow growth in two last years. Last year the yearfactor for the year 2005 was used as basis for prediction of growth in 2006 and 2007 leading to slight underestimation of stock weight at age in 2007 as growth in 2006 seems to have been a little better than in 2005. This year the procedure is repeated i.e the 2006 growth was used for the years 2007 and 2008.

Mean weight at age in the catches is predicted from mean weight at age in the stock the same year by an equation of the form

$$\log Wc_{a,t} = \alpha + \beta \log W_{a,t}$$

Figure 3.4.7.2 shows the data and the fitted relationship. The fitted relationship predicts that catch weights will be below stock weights when the latter are above 3100g but there are no indications in the near future that the mean weight of any agegroup will reach that value.

Maturity at age was predicted from mean weight at age in the stock by an equation of the form

$$\log it(P_{a,t}) = \alpha + \beta \log W_{a,t}$$

The data and the fitted relationship are shown in figure 3.4.7.3. The fitting is done separately for the period 1985 – 2000 and 2001 – 2007 with the latter relationship used for prediction.

Haddock fisheries in Icelandic waters tend to avoid small haddock so when growth is slower the year classes recruit slower to the fisheries. Figure 3.4.7.4 shows the relationship between mean weight at age in the stock and selection at age of the fisheries with a curve fitted to the data. The selection is assumed to be flat when mean weight at age in the stock exceeds 2 kg.

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 mean weight at age is now much lower than it was in the years 1985 – 2000 the reference mortality is does now apply to much smaller fish than in the period 1985 – 2000 so she same value of F4-7 will lead to higher fishing mortality of the size fully recruited to the fisheries. To clarify an example can be taken when growth so slow that fish of age **a** in 2007 was of similar size than fish of age **a-1** in the reference period and F4-7 was the reference F then F5-8 should be set at the reference value in 2007.

Figure 3.4.7.5 shows the mean weight at age in the stock in 1985-2000 and predictions for 2008 and the predicted selection from those weights. The predicted mean selection of ages 4-7 in 2007 is only 75% of the value obtained from the 1985-2000 curves so the F4-7 in 2008 should be 0.47x0.75 or 0.35. The year classes following the 2003 year class are all much smaller than the 2002 and 2003 so unweighted fishing mortality becomes somewhat questionable in coming years. In 2008 the fisheries will mostly be 5 and 6 year old haddock and in 2009 6 and 7 year old. In 2009 the most important age groups in the fisheries will be 6 and 7 years old so the justification of lowering F below Fpa will probably not be valid even though growth continues to be slow.

Stock numbers in the year 2007 and recruitment in 2007 – 2008 were obtained from the Adapt type model based on both of the surveys and the same model was used for prediction as for asessment.

A TAC constraint of 105 000 tonnes was used for the year 2007. The estimate was the sum of the TAC for the fishing year starting September 1st 2006 that was remaining in the beginning of 2007 and 26% of the estimated TAC for the fishing year 2007-2008 but 26% of the TAC for the fishing year 2006-2007 was taken in the year 2006. 26% for the first 4 months of the fishing year is very low proportion and could be an indication that the quota will not be caught. Looking at the development of the landings for the first 4 months of 2007 they are similar to 2006 when the landings are estimated to be 97 000 tonnes.

In the prognosis last year a TAC constraint of 110 000 t was used for the year 2006 while the landings are now estimated to be 97 000 tonnes.

Stochastic short term prognosis were done using the Adapt type model. Recruitment after the 2006 year class was assumed to be lognormally distributed with the mean equal to the geometric mean of the recruitment 1979 – 2005 (60 million at age 2) and CV the estimated CV of the recruitment in the same period. The F of 0.35 was used for the years 2008 and later. (The prognosis is also presented based on F=0.47) 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, as changes in weight at age are usually not predicted. .

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 3.4.7.3. and figure 3.4.7.6. It should be noted that the the yield per recruit analyzes were not updated this year and the results are from last year.

Compared to the estimated fishing mortality of F4–7=0.65 for 2006, Fmax=0.44 and F0.1=0.16.

Yield per recruit at Fmax corresponds to 0.88kg. (Table 3.4.7.2). Mean weight at age as observed in the most recent years would give considerably lower yield per recruit.

A plot of spawning stock biomass and recruitment from 1981- 2006 is shown in Figure 3.4.7.7 and a plot of recruitment vs. spawning stock in figure 3.4.7.8.

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 2007/2008 falls withing the calendar year 2007 and 2/3rd within the calendar year 2008. The TAC for the next fishing year will therefore be 1/3rd of the landings in 2007 plus 2/3rd of the advice for 2008.

3.4.7.3 Projection of catch and biomass

Results from short term prediction based on the Adapt run using both the surveys are shown in table 3.4.7.5 and in table for 3.4.7.4 short term prediction based on the ADCAM run tuned with the March survey (last years SPALY) .

At the beginning of 2007, the biomass of age 3+ is predicted to be 300 thousand tonnes with a spawning stock of 164 thousand tonnes according to the Adapt run tuned with both the surveys. Comparable numbers for the SPALY run from last year are 337 and 182 thosand tonnes.

With a catch of 105 000 t in 2007, fishing mortality is estimated to be 0.48 and at the start of 2008 the biomass of age 3+ is predicted to be 285 000 t and the spawning stock 192 000 tonnes. Landings in 2008 will be 95 000 tonnes if F4-7=0.35 but 120 000 tonnes if F4-7 = 0.47. .

In section 3.4.7.1 manipulations to predict selection from mean weight at age, possible changes in target F from 0.47 to 0.35 and other factors are discussed. The effect of those factors on the catch in 2008 are shown in the table below.

Assessment	March survey	Adapt both surveys	March survey	Adapt both surveys	March survey	Adapt both surveys
Selection	Age based mean of last 5 years		Selection linked to mean weight at age in the stock.			
$F_{4\text{-}7}$ 2008	0.47		0.35		0.47	
Landings 2008	155	136	110	95	136	120

Figure 3.4.7.9 shows the output of the short term prognosis including errors in mean weight at age and assessment errors, assuming F4-7=0.35 after 2007. It indicates that the landings will be near 100 thousand tonnes for some years but the uncertainity is considerable. The projections indicate the landings will begin to drop after 2009 but the landings in 2010 and later will in the end depend on the size of year class 2007 and later year classes. Lower fishing mortality leads to the the 2003 year class lasting longer. Figure 3.4.7.10 shows the same things based on F=0.47.

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.

As described in Björnsson and Jónsson (2004) discard and other hidden mortality, most likely caused by the fisheries might be a potential problem for haddock stock. The hidden mortality by mesh penetration is predicted to be highest for ages 1 and 2. The problem has been relatively small in recent years due to relatively little spatial overlap between the fishing effort and the recruits and it will probably be small in 2008 when agegroups 5 and older will be much more abundant in the stock than the younger age groups. Increased proportion of haddock caught by longliners could also reduce this problem.

Catches of Icelandic haddock are very size selective and fishermen try to avoid small haddock. Basing the advice on a constant fishing mortality for a given age age range will in years of low mean weight at age increase effort towards larger fish. Linking reference fishing mortality to certain size range would help in solving this problem.

Predictions indicate that landings will start to decrease after 2009 as the 2003 year class disappears from the fishery. Lowering fishing mortality will cause the current large year classes to last longer in the fishery but the landings will be lower in next 2-3 years but higher after that.

Instead of basing the advice on fishing mortality the advice could be based on yield divided by index of haddock above certain size as shown in figure 3.4.5.19. In that case growth would have to be considered and the advice based on biomass of > 40cm or > 45cm in the assessment year.

3.4.9 Comments on the assessment

The current assessment was done using groundfish surveys in March and October for tuning.

The assessment presented here gives F_{4-7}=0.66 in 2006 which is an increase from 2005 when F_{4-7} is now estimated to have been 0.54

This years assessment gives a more pessimistic view of the stock of the stock than last years assessment mostly caused by inclusion of the autumn suvey in the tuning. The autumn survey has not been used directly for tuning in recent year but it has been noted that assessment using the autumn survey gives substantially lower recruitment estimates than assessment using the March survey. This year other factors like less than predicted number of younger age groups in the catches and lower than predicted catches could indicate that the stock is not strong as previously thought.

Growth of haddock continues to be slow but has improved slightly from record low in 2005 Mean weight at age are now near historic low and below it for the 2003 year class. The slow growth causes the the strong year classes from 2002 and 2003 to recruit late to the fishery but the prognosis is set up to take care of that.

Biomass of age 3+ in 2007 is now estimated to be 300 thousand tonnes but was estimated to be 336 tonnes last year, the difference is nearly all caused by changed tuning fleets

This year work from last year predicting mean weight at age in the catches, maturity at age and selection from mean weight at age in stock is repeated. In addition it is considered to lower the target fishing mortality from 0.47 to 0.35 to account for slow growth.

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, more so if the autumn survey is used for tuning. 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 classes might have been seen in that period.

Many of the manipulations described in this report are caused by the fact that the assessment is based on a catch at age model while selection of the fisheries and possibly maturity is more related to size of the fish. In period of large change in growth a length based model like GADGET might be more appropriate.

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	2005	2006
Belgium				
Faroe Islands	833	1035	1372	1499
Iceland	59970	83791	95859	96115
Norway	30	9		
UK	51			
Total	60884	84835	97231	97614

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
2005	1577	9580	7169	25996	14108	4841	837	250
2006	**157**	**9930**	**20900**	**6688**	**19218**	**7806**	**2257**	**316**

Table 3.4.4.1 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	33	127	333	736	1145	1512	1944	2232	3272
2007	48	170	350	615	1053	1514	1786	2073	2198
2008	48	190	401	641	946	1396	1819	2049	2279
2009	48	190	430	703	975	1291	1715	2076	2261

Table 3.4.4.2 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	398	848	1212	1469	1898	2271	2952	3141
2006	429	723	1087	1496	1754	2167	2591	2923
2007	450	728	1058	1512	1924	2147	2371	2464
2008	485	796	1087	1408	1823	2173	2352	2525
2009	485	834	1156	1436	1731	2090	2373	2511

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	2.7	11.7	46.2	62.1	73.9	91,8	100	100
2007	0	2.2	12.9	39.6	71.1	84.2	89.7	93.1	94.4
2008	0	2.2	15.3	37.5	62.5	81.3	88.4	91.6	93.7

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
2006	38.39	90.06	575.79	179.18	18.92	62.94	16.24	6.74	0.7	0.29
2007	34.01	66.06	88.56	436.14	85.73	7.78	21.61	4.74	2.06	34.01

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
2005	98.52	73.87	530.9	171.08	24.38	81.16	23.04	9.29	1.68	0	0.13
2006	0.31	4.03	3.95	14.04	22.11	8.15	14.87	6.18	1.99	0.99	0.15

Table 3.4.6.1 Haddock in division Va. Summary table from the SPALY run using the March survey for tuning.

year	Recruitment at age 2	Biomass 3+ tons	SSB tons	Landings tons	Yield/SSB	F_{4-7}
1979	78834	163141	95978	59190	0.62	0.53
1980	37256	191830	116121	50902	0.44	0.44
1981	9678	204404	139244	63491	0.46	0.49
1982	42484	179362	136050	68533	0.5	0.46
1983	30324	144745	109610	64698	0.59	0.49
1984	18695	111479	81342	48121	0.59	0.51
1985	42570	99196	63716	50261	0.79	0.56
1986	87734	92294	55652	47272	0.85	0.71
1987	166422	104786	44243	40132	0.91	0.66
1988	43835	153653	67127	53871	0.8	0.66
1989	24793	169227	100441	62712	0.62	0.63
1990	23642	142974	109962	67038	0.61	0.61
1991	81112	118203	87202	54694	0.63	0.62
1992	167614	103349	65133	47026	0.72	0.7
1993	35955	128756	69645	48737	0.7	0.69
1994	39418	124369	80535	59007	0.73	0.68
1995	70902	118420	80760	60111	0.74	0.67
1996	36210	105240	67771	56716	0.84	0.7
1997	99446	86329	57731	44006	0.76	0.65
1998	16627	95368	62790	41374	0.66	0.68
1999	49586	87240	61619	45231	0.73	0.72
2000	119784	85858	59445	41870	0.7	0.67
2001	152682	112158	67105	39530	0.59	0.55
2002	183297	164598	95948	50294	0.52	0.49
2003	46024	214887	143797	60598	0.42	0.45
2004	187104	244395	175720	84405	0.48	0.47
2005	460981	263764	173918	96655	0.56	0.54
2006	72865	328307	146796	97366	0.66	0.62
2007	57166	336771	181949	105125	0.58	0.43
2008	67762	328689	223286	109588	0.49	0.35
Mean 79-06	85027	160126	100688	60618	0.64	0.58

Table 3.4.6.2 Haddock in division Va. Number in stock from the SPALY run using the March survey. Shaded cells are input to prediction

Year/age	1	2	3	4	5	6	7	8	9
1979	45.5	78.8	120.3	26.8	20.1	21.2	3.2	0.8	0.1
1980	11.8	37.3	64.3	96.3	18.4	10.8	8.7	1.1	0.3
1981	51.9	9.7	30.1	51.4	69	11	5	3.4	0.4
1982	37	42.5	7.9	24.1	37.3	40.8	4.5	1.8	1.2
1983	22.8	30.3	34.7	6.2	17.1	21.6	19.5	1.7	0.6
1984	52	18.7	24.8	27.7	3.9	9.7	9.1	8.1	0.6
1985	107.2	42.6	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	1.3
1987	53.5	166.4	71.6	24.9	5.8	5	2.8	0.3	0.5
1988	30.3	43.8	134.6	52.2	13.6	2.4	1.9	1.1	0.1
1989	28.9	24.8	35.7	100.8	29.1	5.9	0.9	0.7	0.3
1990	99.1	23.6	20.2	26.9	61	14.8	2	0.3	0.2
1991	204.7	81.1	19	14.5	15.6	29.1	5.8	0.7	0.1
1992	43.9	167.6	64.3	14.2	8.4	7.1	11.4	2.1	0.2
1993	48.1	36	134.8	46.2	7.8	3.5	2.5	3.9	0.6
1994	86.6	39.4	29.2	99.7	26	3.3	1.3	0.8	1.2
1995	44.2	70.9	32	21.2	58.1	11.2	1.2	0.4	0.2
1996	121.5	36.2	56.1	21.3	12.3	26.4	4	0.4	0.1
1997	20.3	99.4	28.6	37.6	11	6	9.5	1.2	0.1
1998	60.6	16.6	80.1	20	20.3	4.7	2.6	3.2	0.4
1999	146.3	49.6	13.4	58.1	10.6	8.8	1.8	0.9	0.9
2000	186.5	119.8	39.7	9.6	32.5	4.1	3	0.6	0.3
2001	223.8	152.7	96	26.9	5.7	14.6	1.5	1	0.2
2002	56.2	183.2	123.1	68.6	15.8	3.2	6.4	0.5	0.3
2003	228.4	46	149	91.4	41.9	8.4	1.6	2.5	0.2
2004	563	187	37.4	115.5	60.2	22.7	4.2	0.7	0.8
2005	89	460.9	151.9	27.2	78	31.9	10.7	1.7	0.2
2006	69.8	72.9	376	115.7	15.9	41.3	13.4	4.2	0.5
2007	82.8	57.2	59.5	298.6	75	7.1	17.1	4.3	1.3
2008	73.1	67.8	46.4	46.6	209	43.1	3.5	7.8	1.8
2009	73.1	59.8	54.9	35.9	32.7	129.4	23	1.7	3.6
2010	73.1	59.8	48.5	42	24.5	20	70.8	11.2	0.8
2011	73.1	59.8	48.5	37.1	28.4	14.7	10.9	35.6	5.1

Table 3.4.6.3 Haddock in division Va. Fishing mortality from the SPALY run using the March survey.

Year/age	2	3	4	5	6	7	8	9
1979	0.004	0.023	0.174	0.423	0.69	0.85	0.85	0.85
1980	0.014	0.023	0.133	0.311	0.573	0.743	0.859	0.859
1981	0.004	0.021	0.12	0.325	0.7	0.8	0.874	0.874
1982	0.002	0.034	0.146	0.346	0.54	0.789	0.901	0.901
1983	0.001	0.025	0.259	0.364	0.662	0.673	0.906	0.906
1984	0.004	0.038	0.236	0.428	0.715	0.642	0.903	0.903
1985	0.009	0.12	0.329	0.488	0.744	0.689	0.94	0.94
1986	0.003	0.129	0.44	0.643	0.959	0.787	0.96	0.96
1987	0.013	0.115	0.402	0.686	0.772	0.77	0.966	0.966
1988	0.004	0.089	0.384	0.638	0.817	0.805	0.982	0.982
1989	0.005	0.086	0.302	0.476	0.904	0.838	0.994	0.994
1990	0.019	0.134	0.346	0.541	0.73	0.83	0.99	0.99
1991	0.032	0.088	0.347	0.591	0.735	0.821	0.995	0.995
1992	0.018	0.131	0.404	0.68	0.838	0.863	0.999	0.999
1993	0.008	0.102	0.373	0.651	0.8	0.939	1	1
1994	0.009	0.123	0.34	0.647	0.792	0.959	1.01	1.01
1995	0.034	0.205	0.341	0.589	0.82	0.942	1.041	1.041
1996	0.035	0.201	0.463	0.519	0.825	0.973	1.048	1.048
1997	0.016	0.16	0.416	0.643	0.654	0.895	1.037	1.037
1998	0.015	0.121	0.436	0.631	0.791	0.843	1.026	1.026
1999	0.023	0.132	0.381	0.744	0.876	0.879	1.009	1.009
2000	0.022	0.189	0.326	0.598	0.832	0.926	0.997	0.997
2001	0.015	0.136	0.331	0.377	0.623	0.855	0.977	0.977
2002	0.007	0.097	0.293	0.432	0.488	0.755	0.965	0.965
2003	0.007	0.055	0.217	0.412	0.498	0.667	0.958	0.958
2004	0.008	0.119	0.193	0.436	0.554	0.699	0.961	0.961
2005	0.004	0.072	0.334	0.437	0.667	0.735	0.956	0.956
2006	0.002	0.03	0.233	0.609	0.679	0.946	0.941	0.941
2007	0.008	0.045	0.157	0.354	0.511	0.589	0.648	0.648
2008	0.01	0.057	0.152	0.28	0.428	0.54	0.584	0.584
2009	0.01	0.068	0.182	0.294	0.403	0.521	0.593	0.593
2010	0.01	0.067	0.193	0.314	0.405	0.488	0.581	0.583

Table 3.4.6.4 Haddock in division Va. Summary table from the Adapt run both the surveys for tuning.

Year	Recruitment at age 2	Biomass 3+ tons	SSB tons	Landings tons	Y/SSB	F4-7
1979	83747	167578	98406	59190	0.601	0.573
1980	36665	197955	119118	50902	0.427	0.384
1981	9758	214309	146537	63491	0.433	0.513
1982	42214	188330	143248	68533	0.478	0.453
1983	30201	154238	117733	64698	0.55	0.477
1984	19949	118839	88032	48121	0.547	0.503
1985	41798	106663	70380	50261	0.714	0.52
1986	89077	94221	57384	47272	0.824	0.787
1987	167335	103846	43116	40132	0.931	0.638
1988	47697	153934	67084	53871	0.803	0.654
1989	26693	170414	100484	62712	0.624	0.656
1990	22368	146847	112274	67038	0.597	0.577
1991	80259	121903	90147	54694	0.607	0.6
1992	170420	105951	67993	47026	0.692	0.695
1993	37566	129982	70863	48737	0.688	0.676
1994	41322	126354	81798	59007	0.721	0.669
1995	70924	121296	82589	60111	0.728	0.653
1996	35120	107767	69557	56716	0.815	0.709
1997	102269	86966	58346	44006	0.754	0.619
1998	18266	97736	64468	41374	0.642	0.654
1999	50285	90891	64097	45231	0.706	0.705
2000	120740	89600	62192	41870	0.673	0.667
2001	154635	115251	69457	39530	0.569	0.502
2002	187147	168748	99320	50294	0.506	0.449
2003	44797	219965	147659	60598	0.41	0.389
2004	166812	250199	180435	84405	0.468	0.48
2005	405094	260025	175235	96655	0.552	0.539
2006	65392	305098	142223	97366	0.685	0.657
2007	56978	300391	164467	105012	0.638	0.481
mean	84591	150532	96078	57280	0.634	0.586

Table 3.4.6.5 Haddock in division Va. Number in stock according to the Adapt run using both surveys. Shaded cells are input to prediction

Year/age	1	2	3	4	5	6	7	8	9
1979	44.8	83.7	123.7	28.1	20.7	21.5	3.3	0.8	0.1
1980	11.9	36.7	68.4	99.4	19.3	11	8.8	1	0.2
1981	51.6	9.8	29.5	54.8	71	11.9	5.6	3.8	0.3
1982	36.9	42.2	8	23.7	40.4	42.8	4.3	2	1.5
1983	24.4	30.2	34.5	6.3	16.9	23.4	22.3	1.5	0.6
1984	51.1	19.9	24.7	27.6	3.8	9.7	9.8	10.3	0.4
1985	108.8	41.8	16.3	19.6	18.1	2	3.5	4.6	4.4
1986	204.4	89.1	33.8	11.7	11.5	9.4	0.9	1.5	1.5
1987	58.3	167.3	72.8	24.4	6.1	5	2.4	0.3	0.4
1988	32.6	47.7	135	52.7	13.2	2.6	2	0.9	0.1
1989	27.3	26.7	38.9	101.4	28.8	5.7	1	0.7	0.2
1990	98	22.4	21.8	29.5	62.1	14.8	1.9	0.3	0.1
1991	208.2	80.3	17.9	15.5	16.9	29.3	6.1	0.7	0.1
1992	45.9	170.4	63.5	13.5	9.1	7.8	11.7	2.3	0.3
1993	50.5	37.6	137.1	45.3	7.3	3.7	2.8	4.2	0.7
1994	86.6	41.3	30.6	101.7	25.7	3.1	1.4	0.9	1.4
1995	42.9	70.9	33.6	22.3	58.8	11.3	1.1	0.5	0.4
1996	124.9	35.1	55.9	21.8	13.1	27	4.2	0.4	0.1
1997	22.3	102.3	27.4	37.7	11.4	6.4	9.5	1.2	0.1
1998	61.4	18.3	82.5	19.1	20.8	4.9	3	3.3	0.4
1999	147.5	50.3	14.8	60.2	10.2	9.4	1.8	1.1	1
2000	188.9	120.7	40.2	10.8	34	4	3.2	0.7	0.3
2001	228.6	154.6	96.7	27	6.7	15.3	1.4	1	0.2
2002	54.7	187.1	124.6	69	15.7	4.1	6.9	0.5	0.4
2003	203.7	44.8	152.3	92.4	41.8	8.2	2.4	2.8	0.2
2004	494.8	166.8	36.4	118.9	60.9	22.7	4.1	1.2	1.1
2005	79.9	405.1	135.3	26.1	81.1	32.3	10.7	1.6	0.5
2006	69.6	65.4	330.2	102.1	14.9	42.9	13.7	4.3	0.6
2007	69	57	53.4	261.4	64.7	6.1	17.7	4.1	1.5
2008	72.7	56.5	46.2	41.4	177.5	34.7	2.7	7.2	1.6
2009	72.7	59.5	45.8	35.7	29.1	109.9	18.5	1.3	3.3
2010	72.7	59.5	48.2	35	24.4	17.8	60.1	9	0.6

Table 3.4.6.3 Haddock in division Va. Fishing mortality from the Adapt run using both the surveys for tuning.

Year/age	2	3	4	5	6	7	8	9
1979	0.002	0.019	0.175	0.431	0.698	0.989	1.127	1.013
1980	0.018	0.023	0.136	0.282	0.48	0.636	0.902	0.661
1981	0.001	0.02	0.105	0.306	0.815	0.824	0.749	0.793
1982	0.001	0.04	0.135	0.347	0.453	0.879	1.032	0.925
1983	0	0.023	0.306	0.361	0.668	0.574	1.07	0.599
1984	0.003	0.034	0.222	0.421	0.815	0.553	0.651	0.602
1985	0.011	0.128	0.331	0.461	0.607	0.68	0.895	0.797
1986	0.002	0.128	0.447	0.642	1.142	0.919	1.046	0.995
1987	0.015	0.122	0.416	0.664	0.697	0.776	0.829	0.782
1988	0.003	0.086	0.406	0.635	0.772	0.803	1.18	0.906
1989	0.003	0.077	0.29	0.467	0.924	0.944	1.409	1.119
1990	0.022	0.142	0.356	0.551	0.689	0.713	0.897	0.737
1991	0.034	0.082	0.331	0.576	0.722	0.773	0.892	0.786
1992	0.018	0.137	0.419	0.702	0.834	0.826	1.004	0.853
1993	0.006	0.098	0.368	0.656	0.764	0.916	0.911	0.913
1994	0.008	0.116	0.348	0.619	0.809	0.9	0.678	0.807
1995	0.037	0.234	0.33	0.578	0.792	0.913	0.968	0.929
1996	0.047	0.195	0.445	0.512	0.847	1.033	1.143	1.042
1997	0.015	0.161	0.395	0.64	0.573	0.868	0.982	0.88
1998	0.013	0.115	0.425	0.591	0.782	0.818	1.017	0.917
1999	0.024	0.115	0.371	0.74	0.879	0.831	0.929	0.866
2000	0.022	0.197	0.274	0.596	0.838	0.962	0.944	0.959
2001	0.016	0.138	0.344	0.283	0.594	0.787	0.763	0.777
2002	0.006	0.099	0.3	0.448	0.358	0.69	0.719	0.692
2003	0.007	0.048	0.218	0.409	0.488	0.442	0.714	0.581
2004	0.009	0.135	0.182	0.434	0.558	0.744	0.65	0.721
2005	0.004	0.081	0.362	0.437	0.66	0.697	0.86	0.717
2006	0.003	0.034	0.256	0.689	0.683	0.998	0.852	0.961
2007	0.01	0.054	0.187	0.423	0.611	0.704	0.774	0.774
2008	0.01	0.057	0.152	0.28	0.428	0.54	0.584	0.584
2009	0.01	0.068	0.182	0.294	0.403	0.521	0.593	0.593

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. Selection pattern used in short term prognosis. Reference is ages 4 to 7.

Year/age	2	3	4	5	6	7	8	9
2006	0.014	0.11	0.595	1.067	1.386	1.697	1.737	1.737
2007	0.017	0.092	0.381	0.895	1.246	1.477	1.663	1.663
2008	0.019	0.125	0.389	0.797	1.262	1.552	1.745	1.825

Table 3.4.7.3 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 3.4.7.4 Haddock in division Va. Output from short term prediction using results from the SPALY model (ADCAM) based on the March survey . Tac constraint of 110 000 tonnes for 2006.

2007				
B3+	SSB	Fmult	F4-7	Landings
337	182	0.691	0.426	105

2008					2009	
B3+	SSB	Fmult	F4-7	Landings	B3+	SSB
329	224	0.2	0.123	43	351	266
329	224	0.3	0.185	62	335	253
329	224	0.4	0.246	81	320	240
329	224	0.5	0.308	98	305	228
329	224	0.6	0.37	115	292	217
329	224	0.7	0.431	131	279	207
329	224	0.8	0.493	145	267	197
329	224	0.9	0.554	160	256	187
329	224	1	0.616	173	245	179
329	224	1.1	0.678	186	235	170
329	224	1.2	0.739	198	225	162
329	224	1.3	0.801	209	216	155
329	224	1.4	0.862	220	207	148
329	224	1.5	0.924	230	199	141
329	224	1.6	0.986	240	192	135
329	224	1.7	1.047	249	184	129
329	224	1.8	1.109	258	177	123
329	224	1.9	1.171	266	171	118
329	224	2	1.232	274	164	113

Table 3.4.7.5 Haddock in division Va. Output from short term prediction using results from the Adapt run using both the surveys. Tac constraint of 105 000 tonnes for 2006.

2007				
B3+	SSB	Fmult	F4-7	Landings
300	164	0.733	0.481	105

2008					2009	
B3+	SSB	Fmult	F4-7	Landings	B3+	SSB
285	192	0.1	0.066	20	330	253
285	192	0.2	0.131	39	314	240
285	192	0.3	0.197	57	298	227
285	192	0.4	0.263	73	284	215
285	192	0.5	0.328	89	270	204
285	192	0.6	0.394	104	257	193
285	192	0.7	0.46	118	245	183
285	192	0.8	0.525	131	234	174
285	192	0.9	0.591	144	223	165
285	192	1	0.657	156	213	157
285	192	1.1	0.722	167	204	149
285	192	1.2	0.788	177	195	142
285	192	1.3	0.854	187	187	135
285	192	1.4	0.919	197	179	128
285	192	1.5	0.985	206	171	122
285	192	1.6	1.051	214	164	116
285	192	1.7	1.116	222	157	111
285	192	1.8	1.182	230	151	106
285	192	1.9	1.248	237	145	101
285	192	2	1.313	244	139	96

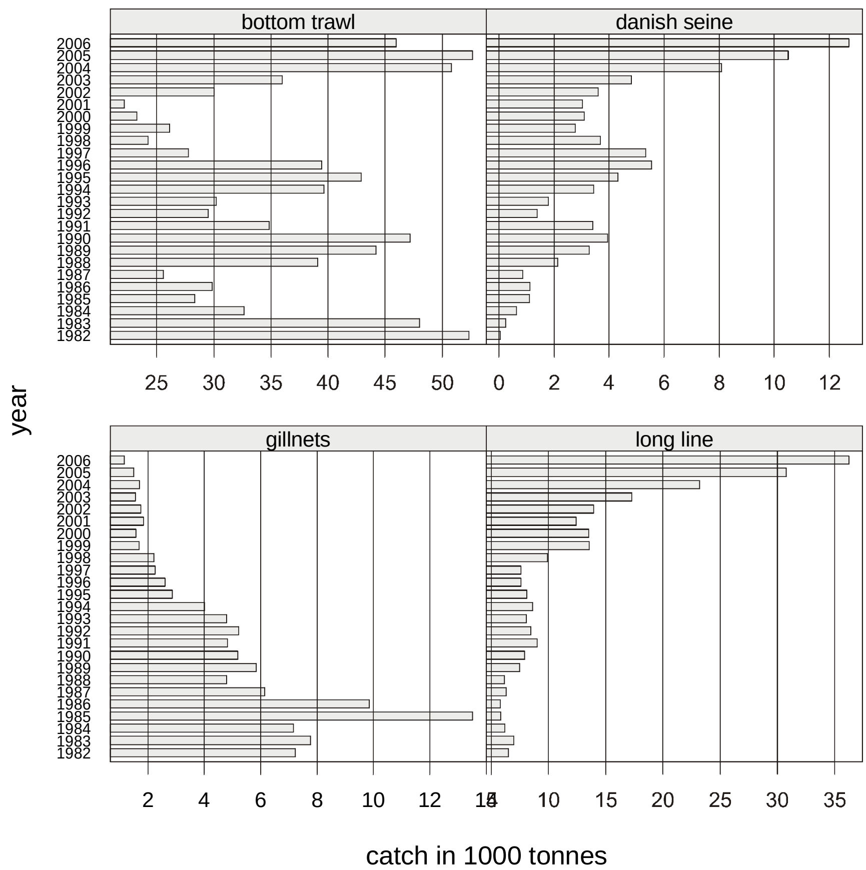


Figure 3.4.2.1 Haddock Division VA. Landings by fishing gear 1982 -2006.

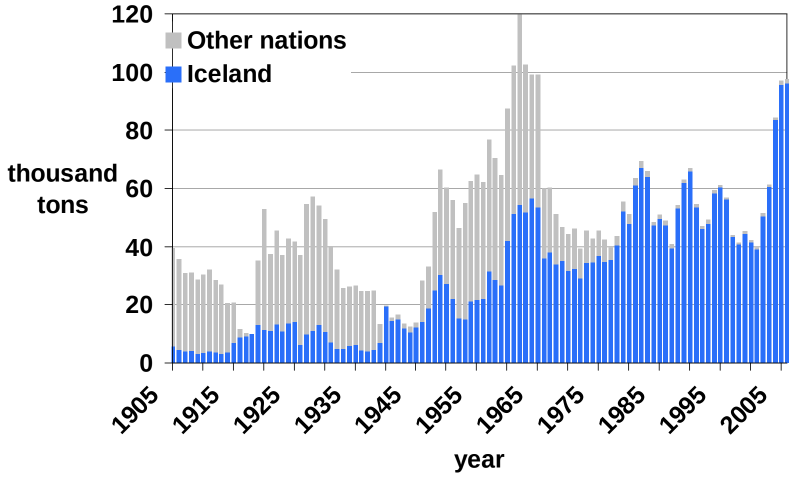


Figure 3.4.2.2 Haddock in division Va. Landings 1905 – 2005.

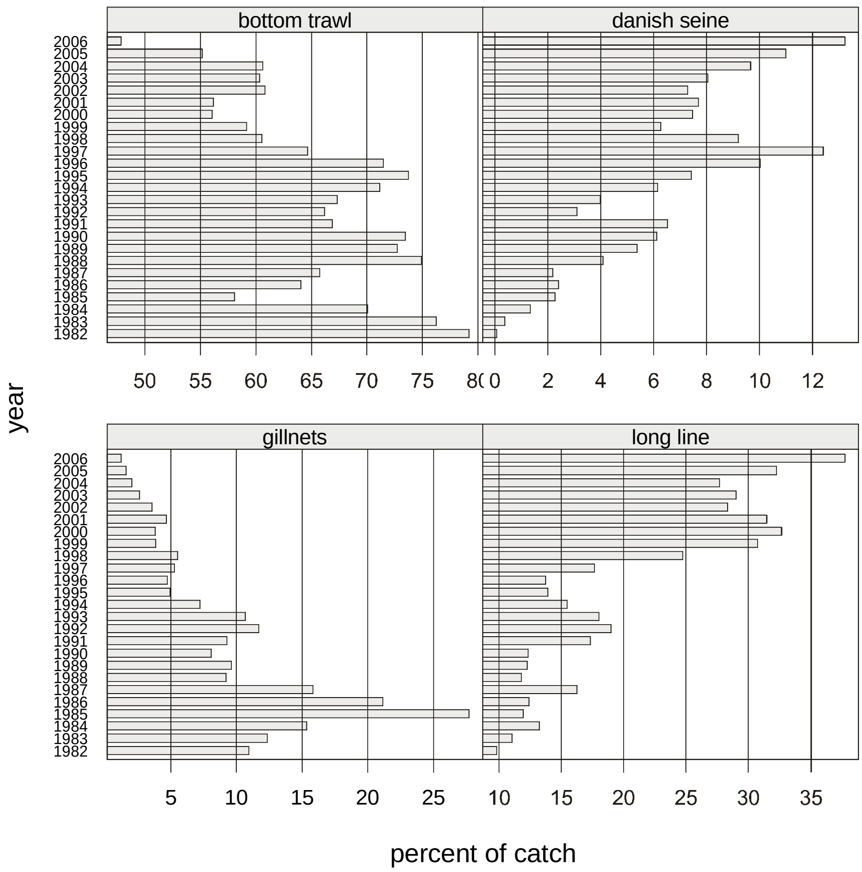


Figure 3.4.2.3 Haddock Division VA. Landings in percent of total by gear and year. The upper picture shows landings in tons and the lower percent of total.

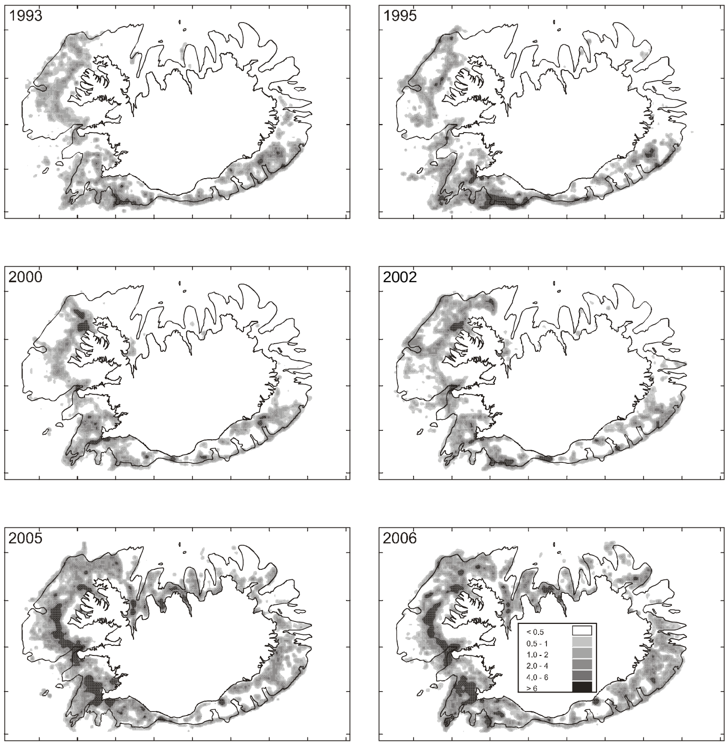


Figure 3.4.2.4 Haddock Division VA. Spatial distribution af landings. The legend show tonnes per square mile.

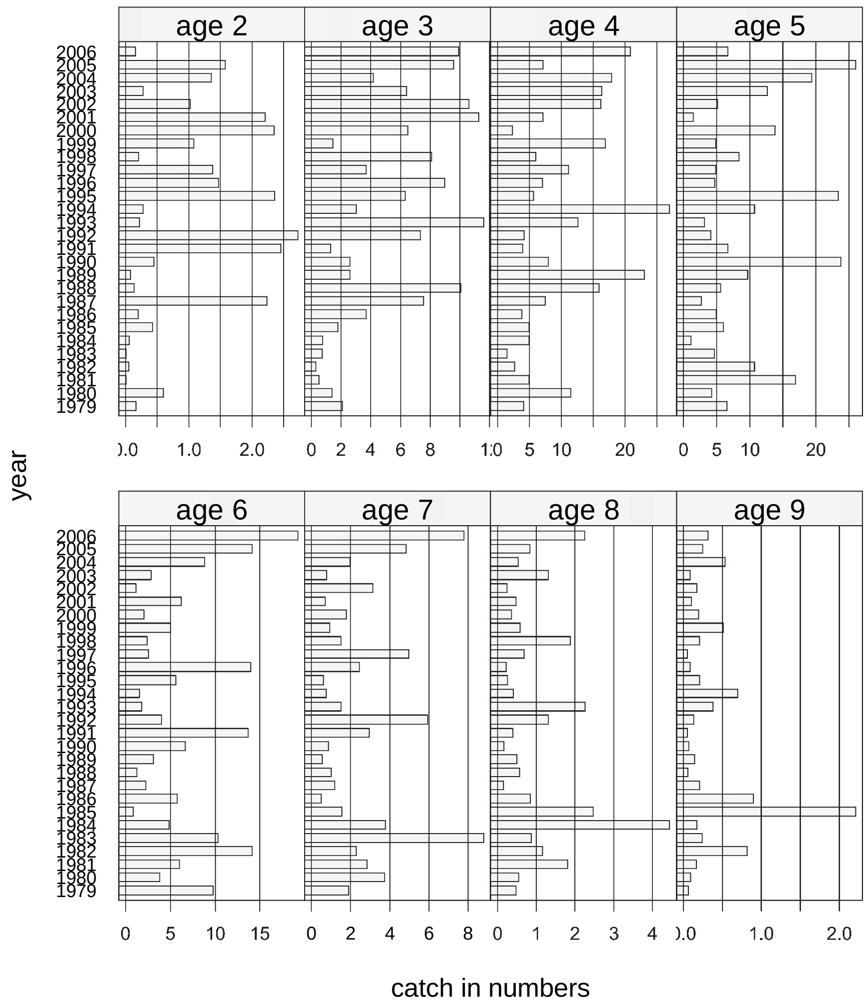


Figure 3.4.3.1 Haddock in division Va. Age disaggregated catch in numbers.

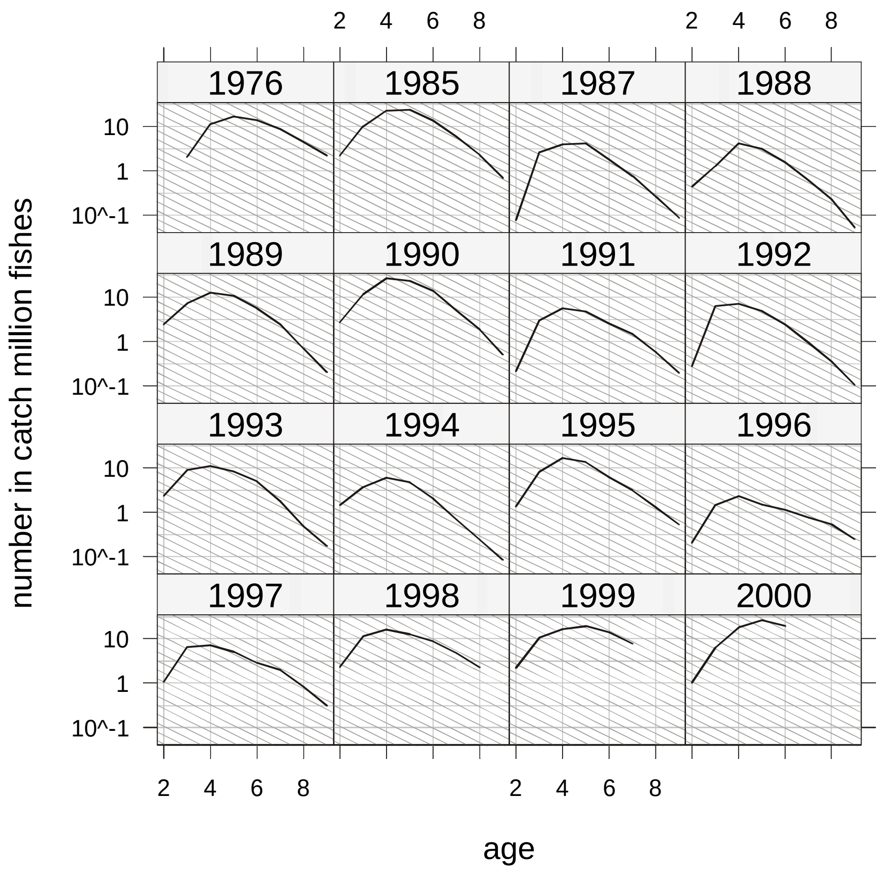


Figure 3.4.3.2. Haddock in division Va. Age disaggregated catch in numbers plotted on log scale. The grey lines show Z = 0.6.

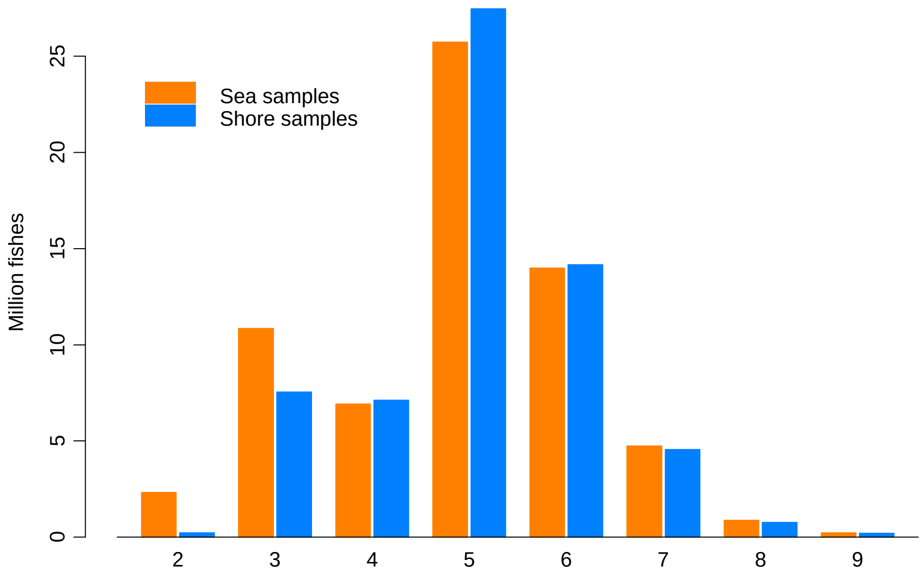


Figure 3.4.3.3 Comparison of catch in numers in 2006 based on port samples and shore samples.

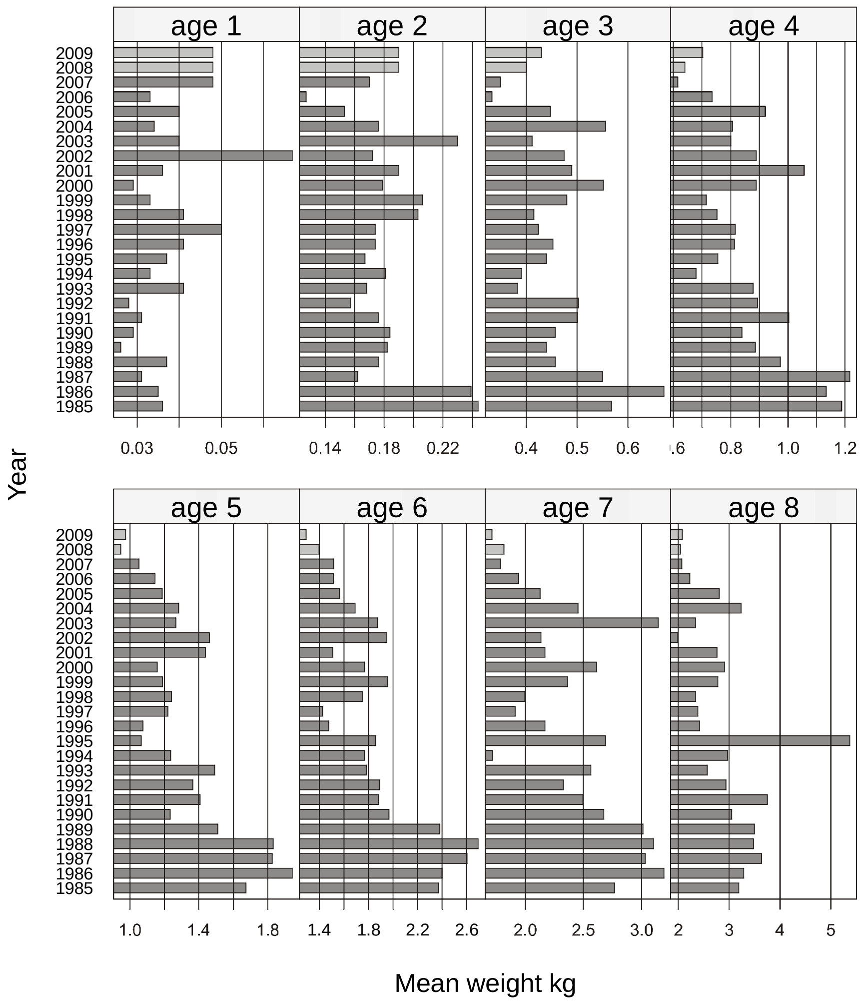


Figure 3.4.4.1 Haddock in division Va. Mean weight at age in the survey. Perdictions are shown as light grey. The values shown are used as weight at age in the stock.

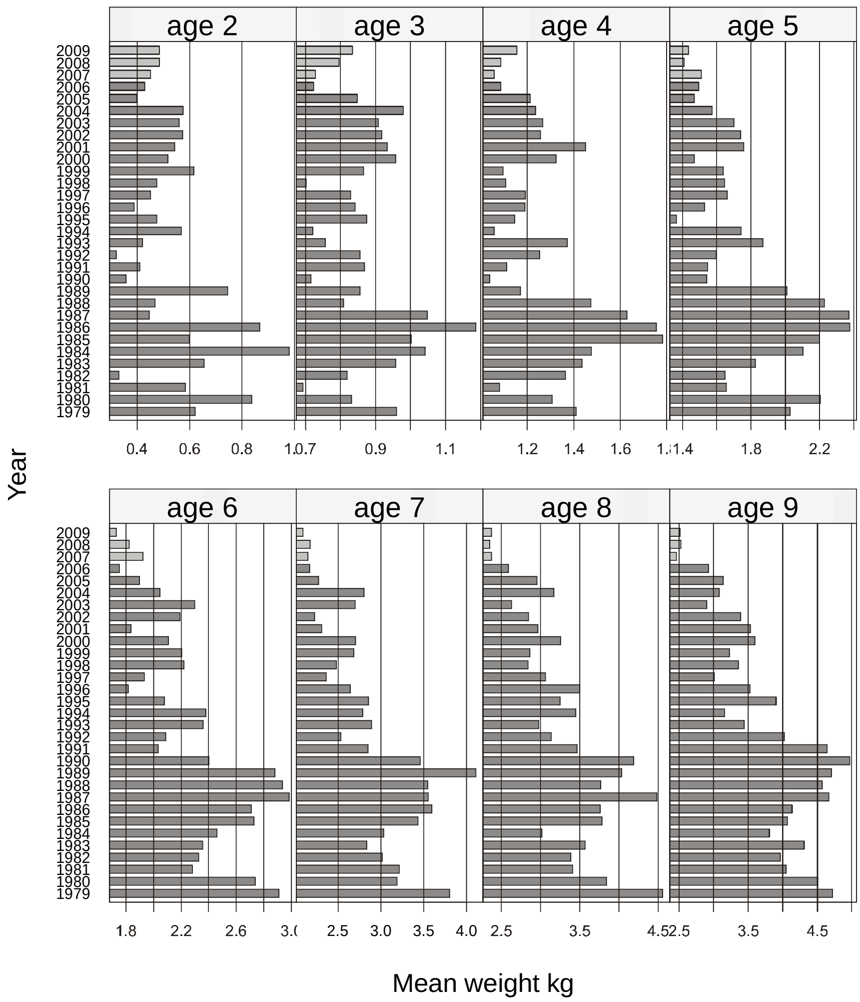


Figure 3.4.4.2 Haddock in division Va. Mean weight at age in the catches. Perdictions are shown as light grey.

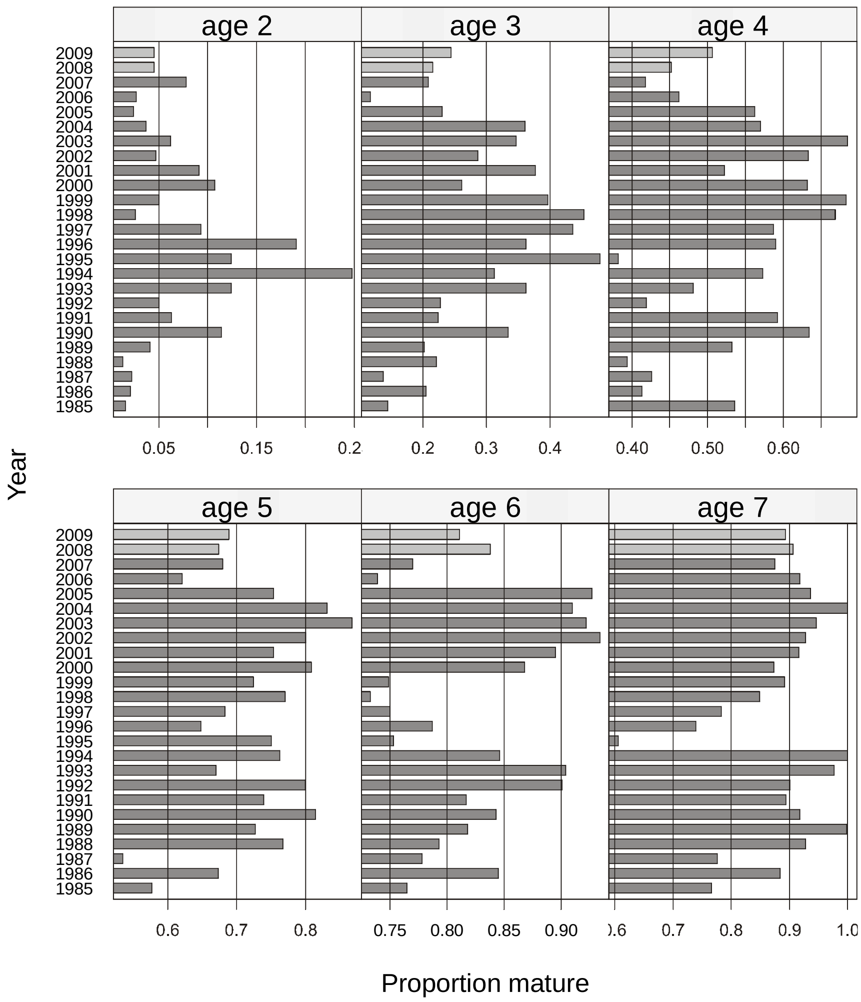


Figure 3.4.4.3 Haddock in division Va. Maturity at age in the survey. The light grey bars indicate prediction. The values are used to calculate the spawning stock.

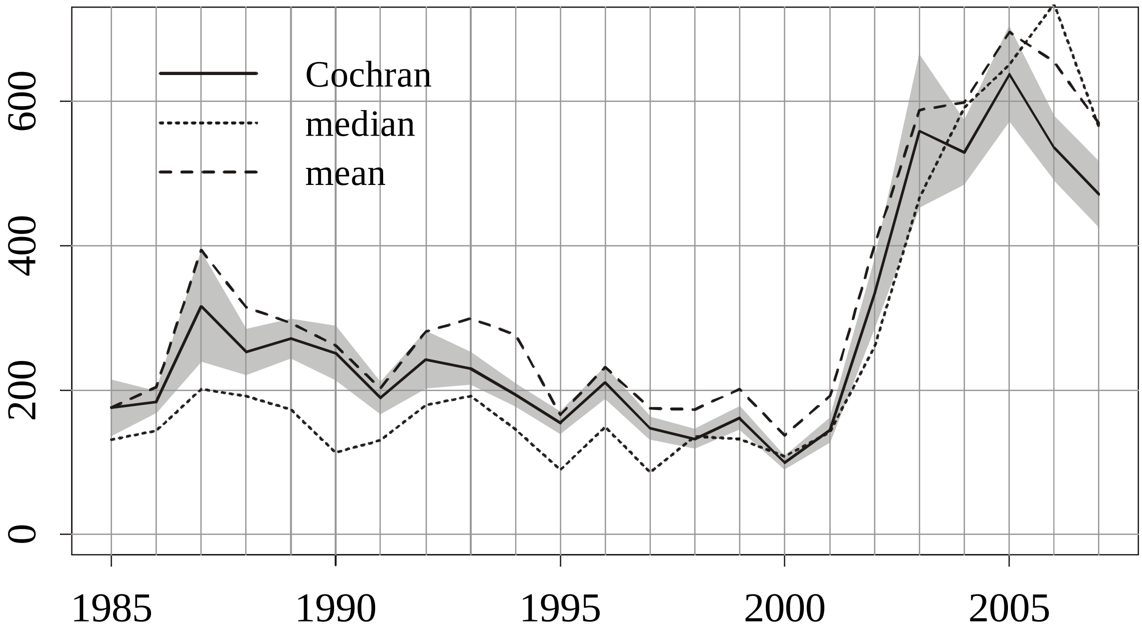


Figure 3.4.5.1. Haddock in division va. Total biomass index from the groundfish survey. 1000 tonnes. The shaded area shows show the standard error in the estimate of the indices. Indices based on unweighed mean of all stations and number of stations with haddock times median of the haddock catch at those stations are shown for comparison.

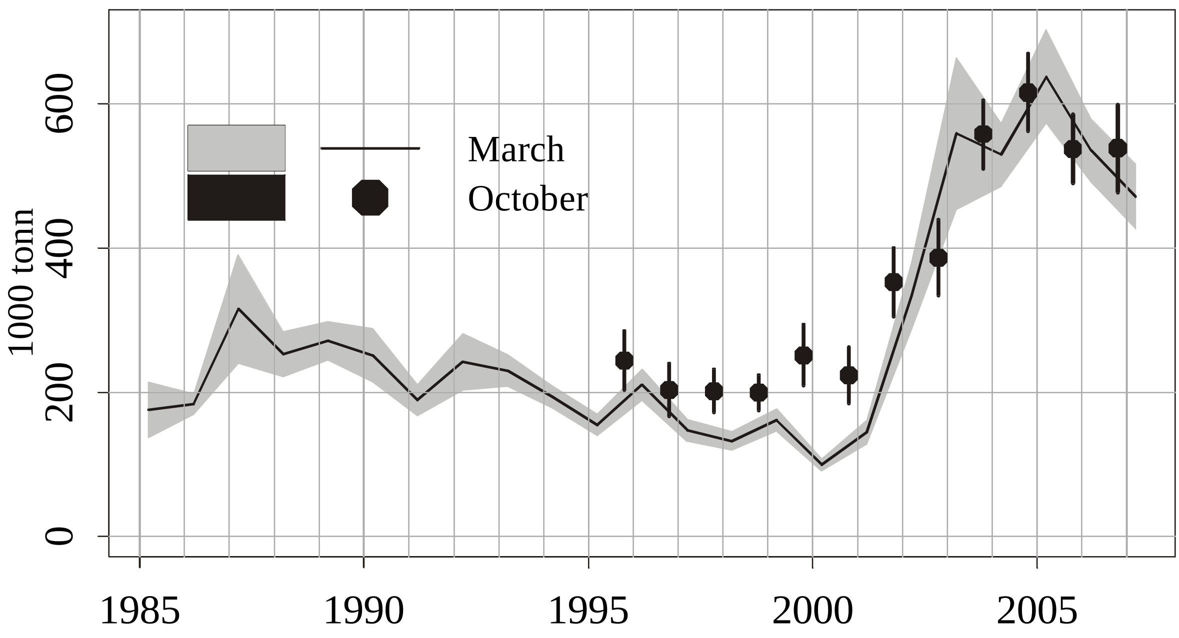


Figure 3.4.5.2 Icelandic haddock. Total biomass indices from the groundfish surveys in March (lines and shading) and the groundfish survey in October vertical segments. The standard error in the estimate of the indices is shown in the figure.

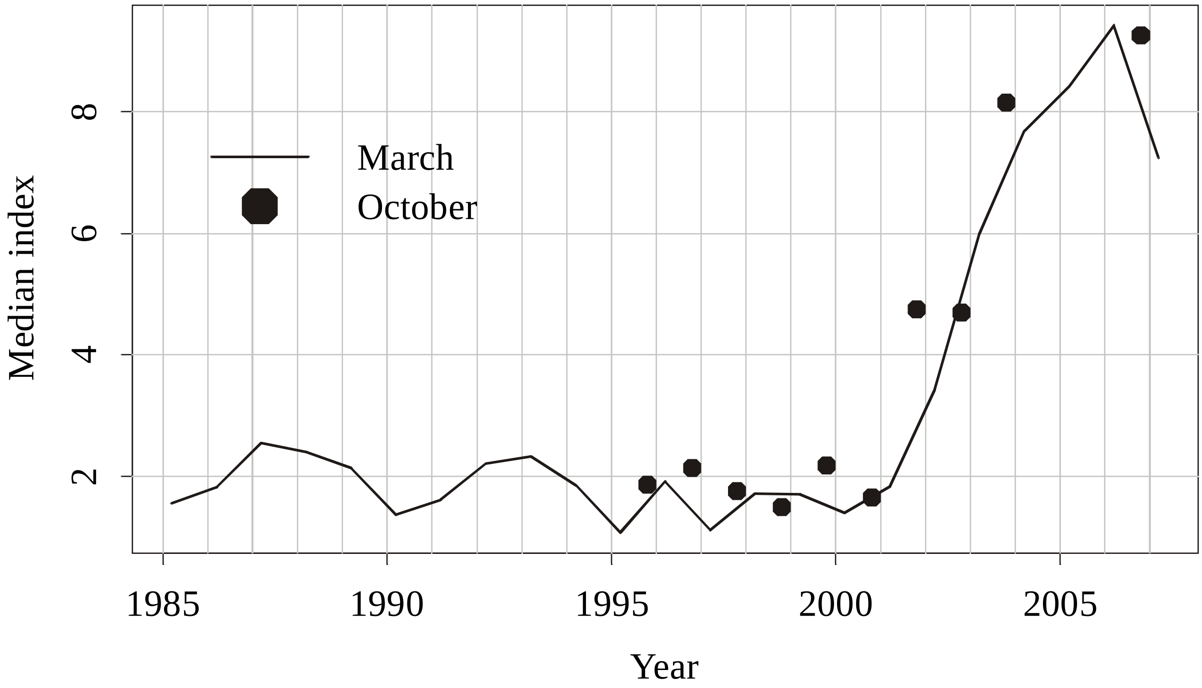


Figure 3.4.5.3 Icelandic haddock. Median indices from the groundfish survey in March and the autumn survey. The index is calculated as the number of stations where haddock is caught times median of the haddock catch at those stations are shown for comparison. The line show the March survey and the dots the autumn survey.

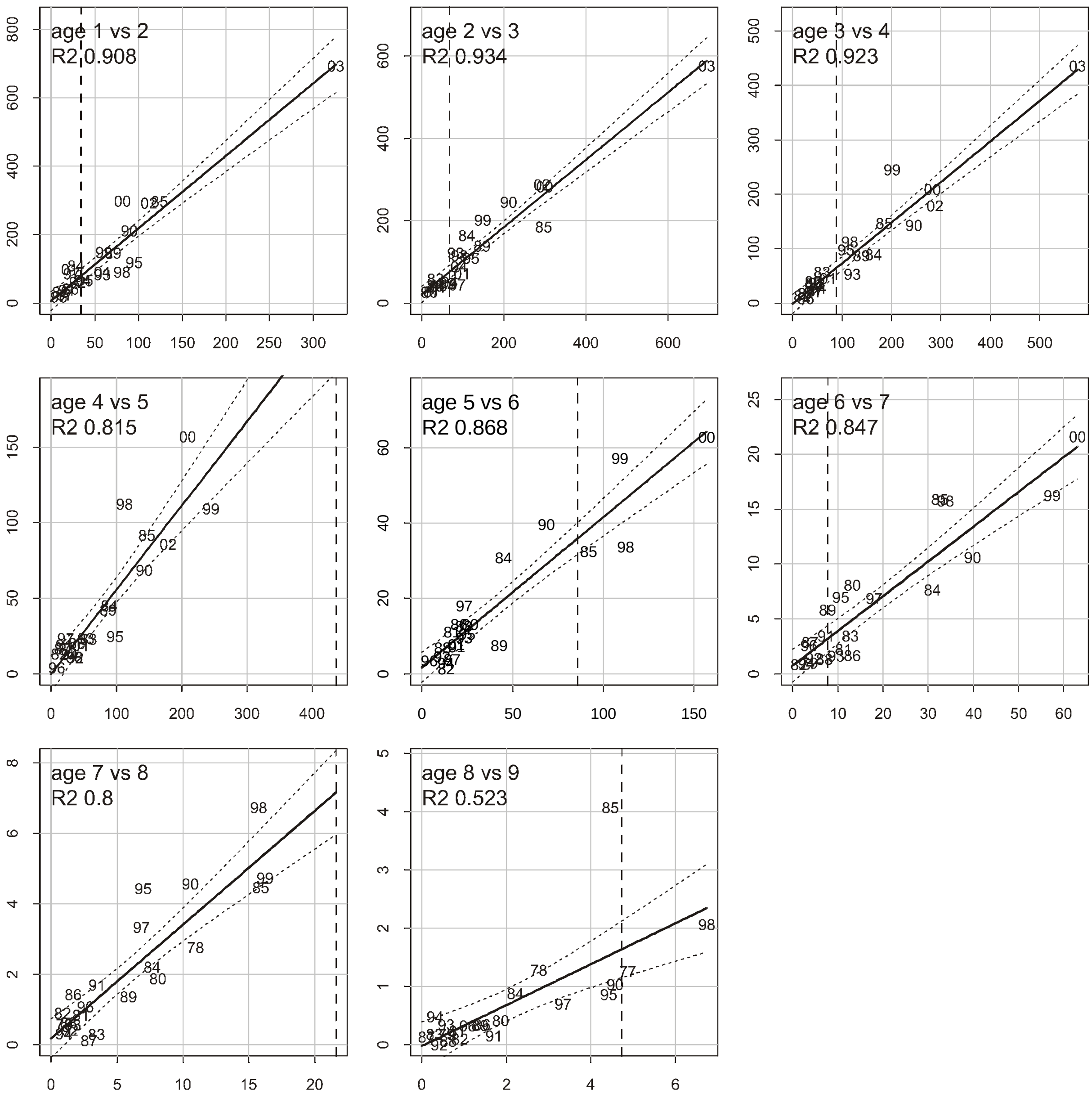


Figure 3.4.5.4 Haddock in division Va. Indices from March survey plotted against indices of the same year class one year earlier. The letters in the figure are year classes. The dashed vertical lines show the most recent values and the intersection of the gray lines the most recent pair.

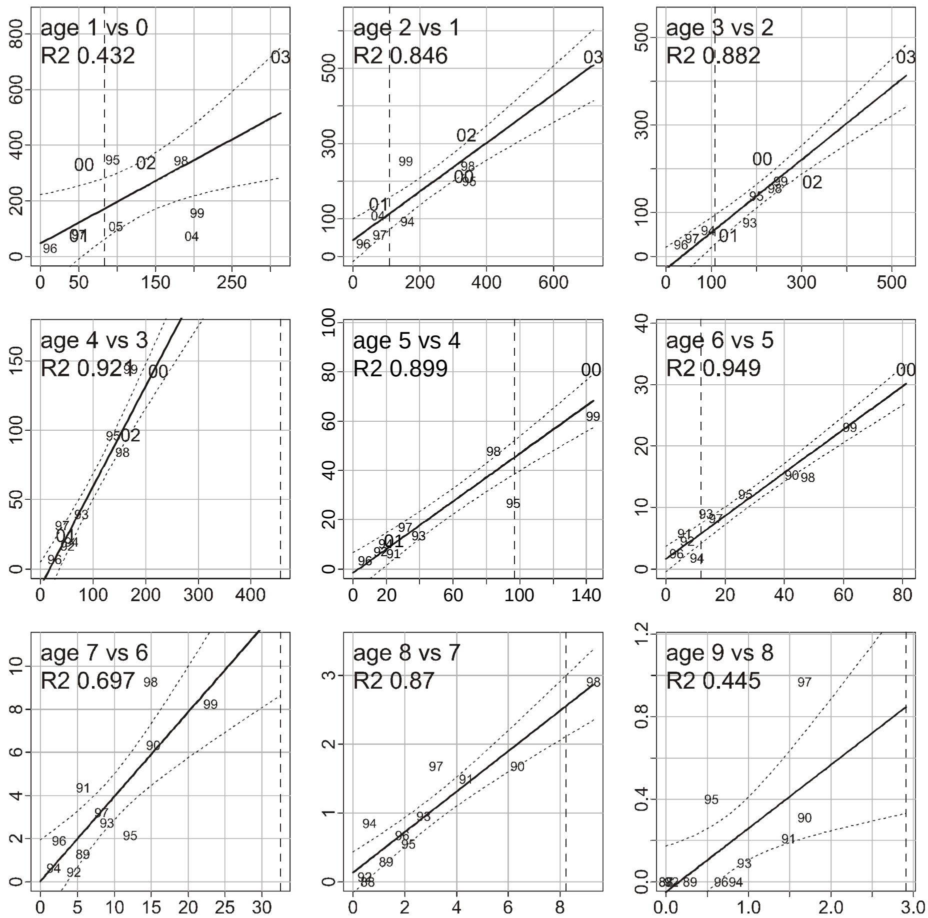


Figure 3.4.5.5 Haddock in division Va. Indices from October survey plotted against indices of the same year class one year earlier. The letters in the figure are year classes. The dashed vertical lines show the most recent values.

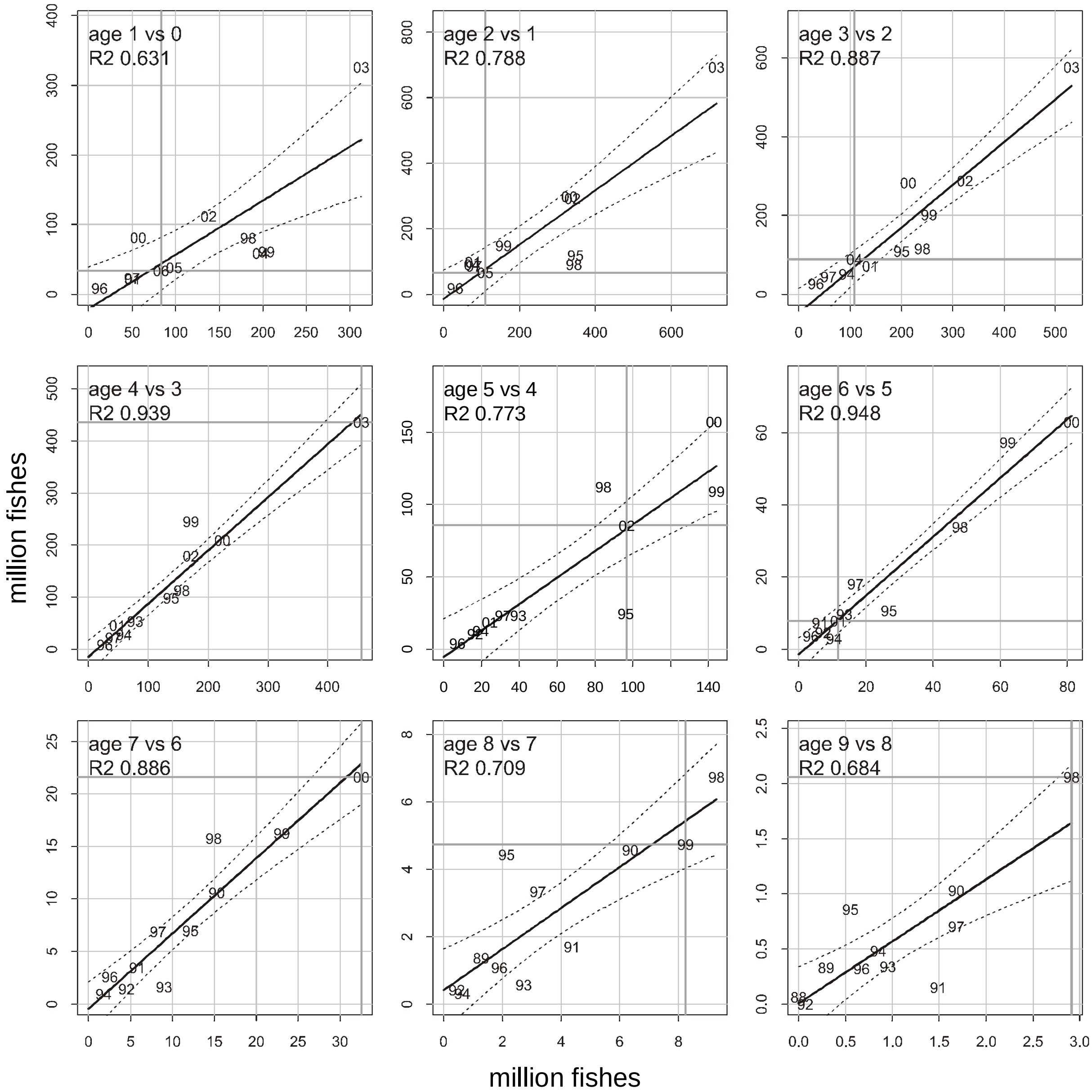


Figure 3.4.5.6 Haddock in division Va. Indices from the March survey plotted against indices of the same year class in the Autumn survey one year earlier. The letters in the figure are year classes. The dashed vertical lines show the most recent values.

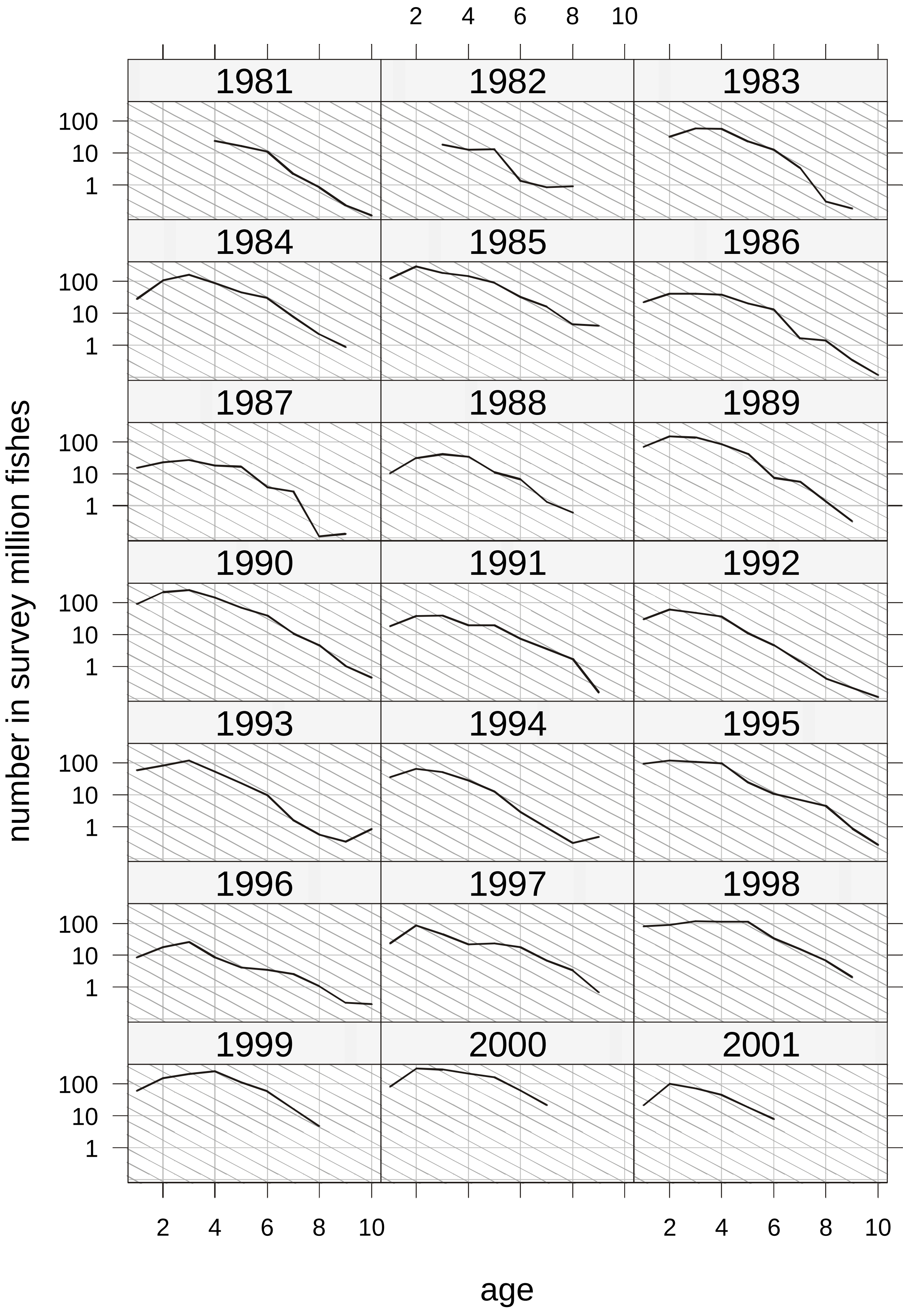


Figure 3.4.5.7. Catchcurves from the groundfish survey in March. Grey lines show Z=1.

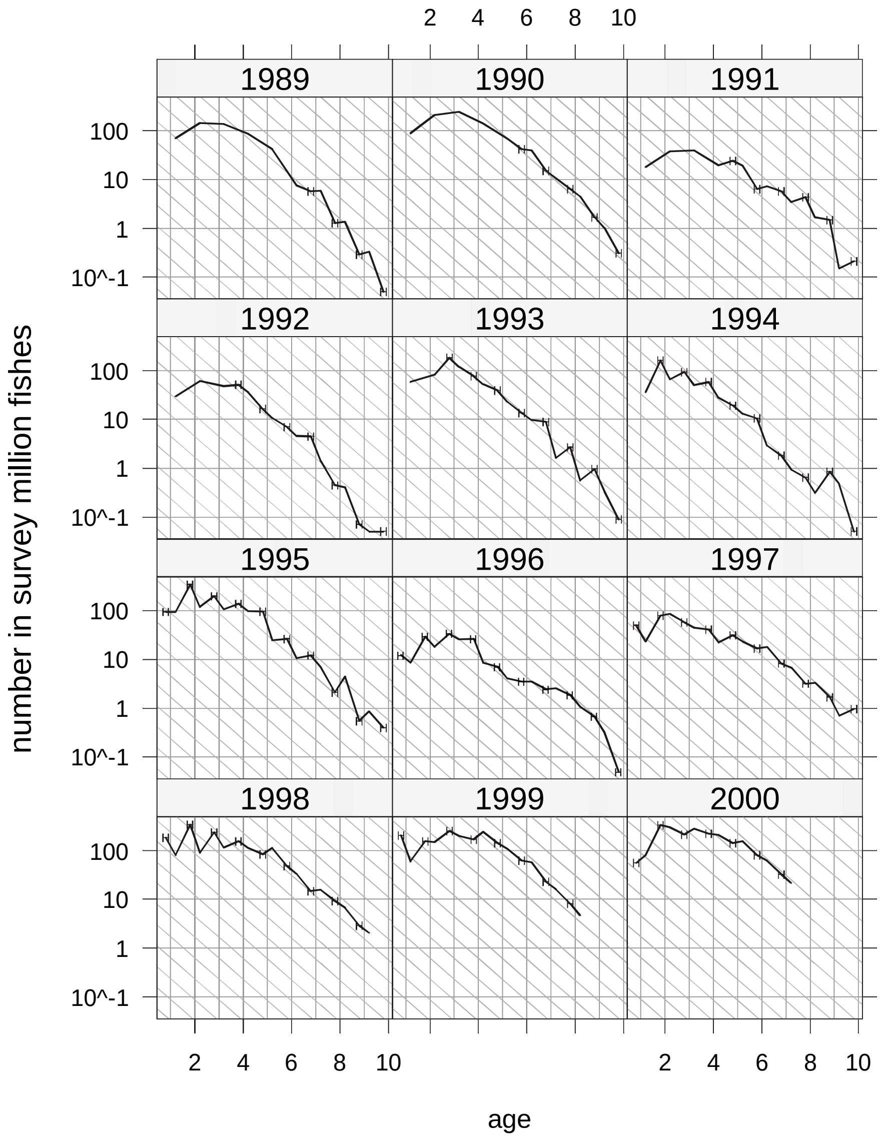


Figure 3.4.5.8. Catchcurves from the groundfish surveys in March and October. Grey lines show Z=1. Points from the autumn survey are labelled "H".

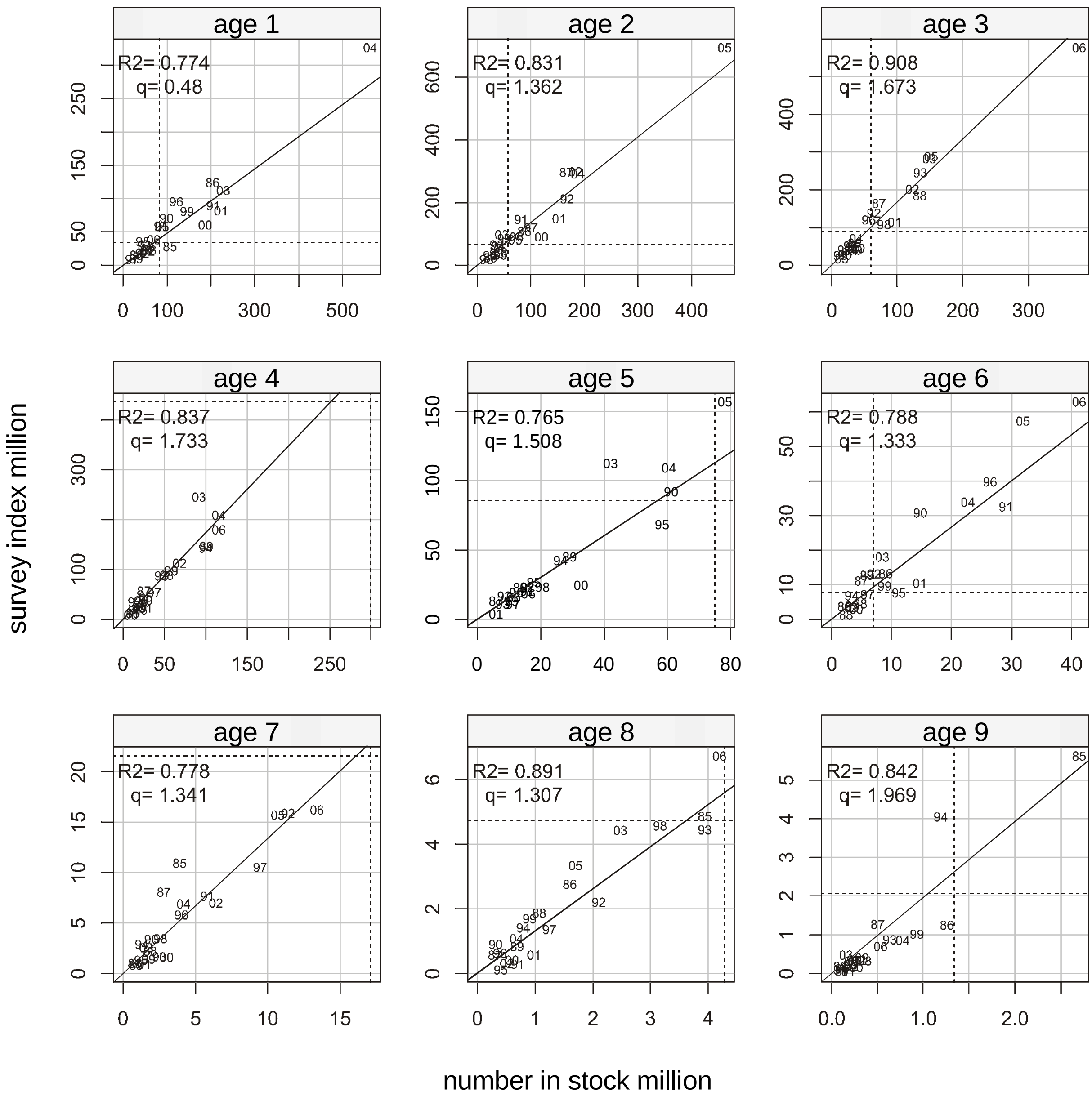


Figure 3.4.5.9 Icelandic haddock. Abundance indices from the March survey vs. number in stock according to the SPALY run from last year. Line fitted through origin on original scale. . The fitted line uses the data until 2002. Dashed lines show most recent estimates.

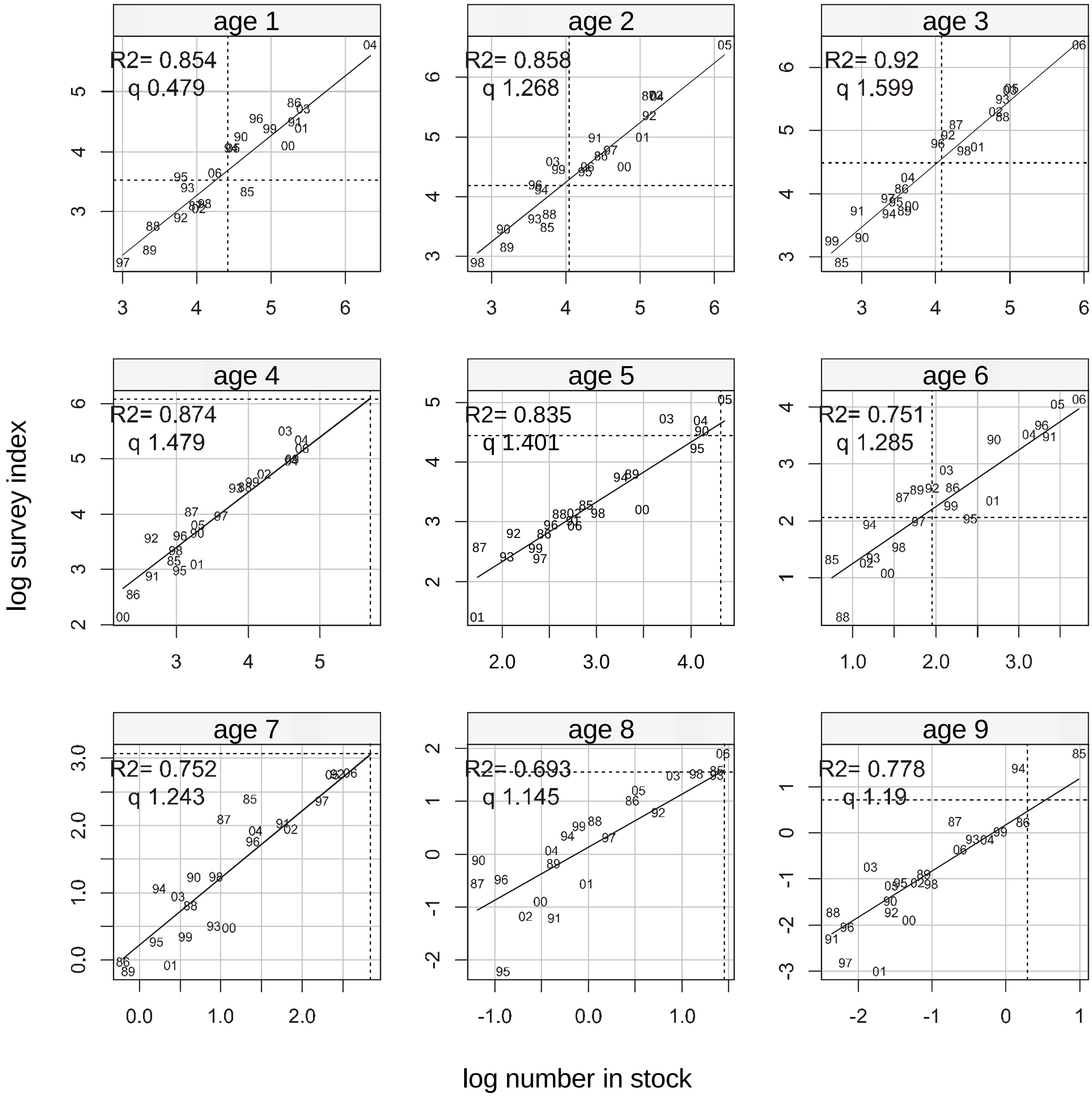


Figure 3.4.5.10 Icelandic haddock. Abundance indices from the March survey vs. number in stock according to the SPALY run from last year. Line with slope 1fitted through origin on log-scale. . The fitted line uses the data until 2002. Dashed lines show most recent estimates.

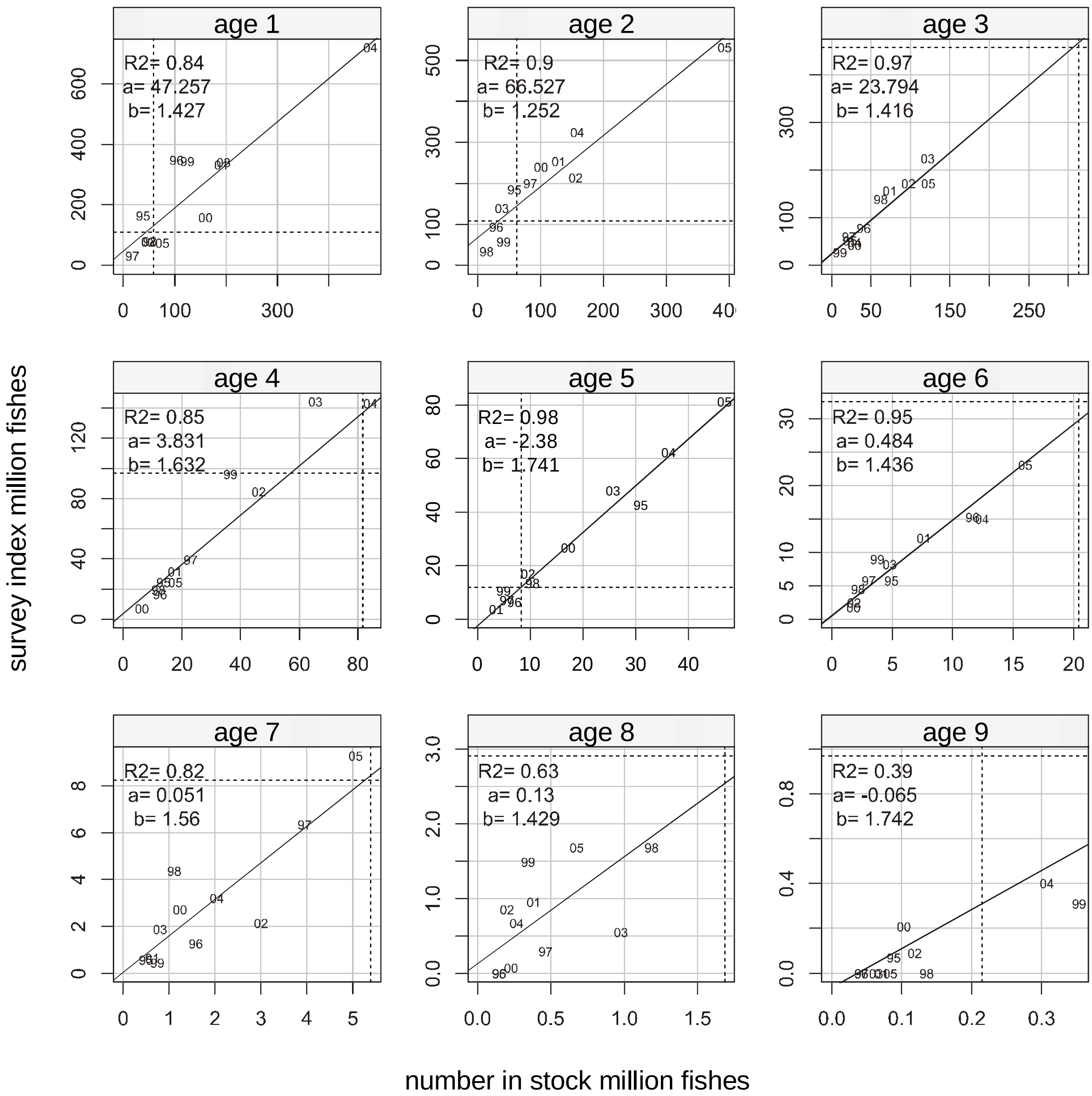


Figure 3.4.5.11 Icelandic haddock. Abundance indices from the October survey vs. number in stock according to the SPALY run from last year. Line fitted through origin on original scale. . The fitted line uses all the data as the assessment is not using the autumn survey.

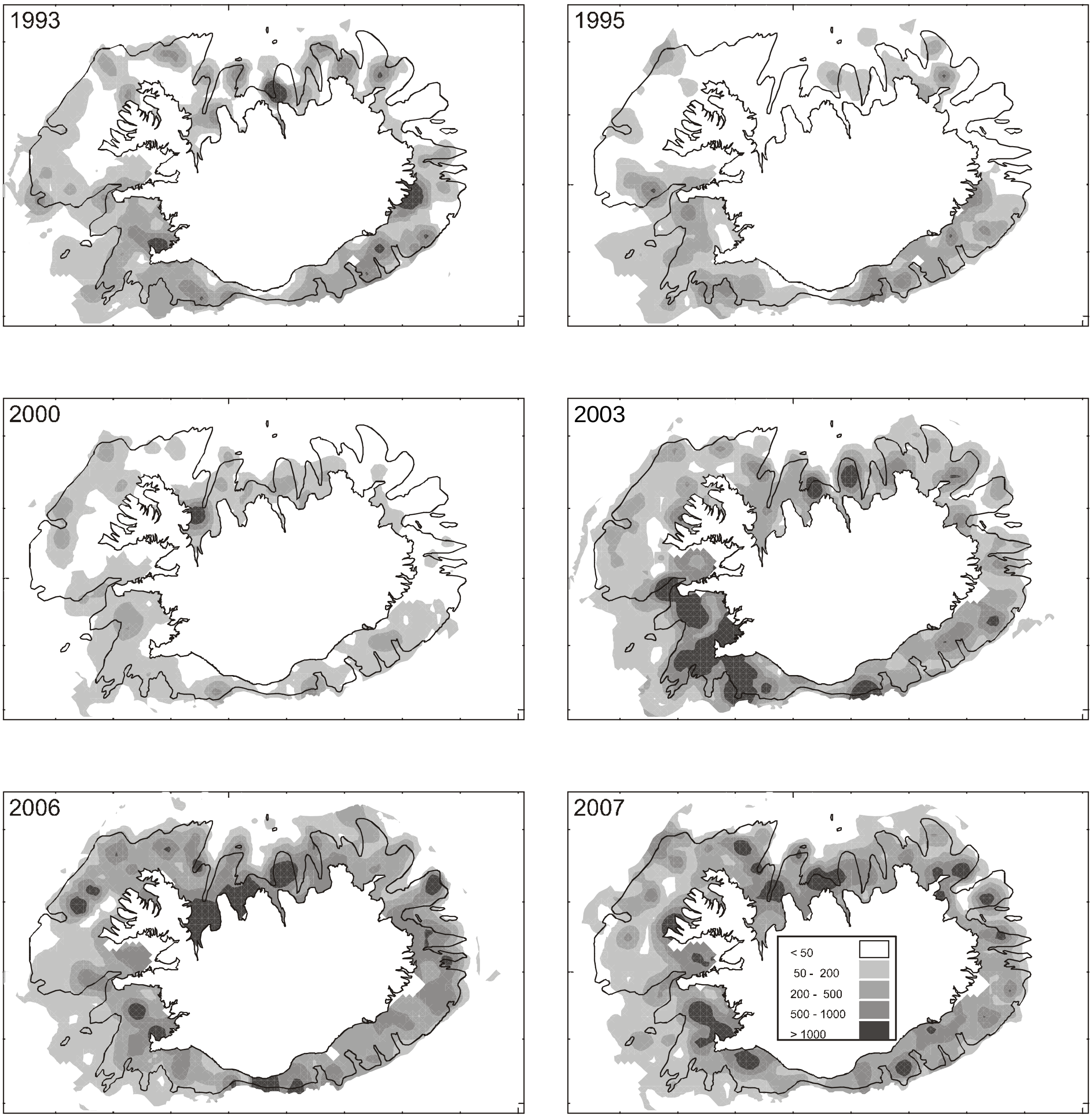


Figure 3.4.5.12. Spatial distribution of haddock in the groundfish survey in March. The legend show kg per hour towed.

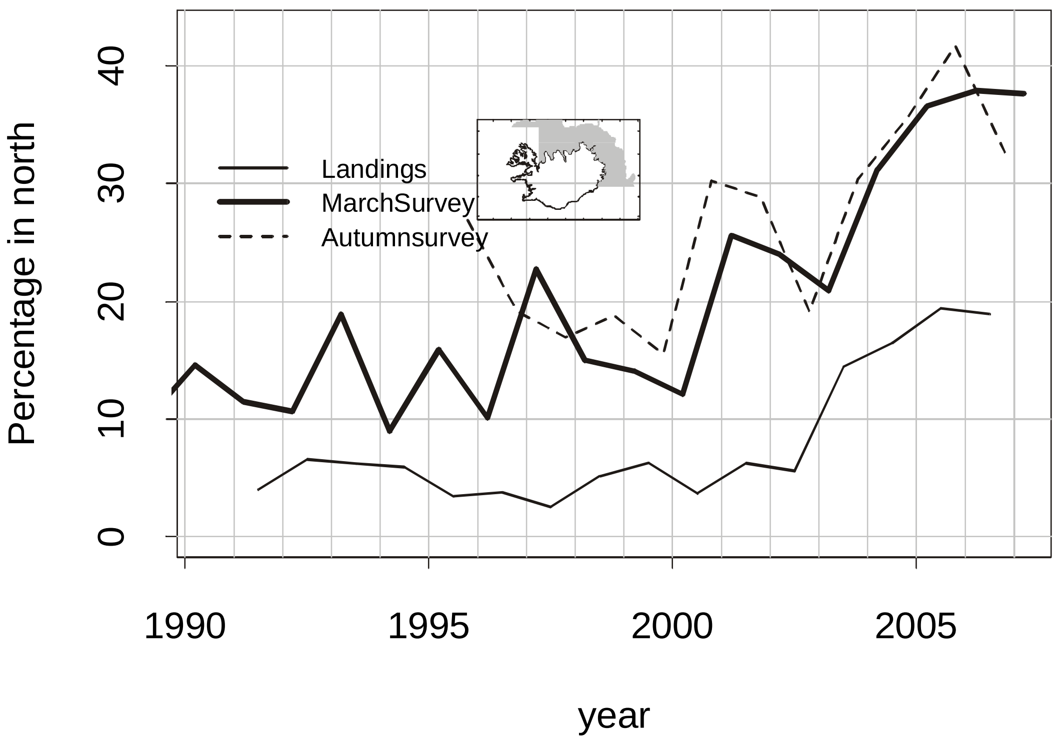


Figure 3.4.5.12. Proportion of the landings and the biomass of 42cm and older haddock that is in the north area. The small figure shows the northern area.

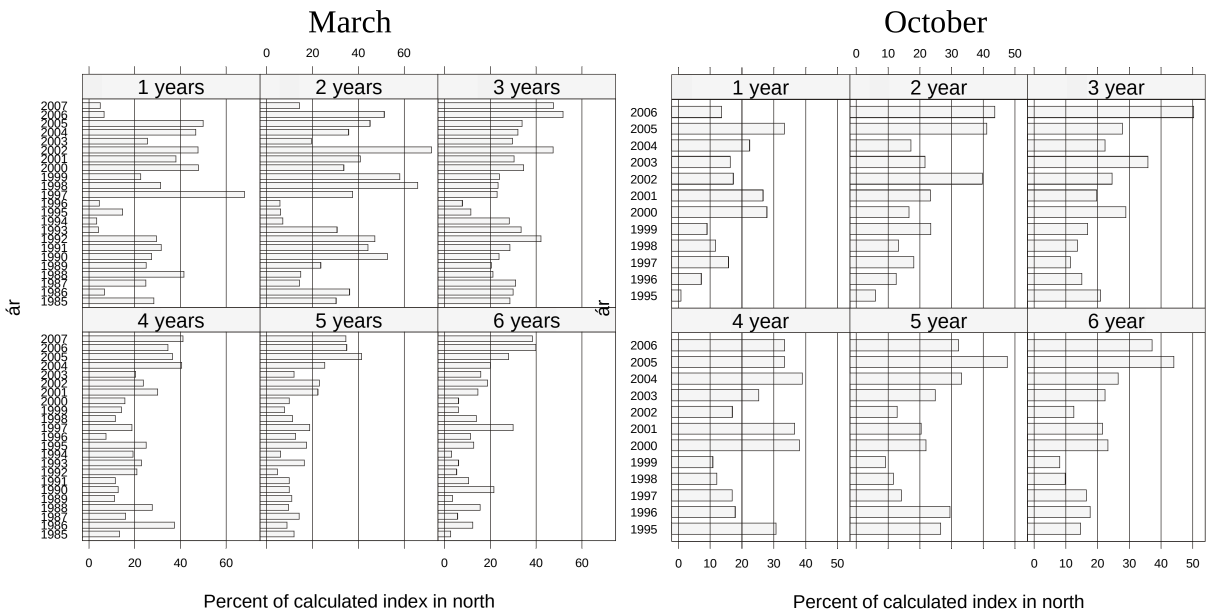


Figure 3.4.5.13. Proportion of each age group in the northern area in March and October.

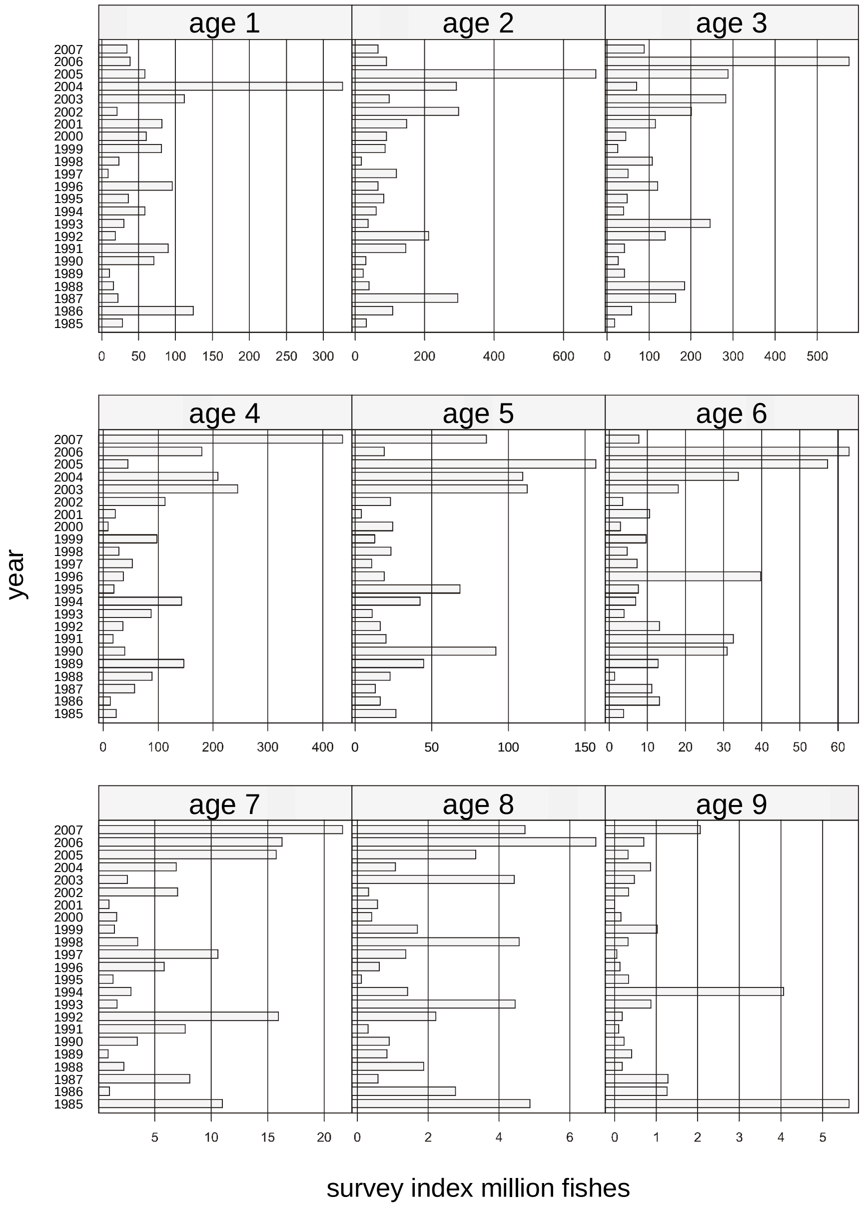


Figure 3.4.5.14. Haddock in division Va. Age disaggregated indices from the groundfish survey in March.

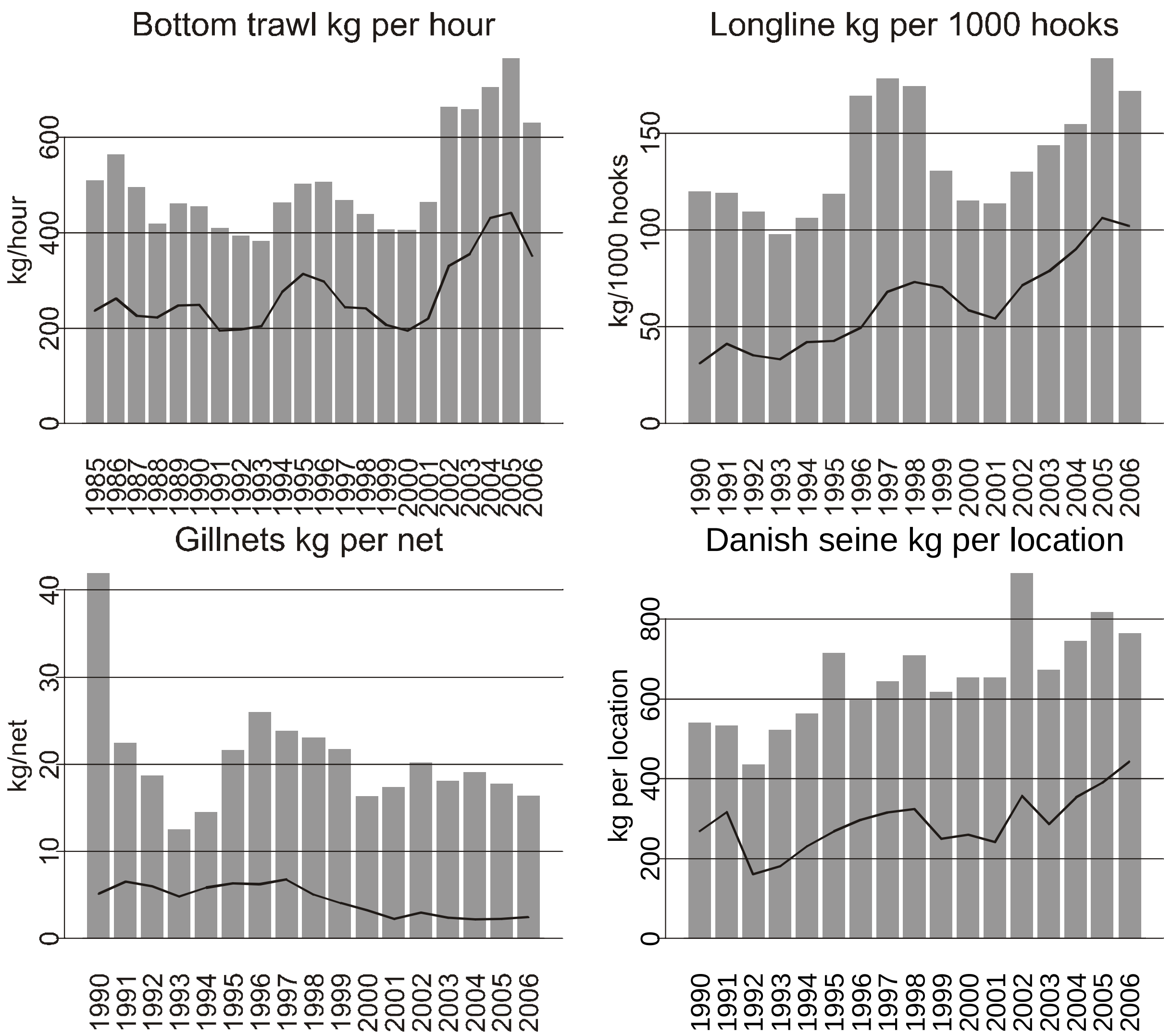


Figure 3.4.5.15. Catch per unit effort in the most important gear types. The bars are based on locations where more than 50% of the catch is haddock and the lines on all records where haddock is caught. A change occurred in the longline fleet starting September 1999. Earlier only vessels larger than 10 BRT were required to return logbooks but later all vessels were required to return logbooks.

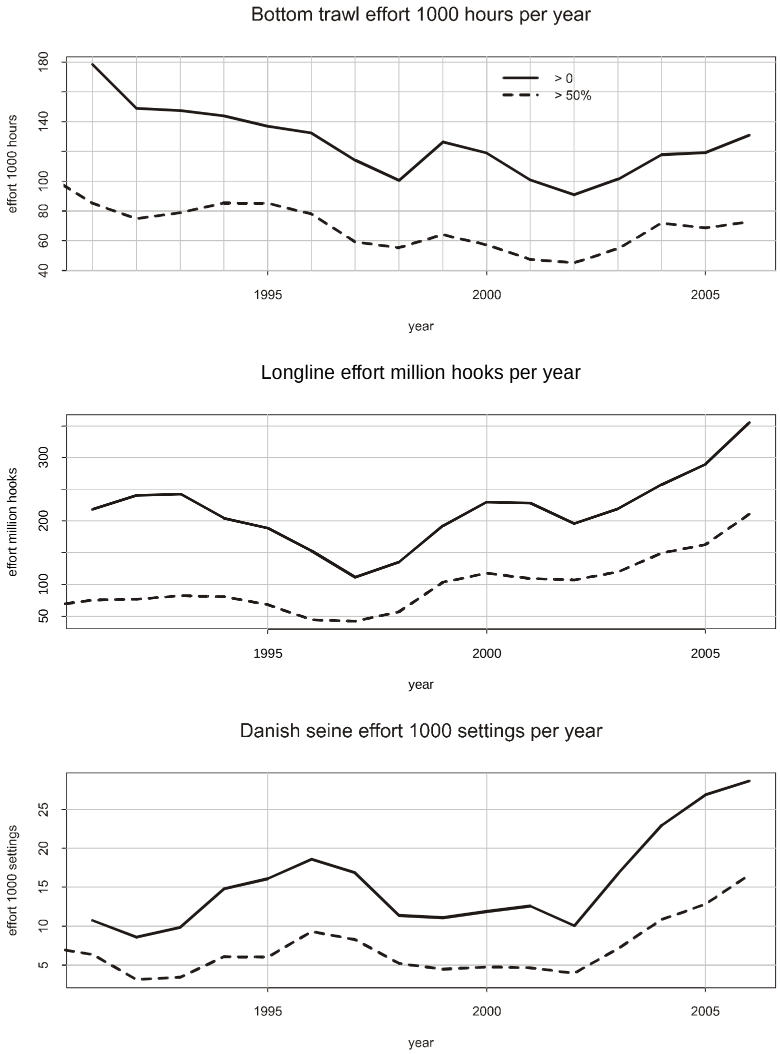


Figure 3.4.5.16. Effort towards haddock. The effort is calculated as the ratio of the total landings for the gear and the CPUE based on records where haddock was more than 50% of the registered catch.

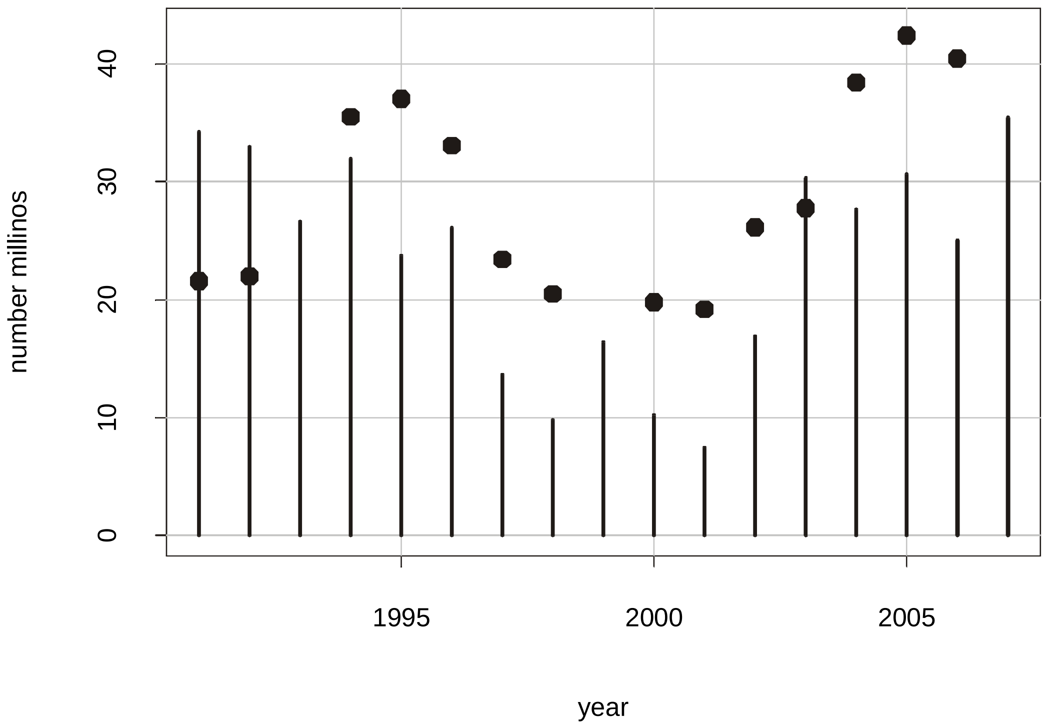


Figure 3.4.5.17. Number of haddock caught. The number is calculated by multiplying the mean number of 42cm and larger haddock per hour in the groundfish survey in March in each statistical square (1/2x1degree) by the trawling effort in that square. Catch in number for bottom trawl is shown for comparison (the dots).

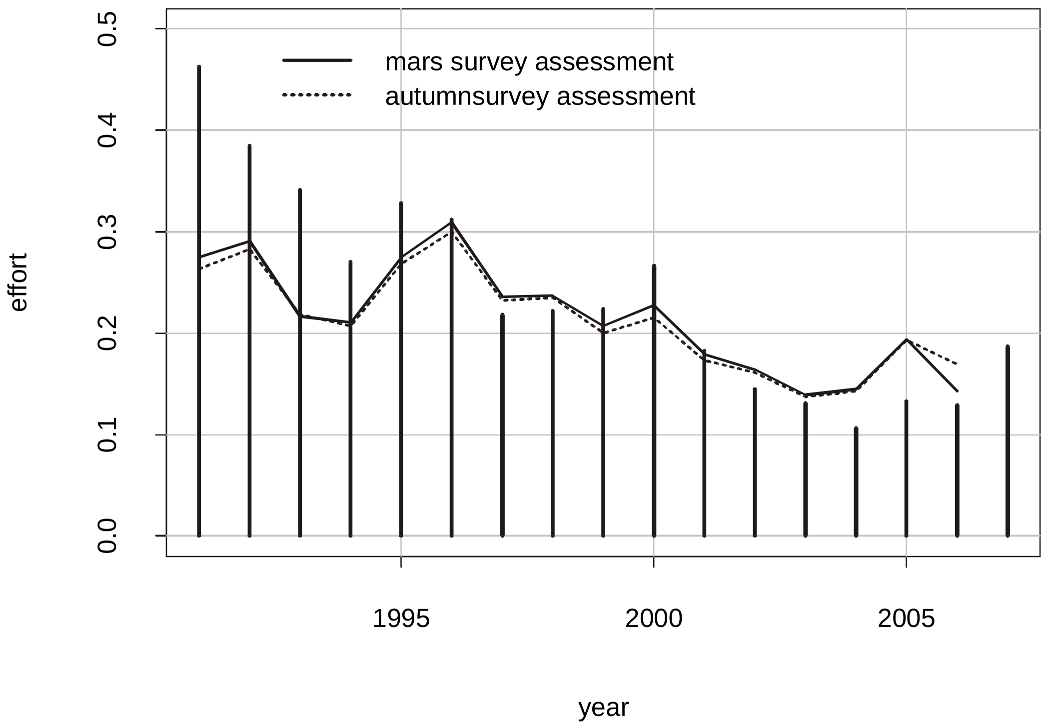


Figure 3.4.5.18. Index of proportion of haddock larger than 42cm caught by bottom trawl each in each year. The index is calculated by dividing the total number caught as shown in figure 3.4.15 by the abundance index from the survey. Proportion of age 4 and older caught according to assessment is shown for comparison

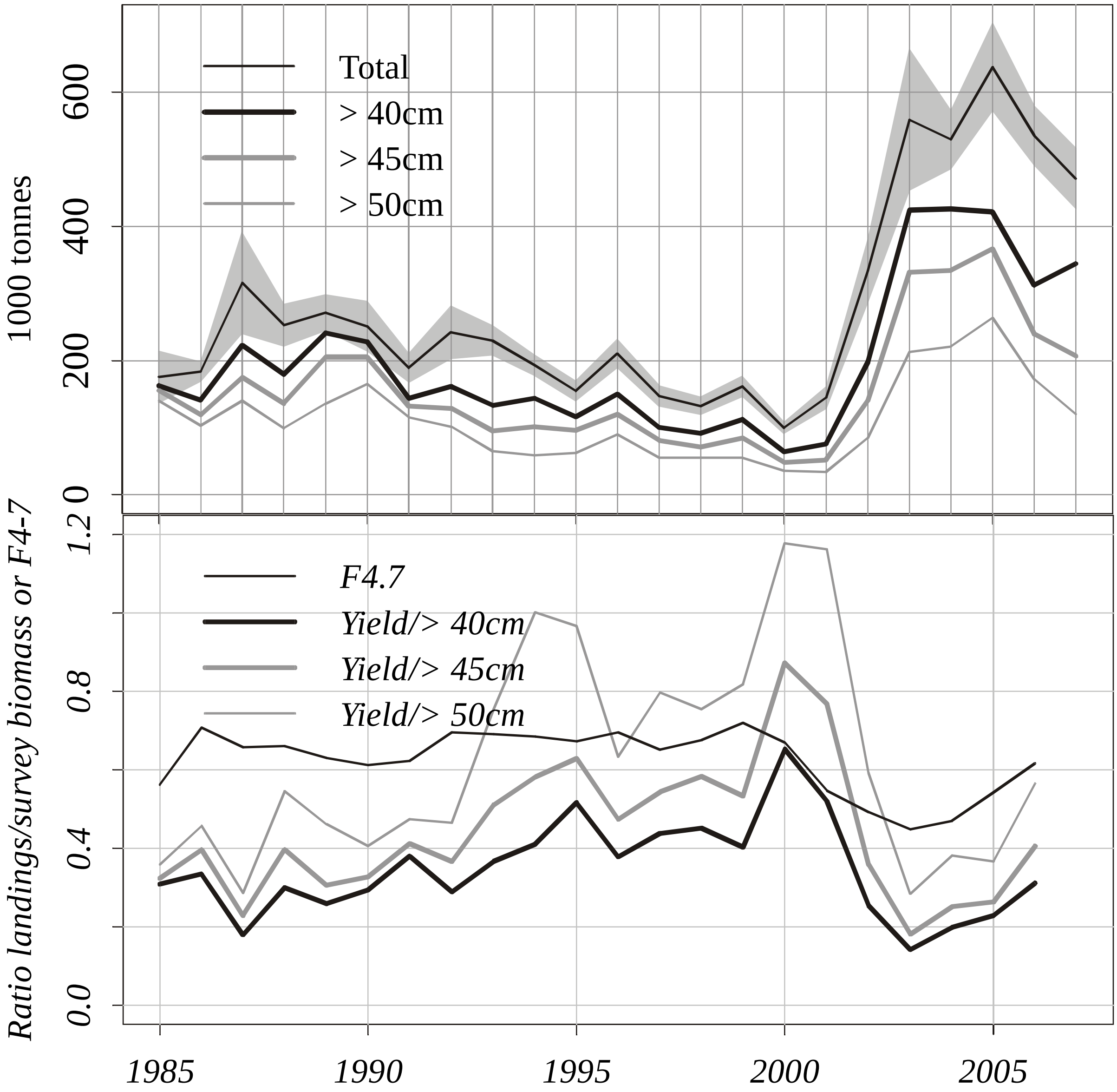


Figure 3.4.5.19. Haddock in division Va. Abundance indices of haddock above given size in the groundfish survey in March and measures of effort derived by dividing landings divided by survey biomass above given size. F4-7 from an assessment tuned with March survey is shown for

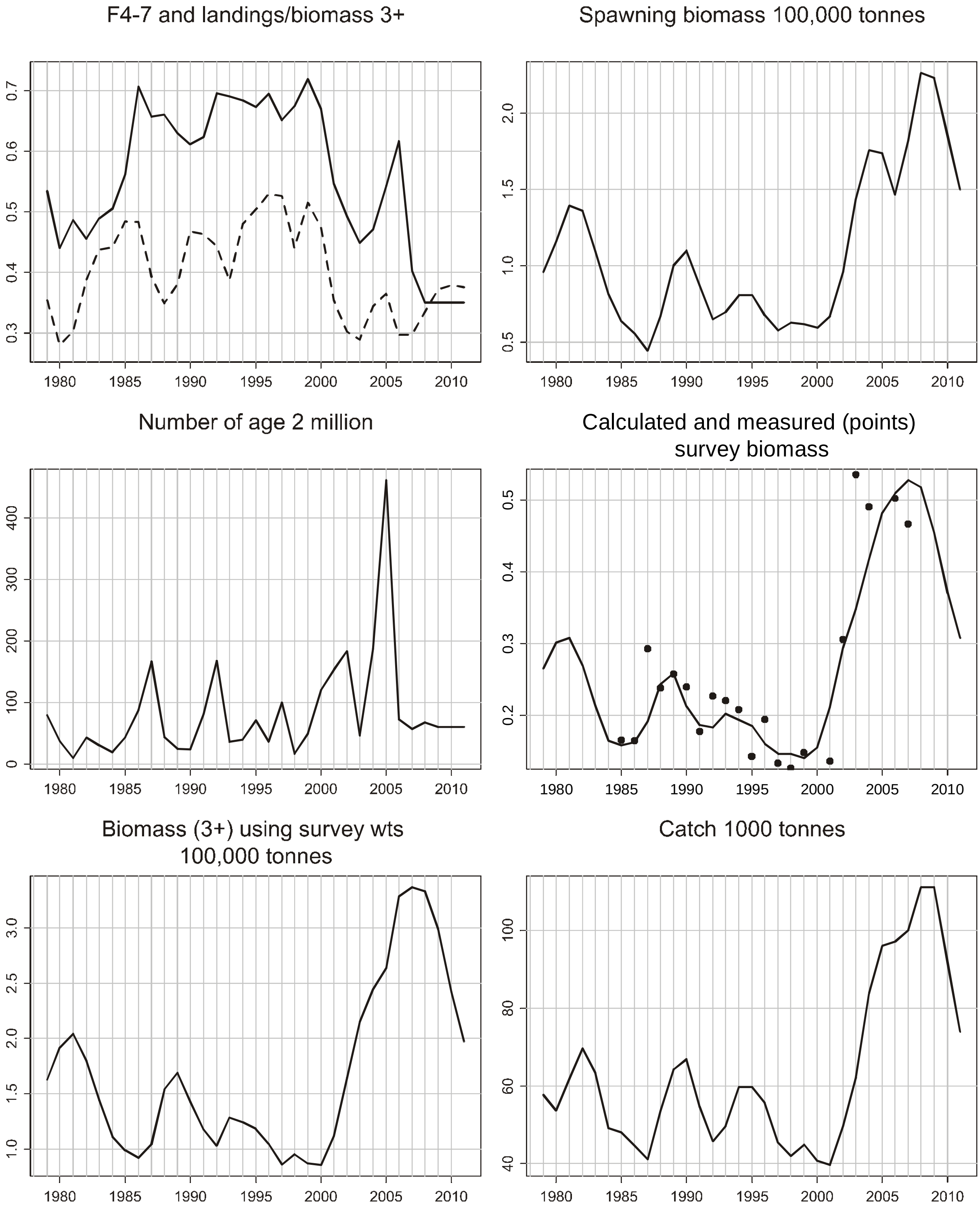


Figure 3.4.6.1. Haddock in division Va. Summary plots from the SPALY run using the March survey

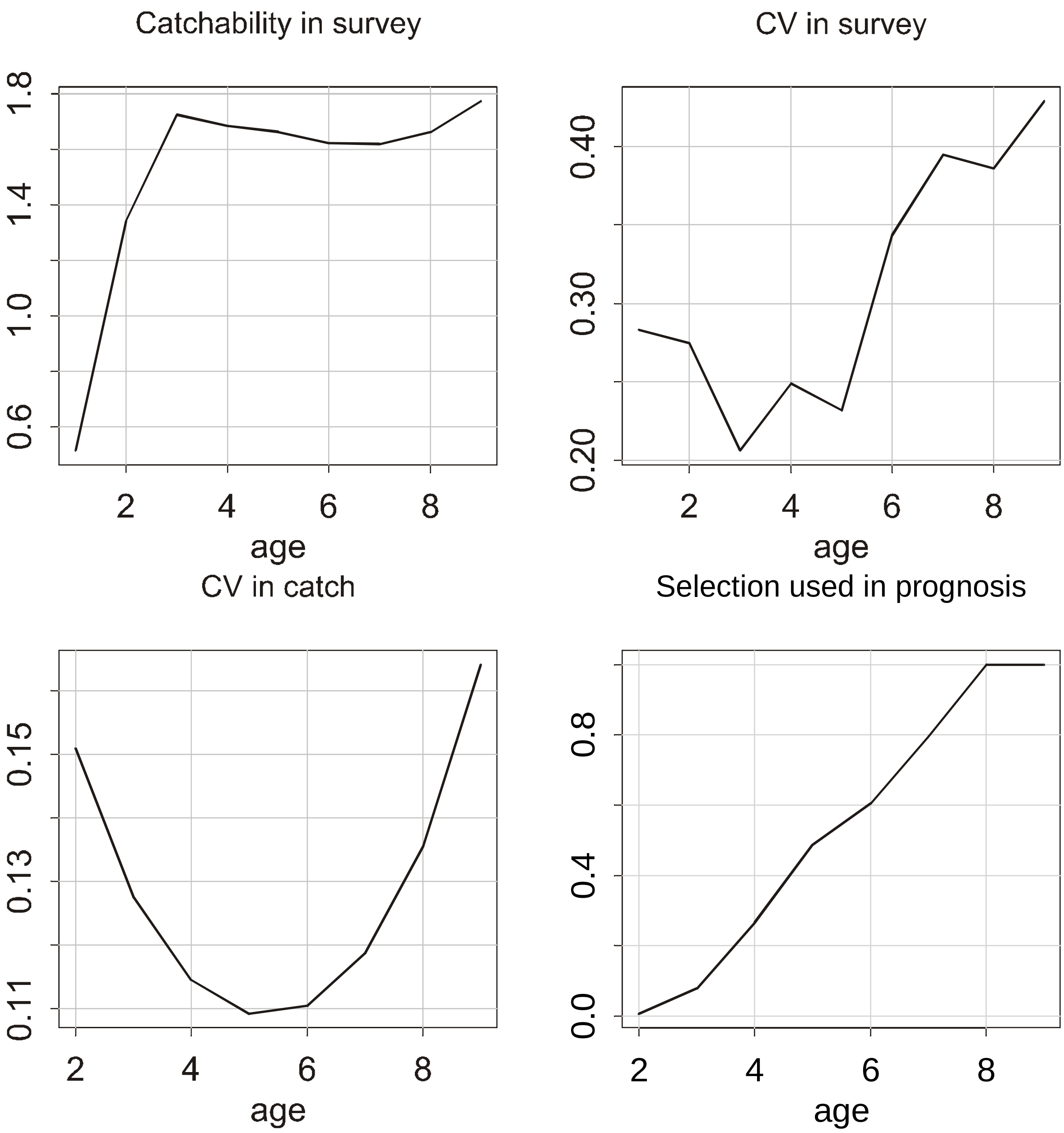


Figure 3.4.6.2. Haddock in division Va. SPALY model based on the March survey. Model estimate of selection pattern and variance in survey and in the catch. Selection used in prognosis is the mean of last 5 years.

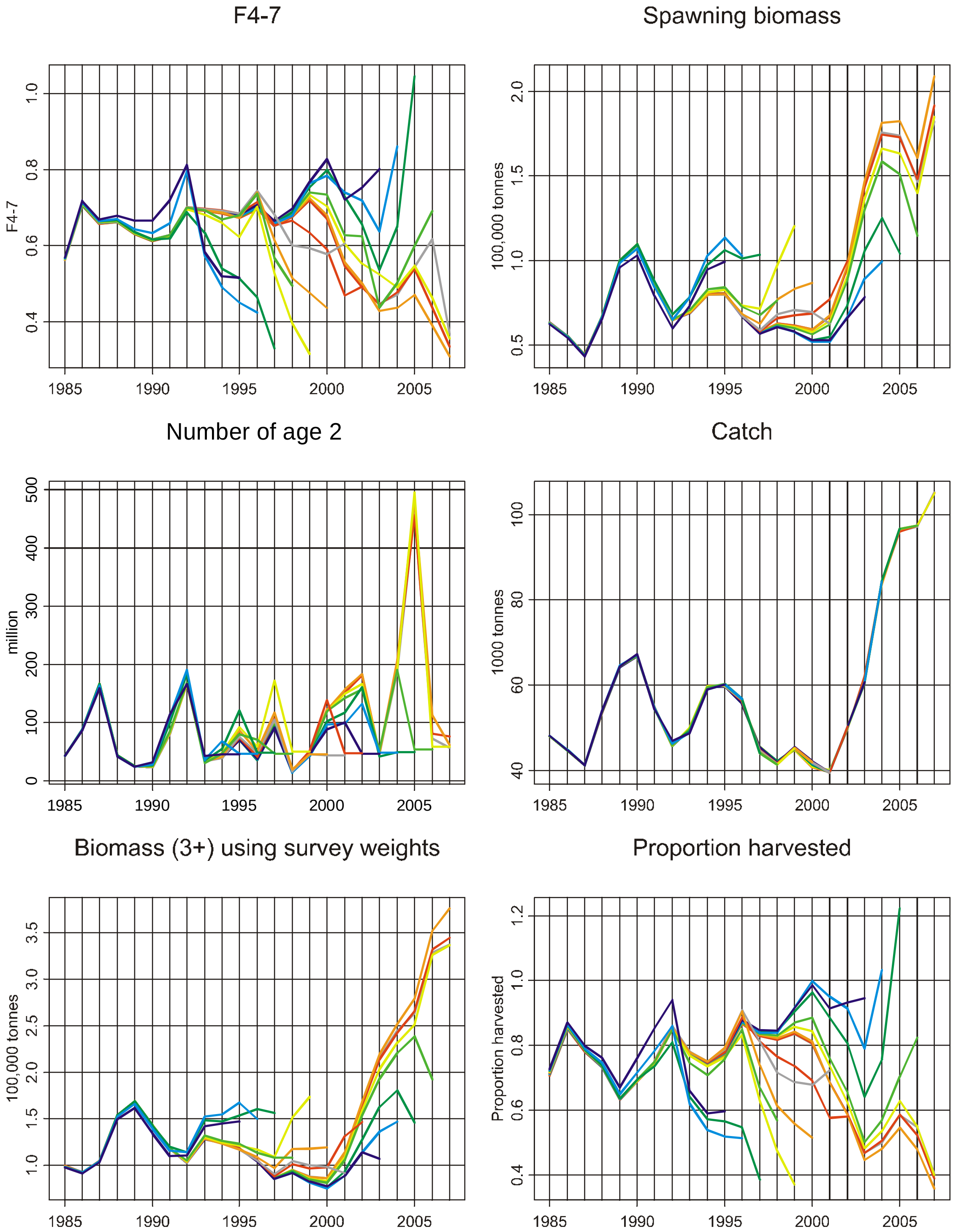


Figure 3.4.6.3 Haddock in division Va. Retrospective pattern from the ADCAM run using indices from age 1 to 9.

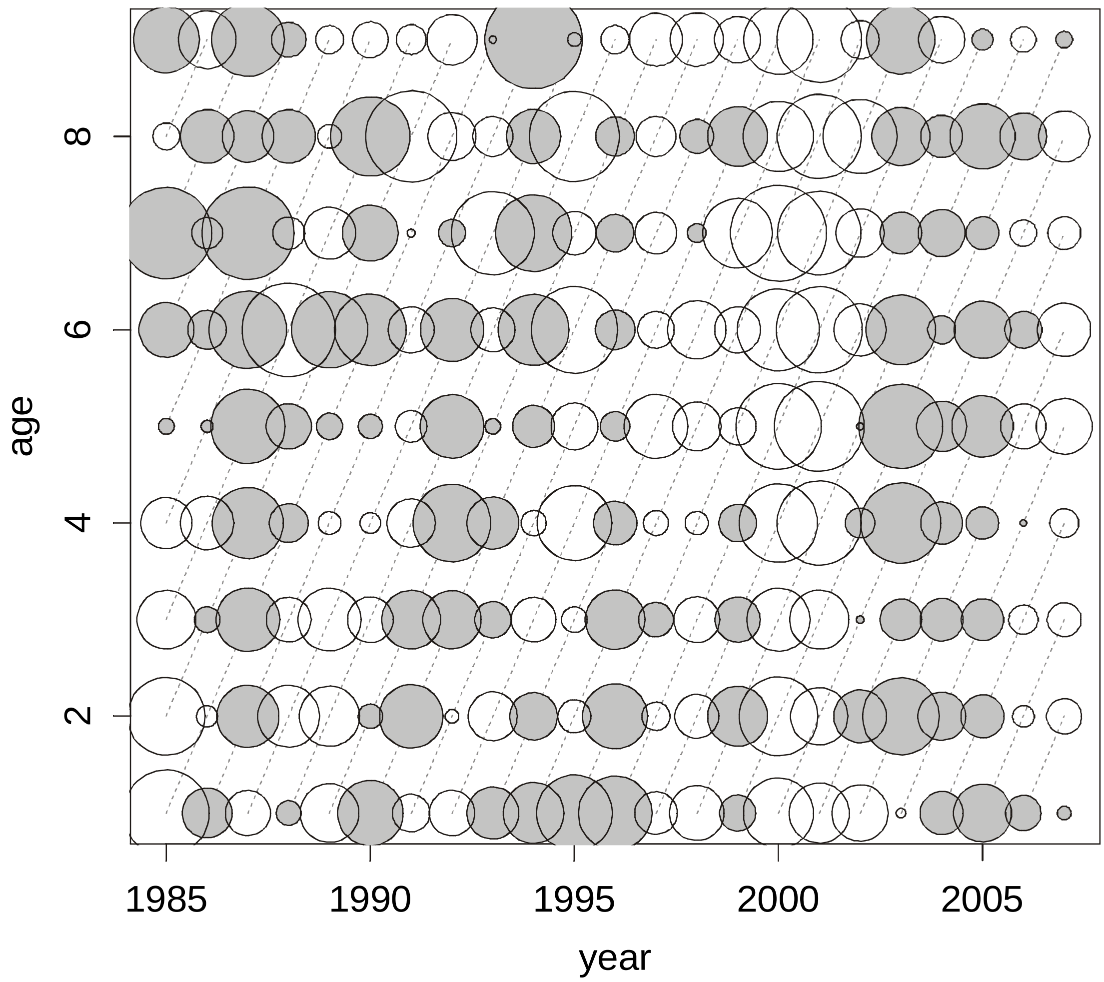


Figure 3.4.6.4 Residuals from the fit to survey data . Coloured circles indicate positive residuals (observed > modelled). The largest circle corresponds to a value of 0.78 and residuals are proportional to the area of the circles.

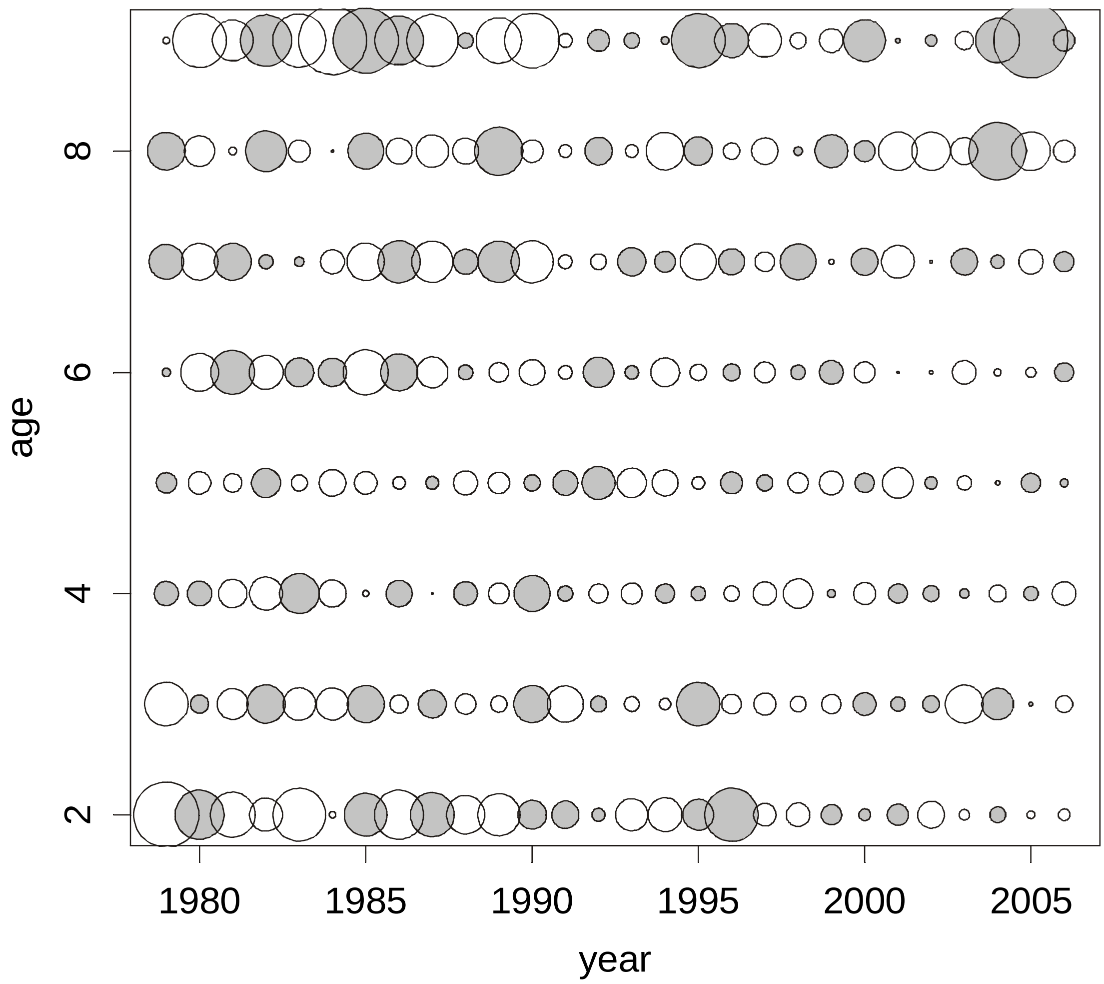


Figure 3.4.6.5 Haddock in division Va. Residuals from the model fit to catch at age data using the selected AD-cam model. .

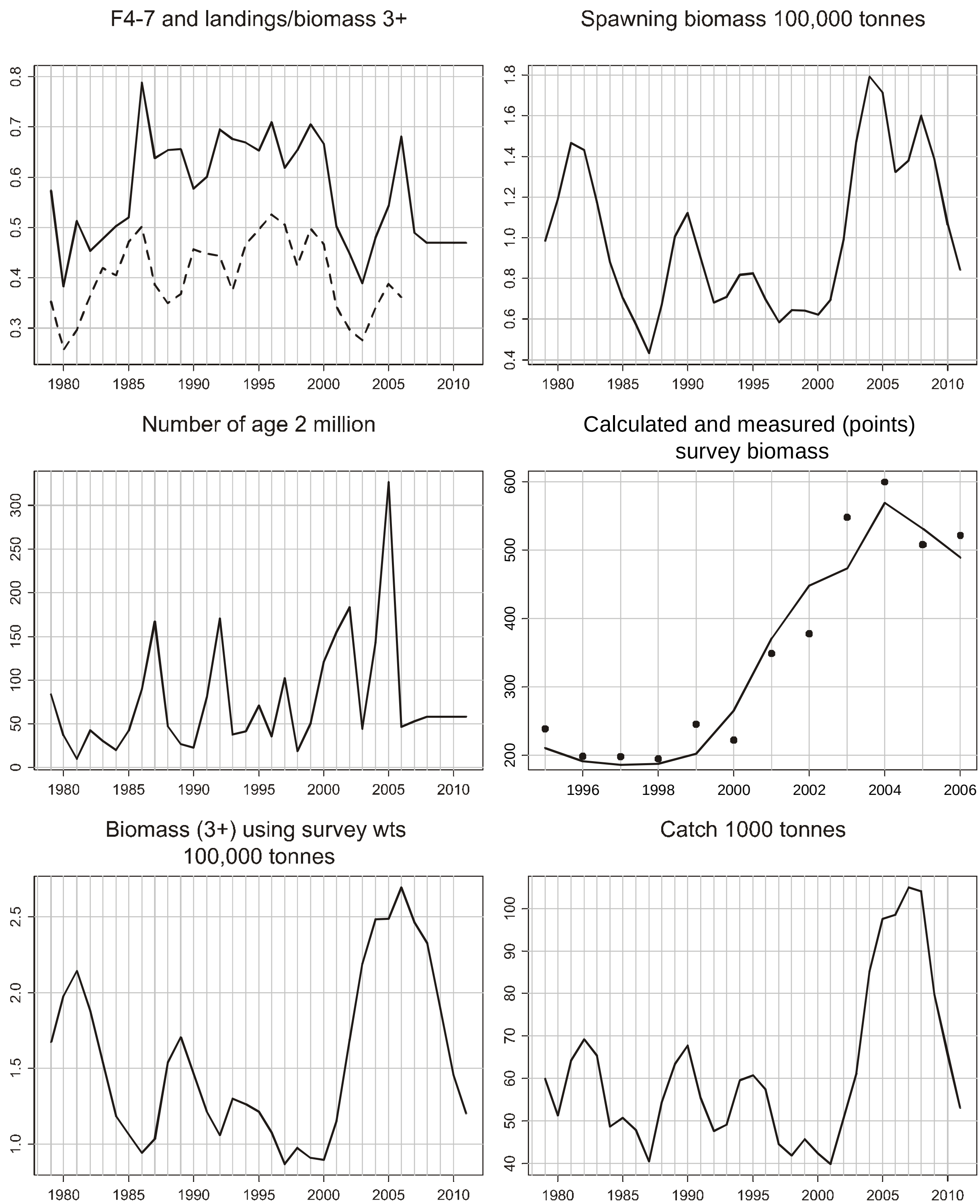


Figure 3.4.6.6. Haddock in division Va. Summary plots from an Adapt run using the Autumn survey

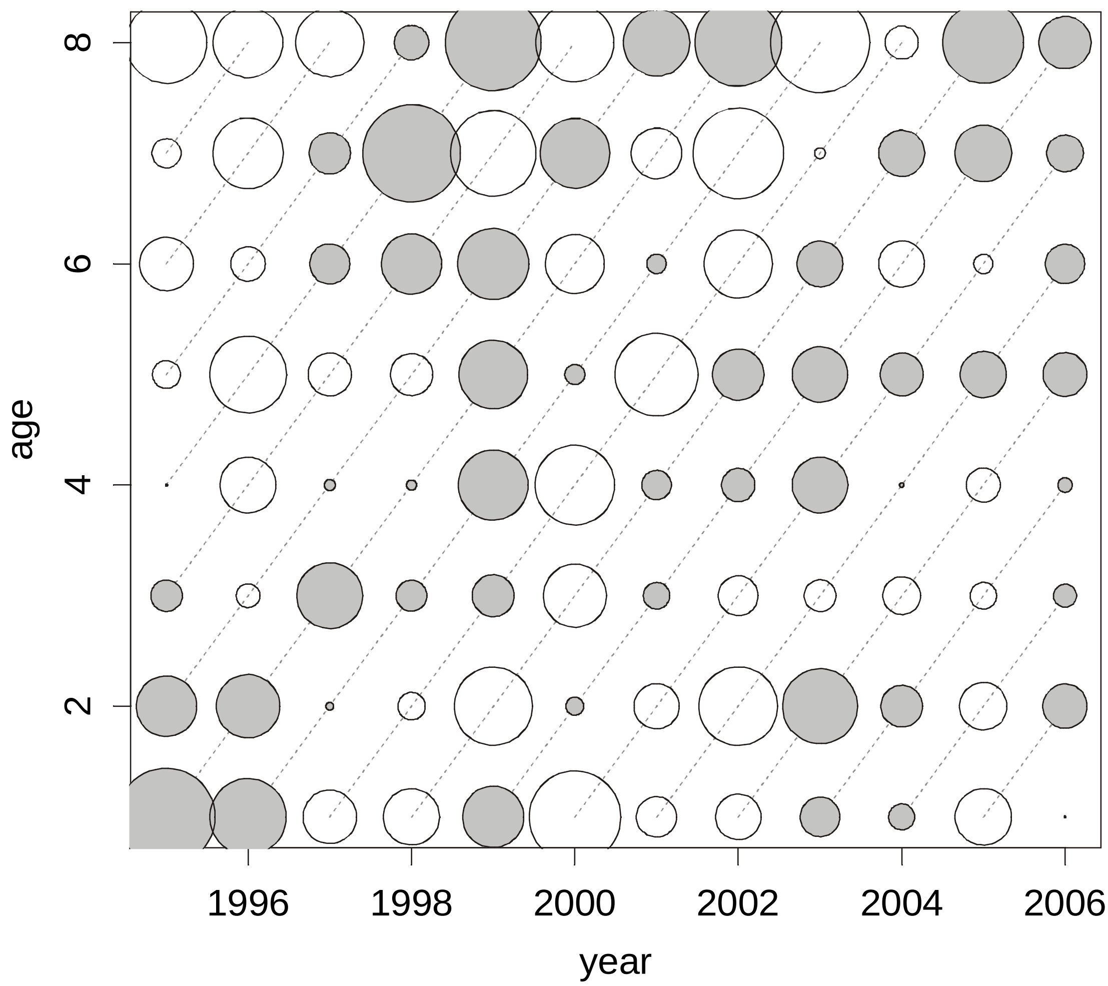


Figure 3.4.6.7 Residuals from the fit to survey data . from Adapt run based on the autumn survey. Coloured circles indicate positive residuals (observed > modelled). The largest circle corresponds to a value of 0.78 and residuals are proportional to the area of the circles.

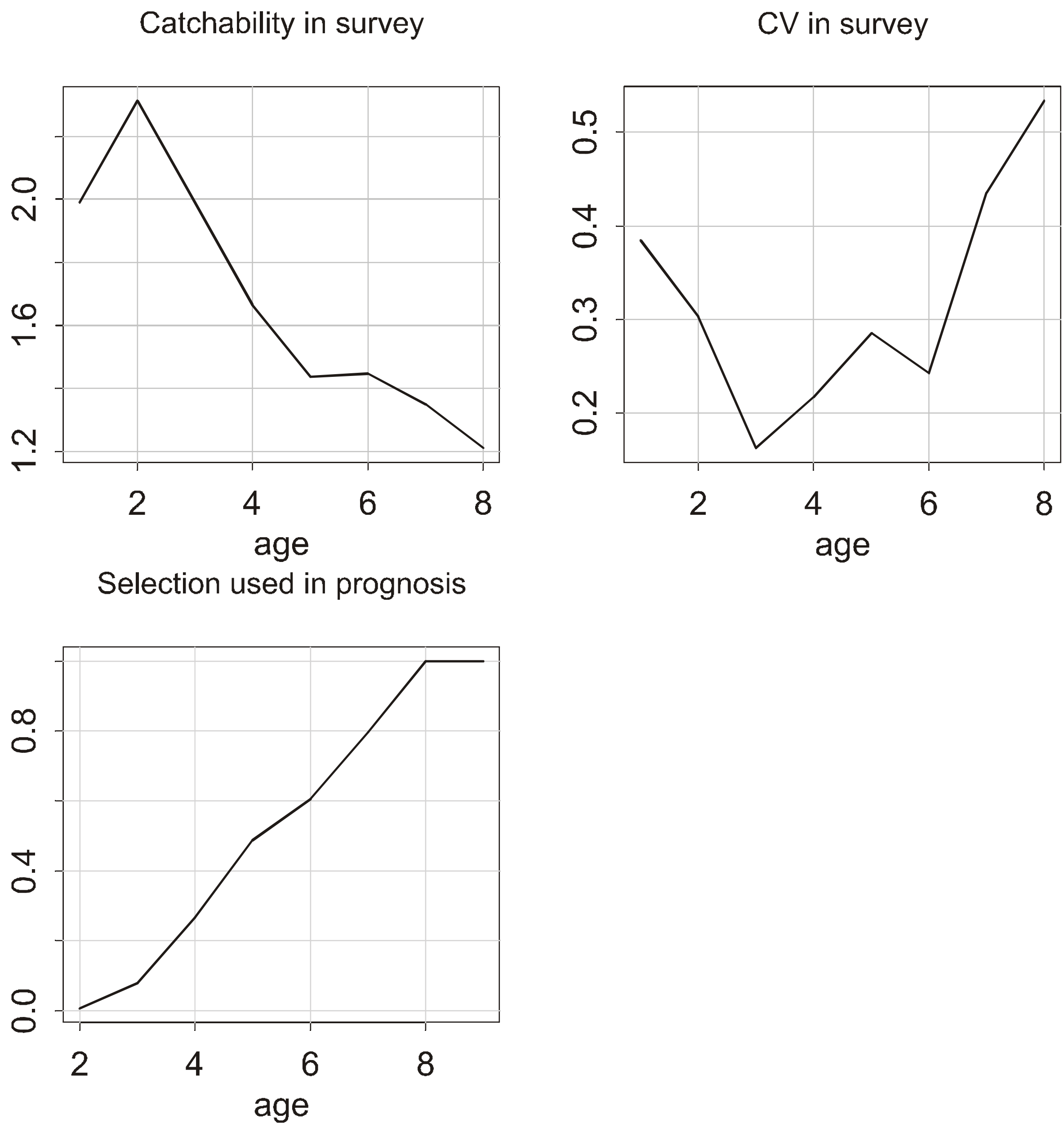


Figure 3.4.6.8. Haddock in division Va. Adapt model based on the autumn survey. Model estimate of selection pattern and variance in survey and in the catch.

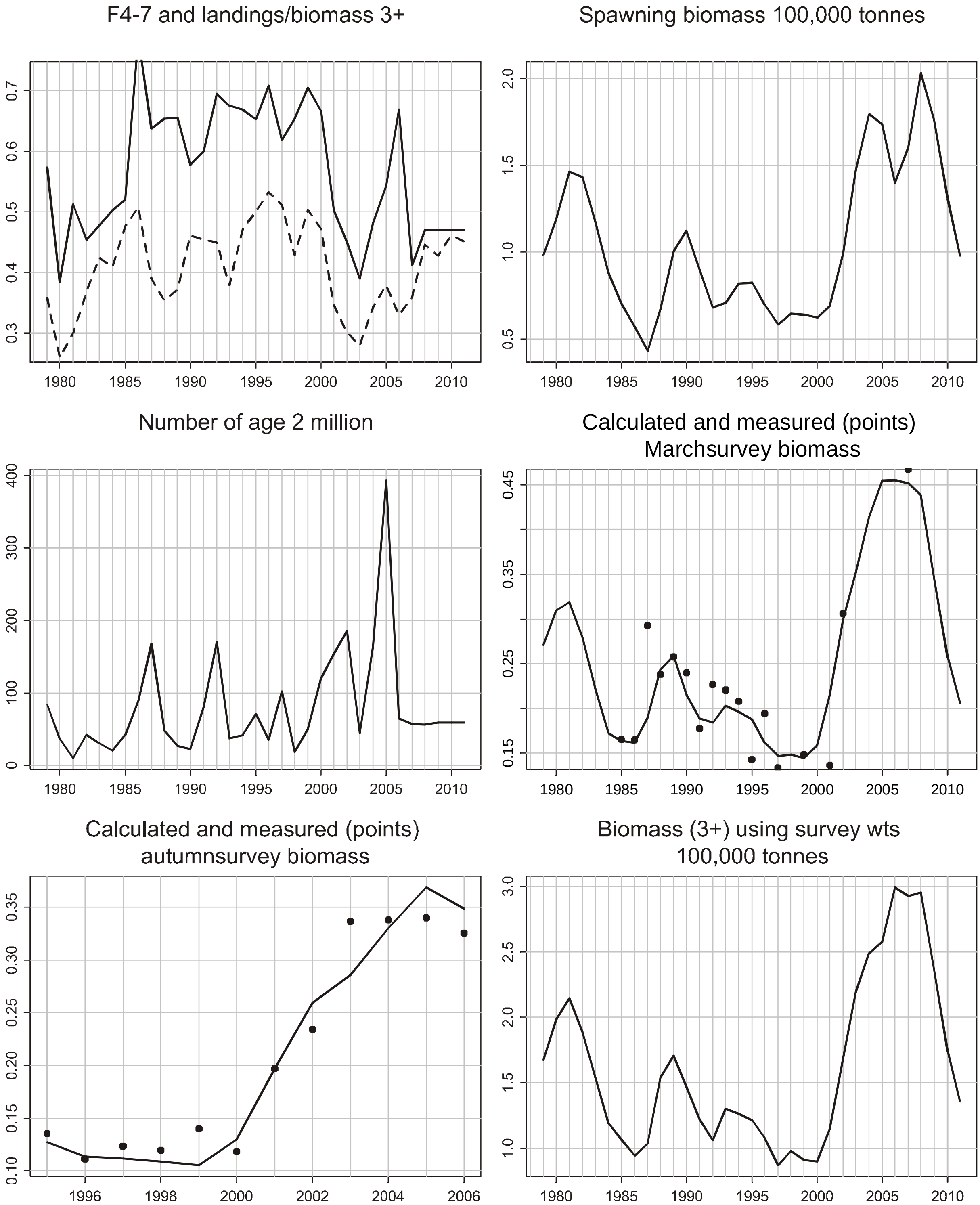


Figure 3.4.6.9. Haddock in division Va. Summary plots from an Adapt run using theAutumn survey

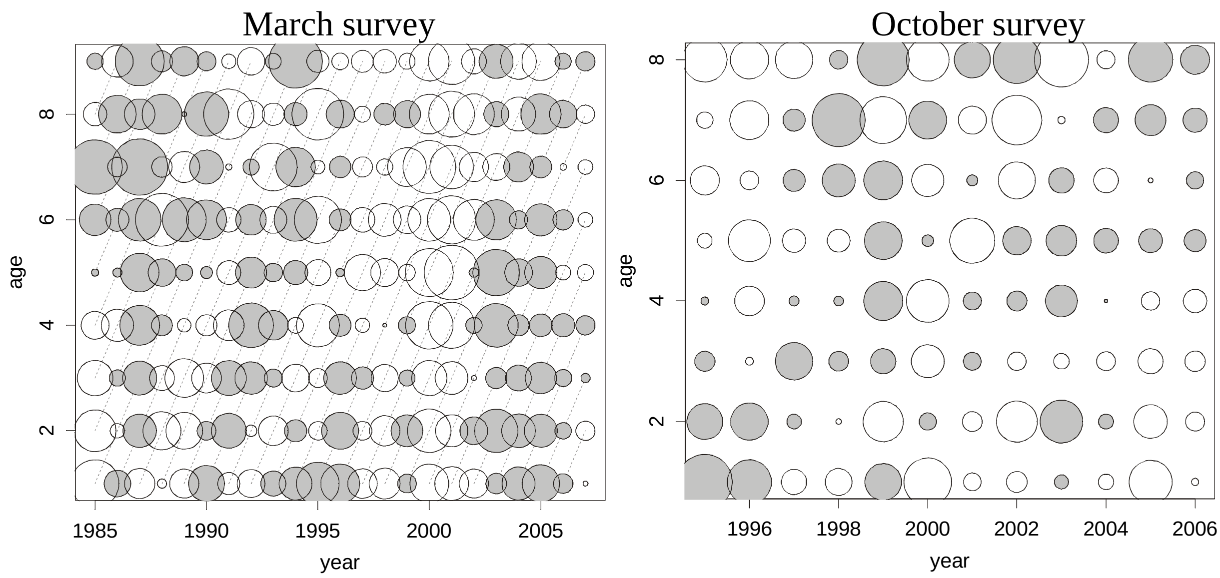


Figure 3.4.6.10. Haddock in division Va. Residuals from the fit to survey data . from Adapt run based on the both the surveys. Coloured circles indicate positive residuals (observed > modelled). The largest circle for the March survey corresponds to a value of 0.87 and the largest circle for the autumn survey to 0.89. residuals are proportional to the area of the circles.

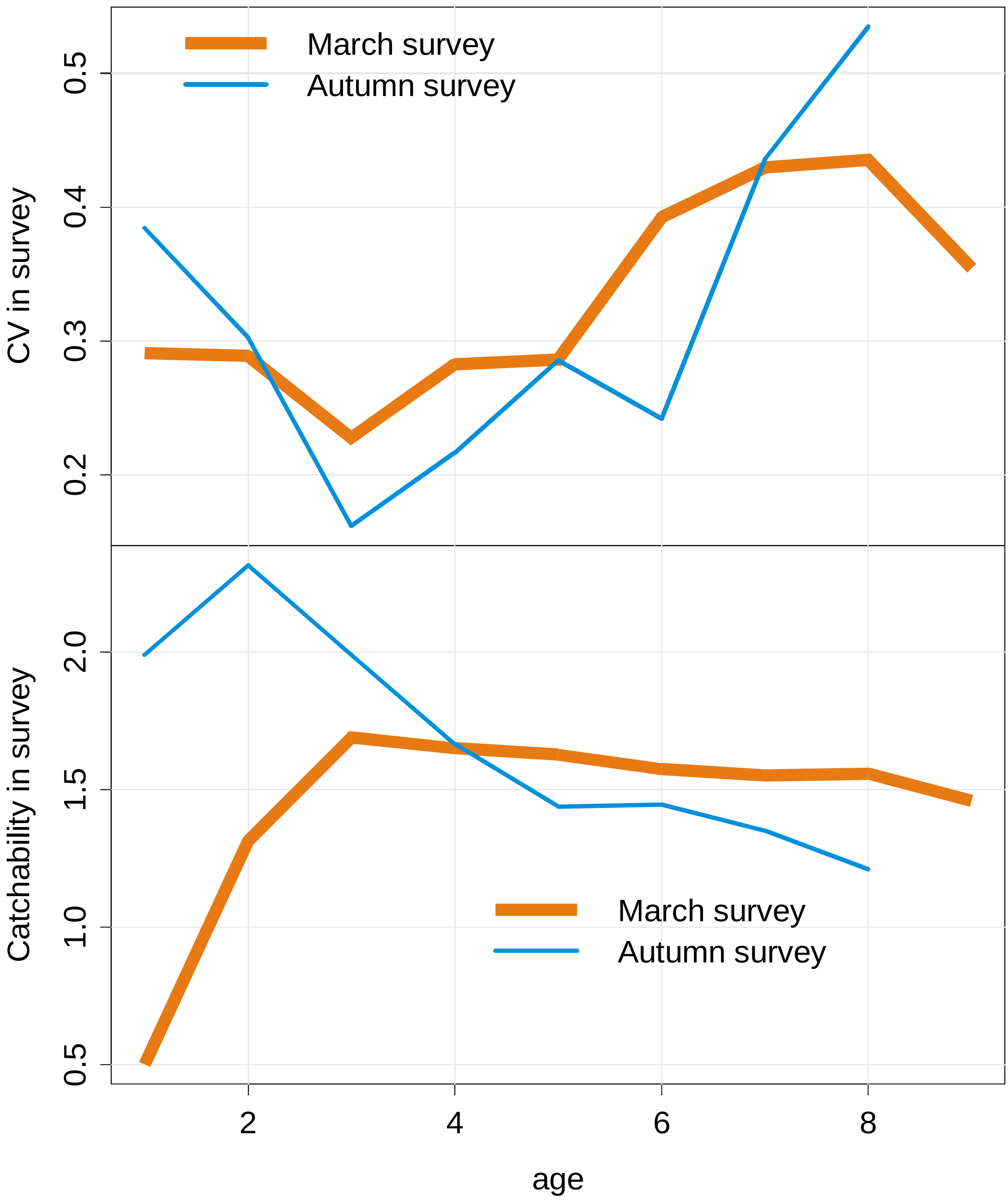


Figure 3.4.6.11. Haddock in division Va. Estimated catchbility and CV of the surveys in the Adapt run using both surveys for tuning.

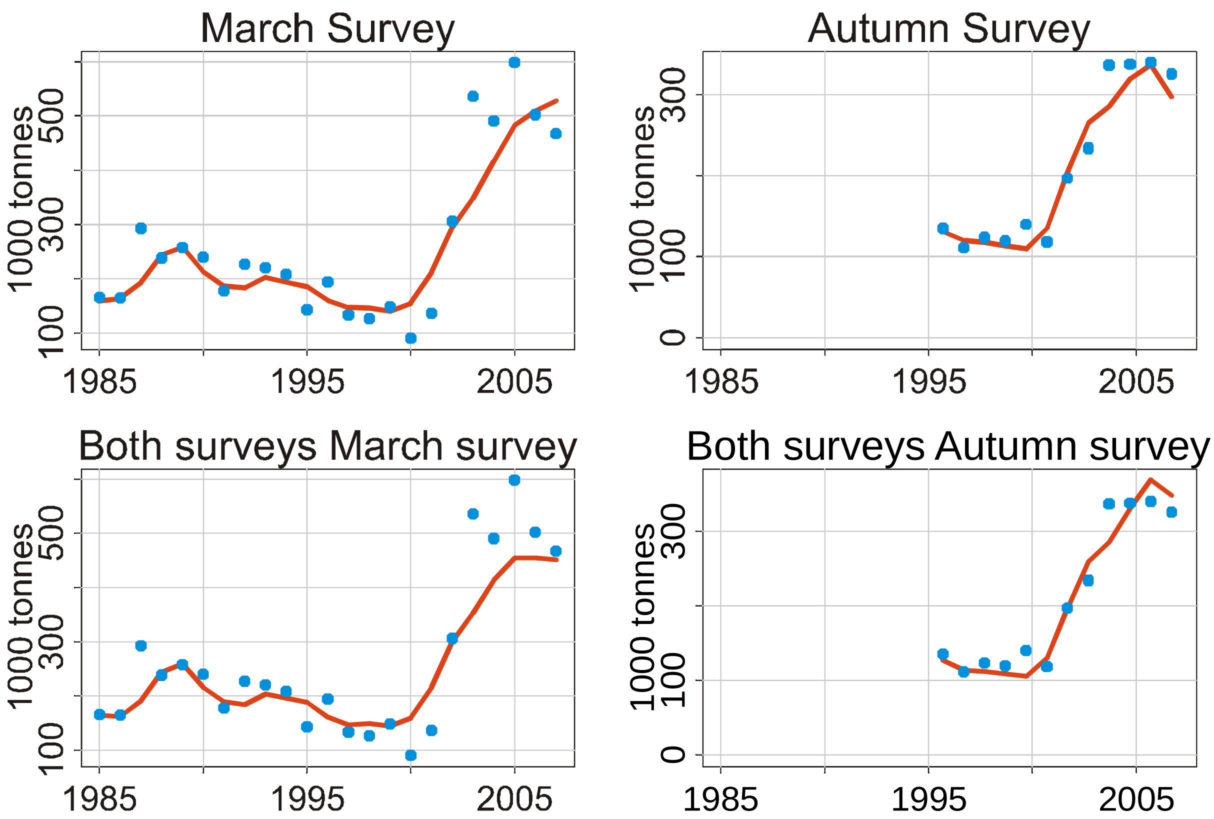


Figure 3.4.6.12. Haddock in division Va. Predicted and observed survey biomass according to runs based on one survey at time and an Adapt run using both the surveys for tuning. Weight at age in the spring survey is used to calculate the survey biomass in the autumn survey.

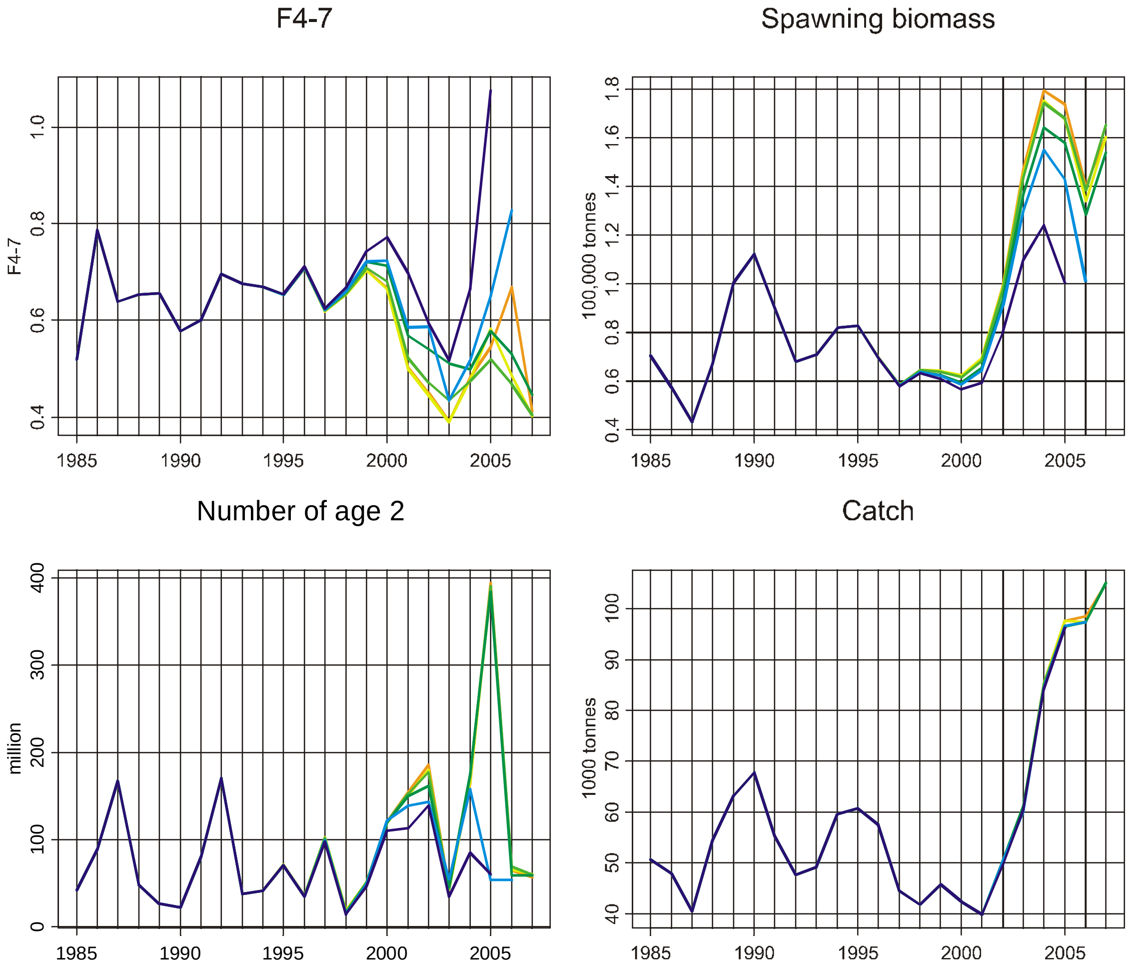


Figure 3.4.6.13. Haddock in division Va. Retrospepective pattern from the Adapt model using both the surveys for tuning.

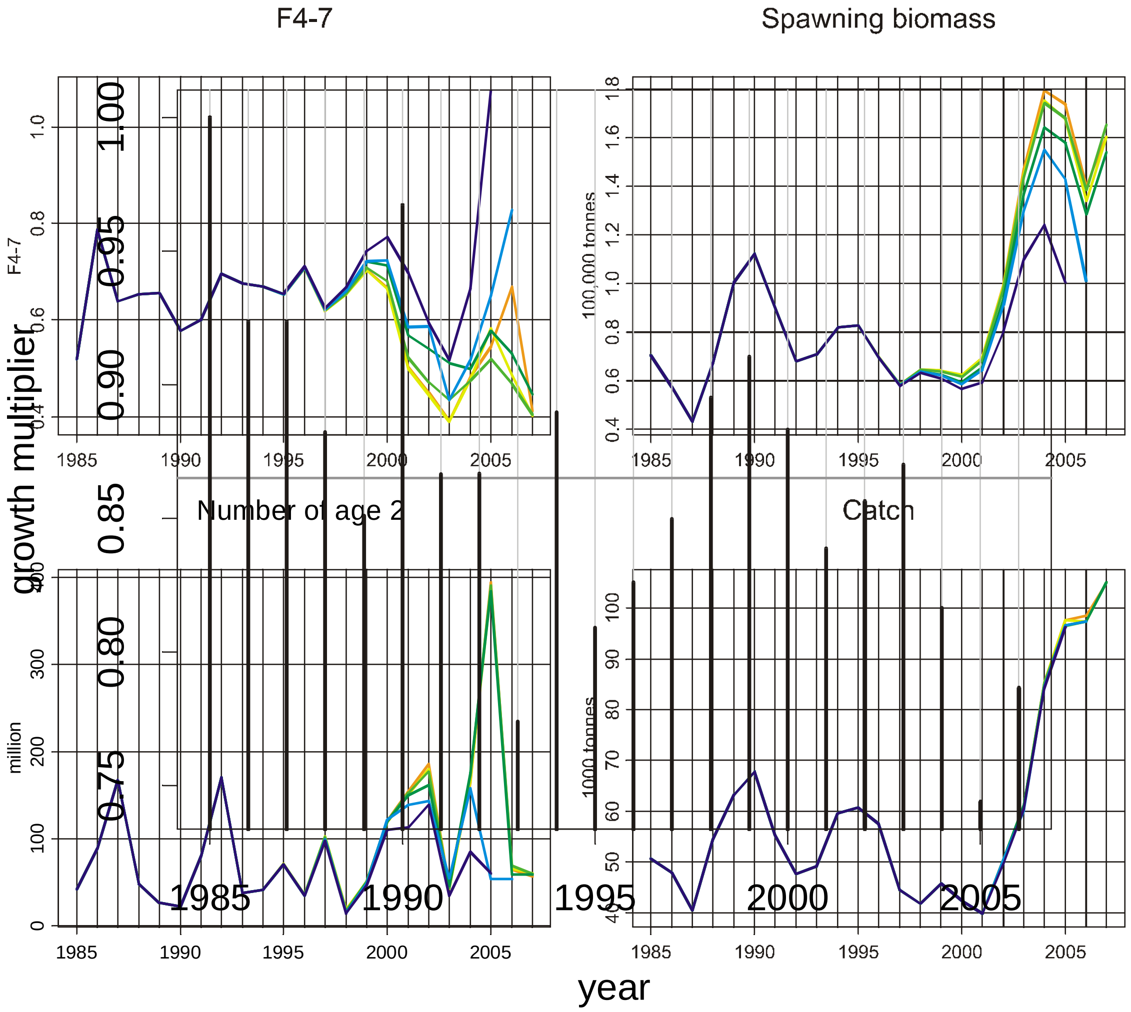


Figure 3.4.7.1. Haddock in division Va. Estimated year factor in model predicting growth.

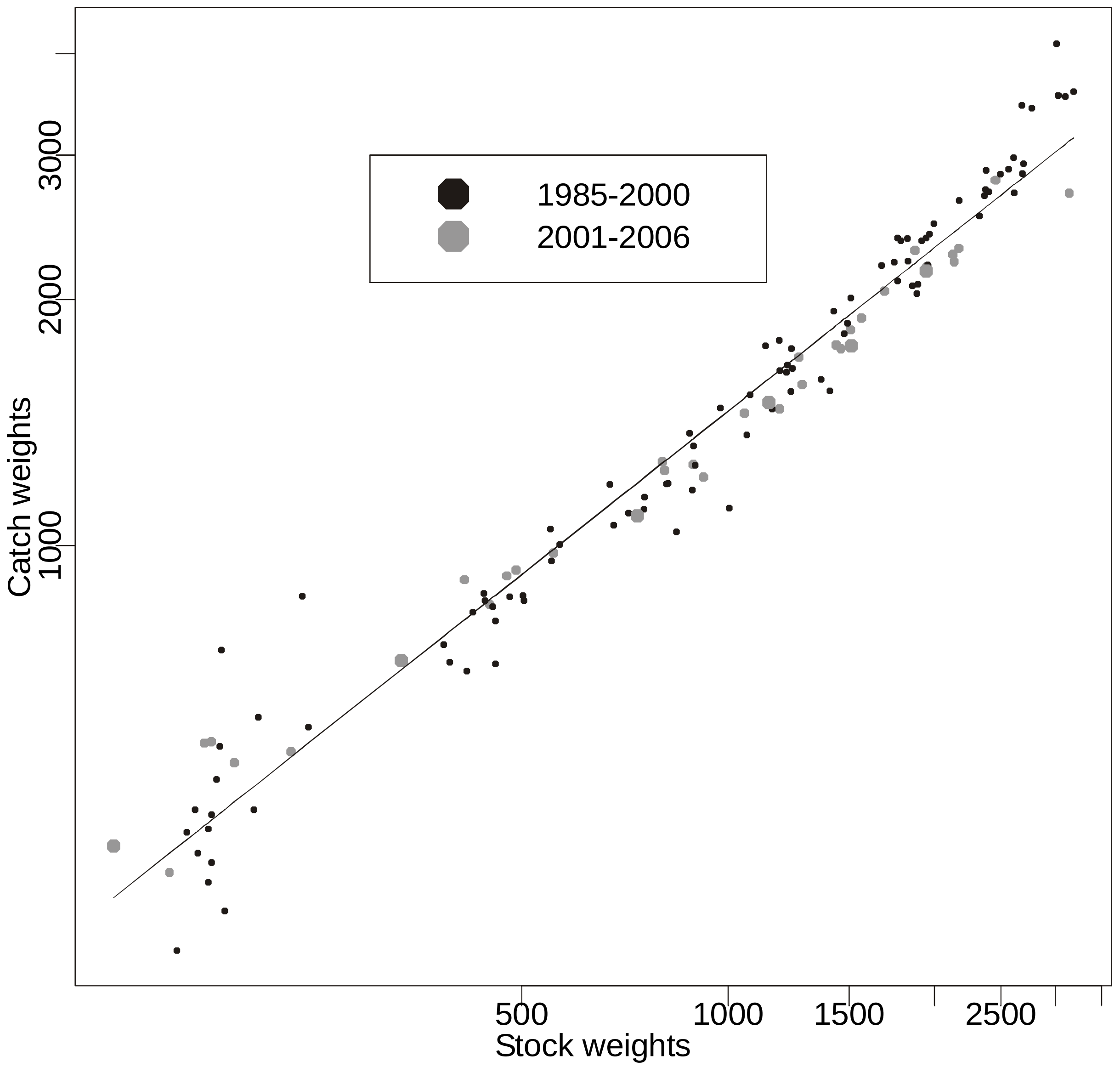


Figure 3.4.7.2. Haddock in division Va. Catch weights vs. stock weights with fitted relationship shown on plot.

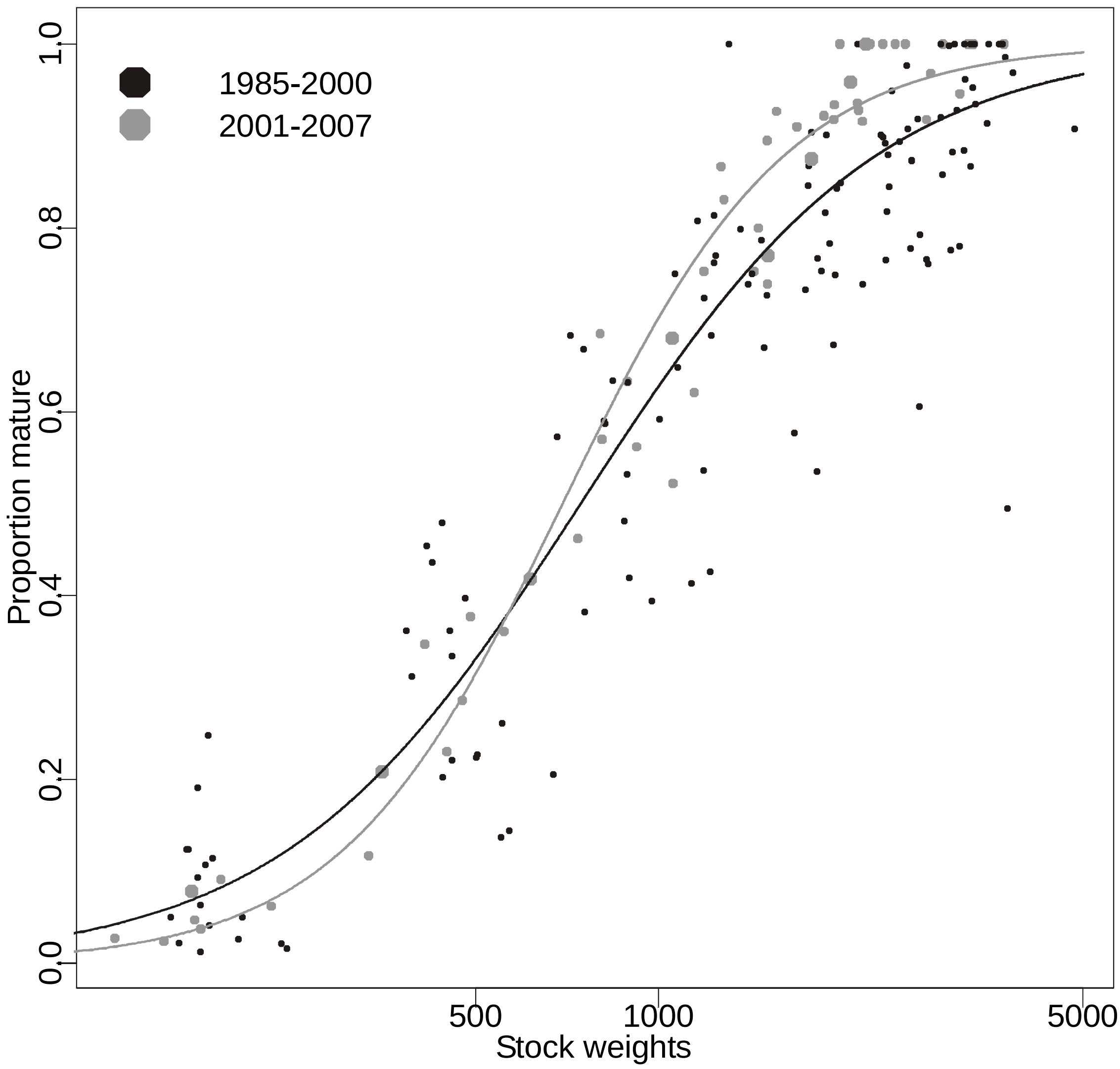


Figure 3.4.7.3. Haddock in division Va. Proportion mature vs. stock weights with fitted relationships shown on plot.

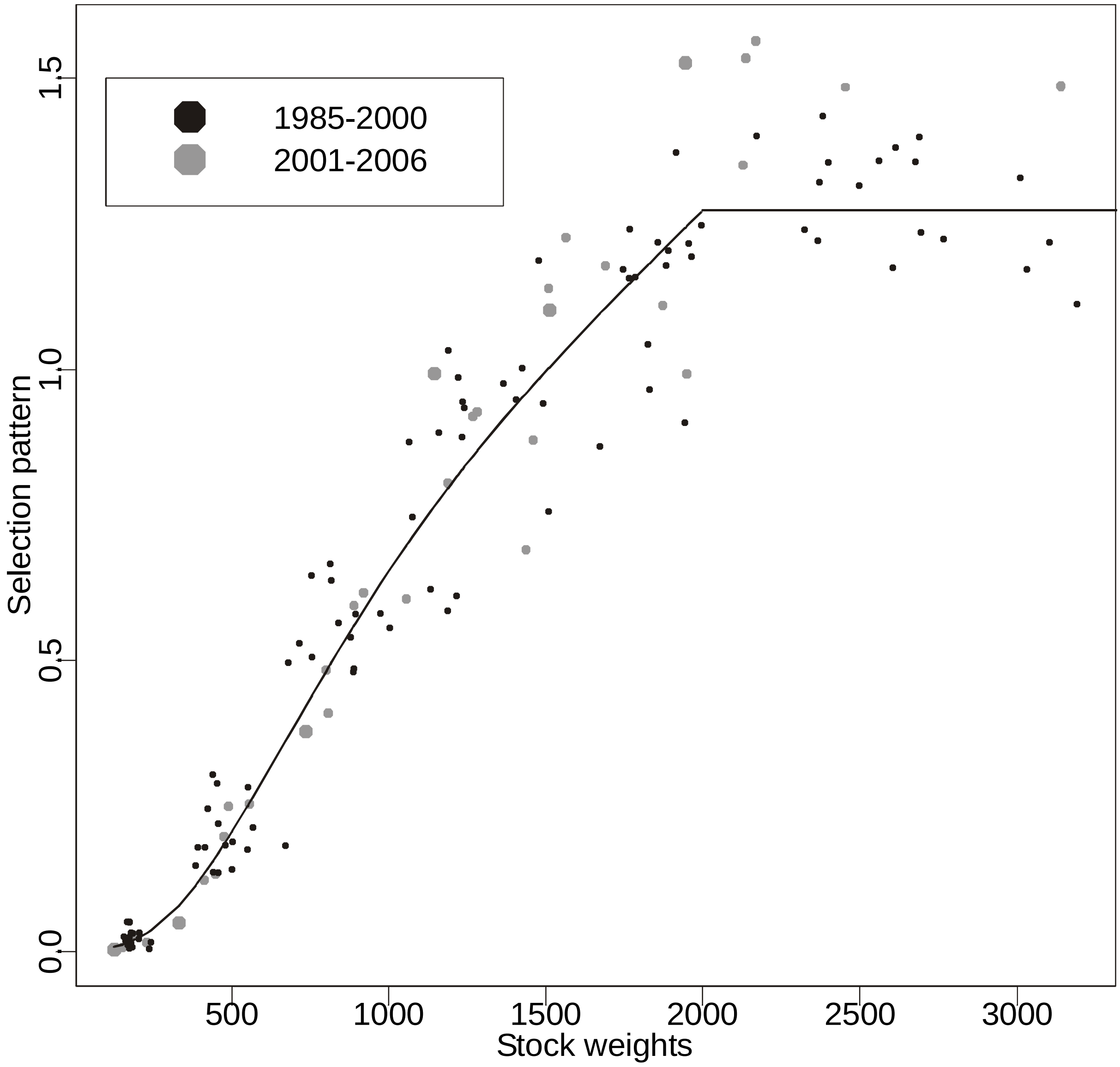


Figure 3.4.7.4 Haddock in division Va. Relationship between selection pattern and mean weight at age in the stock with fitted relationship shown.

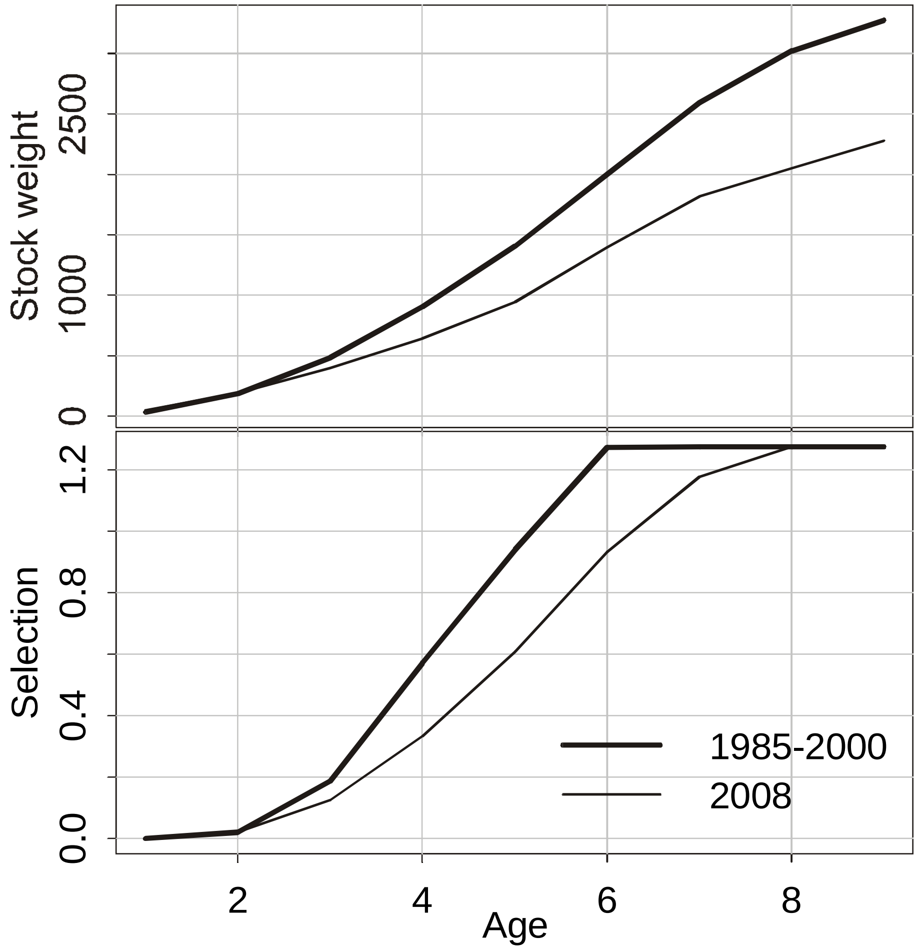


Figure 3.4.7.5 Haddock in division Va. Comparison of mean weights at age in 1985 – 2000 with predicted values for the year 2008. The lower figure shows the predicted selection based on the mean weight at age and the curve in figure 3.4.7.4.

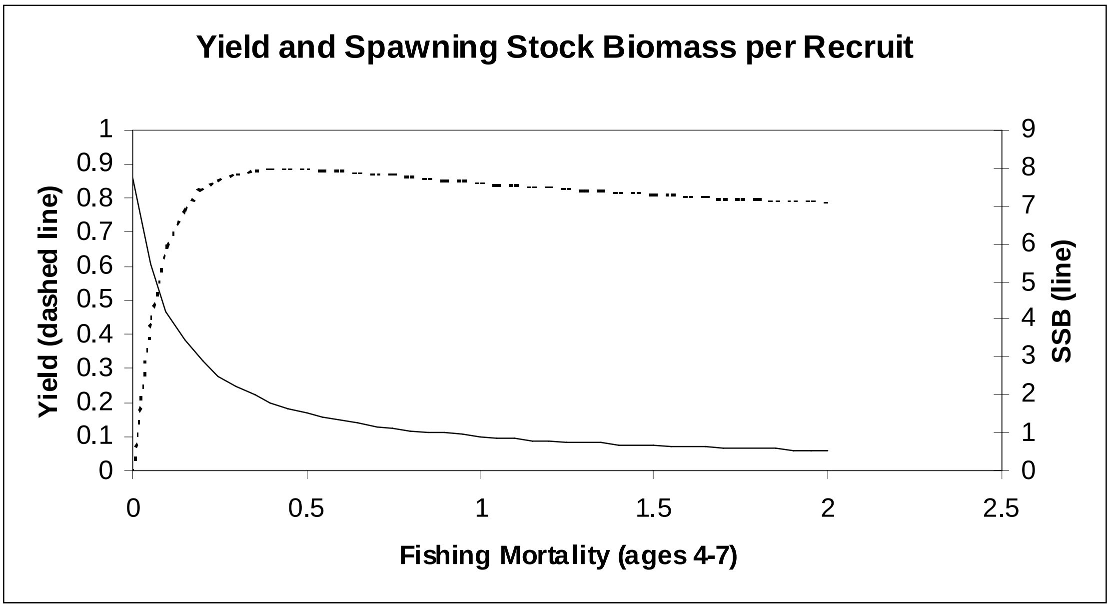


Figure 3.4.7.6 Haddock in division Va. Yield per recruit.

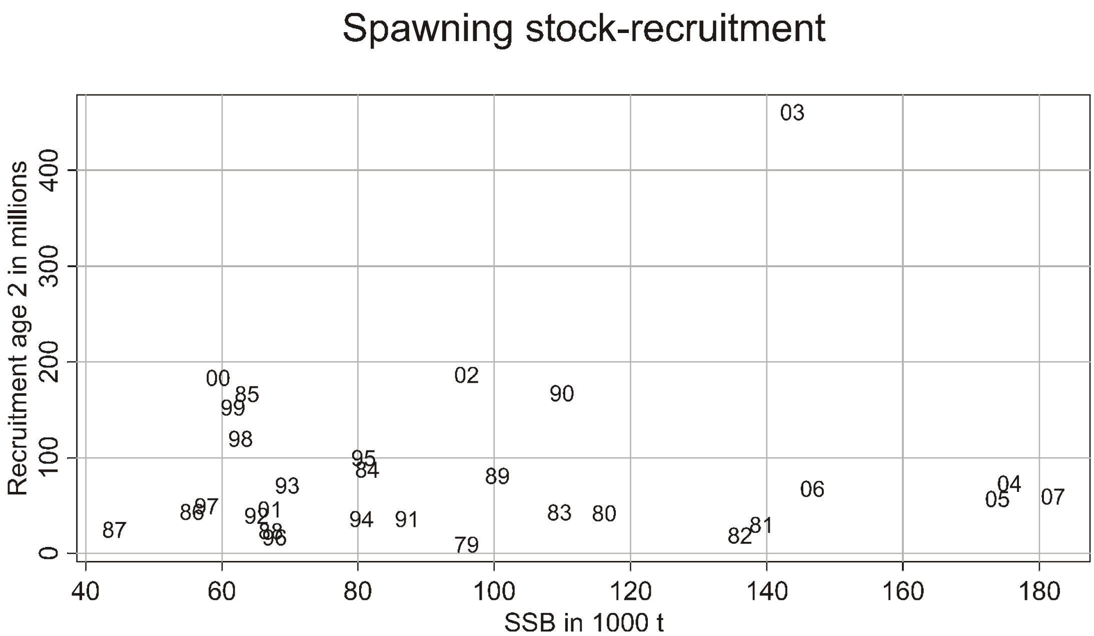


Figure 3.4.7.7 Haddock in division Va. Spawning stock vs. fishing mortality.

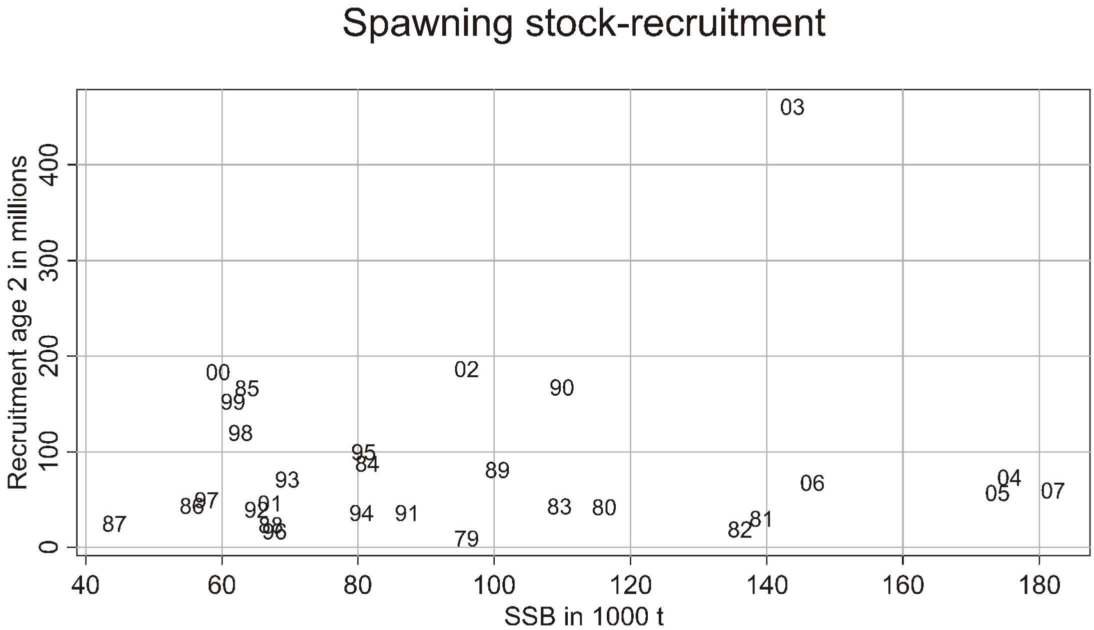


Figure 3.4.7.8 Haddock in division Va. Spawning stock vs. recruitment. . The labels in the figure show year classes.

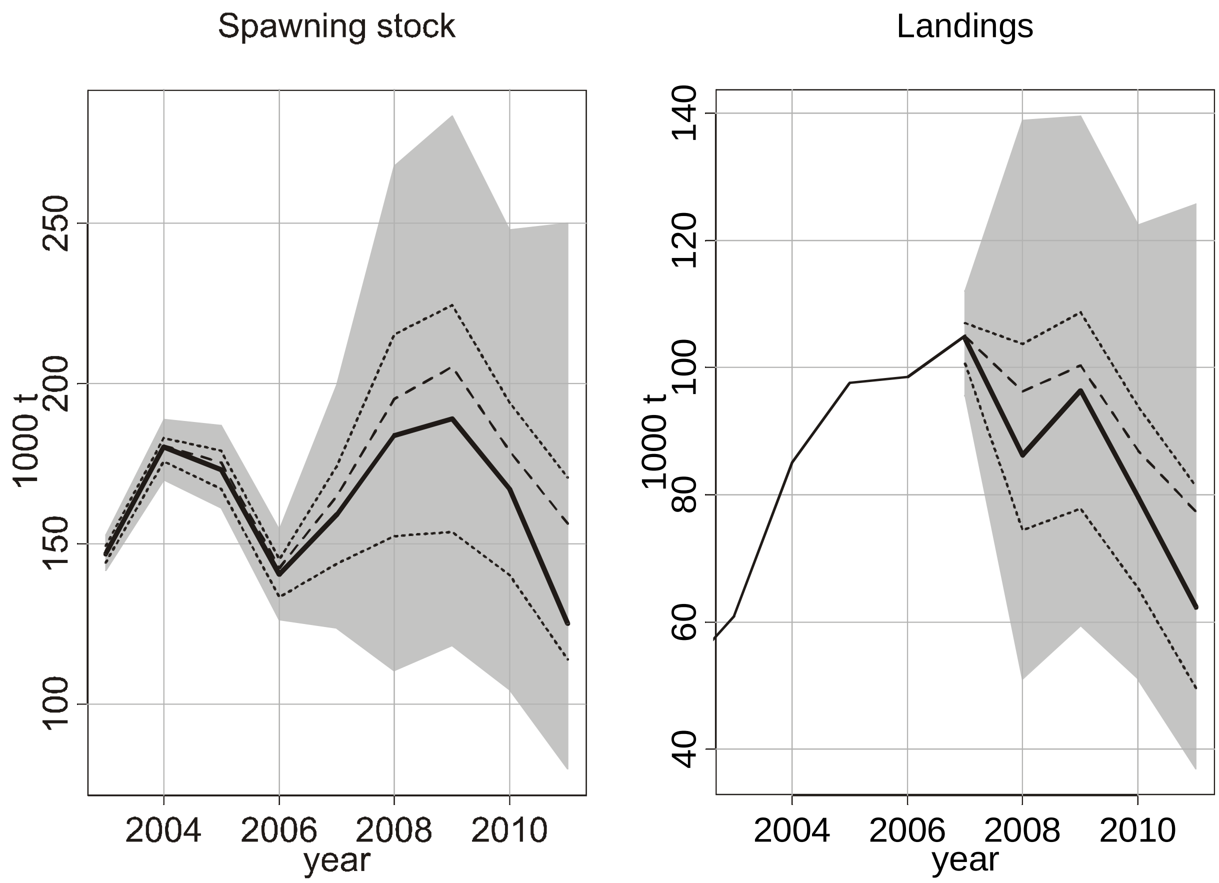


Figure 3.4.7.9 Haddock in division Va. Cumulative probability profiles of landings, and SSB according to the SPALY run based on the March survey. F=0.35 and 15%CV in assessment.

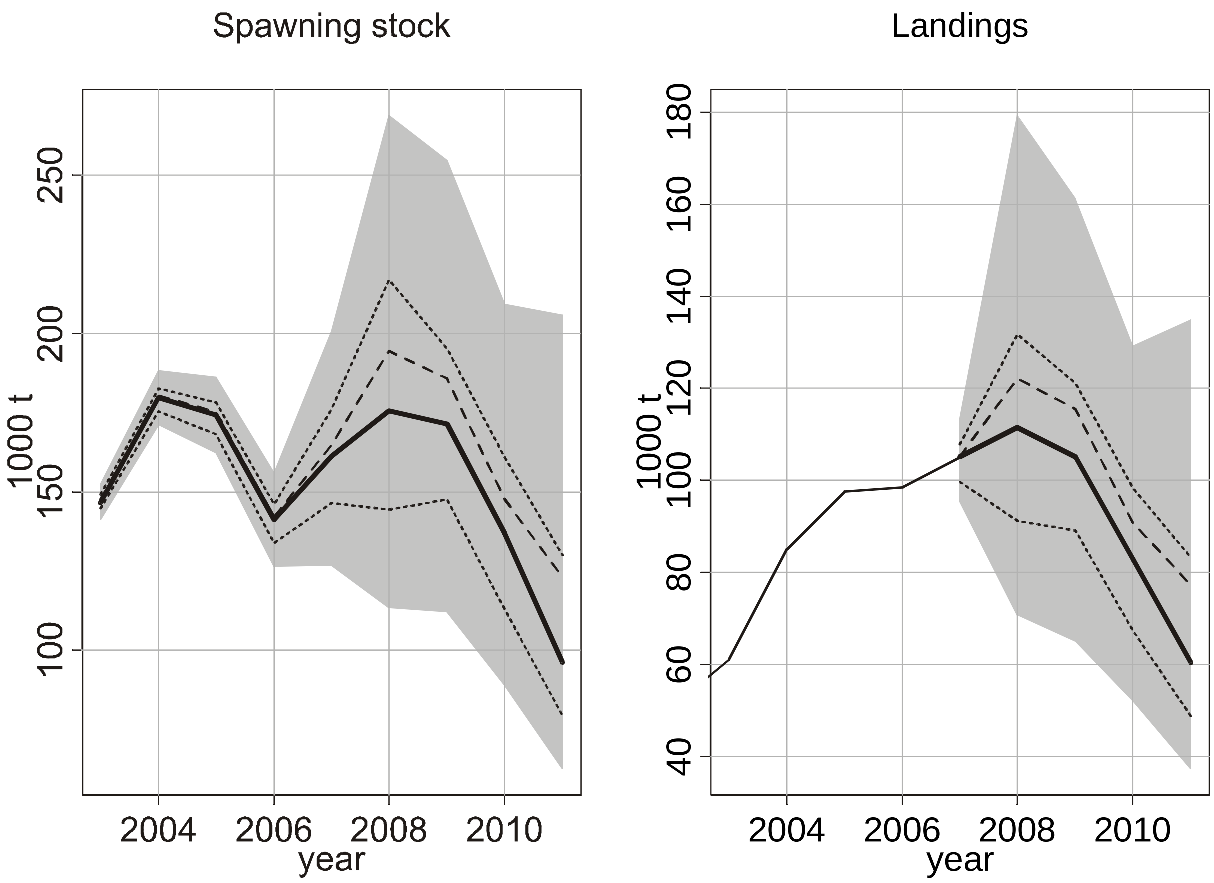


Figure 3.4.7.10 Haddock in division Va. Cumulative probability profiles of landings, and SSB according to the SPALY run based on the March survey. F=0.47 and 15%CV in assessment.

3.5 Icelandic summer spawning herring

Summary

Input data

- The total reported landings in 2006 were 135 thous. tons while the TAC was 130 thous. tons.
- The catch in 2006/07 consisted largely of young herring while older are less pronounced.
- Since the last year assessment (2006), the catch at age has been recalculated for the fishing seasons 1990/91 to 1993/94 and 1998/99 to 1999/00 and those results are used in present assessment, as well as unchanged catch data for earlier seasons and the most recent fishery data (2006/07). Re-ageing for the years 1995-1997 remain but according to the preceding re-ageing, they are not consider to affect the analytical assessment largely.
- The total estimate of the adult stock in the herring acoustic surveys was 786 thous. tons, confirming the historically high estimate in the 2007 survey.

Assessment

- Since it is not known if persistent overestimation of fishing mortality due to biases in the stock assessment in the past years has deviated in the current assessment, the more precautionary TAC than implied by the predictions based on the analytical assessment should be considered.

Predictions

- Fishing at $\mathbf{F}_{0.1}$= 0.22 in the fishing season 2007/08 will give at catch of 150 thous. tons, but because of unresolved pattern in diagnostic more cautious TAC is required.

Comments

- There was a large uncertainty regarding the assessment of the stock last year. Using the recalculated catch at age matrices and updated data improved the models running. However, the models showed retrospective patterns in the time series in the period of 1997 to 2003 that can not be explained satisfactorily at present.
- There are still concerns regarding the fact that most of the catch is taken in another area than most of the adult stock was measured in the acoustic survey that took place after the fishery had ceased.
- The high catch ratio of the 2002 year class could imply a high fishing mortality of the year class, or at worst overfishing, since no herring were observed in the main fishing area of the fleet during the acoustic measurements around month later. However, opposed to these worries, the ratio between the catch number and the survey estimate of the 2002 year class gave F well below acceptable level, or F=0.19.
- The very high body weights at age in 2006/07 for youngest age groups as well as the season before, evokes concerns if the growth condition are really that good or alternatively if the ageing is interfered by different growth pattern causing separation of annual growth rings problematic.

3.5.1 Fishery

The landings of Icelandic summer-spawning herring by fishing season from 1983 - 2006 are given in Table 3.5.1.1 and in Figure 3.5.1.1. The total landings in 2006/2007 season were about 135 thousands tonnes with no discards reported. The quality of the herring landing data regarding discards and misreporting is consider to be adequate as implied in a general summary in section 3.1. The fishery took place in September through January off east and west off Iceland, as has been since the fishing season 1997/98, but most extensively off the south coast which differ from recent seasons. Overview of geographical distribution of the catches is given in Figure 3.5.1.2. The difference between the total catch (135 thousands t) and the TAC for the season (130 thousands t) is due to outstanding quota from the previous fishing season.

Like in the fishing seasons 2004/05 and 2005/06 a small part of the Norwegian spring spawning herring (NSSH) stock was mixed with the Icelandic summer spawning herring stock east of Iceland in the 2006/07 season. Based on port inspections, it was estimated to be just below 1000 t of NSSH mixed with the summer spawning herring during October through December (compared to 2691 t the season before). The estimates are gathered by determinations of the maturity stage in samples from the landing to get a relative ratio between the two stocks (NSSH being a spring spawners with gonads starting to develop while the Icelandic summer spawners are on a resting stage until March). Summing over all landings the product of the NSSH stock's ratio and the corresponding total catch provides then the estimate of the total catch of NSSH in the fishery. On the basis of temporal and spatial distribution of the NSSH in previous years, the catch of NSSH in the fishery of the Icelandic summer spawning herring is not considered to be an issue of misreporting of catch for the time being.

3.5.2 Fleets and fishing grounds

Until 1990, the herring fishery took place during the last three months of the calendar year. During 1990-2006 the autumn fishery continued until January or early February of the following year, and has started in September since 1994. 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. All seasonal restricted landings, catches and recommended TACs since 1984 are given in thous. tonnes in Table 3.5.1.1.

About 79% of the catch in 2006/07 was taken with purse-seines and about 21% with pelagic trawls, which is amongst the highest proportion in purse-seines since 1997/98 (see Figure 3.5.2.1). A part of the catches since the fishing season 1998/99 has been taken west off Iceland (opposite to the traditional east coast fishery) or ranging from about 15% (in 2004/05) to 55% (in 2002/03). In the fishing season 2006/07, around 20% and 18% of the catch were taken west and east off Iceland, respectively, while 60% were from the south coast. Such large catches have not been taken from south coast in recent years (Guðmundsdóttir and Sigurðsson 2004; Previous stock's assessment reports).

To protect juveniles herring (27 cm and smaller) in the fishery, area closures are inforced as stated by a regulation about the herring fishery set by the Icelandic Ministry of Fisheries (no. 376, 8. Oktober 1992). In the fishing season 2003/04, area closures were common as small herring was frequently present in the catches, four closures were in the fishing season 2004/05, only one in 2005/06, while six closures were inforced in 2006/07 because of small herring in the catch and two because of high proportion of bycatch.

3.5.3 Catch in numbers, weight at age and maturity

Procedure for catch at age estimation:

The annual estimations in the catch at age matrix are based on dividing the annual landings into cells according to the fishing gear, geographical location and month of fishing. The annual number of cells depends then on number of factors, including the spatial and temporal distribution of the fishing and the gear used and the sampling intensity. The number of weight-at-length relationships and length-at-age relationships applied differ between years and are on the range of 1-2 in both cases. Since 1990 to present, all available length measurements are used for the estimations in the cells, while length of aged fish was only used in earlier estimations.

The numbers caught in the fishing seasons 1990/91 through 1993/94 and 1998/99 through 1999/00 were recalculated this year (2006). The main reasons for the revisions for these fishing seasons are the re-aging of the fish and not having used all available catch samples in former estimation (i.e. the length measurements). Re-aging of herring from the catch samples in the fishing seasons from the year 1990 that remains (1994/95 through 1997/98) is ongoing at the Marine Research Institute. When the re-aging is accomplished the number at age in the catch will be re-estimated. Previous work suggests though that only a small changes can be expected.

Catch at age in 2007:

Data from samples taken from purse seine and pelagic trawl were used to calculate catch in numbers at age for total landings in the fishing season 2006/07 in a traditional manner (Table 3.5.3.1). The calculations were accomplished by dividing the total catch into 10 cells confined by area (four areas), months, and fishing gear as the catch- and sample sizes allowed. One weight at length relationships was used that was derived from the length and weight measurements of the catch samples and two length-at-age relations (east and west of 15°W). The catches of the Icelandic summer spawners in numbers at age for last fishing season (2006/07) as well as back to 1982 are given in Table 3.5.3.2 (recalculated; see above).

Weight at age:

The mean weight at age is derived from the same catch samples (Table 3.5.3.3). The mean weights from the catch are set to represent the weights for the stock. The total number of fish weighed from the catch in 2006/07 was 3184 and 2921 of them were aged from their fish scales. The geographical location of the sampling is shown on Figure 3.5.3.1.

Proportion mature:

The proportion mature at age has traditionally been estimated annually from the catch data alone for the stock, until in the last year assessment (2006) where the proportion mature was fixed. The reason for the changes in 2006 was the belief that the large variation of the maturity values over the years was more related to imprecision of the estimations than variation in the stock. In this years assessment we apply the same fixed maturity ogives, where proportion mature at age 3 is set 20% and 85% for fish at age 4, while all older fish is considered mature.

Observed versus predictions of catch composition:

The year class from 2002 dominated in the total catch weight (38%) and total catch number (38%) (Figure 3.5.3.2). The 2003 year class was also abundant in the catch (17% by weight and 20% by number). The strong year classes from 1999 and 2000 were expected to dominate in the total catch weight in 2006/07 according to the 2006 assessment (30% and 26%, respectively). That fishing pattern was only observed off east Iceland (24 thousands t) were 31% and 22% of the catch weights belonged to the 1999 and 2000 year classes, respectively.

The discrepancy between the expected and observed fishing pattern is thought to be related to the fact that the fishing fleet had problems to fish off the W-coast where the herring stayed too deep for purse-seiners and to close too shores for the pelagic-trawlers (prohibited within 12 nm). The younger herring of the south coast was however, easily accessible to the purse-seiners that could operate there despite a high frequency of bad weather conditions during the season. Other thing that could also partly explain the discrepancy in the observed and expected fishing pattern is the limited information regarding year class strength of the juveniles in the stock that will enter the fishable stock in the coming season, in this case the 2002 year class. In other words, the 2002 year class was possibly underestimated in last year assessment, as well as the January 2006 survey, and therefore also underestimated in the expected landings during the 2006/07 fishing season.

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 varies spatially 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 acoustic estimate for 2007 is based on three acoustic surveys, off the east coast in middle of February, off the south and west coast during January 8-22th, and off the west coast on March 2nd (Figure 3.5.4.1). The fishery had ceased when the surveys took place. On the main fishing grounds off the south coast during October through December (constituted to 60% of the total catch in 2006/07) the survey in January recorded no herring, while around 615 thousands t of adult herring (>26cm) were measured in the small fjord Grundarfjordur in W Iceland (the mean of three separated estimates in the same day). In other areas off the west coast 138 thousands t of herring <26cm were measured and 26 thousands t off the east coast. The total estimate of the adult stock was therefore 786 thous. t. Figure 3.5.4.2 shows the total estimated biomass of 4 year and older herring in the acoustic survey since 1987.

The 1999 and 2002 year classes were most numerous in the survey or 19% and 30%, respectively, of the total number of herring. The results imply that the 2002 year class is above average in size as has been speculated from the results of acoustic surveys in the last two years (Table 3.5.4.2). The number of fish at age 3 indicates that the 2003 year class is moderate in size as the last years estimate suggested also.

The stock composition in terms of age in the acoustic estimation in 2006/07 is based on total 6 samples where 2 samples were taken in the eastern area and 4 in the western (Table 3.5.4.2). The total number of aged scales from these samples was 484.

The vessels used in the acoustic surveys this year, as well as previous years, were equated with EK500/BI500 and were operated at 38 kHz. The equipment calibrations were from April 2005. The threshold of -69 to -72 dB were used in the data processing with the BI500 software. The threshold target strength (TS) for individual fish (*TS-threshold/40logR)* was set at -60 dB. The survey tracks were often irregular so the whole survey area was divided into cells at different size and the mean TS values calculated for each cell (with MAP in the BI500). The TS-length (L) relationship applied was the following: TS=20 log L-72 dB. As normally practiced in acoustic surveys, trawl samples were used to get information about the schools species- and length composition. The annual number of days allocated to measure the adult part of the stock differs but shows a downward trend since its establishment (Figure 3.5.4.3). In 2006/2007, totally 21 days were obtained to measure the adult while no days were allocated to measure the juveniles of the stock off NW to NE Iceland, as use to be a standard procedure earlier. As the number of days for the survey has decreased, there is an indication from the fishery of the fleet that the distribution of the stock has increased (Figure 3.5.4.3).

3.5.5 Assessment

In 2005 there was a large uncertainty regarding the assessment of the stock and no assessment was considered reliable. Assessments had been consistently biased in overestimating the spawning stock for some years. Discrepancies in the catch and survey datasets were suggested to be a part of the overestimation problem. The overestimation was also suggested to be related to a possible higher natural mortality because of much more widespread spatial distribution of the stock since 1997, which means more accessibility for predators. Furthermore, higher mortality could also be related to the fishery with the pelagic trawl, but since 1997 around 20-60% of the catch is taken by the pelagic trawl. Yet another worry was the reduction of the part of the stock that was acoustically measured east of Iceland. Last year (2006) assessments were done by using revised catchdata back to 2000/01. Despite better behaviour of all models and general agreement between them the final assessment in 2006 done with NFT-Adapt was not considered reliable enough by ACFM and recommended TAC was set the as the last three years.

3.5.5.1 Analysis of input data

In the analysis hereafter the revised catchdata are used (see section 3.5.3). Catch curves were plotted by using data from the fishing seasons 1986/87-2006/07 (Figure 3.5.5.1.1). From them it can be seen that the total mortality signal in the fully recruited age groups is around 0.4 provided that effort has been the same the whole time. When the catch curves are plotted by year classes (Figure 3.5.5.1.2) the assumption can be taken that in later years the fish is fully recruited to the fishery at younger ages. By inspecting the catchcurve for the 1994 year class, a drop is observed in the curve at age 9 but the curve continues with the same slope as before. This is in line with that in 2003 the fleet concentrated in fishing the big 1999 and 2000 year classes as it didn't find the older part of the stock. For the 2002 year class the curve between age 3 and 4 is very steep. This is in agreement to the observation that in the fishing season 2006/07 the 2002 year class was the most abundant one in the fishery and rumour from the fleet that they were avoiding the 2002 year class in the fishing season 2005/06 as they were targeting older herring (mainly the year classes from 1999 and 2000).

There are indication that the fishing effort changed in last years (higher effort for younger age classes; see second point in section 3.5.11.2) so the plot of Ln(catch-ratio) (Figure 3.5.5.1.3) is probably of little significance in predicting the total mortality for the last year.

Catch curves were also plotted using the age disaggregated survey indices (Figure 3.5.5.1.3). The lines are zig-zagged which can be caused by inadequate sampling in the survey (Table 3.5.4.2). The mortality sign looks a bit higher than 0.4 but is very noisy. Last year a comparison between ages in the survey was made by fitting a line through the origin (ICES CM 2006/ACFM:26, Figure 3.5.5.1.4) and the correlation from the regression written on the figure. Based on those indices, ages 3-9 could be considered as reliable age disaggregated indices in assessment.

The conclusion from the above is that both the catch- and the survey data are showing similar trend in Z, the survey data being noisier than the catch data.

3.5.5.2 Exploration of different assessment models

In order to explore the data this year, three assessments tools were used, namely NFT-ADAPT (VPA/ADPAT version 2.3.2 NOAA Fisheries Toolbox), XSA (Version 3.1, Lowestoft) and a new version of TSA (older version see Gudmundsson, G. 1994). Both NFT-Adapt and XSA used catch data from 1986/87-2006/07 and survey data from 1987/88-2006/07. TSA used one year less catch data, 1987/88-2006/07. Natural mortality is M=0.1 for all age groups, proportion of M before spawning is set to 0.5 and proportion of F before spawning is set to 0. More details about the different models running and results are given in a working document (ICES, NWWG, WD 23).

<u>NFT-Adapt:</u>

In NFT Adapt the estimated parameters are the stock in numbers. The parameters are output by the Levenburg-Marquardt Non-Linear Least Squares minimization algorithm (see VPA/ADAPT Version 2.0, Reference Manual). Corresponding to previous assessment, the estimated parameters were stock numbers for ages 4 to 10 in 2007, but stock numbers at age 3 were set to the geometric mean from 1986-2004.

The final Adapt run in 2007 shows higher F in the years 1999-2003 than the 2006 assessment, resulting correspondingly with a slight decrease in SSB in the same years (Figure 3.5.5.2.1). The estimates of recruitment in the runs in 2006 and 2007 are similar for all year classes, except the 2002 year class (3 years old in 2005) where adding the new data resulted in more than doubling of its size.

In NFT Adapt there are three options (classic, average and Heincke) to calculate the value of fully-recruited fishing mortality in the terminal year. One of the input variables it uses is *input partial recruitment*. In the 2006 assessment it was set as 1 for ages 6 and older. As it is believed that the 2002 year class was fully recruited to the fishery in last fishing season it was decided to set the *input partial recruitment* to 1 for ages 4 and older in 2006/07. The different options were tested and based on residuals of sum of squeares (RSS) the classic one chosen. It must be noted though, that RSS was at a similar level for these runs.

The catchability at age in the survey, as estimated this year and in last year's assessment, and the CV is shown in Figure 3.5.5.2.2. It is seen that the catchability this year is estimated a bit higher, but the line has the same shape as last year. Like in the last year assessment (2006) the final Adapt run was without the years 1997 and 2001 in the tuning series.

Residuals of the model fit are shown in Figure 3.5.5.2.3 and Table 3.5.5.2.1. The highest values are in the years 1997 to 2003. In this period both the year classes from 1994 and 1996 are seen greater in the survey each year than estimated in the model. Another cohort effect seen is for the year class 1984. The model estimates it greater than seen in the survey, but the residuals are not very big. This 1984 year class has always been considered small, but the one from 1983 was a big one. In acoustic surveys it is not uncommon to see year effects. One could say that 1988 was a negative one and 1997 was a positive year.

Retrospective analysis (Figure 3.5.5.2.4) shows that there has been a consistent bias in the assessment which seems to have stopped now. The bias is consistent in overestimating the spawning stock and underestimating the fishing mortalities. Even though this bias seems to have stopped now, the assessment should be taken with care. To get an indication of the uncertainty in the model parameters bootstrap was run (1000 replicates). The results from the bootstrap run are shown in Figure 3.5.5.2.5. Temporal patterns are reproduced, but the uncertainty can been seen. Figure 3.5.5.2.6 shows the probability and the cumulative distribution in 2006. The figure indicates that there is about 50% probability that the spawning stock is below 770 thousand tonnes and about 70% likely that it is below 820 thousand tonnes. These bootstrap analyses do however not take into account the bias in the assessment.

From the bootstrap with 1000 replicates, the residuals sum of square (RSS) was calculated and a line drawn for the RSS value from the final Adapt run in 2007. The relation between N weighted F 5-10 in 2006 and SSB in 2007 from the 1000 replicates was then compared to the results of Adapt, as well as XSA and TSA, (Figure 3.5.5.2.7).

<u>XSA:</u>

The final XSA run in 2007 was tuned with age 3-9 (corresponding to NFT-ADAPT). The results indicate strong 2002 and 2003 year classes and a SSB of 670 thousands tons in the end of year 2006 (Figure 3.5.5.2.8). The residuals of the surveys and the model fit were worse behaved than in NFT-Adapt and the retrospective pattern showed a little consistency in the patterns for the last years (ICES 2007, NWWG, WD 23).

<u>TSA:</u>

As in last year assessment, three different runs were made in TSA, with fixed natural mortality (M=0.1), higher M over the last years (M=0.1 for 1987-1993 but then increases linearly to M=0.205 for 1997-2006), and allowing the catchability of surveys to change. The different approaches gave different indication of the stock status (ICES 2007, NWWG, WD 24; ICES 2007, NWWG, WD 23). The results gave however no strong indication to choose one approach rather than another.

<u>Comparisons of models:</u>

The estimations of recruitment, spawning stock biomass, and N weighed average F5-10 from the three models (NFT-Adapt, XSA and TSA with changing M) were compared (Figure. 3.5.5.2.8). The comparison indicates that the main difference between XSA and Adapt in the 2007 SSB estimates is the lower estimate particularly of the large 1999 and 2000 year classes in XSA and higher fishing mortality (ICES 2007, NWWG, WD 23).

As in previous years there is a retrospective pattern in the results from all the models (ICES 2007, NWWG, WD 23). Different from XSA and TSA, the NFT-Adapt pattern shows improvements from the last assessment (Figure 3.5.5.2.4) where the results are consistent for the last three years, while the pattern shows still a consistently overestimation of the spawning stock in 1997-2003. On the basis of the retrospective patterns, behavior of residuals from the surveys (Figure 3.5.5.2.3), and model selection in last year assessment, the WG considers that the NFT-Adapt run is most representative of the recent stock trends. However, because of unresolved pattern in diagnostic it is considered that using results from this assessment as a point estimator for forward prediction is questionable.

3.5.6 Final assessment

The output and model settings of the adopted final model (NFT-Adapt, run 8) are shown in Table 3.5.6.1. Stock numbers and fishing mortalities derived from the run are shown in Table 3.5.6.2 and Table 3.5.6.3, respectively, and summarized in Table 3.5.6.4 and Figure 3.5.5.2.1.

The assessment (Table 3.5.6.4 and Figure 3.5.6.2) indicates that the fishing mortality has been fluctuating between 0.25 and 0.4 most of the time, which is above $F_{\mathbf{pa}}$ but has been declining since 2003 and is now below $F_{\mathbf{pa}}$. F_{lim} is not defined for the stock. The spawning stock has been fluctuating between 300 ($F_{\mathbf{pa}}$) and 400 thousand tonnes and rising since 2001 and is now close to the highest level ever. The 1999 year class (age 3 in 2002) is the largest one in the whole series and the 2000 year class is also large. There are further indications that the 2002 year class is large, but it had the highest value ever in the acoustic surveys as 2 years old.

3.5.7 Short term prediction

Because of the uncertainty in the analytical assessment as noticeable from section 3.5.5.2, the prediction is presented here only for illustrative purposes.

3.5.7.1 Prognosis from stock estimations

3.5.7.1.1 Recruitment and weight estimates

<u>The 2002 year class:</u> Both the catch ratio in 2006/07 (38% in number) and the survey estimates in 2004 and 2006 of the 2002 year class indicate that is well above average in size. Furthermore, the stock estimates from NFT-Adapt of the number at age 5 in 2007/08 is high, despite that the 2005 survey suggest that the 2002 year class is below average. Accordingly, the NFT-Adapt estimate is used directly in the prognosis.

<u>The 2003 year class:</u> The estimated number of the 2003 year class in 2007/08 (age 4) from XSA and Adapt (733 and 537 millions, respectively) indicate that it is strong. This high estimate is mainly driven by the high catch ratio of the year class in 2006/07. On the contrary, the 2005 and 2006 acoustic surveys indicate that the year class is only around average in size (470 and 608 millions, respectively). Thus, the WG decided to lower the strength of the year class in the way that it was set as average size in 2006 (i.e. geometrical mean for age-3 over 1986-2005; 540 millions), subtracted by catch number at age 3 in 2006 (118 millions) and then by the natural mortality (0.1), which gives the number at age 4 in 2007 (381 millions).

<u>The 2004 year class:</u> There is no estimate available for the 2004 year class so its number was set as the geometrical mean for age-3 over 1986-2005 (540 millions).

The weight at age in the prognosis was set equal to the average weight at age in the catch data over the most recent three years (fishing seasons 2004/05 through 2006/2007) (Figure 3.5.7.1). In this respect, attention should be given to the “comments to the assessment” (below) regarding the annual changes in the weights at age.

3.5.7.1.2 Prognosis results

The selection pattern used in the prognosis was determined from the fishing mortality at age ($F_{age\ i}/F_{age5\ to\ 10}$), averaged over 2001 to 2006 from the final run. All input values for the prognosis are given in Table 3.5.7.1. The number at age 3 in the years 2007, 2008, and 2009 represents the geometric mean over the period according to the analyses.

The results of the prognosis from the final NFT-Adapt run is shown in Table 3.5.7.2. with five different options. Fishing at 0.22 (= $F_{0.1}$; the stock is managed at F=0.22) would correspond to a catch of 153 thousand tons in 2007/08 season. Keeping the TAC of 2007/08 equal to the last years TAC (130 thousand tons) corresponds to F=0.184.

3.5.8 Medium term predictions

No medium term predictions were performed.

3.5.9 Management consideration

The fishing mortality on the Icelandic summer-spawning herring has been above the management target in previous years mainly due to biases in the stock assessment. Because the target is relatively conservative this overestimation has fortunately not had negative consequences to the development of the stock. Since it is not known if the overestimation has been deviated in the current assessment a more precautionary TAC than implied by the predictions based on the analytical assessment should be considered.

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 have not dealt with this issue.

The fishing mortality has since 1990 been on the average 0.304 or approximately 40% higher than the intended target of $F_{0.1}$=0.22. 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 B_{lim}. As there is an agreed management strategy that have been applied since the fishery was reopened 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 on the assessment

3.5.11.1 Data consideration

The WG emphasizes that the survey indices have traditionally been set to represent the stock level in the end of the former year in the assessment (e.g. 31st December 2006 for the 2006/07 season). However, the survey estimates are neither accounting for the variation in timing of the fishing nor the actual catch quantity. When looking at the monthly distribution of the catch over the fishing season 1990/91 to 2005/05 in comparison to the terminate day of the surveys (Fig. 3.5.11.1), it is apparent that considerable catches are taken after the surveys in some years (e.g. 1995/96 to 2003/04) while not in others (e.g. after 2003/04). Thus, the WG suggest that the number at age matrix from the survey (Table 3.5.4.1) should be reworked for next assessment by subtract the corresponding number at age in the catch subsequent to the terminate day of the surveys.

It became apparent in the acoustic survey in 2007 in Grundarfjörður (a small fjord in SW Iceland where ¾ of the stock was measured) the need for a fishing gear onboard the MRI research vessels that can be used to collect herring samples under the various condition. Onboard the vessel there was no gear to collect proper sample from the extreme dense and large herring schools. Thus, the stock estimation had to relay on samples from a commercial vessel that was operating with a purse-seine on a small portion of one of the many large schools in the area. The consequence of this incomplete sampling in the area is an uncertain estimation of the combination of the stock. Accordingly, the working group recommends that MRI get hold of a proper fishing gear to collect samples under various conditions, such as so called “Multisampler” trawl (Engås et al. 1997), to reduce these kinds of uncertainty in the future.

In last years assessment it was noticed that the weight at age for the youngest age groups (age 2 through 4) were high. The catch in 2006/07 indicates that the weights at age continue to rise and are at record high level for age 2 to 4 (Figure 3.5.7.1). There are concerns that some recent winter rings on the fish scales could be so weak that they are unnoticeable in the age reading, with the consequence that the fish is aged a year younger than it actually is. The WG has done arrangements to overcome these concerns, which could otherwise become a major problem in future assessment of the stock. It includes measurements of each annual summer growth on the fish scales from the last three years and compare it to previous years (e.g. 1998 and 1999). These measurements of annual rings thickness is a standard procedure at the Institute of Marine Research in Bergen, Norway, for herring aging and their technique will be applied for the Icelandic stock.

At MRI there is an ongoing work in estimating the maturity ogive for the stock back in time. The work is based on different methods that rely on different data including (1) maturation stage from an inspection of the gonads in the catch samples and (2) determination of age of first spawning from the fish scales growth layer (i.e. counting of rings prior- and post-first spawning) simultaneously with the age reading. The counting of the separated growth rings ceased in 1992 and has not been practised since then. Because of the various problems related to maturity ogive estimations that rely only on maturation stage determination, it is recommended that the counting of the separated growth rings should be re-established at MRI as a part of routine work in ageing herring. That is considered to be a valuable step towards a reliable annual estimation of maturity ogive of the stock.

3.5.11.2 Assessment quality

In previous years there has been concerns regarding the assessment because of retrospective patterns of the models. In the last year assessment (2006) there was observed an improvement in the pattern from NFT-Adapt, which has continued in this year assessment for the last three years in the series. Considering this improved behavior, the general agreement of the different assessment models, stock estimations from the assessment models and the acoustic survey 2007, the state of the stock is considered good. However, no assessment was provided in the assessment 2005 due to data and model problems and in the year after ACFM rejected the assessment due to the retrospective pattern. Despite for indications for improvements in the retrospective pattern in the last three years, the observed retrospective pattern during the period 1997-2003, gives the WG a reason to be reasonable careful in the advices for the fishing season 2007/08.

As was pointed out in last year assessment report, the location of the main fishing grounds and the distribution of the stock according to the acoustic survey in the same season are often very different. This observation goes also for the 2006/07 season where most of the fishing took place off south Iceland in October-December while no herring was observed there in the January acoustic survey. This difference causes uncertainty in the assessment because it is impossible to tell if the fishery and the survey are focusing on the same stock component. A survey during the main herring fishery in 2006/07 would have reduced this uncertainty, and the WG emphasizes the need of resume those surveys. A specific problem in this year assessment was if the fishery of the 2002 year class off the south coast (1) reflected its year class strength or (2) if the year class was simply very assessable there, then with the consequence of very high F of the year class. Estimation of F from the catch number and the survey estimate of the 2002 year class (F=0.19) indicated however that F was well within acceptable level, giving the first explanation more plausibility.

3.5.11.3 Response to technical minutes

As requested last year in technical minutes by RGNW2, the WG has provided descriptions regarding instruments and design of the herring acoustic survey as well as historical information regarding the survey (see last paragraph in section 3.5.4).

3.5.12 References

Engås, A. , R. Skeide, and C.W. West 1997. The ‘MultiSampler’: a system for remotely opening and closing multiple codends on a sampling trawl. Fisheries Research 29: 295-298

Guðmundsdottir, A. and Th. Sigurðsson 2004. The autumn and winter fishery distribution of the Icelandic summer spawning herring during 1978-2003. Marine Research Institute, Reykjavik, Iceland. Report, no. 104.

Gudmundsson, G. 1994.Time series analysis of catch-at-age observations. Applied Statistics, 43: 117-126.

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	95.7	95.7	125
2002/2003*	96.1	96.1	105
2003/2004*	130.7	130.7	110
2004/2005	114.2	114.2	110
2005/2006	103	103	110
2006/2007	135	135	130

***Summer fishery in 2002 and 2003 included**

Table 3.5.3.1. Overview of the catch data for Icelandic summer-spawning herring 2006/07.

	West of 15°W	East of 15°W	Total
Total catch (thousands tonnes)	110.3	25.0	135.3
Number of samplings for ageing	30	28	58
Number of aged fish	1692	1229	2921
Number of weighed fish	1830	1354	3184
Number of samplings for length determinations	106	47	153
Number of fish length measured	19162	4729	23891

Table 3.5.3.2. Catch in numbers (millions) and total catch in weight (thous. tonnes) of Icelandic summer-spawning herring (1981 refers to season 1981/1982 etc).

Year\age	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Catch
1981	2.283	4.629	16.771	12.126	36.871	41.917	7.299	4.863	13.416	1.032	0.884	0.760	0.101	0.062	39.544
1982	0.454	19.187	28.109	38.280	16.623	38.308	43.770	6.813	6.633	10.457	2.354	0.594	0.075	0.211	56.528
1983	1.475	22.499	151.718	30.285	21.599	8.667	14.065	13.713	3.728	2.381	3.436	0.554	0.100	0.003	58.867
1984	0.421	18.015	32.244	141.354	17.043	7.113	3.916	4.113	4.517	1.828	0.202	0.255	0.260	0.003	50.304
1985	0.112	12.872	24.659	21.656	85.210	11.903	5.740	2.336	4.363	4.053	2.773	0.975	0.480	0.581	49.368
1986	0.100	8.172	33.938	23.452	20.681	77.629	18.252	10.986	8.594	9.675	7.183	3.682	2.918	1.788	65.500
1987	0.029	3.144	44.590	60.285	20.622	19.751	46.240	15.232	13.963	10.179	13.216	6.224	4.723	2.280	75.439
1988	0.879	4.757	41.331	99.366	69.331	22.955	20.131	32.201	12.349	10.250	7.378	7.284	4.807	1.957	92.828
1989	3.974	22.628	26.649	77.824	188.654	43.114	8.116	5.897	7.292	4.780	3.449	1.410	0.844	0.348	101.000
1990	12.567	14.884	56.995	35.593	79.757	157.225	30.248	8.187	4.372	3.379	1.786	0.715	0.446	0.565	105.097
1991	37.085	88.683	49.081	86.292	34.793	55.228	110.132	10.079	4.155	2.735	2.003	0.519	0.339	0.416	109.489
1992	16.144	94.86	122.626	38.381	58.605	27.921	38.42	53.114	11.592	1.727	1.757	0.153	0.376	0.001	108.504
1993	2.467	51.153	177.78	92.68	20.791	28.56	13.313	19.617	15.266	4.254	0.797	0.254	0.001	0.001	102.741
1994	5.738	134.616	113.29	142.876	87.207	24.913	20.303	16.301	15.695	14.68	2.936	1.435	0.244	0.195	134.003
1995	4.555	20.991	137.232	86.864	109.14	76.78	21.361	15.225	8.541	9.617	7.034	2.291	0.621	0.235	125.851
1996	0.717	15.969	40.311	86.187	68.927	84.66	39.664	14.746	8.419	5.836	3.152	5.18	1.996	0.574	95.882
1997	2.008	39.24	30.141	26.307	36.738	33.705	31.022	22.277	8.531	3.383	1.141	10.296	0.947	2.524	64.682
1998	23.655	45.39	175.529	22.691	8.613	40.898	25.944	32.046	14.647	2.122	2.754	2.15	1.07	1.011	86.998
1999	5.306	56.315	54.779	140.913	16.093	13.506	31.467	19.845	22.031	12.609	2.673	2.746	1.416	2.514	92.896
2000	17.286	57.282	136.278	49.289	76.614	11.546	8.294	16.367	9.874	11.332	6.744	2.975	1.539	1.104	100.332
2001	27.486	42.304	86.422	93.597	30.336	54.491	10.375	8.762	12.244	9.907	8.259	6.088	1.491	1.259	95.675
2002	11.698	80.863	70.801	45.607	54.202	21.211	42.199	9.888	4.707	6.52	9.108	9.355	3.994	5.697	96.128
2003	24.477	211.495	286.017	58.120	27.979	25.592	14.203	10.944	2.230	3.424	4.225	2.562	1.575	1.370	130.741
2004	23.144	63.355	139.543	182.45	40.489	13.727	9.342	5.769	7.021	3.136	1.861	3.871	0.994	1.855	114.237
2005	6.088	26.091	42.116	117.91	133.437	27.565	12.074	9.203	5.172	5.116	1.045	1.706	2.11	0.757	103.043
2006	52.567	118.526	217.672	54.800	48.312	57.241	13.603	5.994	4.299	0.898	1.626	1.213	0.849	0.933	135.303

Table 3.5.3.3. The mean weight (g) at age of Icelandic summer-spawning herring from the commercial catch (1981 refers to season 1981/1982 etc).

Year\age	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1981	61	141	190	246	269	298	330	356	368	405	382	400	400	400
1982	65	141	186	217	274	293	323	354	385	389	400	394	390	420
1983	59	132	180	218	260	309	329	356	370	407	437	459	430	472
1984	49	131	189	217	245	277	315	322	351	334	362	446	417	392
1985	53	146	219	266	285	315	335	365	388	400	453	469	433	447
1986	60	140	200	252	282	298	320	334	373	380	394	408	405	439
1987	60	168	200	240	278	304	325	339	356	378	400	404	424	430
1988	75	157	221	239	271	298	319	334	354	352	371	390	408	437
1989	63	130	206	246	261	290	331	338	352	369	389	380	434	409
1990	80	127	197	245	272	285	305	324	336	362	370	382	375	378
1991	74	135	188	232	267	289	304	323	340	352	369	402	406	388
1992	68	148	190	235	273	312	329	339	355	382	405	377	398	398
1993	66	145	211	246	292	324	350	362	376	386	419	389	389	389
1994	66	134	201	247	272	303	333	366	378	389	390	412	418	383
1995	68	130	183	240	277	298	325	358	378	397	409	431	430	467
1996	75	139	168	212	258	289	308	325	353	353	377	404	395	410
1997	63	131	191	233	269	300	324	341	355	362	367	393	398	411
1998	52	134	185	238	264	288	324	340	348	375	406	391	426	456
1999	74	137	204	233	268	294	311	339	353	362	378	385	411	422
2000	62	159	217	268	289	325	342	363	378	393	407	425	436	430
2001	74	139	214	244	286	296	324	347	354	385	403	421	421	433
2002	85	161	211	258	280	319	332	354	405	396	416	433	463	460
2003	72	156	189	229	260	283	309	336	336	369	394	378	412	423
2004	84	149	213	248	280	315	331	349	355	379	388	412	419	425
2005	106	170	224	262	275	298	324	335	335	356	372	394	405	413
2006	107	189	234	263	290	304	339	349	369	416	402	413	413	467

Table 3.5.4.1. Acoustic estimates (in millions) of the Icelandic summer spawning herring in the seasons 1987/88-2006/07 (age refers to the former year, i.e. autumns). No survey was conducted in 1994/95.

YEAR\AGE	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1987/88	116	401	858	308	57	33	70	37	24	18	24	10	4	5
1988/89	636	201	233	381	188	46	26	33	17	10	9	5	3	5
1989/90	139	655	179	279	593	180	22	22	13	10	2	-1	-1	-1
1990/91	404	132	259	94	191	514	79	38	9	13	-1	-1	-1	-1
1991/92	598	1050	355	320	90	138	257	21	10	-1	9	-1	-1	1
1992/93	268	831	730	159	131	54	96	97	25	1	1	3	-1	-1
1993/94	302	505	883	496	67	58	106	49	36	-1	4	18	-1	-1
1994/95	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
1995/96	217	134	762	278	385	177	98	49	16	29	48	4	-1	-1
1996/97	33	271	134	469	270	326	217	93	55	39	30	53	19	13
1997/98*	292	602	81	57	287	156	203	106	35	27	14	36	14	12
1998/99	100	256	1082	103	52	135	71	102	54	17	14	3	4	9
1999/00	516	839	239	606	88	43	166	90	121	78	22	4	11	-1
2000/01	190	967	1316	191	482	34	16	38	14	15	15	2	3	-1
2001/02*	1048	287	217	260	161	346	62	57	38	46	38	21	4	-1
2002/03	1732	1919	553	206	262	153	276	99	48	55	19	24	24	1
2003/04	1115	1435	2058	331	109	101	39	46	7	6	8	11	-1	2
2004/05	2417	714	1022	1047	171	62	44	11	24	13	-1	2	11	-1
2005/06	470	444	345	819	1221	281	122	130	73	65	10	9	4	12
2006/07	110	608	1060	410	425	693	96	124	49	1	-1	-1	-1	1

*** The estimates from the fishing season 1997/98 and 2001/02 were omitted from the tuning procedure in the assessment 2007 because of incomplete coverage of the surveys due to weather condition and time limitations.**

Table 3.5.4.2. Number of scales by ages and number of samples taken in the annual acoustic surveys of Icelandic summers-spawning herring in the seasons 1987/88-2006/07 (age refers to the former year, i.e. autumns). In 2000 seven samples were used from the fishery.

															No. of samples		
Year\age	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total	Total	West	East
1987/88	11	59	246	156	37	28	58	33	22	16	23	10	5	8	712	8	1	7
1988/89	229	78	181	424	178	69	50	77	42	29	23	13	7	12	1412	18	5	10
1989/90	38	245	96	132	225	35	2	2	3	3	2	0	0	0	783	8		8
1990/91	418	229	303	90	131	257	28	6	3	8	0	0	0	0	1473	15		15
1991/92	414	439	127	127	33	48	84	5	3	0	2	0	0	1	1283	15		15
1992/93	122	513	289	68	73	28	38	34	6	2	2	6	0	0	1181	12		12
1993/94	63	285	343	129	13	15	7	14	11	0	1	3	0	0	884	9		9
1994/95															0			
1995/96	183	90	471	162	209	107	38	18	8	14	18	2	0	0	1320	14	9	5
1996/97	24	150	88	351	141	137	87	32	15	10	7	14	4	2	1062	11	4	7
1997/98	101	249	50	36	159	95	122	62	21	13	8	15	8	5	944	14	7	7
1998/99	130	216	777	72	31	65	59	86	37	22	17	5	6	11	1534	17	10	7
1999/00	116	227	72	144	17	13	26	26	27	10	8	2	1	0	689	7	3	4
2000/01	116	249	332	87	166	10	7	21	8	14	11	3	1	0	1025	14	10	4
2001/02	61	56	130	114	62	136	25	24	17	21	17	10	3	0	676	9	4	5
2002/03	520	705	258	104	130	74	128	46	26	25	13	15	10	1	2055	22	12	10
2003/04	126	301	415	88	35	32	15	17	3	4	4	6	1	1	1048	13	8	5
2004/05	304	159	284	326	70	29	17	5	8	4	0	3	3	0	1212	13	4	9
2005/06	217	312	190	420	501	110	40	38	26	18	5	5	5	7	1894	22	14	8
2006/07	19	77	134	64	71	88	22	4	2	2	0	0	0	1	484	6	4	2

Table 3.5.5.2.1. The residuals from survey observations and NFT-Adapt results for Icelandic summer spawning herring (no surveys in 1994, 1997, and 2001).

Year\age	4	5	6	7	8	9	10
1987	-0.33	-0.38	0.07	-0.22	-0.56	-0.18	-0.35
1988	-0.35	-0.92	-0.85	0.11	0.18	-0.22	0.05
1989	0.44	-0.48	-0.30	0.06	0.51	-0.31	-0.05
1990	-0.77	-0.45	-0.70	-0.22	0.43	0.09	0.79
1991	0.32	0.31	0.37	-0.34	-0.13	0.25	-0.99
1992	-0.16	0.03	-0.02	0.04	-0.46	-0.17	-0.18
1993	-0.15	0.01	0.08	-0.57	-0.37	0.37	-0.54
1994							
1995	-0.36	0.53	-0.12	0.14	-0.06	0.55	0.26
1996	0.38	-0.21	0.60	0.33	0.41	0.40	1.03
1997							
1998	-0.08	0.54	-0.06	-0.41	0.09	-0.51	-0.31
1999	0.49	-0.01	0.59	0.12	-0.29	0.64	0.03
2000	0.92	1.18	0.35	0.86	-0.56	-1.17	-0.49
2001							
2002	-0.03	0.17	0.00	0.78	1.07	1.30	1.06
2003	0.25	0.09	0.08	-0.30	0.19	0.07	-0.25
2004	0.25	-0.07	-0.21	-0.25	-0.69	-0.55	-0.91
2005	-0.83	-0.52	0.10	0.22	0.47	0.04	0.72
2006	0.00	0.20	0.02	-0.34	-0.22	-0.58	0.12

Table 3.5.6.1. Model settings and results of model parameters from NFT-Adapt run 8 for Icelandic summer spawning herring.

VPA Version 2.3.2

Model ID: Run 8 in 2007:00:00 same as run 7 but with forward plusgroup computations

Input File: C:\NFT\VPA\2007\RUN8\RUN8.DAT

Date of Run: 10-apr-07 Time of Run: 16:56

Levenburg-Marquardt Algorithm Completed 6 Iterations
Residual Sum of Squares = 27.0621

Number of Residuals = 119
Number of Parameters = 7
Degrees of Freedom = 112
Mean Squared Residual = 0.241626
Standard Deviation= 0.491554

Number of Years = 21
Number of Ages = 10
First Year = 1986
Youngest Age = 3
Oldest TRUE Age = 11

Number of Survey Indices Available = 7
Number of Survey Indices Used in Estimate = 7

VPA Classic Method – Auto Estimated Q's

Stock Numbers Predicted in Terminal Year Plus One -2007

Age	Stock Predicted	Std. Error	CV
4	536651.687	2.73E+05	5.08E-01
5	604508.578	2.32E+05	3.84E-01
6	313922.36	1.03E+05	3.29E-01
7	478345.681	1.44E+05	3.02E-01
8	654941.69	1.85E+05	2.83E-01
9	108298.966	3.20E+04	2.95E-01
10	61173.948	1.72E+04	2.81E-01

Catchability Values for Each Survey Used in Estimate

INDEX	Catchability	Std.Error	CV
1	1.13E+00	1.26E-01	1.11E-01
2	1.44E+00	1.72E-01	1.20E-01
3	1.28E+00	1.19E-01	9.30E-02
4	1.24E+00	1.20E-01	9.62E-02
5	1.31E+00	1.52E-01	1.16E-01
6	1.58E+00	2.20E-01	1.39E-01
7	1.80E+00	2.68E-01	1.49E-01

-- Non-Linear Least Squares Fit --

Default Tolerances Used

Scaled Gradient Tolerance = 6.06E-06
Scaled Step Tolerance = 3.67E-11
Relative Function Tolerance = 3.67E-11
Absolute Function Tolerance = 4.93E-32

VPA Method Options

-Catchability Values Estimated as an Analytic Function of N
- Pope Approximation Used in Cohort Solution
- Plus Group Forward Calculation Method Used
- Arithmetic Average Used in F-Oldest Calculation
- F-Oldest Calculation in Years Prior to Terminal Year
Uses Fishing Mortality in Ages 8 to 10
- Calculation of Population of Age 3 In Year 2007
= Geometric Mean of FirstAge Populations
Year Range Applied = 1986 to 2004

Stock Estimates

Age 4
Age 5
Age 6
Age 7
Age 8
Age 9
Age 10

Full F in Terminal Year = 0.137

F in Oldest TRUE Age in Terminal Year = 0.113

Full F Calculated Using Classic Method

F in Oldest TRUE Age in Terminal Year has been
Calculated in Same Manner as in All Other Years

Age	Input Partial Recruitment	Calc Partial Recruitment	Fishing Mortality	Used In Full F	Comments
3	0.7	0.647	0.1907	NO	Stock Estimate in T+1
4	1	1	0.2945	YES	Stock Estimate in T+1
5	1	0.522	0.1536	YES	Stock Estimate in T+1
6	1	0.311	0.0917	YES	Stock Estimate in T+1
7	1	0.271	0.0799	YES	Stock Estimate in T+1
8	1	0.383	0.1129	YES	Stock Estimate in T+1
9	1	0.303	0.0891	YES	Stock Estimate in T+1
10	1	0.465	0.137	NO	Input PR * Full F
11	1	0.384	0.113		F-Oldest

Table 3.5.6.2. Icelandic summer spawners stock estimates (from NFT-Adapt) in numbers (thousands) during 1986-2007.

AGE	1986	1987	1988	1989	1990	1991
3	1124477	548878	282481	435168	292898	835751
4	378871	1009695	493655	251074	372232	250867
5	118139	310534	871195	407362	201832	282594
6	97888	84589	223638	693770	294568	148768
7	200207	68900	56923	136406	448295	190669
8	72148	107312	43556	29670	82414	256077
9	52354	47920	53115	20261	19127	45798
10	38698	36922	28871	17430	12724	9519
11	42222	26841	20126	14377	8835	7354
12	67952	75739	58132	40836	39684	37366
Total	2192956	2317330	2131691	2046354	1772609	2064763

AGE	1992	1993	1994	1995	1996	1997
3	1048067	627960	683229	208824	197245	779760
4	671861	858096	519544	490161	168984	163284
5	180306	491279	607328	362338	312977	114558
6	173618	126639	356368	413625	245229	201209
7	101515	101350	94811	239501	270446	156327
8	119990	65295	64538	62090	143674	164179
9	126948	72025	46418	39083	35862	92272
10	31853	64343	46511	26495	20882	18423
11	4661	17795	43699	27155	15849	10886
12	34761	31861	39895	57162	57520	50514
Total	2493579	2456644	2502339	1926434	1468669	1751413

AGE	1998	1999	2000	2001	2002	2003
3	317221	559584	436018	522958	2010528	1318030
4	668230	243857	452764	340037	432951	1742282
5	119075	437671	168544	280046	225471	324402
6	78633	86159	261981	105620	164364	160632
7	147116	62957	62652	164173	66712	97164
8	109389	94212	44118	45707	96716	40187
9	119046	74301	55314	32031	31488	47371
10	62301	77234	48353	34482	20648	19086
11	8555	42439	48928	34359	19554	14205
12	38219	33680	48060	65285	64557	43294
Total	1667785	1712096	1626732	1624696	3132988	3806653

AGE	2004	2005	2006	2007
3	609651	1018676	717695	561934
4	991422	491369	896918	536652
5	1304414	764339	404548	604509
6	238246	1006731	579443	313922
7	118731	177059	783998	478346
8	63574	94375	133989	654942
9	22853	48638	73909	108299
10	32453	15190	35255	61174
11	15148	22686	8825	27817
12	39547	38373	45061	61174
Total	3436039	3677436	3679640	3408768

Table 3.5.6.3. Estimated fishing mortality at age of Icelandic summer-spawning herring (from NFT-Adapt) during 1986-2006.

AGE	1986	1987	1988	1989	1990	1991
3	0.0077	0.006	0.0179	0.0562	0.0549	0.1183
4	0.0989	0.0475	0.0921	0.1183	0.1755	0.2303
5	0.2341	0.2283	0.1277	0.2242	0.205	0.3872
6	0.2512	0.2961	0.3944	0.3367	0.335	0.2822
7	0.5236	0.3586	0.5515	0.4039	0.46	0.3631
8	0.3092	0.6033	0.6653	0.3391	0.4875	0.6017
9	0.2492	0.4067	1.0143	0.3652	0.5978	0.2631
10	0.2659	0.5068	0.5972	0.5795	0.4482	0.6141
11	0.2748	0.5056	0.7589	0.4279	0.5112	0.493
12+	0.2748	0.4549	0.4874	0.169	0.0975	0.0966
WF 5-10	0.3499	0.3407	0.2591	0.3123	0.3811	0.4206
WF 4-10	0.2506	0.1630	0.2125	0.2810	0.3276	0.3803

AGE	1992	1993	1994	1995	1996	1997
3	0.1	0.0895	0.2321	0.1117	0.089	0.0544
4	0.213	0.2456	0.2604	0.3486	0.2887	0.2157
5	0.2533	0.221	0.2841	0.2904	0.3418	0.2763
6	0.4383	0.1895	0.2974	0.3249	0.3502	0.2131
7	0.3413	0.3513	0.3233	0.411	0.3991	0.257
8	0.4104	0.2412	0.4016	0.4489	0.3428	0.2214
9	0.5795	0.3373	0.4607	0.5268	0.5661	0.2928
10	0.4822	0.2869	0.4381	0.4138	0.5514	0.6671
11	0.4907	0.2885	0.4335	0.4632	0.4868	0.3938
12+	0.0716	0.0353	0.1353	0.2068	0.2216	0.3699
WF 5-10	0.4012	0.2461	0.3099	0.3477	0.371	0.2548
WF 4-10	0.3113	0.2459	0.2951	0.3480	0.3594	0.2478

AGE	1998	1999	2000	2001	2002	2003
3	0.163	0.1118	0.1486	0.0889	0.0432	0.1848
4	0.3232	0.2694	0.3804	0.3109	0.1886	0.1894
5	0.2236	0.4132	0.3674	0.4329	0.2391	0.2087
6	0.1223	0.2186	0.3674	0.3595	0.4257	0.2023
7	0.3457	0.2556	0.2153	0.4291	0.4068	0.3242
8	0.2868	0.4325	0.2202	0.2726	0.6138	0.4645
9	0.3327	0.3296	0.3726	0.3391	0.4007	0.2782
10	0.2839	0.3565	0.2417	0.4673	0.274	0.1311
11	0.3011	0.3729	0.2781	0.3597	0.4295	0.2913
12+	0.2128	0.3437	0.3141	0.3208	0.6088	0.2688
WF 5-10	0.2765	0.3706	0.3334	0.4064	0.3777	0.2410
WF 4-10	0.3005	0.3477	0.3528	0.3740	0.2988	0.2040

AGE	2004	2005	2006
3	0.1157	0.0273	0.1907
4	0.1601	0.0944	0.2945
5	0.159	0.1769	0.1536
6	0.1968	0.1501	0.0917
7	0.1296	0.1787	0.0799
8	0.1678	0.1444	0.1129
9	0.3084	0.2218	0.0891
10	0.258	0.4431	0.137
11	0.2448	0.2698	0.113
12+	0.2582	0.1668	0.114
WF 5-10	0.1661	0.1657	0.1017
WF 4-10	0.1640	0.1522	0.1611

Table 3.5.6.4. Summary table from NFT-Adapt run 8 for Icelandic summer spawning herring.

	RECRUITS AGE 3	TOTALBIOM. (AGE 3+)	TOTALSPBIO.	LANDINGS (AGE 3+)	YIELD/SSB	WF 5-10
YEAR	(MLLIONS)	(THOUS. T)	(THOUS. T)	(THOUS. T)		
1986	1124	449	296	66	0.221	0.350
1987	549	518	394	75	0.191	0.341
1988	282	511	437	93	0.213	0.259
1989	435	473	400	101	0.252	0.312
1990	293	422	362	104	0.288	0.381
1991	836	433	319	107	0.335	0.421
1992	1048	514	352	107	0.305	0.401
1993	628	556	434	103	0.237	0.246
1994	683	561	449	134	0.298	0.310
1995	209	469	412	125	0.304	0.348
1996	197	355	313	96	0.306	0.371
1997	780	376	276	65	0.235	0.255
1998	317	374	306	86	0.281	0.277
1999	560	380	296	93	0.312	0.371
2000	436	402	315	100	0.317	0.333
2001	523	371	287	94	0.326	0.406
2002	2011	628	338	96	0.284	0.378
2003	1318	736	496	129	0.260	0.241
2004	610	792	654	112	0.172	0.166
2005	1019	888	698	102	0.147	0.166
2006	718	965	785	130	0.165	0.102
2007	562	917	783			

Table 3.5.7.1. The input data used for prognosis of the Icelandic summer-spawning herring. The geometric mean of number at age 3 on Jan. 1st was used as the recruits for the following years while number at age on Jan 1st 2007 are from NFT-Adapt.

Age	Mean weights (kg)	M	Maturity ogive	Selection pattern	Mortality prop. Before spawning F	M	Number at age Jan. 1st 2007
3	0.169	0.1	0.20	0.40	0	0.5	561.934
4	0.224	0.1	0.85	0.80	0	0.5	381.365
5	0.258	0.1	1.00	1.00	0	0.5	604.509
6	0.282	0.1	1.00	1.00	0	0.5	313.922
7	0.306	0.1	1.00	1.00	0	0.5	478.346
8	0.331	0.1	1.00	1.00	0	0.5	654.942
9	0.344	0.1	1.00	1.00	0	0.5	108.299
10	0.353	0.1	1.00	1.00	0	0.5	61.174
11	0.384	0.1	1.00	1.00	0	0.5	27.817
12+	0.387	0.1	1.00	1.00	0	0.5	61.174

Table 3.5.7.2. The prognosis of the Icelandic summer spawning herring for two fishing seasons under five different options (listed below) from the final NFT-Adapt run. The biomasses of 3+ and the spawning stock are in the beginning of the season.

2007/2008				2008/2009			
TAC	3+ stock	Sp. Stock	F (5-10)	TAC	3+ stock	Sp. Stock	F (5-10)
110	881	753	0.154	110	861	731	0.159
130	881	753	0.184	130	840	711	0.196
140	881	753	0.200	140	830	702	0.216
150	881	753	0.216	150	819	692	0.237
153	881	753	0.220	140	819	692	0.220

Table 3.5.7.3. The expected contribution in weight and percentages of the different age classes to the catch in the two next fishing seasons of the Icelandic summer-spawning herring according to option 5 in Table 3.5.7.2. ($F_{0.22}$).

Age\Season	Catch in weight (10^3 t) 2007/2008	2008/2009	Catch in weight (%) 2007/2008	2008/2009
3	7.590	7.588	5	5
4	11.295	13.815	7	10
5	29.810	14.687	19	10
6	16.930	23.669	11	17
7	27.981	13.331	18	10
8	41.539	22.025	27	16
9	7.142	31.357	5	22
10	4.134	5.313	3	4
11	2.044	3.264	1	2
12+	4.536	4.952	3	4
Total	153	140	100	100

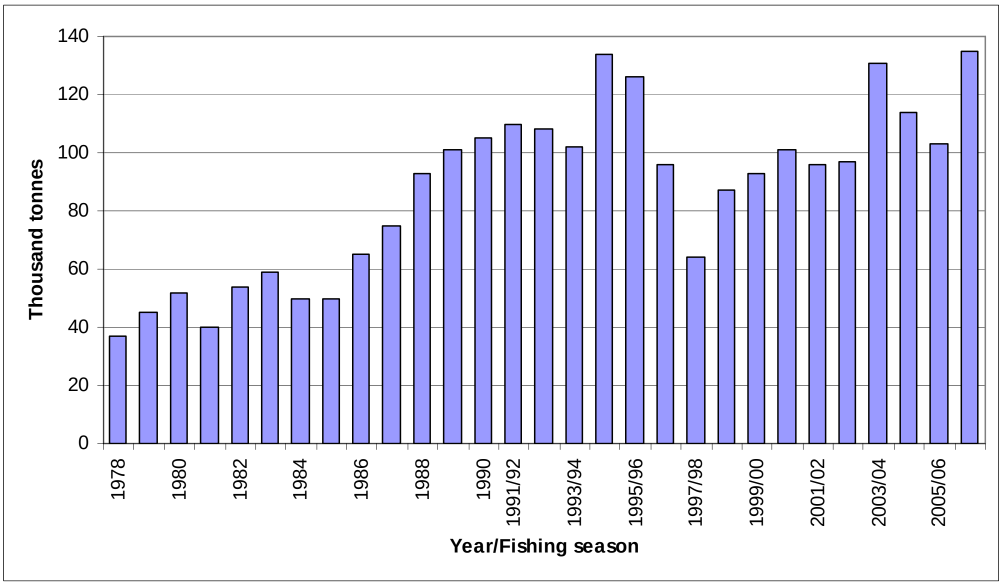


Figure 3.5.1.1. Total catch (in thousand tonnes) of the Icelandic summer-spawning herring in 1978/79-2006/07.

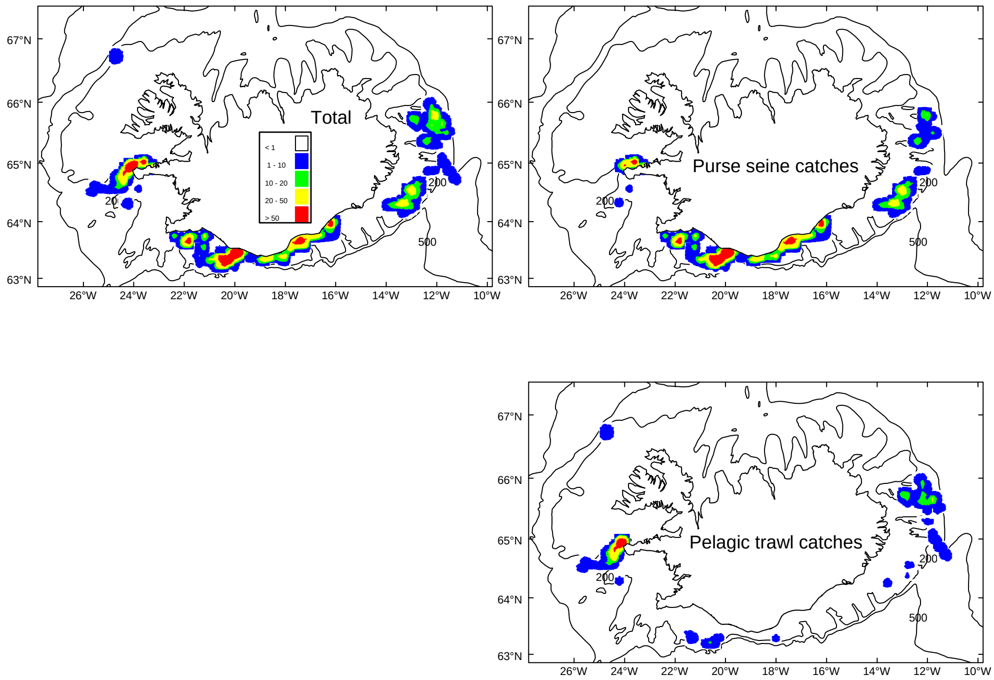


Figure. 3.5.1.2 Distribution of the total catches and by gears of the Icelandic summer spawning herring in the fishing season 2006/07 based on data from logbooks.

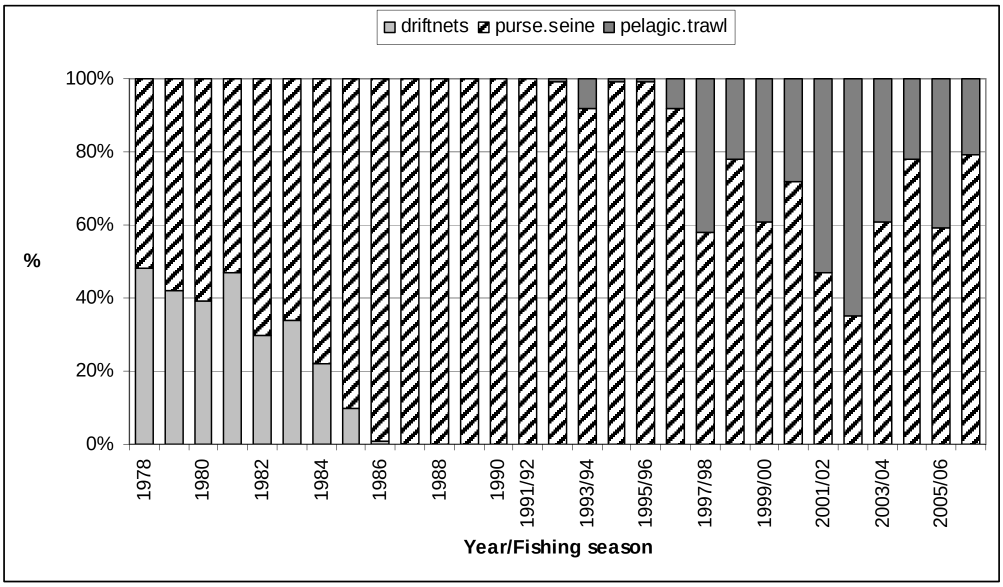


Figure 3.5.2.1. Proportion of the catches of the Icelandic summer-spawning herring in 1978/79-2006/07 taken by different gears.

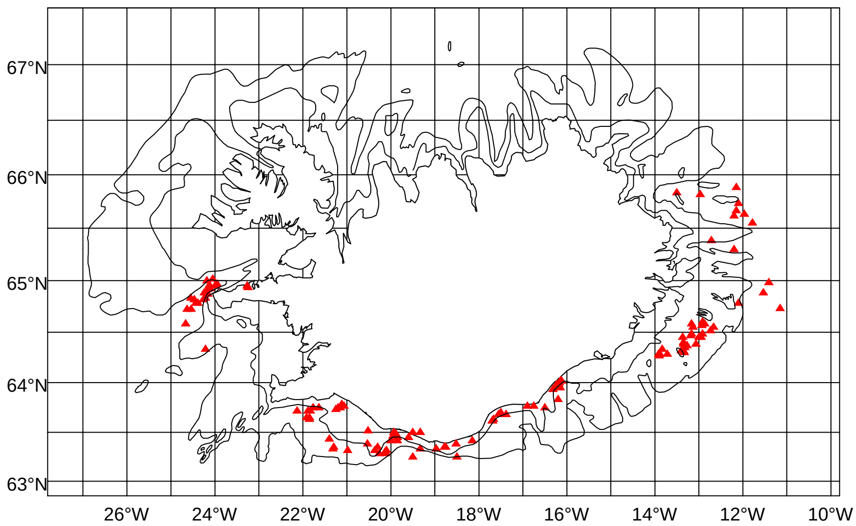


Figure 3.5.3.1. The locations of the Icelandic summer-spawning herring catch samples in 2006/07.

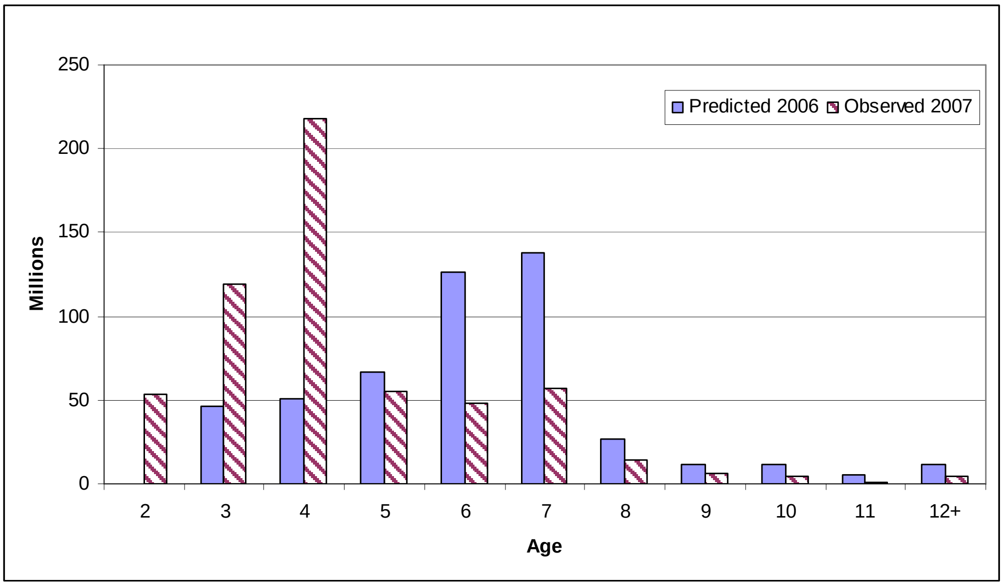


Figure 3.5.3.2. Icelandic summer spawning herring. Predicted catch in numbers in 2006 and observed in 2007.

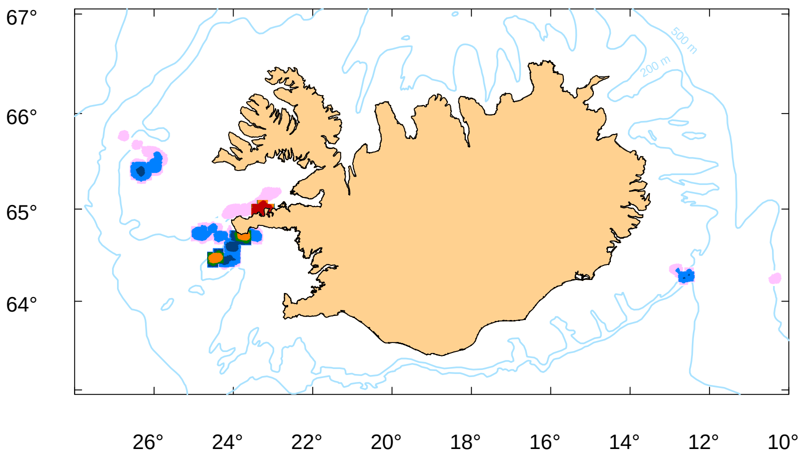


Figure 3.5.4.1. Distribution of Icelandic summer-spawning herring according to acoustic surveys in Jan.-February 2007 (total 825 thousands tonnes).

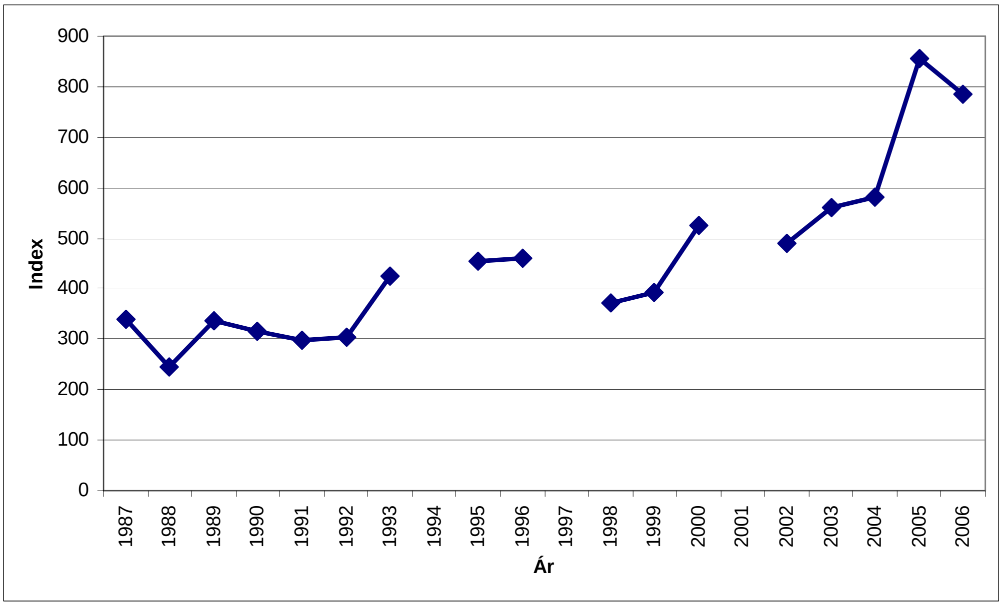


Figure 3.5.4.2 Total biomass from the acoustic surveys for ages 4 and older in the fishing seasons 1987/88 to 2006/07. The years in the plot refer to the end of the year.

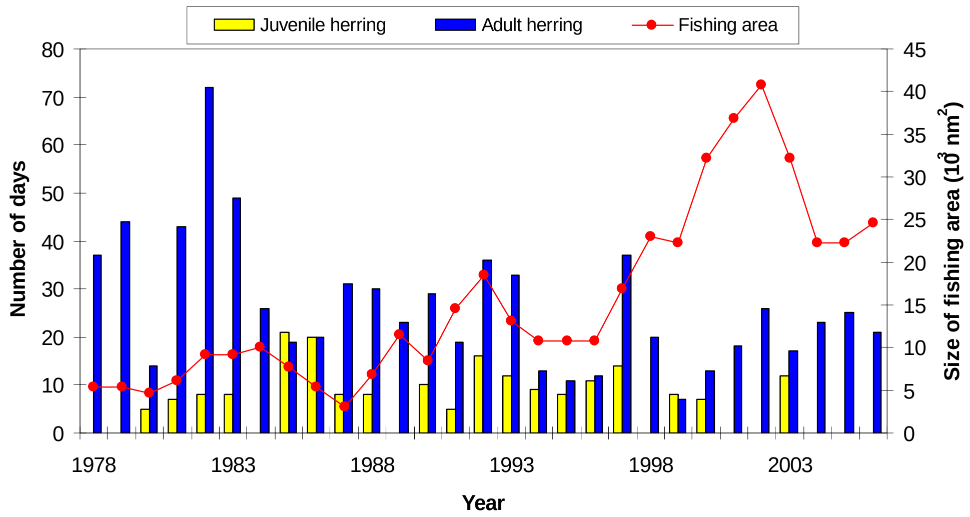


Figure 3.5.4.3. Number of days assigned for acoustic measurements of Icelandic summer-spawning herring for both juveniles and adults (bars) and estimated size of the area (nm^2) that the commercial fleet is fishing herring during each season from 1978/79 through 2006/07 according to fishing reports (based on number of squares where catch was recorded).

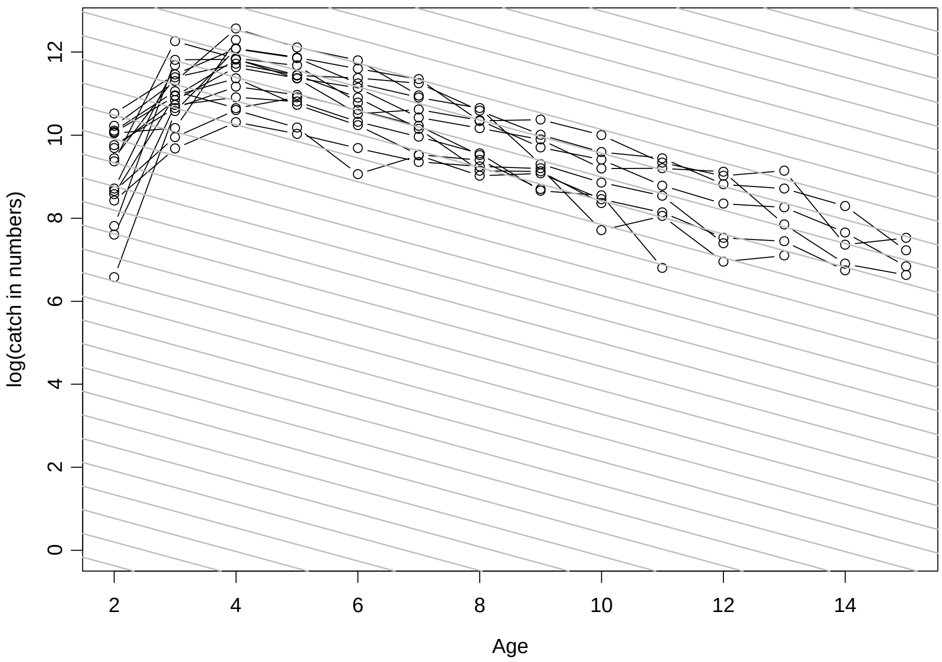


Figure 3.5.5.1.1 Catch curves by year classes 1988-2003. Grey lines correspond to Z=0.4.

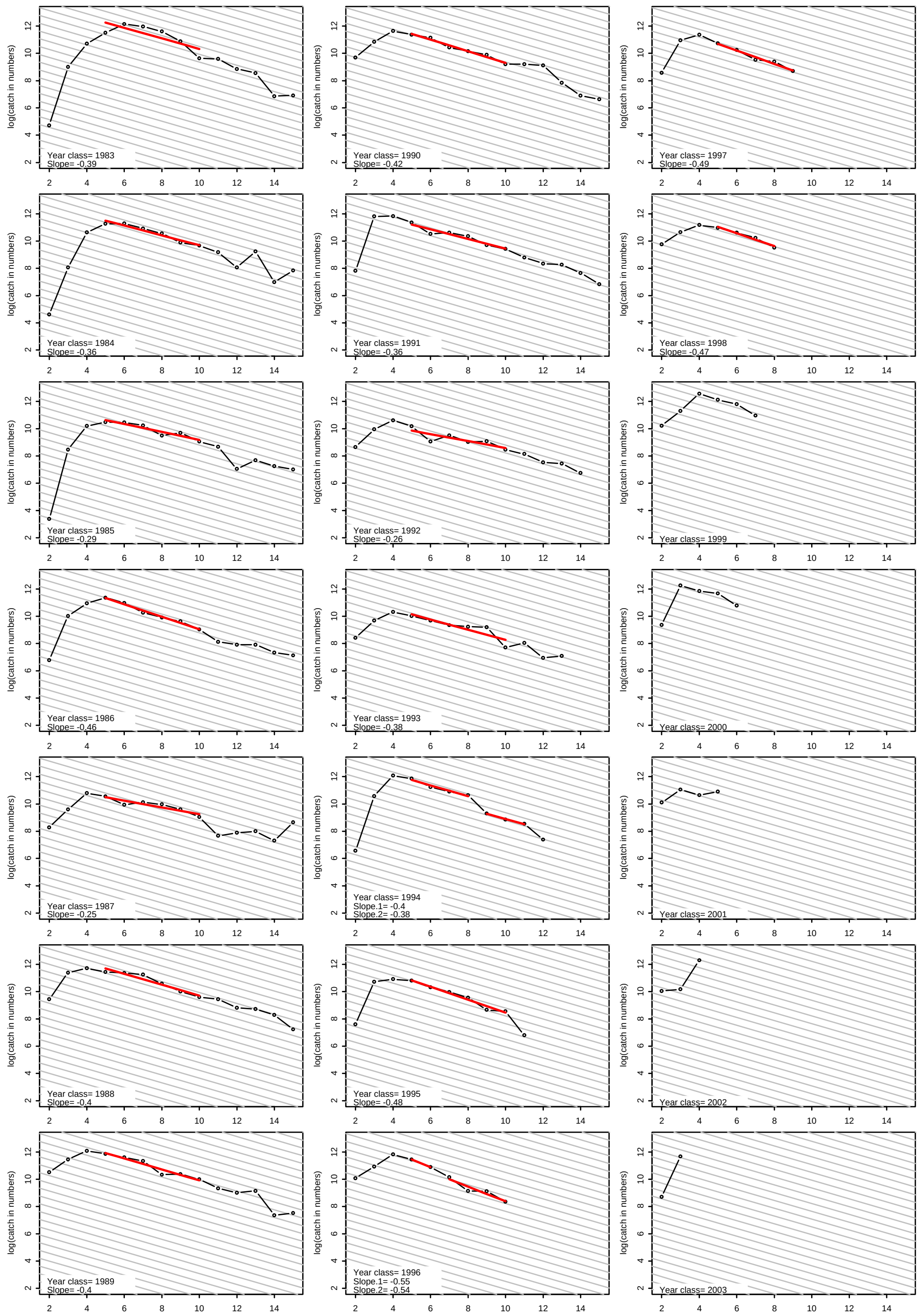
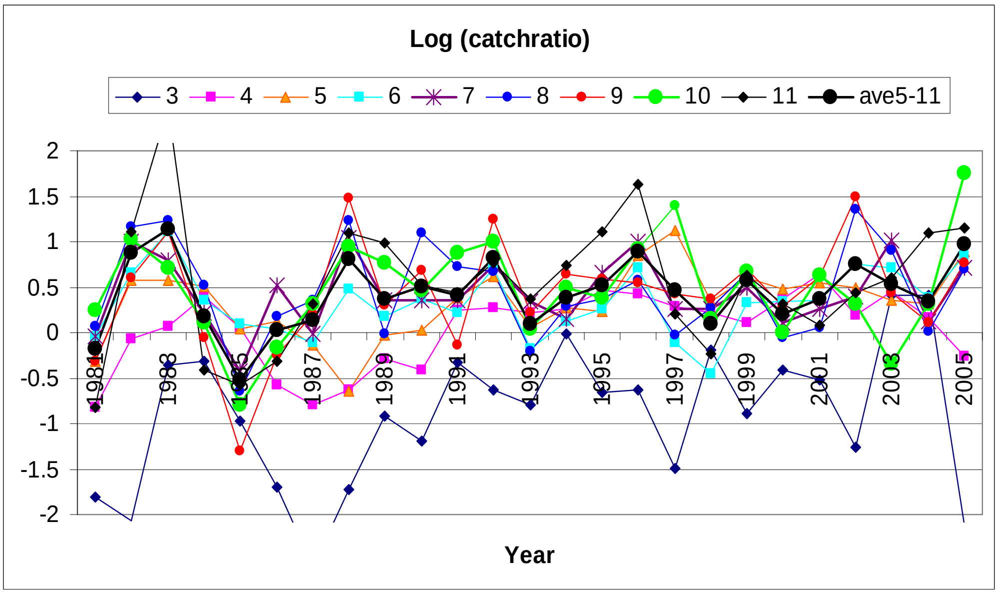


Figure 3.5.5.1.2. Catch curves by year classes 1983-2003. Red line is a fitted line for ages 5-10. The slope of each line is given in each plot. Grey lines correspond to Z=0.4.



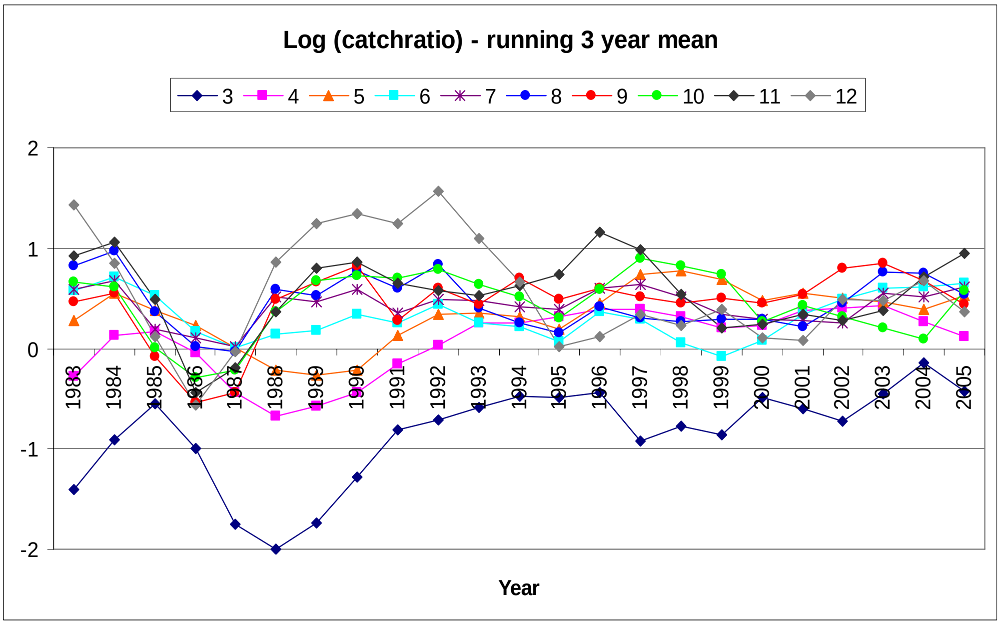


Figure 3.5.5.1.3. Icelandic summer spawning herring. Ln catch ratio by year and age.

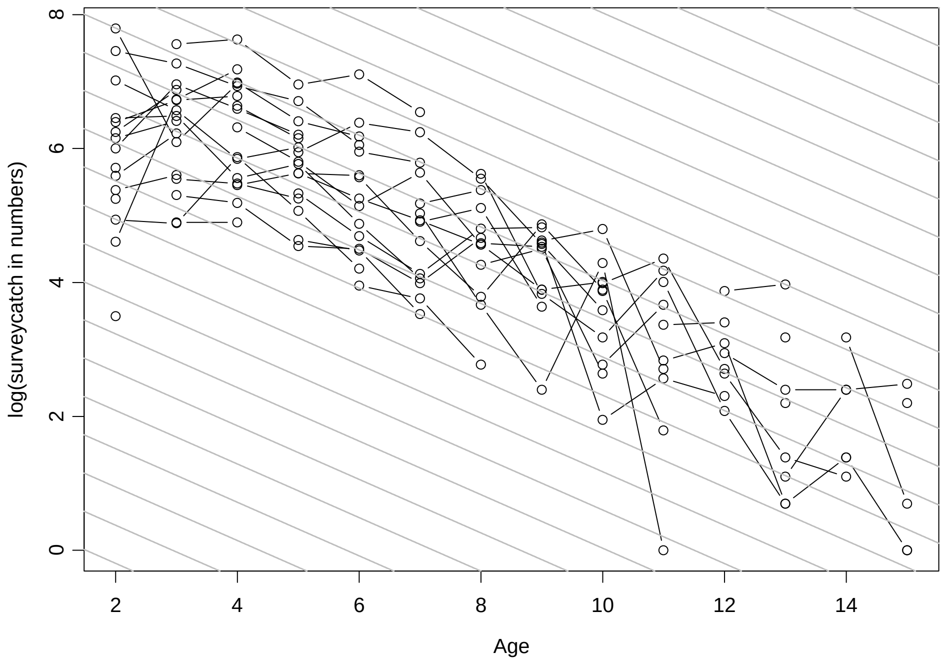


Figure 3.5.5.1.2 Catch curves for the icelandic summer spawning herring made from survey data in the seasons 1985/86-2006/07. Grey lines correspond to Z=0.4.

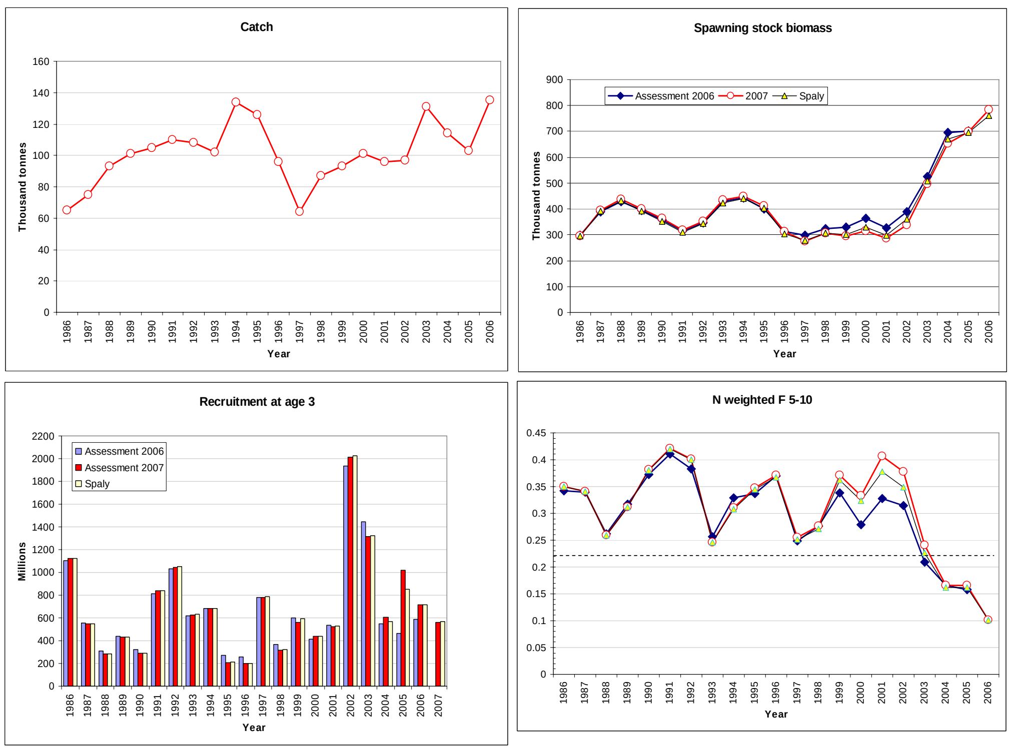


Figure 3.5.5.2.1. Icelandic summer-spawning herring. Comparisons of NFT-Adapt runs.

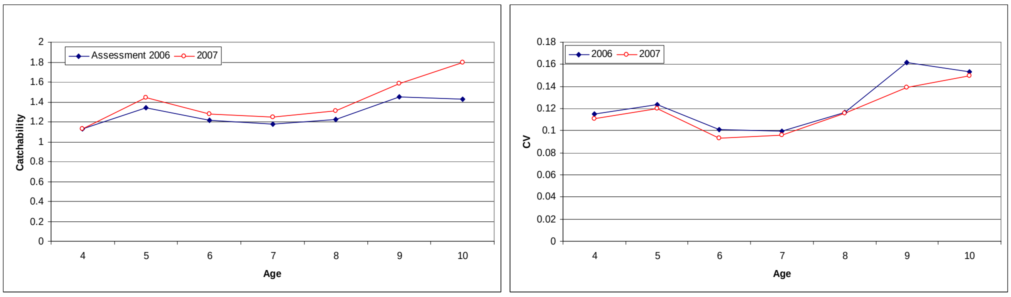


Figure 3.5.5.2.2. Icelandic summer-spawning herring. The catchablity and its CV for the acoustic surveys used in an Adapt run.

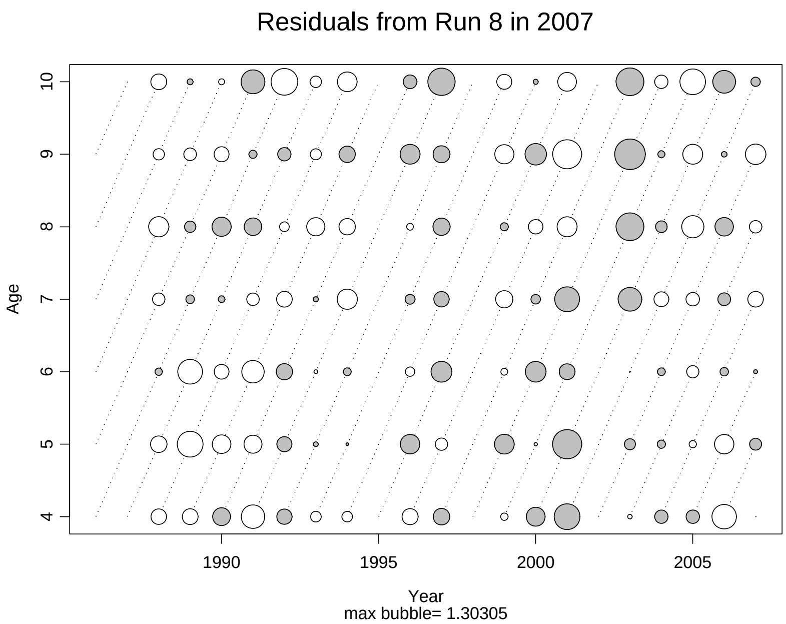


Figure 3.5.5.2.3 Icelandic summer spawning herring. Residuals from survey observations. Filled bubbles are positive. Max bubble = 1.30

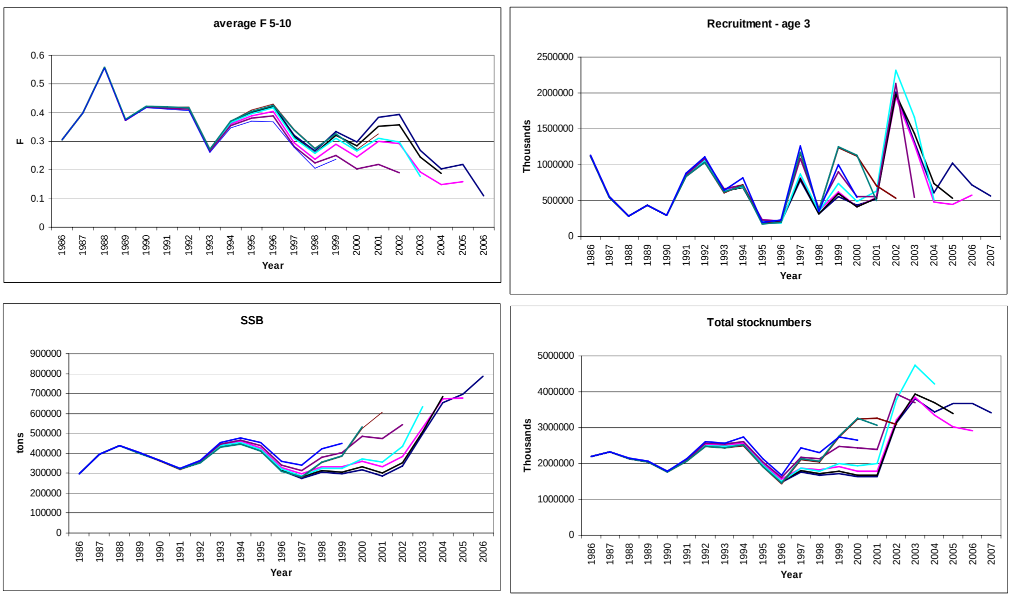


Figure 3.5.5.2.4. Icelandic summer spawning herring. Retrospective pattern in N weighted F, spawning stock biomass and recruitment from NFT-Adapt #8.

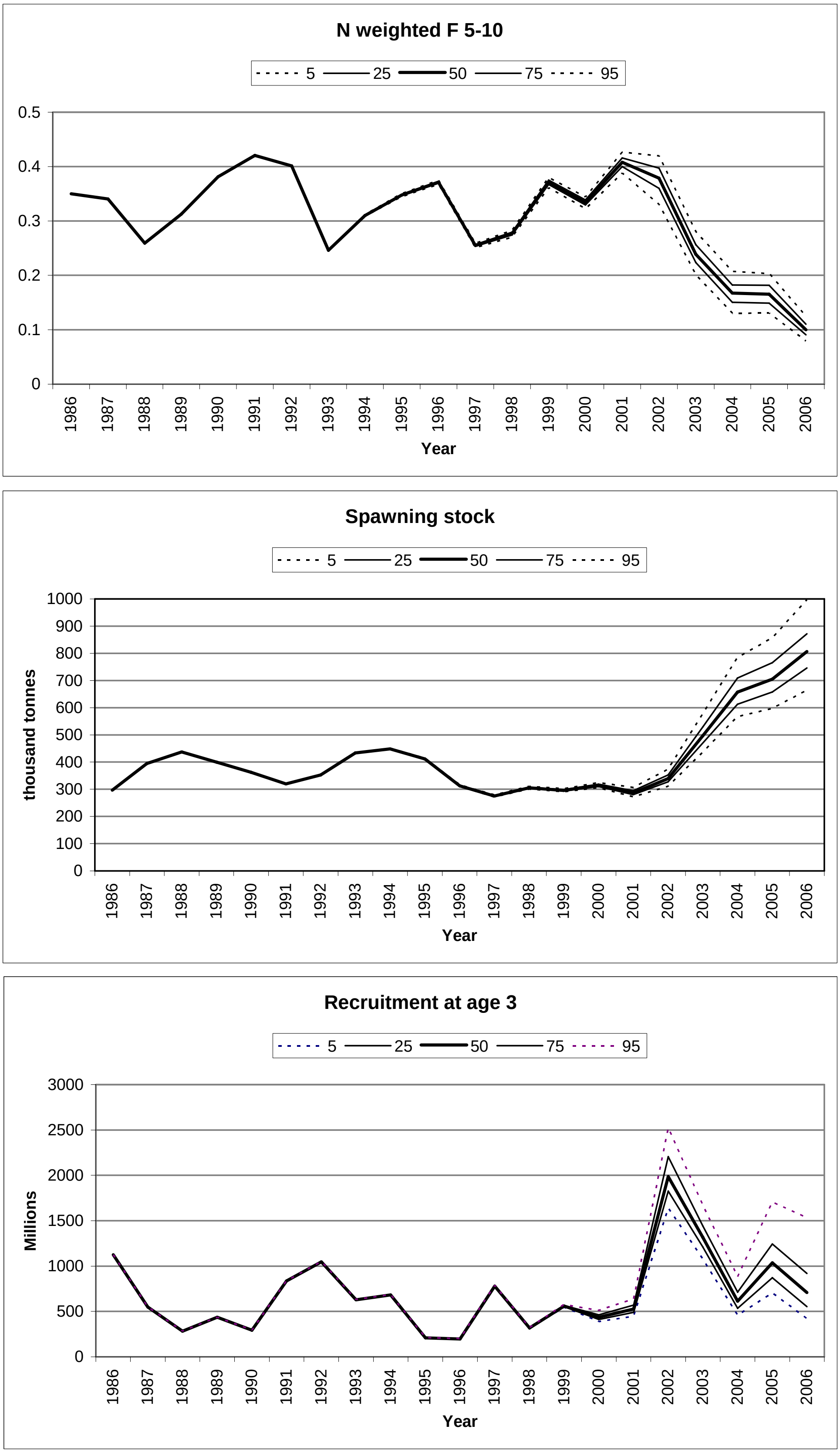


Figure. 3.5.5.2.5. Icelandic summer spawning herring. Results from bootstrapping with Adapt (1000 replicates).

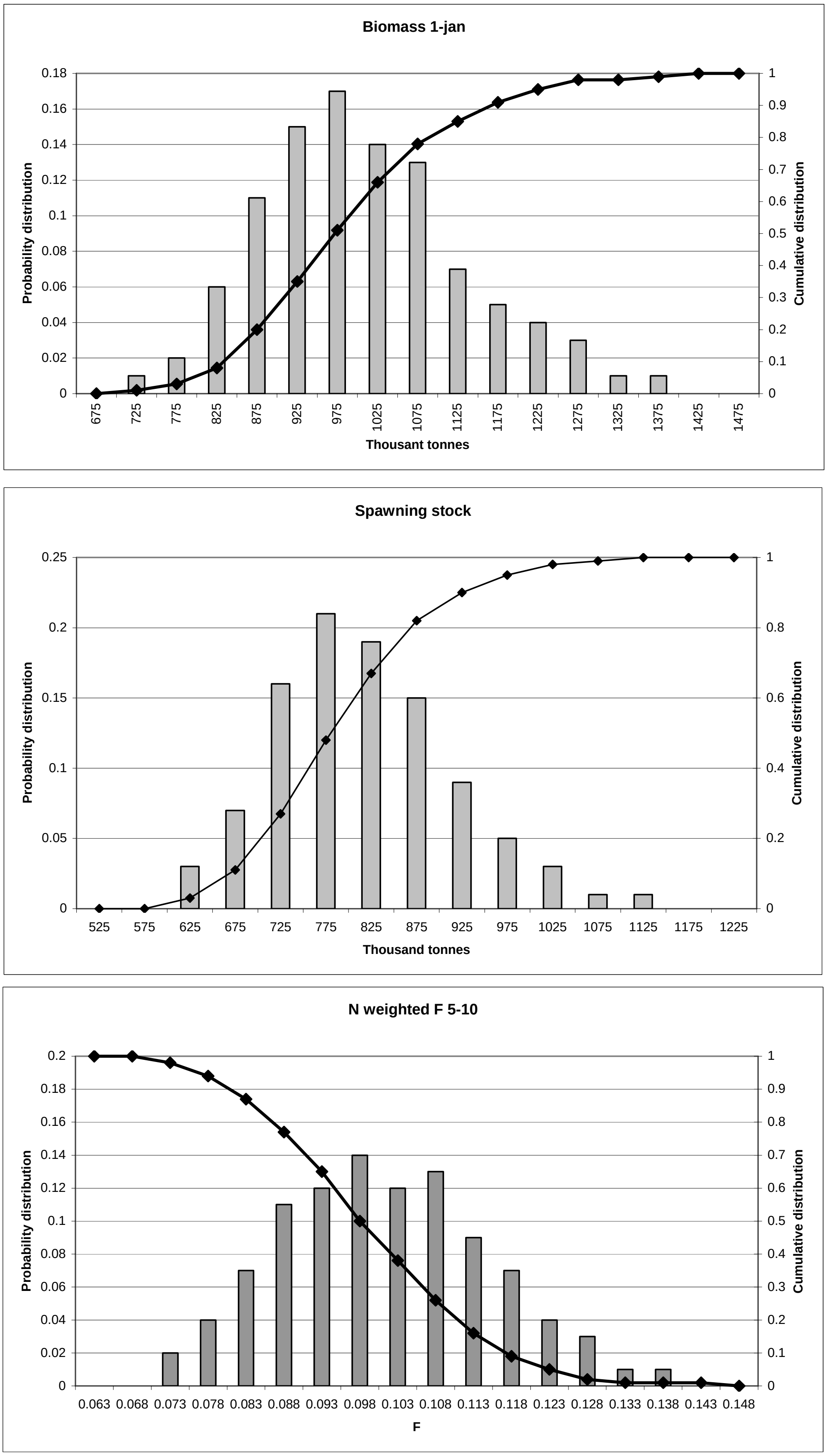


Figure 3.5.5.2.6. Probabilities plot for a bootstrap run with 1000 replicates of the final Adapt run for Icelandic summer-spawning herring.

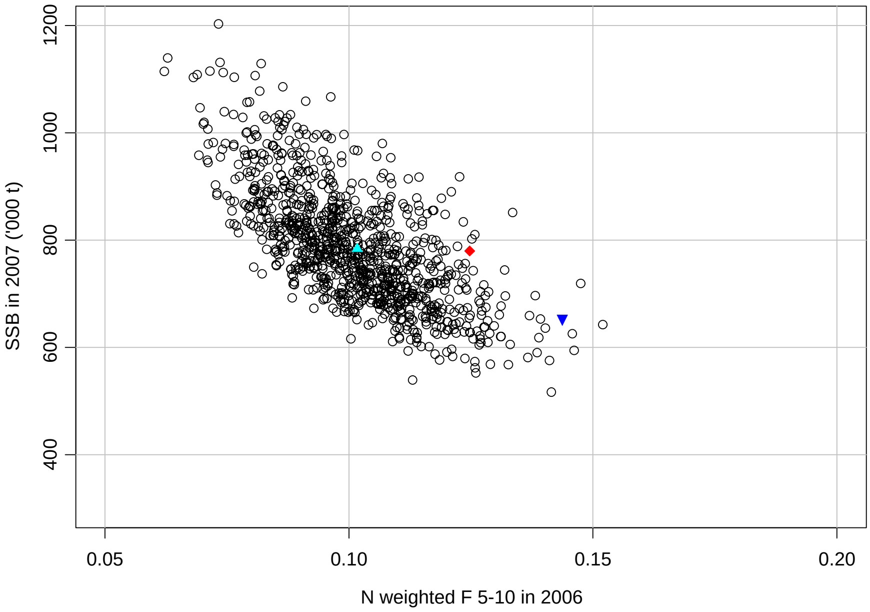


Figure 3.5.5.2.7. A bootstrap results with 1000 replicates of the final Adapt run for SSB in 2007 of Icelandic summer-spawning herring against average weighed F over age 5-10 in 2006, as well as the point estimate from the final Adapt (light blue triangle), final XSA (dark blue reversed triangle), and TSA with changing M (red diagonal).

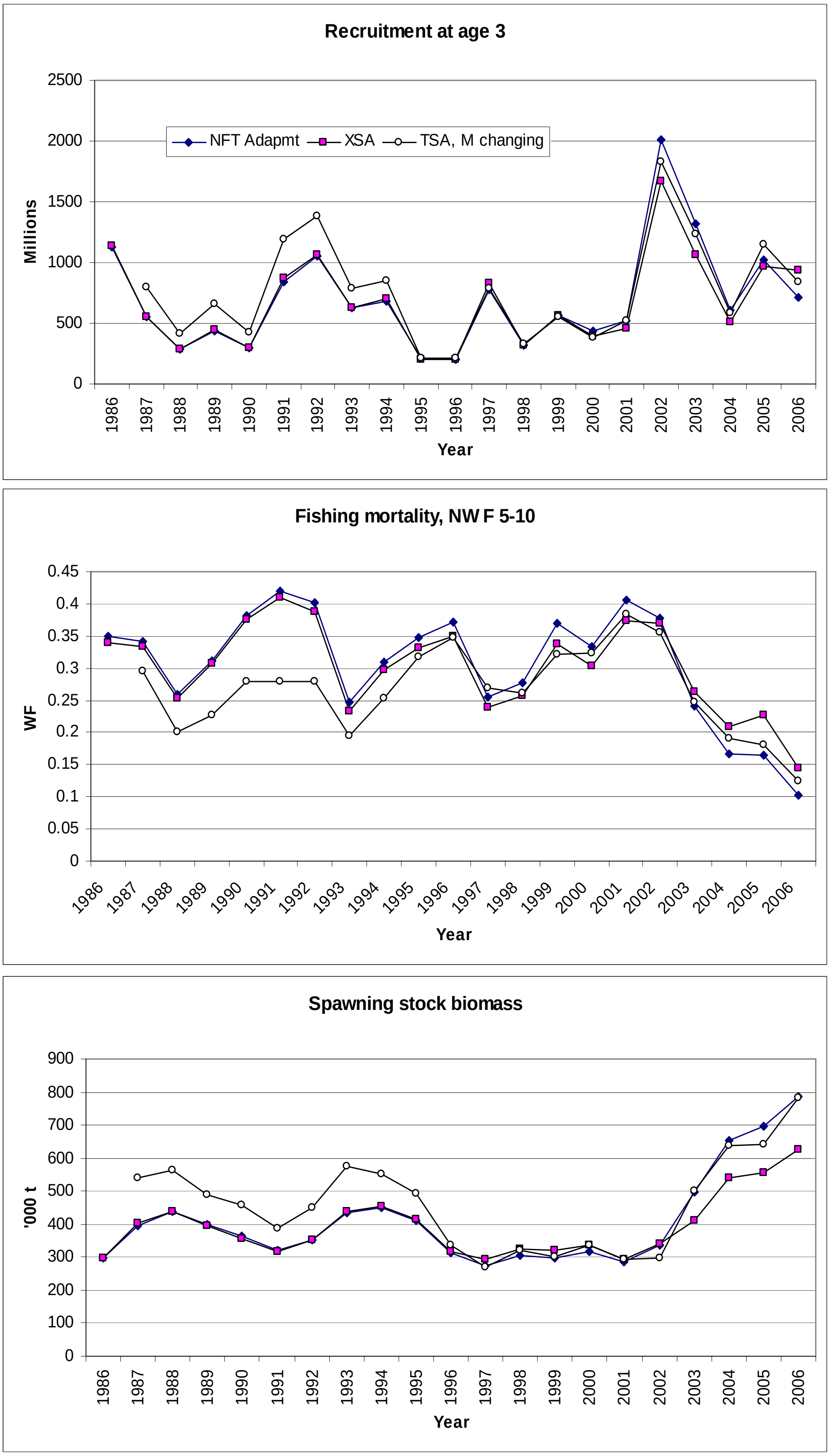


Figure 3.5.5.2.8. Comparisons of results from three different analytical assessment models (NFT-Adapt, XSA, and TSA) for Icelandic summer-spawning herring.

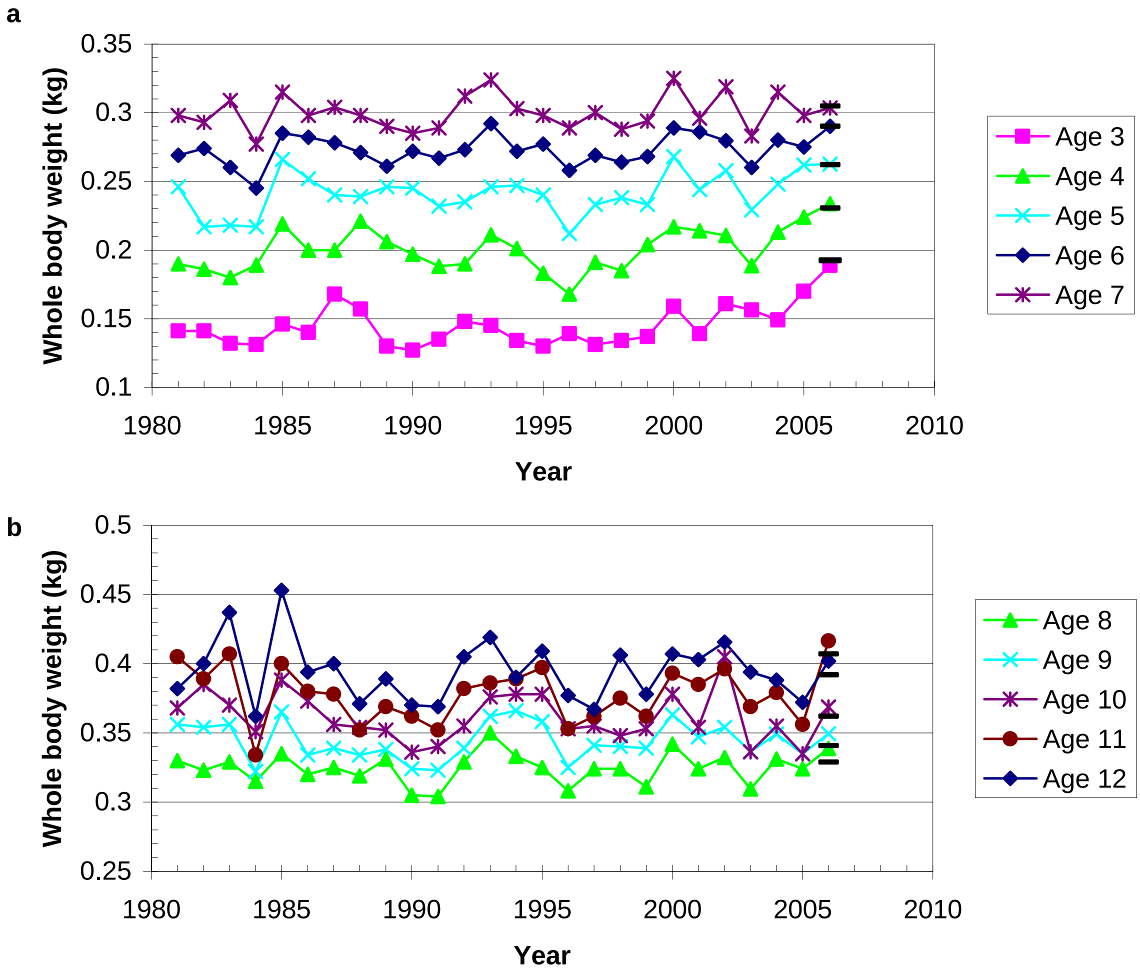


Figure 3.5.7.1. Mean weight at age estimates over 1981 through 2006 from the catch at age estimations of Icelandic summer-spawning herring and the mean weight at age from raw data in 2006 (-) (the years refer to the fishing seasons).

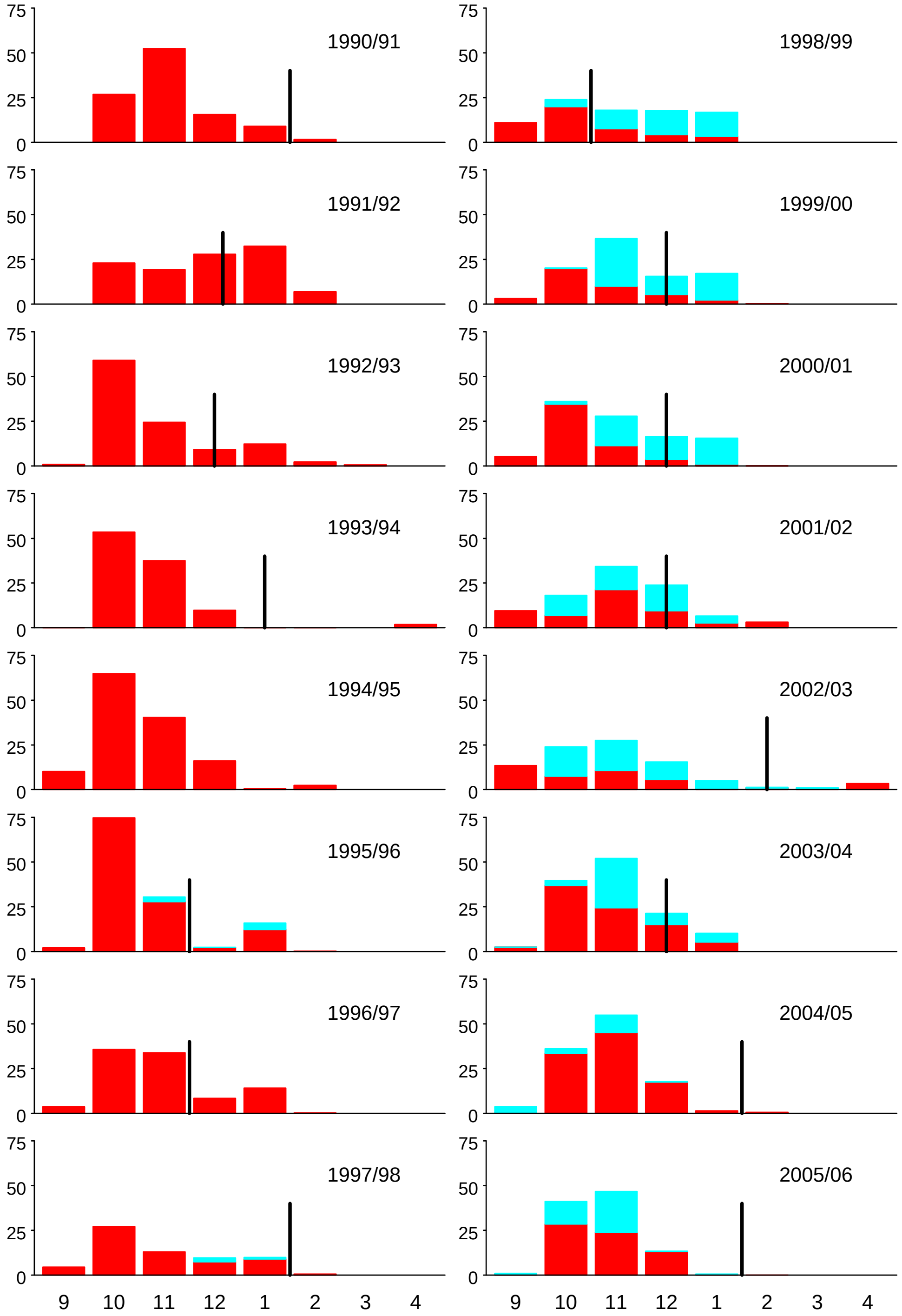


Figure 3.5.11.1. Monthly catch of Icelandic summer-spawning herring over the fishing season 1990/91 to 2005/05 off East (red dark bars) and West (light blue bars) Iceland as well as the cessation day of the annual acoustic surveys (indicated with horizontal lines). No survey took place in 1994/95.

3.6 Capelin in the Iceland-East Greenland-Jan Mayen area

Summary

- Last year (2006) the advice was not to open the fishery in the season 2006/07 until assessment surveys had verified that a catch could be allowed with the usual prerequisite of a remaining spawning stock of 400 000 t after taking account of natural mortality.
- The fishery was opened in January 2007.
- Last year no information about the recruiting year classes was at hand. This year results from a survey in November 2006 are available and on the basis of them starting quota of 206 thous. t can be set.
- TAC will be revised after in season surveys.

3.6.1 Fishery

3.6.1.1 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 2 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 rates 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. A detailed description and test of this method for the period 1979-2001 was given by Gudmundsdottir and Vilhjálmsson (2002). A summary of the results of this catch regulation procedure is given in Table 3.6.1.1.1.

However, since 2001 until 2005 (inclusive) the juvenile distribution areas have changed and it has not proven possible to locate them but in part, if at all. The above catch procedure could therefore not be used. This has been tackled by setting very low, and sometimes no, summer/autumn TACs and the fishery not been opened until a 'reliable' fishable stock assessment has been obtained, usually in January of the season.

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. There was also a ban on capelin fishing during the summer/autumn seasons in 2005 and 2006 due to lack of information on the state of the stock. In addition, areas with high abundances of juvenile age 1 and 2 capelin (on the shelf region off NW-, N- and NE-Iceland) have usually been closed to the summer and autumn fishery.

3.6.1.2 The fishery in the 2006/07 season

Because of a total lack of information on the state of the stock, ACFM recommended in 2006 that fishery should not be opened until assessment surveys had verified that a catch could be allowed with the usual prerequisite of a remaining spawning stock of 400 000 t after taking account of natural mortality. This advice was accepted by all parties concerned.

On the other hand, survey results in January and March 2007 finally resulted in a TAC of 370 000 t for the 2007 winter season (Section 3.6.3). The first spawning run entered the warm Atlantic water off the southeast coast at the beginning of the second week of February. From there, the capelin migrated fairly fast westward in near-shore areas and much of the spawning took place off the Snaefellsnes peninsula as well as off the south coast. Distribution of the catches are shown in Figure 3.6.1.2.1. As usual, catch rates were high in February, but started to fall in the first week of March. Around that time schools of capelin were reported off the Vestfirdir peninsula. These reports were checked by research vessels and 15 000 t were subsequently added to the TAC, raising the total to 385 000 t.

The total catch during the 2007 winter season was 377 000 t, leaving a spawning stock of about 410 000 t (Table 3.6.1.1.1). A large proportion of the 2007 winter catch was processed for human consumption.

3.6.2 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 3.6.2.1 and by season in Figure 3.6.2.1.

The total catch in numbers during the summer/autumn 1985–2006 and winter 1986–2007 seasons is given by age and years in Tables 3.6.2.2 and 3.6.2.3.

The distribution of the catch during the summer 2006 and winter 2007 seasons is given by length groups at age in Tables 3.6.2.4 and 3.6.2.5.

3.6.3 Surveys

3.6.3.1 0-group and 1-group surveys in August

The distribution and abundance of 0-group capelin in the Iceland-East Greenland-Jan Mayen area has not been recorded in August since 2003 as the 0-group surveys were dismissed in 2004. The same is true for age 1 capelin which was recorded during the 0-group surveys (Tables 3.6.3.1.1 and 3.6.3.1.2.

3.6.3.2 Surveys on immature 1 and 2 capelin in summer/autumn 2006

There was so much drift ice in the most likely juvenile area between NW-Iceland and Greenland as well as over the Greenland shelf west of the Denmark Strait that no attempt was made to survey the area in spring and early summer 2006.

In July 2006 there began a multidisciplinary project (oceanography/ecology) covering the area from Ammassalik in the west to about 10°W east of Iceland as well as the Iceland Sea north to 71°N. One of the main purpose of this project is to study the distribution, behaviour and feeding habits of all age groups of capelin in spring and summer. With regard to capelin, this first survey was not totally successful since ice still covered large parts of the area next to Greenland, in places quite wide.

The results of this survey have not been analyzed fully, but although all age groups of capelin were encountered their abundance was low although occurring in fairly wide parts of the survey area.

This time, the November 2006 survey recorded immature capelin, mostly in the Denmark Strait and north of the Vestfirdir peninsula but also in more scattered condition off the Icelandic north coast (Figure 3.6.3.2.1). The total estimate came to about 45 billion age 1 capelin, which is roughly half that indicating a good-to-large year class. The numbers of age 2 immature capelin were very low, which is in tune with the low contribution of age group to the spawning stock in the last few years. Although juvenile capelin were not registtered in large numbers, their distribution pattern had become quite similar to that experienced before 2002. However, there was quite much drift ice off the E-Greenland coast from about 32°W and at least north to Scoresby Sound and, therefore, this is both north and northeast Iceland and in the Denmark Strait. Drift ice prevented any search over the Greenland plateau west of there. An age disaggregated abundance by age, length and weight is given in Table 3.6.3.2.1.

3.6.3.3 Surveys on the adult fishable stock

In spring 2006 there was much drift ice in the area between Iceland and Greenland and to Scoresby Sound in the north reaching east to the Kolbeinsey Ridge. Hence, conditions for the surveying of capelin in the Iceland/E-Greenland area were quite hopeless. As mentioned in the previous section, a four week interdisciplinary survey was carried out of the area from 32°W, through the Denmark Strait and north of Iceland to the latitude of Jan Mayen (71°N). Few capelin were located, but sea ice still covered many of the likeliest areas.

Very few adult, fishable capelin were located in November and December 2006 (Figure 3.6.3.3.1) leading to a recommendation of a continued fishing ban, which was accepted. The research vessel was tied up in harbour on the east coast in order to facilitate as early a start as possible in January 2007.

In the first ten days of January 2007 two research ships located and assessed concentrations of capelin in deep water just east of the Kolbeinsey Ridge off central north Iceland (Figure 3.6.3.3.2). In view of the results of this survey, a preliminary TAC of 180 000 t could be set and the fishing ban thus lifted.

During 23-31 January, another assessment survey was carried out east of Iceland and it became obvious that capelin had gradually been arriving in this area from the north, which resulted in a total estimate of 715 000 t of mature fish (Figure 3.6.3.3.3, Table 3.6.3.3.1). This corresponded to a TAC of 370 000 t for all of the winter 2007 season, when account had been taken of the catch taken previously. An age disaggregated abundance by age, length and weight is given in Table 3.6.3.3.1.

In March and April two attempts were made to assess reports of a western migration. Total estimate of adults came to some 15 000 t (Figure 3.6.3.3.4). In deeper waters there were only immature capelin.

3.6.4 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), 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 1978/79–2006/07 seasons. The results are given in Tables 3.6.4.1 and 3.6.4.2 (1 August and 1 January, respectively). Table 3.6.4.2 also gives the remaining spawning stock by number and biomass in March/April 1979–2007.

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 is normally used to calculate stock biomass of the maturing components in summer, but due to lack of data the January weights were backcalculated.

Because there is a small weight increase among mature capelin in February and March, the remaining spawning stock biomass is underestimated.

An overview of stock developments during 1978–2007 is given in Table 3.6.4.3.

3.6.5 Stock prognoses

3.6.5.1 Stock prognosis and TAC in the 2006/07 season

Data for predicting the abundance of the fishable stock in the 2006/2007 season were not available beforehand. Therefore, TACs were set (and changed) as 'reliable' acoustic stock asesssments became available in January and March. Obviously, this is an extremely awkward situation for fishers, producers and researchers alike.

3.6.5.2 Stock prognosis and TAC in the 2007/08 season

To predict the abundance of the fishable stock in the 2007/08 season a knowledge of the amount of immature capelin at age 1 and 2 from the autumn 2006 are needed. The results from the survey in November 2006 can be used for capelin at age 1 (it came to $44.7*10^9$ individuals, Table 3.6.3.2.1). However, as there were hardly any immature capelin at age 2 then data for predicting the amount of age 3 capelin in autumn 2007 is lacking. In the last few seasons the contribution of the older year class in the stock and the catches has been low (Figure 3.6.5.2.1). Several options were tried for determining the size of the 2 group amongst them the mean of the last two year. (2.6%) . A mean weight for the older age group is also needed. A long term average was used, that is 22.6 g. With these input values the procedure for calculating a TAC as described in Gudmundsdottir and Vilhjálmsson (2002) was done. The predicted TAC resulting from these excercises are relatively low, in the range of 290 to 325 000 t, resulting in a start quota in the range of 190 to 220 000 t.

The working group decided to use the results when the older age group was set to 2.6%. If the fishery starts in August the start quota will be 217 000 t (2/3 of predicted TAC 325 000 t). If however the fishing season starts in November the starting quota will be 206 000 t (2/3 of predicted TAC 308). Under the presently uncertain circumstances, the younger year class measured only half of a normal to good one, so no summer fishery should be allowed.

3.6.5.3 Management of capelin in the Iceland-East Greenland-Jan Mayen area

The fishable stock consists of 2 age groups (2 and 3 year olds in autumn, spawning at ages 3 and 4 in the following spring). 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.

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 during the fishing season. Prior to that no fishery has been allowed unless an assessment has shown that at least 2-300 000 t can be taken allowing for natural mortality and a remaining spawning stock of 400 000 t.

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. If the predicted fishable stock biomass is < 500 000 t, the fishery is not opened until after the within-season acoustic survey in autumn/winter. Furthermore, the starting quota will never exceed 1 million tonnes.

3.6.6 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, the use of this target reference point, as reflected in the stock history, indicates that it is precautionary.

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 in setting a preliminary TAC when the projected fishable stock biomass August 1 is lower than 500 000 t. In such cases the fishery should not be opened until late or after the completion of a stock assessment survey in autumn/winter in that season. In cases when the biomass estimates are beyond the historical maximum (1 600 000 t) it is suggested that a the preliminary TAC should not exceed 1 000 000 t.

3.6.7 Special comments

In the last five years great difficulties have been encountered in locating and assessing the juvenile part of the stock (ages 1 and 2; 2 and 3 after 31 December). In this period, the quarterly monitoring of environmental conditions of Icelandic waters, shows a rise in sea temperatures north and east of Iceland, which probably also reaches farther north and northwest. The temperature increase is so large that it has probably led to displacements of the juvenile part of the capelin stock. On the basis of experience gained before and during assessment surveys of the 2002/2003 season, these displacements have obviously been so large that juvenile capelin, in particular the 2001 year class, were not available to the autumn 2002 assessment survey as it was carried out. Therefore, while the very low numbers of immature capelin of the 2001 and later year classes recorded until 2006 should be taken seriously, they do not necessarily indicate a radical decline of the adult fishable stock.

3.6.8 Sampling

Investigation	No. of samples	Length meas. individuals	Aged individuals
Fishery 2006	2	200	200
Survey 2006	53	4965	3827
Fishery 2007	44	4604	1842
Survey 2007	38	3622	3549

3.6.9 Comments on the assessment

Data consideration

Informations about the size of the incoming 2005 year class are only available from an acoustic survey in November 2006. Results from a survey conducted in summer 2006 showed low values. Since 2004 there have been no 0-group surveys, but both 0-group and age 1 capelin used to be recorded during these surveys.

Assessment quality

The final assessment is based on results from two acoustic surveys during winter 2007. The survey estimates are treated as unbiased point estimates. Surveys both before and after these gave informations about the distribution of the stock.

Table 3.6.1.1.1 Preliminary TACs for the summer/autumn fishery, recommended TACs for the entire season, landings and remaining spawning stock (000 tonnes) in the 1994/95–2006/07 seasons.

Season	94/95	95/96	96/97	97/98	98/99	99/00	00/01	01/02	02/03	03/04	04/05	05/06	06/07
Prelim. TAC	950	800	1100	850	950	866	975	1050	1040	835	335	235	180.0
Rec. TAC	850	1390	1600	1265	1200	1000	1090	1325	1000	875	987	235	385.0
Landings	842	930	1571	1245	1100	934	1065	1249	988	741	783	238	376.8
Spawn. stock	420	830	430	492	500	650	450	475	410	535	602	400	410

Table 3.6.2.1. The international capelin catch 1964–2007 (thousand tonnes).

Year	Winter season					Summer and autumn season						Total
	Iceland	Norway	Faroes	Greenland	Season total	Iceland	Norway	Faroes	Greenland	EU	Season 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	692.0	9.0	-	-	-	-	9.0	701.1
2006	193.0	8.0	30.0	7.0	238.0	-	-	-	-		-	238.0
2007	307.0	38.0	19.0	12.8	376.8							

Table 3.6.2.2 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) 1985–2006. No catch in 2006.

	YEAR										
AGE	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
1	0.8	+	+	0.3	1.7	0.8	0.3	1.7	0.2	0.6	1.5
2	25.6	10.0	27.7	13.6	6.0	5.9	2.7	14.0	24.9	15.0	9.7
3	15.4	23.3	6.7	5.4	1.5	1.0	0.4	2.1	5.4	2.8	1.1
4	0.2	0.5	+	+	+	+	+	+	0.2	+	+
Total number	42.0	33.8	34.4	19.3	9.2	7.7	3.4	17.8	30.7	18.4	12.3
Total weight	919.7	772.9	458.6	371.4	121.0	111.2	56.0	298.1	611.6	324.1	205.7

	YEAR										
AGE	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1	0.2	1.8	0.9	0.3	0.2	+	+	0.3	+	-	-
2	25.2	33.4	25.1	4.7	12.9	17.6	18.3	11.8	5.3	0.4	-
3	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	38.4	45.8	28.9	5.7	16.5	18.8	20.8	14.3	5.8	0.4	-
Total weight	773.7	763.6	440.5	102.4	265.1	294.0	339.7	199.5	92.0	9.0	-

Table 3.6.2.3 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) 1986–2007.

	YEAR										
AGE	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
2	0.1	+	+	0.1	1.4	0.5	2.7	0.2	0.6	1.3	0.6
3	9.8	6.9	23.4	22.9	24.8	7.4	29.4	20.1	22.7	17.6	27.4
4	6.9	15.5	7.2	7.8	9.6	1.5	2.8	2.5	3.9	5.9	7.7
5	0.2	-	0.3	+	0.1	+	+	+	+	+	+
Total number	17.0	22.4	30.9	30.8	35.9	9.4	34.9	22.8	27.2	24.8	35.7
Total weight	391.8	560.5	657.2	665.1	686.8	202.4	621.1	489.6	567.1	539.8	723.6

	YEAR										
AGE	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
2	0.9	0.3	0.5	0.3	0.4	0.1	0.1	0.6	0.1	0.1	0.3
3	29.1	20.4	31.2	36.3	27.9	33.1	32.2	24.6	31.5	10.4	19.5
4	11.0	5.4	7.5	5.4	6.7	4.2	1.9	3.0	3.1	0.3	0.5
5	+	+	+	+	+	+	+	+	-	-	-
Total number	41.0	26.1	39.2	42.0	35.0	37.4	34.4	28.3	34.7	10.8	20.3
Total weight	797.6	481.3	658.9	830.3	787.2	955.0	648.0	542.9	692.0	230.0	376.8

Table 3.6.2.4 The total international catch in numbers (millions) of capelin in the Iceland-East Greenland-Jan Mayen area in the summer/autumn season of 2006 by age and length, and the catch in weight (thousand tonnes) by age group. No catch in summer/autumn 2006.

Total length (cm)	Age 1	Age 2	Age 3	Total	Percentage
12					
12.5					
13					
13.5					
14					
14.5					
15					
15.5					
16					
16.5					
17					
17.5					
18					
18.5					
Total number	0	0	0	0	0
Percent					
Total weight	0	0	0	0	0

Table 3.6.2.5 The total international catch in numbers (billions) of capelin in the Iceland-East Greenland-Jan Mayen area in the winter season of 2007 by age and length, and the catch in weight (thousand tonnes) by age group.

Total length (cm)	Age 2	Age 3	Age 4	Total	Percentage
12	0.008	0.000	0.000	0.008	0.040
12.5	0.011	0.032	0.000	0.043	0.212
13	0.043	0.085	0.000	0.128	0.629
13.5	0.086	0.216	0.000	0.302	1.483
14	0.065	1.143	0.000	1.208	5.930
14.5	0.032	2.362	0.032	2.426	11.913
15	0.032	3.922	0.043	4.098	20.120
15.5	0.000	4.324	0.065	4.389	21.550
16	0.000	3.623	0.054	3.677	18.055
16.5	0.000	2.383	0.119	2.502	12.284
17	0.000	1.132	0.108	1.240	6.089
17.5	0.000	0.205	0.022	0.226	1.112
18	0.000	0.108	0.011	0.119	0.582
Total number	0.278	19.535	0.453	20.266	
Percentage	1.4	96.4	2.2	100.000	100.000
Total weight	3.3	362.6	10.9	376.8	

Table 3.6.3.1.1 Abundance indices of 0-group capelin 1970-2003 and their division by areas. No surveys after 2003.

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

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

	1996	1997	1998	1999	2000	2001	2002	2003	
NW-Irminger Sea	2	5	+	NA	NA	NA	NA	+	No surveys
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 3.6.3.1.2 Estimated numbers, mean length and weight of age 1 capelin in the August surveys for 1983–2001.

	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

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Number (10^9)	143	87	55	94	99	No surveys for age 1				
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 3.6.3.2.1 Assessment of capelin in the Iceland/Greenland/Jan Mayen area, November 2006. (Numbers in billions, biomass in thousand tonnes)

Length (cm)	Average weight (g)	Numbers at age			Numbers	Biomass
		1	2	3		
7.5	1.2	0.050	0.000	0.000	0.050	0.1
8	1.5	1.241	0.000	0.000	1.241	1.9
8.5	2.0	4.253	0.000	0.000	4.253	8.3
9	2.4	6.798	0.000	0.000	6.798	16.1
9.5	2.8	7.678	0.000	0.000	7.678	21.3
10	3.3	7.492	0.000	0.000	7.492	25.1
10.5	3.7	5.478	0.000	0.000	5.478	20.5
11	4.6	4.703	0.000	0.000	4.703	21.6
11.5	7.1	3.294	0.000	0.000	3.294	23.3
12	6.3	1.509	0.000	0.000	1.509	9.6
12.5	7.2	1.148	0.079	0.000	1.227	8.8
13	8.4	0.819	0.197	0.000	1.015	8.5
13.5	10.1	0.222	0.204	0.017	0.443	4.5
14	11.7	0.059	0.815	0.098	0.972	11.4
14.5	13.5	0.000	1.225	0.015	1.240	16.8
15	15.9	0.000	1.293	0.003	1.296	20.6
15.5	17.4	0.000	0.747	0.052	0.798	13.9
16	18.4	0.000	0.540	0.082	0.623	11.5
16.5	22.1	0.000	0.291	0.086	0.377	8.3
17	26.4	0.000	0.041	0.000	0.041	1.1
17.5	27.5	0.000	0.000	0.002	0.002	0.1
Total numbers		44.743	5.431	0.354	50.528	253.0
Total biomass		165.7	81.4	5.9	253.0	
Average weight (g)		3.7	15.0	16.7	4.9	
Average length (cm)		10.0	14.8	15.3	10.5	
Percentage by number		88.6	10.7	0.7	100.0	

Table 3.6.3.3.1 Assessment of adult capelin in the Iceland/Greenland/Jan Mayen area, 21/01-31/01 2007. (Numbers in billions, biomass in thousand tonnes)

LENGTH (CM)	AVERAGE WEIGHT (G)	AGE 2	AGE 3	AGE 4	NUMBERS	BIOMASS
12	6.2	0.016	0.000	0.000	0.016	0.095
12.5	7.7	0.020	0.061	0.000	0.082	0.626
13	9.7	0.082	0.161	0.000	0.243	2.347
13.5	11.1	0.164	0.409	0.000	0.573	6.359
14	12.9	0.123	2.169	0.000	2.292	29.446
14.5	14.4	0.061	4.481	0.061	4.604	66.198
15	16.2	0.061	7.632	0.082	7.775	126.107
15.5	18.4	0.000	8.204	0.123	8.327	153.554
16	20.7	0.000	6.961	0.135	7.096	146.672
16.5	22.6	0.000	4.522	0.225	4.747	107.086
17	24.6	0.000	2.148	0.205	2.353	57.787
17.5	26.6	0.000	0.389	0.041	0.430	11.429
18	28.7	0.000	0.205	0.020	0.225	6.457
Total numbers		0.527	37.341	0.892	38.761	714.165
Total biomass		5.586	689.494	19.071	714.165	
Average weight (g)		10.6	18.5	21.4	18.5	
Average length (cm)		11.5	15.5	16.2	15.5	
Percentage by number		1.4	96.3	2.3	100.0	

Table 3.6.4.1 The estimated number (billions) of capelin on 1 August 1978–2006 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**	**2005**	**2006**	
1 juvenile	167.9	138.0	145.6	139.7	142.3	131.8	57.2	95.1*	51.5*	
2 immature	19.2	24.4	25.0	9.0	23.9	11.4	3.5	2.6	NA	
2 mature	89.5	85.9	65.7	86.7	68.0	82.1	86.6	35.0	62.5	
3 mature	23.2	12.6	16.0	16.9	5.9	15.7	7.5	2.3	1.7	
4 mature	+	+				+				
Number immat.	187.1	162.4	170.6	148.7	166.2	143.2	55.6[1)]	95.1*	51.5*	
Number mature	112.7	98.5	81.7	103.6	73.9	97.8	94.1	37.6	64.2	
Weight immat	621	612	645	615	713	596	170*	380*	206*	
Weight mature	1576	1703	1519	1817	1280	1544	1481	830	1050	

*** preliminary**

NA: not available

Table 3.6.4.2 The estimated number (billions) of capelin on 1 January 1979–2007 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	2006	2007
2 juvenile	140.9	115.8	122.2	117.3	109.4	134.6	48.0	79.8*	43.2*
3 immature	16.1	20.5	21.0	7.6	9.4	11.4	2.9	2.2	NA
3 mature	53.2	68.2	46.3	59.3	58.4	54.2	86.6	29.4	52.5
4 mature	16.0	10.0	10.5	10.5	2.9	6.2	7.5	1.9	1.4
5 mature	+	+	+	+		+	+	-	-
Number immat.	157.0	136.3	161.2	126.6	105.1	143.5*	50.9	82.0*	43.2*
Number mature	69.3	78.2	56.8	69.8	61.3	60.4	72.5	31.3	53.9
Weight immat.	585	535	655	510	487	597*	214	336*	180*
Weight mature	1171	1485	1197	1445	1214	1204	1450	639	997
Number sp.st.	29.5	34.2	21.3	22.9	20.7	28.2	36.3	18.8	19.1
Weight sp. st.	500	650	450	475	410	535	602	400	410

*** preliminary**

NA: not available

Table 3.6.4.3 Capelin in the Iceland-East Greenland-Jan Mayen area 1978-2007. 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.

Season Summer/winter	Recruitment	Total Stock biomass	Landings	Spawning stock biomass
1978/79	164	2832	1195	600
1979/80	60	2135	980	300
1980/81	66	1130	684	170
1981/82	49	1038	626	140
1982/83	146	1020	0	260
1983/84	124	2070	573	440
1984/85	251	2427	897	460
1985/86	99	2811	1312	460
1986/87	156	3106	1333	420
1987/88	144	2639	1116	400
1988/89	81	2101	1037	440
1989/90	64	1482	808	115
1990/91	118	1293	314	330
1991/92	133	1975	677	475
1992/93	163	2058	788	499
1993/94	144	2287	1179	460
1994/95	224	2287	864	420
1995/96	197	3007	929	830
1996/97	191	2885	1571	430
1997/98	165	2348	1245	492
1998/99	168	2197	1100	500
1999/00	138	2315	933	650
2000/01	146	2164	1071	450
2001/02	140	2432	1249	475
2002/03	142	1993	988	410
2003/04	132	2540	741	535
2004/05	57	1651	783	602
2005/06	95*	975*	238	400
2006/97	51*	1177*	377	410
2007/08 1)	NA			400

*** preliminary**

1) predicted

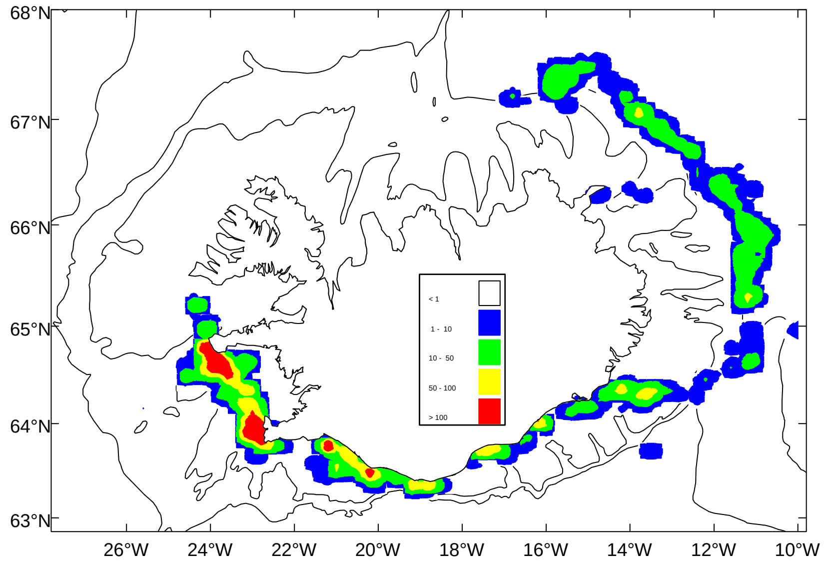


Figure 3.6.1.2.1. Distribution of the catches of the Icelandic capelin in the fishing season 2006/07 based on data from logbooks.

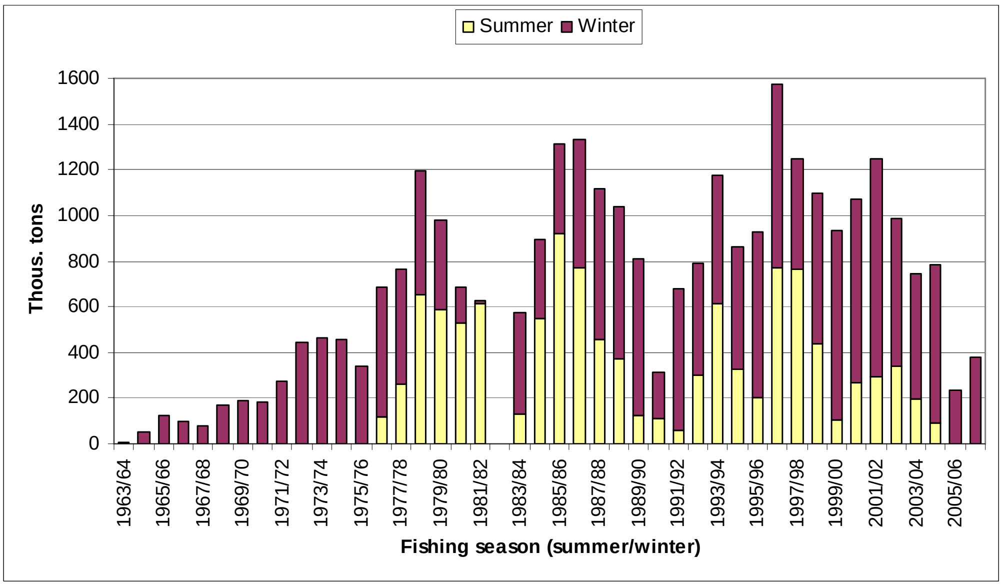


Figure. 3.6.2.1 Total catch (in thousand tonnes) of the Icelandic capelin in 1963/64-2006/07.

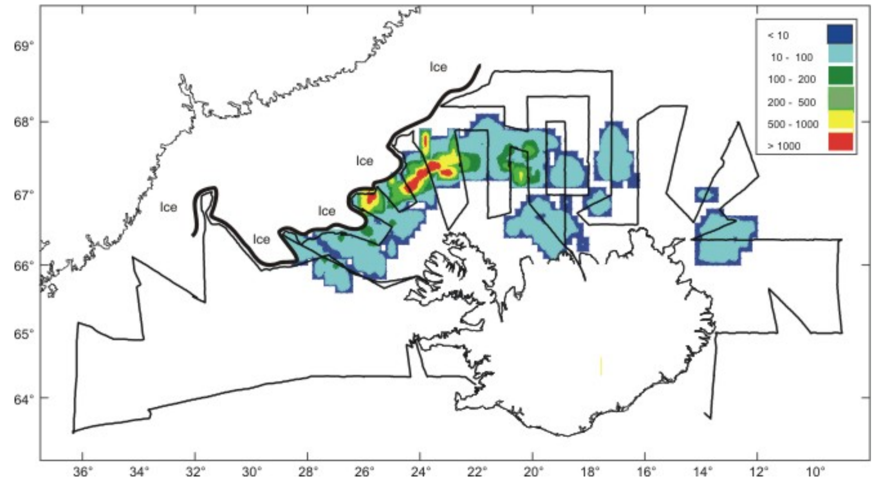


Figure 3.6.3.2.1. Cruise tracks, relative densities (as SA values) and the ice edge during an acoustic survey by r/v Arni Fridriksson in November 2006.

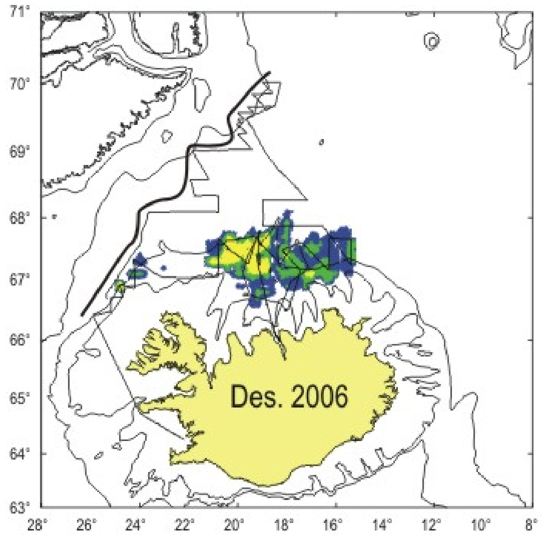


Figure 3.6.3.3.1. Capelin survey in December 2006 to check capelin reports from a groundfish otter trawler fishing for cod. Very small amount of capelin were recorded.

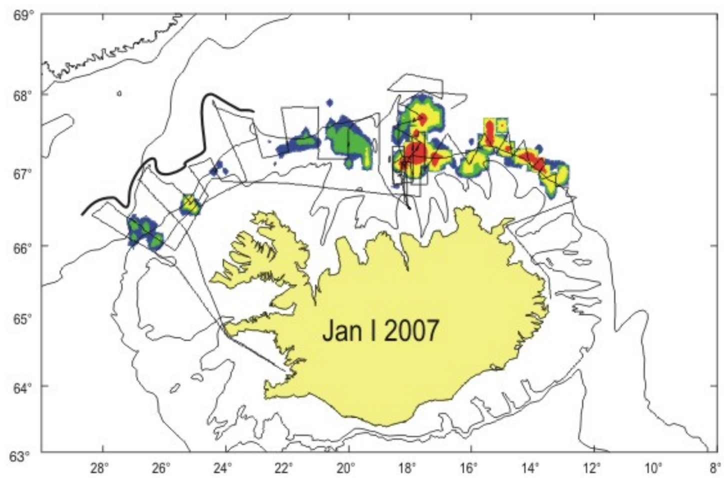


Figure 3.6.3.3.2. Acoustic assessment of capelin by r/v Arni Fridriksson and r/s Bjarni Saemundsson in the first days of January 2007.

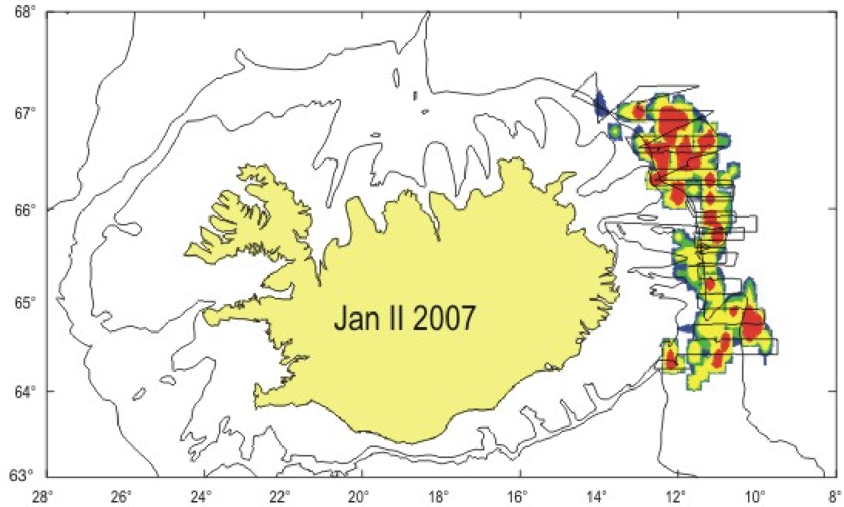


Figure 3.6.3.3.3 The main capelin assessment survey carried out with the r/v Arni Fridriksson in late January 2007.

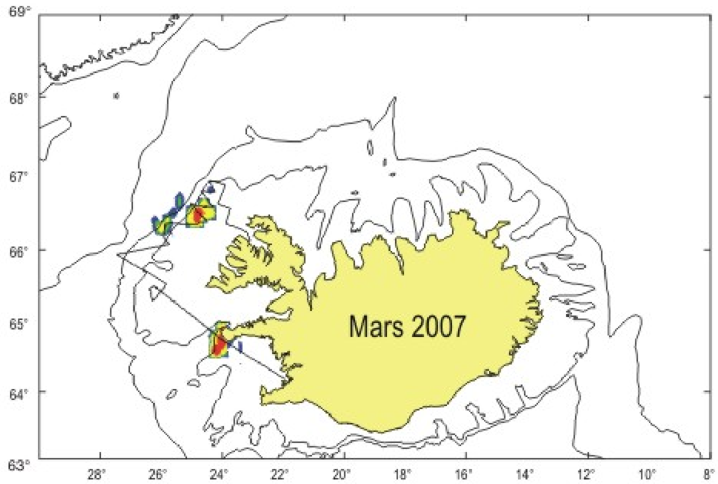


Figure 3.6.3.3.4. An attempt to assess reports of a western migration on r/s Bjarni Saemundsson.

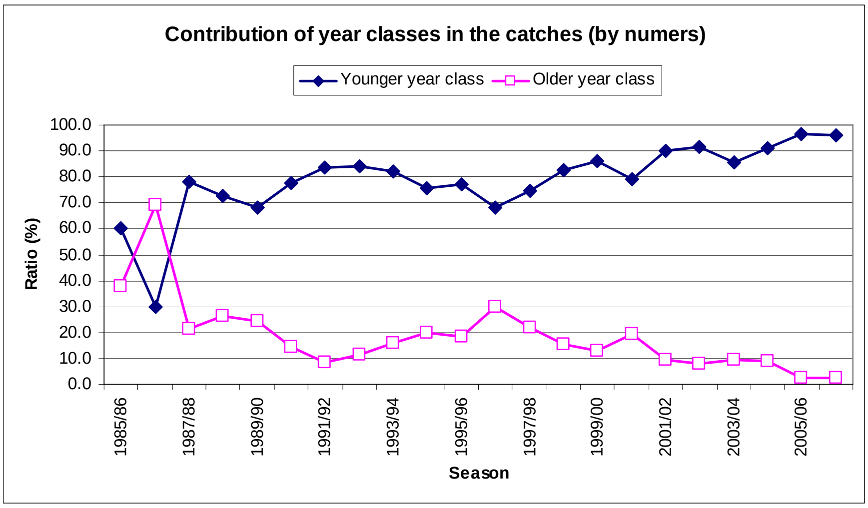


Figure 3.6.5.2.1. Contribution (as ratio) of 2 year old (younger year class) and 3 year old (older year class) capelin in the catches in the seasons 1985/86-2006/07.

4 Overview on ecosystem, fisheries and their management in Greenland waters.

4.1 Ecosystem considerations

The marine ecosystem around Greenland is located from arctic regions to subarctic regions. The watermasses in East Greenland are composed of the polar *East Greenland Current* and the warm and saline *Irminger Current*. As the currents rounds Cape Farewell at Southernmost Greenland the Irminger water subducts the polar water and mix extensively and forms the relatively warm *West Greenland Current*. 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. Depending of the relative strength of the two East Greenland currents, The Polar Current and the Irminger Current, the marine environment experience extensive variability with respect to temperature and speed of the West Greenland Current. 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 is the most prominent example of such a change.

In resent years temperature have increased significant in Greenland water to about 2^{o}C above the average for the historic average, with historic high temperatures registered in 2003 (50 years time series). Recently increased growth rates for some fish stocks as indicated from the surveys might be a response of the stock to such favourable environmental conditions. As has been observed with the Icelandic cod stock an important interaction between cod and shrimp and a historic large shrimp biomass is in West Greenland water in present time would make feeding conditions optimal for fish predators (Hvingel 2004). Data from the Greenlandic survey indicate an increase in abundance of Blue whiting from 1998-2002 to 2003-2005. Potential changes in other warm-water species could not be investigated due to the low catchability of these species by the survey.

4.2 Description of the fisheries

Fisheries targeting marine resources off Greenland can be divided into inshore and offshore fleets. The Greenland fleet has been built up through the 60s and is today comprised of 450 ships with an inside motor and a large fleet of small boats. It is estimated that around 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 by GRT 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 difference between the fleet in the northern and southern part of Greenland. In south, were the cod fishery was a major resource the average vessel 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, roughhead grenadier and in recent years cod in Disko Bay.

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.

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 seabirds (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 resources are exploited by several nations mainly EU, Iceland, Norway and Russia,. 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 waters. In East Greenland the fishery has been increasing in recent years due to a small longline fishery and limited commercial “experimental fisheries” using trawl. 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 use shrimp trawls 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). Some segments of the longline fleet target Atlantic halibut.

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. Since 2004 this fishery has ceased due to the low capelin biomass. 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. From 1992 to 2004 the biomass of offshore cod at West Greenland have been negligible. In 1969 the offshore shrimp fishery started and has been increasing ever since reaching a historic high of close to 150 000 t in 2003. Recent catches however indicate a decline in the shrimp fishery.

4.4 Description of the most important commercial fishery resources – except mammals

4.4.1 Shrimp

The shrimp Pandalus borealis stock in Greenland waters is considered in good condition although a decrease in estimated biomass of the West Greenland has been observed over the last two years. The stock in East Greenland is considered stable based on available information. The 2003 West Greenland biomass (690 000 tonnes) was the highest in the time series but has since then decreased (2004; 640 000 tonnes and in 2005; 550 000 tonnes) but biomass-levels are still regarded as non-critical.

4.4.2 Snow crab

The biomass of snow crab in Greenland waters has decreased substantially since 2001. Snow crab has been exploited inshore since the mid 90s and offshore since 1999. Total landings have been reported to amount to 5 511t in 2005 down from 15 139t in 2001. The majority of the catch in recent years has been taken from the small vessel fleet fishing offshore. After several years of decreasing CPUE it now appears to have stabilized at low levels in the majority of areas. .

4.4.3 Scallops

The status of scallops in Greenland is unknown. From the mid 80s to the start 90s landings were between 4-600 t yearly. Since then landings have increased to around 2000 t. 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 5515 t where only 300 t 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. The information on spawning offshore is limited as the survey takes place well after the spawning period. However offshore spawning has been inferred of East Greenland since 2004 and in spring 2007 dense concentrations of unusual large cod were actively spawning off East Greenland. 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, high temperatures and spawning cod in East Greenland) cod could re-colonise the offshore areas and therefore a recovery plan is urgently required to rebuild the stock.

4.4.6 Redfish

Advice on demersal stocks under mixed fisheries consideration.

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 component in NAFO SA 0+1 has remained stable in the last decade, sustaining a fishery of about 10 000 t annually. The East Greenland stock is a part of a complex distributed to Iceland and Faroe Islands. The recent status of this stock of is unknown, but in a longer time perspective the stock is at a low level.

4.4.8 Lump sucker

The status of the lumpfish is unknown. The landing of lumpfish has increased the last couple of years reaching close to 9 000 t in 2003. Catches has remained at that level since. 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. It is especially important to give the spawning stock of East Greenland the maximum protection to secure the spawning potential that may be able to utilize the favourable environmental conditions (large shrimp stock and high temperatures). A recovery plan is recommended to ensure a sustainable increase in SSB and recruitment. Such plan must include appropriate measures to avoid any cod by-catch in other fisheries deploying mobile gears capable of catching cod. Observers must monitor functionalism of measures.

Reference

Gordon, J.D.M., Bergstad, O.A., Figueiredo, I. And G. Menezes. 2003. Deep-water Fisheries of the Northeast Atlantic: I Description and current Trends. J. Northw. Atl. Fish. Sci. Vol: 31; 37-150.

East Greenland

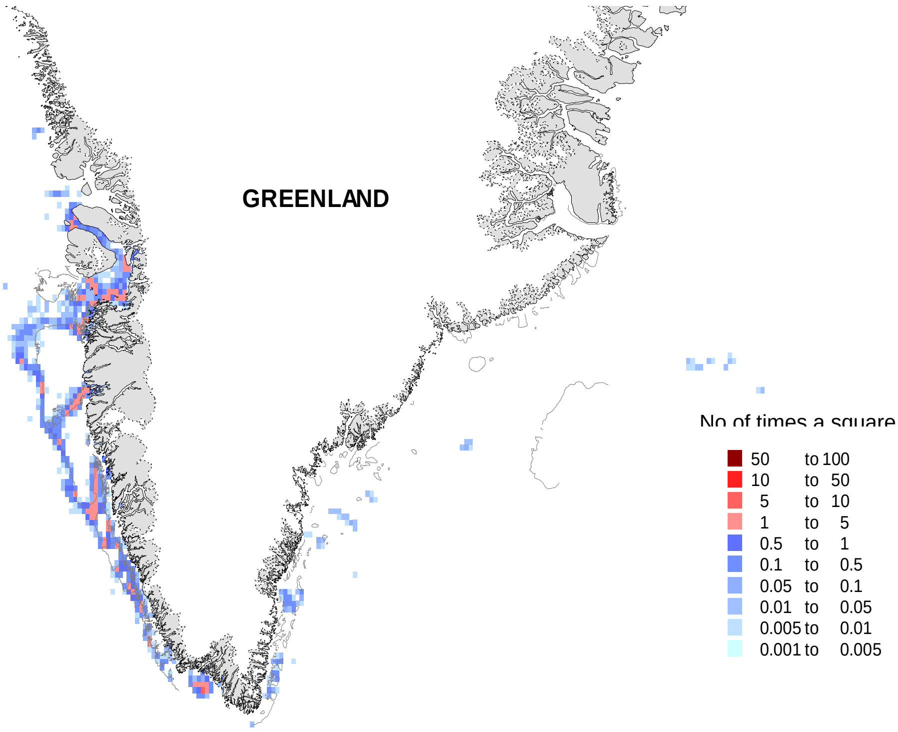
OFFSHORE:	VESSELS	TONNES	DICARD
Capelin	70	117838	0
G.halibut	26	8026	10
A.Halibut	10	248	0
Shrimp	28	7349	11
S. mentella Pel.	35	10680	11
Redfish sp.	2	106	0
S.Marinus	19	366	0
Roundn. grenadier	19	104	6
Wolffish	3	10	0
Mixed quota	3	485	1

West Greenland

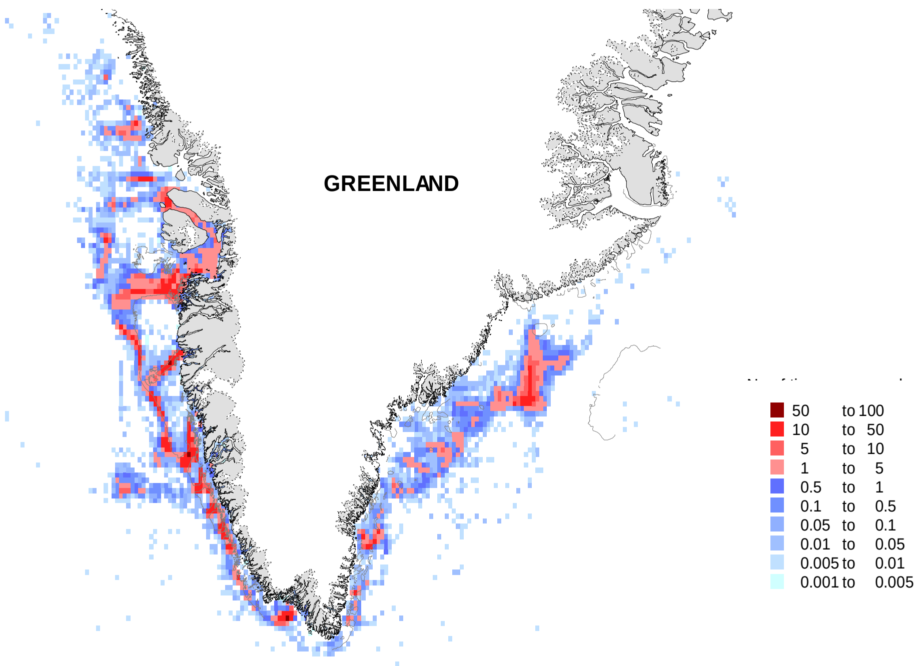
OFFSHORE:	VESSELS	TONNES	DICARD
G.halibut	17	9502	18
A.halibut	1	20	0
Shrimp	20	58623	9
Redfish sp.	14	2349	0
Roundn. grenadier	7	46	30
Cod	10	728	0
Inshore:			
Snow crab	12	2802	41
Scallops	4	2215	0

***vessels number included vessels from EU, Norway and Iceland**

Impact of shrimp fishery in 2002



Disturbance by fishing gear during the history of logbooks (~ 20 years)



5 Cod Stocks in the Greenland Area (NAFO AREA 1 and ICES Subdivision IVb)

5.1 Stock definition

The cod found in Greenland is derived from three separate “stocks” that each is labelled by their spawning areas: I) offshore cod spawning of East and West Greenland waters; II) cod spawning in West Greenland fiords cod and III) Icelandic spawning where the offspring occasionally are transported in significant quantities with the Irminger current to Greenland water (fig. 5.1.1).

Offshore, the offspring is carried pelagically over vast distances: the Icelandic offspring generally settles off East and South Greenland, the offspring from the Greenland offshore spawning is believed mainly to settled off the West Greenland coast (Wieland and Hovgård, 2002). Significant larval drifts from Iceland occur irregularly; e.g. in 1973 and 1984 (Buch et al, 1994, Schopka, 1994). Spawning cod is documented in many fjords between 64 and 67°N in West Greenland (Hansen 1949, Smidt 1979, Buch *et al*., 1994). Recent summaries of the stock structure and developments, that provide references to the more detailed studies includes: Wieland and Storr-Paulsen, 2005, Storr-Paulsen et al. 2004, ICES 2005, Wieland and Hovgård, 2002, Buch et al. 1994.

Tagging information show that cod tagged in the fiords are predominately recaptured in the same fiord as tagged or in the adjacent coastal areas (Storr-Paulsen et al, 2004, Hovgård and Christensen, 1990, Hansen, 1949). Bank tagged cod are predominately recaptured on the Banks and to a lesser extent in the coastal area. The returns of the cod tagged in the coastal areas are in contrast found distributed over all the three habitats. The tagging experiments thus indicate that the offshore and inshore cod are generally separated but that the coastal area is a zone of mixing. A considerable number of tags are returned from Icelandic waters, especially from tagging in the coastal areas and the banks in East and Southwest Greenland (ICES XIV, NAFO Div. 1EF).

5.2 Information from the fisheries

5.2.1 The development in catches

The inshore Greenland commercial cod fishery in West Greenland started in 1911 by opening the cod trading at localities where cod seemed to occur regularly. The fishery expanded over the next decades through a development of a number of new trading places. 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). From 1993 to 2001 the inshore catches were low – in the range 500-2 000t. Inshore catches have since increased to reach 6000 tons in 2005.

In 2006 the inshore catches amounted to 7400 t. The catches were taken all along West Greenland from NAFO Div. 1A to 1F. Catches were highest between June and September which is the main period of the pound-net fishery.

The offshore fishery took off in 1924 when Norwegian fishers discovered dense concentrations of cod on Fylla Bank. The West Greenland offshore fishery rapidly expanded to reach 120 000 t in 1931 – a level that remained for a decade (Horsted 2000). During World War II landings decreased by 1/3 as only Greenland and Portugal participated in the fishery. Less is known about the offshore cod fisheries off 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 5.2.1.). 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. Annual catch level of 40 000 t was only exceeded during short periods due to the occurrence of the strong year classes 1973 and 1984. During 1989–92 the fishery, which almost exclusively depended on the 1984 year-class shifted from West to East Greenland. The offshore fishery completely collapsed in 1993. From 1994 to 2001 no directed offshore cod fishery has taken place. From 2002 limited quotas have been allotted to Faeroese and Norwegian vessels and in 2005-2006 Greenland trawlers were allowed limited quotas for experimental cod fishery. Offshore catches of cod increased from 400 t in 2004 to 850 t in 2005.

The offshore catches in 2006 amounted to 2,400 distributed as: Long-line 485 t in East and 241 t in West Greenland; Trawl 1496 t in East and 167t in West Greenland. In addition 5t was landed as by-catch in fisheries targeting Greenland Halibut.

The catch rates in the 2006 Greenland experimental cod fisheries have been very high especially in East Greenland.

5.2.2 Length and age distributions, catch and weight at age in 2006

There is an overall lack of landing sample information from the 1990's were the cod fishery was very low. Length frequency information is generally lacking for the offshore fisheries where cod was mainly taken as a by-catch. For the inshore fisheries length frequency information is lacking for several years.

In 2006 the sampling level was considerable. In the inshore fisheries length frequencies was measured from 38 samples from NAFO Div. 1B and 1DEF. The total number of measured cod amounted to 9500. The length distribution was splitted onto age groups by ALK information from the inshore gill-net survey. Size and age distribution and catch at age are aggregated in div. 1ABCD and 1EF. The age and length distributions are provided in fig. 5.2.2.

The limited offshore fishery in 2006 was conducted by 4 trawlers and 2 long-liners. The areas fished are shown in fig. 5.2.3. Length frequency information was collected on 2 trawlers and 1 long-liner. A high number of hauls/sets have been sampled from both vessel types in East and West Greenland with a total numbers of fish measured of 13 000 cod. The length distribution was splitted onto age groups by ALK information from the German and Greenland surveys. The age and length distributions are provided in fig. 5.2.4 .

5.2.3 Documentation on spawning off East Greenland in 2007

The German and Greenland trawl surveys takes place well after the spawning period and reliable maturity information can therefore not be sampled on the regular surveys. The NWWG therefore in its last report used maturity information provided in Horsted et al. 1983. The recent years offshore fisheries has however documented (skippers reports and photos, cod roe production figures) dense concentrations of large spawning cod off East Greenland at least since 2004. To rigidly document the spawning the Greenland Institute of Natural resources dispatched an observer on a trawler fishing within the experimental cod fisheries framework.

The fishery took place April 7-14, 2007, in the Kleine Bank/Holsshoe area (aprox. 64°30' N, 37°20' W) at depth 150-400 m, targeting dense concentrations of mature cod (average catch rates in 14 hauls were 25 t per hour). The cod was large with an average size of 88 cm(fig. 5.2.5). 510 cod was maturity staged according to Tomkiewicz et al, (2002) of which 85 percent was classified as spawners. The majority of the mature fish were actively spawning (stages V-VI). Maturity by age is not available yet but the L-50% maturity (both sexes combined) is estimated at ca. 60 cm. The spawning area is historical well known being the area of highest cod egg concentration in the Northwestlant programme in 1963 (Wieland and Hovgård, 2002). The limited offshore fisheries that have taken place during spring in the most recent years have been confined to this area and no information is available on spawning in other areas

5.2.4 Quota settings for 2007

Greenland companies have been given licenses for a total of 3000t of cod to be fished offshore under the framework of commercial experimental fisheries. This framework implies that the fishing areas and periods are based on the advise from the Greenland Institute of Natural Resources who arrange for the sampling and measuring activities onboard. . The catches north of 63N has bee restricted to 1000t to be taken during the spawning period to secure that the scientific objectives of assessing the spawning conditions are met. Quotas have also been allotted to: the Faeroe Islands (250t) Norway (625t) and the EU (1000t). The expected 2007 offshore cod landings are thus totaling 4875t..

The inshore cod fisheries are not constrained by quotas.

5.2.5 Discards in the shrimp fisheries

Use of sorting grids in the shrimp fisheries has been compulsorily in the shrimp fisheries since 2002. Discards levels in this fishery is assessed in an ongoing observer project that since 2006 have covered nine trips (vessels from three nationalities, fishing in NAFO Div. 1BCDE and ICES XIV with a total of 259 hauls examined). The average level of fish discards as measured relative to the shrimp catch is found at 2.6 % (range 1.2%-5.6%). Most of the discard consists of non-commercial species and capelin. Average discard of commercial species were: Redfish 0.52%, Greenland Halibut 0.33% and cod 0.07% (WD 16, 2007).

5.3 Surveys

5.3.1.1 Results of the German groundfish survey off West and East Greenland

Annual abundance and biomass indices have been derived from 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. Figure 5.3.0 indicate names of the 7 strata. 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, 1994 and 2006 the survey coverage was incomplete off East Greenland and in 1995 and 2002 in West Greenland partly due to technical problems. In 2006, stratum 5 was only fished by 3 hauls due to bad weather conditions.

Cod stock abundance indices

Table 5.4 lists abundance and biomass indices for West and East Greenland, respectively, and combined for the years 1982–2006. Trends of the estimated biomass and SSB index for West and East Greenland are shown in Figure 5.3.1,. In 2005, the spawning stock biomass index was revised and based on survey biomass index 1982-2006, and historical maturity data presented by Horsted et al. (1983). The figure illustrates the pronounced increase in stock abundance and biomass indices from 1984 to 1987 due to good recruitment of the predominating year classes 1984 and 1985. Since 1988, stock abundance and biomass indices decreased dramatically by 99% to only 5 million fish and 6 000t in 1993. Some rises have been observed since 2005 but the present SSB index of 31 000 t is still considered low.

The 2006 survey was characterized by an unusual variability in catch-rates that is reflected in the high 2006 survey abundance confident interval of 109 %. Moreover, a stratum 5 that last year accounted for 36% of the abundance and 20% of the biomass was only fished by 3 stations in the northernmost part of the strata.

The 2006 survey results confirmed previous findings indicating a strong incoming year class 2003. At age 3, this year class constituted almost 80 % of the present stock index of 280 million individuals. The stock biomass index was 239.000 tons. Both indices represent the highest stock sizes in 15 years. The year class 2003 at age 3 in 2006 is assessed as the strongest year class since year class 1984. The 2003 year-class size were estimated at 83% of the size of the 1984 year-class as age 2. At age 3 in 2006 the size of the 2003 year-class is estimated at 32%. Estimates based on age 3 cod is generally considered the more reliable as cod is then fully recruited to the survey . This may, however, not imply here due to the high confidence intervals seen in 2006.

The survey density is calculated as catch numbers raised to standard tow duration (catch numbers*0.5hour/towed time) divided by 'a standard sized covered area' derived as wingspread (=0.022 km)*vessel speed (=4.5*1.8 km/hour)*standard tow duration (=0.5hour). Underestimates may be obtained when the actual towing speed is less than 4.5 kn.

The practice of not including strata abundances and biomasses for strata with less than 5 hauls implies that abundance and biomass for these areas is implicitly assumed at zero. This compromises total abundance/biomass estimates in years with reduced coverage.

Cod age composition

Age disaggregated abundance indices for West, East Greenland and total are listed in Tables 5.5–7, respectively, and are based on 1773 individual age determinations in 2006. The year class 2003 at age 3 is clearly dominating survey catch. The recruiting year classes 1998-2002 are considered weak as compared to the strong 1984- and 1985-year classes. Besides year class 2003, year classes 2004 at age 2 and 2005 at age 1 are above average and thus likely indicate further potential for stock recovery. Age groups 1 and 2 seem are likely sampled quantitatively and thus represent a reasonable index for juvenile cod. Year classes 2004 and 2005 are mainly distributed along the coast of West Greenland (Fig. 5.3.2). 0-group distribution has changed between 2003 and 2004-2006. In 2004 and 2006, 0-group specimens were also found in considerable numbers along the west coast of Greenland. In 2003, 0-groups were mainly encountered in the easternmost part of the survey area adjacent to Icelandic waters. In 2005, 0-group specimens appeared with high densities both in East and West Greenland waters. 0-group distributions may be considered a proxy for the setling area, but 0-group abundance is not considered representative in quantitative terms in the German survey (see section 5.1).

Cod 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 5.3.3 and 5.3.4 respectively for the period 1982–2006. They reveal pronounced area and temperature effects. Age groups 3–10 years off East Greenland were found to be in average 15% larger 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. From 2005 to 2006, values indicate a slight decrease in size for all ages at East Greenland and a decrease in size for ages 1 to 4 at West Greenland, but a further increase in size for ages > 4 at West Greenland. 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.

5.3.2 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 5.3.6). 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.

The survey is conducted by R/V Paamiut that until 2004 was equipped with a 3000/20-mesh Skjervøy with a twin cod end. In 2005 the Skjervøy trawl were replaced with a Cosmos trawl (Wieland and Bergström, 2005). Calibration experiments with the two the trawls were conducted in 2004 and 2005 and a formal analysis of conversion factors were established for shrimp (Rosing and Wieland, 2005). The catches of cod in the calibration experiments were variable and generally low (average 10 cod per tow). Two independent sets of experiments suggested a between gears catchabilitiy difference (q-new/q-old) at 1.6 and 1.8, respectively. The catchability of the cosmos trawl was thus set as 1.7 times the Skjervøi. Of this difference a small fraction can be attributed to an increase in the trawl wingspread that is already explicitly included in the abundance estimate. This imply that an additional gear correction of 1.63 need be employed when expressing the survey indices for 2005 and 2006 in the Skjervøy trawl units. Last years survey correction reporting the 2005 survey results has been re-calculated using the new correction factor.

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 arbitrarily set at 1.0, implying that estimates are indices of abundance and biomass. Confidence intervals (CI) were set at the 95% level of significance of the stratified mean.

Survey stock biomass and abundance indices

In 1992 the biomass decreased by more than 95 % to only 250 t and remained at this low level until recent years (Table 5.9). Since 2001 a slight improvement was detected in the biomass index and in 2005 the biomass level increased tenfold compared to 2004, estimated to be close to 24 200 t (fig. 5.3.5). The 2005 survey biomass and abundance estimates were, however, heavily influence by a single atypical haul that accounted for more than 50% of the total biomass.

In 2006 biomass and abundance indices were estimated at 16 400 tons and 45 mill. individuals. These values are lower than in 2005 (38% and 9 %, respectively). Both biomass and abundance was concentrated in the southernmost areas, i.e. 73% of the biomass and 63% of the abundance found in NAFO Div. 1F (table 5.8 and 5.9, fig 5.3.6). The year-classes 2003 dominate the survey catches accounting for 63% of the total abundance. This year-class was, as last year, concentrated in the southernmost areas – NAFO 1F (fig.5.3.7). The 2005 year-class (age 1 ~ length 15-20 cm) that is not fully recruited to the survey appear at the highest value on record. The change in survey gear in 2005 may, however, compromise face value comparisons. The 2005 year class is distributed more northerly ~NAFO 1BCDE (fig. 5.3.7).

Average length, weight and maturity stages as measured from the ALK samples are provided in tables 5.16-5.18. The low maturity indices for the older individuals indicate that spawning takes place well before the survey period.

5.3.3 Offshore Survey information on haddock occurrence useful for stock identification

Haddock is rarely seen in the west Greenland area and the species is not known to spawn in Greenland waters. For this reason the occurrence of small haddock has been used as an indicator for current conditions that have allowed haddock-and hence also cod- to be carried from Iceland to Greenland waters (Hovgård and Messtorf, 1987; Dickson and Brander, 1993).

Haddock was seen abundant in association with the large 1984 year-class of cod but were scarcely seen in the German survey from then and until 2000 (Fig. 5.3.9) when mainly seen in one large catch at East Greenland (fig. 5.3.12). Few haddock were found in 2001 and 2002. Haddock abundance peaked in 2003 and declined since then. Based on age readings undertaken from 2004 to 2006 and length-frequency distributions (LFDs), the major component in 2003 was 0-group haddock with a length of about 13.5 cm (fig. 5.3.11). 0-groups also appeared in the surveys in 2004-2006. LFDs indicate that the haddock off West Greenland grew from age 0 in 2003 to age 3 in 2006 at a length of 35-40 cm. This is in accordance with the trend in haddock biomass, which peaked in 2005 (Fig. 5.3.9).

The numbers of haddock caught in the Greenlandic surveys has been very low until 2002 but has occurred more frequent since then, notably in 2004 (fig. 5.3.8). The Haddock catches has not been aged but the length distribution characterized by modes around 22 cm in 2004 and 30 cm in 2005 (fig 5.3.10) suggest an inflow from year-class 2003.

A small amount of haddock, 950 kg, was landed from the Greenland experimental cod fisheries conducted in Southwest Greenland (NAFO Div. 1F) in October-December, 2006. Observer information (29 haddock) indicate a mean haddock length of 40 cm, the sample was however, taken in a commercial trawl (140mm mesh-size in the cod-end).

5.3.4 West Greenland young cod survey

A survey using gangs of gill nets with different mesh-sizes has been developed and used since 1985 with the objective of assessing the abundance of age 2 and age 3 cod in the inshore areas. Selectivity and fishing power estimates are documented in Hovgård (1996) and Hovgård and Lassen (2000). The fishing power dependents on the net material. It has been impossible to substitute damaged net section with the original net materials and substitution with alternative net materials were therefore made in 2004 and in 2006. Comparative fisheries indicate that the change in net materials has resulted in increased fishing power but no rigid analysis has yet been carried out. The survey has been focusing on the inshore areas near Sisimiut (NAFO Division 1B) and Nuuk (NAFO Division 1D).

The gill-net abundance indices increase in 2006 for both areas and for both age 2 and 3 and the present indices are generally above the levels observed during the 1990’s (table 5.14, Fig. 5.3.13). The successive change of net materials during the recent years may however have contributed to the increased catch rates. The present abundance indices are below those found in the mid 1980’s when the large 1984 year class were pre recruits. This year-class, that is believed drifting from Icelandic spawning grounds, was observed in all inshore areas south of Div. 1B (see e.g. Storr-Paulsen et al, 2004) and gave rise to a considerable fishery for the artesian fisheries that predominately take place inshore.

5.3.5 Stock assessment

Historic assessment's

Before the collapse of the cod stock in the 1990's cod in East Greenland were assessed by the ICEC East Greenland Cod Working Group whereas cod in NAFO Div. 1 (West Greenland area) was assessed by the Scientific Council at NAFO. The two assessments were generally worked up by the same group of scientists and included catches in both inshore and offshore areas. After the offshore stock collapse futile attempts were made to assess the inshore stock, where a limited fishery still occurred, only using inshore catch at age information. Attempts were similarly made for conducting an analytical assessment of the offshore stock using only offshore catches (see e.g. ICES 1996/Assess:15). The attempts to split the inshore and offshore assessments suffers from two weaknesses: 1) It relies on the crude assumption that the inshore fisheries only catch cod from the inshore spawning stock and *visa versa* – an assumption that can not be supported and 2) was implemented using only German age composition information to break down the offshore catches into catch at age. Assessments of the offshore stock after 1996 have been rejected by ACFM due to insignificant catches. At the present NWWG meeting it was decided to provide a rough estimate of the stock size by scaling the German survey catches to the absolute (i.e. VPA) scale. The approach is to estimate survey catchability by relating estimated historical VPA abundances to the concurrent survey abundance found in the German survey and to apply these catchability coefficients to the 2006 German abundance estimates.

Total Greenland catch-at-age and weight at-age was derived by combining information from East and West Greenland from ICES, 1995. As in some previous assessments (e.g. ICES 1994) M was set at 0.2 and an E-coefficient, to account for emigration, of 0.1 per year was added to M for all age groups of age 5 and older. The magnitude of E should be considered arbitrary (e.g. note the NWWG in 1992 applied an E of 0.7 for the 1984 year-class at age 6 in an attempt to more concrete account for the migration to Iceland). An XSA covering the 1965-1995 period was run tuned with the German survey information 1982-1995. The VPA estimates from this run were in essence similar to those available in 1994. Age group 1 and 2 stock abundances were derived by 'back discounting' year-classes age 3 strength by exp(0.2). Catchability coefficients were calculated for each age group by linear regressing VPA estimates on Survey abundances (model without an intercept term), see (fig. 5.3.14). The survey abundance estimates for 2006 (table 5.15) do not include the abundance from stratum 5.1 and 5.2 where only 3 hauls were made. The abundance from these areas was estimated at 67 mill cod that was added to the abundances from table 5.15. Stock abundances were subsequently calculated by multiplying the 2006 survey abundance by the catchability coefficients. Applying the mean-weight-at-age observed in 2006 and a historical maturity ogive allows B3+ and SSB to be derived (table 5.15). The estimates suggest that the present size of the cod stock is similar to what was experienced in the early 1980's before the recruitment of the strong 1984 year-class (fig. 5.3.14). The documentation of the scaling exercise is available in the NWWG stock folder.

5.4 Climate effects

Cod is reaching its ecological northern boundary off Greenland and stock development is considered sensitive to changes in the climatic conditions. Stock parameters are strongly affected by environmental conditions and are in general characterized by slow growth, low conditions late maturation and highly variable recruitment. (Lloret and Rätz 2000, ICES 2002). Both air and water temperature has been increasing from low levels around 1990 and are now found at historical high levels.

5.5 State of the stock

The two survey abundance indices both indicate that the cod stock is presently significantly above the very depressed state that was experienced in the 1990’s. The up scaling of the German survey estimates however also suggests that the total biomass and SSB is still low compared to the 1965-1990 historical levels.

The increase in abundance experienced since the late 1990’s appear to be affecting all stock components found in Greenland

Off East Greenland an offshore spawning stock has been building up in the most recent years and spawning has been inferred since 2004. The observer observations, April 2007, showed very dense spawning shoals (CPUE of 25t hour) of large cod (mean length 88 cm) that were in active spawning. The spawning area is historical well known being the area of highest cod egg concentration in the Northwestlant programme in 1963 (Wieland and Hovgård, 2002).

Both surveys indicate that all year-classes since 2002 are larger than any of the year-class since the 1985 year-class. The 2003 year-class is dominating in both surveys, accounting for 63% and 80 % of the total abundance, respectively. The German surveys indicate that the year-class size is approximately a third of the 1984 year-class. The southern distribution of the 2003 year-class, found in both surveys, and the concurrent occurrence of haddock of the same year-class suggest that this 2003 year-class is dominated by cod that have drifted from Iceland.

The knowledge on the various local fiord spawning cod is limited. The catch has increased gradually from les than 1000t in 2000 to 7400t in 2006. The abundance indices in the inshore gill-net survey show higher recruitment in recent years than were experienced in the 1990’s.

5.6 Management considerations

Although the three cod stock components cannot be assessed separately management should utilize the inferences available on the development of the individual stocks.

The offshore Greenland stock that have been fished only lightly during the last 15 years now contain dense concentrations of large spawning cod in the East Greenland area north of 63N. The offspring of these fish drifts with the Irminger/West Greenland current to settle off West Greenland. This spawning stock should be given the maximum protection to secure the spawning potential that may be able to utilize the favourable environmental conditions, especially the recent temperature increase, that have developed over the last decade.. If experiment fisheries are implemented to assess the development of spawning and the extension of the spawning areas such fisheries need be limited and designated to concrete research needs.

The cod concentrations presently found off south Greenland, *inter alia* the 2003 year-class, show the characteristics usually associated to cod that have drifted as fry to Greenland from spawning areas off Iceland. If of Icelandic origin these cod may be expected to migrate back to Iceland when mature as indicated by historical tagging in the South Greenland area and as inferred for the 1984 year-class (see e.g. ICES, 1992). It is uncertain if cod originally drifted from Iceland contributes to spawning in the Greenland area.

In the recent years most of the inshore fisheries have taken place north of NAFO Div. 1EF where the offshore surveys have located most cod. For that reason it is considered most likely that at present the inshore fisheries relies predominately on cod from the inshore spawning populations. The stock status of the local fiord spawning cod is not known although the recent increases in catches may indicate that they are increasing.

5.6.1 Comments on the assessment

The working group discovered significant differences between abundance information from the German survey used in the report and similar information previously submitted to the Greenland Institute of Natural Resources. Although considerable effort was devoted to clarify these ambiguities the data problems could not be resolved at the meeting. The group recommends a thorough data evaluation be carried out before next years meeting to ensure full transparency in the survey abundance estimations. The practice of not including strata abundances and biomasses for strata with less than 5 hauls implies that abundance and biomass is implicitly assumed at zero. This compromises total abundance/biomass estimates in years with reduced coverage.

The introduction of a new survey trawl in the Greenland offshore survey in 2005 combined with low catch levels in the trawl calibration experiments implies considerable uncertainties regarding trawl conversion factors. Irrespectively of this uncertainty there is no doubt that abundance was very low prior to 2005.

Sampling levels of the commercial fisheries has been low in the years with little fisheries. However, in 2006, the number of samples as well as the number of fish measured has been increased very considerable.

The historical information on maturity at age is limited as the two available abundance surveys are conducted well after the spawning period. An ongoing Greenland program is expected to produce considerable maturity information in the coming year.

5.6.2 References

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Table 5.1 Nominal catch (t) of Cod in NAFO Sub-area 1, 1988-2006 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]	2005
Faroe Islands						
Germany						
Greenland	764	1680	3698	3989	4948	
Japan						
Norway				693 [5]		
UK						
Togo				533 [5]		
Total	764	1680	3698	5215		
WG estimate	-	-				6118

COUNTRY	2006
Faroe Islands	
Germany	
Greenland	
Japan	
Norway	
UK	
Togo	
Total	
WG estimate	7769

[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 5.2 Nominal catch (t) of cod in ICES Sub-area XIV, 1988-2006 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	2005
Faroe Islands					329	205
Germany	3	92	5	1		
Greenland		4	232	78	23	1
Iceland	-	210				
Norway	- [5]	43	13		5	507
Portugal	-	278				
UK (E/W/NI)	149	129				55
United Kingdom			34			
Total	152	756	284	79	357	
WG estimate	-		448[6]	294[7]		836[8]

[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

[8]) Includes 68t from Norway

Table 5.2 Cont. Nominal catch (t) of cod in ICES Sub-area XIV.

COUNTRY	2006
Faroe Islands	
Germany	
Greenland	
Iceland	
Norway	479
Portugal	
UK (E/W/NI)	
United Kingdom	
Total	
WG estimate	1981

Table 5.3 Cod off Greenland (inshore and offshore components). Catches (t) from 1924 – 2006 as used by the Working Group, inshore and offshore by NAFO division 1B and 1D, offshore divided into East and West Greenland. Until 1995, based on Horsted (1994, 2000). * indicates preliminary results.

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 5.3 Cont. Cod off Greenland (inshore and offshore component). * indicates preliminary results.

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*
2005	2351	1162	6043	773	75	847*	6890*
2006	1682	943	7388*	1981	408	2389	9777*

Table 5.4 Cod off Greenland (offshore component), German survey. Abundance (1000) and biomass indices (t) for West, East Greenland and total by stratum, 1982-2006. Confidence intervals (CI) are given in per cent of the stratified mean at 95% level of significance. () incorrect due to incomplete sampling. Spawning stock numbers (SSN, x1000) and biomass indices (SSB, tons) based on survey indices, 1982-2006, and historical maturity data.

	Abundance					Biomass				
YEAR	WEST	EAST	TOTAL	CI	SSN.	WEST	EAST	TOTAL	CI	SSB.
1982	92276	8090	100366	28	16661	128491	23617	152107	25	47868
1983	50204	7991	58195	25	14392	82374	34157	116531	25	48114
1984	16684	(6603)	(23286)	32	6255	25566	(19744)	(45309)	34	21463
1985	59343	12404	71747	33	9404	35672	33565	69236	39	29168
1986	145682	15234	160915	32	11291	86719	41185	127902	26	40878
1987	786392	41635	828026	59	24127	638588	51592	690181	63	55727
1988	626493	23588	650080	48	28940	607988	52946	660935	46	48997
1989	358725	91732	450459	59	63159	333850	239546	573395	46	127083
1990	34525	25254	59777	43	16669	34431	65964	100395	34	35871
1991	4805	10407	15213	29	6992	5150	32751	37901	36	19400
1992	2043	(658)	(2700)	50	238	607	(1216)	(1823)	69	752
1993	1437	3301	4738	36	636	359	5600	5959	41	2560
1994	574	(801)	(1375)	36	224	140	(2792)	(2930)	68	1009
1995	278	7187	7463	93	1415	57	15525	15581	155	7932
1996	811	1447	2257	38	308	373	3599	3973	56	1237
1997	315	4153	4469	75	910	284	13722	14007	90	3663
1998	1723	1671	3394	54	439	130	4348	4479	91	1674
1999	912	2769	3681	34	358	240	3917	4157	62	1747
2000	1926	4816	6742	36	550	570	4778	5349	40	2208
2001	8160	7604	15764	39	1120	2666	15271	17937	42	3955
2002	4121	9691	13812	41	2413	2110	19726	21836	51	8299
2003	5632	19904	25537	45	6060	2264	50867	53131	73	23879
2004	31607	17540	49147	58	4406	6284	32392	38676	38	15585
2005	62774	79455	142230	35	6409	25217	109739	134955	39	33287
2006	219856	(62933)	282789	109	8773	146496	(83287)	229783	78	30811

Table 5.5 Cod off West Greenland (offshore component), German survey. Age disaggregate abundance indices (1000), 1982-2006. *) 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
2005	217	1028	53779	6099	410	569	460	37	23	0	0	0	62622
2006	420	4043	16294	181859	12697	598	2337	1263	113	0	0	0	219624

Table 5.6 Cod off East Greenland (offshore component), German survey. Age disaggregate abundance indices (1000), 1982-2006. *) 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
2005	188	3125	45849	12962	2508	6051	5785	2008	534	98	0	0	79108
(2006)	0	77	1469	45301	8850	2147	2978	1702	257	71	22	0	62874

Table 5.7 Cod off Greenland (total offshore component), German survey. Age disaggregate abundance indices (1000), 1982-2006. *) 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
2005	405	4135	99628	19061	2918	6620	6245	2045	557	98	0	0	141730
(2006)	420	4120	17763	227160	21547	2745	5315	2965	370	71	22	0	282498

Table 5.8 Cod off Greenland (offshore component), Greenland survey. Abundance indices (1000) for West Greenland by division, 1992-2006. Confidence intervals (CI) are given in percent of the stratified mean at 95% level of significance. Since 2005 there has been a change in survey gear. Data obtained since 2005 are corrected to the old scale. **: Preliminary results.

Year	1AN	1AS	1AX	1BN	1BS	1C	1D	1E	1F	West Gr.	CI
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
2005	0	21	62	441	91	1152	3090	3769	40525	49152	45
2006**	0	209	146	2036	691	1520	10095	1885	27945	44526	28

Table 5.9 Cod off Greenland (offshore component), Greenland survey. Biomass indices (t) for West Greenland by division, 1992-2006. Confidence intervals (CI) are given in per cent of the stratified mean at 95% level of significance. Since 2005 there has been a change in survey gear. Data obtained since 2005 are corrected to the old scale. **: Preliminary results.

Year	1AN	1AS	1AX	1BN	1BS	1C	1D	1E	1F	WestGr.	CI
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
2005	0	10	20	202	12	277	828	660	24418	26426	46
2006**	0	55	19	421	46	285	3270	365	11923	16385	33

Table 5.10 Cod off Greenland (offshore component), Greenland survey. Age disaggregate abundance indices (1000) for West Greenland, 1992-2006. Since 2005 there has been a change in survey gear. Data obtained since 2005 are corrected to the old scale. **: Preliminary results.

YEAR	0	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	4	6508
2005	566	3503	30188	11335	1961	923	638	27	7	49148
2006**	-	4210	3682	27874	6968	1396	329	53	16	44528

Table 5.11 Cod catches (t) divided to NAFO -divisions, caught inshore from vessels 50 GRT (Horsted 2000, Statistic Greenland 2006, Greenland Fisheries License Control). [1]Including 1258t transshipped from local inshore fishers to foreign vessels.[2] Including landings 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]
2005	650	2351	1137	1162	278	382	6043[2]
2006	922	1682	577	943	630	1461	7388[2]

Table 5.12 Catch at age (abundance in millions) 1985-2006, 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
2005		0.045	2.018	2.472	0.544	0.159	0.054	0.054	
2006		0.035	3.196	2.628	0.769	0.024	0.000	0.001	

Table 5.13 Weight at age in landing 1985-2006, 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)
2005		0.51	0.78	1.16	1.85	2.55	2.78	3.45	
2006		0.42	0.82	0.99	1.29	2.97		6.37	

Table 5.14: Cod abundance indices (numbers of cod caught per 100 hours net settings) by age as found in NAFO division 1B in the West Greenland inshore gill-net survey 1987 to 2006.

Years																						
Age	1985*	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1	25.6	4.1	0.2	0.2	0.71	0	0.3	0	0	4.2	1.5	0	0	2.1				30.5	1.3	32	47.2	31.9
2	22.6	245.4	121.8	32.6	109.8	108.5	3.4	42.7	21.8	7.8	114.6	28.4	14.4	7				206.5	68.2	27.5	122.6	147.8
3	0	16	232.6	129.5	82.9	107.7	131.2	9.7	22.4	18.5	18.5	40.4	7.7	4.3				72.1	68.9	28.6	35	59.7
4	5.8	8	24.5	111.4	56.8	62.4	53.3	18.4	1.6	11.7	6.7	6.8	3.2	6.2				20.7	21.2	8.9	7.1	24.4
5	0	2.2	1.1	1.9	32	53	11.3	2.7	0.8	0.4	1.2	0.7	0.7	3.3				9	2.9	4.7	4.6	1.3
6	0	2	0.1	0.1	0.7	11.9	2.5	0.2	0.2	0.3	0.2	0.2	0	0.3				0.6	0.1	0.4	1.2	0.7
7	0	0.3	0.2	0	0	0	0.3	0.1	0.1	0	0	0	0	0				0.3	0		3	0.0
8	0	0	0.1	0	0	0	0	0	0	0	0	0	0	0				0	0	0	0	0
CPUE	54	278	380.6	275.7	282.9	343.5	202.3	73.8	46.9	42.9	142.7	76.5	26	23.2	**	**	**	339.7	162.5	102.1	221.1	265.8

* incomplete survey coverage

** no survey coverage

Table 5.14 (cont.): Cod abundance indices (numbers of cod caught per 100 hours net settings) by age as found in NAFO division 1D in the West Greenland inshore gill-net survey 1987 to 2006.

Years																						
Age	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1	68	0	0.6	0	0	0	123.9	0.2	0	0	0	0	2.5	0	0	0.2		0.2	0.2	2.9	9	1.8
2	76.9	95.5	15.7	19.6	78.3	14.4	2.7	60.6	3.9	0.4	2.6	1.1	3.3	10.3	0.4	2.4		6.8	5.6	43.2	26.8	114.0
3	0.4	14.8	67.6	48	47.2	34.5	17.3	22	57	6	1.8	1.2	1.2	17	1.2	1.9		3.7	4	6.2	6.9	36.6
4	2.7	0	5.3	30.1	12.8	4	6.4	9.5	19.7	4.5	4.2	0.1	0.1	0.5	2.7	0.6		2.7	2.3	2.8	1.9	12.9
5	2.9	0.4	0.1	0.9	13.2	3.7	2.3	7	1.8	0.5	3.6	1.7	0.2	0.1	0.4	0.6		0.3	1	1.1	0	4.3
6	3.2	0.5	0.1	0.2	0.1	2.8	0.8	0.6	0.3	0.1	0.2	0.1	0.5	0.1	0.1	0.3		0	0.1	0.5	0	0.2
7	0.2	2.3	0.1	0.1	0	0.1	0.1	0.3	0.1	0	0	0	0	0	0	0.2		0	0	0	0	0.0
8	0.8	0	0.4	0.2	0	0	0	0.1	0	0	0	0	0	0	0	0		0	0	0.1	0	0.3
CPUE	155.1	113.5	89.9	99.1	151.6	59.5	153.5	100.3	82.8	11.5	12.4	4.2	7.8	28	4.8	6.2	**	13.7	13.2	56.8	44.6	170.1

* incomplete survey coverage

** no survey coverage

Table 5.15. 2006 cod stock estimates for cod off Greenland. The survey abundance is raised by conversion factors derived by regressing VPA abundances on Survey abundance. The data window used for the regression is the decade 1982-1991.

Age	Survey Abund.	Conversion Factors	Converted stock Abun.	Mean weight	Maturity ogive	Biomass tons	Spawners tons
1	4366	12,34	53876	74	0	3987	0
2	20476	3,28	67161	334	0	22432	0
3	287202	0,50	143601	572	0,01	82140	821
4	24802	0,54	13393	1592	0,03	21322	640
5	3169	0,59	1870	3028	0,11	5661	623
6	5322	1,93	10271	4881	0,32	50135	16043
7	2988	1,71	5109	5102	0,61	26069	15902
8	383	0,85	326	6566	0,83	2138	1774
9	78	0,85	66	7394	0,94	490	461
10	22	0,85	19	9335	0,98	175	171
					B1+	214548	
					B3+	188129	
					SSB		36435

Table 5.16. Mean maturity stage at age of offshore cod at West Greenland. (Based on maturity stages 1-10 where 5 is mature, described by Tomkiewicz et al. (2002), total number of fish examined: 322 in 2004 and 455 in 2005, numbers ranged from 246 (at age 2 in 2005) to 1 (at age 8+ in 2005)).

Year/Age	nos.	0	1	2	3	4	5	6	7	8+
2004	363	-	1.0	1.4	1.8	2.1	2.2	2.6	2.4	3.0
2005	501	-	1.0	1.1	1.5	2.4	2.4	3.3	3.0	2.0
2006	973	-	1.0	1.0	1.4	1.7	2.1	2.1	2.1	2.3

Table 5.17. Mean weight at age (kg) of offshore cod at West Greenland. Total number of fish examined: 363 in 2004 and 497 in 2005, numbers ranged from 262 (at age 2 in 2004) to 1 (at age 8+ in 2005).

Year/Age	nos.	0	1	2	3	4	5	6	7	8+
2004	363	-	0.04	0.22	0.45	0.82	1.20	1.60	2.80	7.11
2005	501	-	0.03	0.17	0.54	1.00	1.59	2.55	3.08	2.62
2006	973		0.02	0.12	0.32	0.67	1.02	1.67	3.02	6.58

Table 5.18. Mean length at age stage (cm) of offshore cod at West Greenland. Total number of fish examined: 363 in 2004 and 501 in 2005, numbers ranged from 262 (at age 2 in 2004) to 1 (at age 8+ in 2005).

Year/Age	nos.	0	1	2	3	4	5	6	7	8+
2004	363	-	16.8	28.7	37.1	46.9	53.4	57.9	66.6	86
2005	501	5.9	15	26.6	39.8	48.9	56.1	63.1	70	67
2006	973		14.0	24.1	33.8	43.5	50.9	60.1	71.2	91.0

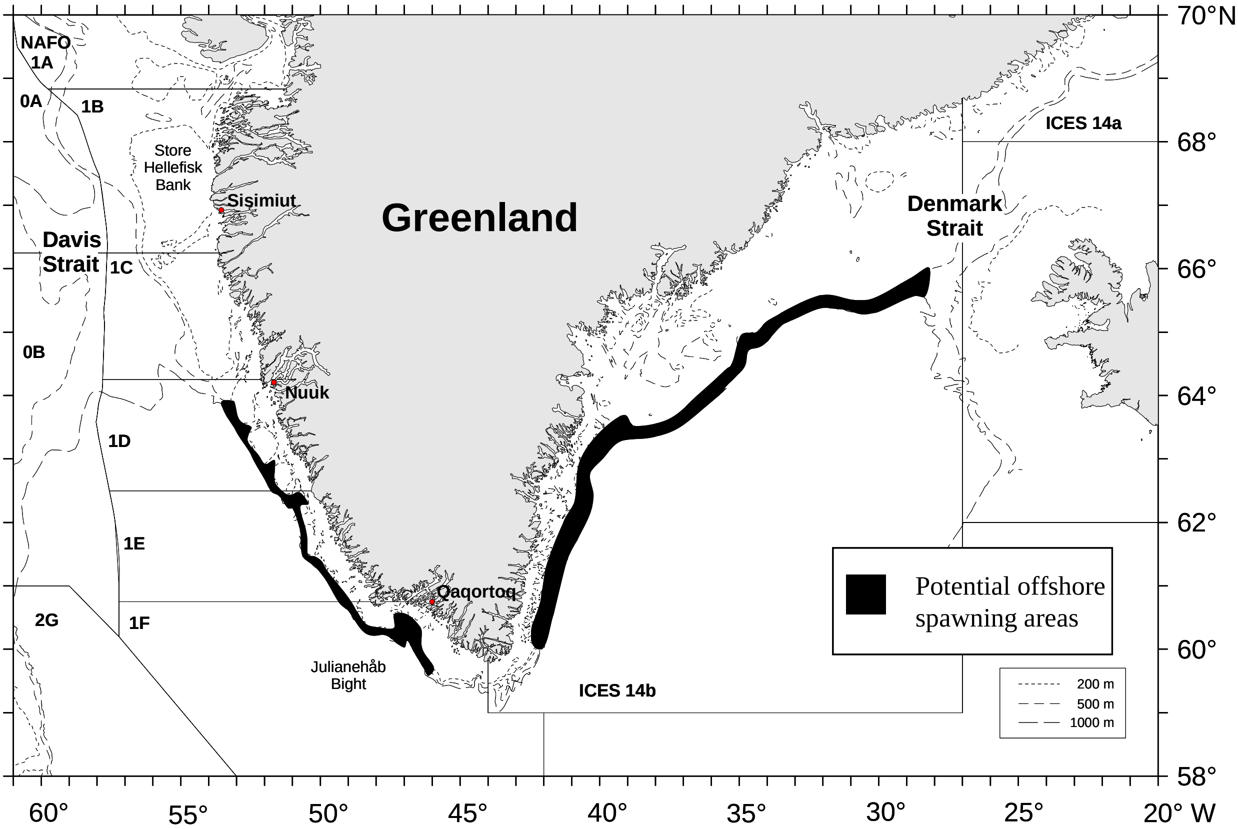


Figure 5.1.1. Historical offshore spawning areas of cod in Greenland.

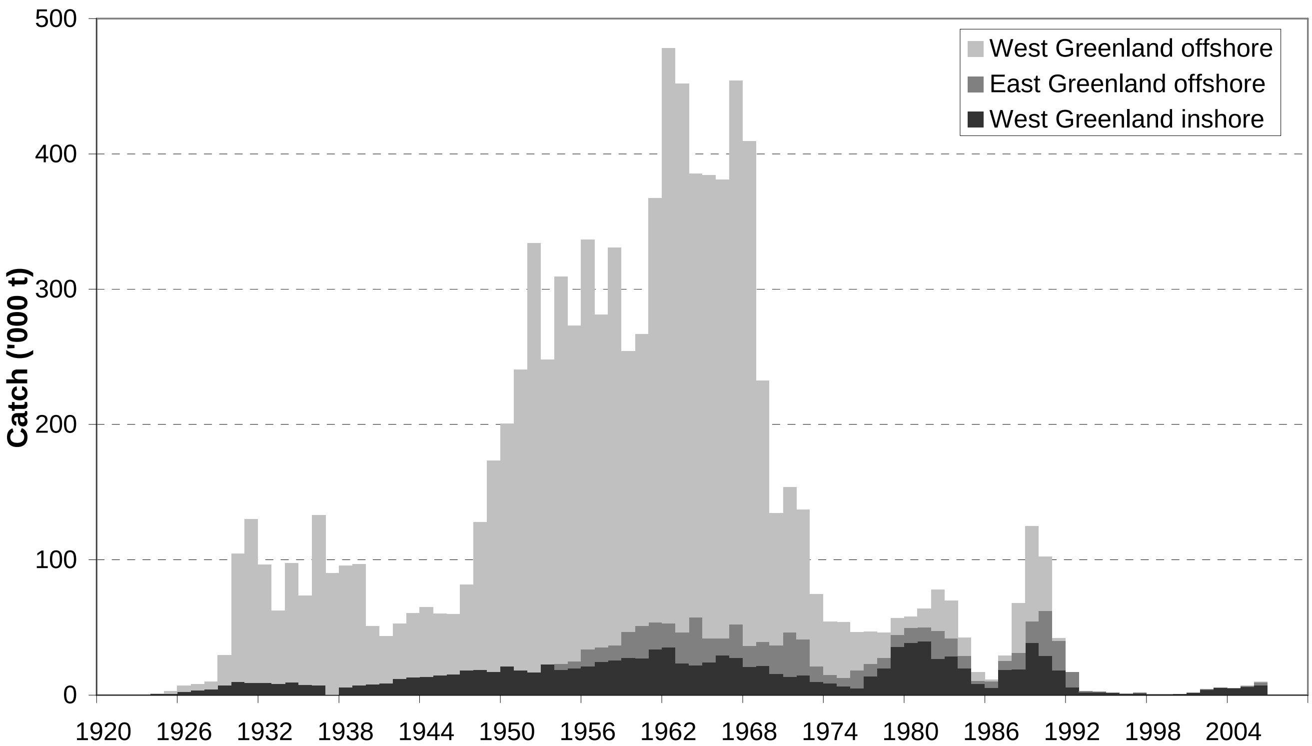


Figure 5.2.1 Cod off Greenland. Catches 1920-2006 as used by the Working Group, inshore and offshore by West and offshore by East Greenland (Horsted 1994,2000). Columns are stacked.

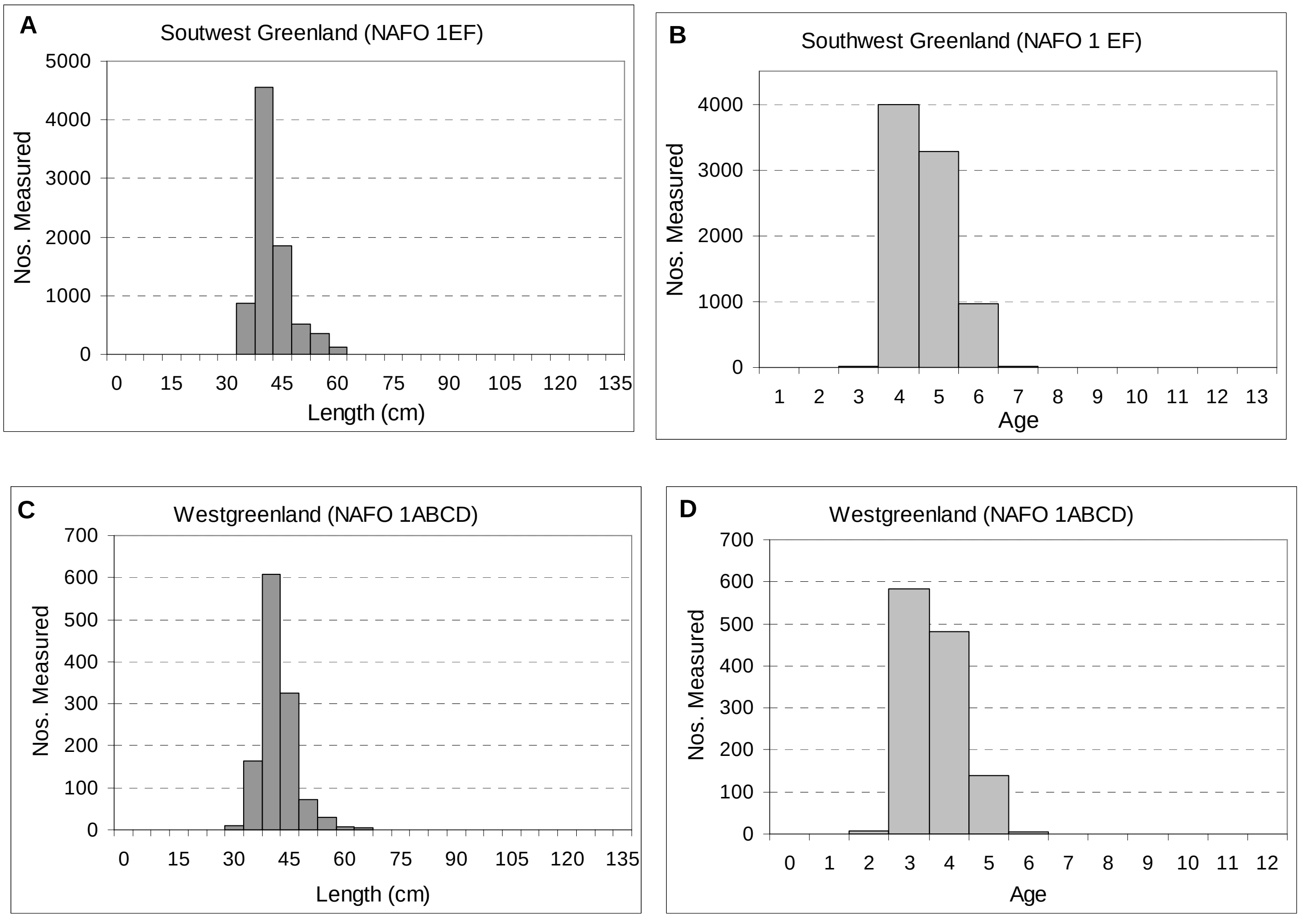


Figure 5.2.2 Length and age distribution of inshore cod landings in figures A and B: Southwest Greenland, NAFO area 1EF, figures C and D: West Greenland, NAFO area 1ABCD in 2006.

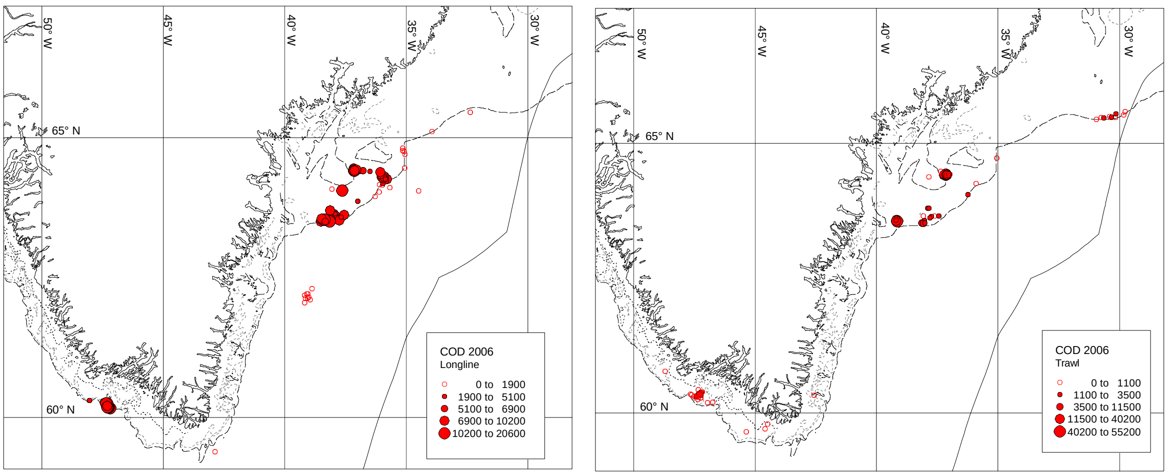


Figure 5.2.3. Fishing areas for offshore trawl and longliners, 2006.

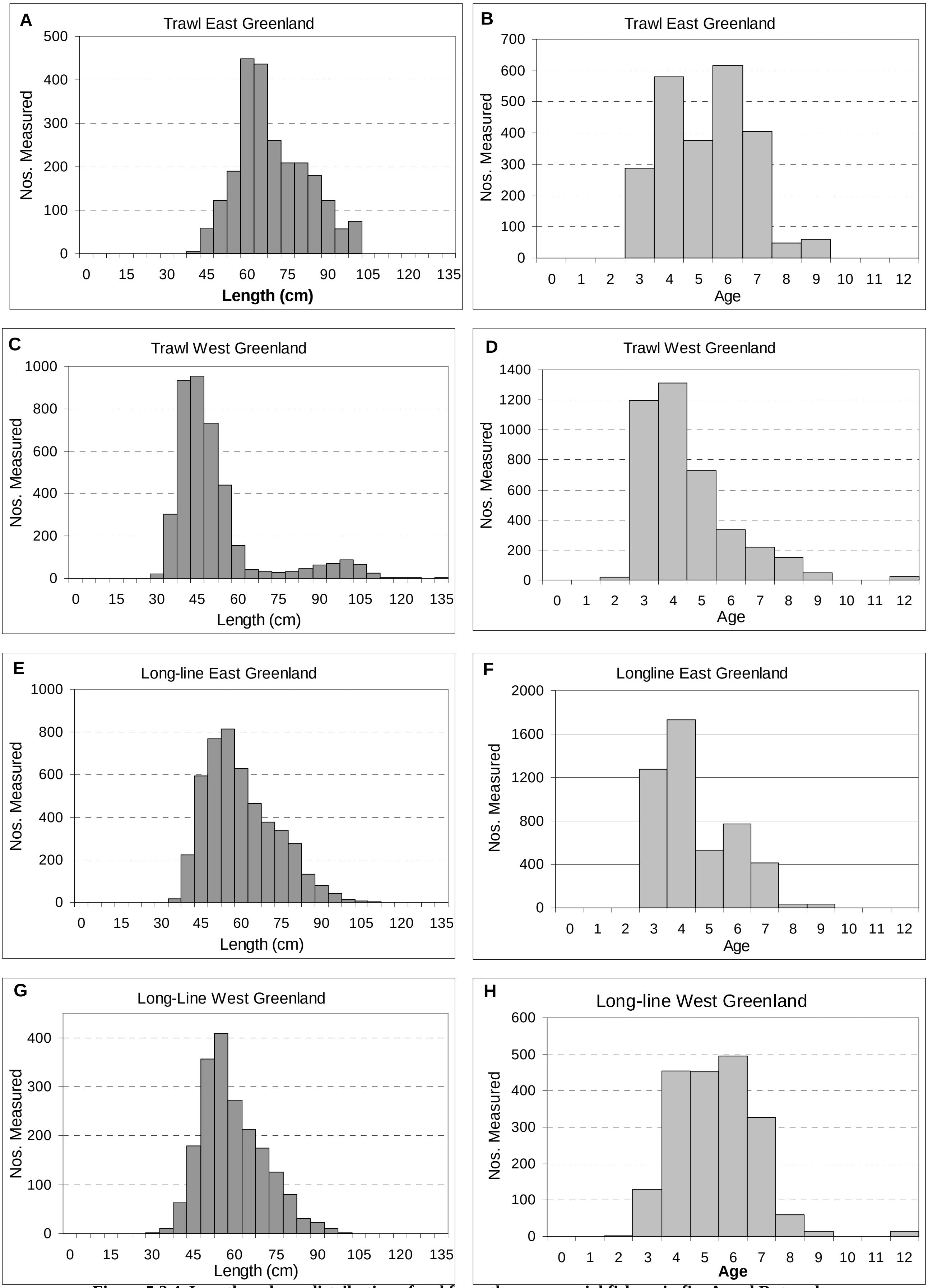


Figure 5.2.4. Length and age distribution of cod from the commercial fishery in fig. A and B: trawl East Greenland, fig. C and D: trawl West Greenland, fig. E and F: Long-liners East Greenland, G and H: Long-liners West Greenland in 2006.

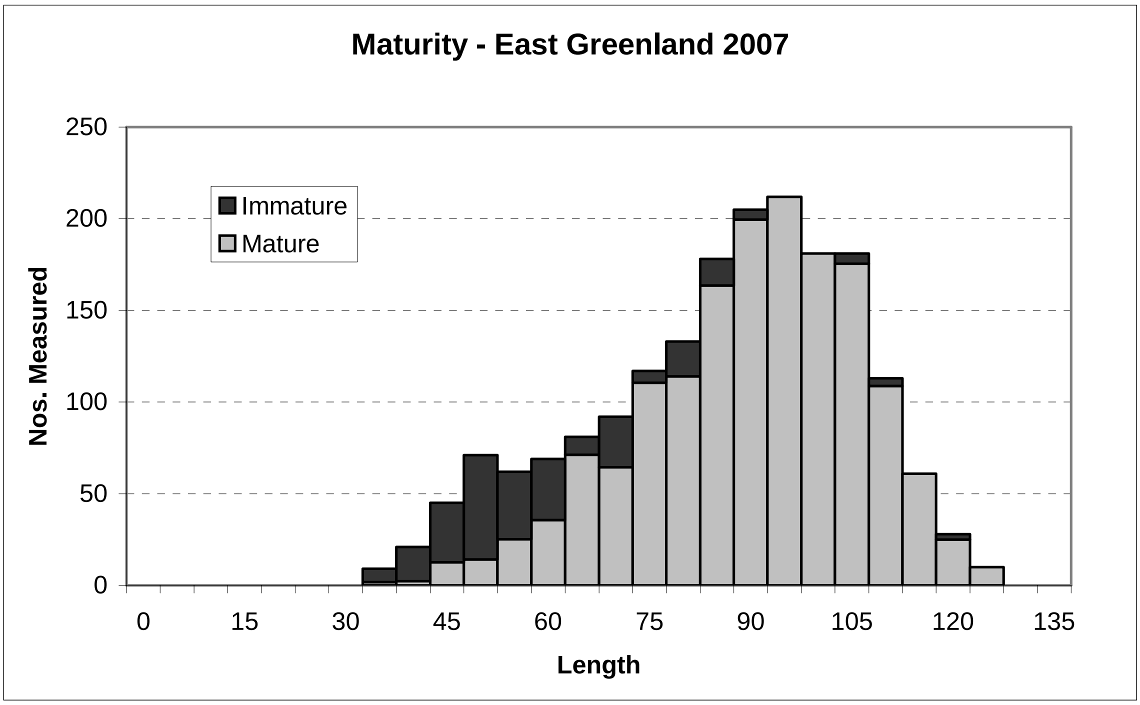


Figure 5.2.5. Maturity information from East Greenland April, 2007. Length distribution of catches separated into mature and immature (mature defined as stages III-VII (Tomkiewicz, 2002), immature as stages I-II plus VIII –X. The majority of the matures were actively spawning (stages V-VI).

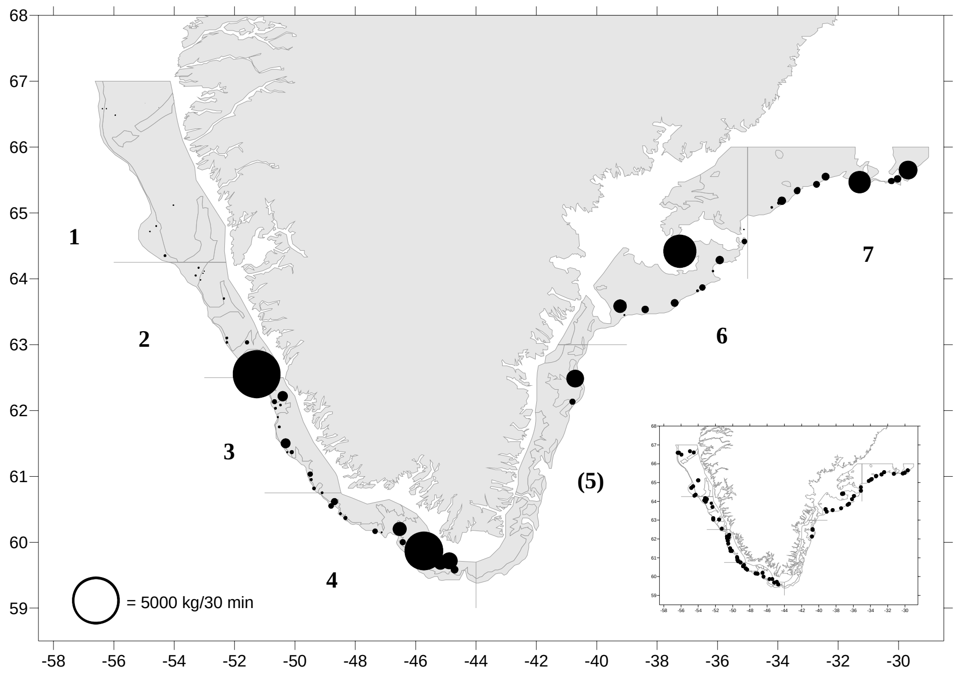


Figure 5.3.0 Cod off Greenland (offshore component, biomass/tow), German survey. Survey area, stratification 1-7 and position of hauls carried out (insert).

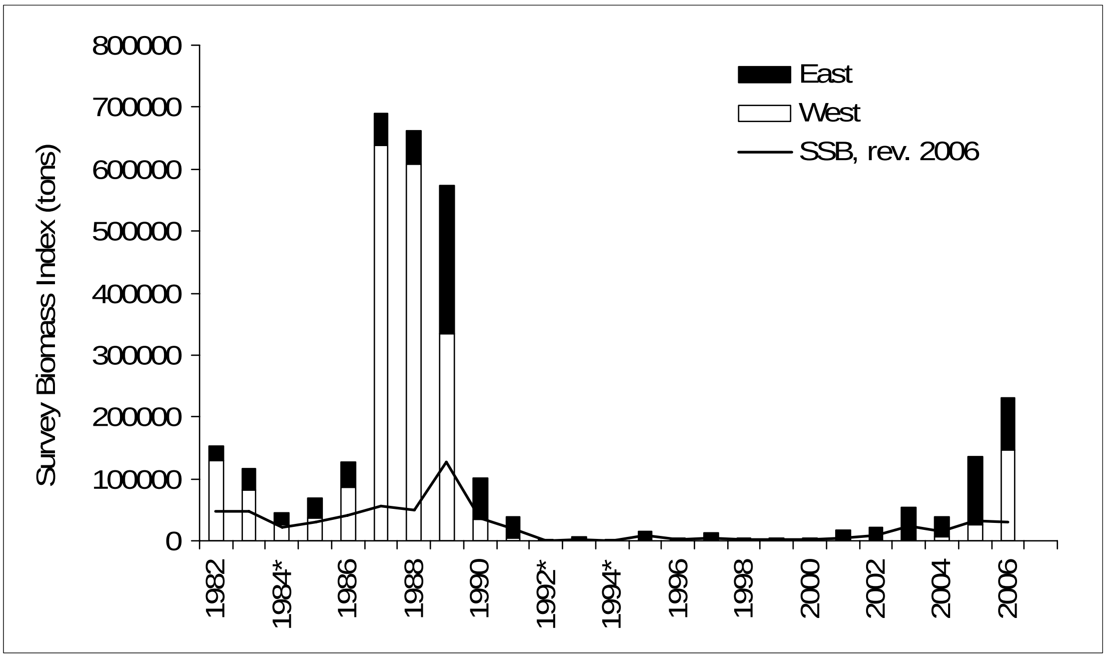
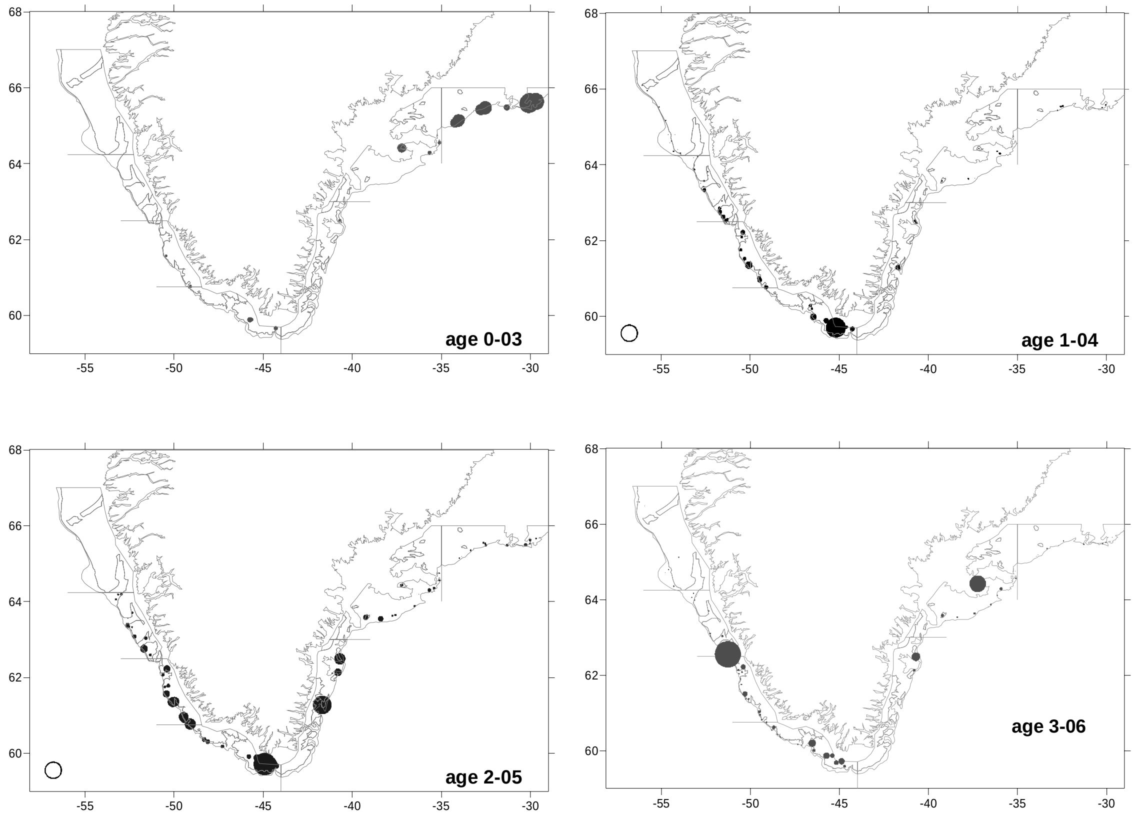
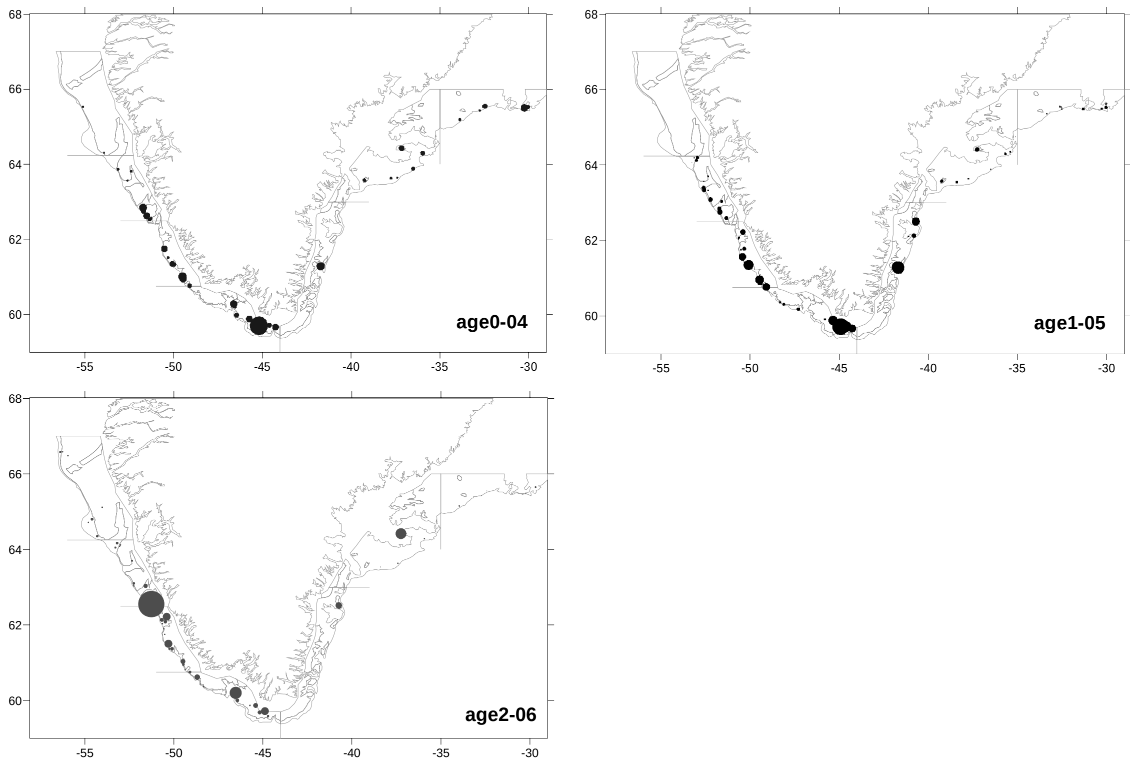


Figure 5.3.1 Cod off Greenland (offshore component), German survey. Aggregated survey biomass indices for West and East Greenland and revised spawning stock biomass, 1982-2005. Incomplete survey coverage in 1984, 1992, 1994, and 2006.

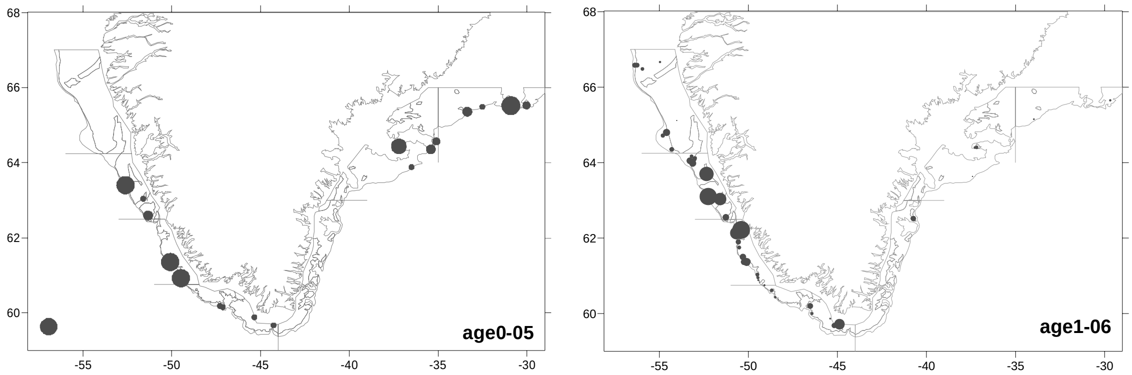


(A) Year class 2003

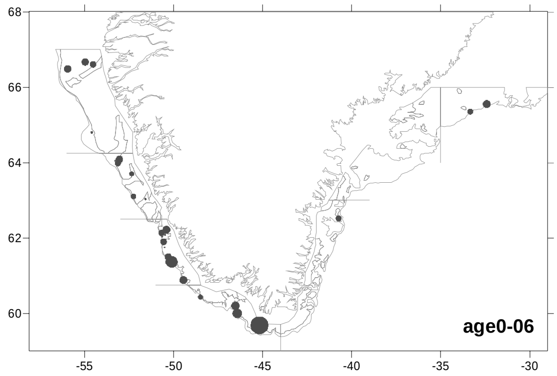


(B) Year class 2004

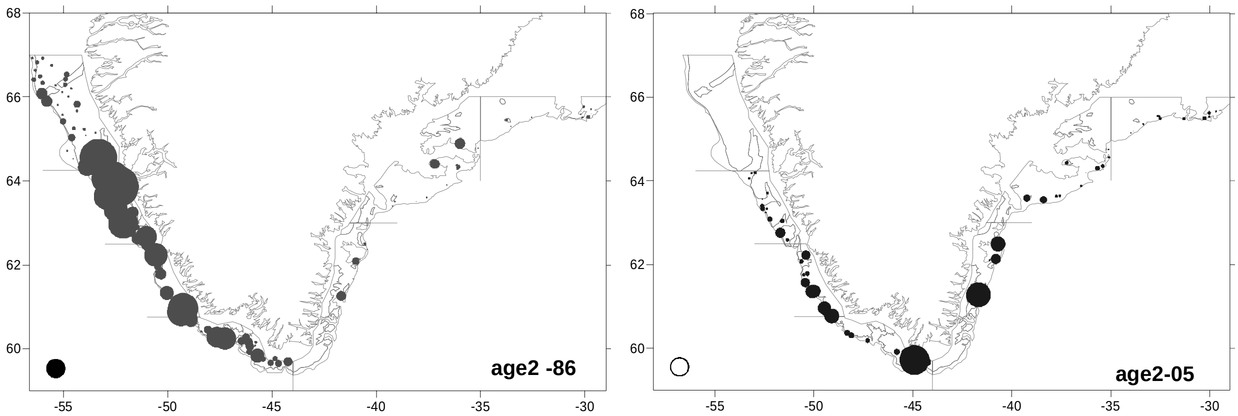
Figure 5.3.2 Relative distribution of the abundance by yearclasses (A) yc 2003, (B) yc 2004, (C) yc 2005, (D) yc 2006 and (E) at age 2 in 1986 and 2005, each for consecutive years. Source German groundfish survey.



(C) Year class 2005



(D) Year class 2006



(E) Comparison at age 2 for yc's 1984 and 2003

Figure 5.3.2. continued Relative distribution of the abundance by yearclasses (A) yc 2003, (B) yc 2004, (C) yc 2005, (D) yc 2006 and (E) at age 2 in 1986 and 2005, each for consecutive years. Source German groundfish survey.

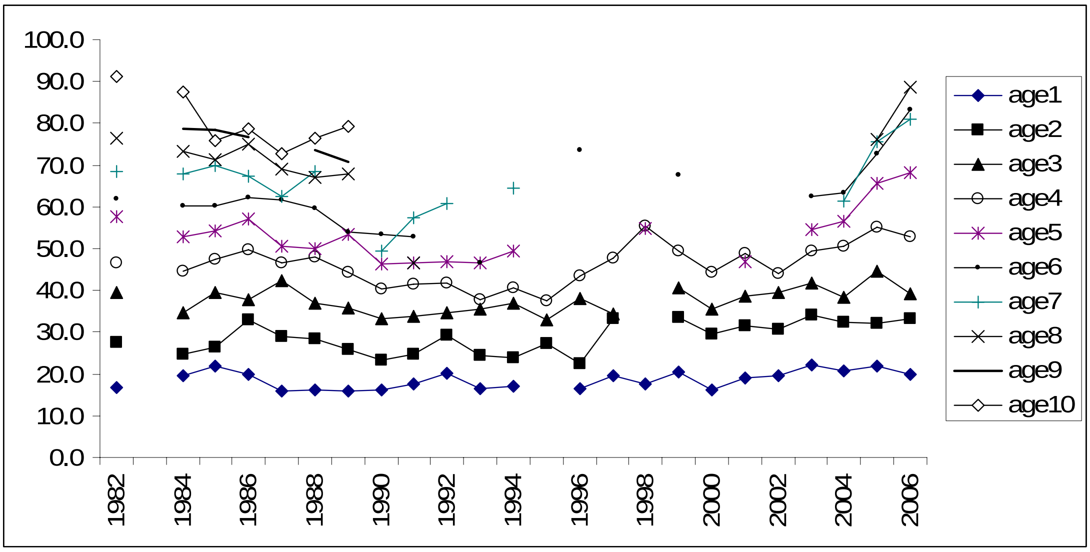


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Figure 5.3.3. Weighted mean length at age 1-10 years 1982, 1984-2006 sampled in West Greenland. Data derived from German survey.

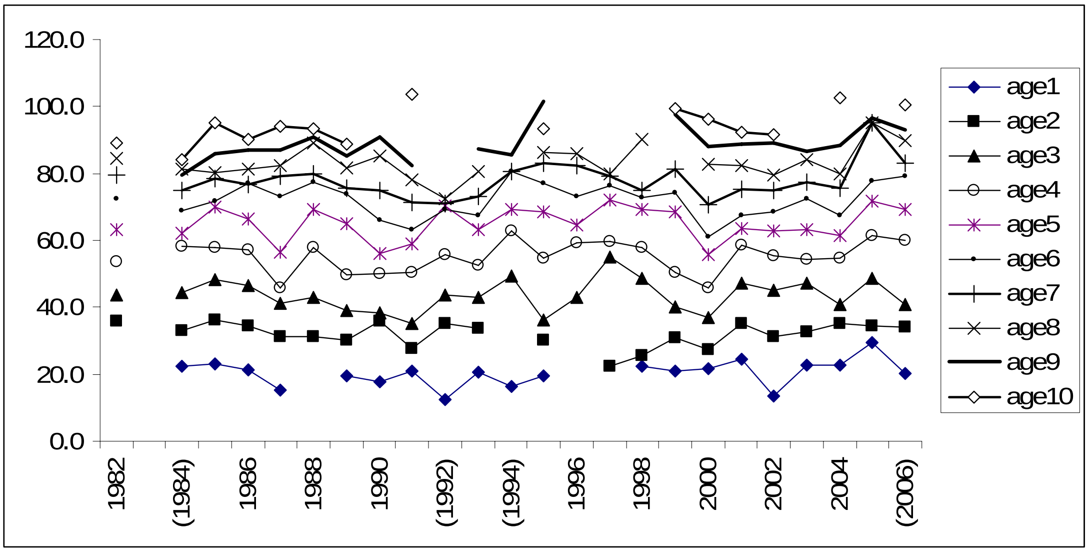


Figure 5.3.4 Weighted mean length at age 1-10 years 1982, 1984-2005 sampled in East Greenland. Data derived from German survey.

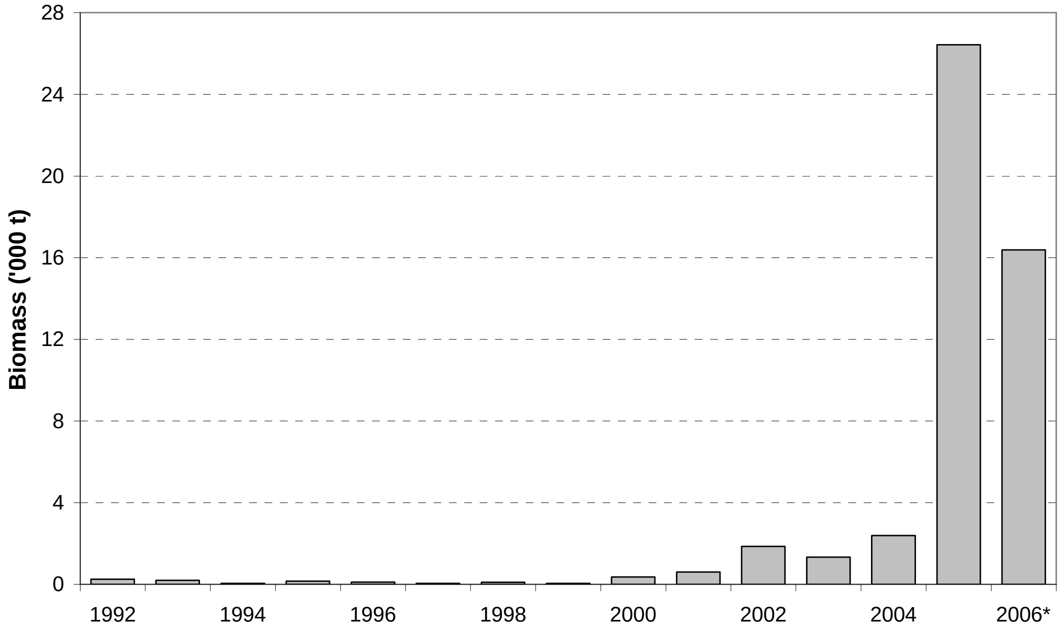
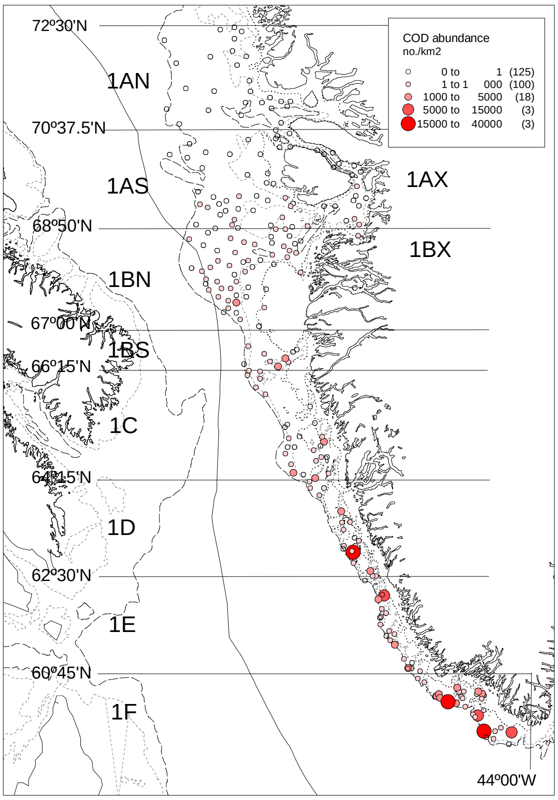


Figure 5.3.5 Cod off Greenland (offshore component), Greenland survey. Aggregated survey biomass indices for West Greenland, 1992-2006. *: Preliminary result.



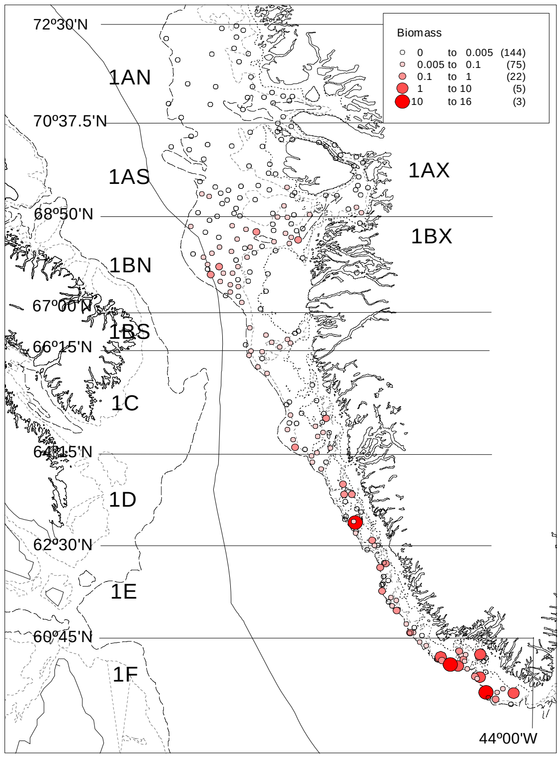
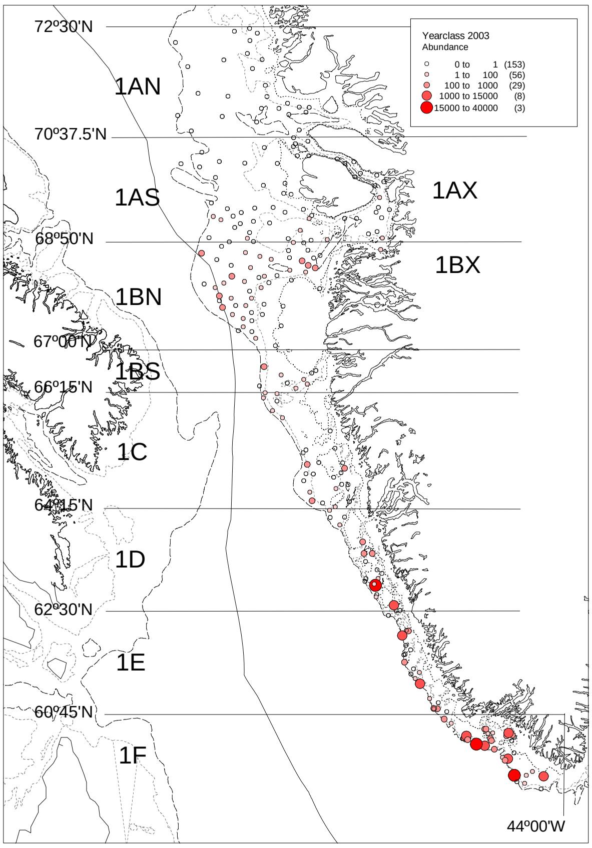


Figure 5.3.6. Number of cod /km² and biomass off Greenland (offshore component), Greenland survey (R/V Paamiut). Survey area, stratification and position of hauls carried out in 2006.



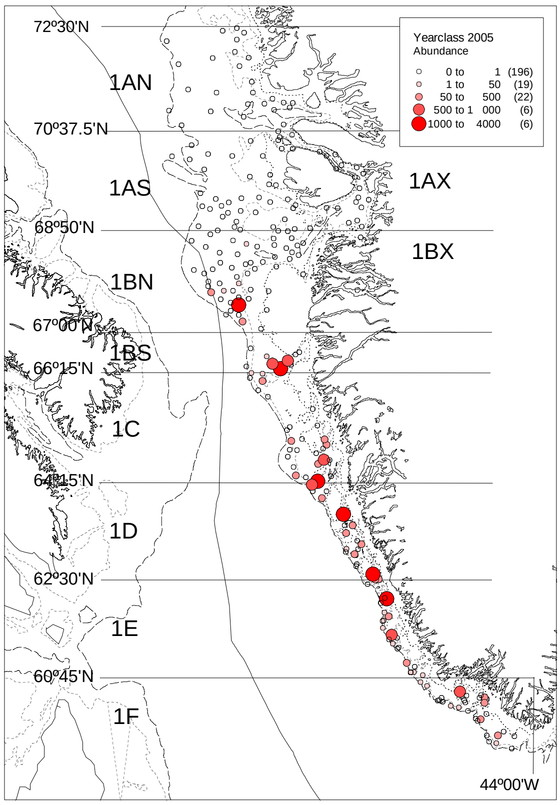


Figure 5.3.7. R/V "Paamiut" Survey 2006. Abundance of year-class 2003 and year-class 2005.

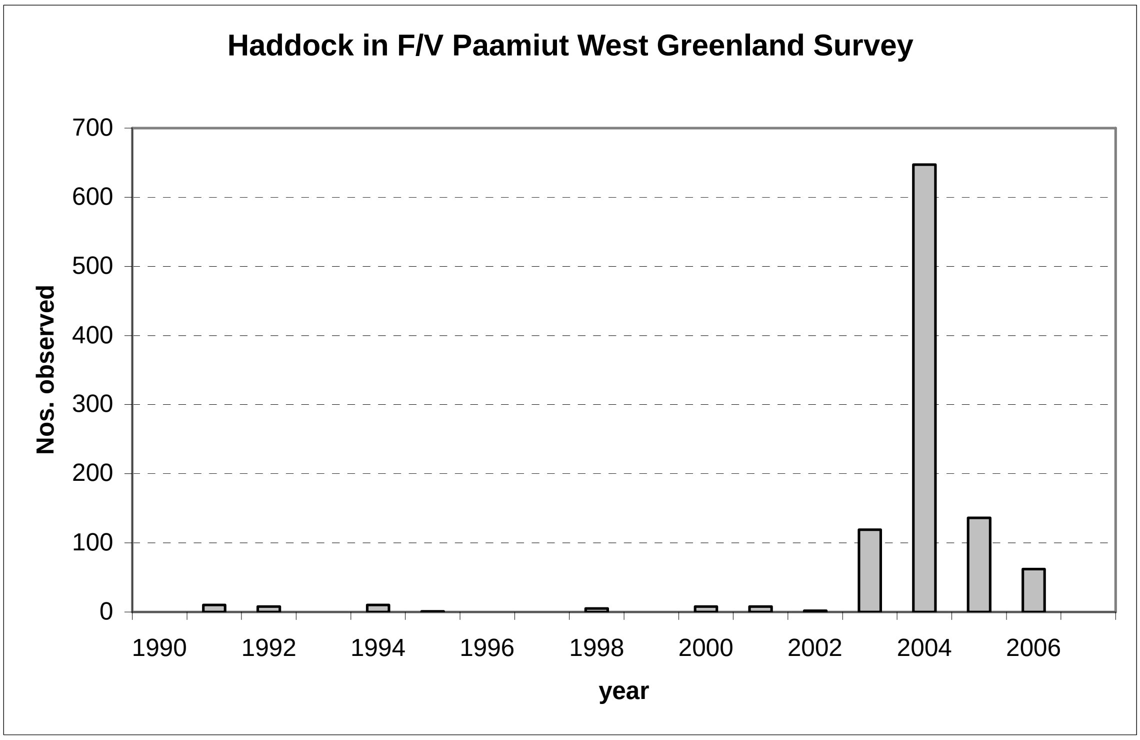


Figure. 5.3.8. Occurrence of Haddock in the Greenland survey off West Greenland, 1991-2006.

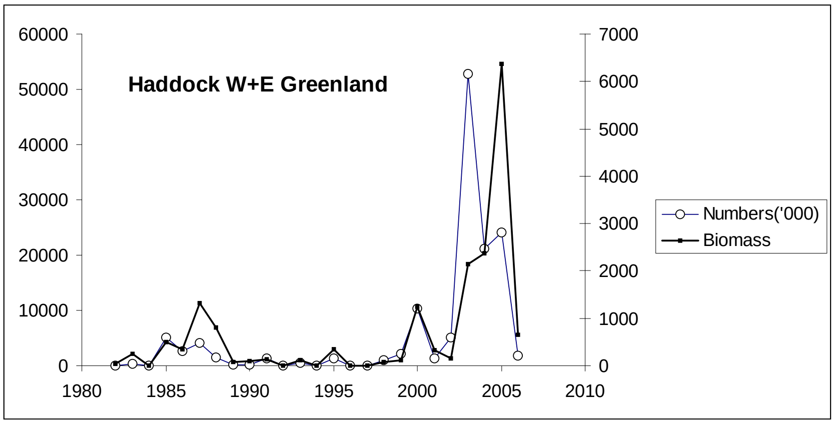


Figure 5.3.9. Occurrence of haddock in the German survey off Greenland, West and East, 1982-2006.

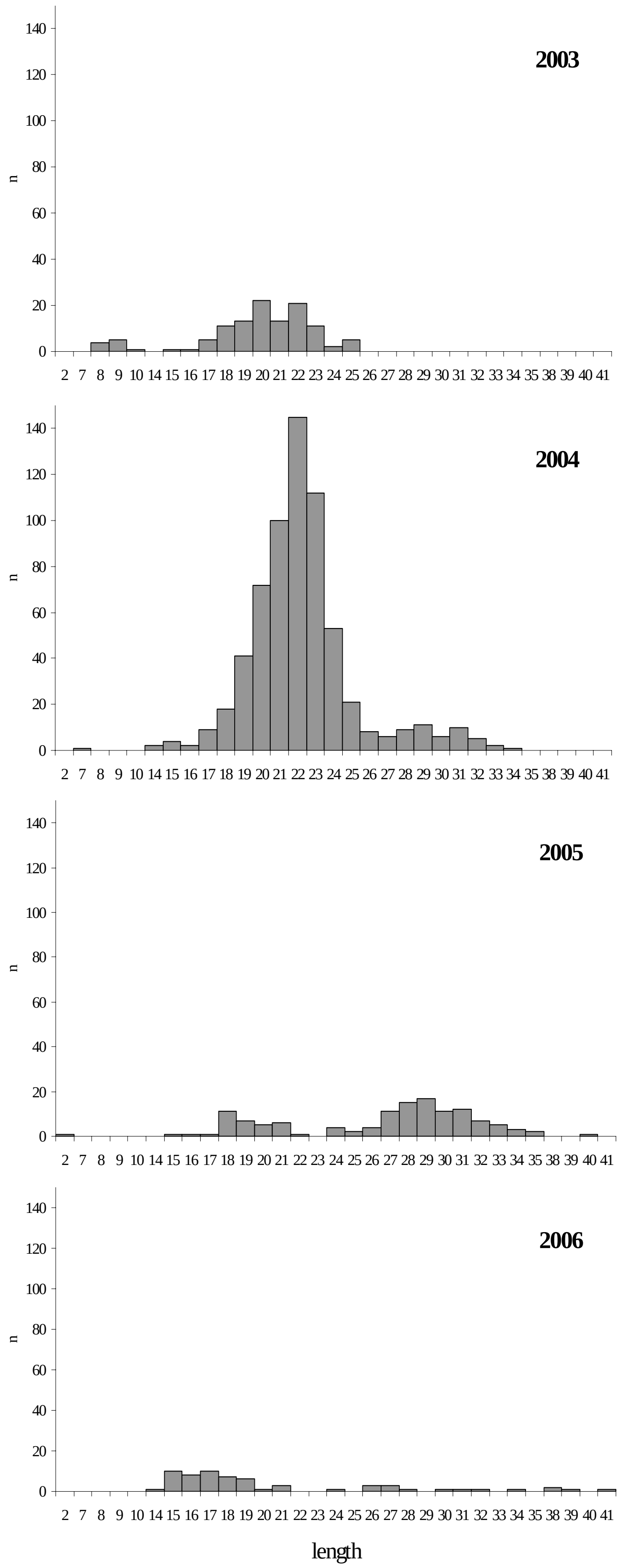


Figure 5.3.10: Haddock length (cm) distribution from R/V Paamiut West Greenland offshore survey 2003-2006.

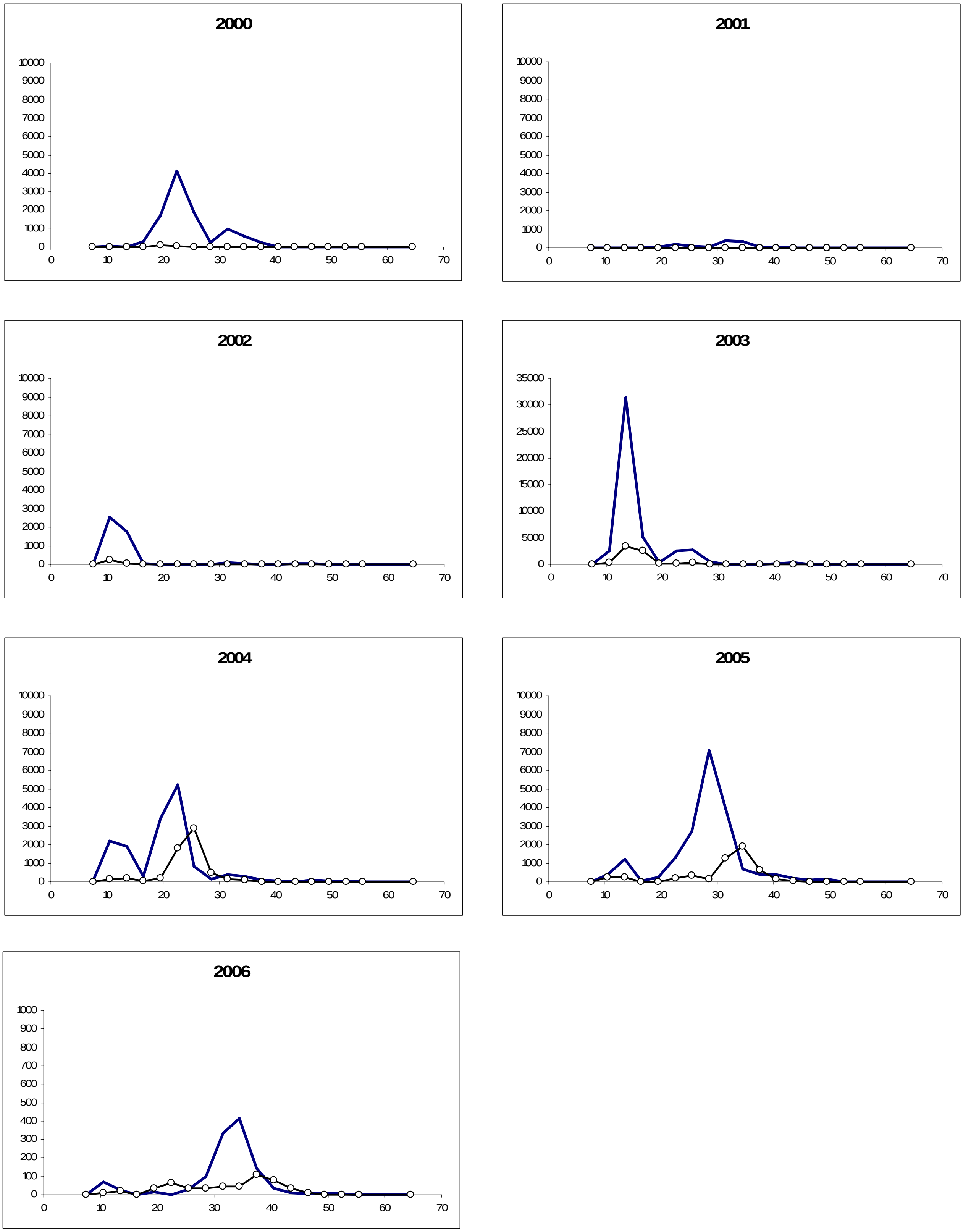


Figure 5.3.11. Length frequency distributions of haddock for West (o-o-o) and East Greenland (—— , '000). Note different y-axis scales in 2003 and 2006.

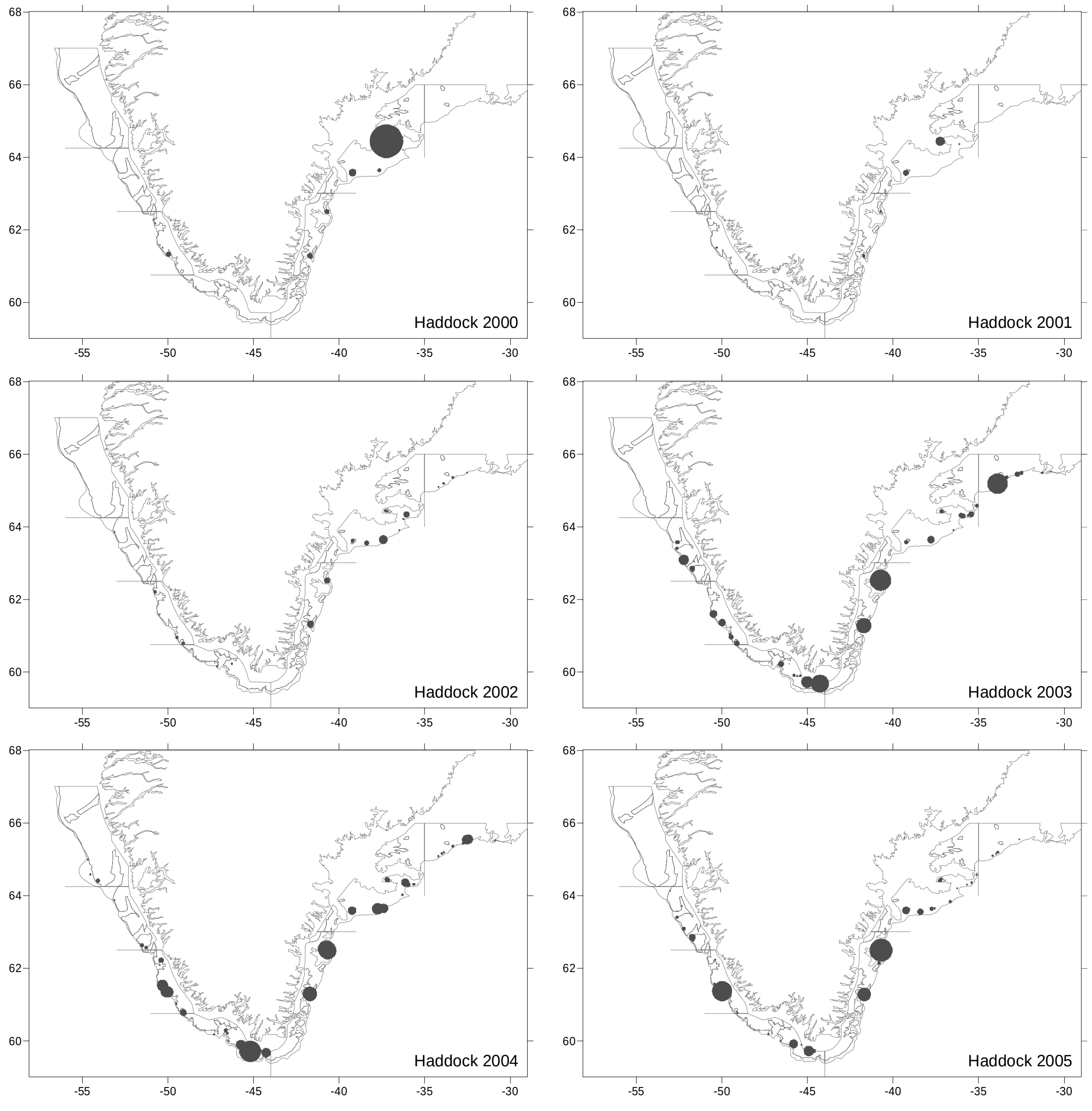
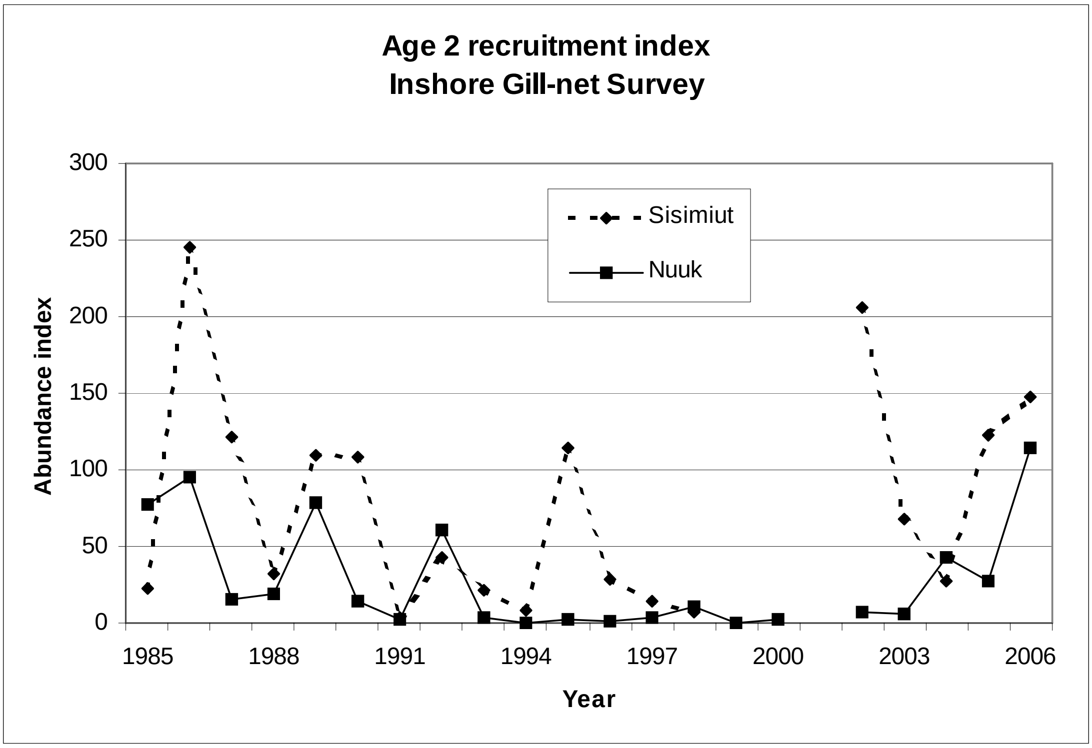


Figure 5.3.12. Relative distribution of haddock in German survey catches off Greenland.



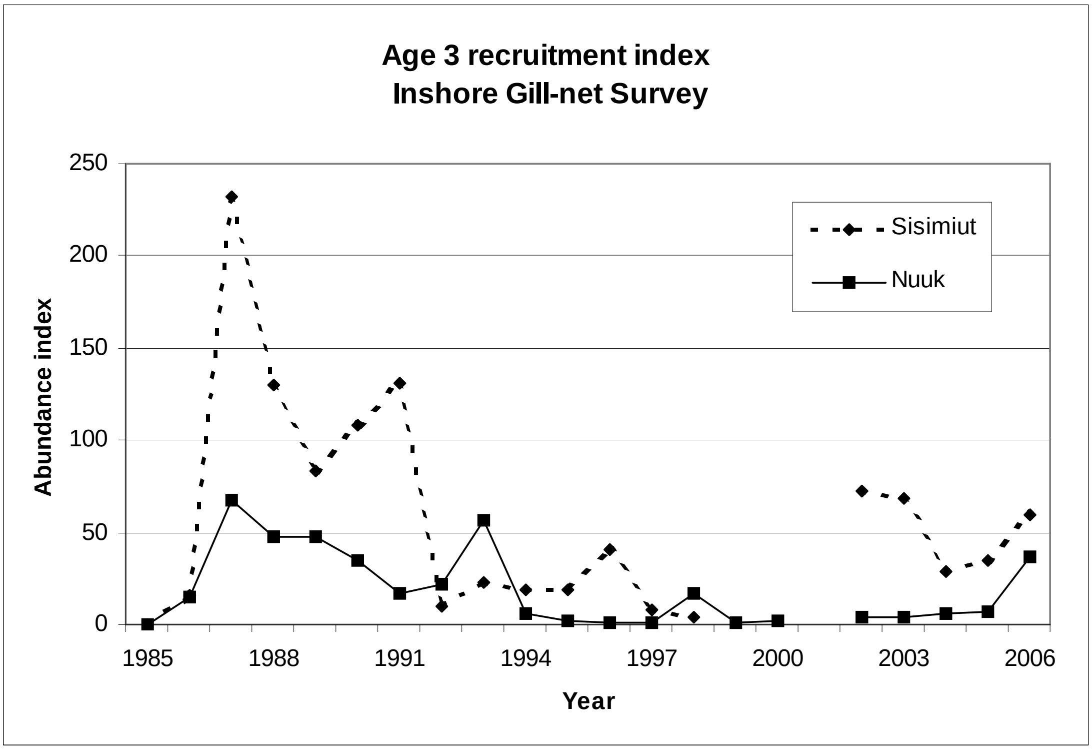
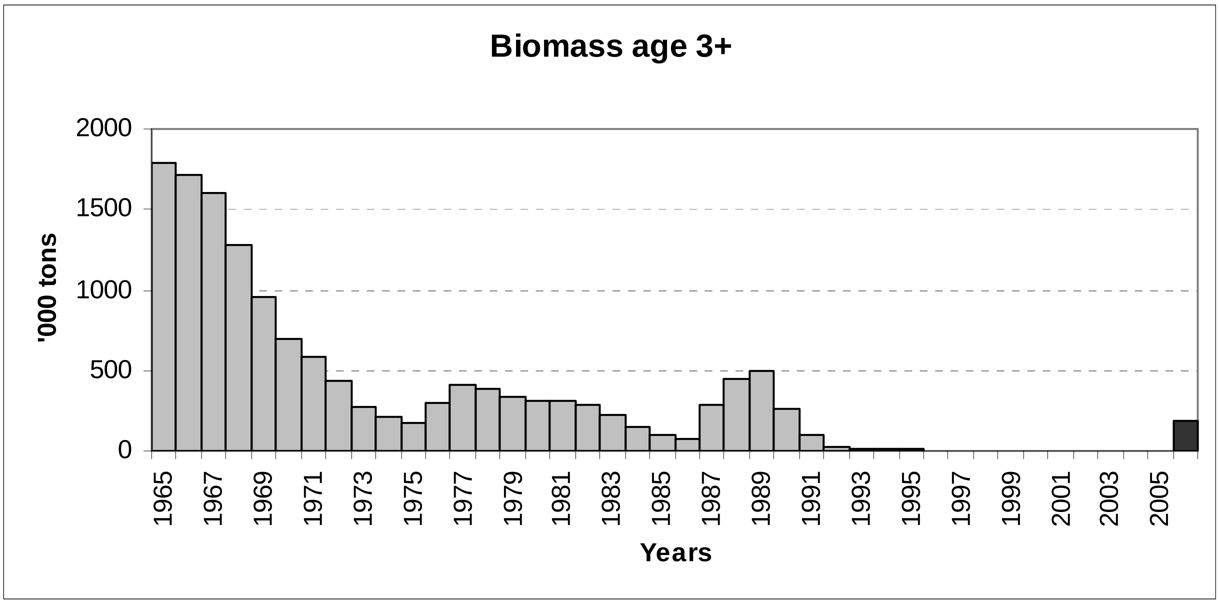


Figure 5.3.13. Recruitment index of age 2 and 3 cod in the inshore gillnet survey in NAFO division 1B (Sisimiut) and 1D (Nuuk) between 1985 and 2006.



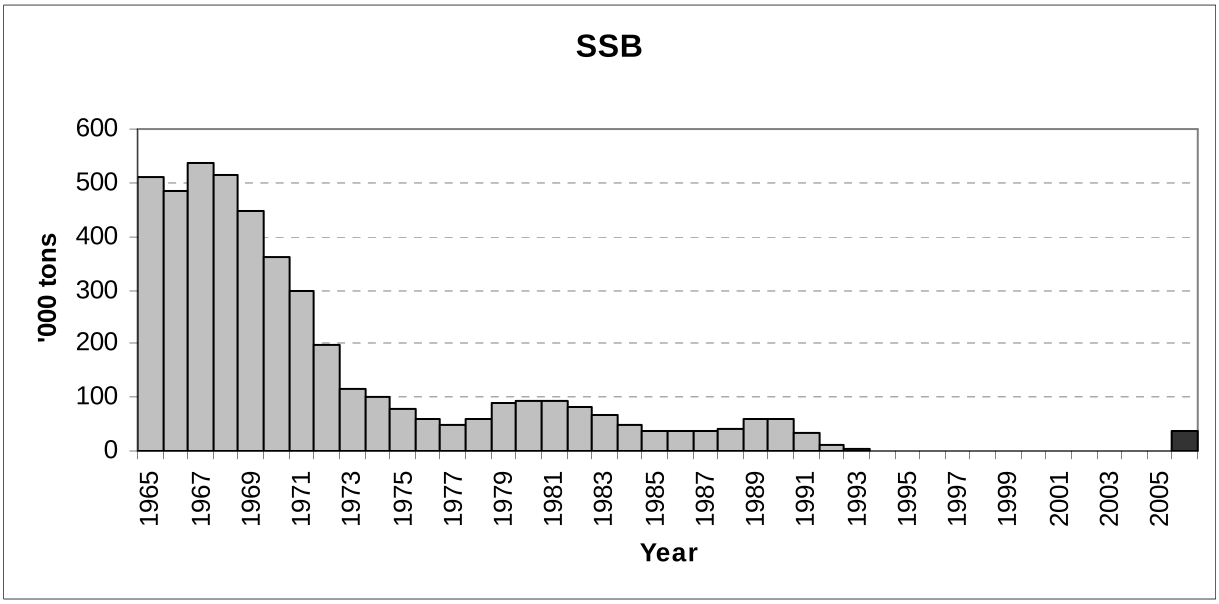


Figure 5.3.14. 2006 Biomass 3+ and SSB of the cod in Greenland waters stock as derived by applying survey-VPA conversion factors (black) compared to the VPA estimates 1965-95 (gray). Biomasses between 1996 and 2005 not shown.

6 Greenland Halibut in Subareas V, VI, XII, and XIV

Greenland halibut in ICES Subareas V, VI, XII and XIV are assessed as one stock unit although precise stock associations are not known.

6.1 Executive summary

Input data to the assessment this year is unchanged from recent years: current surveys have continued and sampling intensity and coverage remains also unchanged. Logbooks from the fishery is still available as haul by haul data. Since 2001 no age readings of otoliths were available from the main fishing areas.

A logistic production model in a Bayesian framework was further developed this year, and current state of the stock as well as predictions were conducted using this model.

The model was able to produce a reasonable simulation of the observed data and was relatively insensitive to input priors. Estimated stock biomass has showed and overall decline since the mid 1980s. Biomass is below its maximum sustainable yield level (B_{MSY}) and mortality by fishery exceeds the value that maximizes yield (F_{MSY}). Results are as follows:

- Stock status:
    - High probability (99%) of being below B_{msy}
    - 2% risk of being below suggested B_{lim} (=30% B_{msy})
- Production potential:
    - Catches around 15 ktons are likely to maintain stock size around its current level
    - MSY 12-35 ktons (inter-quartile range)
- Current exploitation:
    - 89% risk of exceeding F_{msy}
    - 66% risk of exceeding suggested F_{lim} (=1.7F_{msy})
    - 2.3 times larger than the median F_{msy}
- Predictions:
    - Median stock biomass is projected to remain at the current level at catches of 15 ktons/yr – decrease at higher catches and increase if catches are kept below 15 ktons/yr.
    - Median fishing mortality is not projected to decrease towards F_{msy} at catches of 15 ktons/yr, whereas annual catches of 10 ktons/yr are likely to result in a decreasing trend in F reaching F_{msy} within a 10-year period.

There is no information to relate present status of the stock in Div. Vb and XIVb to the mid-1980s as was done for the stock in Div. Va.

Information from the Faroese area is not included in the production model, but indices used are considered to cover also the Faroese area. The individual biomass indices from Vb are Faroese trawl CPUE (1991-2006) that show a slight but continuous decrease in catch rates since 1994, following a significant decrease in the early years 1992-94. The survey/exploratory fishery also shows a continuous decrease since 1994.

In Div. Va fishery and survey indices show similar trends. The fall groundfish survey in Va (1996-2006) indicate a stabilisation at a low level in the last three years. Icelandic trawl CPUE has stabilised in 2005-2006 and are currently 1/4 of that in 1985. Effort is still high and is twice the 1998 effort .

The Greenland survey in XIV had stable biomass index in the previous periods, but index increased in 2006 . Trawl CPUE’s from the various fleets in XIVb have in 2006 increased to the same level maintained in 1994-98.

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 1981–2006 in Tables 6.1–6.6 and since 1961 in Figure 6.1. 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 of 20 000 t in 1998-99, followed by an increase to about 30 000 t in 2003. From 2003 landings have continually decreased to about 21 000 t in 2006.

Landings in Icelandic waters have historically predominated the total landings in areas V+XIV. In the year 1989 with record high total landings Iceland took 97%. Since then fisheries have developed in Div. XIVb and Vb and these areas have gradually increased their share of the total landings to about 30% - 50% in the past decade. In 2006 landings in Va fell to 12 000 t., while landings remained high at about 9 000 t in XIV. Divison Vb experienced decreased landings in 2006 to a historic low of about 900 t.

Fisheries and fleets

In 2006 quotas in Greenland EEZ were almost fully utilised by the principal fleets (86%). Anecdotal information from the Greenland fishery justifies the missing utilisation of the Greenland quota due to allocation of effort into a range of other potential fisheries, e.g. exploratory quotas on cod in East Greenland, Barents Sea cod and quotas of Greenland halibut in northwest Greenland (Baffin Bay). Within the Iceland EEZ, quotas in the fishing year 2005/2006 were almost fully utilized (85%) as in the fishing year 2004/2005 (87%). In the Faroe EEZ the fishery is regulated by a fixed numbers of licenses and technical measures like by-catch regulations for the trawlers and depth and gear restrictions for the gillnetters. Total catch has decreased mainly due to less effort in the gillnet fleet.

Most of the fishery for Greenland halibut in Divisions Va, Vb and XIVb is a directed trawl fishery only minor catches in Va by Iceland, and in XIVb by Germany and the UK comes partly from a redfish fishery.

Spatial distribution of 2006 and historic effort and catch in the trawl fishery in XIV and V is provided in Figures 6.2.-3. Fishery in the entire area had previously occurred in a more or less continuous belt on the continental slope from the slope of the Faroe plateau to southeast of Iceland extending north and west of Iceland and further south to southeast Greenland. Fishing depth ranges from 350-500 m southeast, east and north of Iceland to about 1300 m at East Greenland. In 2006 the distribution of the fishery is limited mostly to western Icelandic fishing grounds and along the east Greenland slopes. The fishery north of Iceland has in recent year mainly developed into a gillnet fishery which in 2006 comprises approx. 10% of the catches in Div. Va.

The major fishing grounds in Icelandic waters are located west of Iceland (64º30-66ºN, 27º-29ºW), where approximately 95% 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 minor fishery also occurred 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 spring.

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, and has been the main Greenland halibut fishery in Vb in recent years. In 2006, however, their catch has decreased considerable, mainly due to a allocation of effort towards monkfish and in some cases to longline fisheries for cod, ling and tusk. .

The fishing grounds in Division XIVb are found on the continental slopes from southeast Greenland to the Icelandic EEZ east of Ammasalik (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 2005 the fishery entered an unexploited area north of 67^{o} N just north of the Icelandic EEZ with catches of about 1 200 t. The fishery began as an exploratory fishery in September 2005 by a Greenlandic vessel, which was followed by 3-4 foreign vessels that operated in the area through October and November. The fishery in 2006 is distributed almost continuously along the continental shelf at depths of 500-1300 m from 30^{o}W to 41^{o}W, and has since 2005, when the area north of 67^{o}N were explored, been the most widespread fishery recorded since 1991. It should be noted that in 2006 also the most comprehensive information (91%) from the fishery is available as logbook data. The main fishing season in XIV has expanded and is in recent years from March to November with the bulk of the catches taken in the 2nd quarter. Both freezer trawlers and fresh fish trawlers operate in the area.

Since 1996 Greenland halibut has been taken as by-catch 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 6.5-6.6 derive from the Hatton Bank area. This fishery still contributes insignificant to the total catches in V,VI, XII and XIV.

By-catch and discard

The Greenland halibut trawl fishery is generally a clean fishery with respect to by-catches. By-catches are mainly redfish, sharks and cod. Southeast of Iceland the cod fishery and the minor Greenland halibut fishery are coinciding spatially.

The mandatory use of sorting grids in Va and XIVb in the shrimp fishery operated since November 2002 are observed to have reduced by-catches considerably. Based on sampling from three trips (93 hauls) in 2006 and 2007, scientific staff observed by-catches of Greenland halibut to be less than 1% by weight (2 g or 0.04 specimens per 1 kg shrimp) compared to about 50% by weight (0.48 kg and 0.81 individuals of Greenland halibut were caught per 1 kg shrimp) observed before the implementation of sorting grids (in 2002) (Sünksen 2007, WD # 16).

Only little information is presently available on discard in the Greenland halibut fishery. Discard records from fishery in XIVb (from logbooks) that suggest discard less than 1% of the catches are considered incomplete.

Stock perception

The scientific basis for the assumption on spawning grounds located west of Iceland is weak and based only on a few observed spawning fish and on distribution of eggs and larvae. 0-group surveys suggest that recruits are supplied to East Greenland and might also drift to West Greenland. Nursery grounds have not been found in the entire assessment area. Tag-recapture experiments have shown migrations of adult fish from Greenland to Iceland and also a mix within Icelandic waters, which supports a drift of larvae from west of Iceland to both Greenland and to north of Iceland. Tagging also suggest occasional migrations of adult fish from east Greenland and Iceland to Faroe Islands.

No major new information has been presented in recent years to contribute to the clarification of stock structure of Greenland halibut. However, compilation of fishery information (Section on Fisheries and Fleets) provides an overview of the geographical distribution of the fishery over time (Fig. 6.1.4.-5.). The distribution suggest that fishery in East Greenland and Iceland occurs continuously along the continental slopes at depth of 500-1000 m, which suggest that Greenland halibut in those areas belong to the same stock entity. A more detailed description of the present perception on stock structure is provided in the NWWG report 2006.

6.3 Trends in Effort and CPUE

Div. Va

Indices of CPUE for the Icelandic trawl fleet directed at Greenland halibut for the period 1985–2006 (Table 6.7, Fig. 6.6.) 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, as well as in 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 6.7).

Catch rates of Icelandic bottom trawlers decreased for all fishing grounds during 1990–1996 (Fig. 6.6.), but increased until 2000-2001. Since 2001 catch rates decreased to a record low in 2004, but has stabilised in 2006. The tendency over time is the same for all fishing grounds in Va Fig, 6.7.), although the less important fishing grounds in north, east and southeast show a more optimistic view in 2006. The derived effort has decreased from a record high in 2003 to a level similar to that prior to 1999. The directly measured effort from logbook information, suggest an effort pattern with a more pronounced maximum in 1996 and further that effort was stable from 2003 to 2004, but decreased in 2005 still being twice of the low in 1998 (Fig. 6.8.).

Div. Vb

Information from logbooks from the Faroese otterboard trawl fleet (>1000 hp) was available for the years 1991-2006 (Table 6.7, Fig. 6.9.-10.). 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 Greenland halibut consisted of more than 50% of the catches and conducted on depths more than 450 meters were selected for the analyses. The standardisation procedure for the logbooks were similar to 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, but increased from 2005 to 2006..

Div. 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 2006 91%). Hauls where targeted species was Greenland 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 1991–2006 were standardised in the same way as described for fleets in Va and so was effort (Table 6.7, Fig.6.11.). Catch rates maintained a high level until 1998, whereafter they decreased significantly from 1998 to 2000. Within the period 2000-2004 catch rates were stable, but since 2004 catch rates have increased considerably by about 40-50%%. The fishery in XIVb started in the late 1980'ies and annual catches have increased from below 500 tons before 1991 to 10 000 t in 2004 and 2005. 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 subdivisions, trace the 2005 CPUE increase to the southernmost areas while 2006 CPUE increase is mainly ocuring in more northerly subdivisions (Fig. 6.12.). Derived effort decreased from 2005 to 2006 by approx 33%.

The trend in CPUE series from Divisions Va, Vb and XIVb do not cohere in the period where time series are comparable. (Fig.6.6-6.11). 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.

Div. 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 (WGDEEP). 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 by-catch from the Spanish fleet since 1998. 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. In addition to the fishery in the Hatton bank area Greenland halibut has also previously been caught in the Reykjanes Ridge area of area XII. (Table 6.5-6.6).

6.4 Catch composition

Otoliths have been sampled from the Icelandic fishery in 2006 but as ageing have not been conducted in Iceland since 2001, no readings were available for the WG. Thus,. the only available aged otoliths in the entire area 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 has been conducted for Greenland halibut and the lack of a catch-at-age matrix do thus prevent an update of any analytical stock assessment approaches.

Length compositions of catches from the commercial trawl fishery in Div. Va are rather stable from year to year. In Fig. 6.13. is shown length distributions since 2000 and compared to average 1985-2006 from the western area of Iceland, comprising the most important fishing grounds. In most years catches are composed of fish smaller than long-term average. Fig. 6.14. show a comparison of length compositions of recent years catches in XIVb, Va and Vb. Fish size from Va are somewhat larger than in Vb and XIV.

6.5 Survey information

Div Va

An October groundfish survey in Icelandic waters (Fig. 6.15.), 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 approx. 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, but stabilised at a low level since 2004 (Figure 6.16.). Abundance indices by fish sizes indicated signs of improved recruitment until 2001, but a significant decrease since 2002 (Fig. 6.16-6.17.). Abundance have in recent years stabilised at a low. The trends in biomass and abundance since 2001 occurred in the entire surveyed area (Fig.6.15.)

Div 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. The survey is designed as an exploratory fishery where the skipper decides haul location; due to the design of the survey with a mix of fixed stations in combination with an exploratory part, and in addition to a shift on area coverage over time, it has been considered inappropriate as a biomass indicator at present time The catch rates from the survey shows a continuous downward trend since the beginning of the survey in 1995. (Fig. 6.18.)

Div. 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. 6.19.). No survey took place in 2001. Total biomass in 2006 was estimated at 23300 tons which is second highest in the time series and a increase compared to 13500 tons in 2005. (Fig. 6.20). Compared to the period 1999-2001, total biomass estimates for the period 2002-2005 is somewhat lower, while the 2006 estimate resemble that of the early period. . The index covering the commercial fishing grounds do also show an increase in 2006 although this is a slight increase.. A GLM analysis performed on the survey catch rates, taking into account area and depth did show a less optimistic development in catch rates in 2006(Fig. 6.21.).

SURVEY /DIVISION	NO HAULS IN 2006 (PLANNED HAULS)	DEPTH RANGE (M)	COVERAGE (KM^2)
Va	150 (150)	500-1300	130 000
XIVb	43 (70)	400-1500	29 000

In September 2006 an extension of the Greenland survey was conducted north (67°N - 72°N) of the area annually surveyed in East Greenland waters. The survey found poor concentrations of Greenland halibut and of 44 hauls were Greenland halibut only found in 18 hauls and only with one haul having a catch higher than 50 kg (30 min hauls)

Calibration of surveys in Va and XIVb

As a part of the 2006 surveys the Icelandic and the Greenlandic research vessels "Arni Fridriksson" and "Paamiut", respectively, met in Icelandic waters in October to conduct parallel trawling experiments. A total of 11 parallel hauls were made. The original plan called for more hauls but due to problems onboard Paamiut the experiment had to be halted. Because of the small number of hauls it was impossible to get good estimates of the relative trawling efficiency of the two vessels. However the average catch of Greenland halibut standardized to number or weight per km^2, was highest for Paamiut but there was no statistical difference (95% level) in the catches between the two vessels (Jørgensen *et al.* WD#26).

6.6 Stock Assessment

6.6.1 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 divisions adequately, while the survey/exploratory fishery in Vb is not considered a good biomass indicator.

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 second 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 especially in the north-western areas. Over the years also technological development of the fishing gear has probably increased catchability. Therefore CPUE series is considered less qualified as biomass indicators than surveys.

- Div. Va: Fishery and survey indices from Va show similar trends. The fall groundfish survey in Va (1996-2006) indicate a stabilisation at a low level in the last three years for all sizes of fish and in all surveyed areas. Within the same period as the Greenland survey in XIVb is conducted (1998-2006) the Icelandic survey increased catch rates until 2001 followed by a decline until 2004. Icelandic trawl CPUE in 1993-2006 are less than half that observed in 1985-1989. CPUE declined since 2001 but has stabilised in 2005-2006. In the last two years CPUE are currently 1/4 of that in 1985. Effort has increased over the entire time-series, but had a recent low in 1998-99. Effort lowered from 2004 to 2005-6 but is still high and is twice the 1998 effort (Fig. 6.8).
- Div. Vb: Faroese trawl CPUE (1991-2006) show a slight but continuous decrease in catch rates since 1994, following a significant decrease in the early years 1992-94. The Faroese survey/exploratory fishery decreases within the entire time series 1994-2006.
- Div. XIVb: The Greenland survey in XIV has stable biomass index in the period 1998-2005, but index increased in 2006 . Trawl CPUE's from the various fleets in XIVb have maintained three distinct periods, a period from 1994-1998 with high and stable CPUE following a decrease in 1998-2000, to a stable period with lower CPUE in 2000-2004. In 2005 and 2006 CPUEs increased markedly to the same level maintained in 1994-98.

6.6.2 A model based assessment

Assessment and management advice was derived using a stochastic version of the logistic production model and Bayesian inference (Hvingel et al. WD #25). The biomass dynamic process equation of this model was similar to the one used in previous assessments (within the ASPIC framework) and a continuation of that work.

6.6.2.1 Modelling framework

The model was built in a state-space framework (Hvingel and Kingsley 2006, Schnute 1994) with a set of parameters (θ) defining the dynamics of the stock. The posterior distribution for the parameters of the model, $p(\theta|data)$, given a joint prior distribution, $p(\theta)$, and the likelihood of the data, $p(data|\theta)$, was determined using Bayes' (1763) theorem:

(1) $$p(\theta \mid data) \propto p(data \mid \theta)\, p(\theta)$$

The posterior was derived by Monte-Carlo-Markov-Chain (MCMC) sampling methods using WinBUGS v.1.4.2 (Spiegelhalter et al. 2004).

The equation describing the state transition from time t to t+1 was a discrete form of the logistic model of population growth including fishing mortality (e.g. Schaefer (1954), and parameterised in terms of *MSY* (Maximum Sustainable Yield) rather than *r* (intrinsic growth rate) (cf. Fletcher 1978):

(2) $$B_{t+1} = B_t - C_t + 4MSY\frac{B_t}{K}\left(1-\frac{B_t}{K}\right)$$

K is the carrying capacity, or the equilibrium stock size in the absence of fishing; B_t is the stock biomass; C_t is the catch taken by the fishery.

To reduce the uncertainty introduced by the "catchabilities" (the parameters that scales biomass indices to real biomass) equation (2) was divided throughout by B_{MSY} (Hvingel and Kingsley 2006). Finally a term for the process error was applied and the state equation took the form:

(3) $$P_{t+1} = \left(P_t - \frac{C_t}{B_{MSY}} + \frac{2\,MSY\,P_t}{B_{MSY}}\left(1-\frac{P_t}{2}\right)\right)\cdot\exp(\nu_t)$$

where P_t is the stock biomass relative to biomass at MSY (P_t=B_t/B_{MSY}) in year t. This frames the range of stock biomass (*P*) on a relative scale where P_{MSY}=1 and *K*=2. The 'process errors', *ν*, are normally, independently and identically distributed with mean 0 and variance σ_ν^2 .

6.6.2.2 Input data

The model synthesized information from input priors and three independent series of Greenland halibut biomasses and one series of catches by the fishery (Table 6.2). The three series of GREENLAND HALIBUT biomass indices were: a standardised series of annual commercial-vessel catch rates for 1985–2006, $CPUE_t$,; and two trawl-survey biomass index for 1996–2006, Ice_t, and 1998-2006, $Green_t$. These indices were scaled to true biomass by catchability parameters, q_{cpue}, q_{Ice} and q_{Green} and lognormal observation errors , *ω, κ* and *ε* were applied, giving:

(4) $$\begin{aligned} CPUE_t &= q_{cpue}B_{MSY}P_t\exp(\omega_t) \\ Ice_t &= q_{Ice}B_{MSY}P_t\exp(\kappa_t) \\ Green_t &= q_{Green}B_{MSY}P_t\exp(\varepsilon_t) \end{aligned}$$

The error terms, *ω, κ* and *ε* are normally, independently and identically distributed with mean 0 and variance σ_{cpue}^2 , σ_{Ice}^2 and σ_{Green}^2 .

Total reported catch in ICES Subareas V, VI, XII and XI 1985-2006 was used as yield data (Table 6.1). The fishery being without major discarding problems or variable misreporting, reported catches were entered into the model as error-free.

Two additional biomass series were available. However, for unknown reasons the Greenland CPUE series showed trends conflicting with those of the other biomass indices – even if restricted to data just opposite the midline next to the Icelandic fishery and were therefore not included. The Faeroese survey covered areas contributing less than 4% of the total catches and was due to design not considered to reflect stock dynamics. This survey it was therefore not included either.

6.6.2.3 Input priors

There is usually little information about the pristine size of a stock. It is commonly assumed that $B_1 = K$, i.e. that the stock was at carrying capacity when records started. This assumption is questionable under any circumstances, but especially so when, as in the present case, the stock had already been fished for some years before the start of the observations. However, in 1985 when the data series starts the stock is considered still to be in its initial fases of exploitation and thus at a relatively high level. Instead of fixing P_1 at K we used a much less informative log-Normally distributed prior with median at 1.8 and 95% confidence limits between 1.5 and 2.25 (Table 6.8, Fig. 6.22).

Existing analyses indicated an estimated CV of around 12% for the Icelandic CPUE and survey series and about 20% for the Greenlandic survey series. Their standard deviations (observation errors) were therefore given inverse gamma distributions with modes corresponding to a CV at 12% and 20% respectively (Table 6.8).

The catchabilities q_{Ice} , q_{Green} and q_{cpue} are confounded with the carrying capacity K. A uniform distribution was therefore not non-informative, and a prior distributions uniform on a log scale was preferred as a reference prior (cf. Gelman et al. 1995, Punt and Hilborn 1997, McAllister and Kirkwood 1998, Hvingel and Kingsley 2006).

For the survey indices these distributions were truncated at -3 on the log scale as it was considered unlikely that these surveys would “see” less than 5% of the total stock. The prior for q_{cpue} was truncated at -10 and 1 (log scale) these values, as well as the upper truncation for q_{Ice} and q_{Green}, was chosen large enough as not to interfere with the posteriors.

Low-information or reference priors were given to *MSY*, *K,* and σ_v as we had little or no information on what their probability distributions might look like. *MSY* was given a uniform prior between 0 and 300 ktons. The upper limit was chosen high enough not to truncate the posterior distribution. *K* was given a wide distribution with a median of 2225 ktons and 95% of the distribution between 300 and 15000 ktons.

6.6.2.4 Model performance

Inference were made from samples from the converged part of the MCMC samples as identified by appropriate statistics (Hvingel et al. WD #25). The model was able to produce a reasonable simulation of the observed data (Fig. 6.23.). The probabilities of getting more extreme observations than the realised ones given in the data series on stock size were in the range of 0.13 to 0.93 i.e. the observations did not lie in the tails of their posterior distributions (Table 6.9). The CPUE series was generally better estimated than the survey series. In particular the first values for the Icelandic survey were interpreted as being too optimistic and 1999-2000 values for the Greenlandic survey was too pessimistic. The Greenlandic survey also overshoots somewhat in the two most recent years. Otherwise no major problems in capturing the variability of the data were detected.

For the parameter P_1 the posterior distribution tended to approximate the input prior (Fig. 6.22.). The prior for the “initial” stock biomass (P_1) was slightly informative giving credit to “close-to-virgin-stock-conditions” at the start of the series in 1985. Changing this prior to make it less informative by giving P_1 a uniform prior between 0 and 2.5 resulted in a slightly more pessimistic interpretation of stock status. This was in particular due to larger uncertainties in estimated stock sizes. However, the estimated posterior for *MSY* was only marginally affected.

The model was having problems estimating the upper limits for absolute stock size from the data alone. It would tend to include very high and unrealistic stock sizes if the catchabilities for the surveys were given reference priors from minus to plus infinity. If the catchability priors for the surveys were relaxed, the uncertainty of absolute stock size would increase in particular by extending the right hand tails of their posteriors. That would again increase the values of summary point estimates like means or medians of these distributions and therefore reduce similar point estimates of F. However, considering the entire probability distributions the results from the two models was not significantly different. Overall, the model was robust to changes in the priors for the process and observation errors. Further, the model estimates of stock sizes were relatively insensitive to additions of new data points (Fig. 6.24.).

The priors for *MSY* and *K* was significantly updated (Fig. 6.22). The posterior for *MSY* was positively skewed with a mode at 16 ktons and upper and lower quartiles at 12 ktons and 35 ktons (Table 6.10). As mentioned above *MSY* was relatively insensitive to changes in prior distributions. The posterior *K* had a mode at around 1000 ktons (Fig. 6.22) with an inter-quartile range of 800-1550 ktons (Table 6.10).

6.6.2.5 Assessment results

At the start of the time series, the estimated median biomass-ratio was above its MSY-level (Fig. 6.25.), and the probability that it had been below the optimum level was small for the following 5-year period (Fig. 6.26). While experiencing increasing fishing mortality to levels above Flim the stock then declined continuously until the mid 1990s to levels below the optimum, B_{msy}. Some rebuilding towards B_{msy} was then seen but in 2001 the stock started to decline again reaching its lowest level in 2004. Since then the stock has been stable at relative low levels. The risk of the biomass being below Bmsy in 2006 is 99% but only 2% of being below 30%Bmsy (Fig. 6.26.), which might be considered to be a limit reference.

The median fishing mortality ratio (*F-ratio*) has exceeded 1 (*Fmsy*) throughout the series (Fig. 6.26.). This parameter can only be estimated with relatively large uncertainty (Fig. 6.26.) and the posteriors therefore also include values below Fmsy. However, the probability that the F has exceeded Fmsy is high for most of the series (Fig.6.26).

The posterior for *MSY* was positively skewed with a mode at 16 ktons (Fig. 6.22.) and upper and lower quartiles at 12 ktons and 35 ktons (Table 6.10). As mentioned above MSY was insensitive to changes in prior distributions.

Within a one-year perspective the sensitivity of the stock biomass to alternative catch options seems rather low. This is due to the inertia of the model used (Hvingel et al WD25) and the low growth rate of the population. Risk associated with five optional catch levels for 2007 are as follows:

Catch option 2007 (ktons)	0	5	10	15	20	30
Risk of falling below B_{lim} ($0.3B_{MSY}$)	10 %	11 %	12 %	12 %	12 %	13 %
Risk of falling below B_{MSY}	98 %	99 %	99 %	99 %	99 %	99 %
Risk of exceeding F_{MSY}	-	28 %	58 %	77 %	87 %	95 %
Risk of exceeding F_{lim} ($1.7F_{MSY}$)	-	15 %	34 %	53 %	66 %	84 %

The risk trajectory associated with ten-year projections of stock development assuming annual catch ranging from 0 to 30 ktons were investigated (Fig. 6.27.). This risk is a result of the projected development of the stock and the increase in uncertainty as projections are carried forward.

Catches around 15 ktons are likely to maintain stock size around its current level, while larger catches have a higher probability of causing further reductions in stock size. Catch options below15 ktons will likely result in stock increase. Taking 20 and higher ktons/yr will increase risk of going below Blim to more than 30% within a 3-year period..The length distributions from the Icelandic survey are in agreement with the model predictions, i.e. there is no sign of above 1996-2006 average recruitment entering the fishable stock in the near future (Fig. 6.28).

6.6.2.6 Conclusions

- Stock status:
    - High probability (99%) of being below B_{msy}
    - 2% risk of being below suggested Blim (=30% B_{msy})
- Production potential:
    - Catches around 15 ktons are likely to maintain stock size around its current level
    - MSY 12-35 ktons (inter-quartile range)
- Current exploitation:
    - 89% risk of exceeding F_{msy}
    - 66% risk of exceeding suggested F_{lim} (=1.7F_{msy})
    - 2.3 times larger than the median F_{msy}
- Predictions:
    - Median stock biomass is projected to remain at the current level at catches of 15 ktons/yr – decrease at higher catches and increase if catches are kept below 15 ktons/yr.
    - As the stock is estimated to be relatively close to 30%B_{msy} the projected risk of exceeding this reference point increases at any catch level due to the inherent uncertainty in making projections
    - Median fishing mortality is not projected to decrease towards F_{msy} at catches of 15 ktons/yr, whereas annual catches of 10 ktons/yr are likely to result in a decreasing trend in *F* reaching F_{msy} within a 10-year period.

6.6.2.7 Discussion

(Hvingel et al. WD #25): In the Bayesian framework fundamental absence of information in the data will yield posteriors as a copy of the input priors. For the data to carry information on all the parameters of any such model the biomass should vary widely both above and below B_{MSY} (Hvingel and Kingsley 2006). If the available data does not span these conditions, problems in fitting stock-production models by any method can be expected (Hilborn and Walters 1992). The plot of the estimated stock (Fig. 6.25.) suggests that the available time series of stock biomass does in fact span the range from 20% to 90% of K. However, the contrast in the exploitation is relatively low and may be the cause of uncertainty in the estimated *MSY*. Precision will likely be improved if the series would include periods with low or no fishing.

Predicted stock dynamics are in this model determined by *MSY* and *K*. These parameters are not in reality constant over time, but vary with changes in a host of environmental factors (Hvingel and Kingsley 2006). When modelled with a time-invariant value, these parameters represent averages over time of their temporary values. The dynamics of the stock under the influence of fishing is also responding to variation in these basic parameters, which is therefore subsumed in the process error (Hvingel and Kingsley 2006). The model is therefore not suited to predict rapid changes in stock size caused by “abnormally” high or low recruitment events. Instead it will tend to average out such fluctuations and provide projections of trend in the series rather than precise values of individual years.

Additional power in short-term predictions may be gained by including information on stock demographics. Age information as translated from otolith readings are currently not considered reliable. However, information of length distribution is available from the Icelandic survey. Initial investigations indicated that recruitment modes in these data could be tracked trough time with an average growth of around 5 cm/yr (Fig. 6.28.). Including such information in the assessment model above could improve short-term predictions.

6.6.3 ASPIC

Formerly a stock-production model approach, ASPIC, has been performed for assessing the Greenland halibut stock. In 2002-2003 ASPIC was the accepted approach to assess the status of the stock. However, since 2004 ASPIC was not able to mimic the indices and failed in estimating the population parameters. This year exploratory exercises were carried out using Icelandic CPUE and survey and the Greenland survey, along with the total catches in V+XIV. From a retrospective analysis given in Fig. 6.29., it appears that F in 2006 is about 2.5 times the Fmsy, while biomass in 2006 is 30% of Bmsy. The estimation of the relative fishing mortality and biomass estimates failed in the retrospective analysis when final year was 2002. No further attempts were therefore made with this model. Instead an alternative approach using a stock production model in a Bayesian framework was conducted as provided in section 6.6.2.

6.6.4 Precautionary reference points

In 2002 a Fpa reference point was introduced in the advice for this stock. Limits for F and B were not explicitly defined. The Fpa was then set to 2/3Fmsy. Back calculating from that value via the formula: Flim = Fpa·exp(1.645σ), where σ = 0.3, as suggested in NWWG (2003) you get Flim=1.1Fmsy. The Blim corresponding to that is 0.9Bmsy (see method of calculations below). Setting reference points that imply a Blim close to Bmsy does in any circumstances not seem appropriate. Further, as the probability of transgressing reference points is calculated directly in this assessment and uncertainty in model estimates therefore explicitly accounted for “buffer reference points” are no longer needed. We therefore propose to introduce a new set of limit reference points as Blim=0.3Bmsy and Flim=1.7Fmsy based on the following considerations:

Blim

The Schaefer production curve fitted by the assessment model is the estimated stock-recruitment relation of the stock. The slope of this curve is decreasing linearly (Fig. 6.30) i.e. there is not a distinct “change-point” where recruitment starts to decline rapidly as the stock is reduced, which could provide a candidate for a Blim reference.

A Blim could instead be set in relation to the time it takes for the stock to recover from this point (cf. Cadrin 1999). The time needed to rebuild an overfished stock from Blim back to Bmsy depends on the stock size at Blim, the rate of growth and fishing mortality.

At 30%Bmsy production is reduced to 50% of its maximum (Fig. 6.30). This is equivalent to the SSB-level (spawning stock biomass) at 50% Rmax (maximum recruitment). Greenland Halibut is believed to be a slow growing species i.e. with relative low *r* (intrinsic rate of increase). This perception is in agreement with the estimated posterior *r* from the model which had 95% confidence intervals ranging from 0.01 to 0.33 (Fig. 6.31). This means that even without fishery it would take at least 6 years to rebuild the stock from 30%Bmsy to Bmsy (calculated by setting *r*=0.33) – but most likely more. If *r* = 0.15 (the 75th percentile of the estimated posterior) recovery time with F=0 is doubled to 12 years.

Once fished down to low levels the stock will, due to the predicted slow recovery potential, spend proportionally longer time at low levels once a recovery plan is implemented and fishing pressure is relaxed. Longer time at low levels means higher risk of “bad things” happening which could destabilise the stock. We therefore propose that the Blim be set no lower than 30% Bmsy.

Flim

An F-ratio (F/Fmsy) corresponding to a yield of 50%MSY (50%Rmax) at a stock biomass of 30%Bmsy (suggested Blim) may be derived from equation 3 as follows:

$$\frac{production}{B_{MSY}} = \frac{2\,MSY\,P_t}{B_{MSY}}\left(1-\frac{P_t}{2}\right),$$

at equilibrium: $C = production$ and

$$F = \frac{C}{B} = \frac{C}{B_{MSY}}\frac{B_{MSY}}{B} \Rightarrow$$

$$F = \frac{2\,MSY\,P_t}{B_{MSY}}\left(1-\frac{P_t}{2}\right)\frac{1}{P}, \quad \text{as } F_{MSY} = \frac{MSY}{B_{MSY}} \Rightarrow$$

$$\frac{F}{F_{MSY}} = Fratio = 2 - P$$

if Blim is 30%Bmsy (P=0.3) then the corresponding Fratio is 1.7 (Fig. 6.30). The proposed Flim at 1.7Fmsy is the fishing mortality that will drive the stock biomass to Blim.

6.7 Management Considerations

Available biological information and information on distribution of the fisheries suggest that Greenland halibut in XIV and V belong to the same entity and do mix. Historic information on tag-recapture experiments in Iceland have shown that Greenland halibut migrate around Iceland. Similar information from Greenland suggests some mix, both between West Greenland and Iceland but also between East Greenland and Iceland. Therefore, management of the stock needs to be in accordance for the present three distinct management areas, XIV, Va and Vb. At present 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.

6.8 Comments on the Assessment .

In the 1990's a VPA was conducted to assess the state of the stock. Only the Icelandic trawler fleet was available for calibration of the VPA.Due to diagnostic problems with the VPA and a strong retrospective pattern in the estimation of F and SSB this approach was rejected in 2000. Also ageing problems caused the rejection of an age based assessment model. At the same time age reading ceased in the main fishing lab dealing with assessment of the stock. This still prevents the reversion to an age based assessment. In 2001 – 2004 a stock production model was used as basis for the advice (ASPIC). In 2004 the ASPIC were not able to track the indices (Icelandic survey and CPUE) and thus rejected as an assessment approach. State of the stock in 2004-2006 was entirely based on indices from surveys and the commercial fishery. In 2006 the stock production model was explored in a Bayesian framework, which has been further developed in this assessment.

6.8.1 Data consideration

The Icelandic CPUE series has for a decade in the 1990s been used as a biomass indicator in the assessment of the stock. However, with the appearance of the new fisheries and surveys in XIV and Vb, indices for those areas were compiled. The commercial CPUE indices are based on haul by haul data from logbooks, and the fisheries for Greenland halibut in the entire area are clean fishery with minor by-catches indices. Thus the quality of these sources are considered good. Despite these qualities, it cannot be out ruled that they are poor biomass indicators due to an assumed scattered distribution of Greenland halibut. Also poor knowledge of stock structure and distribution of the life stages in the area prevent interpretation of the indices and also their use in any model framework. Thus, for the present model framework, a stock production model, that requires cpue indices, it was necessary to reject the Greenland survey due to a contrasting signal to the other indices ,although the quality of the Greenland survey data is considered similar to the series included in the model.

6.8.2 Assessment quality

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 area is not fully understood, any stock index are not easily selected to describe the entire stock development. Among many, one possibility 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. Work is ongoing on age interpretation from otoliths. Preliminary results suggests that Greenland halibut grow slower than previously thought,

The precision of the survey estimates in XIVb and in Va is equal with cv's within the range 15-20%.

6.8.3 Response to ACFM, Technical Minutes

The ACFM review group in its 2006 technical minutes focus on two issues for the Greenland halibut assessment. The WG did address the issues as follows:

- "Maps showing the distribution of catches and effort were very instructive, and were much appreciated.". In section 6.2, Figures 6.2.-5. provide catch and effort distribution for the entire assessment area.
- "The attempts to synthetise the available information through an assessment model framework is appreciated. In addition to the attempts to elaborate on the production model concept, the WG is encouraged to explore a wider range of approaches. Length based methods could be one possible alternative to look at". The WG has further developed the stock production model and the approach is described in Section 6.6.2.

**Table 6.1 GREENLAND HALIBUT. Nominal landings (tonnes) by countries,
in Sub-areas V, VI, XII and XIV 1981-2005, 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	1997	1998
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	30 309 #	20 382

Country	1999	2000	2001	2002	2003 [1]	2004 [1]	2005 [1]	2006 [1]
Denmark		-	-	-	-	-	-	-
Estonia		-	-	8	-	-	5	3
Faroe Islands	3 884	-	121	334	458	338	1 150	829
France	-	2	32	290	177	157	-	64
Germany	3 082	3 265	2 800	2 050	2 948	5 169	5 150	4 299
Greenland	200	1 740	1 553	1 887	1 459	-	-	-
Iceland	11 180	14 537	16 590	19 224	20 366	15 478	13 023	-
Ireland		-	56	-	-	-	-	-
Lithuania		-	-	-	2	1	-	2
Norway	1 187	1 750	2 243	1 998	1 074	1 233	1 124	1 073
Poland		-	2	16	93	207	-	-
Portugal		-	6	130	-	-	-	-
Russia	138	183	187	44	-	262	-	547
Spain		779	1 698	1 395	3 075	4 721	506	-
UK (Engl. and Wales)	261	370	227	71	40	49	10	-
UK (Scotland)	69	121	130	181	367	367	391	-
United Kingdom	-	166	252	255	841	1 304	220	95
Total	20 001	22 913	25 897	27 883	30 900	29 286	21 579	6 912
Working Group estimate	20 371	26 644	27 291	29 158	30 891	27 102	24 978	21 432

1) Provisional data

Table 6.2 GREENLAND HALIBUT. Nominal landings (tonnes) by countries, in Division Va 1981-2005, 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]	2005 [1]	2006 [1]
Faroe Islands	9		15	7	34	29	77	15
Germany	13	22	50	31	23	10	6	1
Greenland								
Iceland	11 087	14 507	2 310 [4]	2 277 [4]	20 360	15 478	13 023	
Norway							100	
Russia								
UK (E/W/I)	26	73	50	21	16	8	8	
UK Scottland	3	5	12	16	5	2	27	
UK								2
Total	11 138	14 607	2 437	2 352	20 438	15 527	13 241	18
Working Group estimate		14 607	16 752	19 714	20 415	15 477	13 172	11 817

1) Provisional data
2) Includes 223 t catch by Norway.
3) Includes 12 t catch by Norway.
4) fished in Icelandic EEZ, but allocated to XIVb

Table 6.3 GREENLAND HALIBUT. Nominal landings (tonnes) by countries, in Division Vb 1981-2005 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]	-	-		-	-	-58

Country	1999	2000 [1]	2001 [1]	2002 [1]	2003 [1]	2004 [1]	2005 [1]	2006 [1]
Denmark								
Faroe Islands	3873		106	13	58	35	887	814
France		1	32	4	8	17		40
Germany	22							
Iceland								
Ireland								
Norway	87	1	2	1	1		1	
UK (Engl. and Wales)	9	35	77	50	24	41	2	
UK (Scotland)	66	116	118	141	174	87	204	
United Kingdom								19
Total	4057	153	335	209	265	180	1 094	873
Working Group estimate	2694 [2]	5079	3 951	2 694	2 459	1 771	892	

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 6.4 GREENLAND HALIBUT. Nominal landings (tonnes) by countries, in Sub-area XIV 1981-2005, 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]	2005 [1]	2006 [1]
Denmark								
Faroe Islands	2			274	366	274	186	
Germany	3047	3243	2 750	2 019	2 925	5 159	5 144	4 298
Greenland	200 [1,4]	1740	1 553	1 887	1 459			
Iceland	93	30	14 280	16 947	6			
Ireland			7					
Norway	1100	1161	1 424	1 660	846	1 114	1 023	1 070
Poland						205		
Portugal			6	130				
Russia	138	183	186	44		261		500
Spain		8	10		2 131	3 406	2	
UK (Engl. and Wales)	226	262	100					
UK (Scotland)				24	188	278	160	
United Kingdom				178	799	1 294		
Total	4806	6627	20 316	23 163 0	8 720	11 991	6 515	5 868
Working Group estimate	5376 [11]	6958	6 588 [6]	6 750 [6]	8 017	9 854	10 185	8 589

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) Does not include most of the Icelandic catch as those are included in WG estimate of Va.

7) Excluding 138 t reported as area unknown.

Table 6.5 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]	2005 [1]	2006 [1]
Faroe Islands		47					40				
France					1			4	30		
Ireland						49					
Lithuania								2	1		2
Poland						2		2	1		
Spain [2]	2	42	67	137	751	1338	28	730	1145	501	
UK					7	5				3	
Russia											46
Norway	2				553	500	316	201	119		
Estonia											2
Total	4	89	67	137	1 312	1 894	384	939	1 296	504	50
WG estimate											

[1] Provisional data

[2] Based on estimates by observers onboard vessels

Table 6.6 GREENLAND HALIBUT. Nominal landings (tonnes) by countries in Sub-area VI, as officially reported to the ICES and estimated by WG.

Country	1996	1997	1998	1999	2000	2001	2002	2003 [1]	2004 [1]	2005 [1]	2006 [1]
Estonia							8			5	1
Faroe Islands											
France							286	165	110		24
Poland							16	91	1		
Spain [2]			22	88	20	350	1367	214	170	3	
UK					159	247	77	42	10	217	74
Russia						1			1		1
Norway					35	317	21	26			3
Total	0	0	22	88	214	915	1775	538	292	225	103
WG estimate											

[1] Provisional data

[2] Based on estimates by observers onboard vessels

Table 6.7. CPUE indices oftrawl fleets in Div Va, Vb and XIVb as derived from GLM multiplicative models.

area	year	cpue	% change in CPUE between years	landings	relative derived effort	% change in effort between years
Iceland Va	1985	1.00		29 197	100	
	1986	1.01	1	31 027	105	5
	1987	1.07	6	44 659	136	29
	1988	1.08	1	49 379	110	-19
	1989	1.03	-4	59 049	125	14
	1990	0.70	-32	37 308	93	-26
	1991	0.68	-3	35 413	98	6
	1992	0.60	-13	31 978	103	5
	1993	0.47	-21	34 134	135	31
	1994	0.39	-18	28 608	102	-24
	1995	0.31	-21	27 391	121	18
	1996	0.26	-15	22 073	95	-22
	1997	0.28	7	16 792	71	-25
	1998	0.44	57	10 595	40	-44
	1999	0.50	14	11 138	92	129
	2000	0.57	15	14 607	114	24
	2001	0.59	3	16 755	111	-3
	2002	0.49	-17	19 714	142	28
	2003	0.32	-34	20 415	156	10
	2004	0.22	-32	15 477	111	-29
	2005	0.24	8	13 015	78	-30
	2006	0.24	0	11 817	91	16
Greenland, XIVb	1991	1.00		875	100	0
	1992	0.93	-7	1 176	144	44
	1993	2.54	173	2 249	70	-51
	1994	3.13	23	3 125	113	61
	1995	3.31	6	5 077	154	36
	1996	3.30	0	7 283	144	-6
	1997	3.44	4	8 558	113	-22
	1998	3.23	-6	5 940	74	-34
	1999	2.56	-21	5 376	114	54
	2000	2.21	-14	6 958	150	31
	2001	2.09	-6	7 216	110	-27
	2002	2.27	9	6 750	86	-22
	2003	2.27	0	8 017	119	38
	2004	2.23	-2	9 854	125	5
	2005	3.06	37	10 185	75	-40
	2006	3.52	15	8589	73	-2
Faroe Islands, Vb	1991	1.00		1 662	100	33
	1992	1.09	9	2 269	125	25
	1993	0.83	-24	4 434	258	107
	1994	0.54	-35	5 225	181	-30
	1995	0.57	5	3 832	70	-61
	1996	0.58	3	6 469	164	135
	1997	0.55	-6	4 870	80	-51
	1998	0.44	-19	3 825	97	22
	1999	0.46	4	4 265	108	11
	2000	0.53	17	5 079	102	-5
	2001	0.48	-11	3 245	72	-30
	2002	0.43	-8	2 694	91	26
	2003	0.53	23	2 426	73	-19
	2004	0.40	-25	1 771	98	33
	2005	0.37	-8	892	55	-44
	2006	0.49	35	873	72	32

Table 6.8. Priors used in the model. ~ means "distributed as..", dunif = uniform-, dlnorm = lognormal-, dnorm= normal- and dgamma = gammadistributed. Symbols as in text.

[redacted]

Year	CPUE		Survey Ice		Survey Green	
	resid.(%)	p.extreame	resid.(%)	p.extreame	resid.(%)	p.extreame
1985	1.39	0.47	-	-	-	-
1986	0.92	0.47	-	-	-	-
1987	-0.76	0.52	-	-	-	-
1988	-1.96	0.56	-	-	-	-
1989	-5.27	0.65	-	-	-	-
1990	4.27	0.37	-	-	-	-
1991	-1.40	0.55	-	-	-	-
1992	-2.05	0.56	-	-	-	-
1993	0.42	0.48	-	-	-	-
1994	0.15	0.49	-	-	-	-
1995	4.30	0.39	-	-	-	-
1996	12.84	0.18	-20.82	0.83	-	-
1997	16.19	0.13	-30.55	0.93	-	-
1998	-1.54	0.56	-3.45	0.57	0.02	0.46
1999	-2.92	0.58	-13.34	0.75	0.34	0.07
2000	-13.20	0.83	17.41	0.20	0.23	0.15
2001	-5.86	0.67	-6.08	0.62	-	-
2002	-5.18	0.65	-7.69	0.66	-0.07	0.62
2003	-5.24	0.66	16.51	0.21	0.01	0.48
2004	3.18	0.39	29.79	0.07	0.02	0.46
2005	2.48	0.42	2.99	0.45	-0.23	0.84
2006	-0.24	0.50	19.08	0.17	-0.31	0.91

Table 6.9. Model diagnostics: residuals (% of observed value), probability of getting a more extreme observation (p.extreame; see text for explanation).

Table 6.10. Summary of parameter estimates: mean, standard deviation (sd) and 25, 50, and 75 percentiles of the posterior distribution of selected parameters (symbols as in the text).

[redacted]

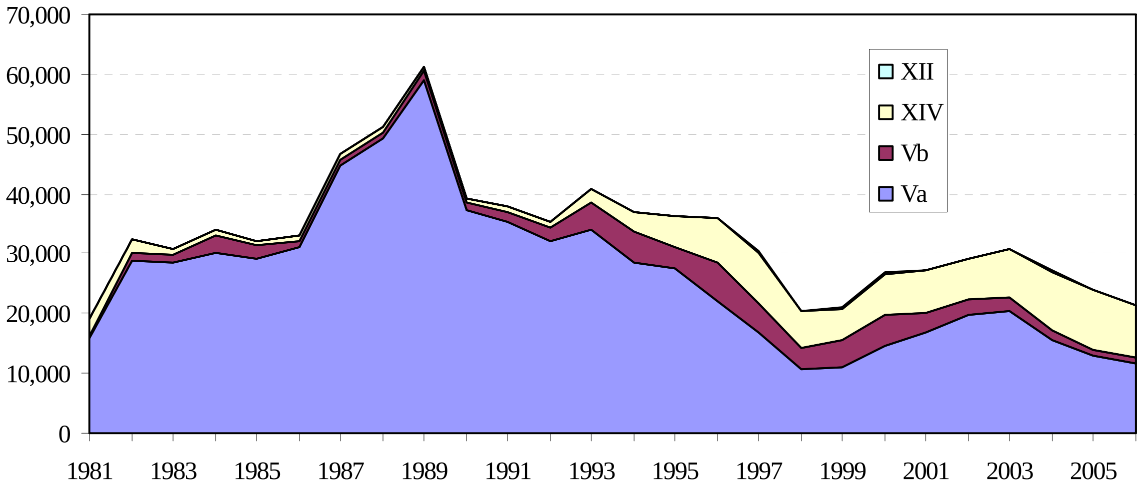


Figure 6.1. Landings of Greenland halibut in Divisions V, XI and XIV. As the landings within Icelandic waters, since 1976, have not officially been separated and reported according to the defined ICES statistical areas, they are set under area Va by the North Western Working Group.

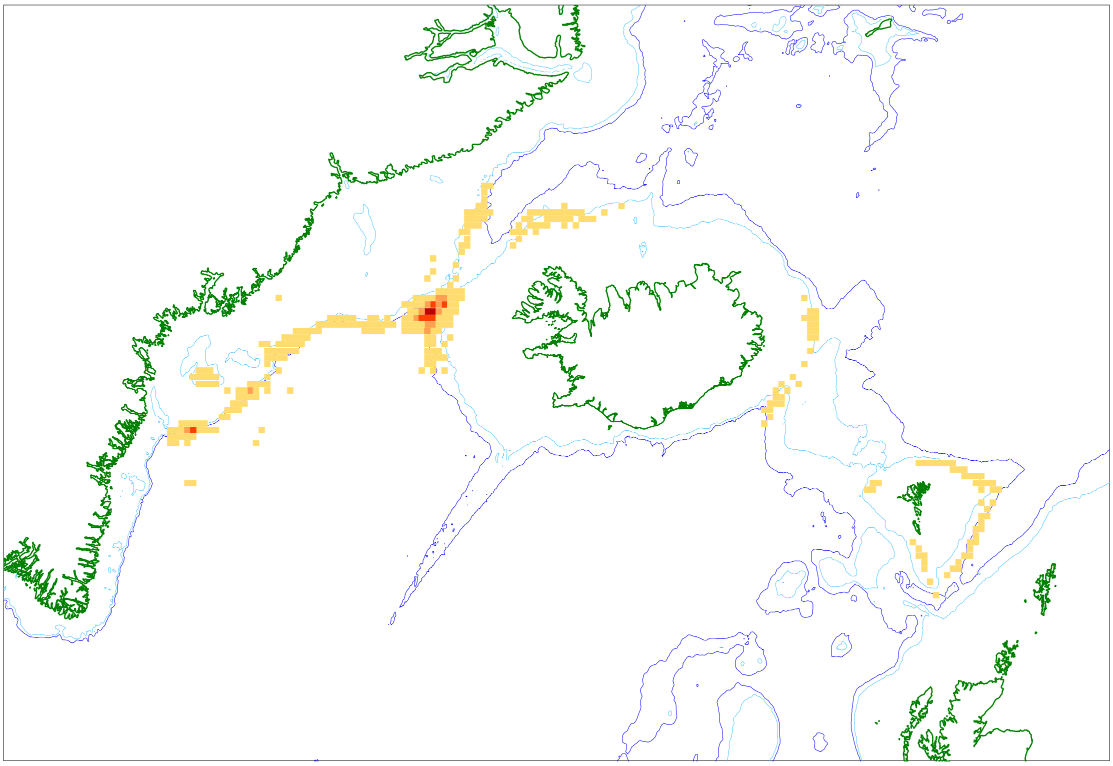


Figure 6.2. Distribution of effort in the fishery in 2006. 500m and 1000 m depth contours are shown

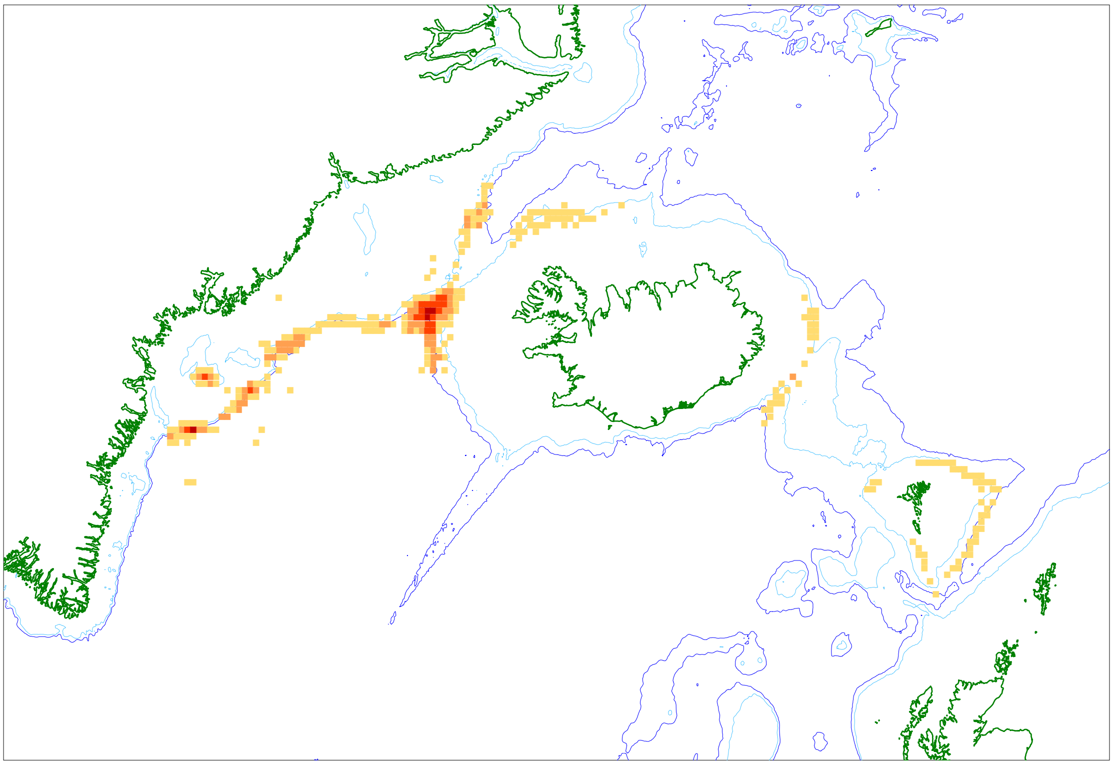


Figure 6.3. Distribution of catches in the fishery in 2006. 500m and 1000 m depth contours are shown

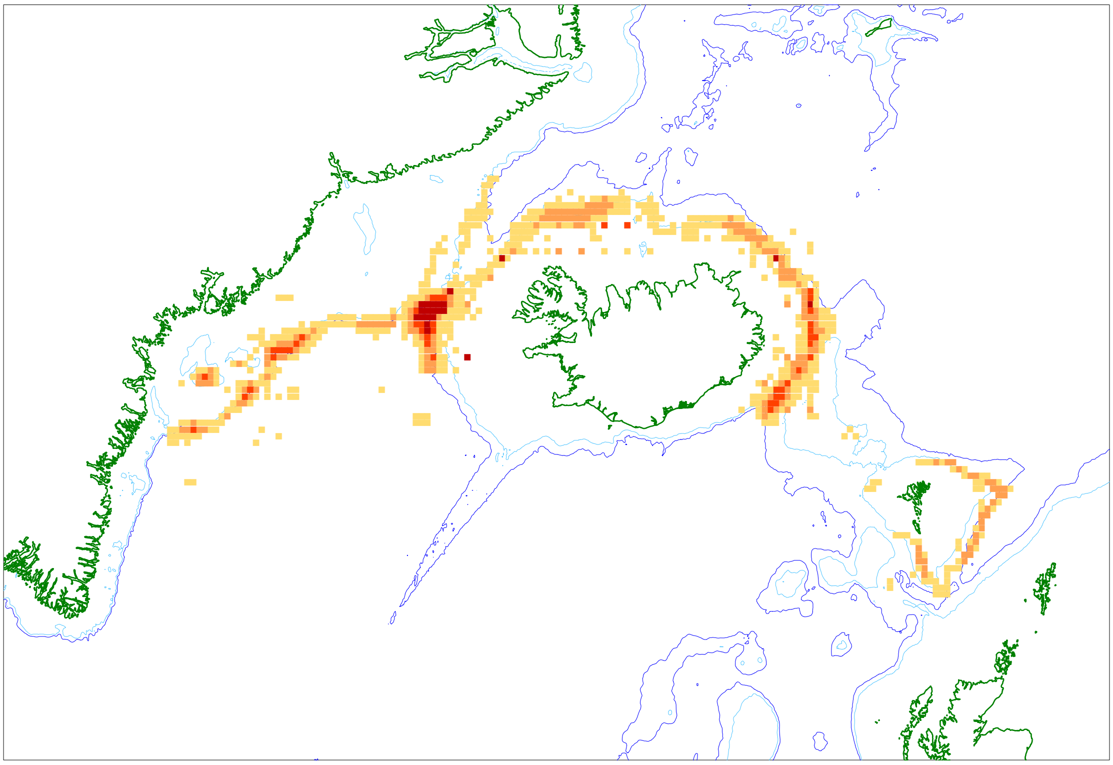


Figure 6.4. Distribution of total effort in the fishery 1991-2006. 500m and 1000 m depth contours are shown.

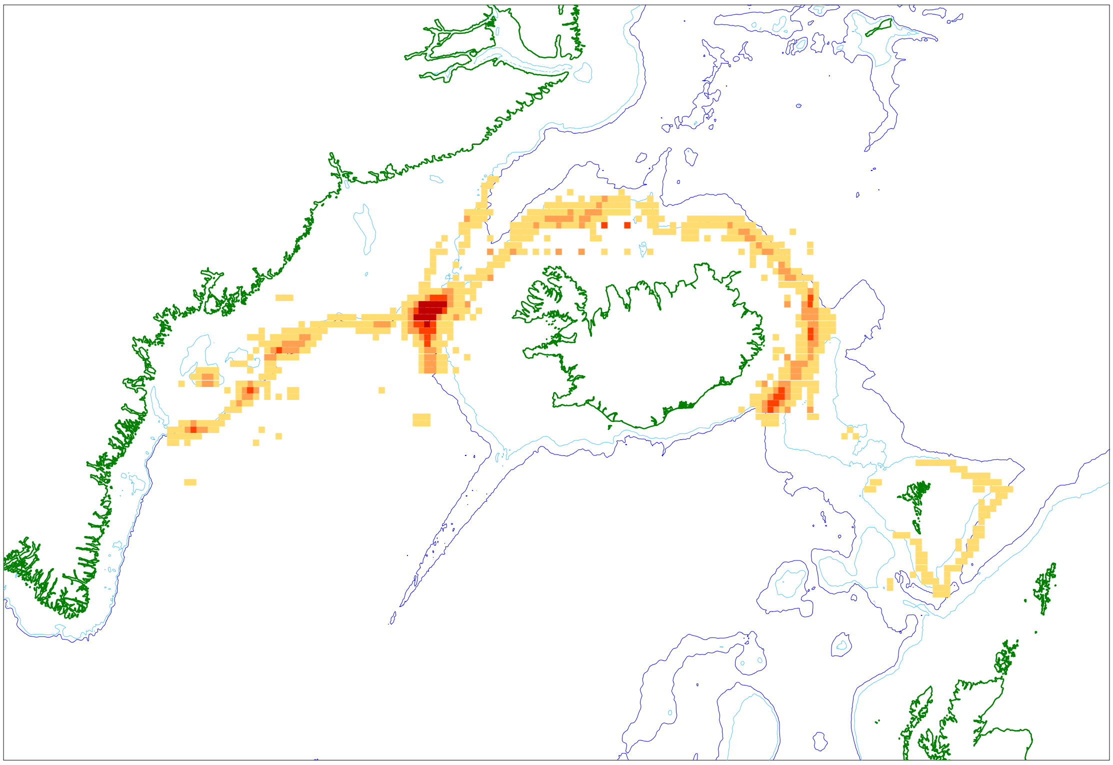


Figure 6.5. Distribution of total catches in the fishery 1991-2006. 500m and 1000 m depth contours are shown.

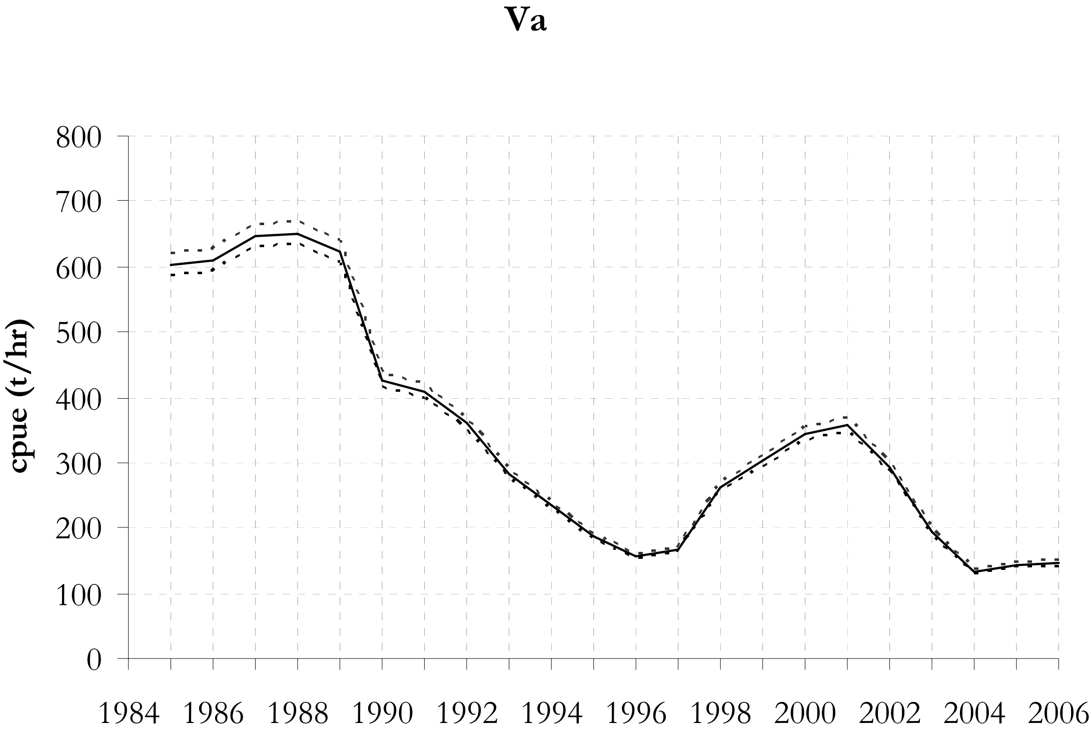


Figure 6.6. Standardised CPUE from the Icelandic trawler fleet in Va. 95% CI indicated.

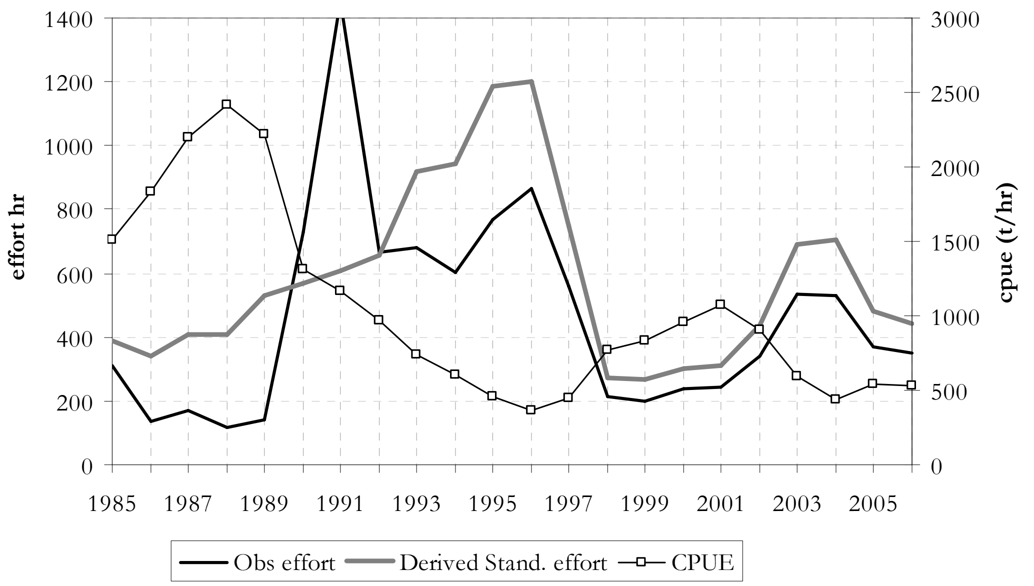


Figure 6.7 Standardised CPUE from the Icelandic trawler fleet in Va by four main fishing areas in Va. 95% CI indicated.

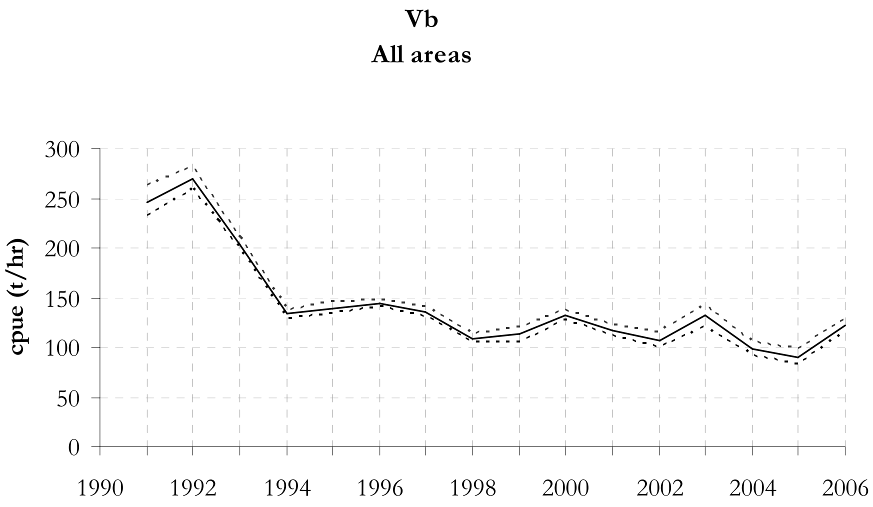


Figure 6.8. CPUE, observed and derived effort from Icelandic trawl fishery.

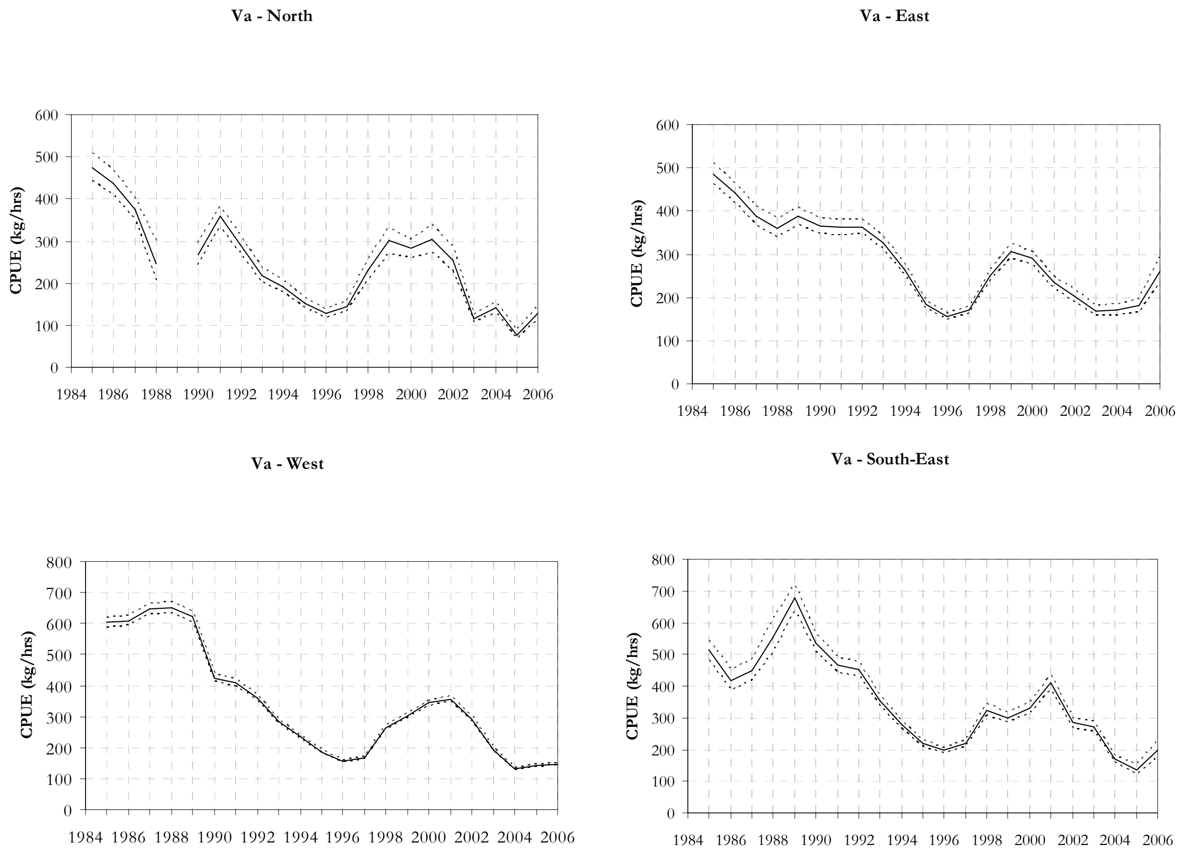


Figure 6.9. Standardised CPUE from the Faroese trawler fleet. 95% CI indicated

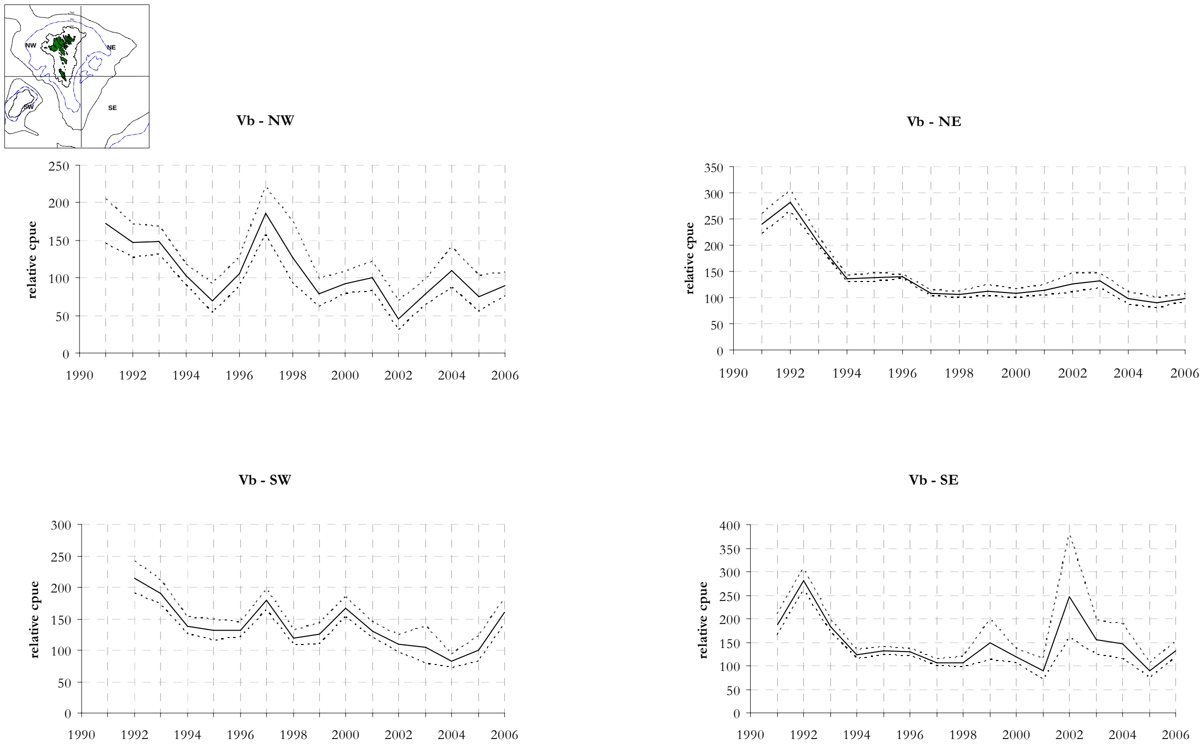


Figure 6.10. Standardised CPUE from the Faroese trawler fleet by four fishing areas as indicated on map. 95% CI indicated.

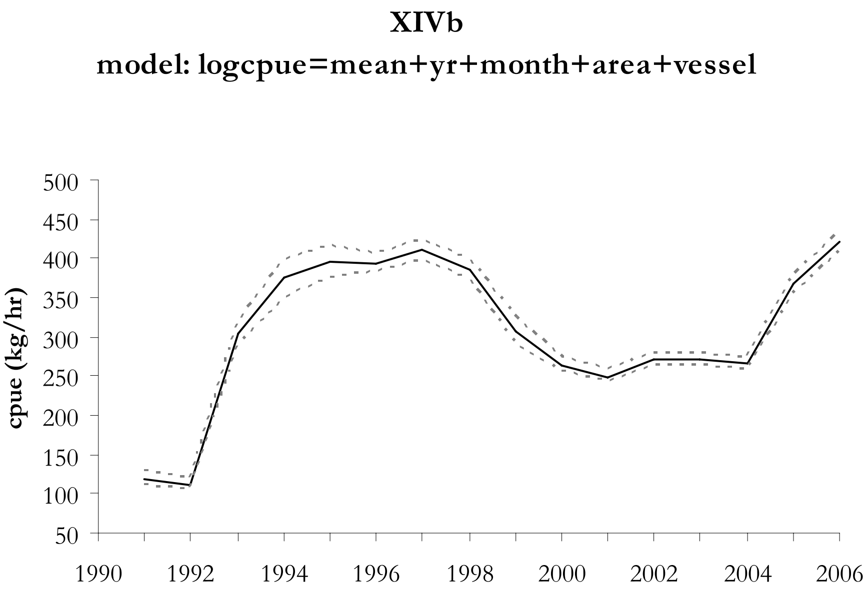


Figure 6.11. Standardised CPUE from trawler fleets in XIVb. 95% CI indicated

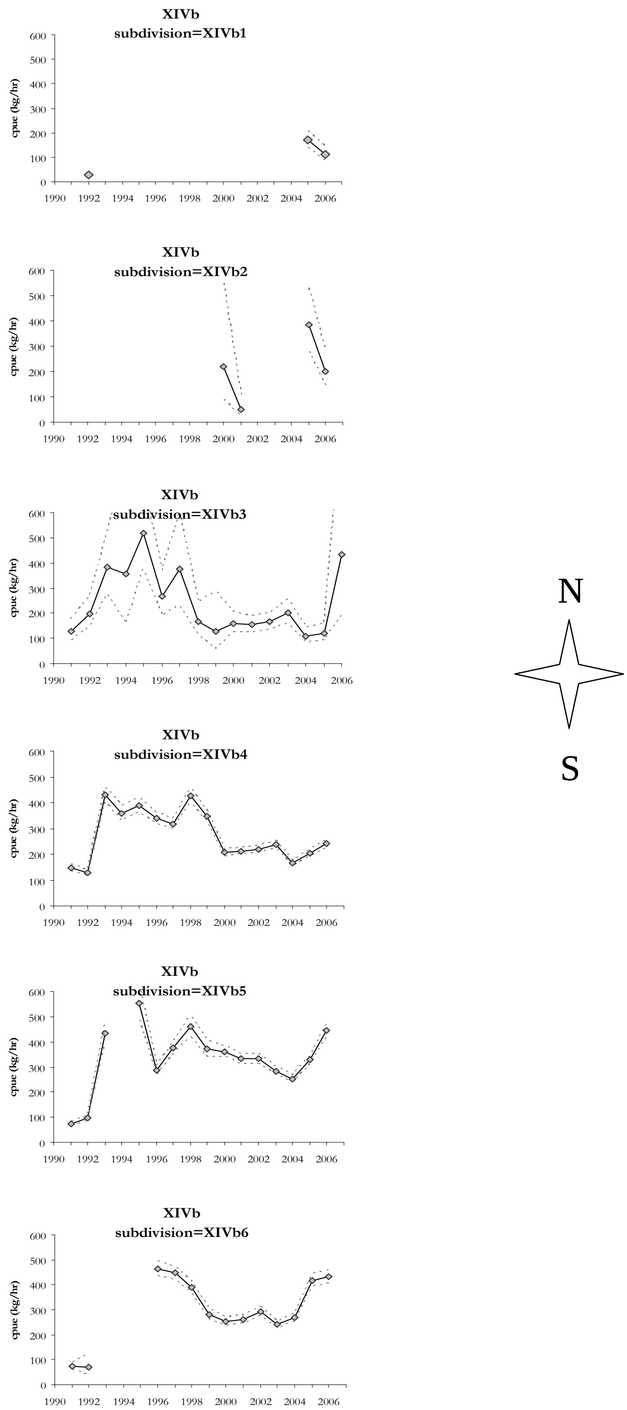


Figure 6.12. Standardised CPUE from trawler fleets in XIVb shown by subdivision in XIVb. 95% CI indicated.

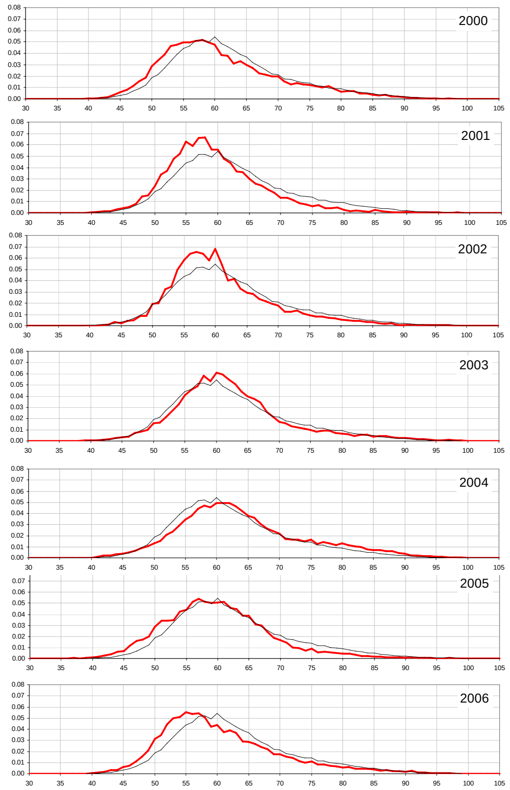


Figure. 6.13. Length distributions from the commercial trawlfishery in the western fishing grounds of Iceland (Va) in the years 2000 – 2006. The thin solid line is average of 1985-2005 and the thick solid line is annual distribution.

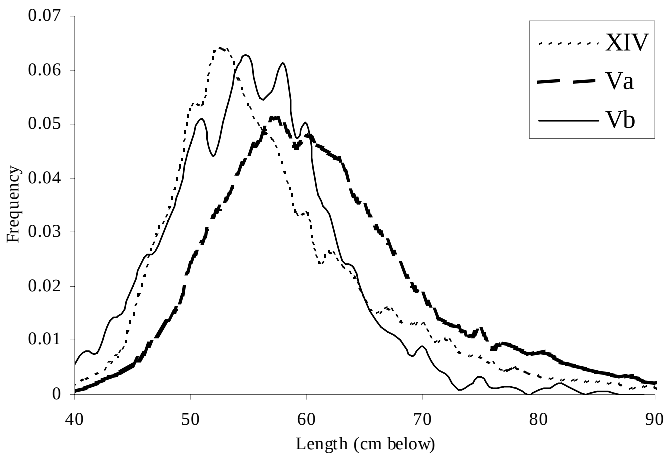


Figure 6.14. Length distributions of Greenland halibut caught in the commercial fishery in ICES Va, Vb and XIV in 2004-2006. Each year weighted equally.

Figure 6.15. Distribution of catches from the Icelandic fall survey 1996-2006.

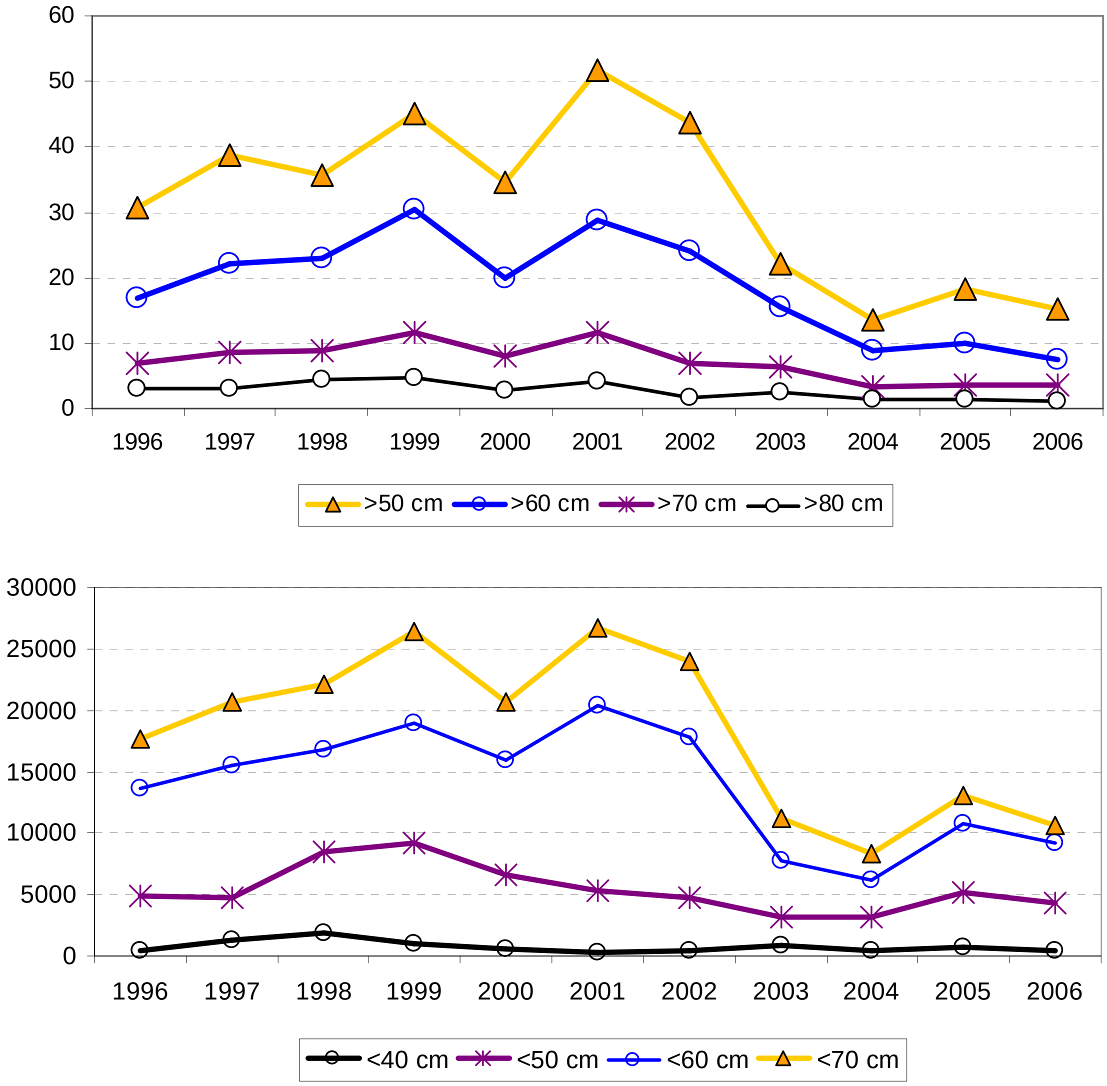


Figure 6.16. Greenland halibut in Icelandic fall groundfish survey; UPPER: biomass indices of lengths larger than indicated and, LOWER: abundance indices by length smaller than indicated.

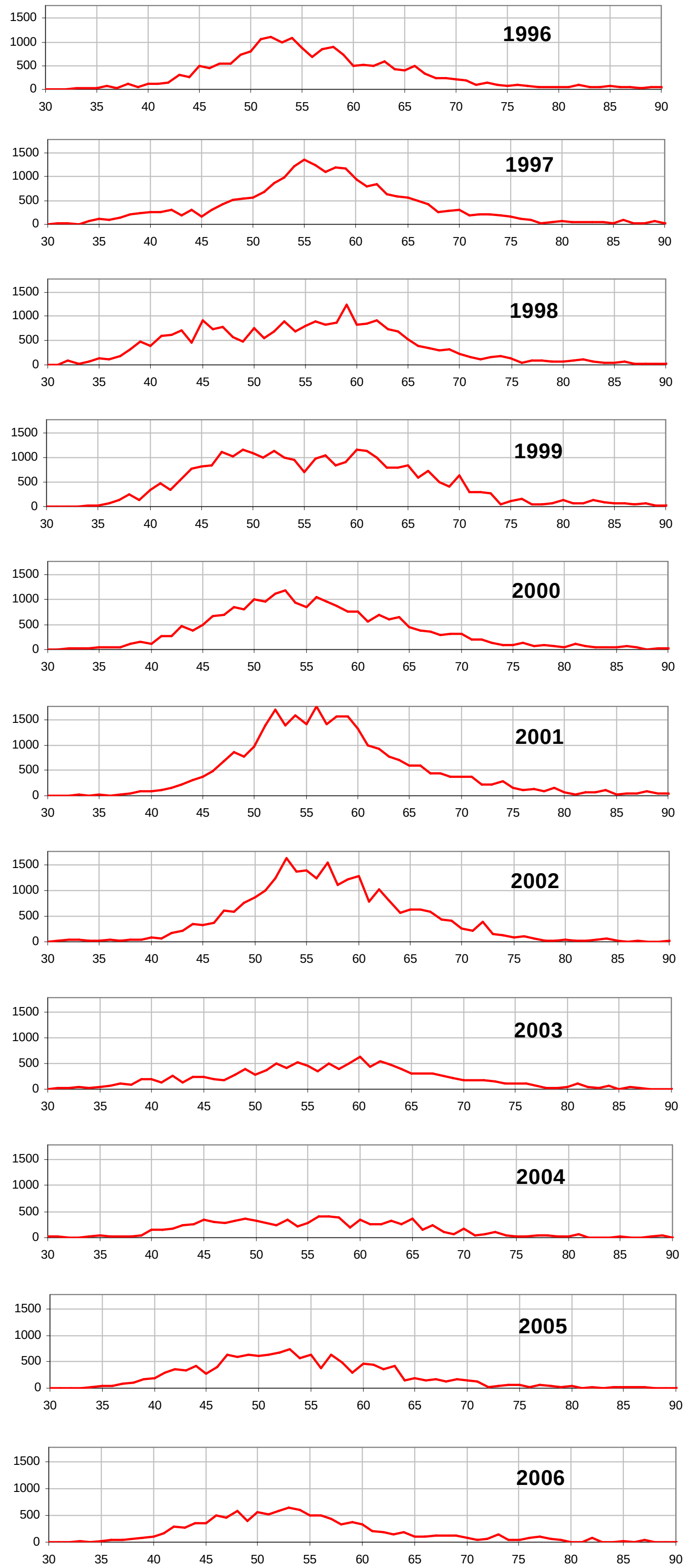


Figure 6.17. Abundance indices by length for the Icelandic fall survey 1996-2006.

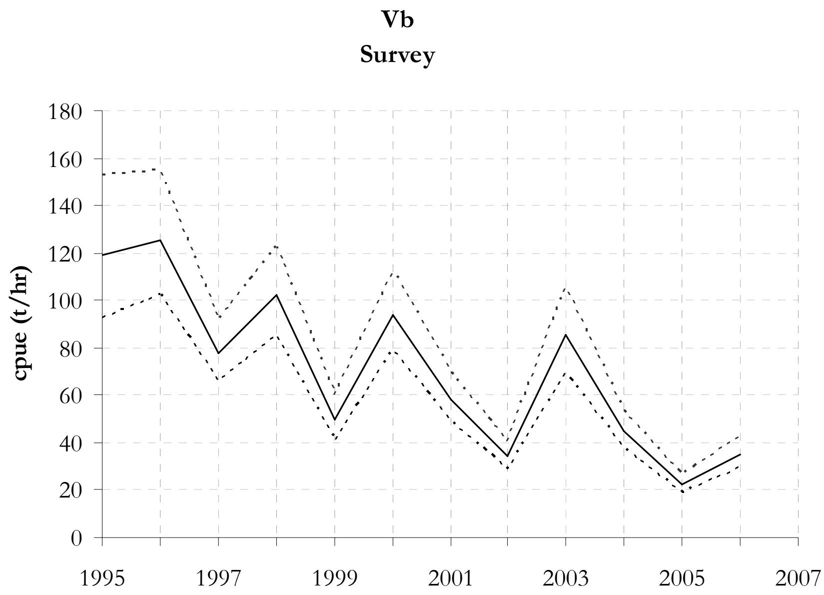


Figure 6.18. Catch rates from a combined survey/fishermans survey in Vb.

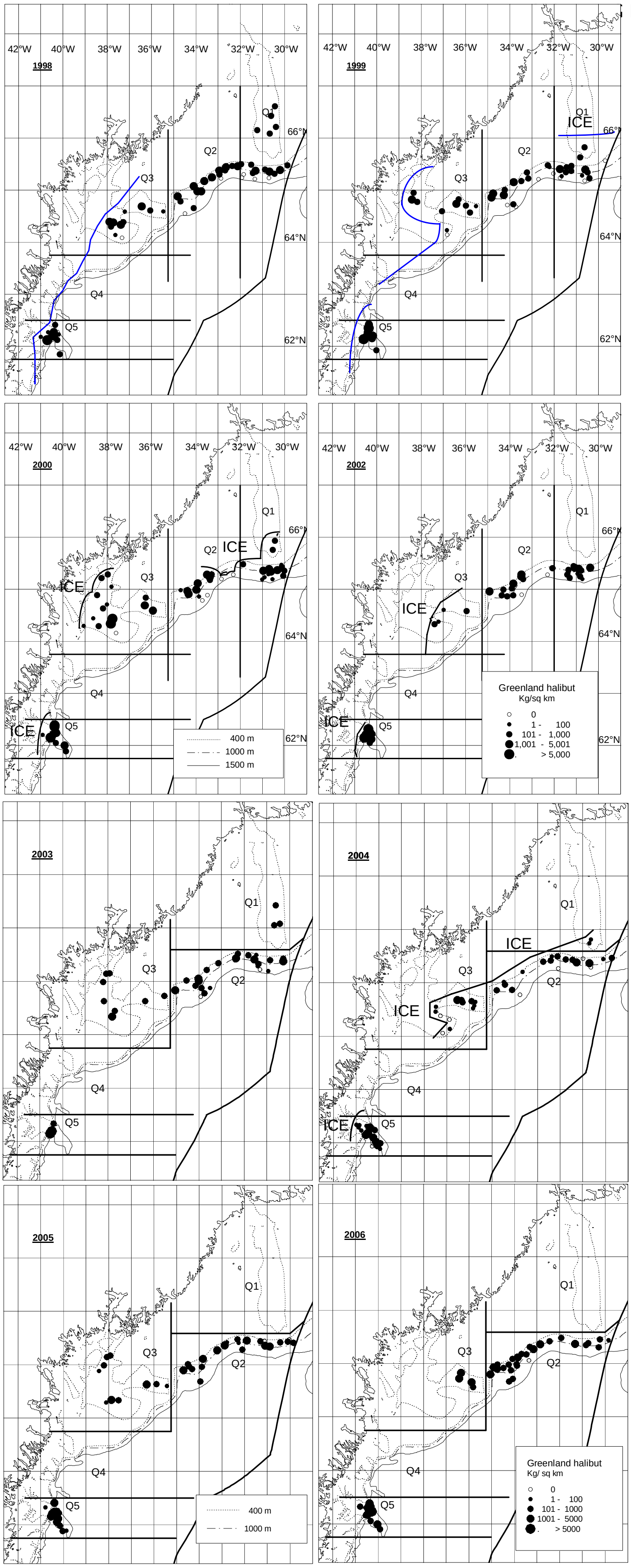


Figure 6.19. Distribution of catches of Greenland halibut at East Greenland in 1998 – 2006 in the Greenland deep-water survey.

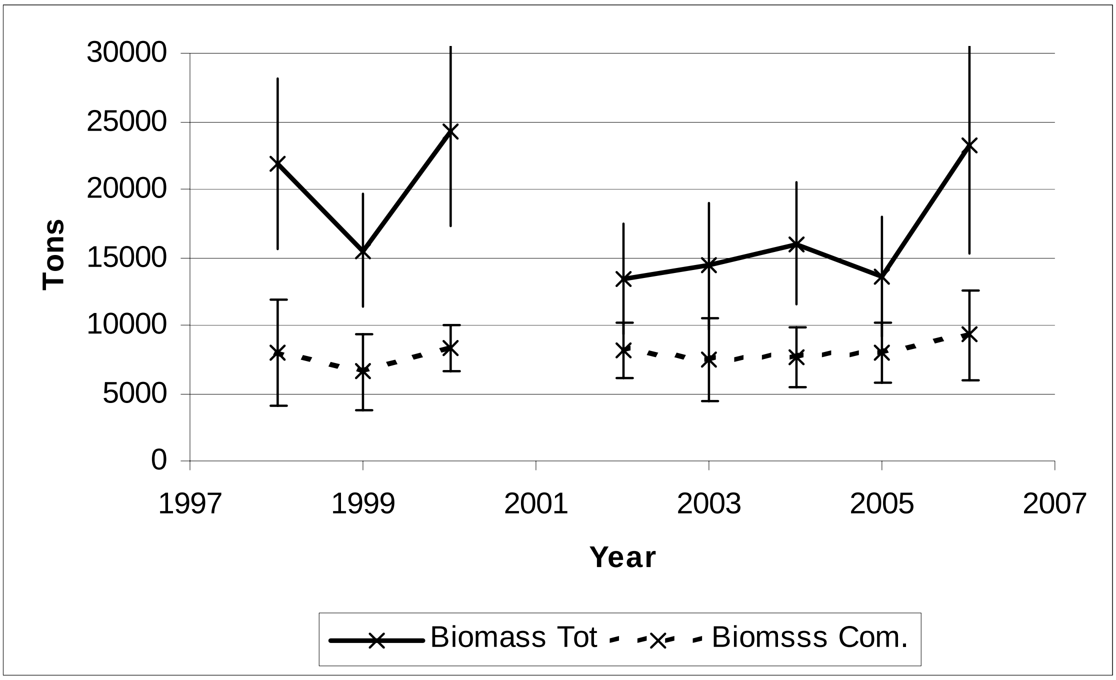


Figure 6.20. Estimated Biomass (t) in div. XIVb from the Greenland deep-water trawl survey with 95% CI indicated.Biomass Tot is is swept area estimates for the entire survey area, Biomass Com.is swept area estimates for strata Q2 and Q5 covered all years.

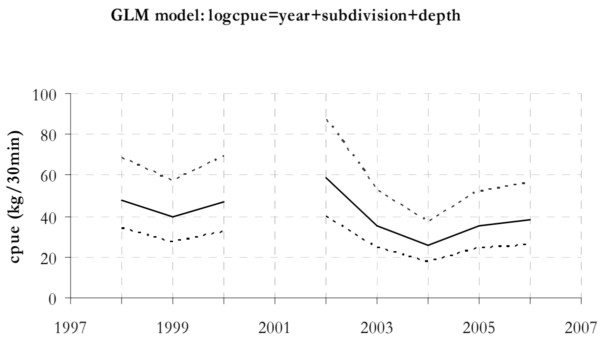


Figure 6.21. Standardised catch rates from the Greenland survey.(95% CI indicated.)

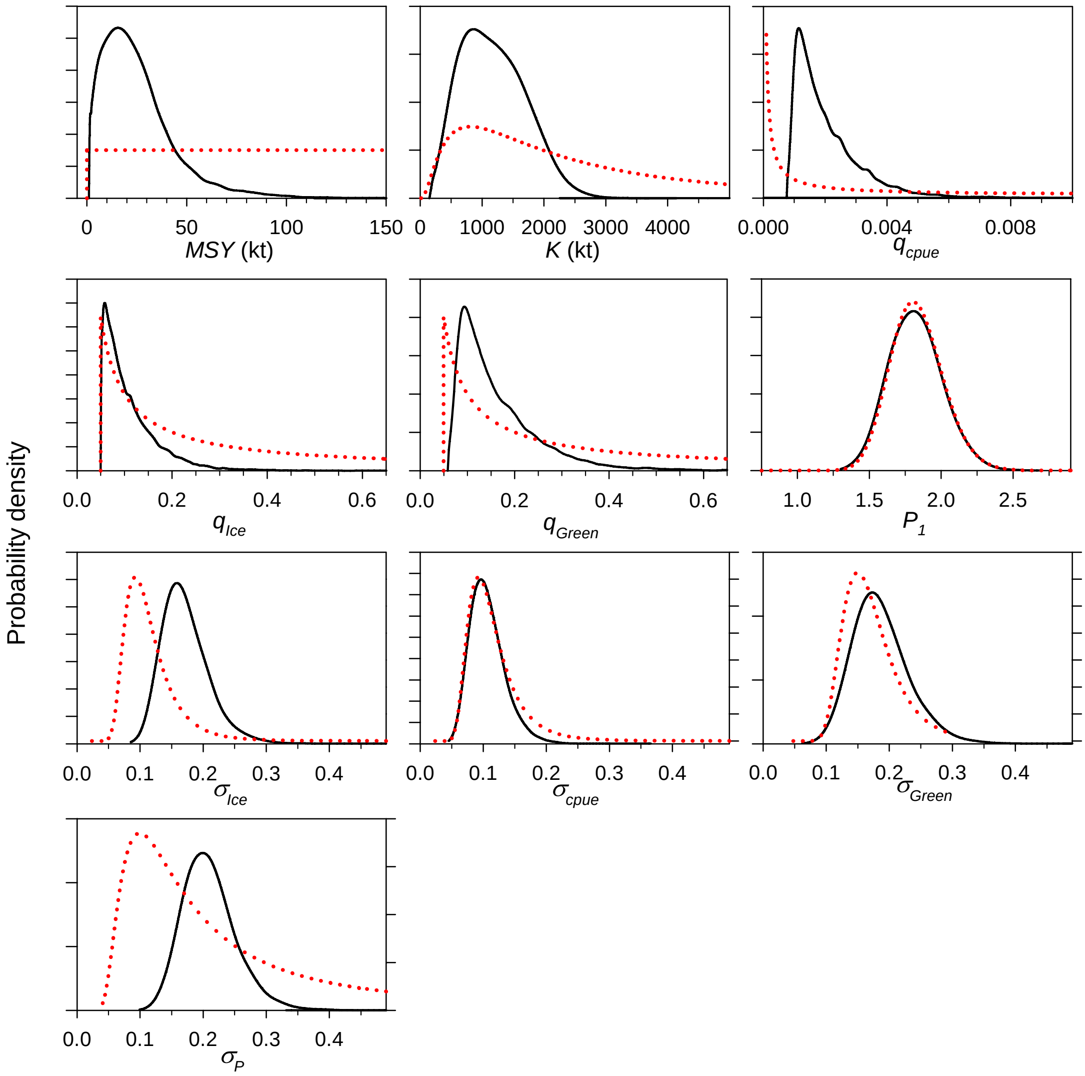


Figure 6.22. Probability density distributions of model parameters: estimated posterior (solid line) and prior (broken line) distributions.

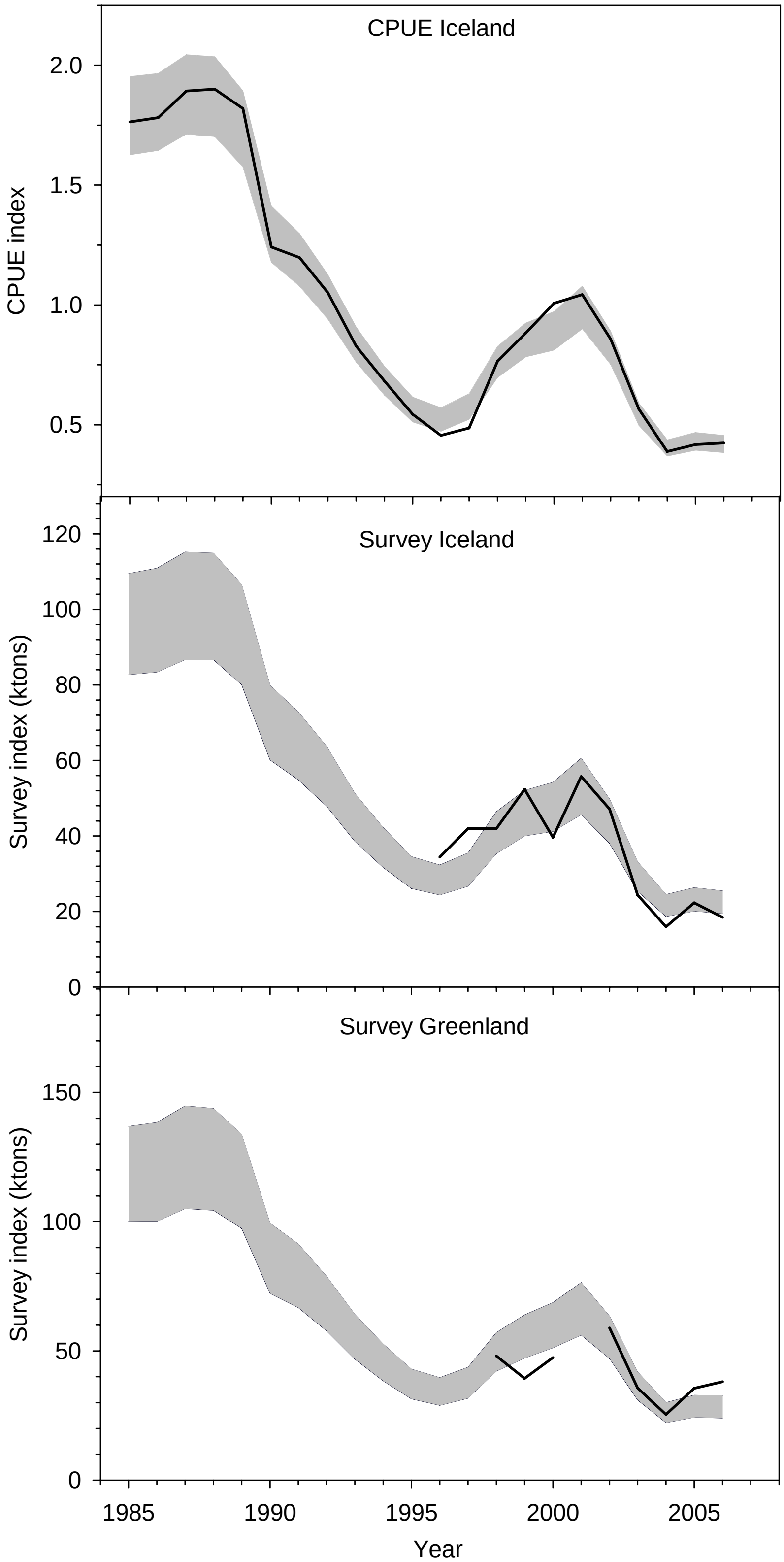


Figure 6.23. Observed (solid line) and predicted (shaded) series of the biomass indices used as input to the model. Gray shaded areas are inter-quartile range of the posteriors.

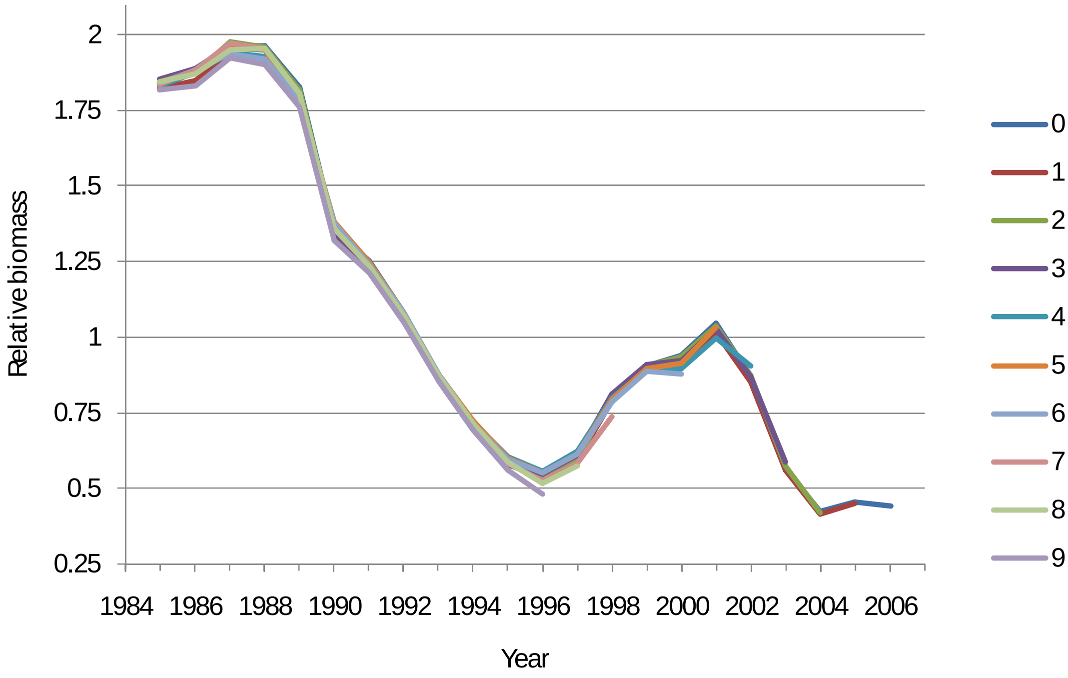


Figure 6.24. Retrospective plot of median relative biomass (*B*/*B*$_{msy}$). Relative biomass series are estimated by consecutively leaving out from 0 to 9 years of data.

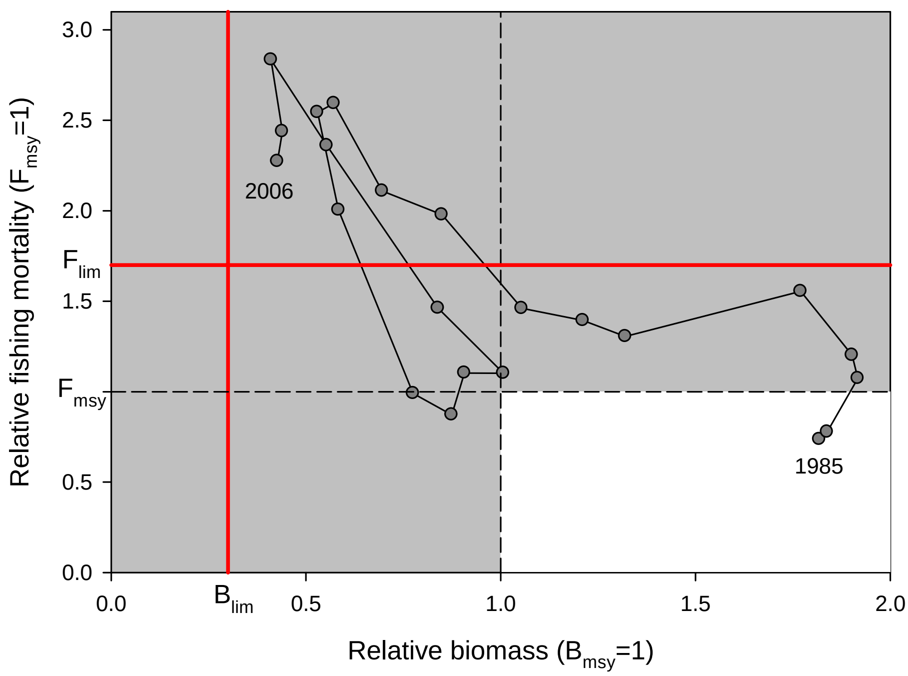


Figure 6.25. Estimated annual median biomass-ratio (*B*/*B*$_{MSY}$) and fishing mortality-ratio (*F*/*F*$_{MSY}$) 1985-2006. Suggested reference points for stock biomass, *B*$_{lim}$, and fishing mortality, *F*$_{lim}$, are indicated by red lines.

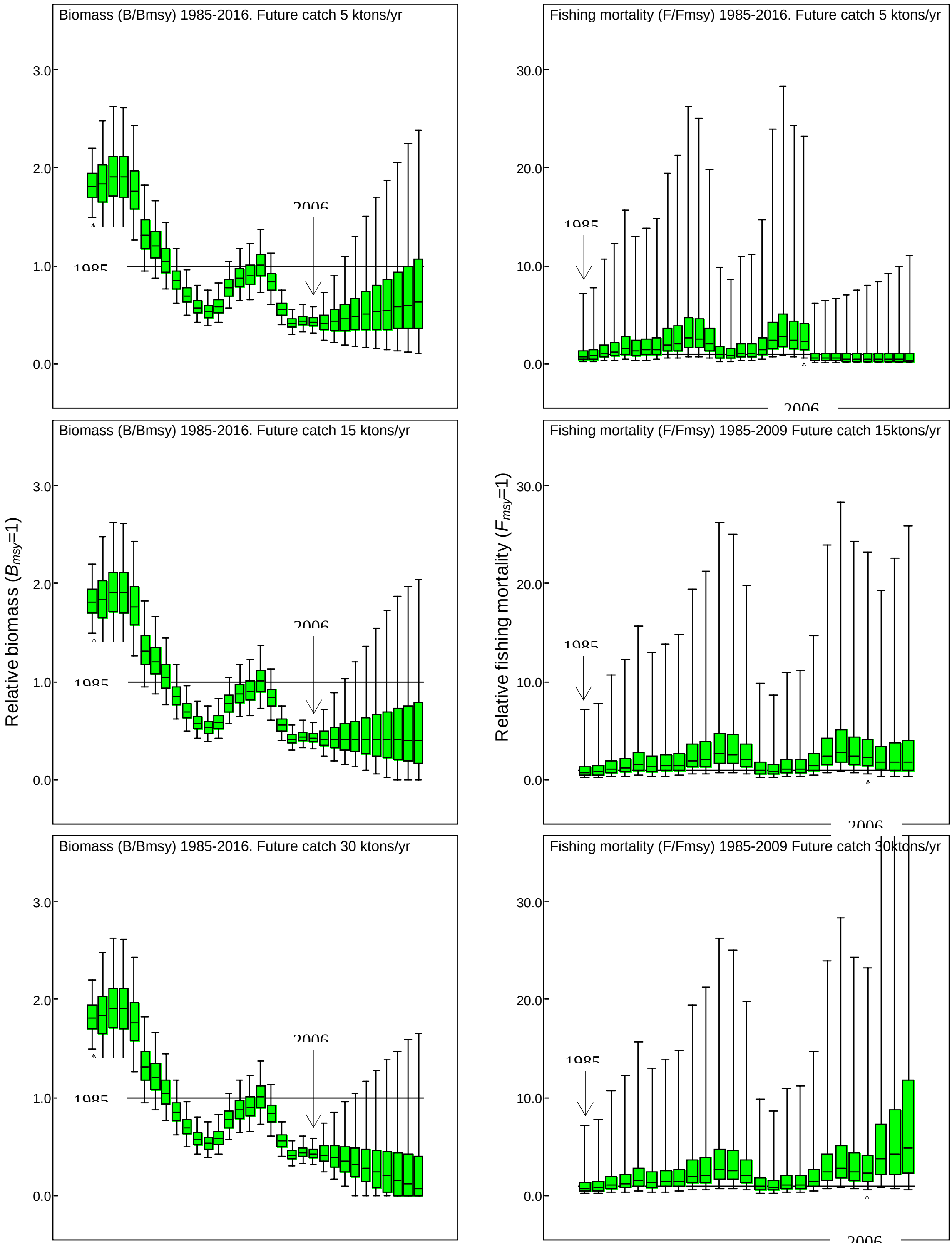


Figure 6.26. Estimated time series of relative biomass (B_t/B_{msy}) and fishing mortality (F_t/F_{msy}). Boxes represent inter-quartile ranges and the solid black line at the (approximate) centre of each box is the median; the arms of each box extend to cover the central 95 per cent of the distribution.

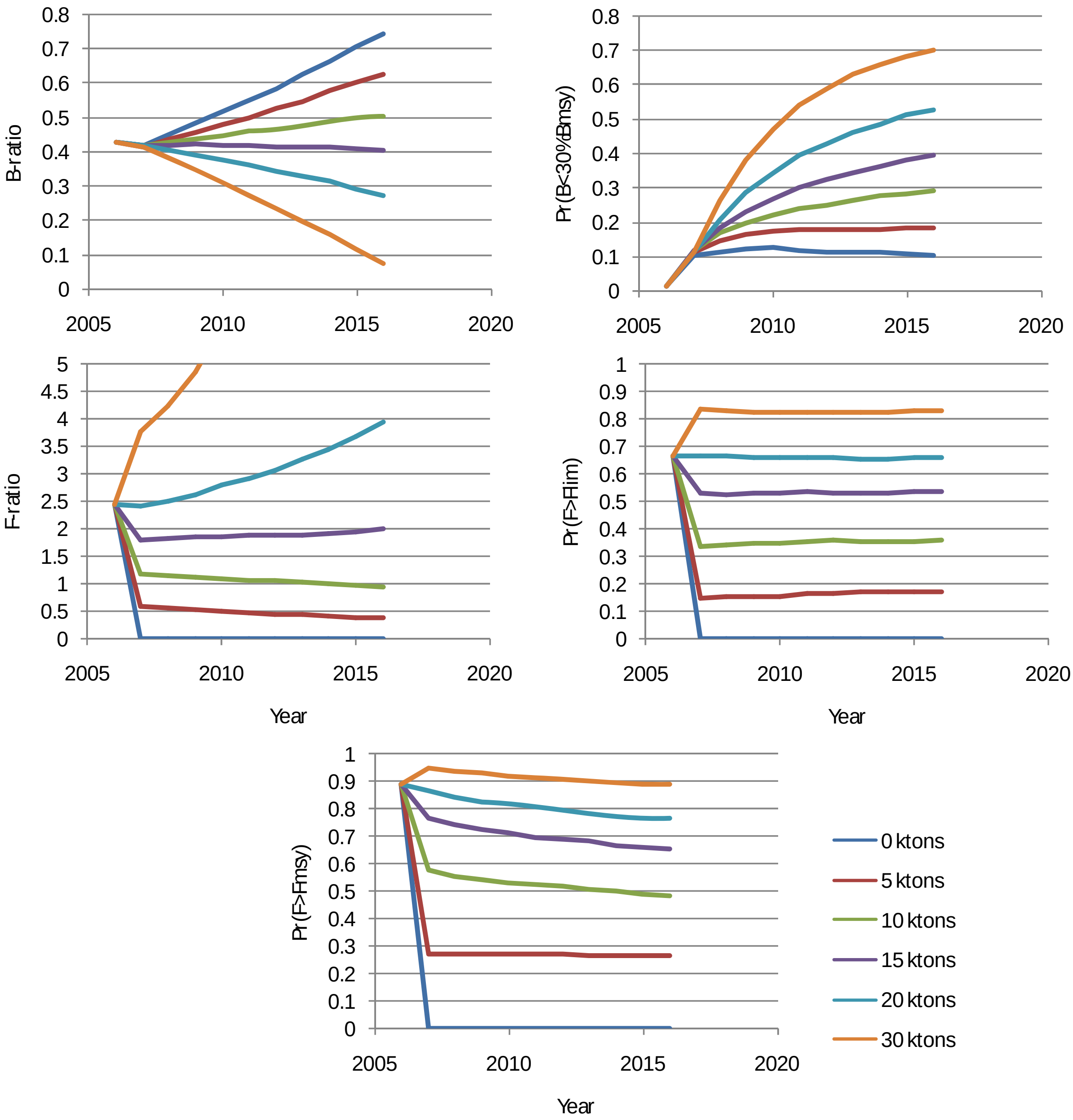


Figure 6.27. Projections: Medians of estimated posterior biomass- and fishing mortality ratios; estimated risk of exceeding F_{msy} and F_{lim} (1.7F_{msy}) or going below and B_{lim} given catches at 0, 5,10, 15, 20 and 30 ktons.

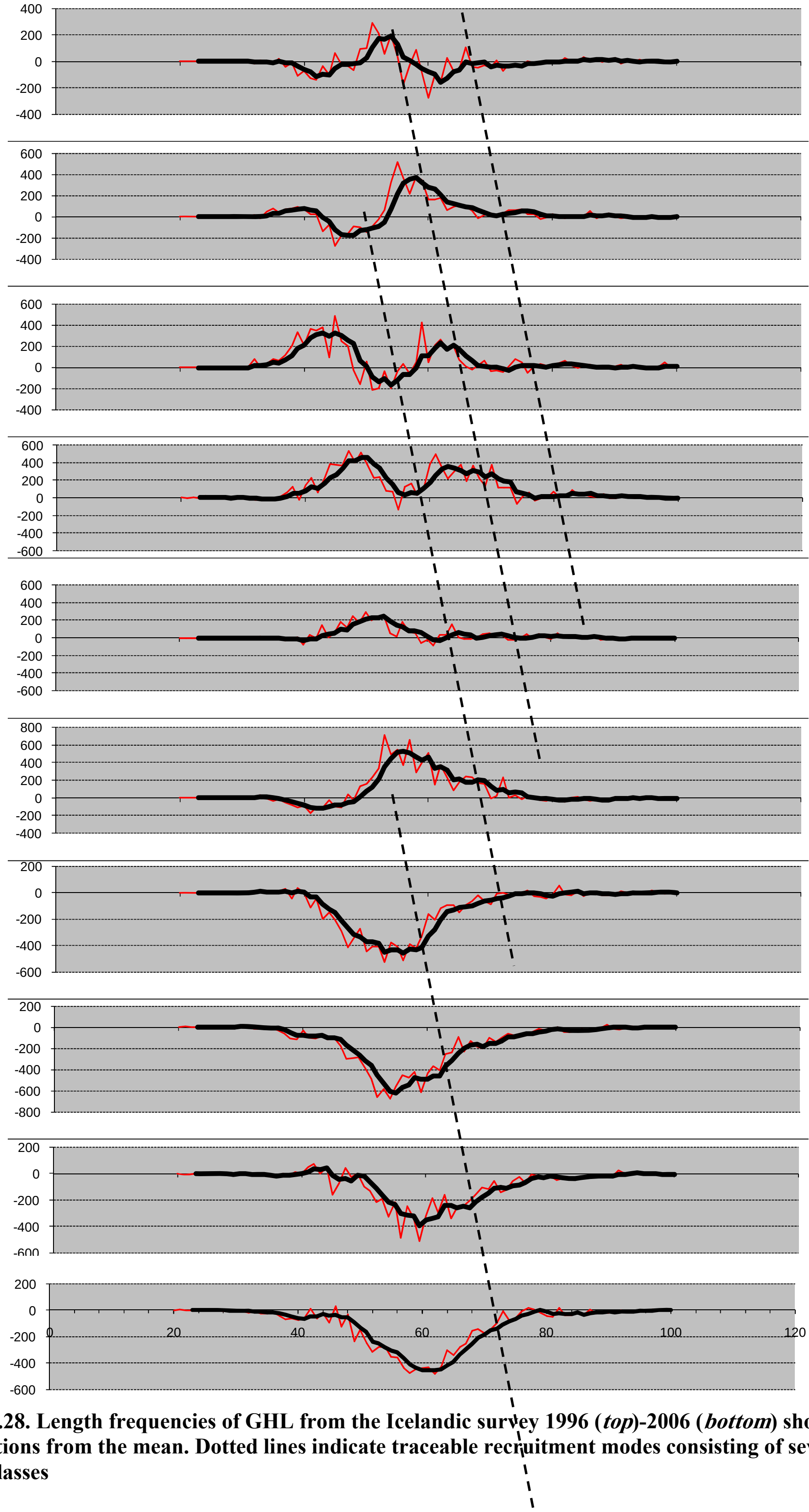


Fig. 6.28. Length frequencies of GHL from the Icelandic survey 1996 (*top*)-2006 (*bottom*) shown as deviations from the mean. Dotted lines indicate traceable recruitment modes consisting of several yearclasses

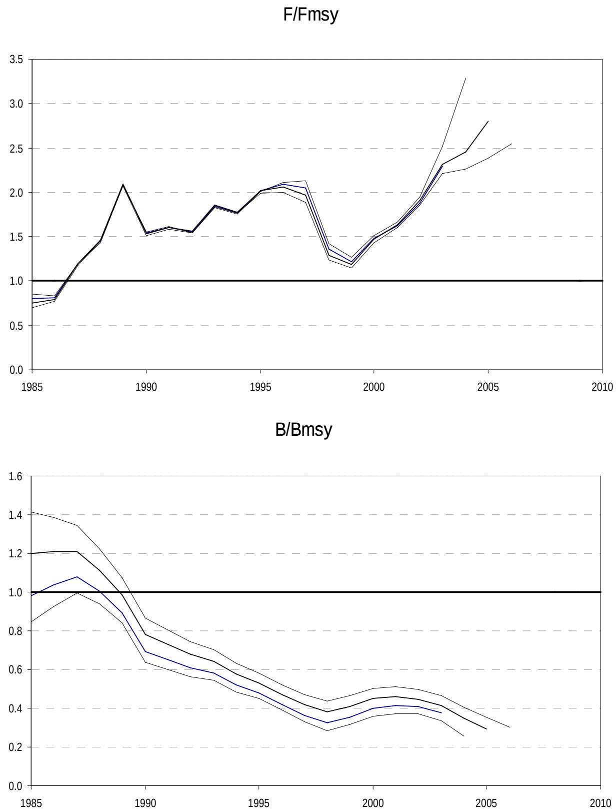


Figure 6.29. Retrospective analysis of ASPIC using the index series Icelandic CPUE and survey, and Greenland survey. The analysis

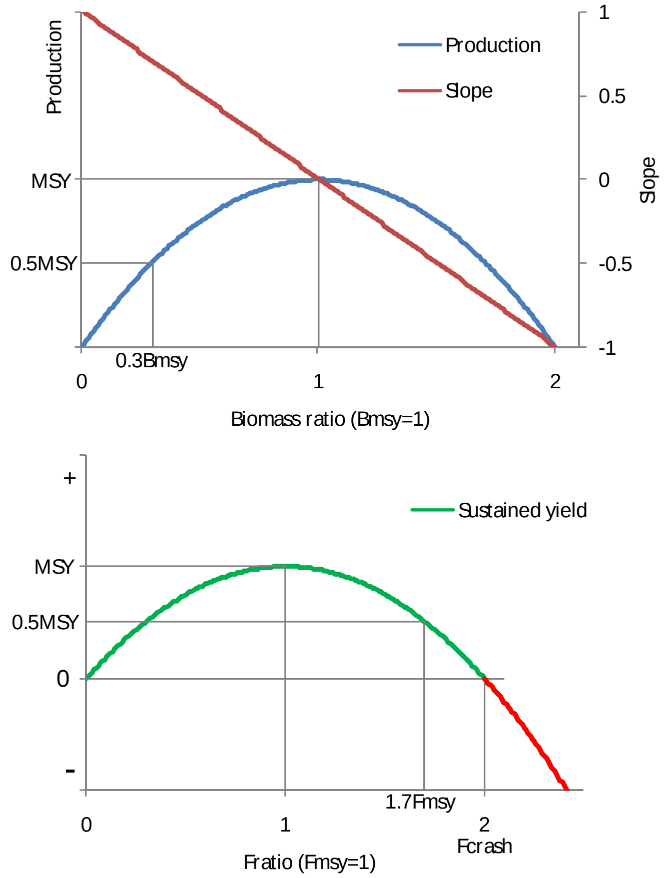


Figure 6.30. The logistic production curve in relation to stock biomass (B/Bmsy) (*upper*) and fishing mortality (F/Fmsy) (l*ower*). *Upper*: points of maximum sustainable yield (MSY) and corresponding stock size are shown as well as the slope (red line) of the production curve (blue line); *lower*: points of MSY and corresponding fishing mortality and Fcrash (F≥Fcrash do not have stable equilibriums and will drive the stock to zero).

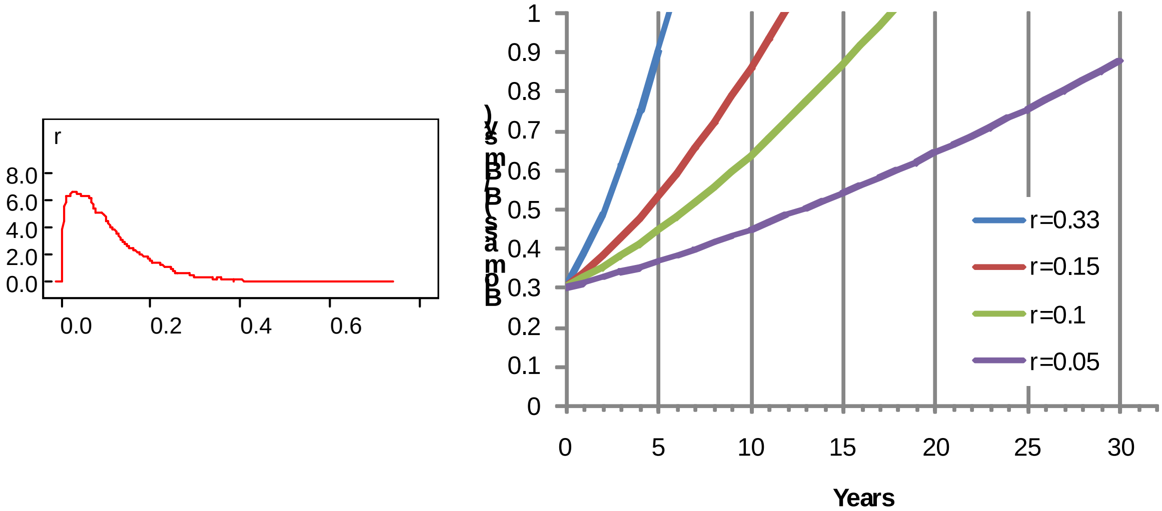


Figure 6.31. *Left*:The posterior probability density distribution of *r*, the intrinsic rate of growth. Right: estimated recovery time from Blim (0.3Bmsy) to Bmsy (relative biomass = 1) given *r*-values ranging within the 95% conf. lim. of the posterior (left figure) and no fishing mortality.

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 and management 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 1160 t in 1997 to 2-9 t in 2003-2006 (Table 7.1.1) due to decreased commercial interest in this species.

7.1 Nominal landings and splitting of the landings into species and stocks

The official statistics reported to ICES do not divide catch by species/stocks, and since the Review Group in 2005 recommended that “multispecies catch tables are not relevant to management of redfish resources”, these data are not given here and the best estimates on the landings by species/stock unit are given in the relevant chapters. Preliminary official landings data were provided by the ICES Secretariat, NEAFC and NAFO, and various national data were reported to the Group. The Group, however, repeatedly faced problems in obtaining catch data, especially with respect to pelagic *S. mentella* (see chapter 10.4). 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 two redfish species, *S. marinus* and *S. mentella* (see WD22 of the NWWG 2006). 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 are 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*.

ACFM has decided to maintain the current advisory units until a synthetic review of stock identification information is 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. ACFM has since 2004 referred to these two advisory units as “demersal *Sebastes mentella* on the continental shelf …” and “pelagic *Sebastes mentella* in the Irminger Sea and adjacent areas …”.

The Group has in the past included the fraction of *S. mentella* that are caught with pelagic trawls above the western, south-western and southern continental slope of Iceland as part of the landing statistics of the demersal *S. mentella*. This practice has been in accordance with

Icelandic legislation, where captains are obligated to report their *S. mentella* catch as either "pelagic redfish" or as "demersal redfish" depending in which fishing area they fish.

According to this legislation, all catch outside the Icelandic EEZ and west of the 'redfish line' (red line shown in Figure 7.1.1, which is drawn approximately over the 1000-m isoclines within the Icelandic EEZ) shall be reported as pelagic *S. mentella*. All fish caught east of the 'redfish line' shall be reported as demersal *S. mentella*. Most of the catches since 1991 have been taken by bottom trawlers along the shelf west, southwest, and southeast of Iceland at depths between 500 and 800 m.

The Review Group in 2005 noted that they "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.' (…) 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 in-cluded in the pelagic assessment." The Review Group in 2006, however, did not "insist on different practices for the time being". Given the conclusions of ACFM on the advisory units at the autumn 2004 meeting, where the issues regarding the allocation of catches according to the 'redfish line' (see above) were not considered, there is an ambiguity regarding the allocation to the two management units.

As the Review Group in 2005 noted that this issue needed more elaboration, detailed portrayals of the geographical, vertical and seasonal distribution of the demersal *S. mentella* fisheries with different gears are presented here, as done last year (see below). Quantitative information on the fractions of the pelagic catches of demersal *S. mentella* is given in chapter 9. The proportion of the total demersal *S. mentella* catches taken by pelagic trawls has varied since 1991 between 0% and 44% (Table 9.1.2), and was on average 25%. No demersal *S. mentella* was caught by pelagic trawls in 2004-2006. As a pragmatic management measure in Iceland, the pelagic catches of *S. mentella* east of the 'redfish line' (chapter 9.1) were allocated to the demersal *S. mentella*, as both a pelagic and a bottom trawl fishery on *S. mentella* occur in the same area. The geographic distribution of the Icelandic fishery for *S. mentella* since 1991 was in general close to the redfish line, off South Iceland, and has expanded into the NAFO Convention Area since 2003 (Figure 7.1.1). The pelagic catches of demersal *S. mentella* were taken in similar areas and depths as the bottom trawl catches (Figure 7.1.2). The vertical and horizontal distribution of the pelagic catches was, however, focusing on smaller areas and depth layers as the bottom trawl catches. The seasonal distribution by depth (Fig. 7.1.3) shows that the pelagic catches were in general taken during autumn, and only in 2003, overlapped with the traditional pelagic fishery during June. The bottom trawl catches of the demersal *S. mentella* were mainly taken in the first quarter of the year and during autumn/winter. The length distributions of the demersal *S. mentella* catches by gear and area are given in Figure 7.1.4. During 1994-1999 and in 2003, the fish taken with pelagic trawls were considerably larger than the fish caught in bottom trawls, and were of similar length during 2000-2002. The fish caught in the north-eastern area were on average about 5 cm larger than those caught in the south-western area.

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). As they grow, the juveniles migrate 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 average year-class strengths were observed in 1972, 1973–74, 1985–91, and in 1995.

There are very few juvenile demersal *S. mentella* in Icelandic waters (see chapter 9), and the main nursery area for this species is located off East Greenland (Magnússon et al. 1988, Saborido-Rey et al. 2004). Abundance and biomass indices of juvenile (<17 cm) redfish from the German annual groundfish survey, conducted on the continental shelf and slope of West and East Greenland down to 400 m, show that juveniles were abundant in 1993 and 1995-1998 (Figure 7.3.1). Juvenile redfish were only classified to the genus *Sebastes* spp., as species identification of small specimens is difficult due to very similar morphological features. The 1999-2006 survey results indicate low abundance and are similar to those observed in the late 1980s. Observations on length distributions of S. mentella fished deeper than 400 m indicate that a part of the juvenile *S. mentella* on the East Greenland shelf migrates into deeper shelf areas (WD12 of NWWG 2006, WD 03) and into the pelagic zone in the Irminger Sea and adjacent waters (WD12 of NWWG 2006, Stransky 2000), with unknown shares.

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. Since 1st October 2000, sorting grids with 22 mm bar spacing have been mandatory to reduce the by-catches. New information on the effect of sorting grids was presented in WD 16, showing by-catch rates of redfish in the shrimp fishery of <1% (average 0.64% in 2006 and 0.52% in 2006-2007).

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 2.a. from NEAFC (ToR c of this Group), regarding the stock identity of *S. mentella*, is dealt with in chapter 7.5.

In special request 2.b., NEAFC seeks “specific advice from ICES along the lines of that given recently regarding deep-sea species on the appropriateness of the introduction of potential management units for redfish in the Irminger Sea and adjacent waters.” In a letter to NEAFC (dated 2 March 2007), ICES “does not consider that there is any change of the basis for the advice. Perhaps, this question needs clarification on what NEAFC intends by the reference to advice for deep-sea species by ICES. I expect your comments on this issue.” As there has been no response from NEAFC on this letter, the Group provides information on the horizontal, vertical and seasonal distribution of pelagic redfish and fisheries in the Irminger Sea and adjacent waters. This information is given in chapter 10.

Special requests 2.c. and 2.d. are closely related, as they demand recommendations on "appropriate harvest control rules that take into account the need to avoid disproportionate exploitation of redfish in different geographical areas" and on "levels of catches and fishing effort which will result in the sustainable exploitation of pelagic redfish in the Irminger Sea and adjacent waters" to "formulate and implement a recovery and subsequent management plan". As described in chapter 10.1.1., the fishery on pelagic *S. mentella* has concentrated in a northeastern and a southwestern area since 1998, with varying shares in those areas, but in general with a greater share in the northeastern area during the second quarter of the year. The latter phenomenon has been taken into account by NEAFC for the fishery in 2006 and 2007, recommending that 80% (2006) and 65% (2007) of the catches could be taken until 1 July (2006) and 15 July (2007), respectively. The Group, however, is concerned with an eventual increase of fishing pressure in the southwestern area after 1/15 July, as the fleet then is forced to take the remaining share of the TAC in that area. The Group concludes that at this time there is not enough scientific basis available to propose an appropriate split of the total TAC among the two fisheries/areas. In the absence of an analytical assessment, a management plan (harvest control rules) can not be established on biological basis. In such a situation, a management plan can be set on an adaptive approach. Setting such a plan requires a dialogue among stakeholders as well as participation by biologists.

NEAFC has made particular reference to "the north-eastern area of the Irminger Sea and adjacent areas" being "important areas of larval extrusion" that "need particular protection to promote the recovery of pelagic redfish in the Irminger Sea and adjacent waters". Considering that the peak of larval extrusion was observed during mid-April to mid-May (Saborido-Rey et al. 2004), reducing fishing effort in this area during this period should be evaluated.

7.5 Stock identity and management units of *S. mentella*

The "Study Group on Stock Identity and Management Units of Redfishes" (SGSIMUR, 31 Aug-3 Sep 2004, Bergen, Norway; ICES 2004) has reviewed the stock structure of demersal and pelagic *S. mentella*. As no consensus about the stock structure could be reached at SGSIMUR, 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 7.5.1.

Two working documents, dealing with the population structure of *S. mentella* (ToR c) were submitted to the Group, using otolith morphometry (WD 11) and genetic markers (WD 22). These WDs address the interrelationships of redfish in ICES sub-areas V, VI, XII and XIV and NAFO sub-areas 1 and 2 (dealt with in this Group) with redfish in ICES sub-areas I and II (dealt with in the Arctic Fisheries Working Group).

The Group did not have sufficient expertise to thoroughly review the scientific content of these documents, but recommends that all documents related to stock identification of redfish should be forwarded to the Stock Identification Methods Working Group (SIMWG), in order to decide if the available new information allows re-evaluation of the stock identity of redfish.

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 7.1.1. Landings of *S. viviparus* in Division Va.

Year	Landings (t)
1996	22
1997	1159
1998	994
1999	498
2000	227
2001	21
2002	20
2003	3
2004	2
2005	4
2006	9

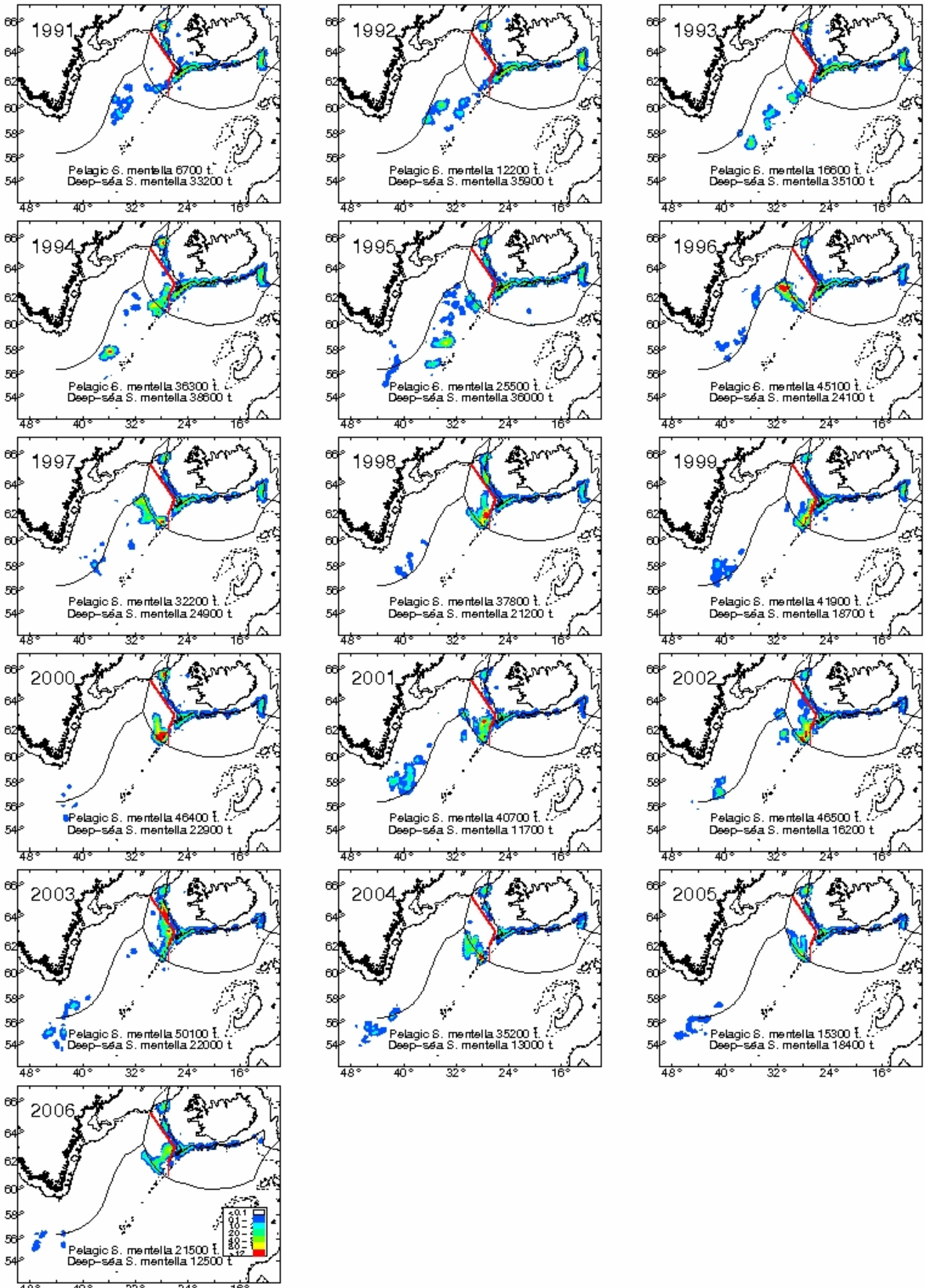


Figure 7.1.1 Geographical distribution of the Icelandic catches of *S. mentella.* The colour scale indicates catches (tonnes per NM^2).

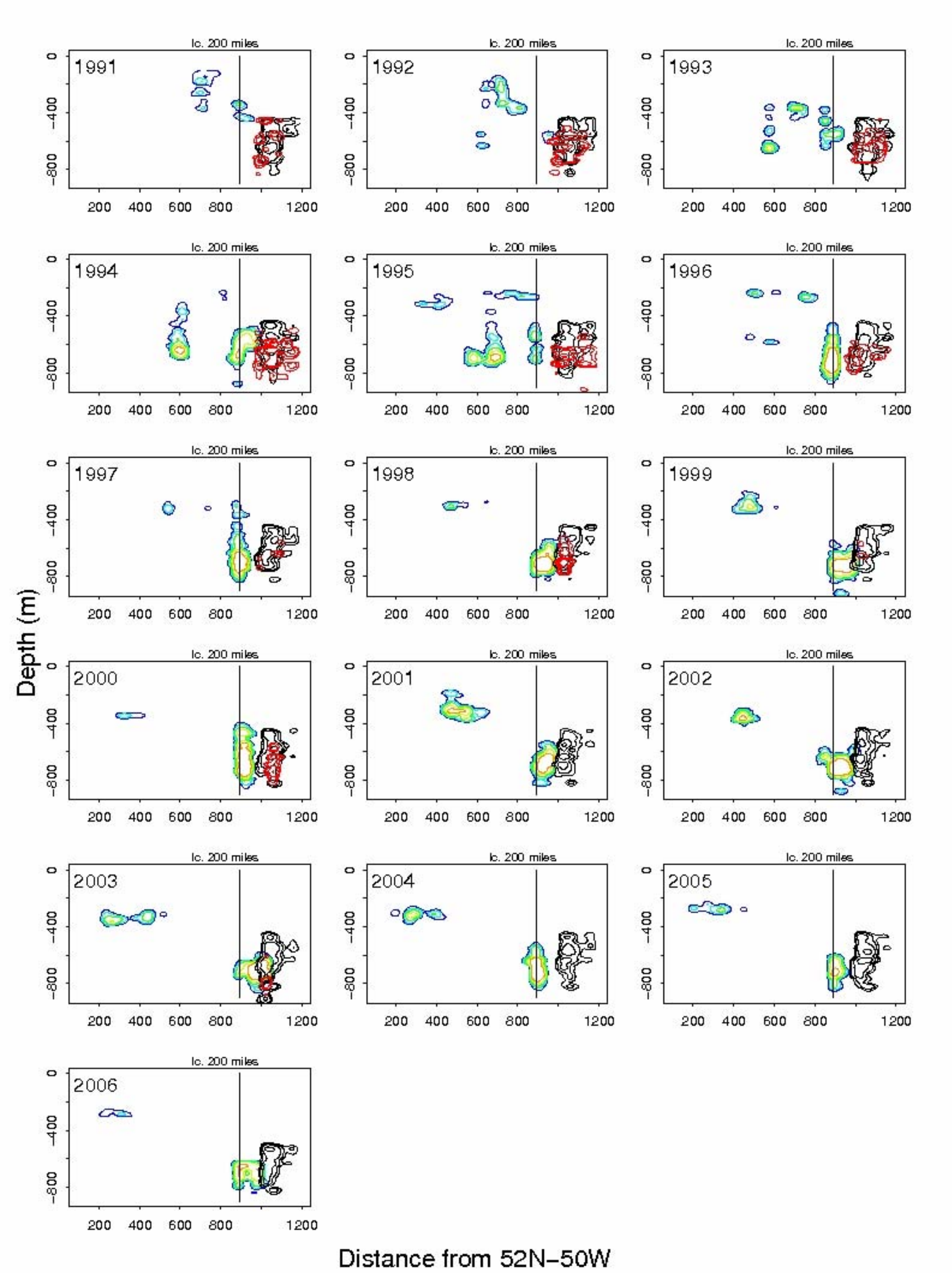


Figure 7.1.2 Distance-depth plot for Icelandic *S. mentella* catches, where distance (in NM) from a fixed position (52°N 50°W) is given. The contour lines indicate catches in a given area and distance. The coloured contours represent the fishery on pelagic *S. mentella*, the black contours indicate bottom trawl catches of demersal *S. mentella*, and the red contours represent catches of demersal *S. mentella* taken with pelagic trawls.

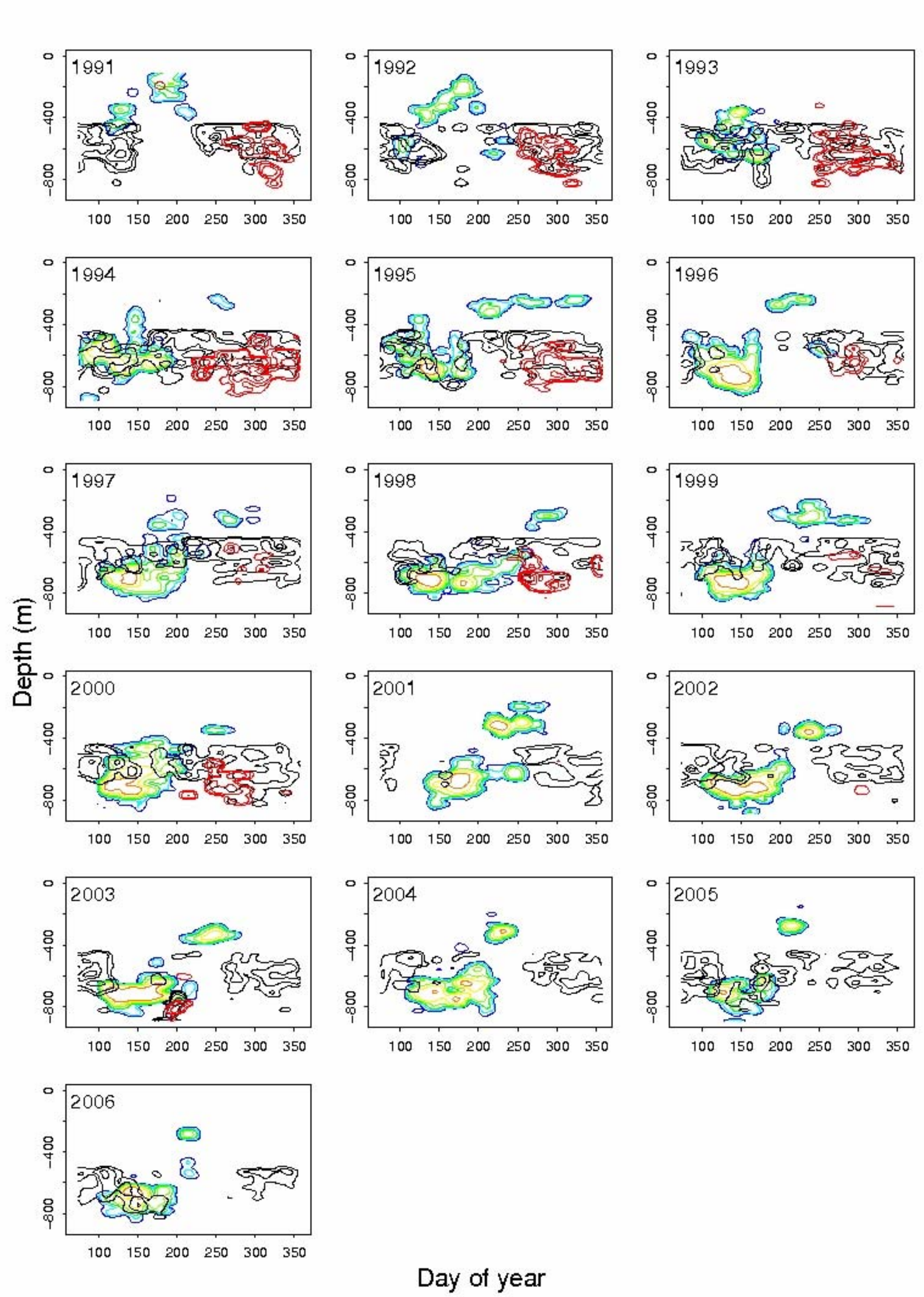


Figure 7.1.3 Depth-time plot for Icelandic *S. mentella* catches, where the y-axis is depth, the x-axis is day of the year and the colour indicates the catches. The coloured contours represent the fishery on pelagic *S. mentella*, the black contours indicate bottom trawl catches of demersal *S. mentella*, and the red contours represent catches of demersal *S. mentella* taken with pelagic trawls.

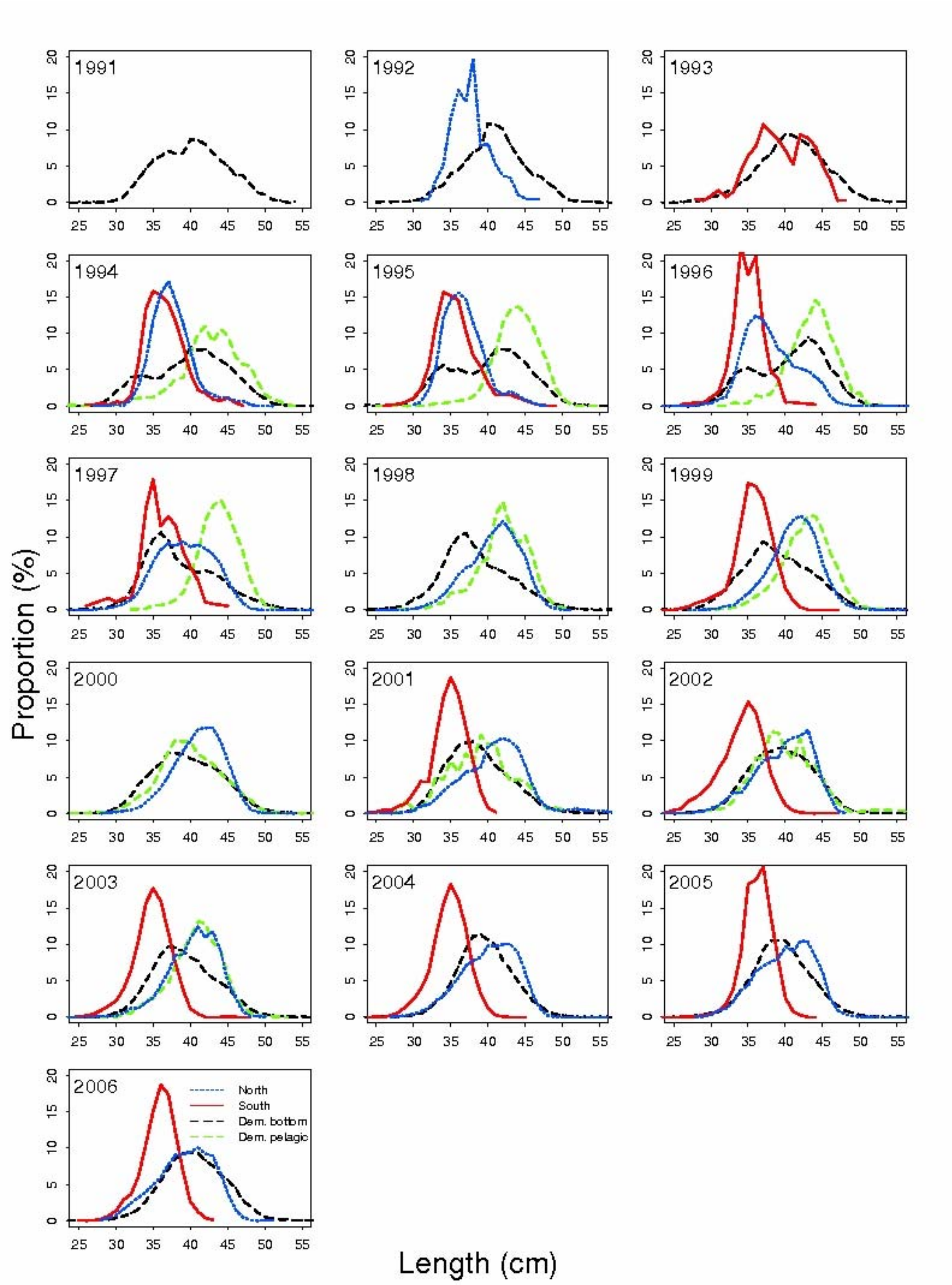


Figure 7.1.4 Length distributions from different Icelandic *S. mentella* fisheries. The blue lines represent the fishery on pelagic *S. mentella* in the northeastern area, the red lines the pelagic fishery in the southwestern area, the black lines indicate bottom trawl catches of demersal *S. mentella*, and the green lines represent catches of demersal *S. mentella* taken with pelagic trawls.

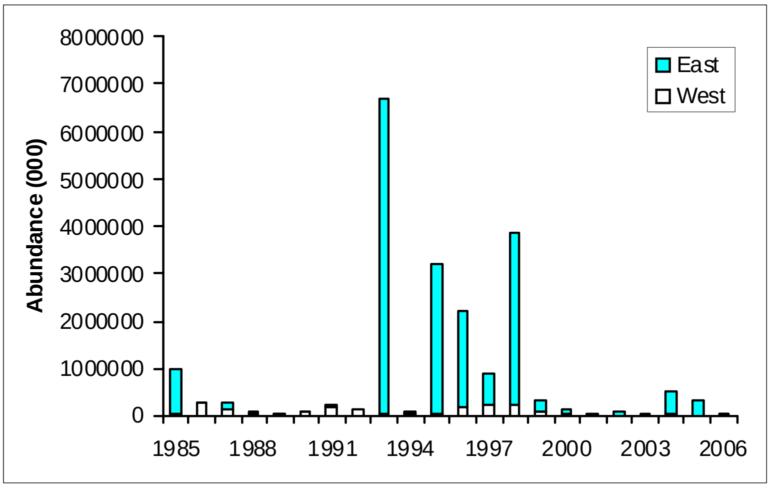


Figure 7.3.1 Survey abundance indices of juvenile *Sebastes* spp. (<17 cm) from the German groundfish survey conducted on the continental shelves off East and West Greenland 1985-2006.

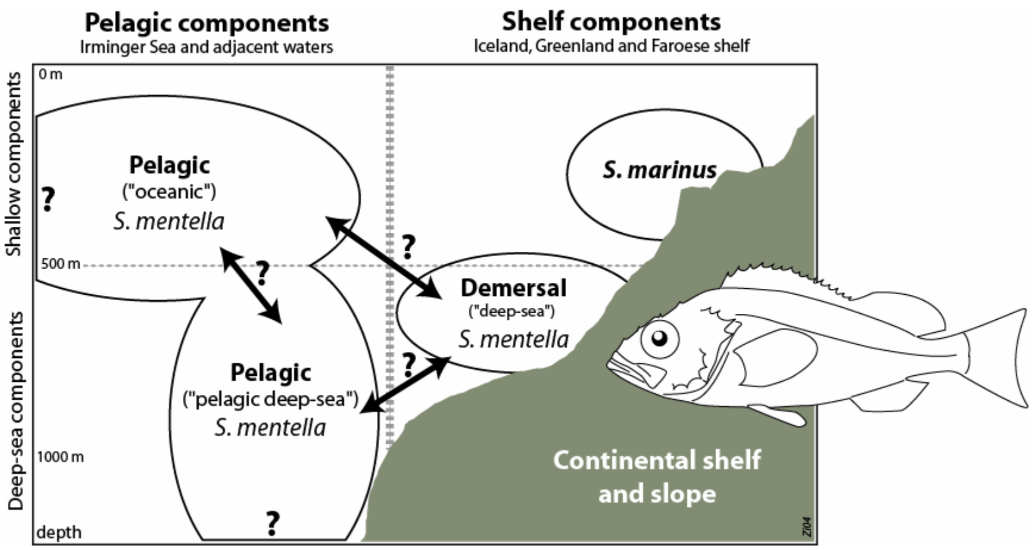


Figure 7.5.1 Possible relationship between redfish occurrences in the Irminger Sea and adjacent waters.

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

Total landings gradually decreased by more than 70% from about 130 000 t in 1982 to about 43 000 t in 1994 (Table 8.1.1 and Figure 8.1.1). Since then, the total annual landings have varied between 33 500 and 51 000 t, with the lowest landings in 2004 and the highest in 2002. The total landings in 2006 were 42 100 t, which was 3 000 t less than in 2005. 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 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 in 2006 were about 41 400 t, about 1 200 t less than in 2005. 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 remaining catches are partly caught as by-catch in gillnet and longline fishery. In 2006, 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 remained at that level until 2004. In 2004, the landings were 2 500 t, which was similar as in 1998 (Table 8.1.1). The landings in 2006 decreased to 656 t, which are the lowest recorded landings during the period 1978-2006. The majority of the *S. marinus* caught in 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, but decreased to 137 t in 2005, and no landings of *S. marinus* were reported from sub-area VI in 2006.

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 were 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 are mainly taken as by-catch in the shrimp fishery. With the opening of the cod fishery off East Greenland in 2007, it is expected that by-catches of *S. marinus* will increase in sub-area XIV.

8.1.1 Biological data from 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	41.398	336	52.538
Va	Germany/UK	Bottom trawl	5		
Va	Faeroe	Longline	153		
Va	Norway	Longline	17		
Vb	Faeroe	Bottom trawl/gillnets	656	42	822
Vb	Various	Bottom trawl	0		
XIV	Various	Bottom trawl	36		
VI	Various	Bottom trawl	0		

The length distributions from the Icelandic commercial trawler fleet in 1989-2006 show that the majority of the fish caught range between 30 and 45 cm (Figure 8.1.3). From 2000 to 2006, 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 8.2.5 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 2003-2006 contributing between 25-30% of the total catch in weight. The average total mortality (Z), estimated from this 10-year series of catch-at-age data (Figure 8.1.5) is about 0.23 for age groups 15+, and about 0.20 for age groups 20+. This estimation is based on Icelandic age readings, but the ageing can vary between readers. Age reading comparison between four age readers revealed that there were significant differences 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 (Stransky et al. 2005a).

Length distribution from the Faeroes commercial catches for 2001-2006 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 1985-2006 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 shallower than 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. The outcome of the model run is given in Table 8.2.2 and model residuals in Figure 8.2.2. The CPUE index increased considerable in 2001 after being at low level 1993-1999 and was until 2006 high but stable (Figure 8.2.1). In 2006, the CPUE index decreased by 12% compared to the previous year but still remains high. Effort towards *S. marinus* gradually decreased from 1986 until 2005 but has, since then, increased and was in 2006 similar as in 2002 (Figure 8.2.1).

Un-standardized CPUE of the Faroese otterboard (OB) trawlers 1991-2006 gradually declined to a record low in 1997 but has since then increased and is now about 80% of the 1991 value (Figure 8.2.3). OB trawlers conduct a mixed fishery and direct their fishery to some extent towards *S. marinus*. Un-standardised CPUE from the Faeroese CUBA pair-trawler fleet, where *S. marinus* is mainly caught as by-catch in the saithe fishery, has been fairly stable since 1991 (Figure 8.2.2). Effort has in recent years fluctuated both for the CUBA and OB trawlers.

8.2.2 Survey data

Figure 8.2.4 shows the total biomass index from the Icelandic spring and autumn groundfish surveys with ±1 standard deviation in the estimate (68% confidence interval). The figure shows a large measurement error in some years most notably in recent years in both the March and October surveys, which 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 8.2.5) 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 8.2.6 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 2004-2006 are about 60% of the highest observed value. The index of the fishable biomass decreased in 2007 and was below the Upa level, but has been at similar level since 2004 (Figure 8.2.5). In comparison, the total biomass in 2007 increased considerably mainly because of increase in biomass in the depth stratum 400-500 m, caused by few large hauls (Table 8.2.1). The total indices were on the other hand used in the BORMICON model (see below). This estimate of the fishable biomass could be used as a proxy for the SSB. Figure 8.2.7 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 8.2.8), 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 8.2.9). There is an indication of recruitment (fish less than 13 cm) observed in both groundfish surveys in 1998-2000 (Figure 8.2.10) and can be seen as 6-8 years old fish in the 2004 autumn survey (Figure 8.2.9). This recruitment is, however, not as large as observed in the 1987 and 1992 March surveys. A large amount of fish between 25 and 30 cm was observed in the 2005 survey, but not observed previously as smaller fish or in the 2006 survey. This could therefore be recruiting fish coming from East Greenland (Figures 8.2.12 and 8.2.13).

In Division Vb, CPUE of *S. marinus* were available from the Faeroes spring groundfish survey from 1994 to 2007 (Figure 8.2.11). After an increase in the period 1995-1998, CPUE decreased drastically and has been for the last six years at the lowest level in the time series. The Faeroes summer survey that has been conducted since 1996 (see Section 2) shows a 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 2006, CPUE decreased and was at the lowest level in the time series (Figure 8.2.11).

From 1985 to 2006, abundance and biomass indices from the German groundfish survey for *S. marinus* (fish >17 cm) are illustrated in Figures 8.2.12 and 8.2.13. 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 both abundance and biomass since 1999. The biomass estimate in 2006 have not been as high since 1987. This increase indicates a possible recovery. The decrease in the biomass in East Greenland waters in the early 1990s is similar to the trend observed in the March survey in Icelandic waters (Figure 8.2.4). The abundance estimates in 2006 (Figure 8.2.12) show less increase than the biomass indices (Figure 8.2.13), indicating growth of the fish. This can been seen as increased number of fish larger than 35 cm (Figure 8.2.14). It can also be seen that there is a considerable increase in fish less than 30 cm from 2003 to 2005, which explains the increase in abundance during this period.

8.2.3 Assessment by use of BORMICON model

The BORMICON (BOReal Migration and CONsumption model) has been applied to the *S.marinus* stock in Va (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 2012 using data until 2007 for estimation. 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 2007 run are shown in Figure 8.2.15.

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 8.2.15-8.2.20 and compared to the results from three previous years in Figure 8.2.21. As may be seen the estimate on catchable biomass for 2007 is similar to the ones estimated in 2006, but lower than 2004 and 2005, with the difference probably driven by the high survey indices 2004 (Figure 8.2.19). Furthermore, the results for 2007 are similar to the one presented in Björnsson and Sigurdsson (2003), where they used data until 2000.

The BORMICON model has been developed further in an EU project and is now called GADGET (www.hafro.is/gadget). The redfish example has now been run with the GADGET program, giving similar trends in biomass but somewhat different prediction (Figure 8.2.23). The goal is to use GADGET for stock assessment work next year but some work on the weight of different likelihood components is needed in the transfer between models.

Figure 8.2.20 shows residuals from the model fit to the survey data, demonstrating large positive residuals in some years, most notably 1993, 1999, 2003-2005 and in 2007. The large positive residuals for 22-37 cm fish observed in 2003-2006 and 9-18 cm fish in 2006 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 poor recruitment of redfish since the 1990-year class and the model mimics those results. The estimated average year class size in 1992-2002 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 catchable biomass is going to be stable for the next few years with an annual catch of 30 000-35 000 t (Figure 8.2.16). 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 33.3 cm (Table 8.2.3). It is not known whether the changes of selection in the fishery are related to model misspecification or recruitment.

Different catch options were tested in the simulations for a fixed catch. As may be seen in Figures 8.2.16, the catchable biomass will decrease in the next 5 years for all catch options exceeding 37 000 t and the total biomass decrease for annual catch above 30 000 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 6 years. It is expected that those year classes will dominate the catches in the next few years, especially the 1990-yearclass. There is an indication of new year classes that are observed as 6-8 year-old fish (about 25-30 cm) in the October survey. These year-classes are, however, not as strong as the 1985- and the

1990-year-classes and were not noticed in the March survey at age 1-4. The BORMICON model estimated the exploitation rate to amount to F=0.25 in 2006. In Vb, survey indices do not indicate an improved situation in the area, and the CPUE indices from the commercial fleet decreased in 2005. In sub-Division XIV, the adult fish are severely depleted, but there are signs of improved recruitment as has been seen in Icelandic waters. No information is available on exploitation rates 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 poor for Division XIV and Vb.

8.2.5 Catch projections and management considerations

Results from the short term prediction are given in Table 8.2.4. 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 30 000 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 g. Based on the model results, a TAC below 35 000 t in the next 5 years would provide a fishable stock size above current biomass level at the end of that period, but the total biomass would decrease because of low recruitment since 1991 (Table 8.2.4). 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 $\mathbf{F_{max}}$.

ACFM recommended in 2005 and 2006 that the total allowable catch in Division Va should be 35 000 t. However, the total annual catches in 2005 and 2006 were around 42 000-45 000 t. The Icelandic authorities give a joint quota for *S. marinus* and demersal *S. mentella* (see Chapter 9.5), which causes this difference.

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 8.2.14 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 in the next five years and lead to fishing mortality close to $\mathbf{F_{max}}$. However, because of poor recruitment, the total biomass is expected to decrease at this catch level.

The group was asked for suggestions for reference points based on the BORMCION model. The result was to propose the SSB in 1995 (minimum SSB) as $\mathbf{B_{pa}}$ and $\mathbf{B_{lim}}$ as $\mathbf{B_{pa}}$/125 000 t.

In this run, $\mathbf{B_{pa}}$ is 150 000 tonnes but $\mathbf{B_{pa}}$ should not be fixed to this value but rather put in relative sense as the 1995 value of the SSB. This precaution is taken as the level of the stock can change in future runs as the model is now based on 23 years of survey data and the yearclass seen in the 2^{nd} March survey is still abundant in the fishery. The biological reference points based on the BORMICON model was, however, not fully evaluated by the Group.

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.

8.4 Comment on the assessment

The basis for advice and the relative state of the stock is based on projection derived from the analytical BORMICON model and survey index series.

The estimate of available biomass in the beginning of 2007 according to this year assessment using the BORMICON model in Va is 14% or 28 000 t lower than last year. Of this difference 7 000 t can be explained by higher than expected landings as the prognosis last year was based on landings of 35 000 t while the landings in 2005 are now estimated to be 41 500 t. The remaining 20 000 t downward revision is driven by the results of the survey in 2005 that showed a downward trend compared to 2004. As the model is set up, responses to changes in the tuning data are relatively slow as both M and F are low. The first year-class seen in the survey is the 1985 year-class. This year-class is still abundant in the stock, so the catchability in the survey is not well defined and changes in the estimate of the catchability and, therefore, stock size could be expected. Variations in growth could also be causing different perception of the stock but the model is based on fixed growth throughout the period. The estimates of the catchable biomass for 2007 have been rather stable in recent years and are now similar to the estimates of the 2002-2003 estimates and 2006 estimate (Figure 8.2.22).

There are only available data on nursery grounds of *S. marinus* in Icelandic and Greenland waters but no nursery grounds are known in the Faeroese waters. In Icelandic waters, nursery areas are found mostly West and North of Iceland at depths between 50 m 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). Other nursery areas might be on the continental shelf off East Greenland. As length (age) increases, migration of young *S. marinus* is anticlockwise from the North coast to the West coast and further to the Southeast fishing areas and to Faeroese fishing grounds in Vb. The largest specimens are found in Division Vb and therefore the 1985 and 1990 year-classes 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, 1978-2006 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	31,686	1,139	519	107	33,451
2005	42,593	2,484	137	115	45,329
2006[1)]	41,381	656	0	37	42,074

1) Provisional

Table 8.1.2 ***S. marinus*. Landings in Va in weight (tonnes) by age 1995-2006. 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 specimens older than 23 years.**

Year/ Age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
7	62	0	**33**	24	7	40	122	130	201	227	236	231
8	374	360	230	**285**	350	65	138	910	211	849	782	1,249
9	1,596	825	482	596	**1,623**	852	395	767	1,366	499	1,925	2,581
10	**9,436**	3,701	1,039	1,211	1,259	**4,308**	1,623	841	1,120	2,109	1,526	3,799
11	2,719	**9,127**	2,702	1,132	1,855	1,894	**7,763**	3,188	1,197	795	3,139	1,941
12	1,319	2,102	**11,583**	3,252	2,528	2,277	1,807	**11,065**	3,952	982	1,919	2,721
13	3,534	1,317	2,828	**12,532**	2,450	1,703	1,983	3,095	**9,788**	2,035	1,378	1,774
14	5,671	1,477	1,373	2,085	**15,566**	2,375	1,252	2,630	2,361	**8,661**	3,027	1,209
15	5,971	4,347	3,142	2,039	1,244	**14,878**	839	1,856	1,978	2,158	**11,920**	3,067
16	1,730	5,456	3,666	2,413	1,276	1,777	**11,686**	3,029	1,218	1,723	2,138	**10,297**
17	852	934	3,035	3,416	1,823	1,184	523	**12,046**	2,267	826	1,472	2,007
18	368	379	900	2,051	2,665	1,624	787	2,097	**6,427**	1,401	1,333	942
19	1,134	259	642	1,018	2,228	2,427	1,068	1,174	761	**5,342**	1,315	750
20	1,144	340	925	729	1,271	2,191	1,801	663	410	1,120	**6,797**	1,113
21	503	1,157	449	523	479	544	970	1,411	604	336	412	**5,642**
22	677	988	520	391	217	447	420	1,028	791	491	466	486
23	1,427	791	681	427	341	270	437	743	755	620	868	208
24	664	0	587	665	218	64	169	363	379	600	636	389
25	762	0	749	516	930	393	130	294	303	284	446	397
26	365	0	271	401	279	340	126	185	75	106	97	0
27	350	0	136	427	649	193	293	83	83	180	324	68
28	725	0	192	360	228	528	204	297	27	153	215	170
29	0	0	149	54	105	371	153	500	106	138	31	117
30	133	0	30	226	231	441	375	174	197	161	227	239
Total	41,516	33,560	36,344	36,773	39,822	41,186	35,064	48,569	36,577	31,796	42,629	41,397

Table 8.2.1 Index on fishable stock of *S. marinus* in the Icelandic groundfish survey 1985-2007 divided by depth intervals.

	Depth Intervals					
Year	< 100m	100-200m	200-400m	400-500m	0 - 400m	Total
1985	7.0	91.1	145.2	23.6	243.2	266.8
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	48.8	91.6	102.3	148.4	250.6
2005	9.4	42.3	112.3	37.6	164.1	201.7
2006	6.0	52.6	95.7	17.0	154.4	171.4
2007	4.9	51.1	76.5	77.4	132.6	209.9

Table 8.2.2 Results of the GLM model to calculate standardized CPUE for Icelandic *S. marinus* fishery in Va. Note that the residuals are shown in Fig. 8.2.2.

```
Call:  glm(formula  =  lafli  ~  ltogtimi  +  factor(ar)  +  factor(veman)  +
factor(skipnr) + factor(reitur), family =
        gaussian(), data = tmp)
Deviance Residuals:
       Min         1Q     Median        3Q      Max
 -6.355384 -0.4587422 0.03021687 0.4936037 5.631437
```

	Value	Std..Error	t.value	ar	index	lower	upper
factor(ar)1986	0.000000000	0.00000000	0.00000000	1986	1.0000000	1.0000000	1.0000000
factor(ar)1987	0.039036175	0.03586744	1.08834576	1987	1.0398081	1.0031738	1.0777803
factor(ar)1988	-0.016418798	0.03647157	-0.45018070	1988	0.9837153	0.9484840	1.0202552
factor(ar)1989	0.025518450	0.03654762	0.69822463	1989	1.0258468	0.9890314	1.0640326
factor(ar)1990	0.027834250	0.03658564	0.76079713	1990	1.0282252	0.9912868	1.0665401
factor(ar)1991	0.021250214	0.03043875	0.69813034	1991	1.0214776	0.9908536	1.0530482
factor(ar)1992	-0.170692513	0.03072564	-5.55537769	1992	0.8430808	0.8175705	0.8693870
factor(ar)1993	-0.299020507	0.03048464	-9.80889003	1993	0.7415442	0.7192796	0.7644980
factor(ar)1994	-0.329476912	0.03136633	-10.50416012	1994	0.7192999	0.6970883	0.7422193
factor(ar)1995	-0.292136242	0.03175051	-9.20099289	1995	0.7466668	0.7233322	0.7707542
factor(ar)1996	-0.288397375	0.03240948	-8.89854904	1996	0.7494637	0.7255634	0.7741513
factor(ar)1997	-0.277424499	0.03236234	-8.57244966	1997	0.7577328	0.7336033	0.7826559
factor(ar)1998	-0.237672927	0.03288501	-7.22739461	1998	0.7884605	0.7629537	0.8148201
factor(ar)1999	-0.292608579	0.03229683	-9.05997708	1999	0.7463142	0.7225957	0.7708113
factor(ar)2000	-0.138741906	0.03244347	-4.27642013	2000	0.8704527	0.8426653	0.8991563
factor(ar)2001	-0.001829819	0.03368803	-0.05431659	2001	0.9981719	0.9651055	1.0323711
factor(ar)2002	0.029724663	0.03316400	0.89629303	2002	1.0301709	0.9965666	1.0649083
factor(ar)2003	0.058952938	0.03445816	1.71085589	2003	1.0607253	1.0247972	1.0979130
factor(ar)2004	0.080973024	0.03530196	2.29372567	2004	1.0843416	1.0467300	1.1233047
factor(ar)2005	0.051178771	0.03384384	1.51220365	2005	1.0525110	1.0174861	1.0887417
factor(ar)2006	-0.078368027	0.03340858	-2.34574539	2006	0.9246241	0.8942440	0.9560363

Analysis of Deviance Table

Gaussian model

Response: lafli

Terms added sequentially (first to last)

	Df	Deviance	Resid. Df	Resid. Dev	F Value	Pr(F)
NULL			43567	110132.2		
ltogtimi	1	66061.52	43566	44070.7	89683.17	0
factor(ar)	20	1299.47	43546	42771.2	88.21	0
factor(veman)	11	927.89	43535	41843.4	114.52	0
factor(skipnr)	192	7670.59	43343	34172.8	54.24	0
factor(reitur)	150	2356.37	43193	31816.4	21.33	0

Table 8.2.3 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	2005	2006
L_{50}	33.60	34.27	34.08	33.70	33.46	34.06	33.12	33.27	32.69	33.26

Table 8.2.4 *S. marinus* in Division Va. Output from short term prediction using results from the BORMICON model, where the annual landings after 2006 is set to 35 000 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
2006	167.2	0.25	322.0	41.1
2007	178.4	0.20	321.0	35.0
2008	190.6	0.19	317.0	35.0
2009	201.0	0.18	312.0	35.0
2010	209.3	0.17	305.0	35.0
2011	211.9	0.17	299.0	35.0

Table 8.2.5 Biological reference points for *S. marinus* in Division Va.

PARAMETERS	ESTIMATION
F_{max}	0.16
$F_{0.1}$	0.09
B_{pa}	125 000 t
Yield per recruit	250 g

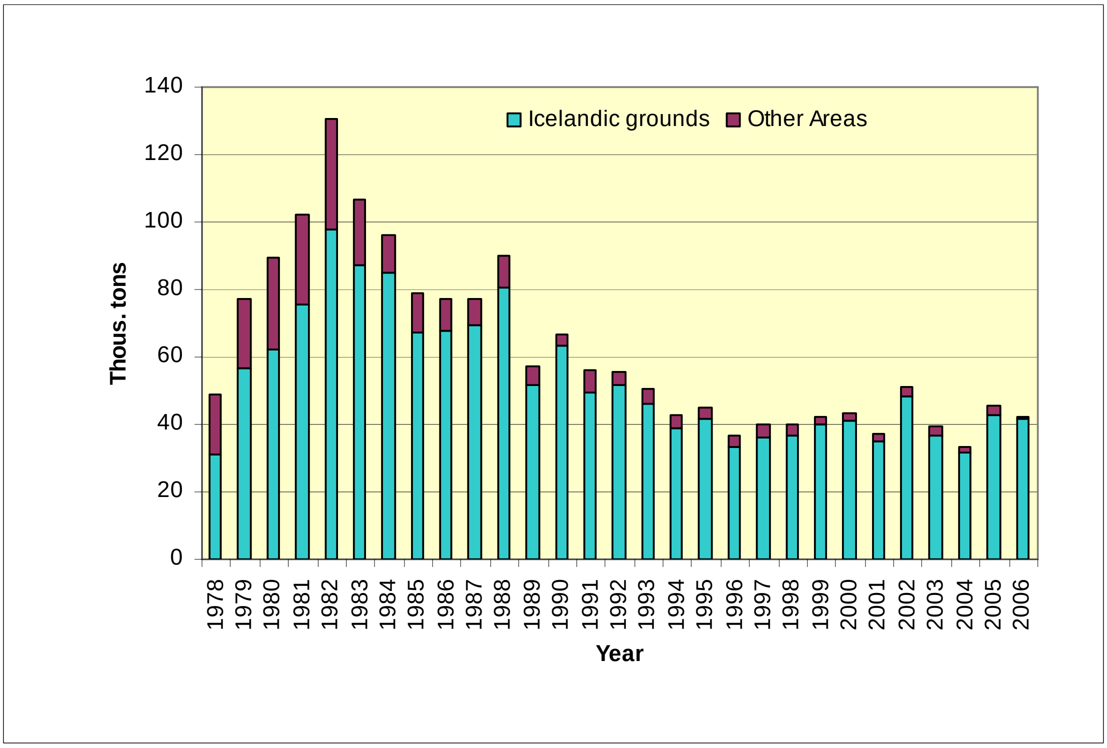


Figure 8.1.1 ***Sebastes marinus*****. Nominal landings in tonnes in ICES Division Va and in other areas (landing statistics for ICES Divisions Vb, VI and XIV combined) 1978-2006. Landings statistics for 2006 are provisional.**

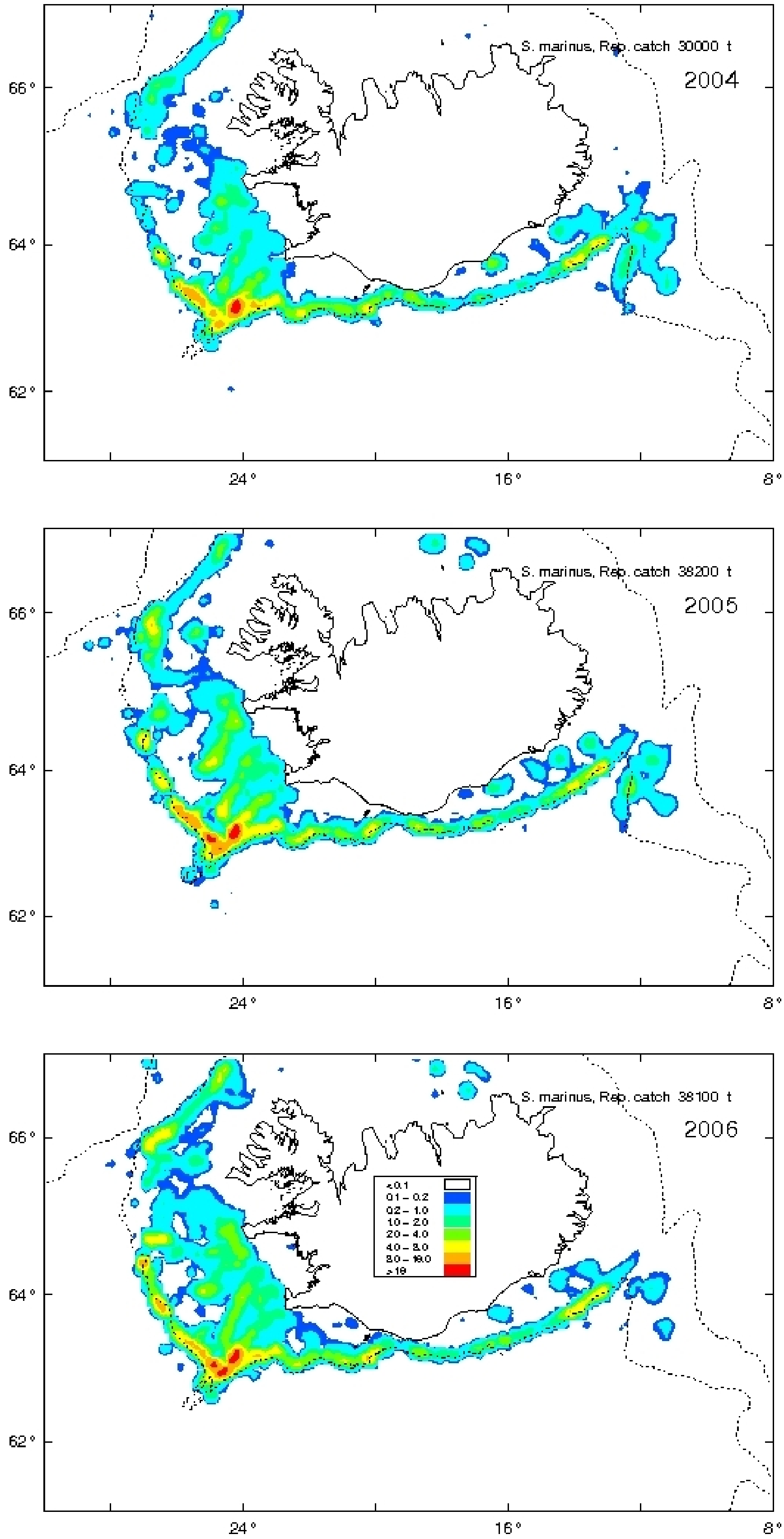


Figure 8.1.2 Geographical distribution of *S. marinus* catches in Division Va 2004-2006.

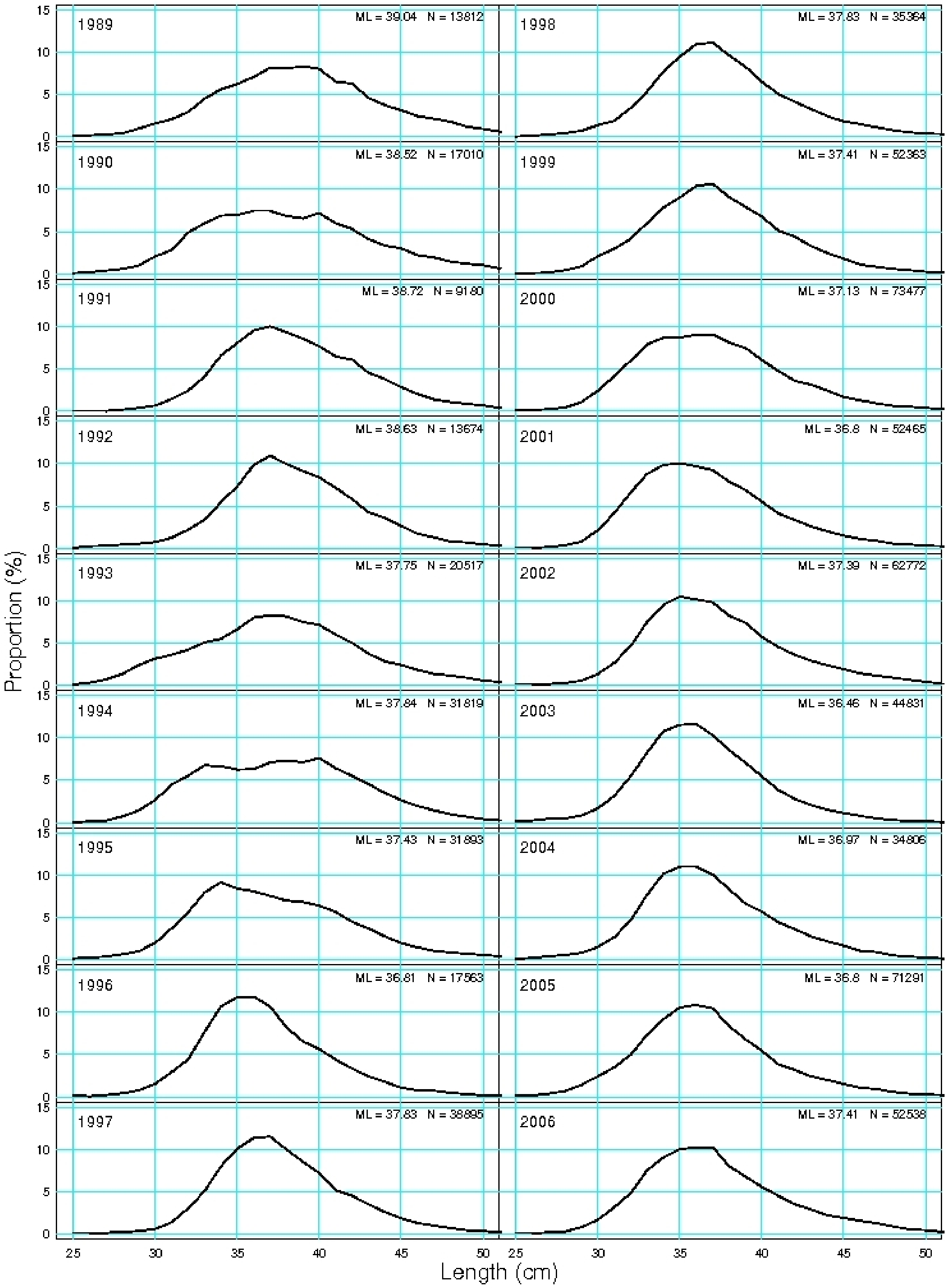


Figure 8.1.3 Length distribution of *S. marinus* in the commercial landings of the Icelandic bottom trawl fleet 1989-2006.

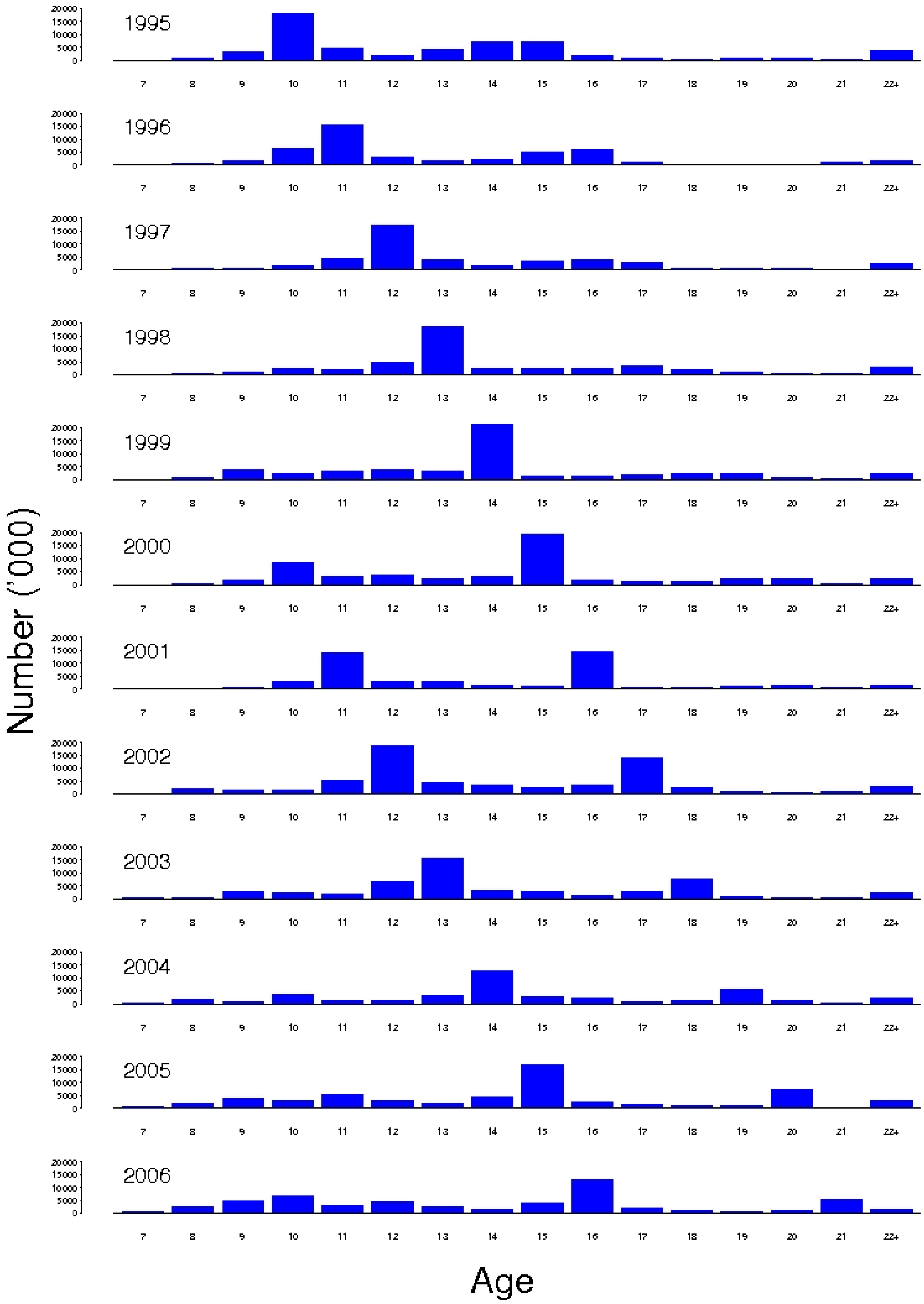


Figure 8.1.4 ***S. marinus.*** **Catch-at-age in numbers in ICES Subdivision Va 1995-2006.**

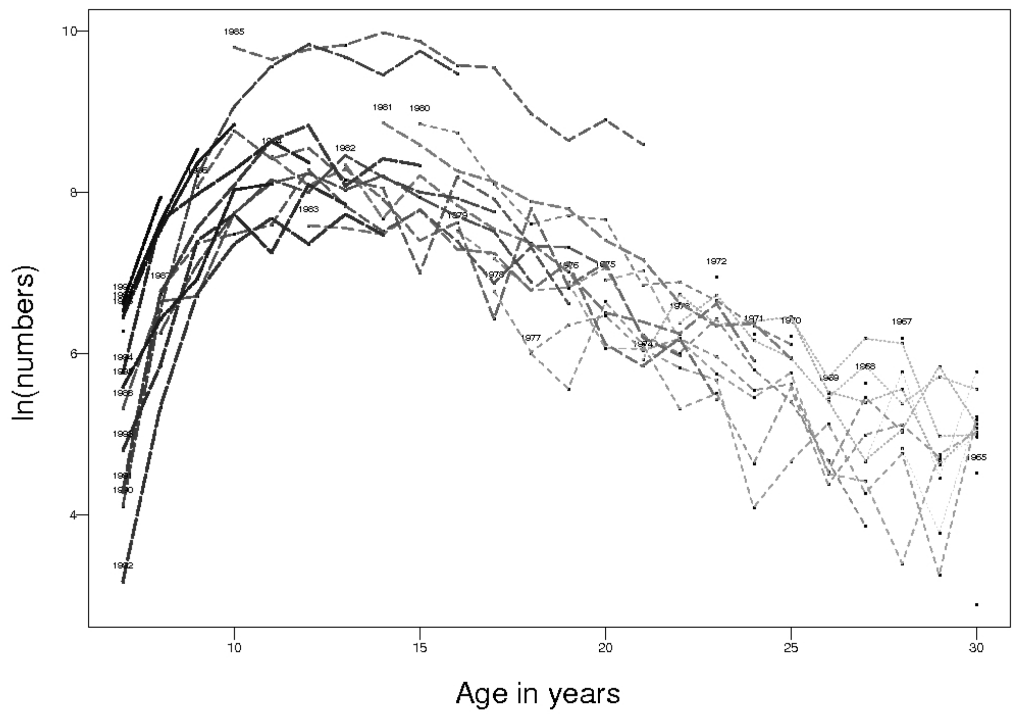


Figure 8.1.5 ***S. marinus*. Catch curve based on the catch-at-age data in ICES Division Va 1995-2006.**

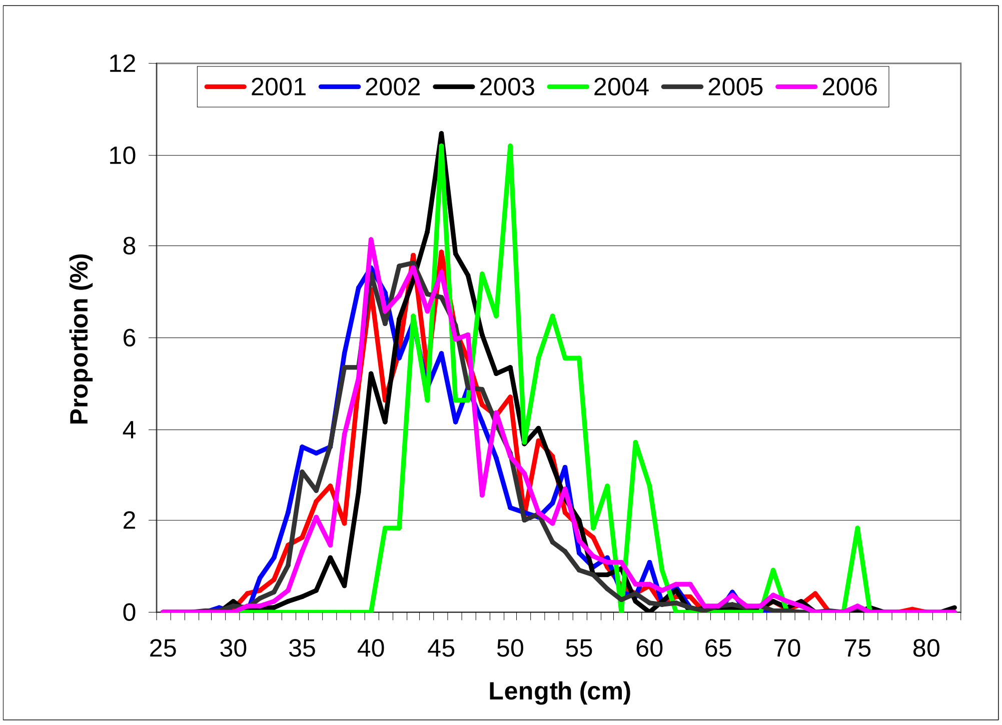


Figure 8.1.6 ***S. marinus*. Length distribution from Faroese catches in 2001-2006.**

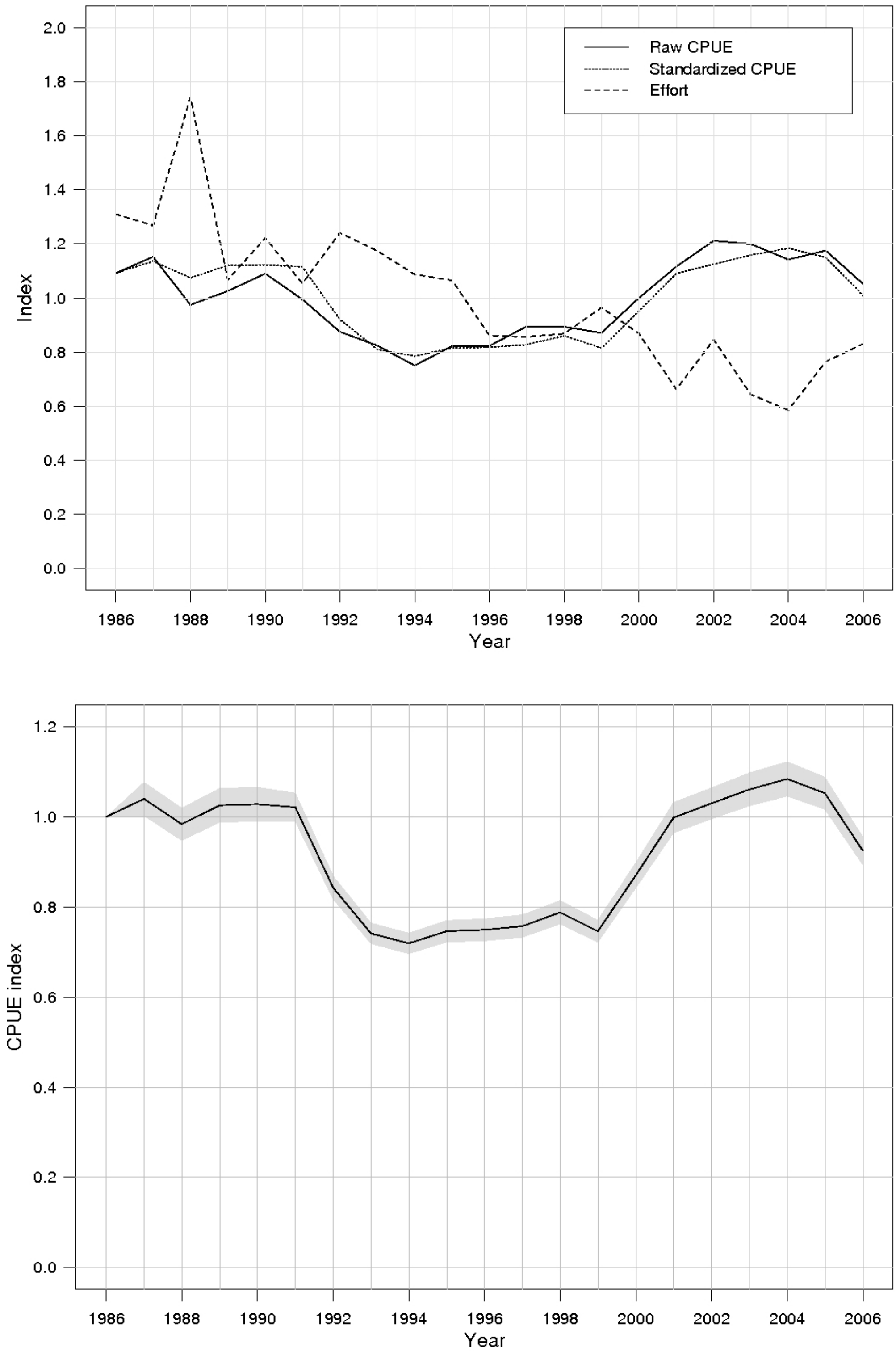


Figure 8.2.1 CPUE of *S. marinus* from Icelandic trawlers based on results from the GLM model 1985-2006 where the *S. marinus* catch composed at least 50% of the total catch in each haul. The upper figure shows the raw CPUE index (sum(yield)/sum(effort)), standardized CPUE index estimated using a generalized linear model, and effort. The lower figure shows the index estimated using a generalized linear model and associated standard error.

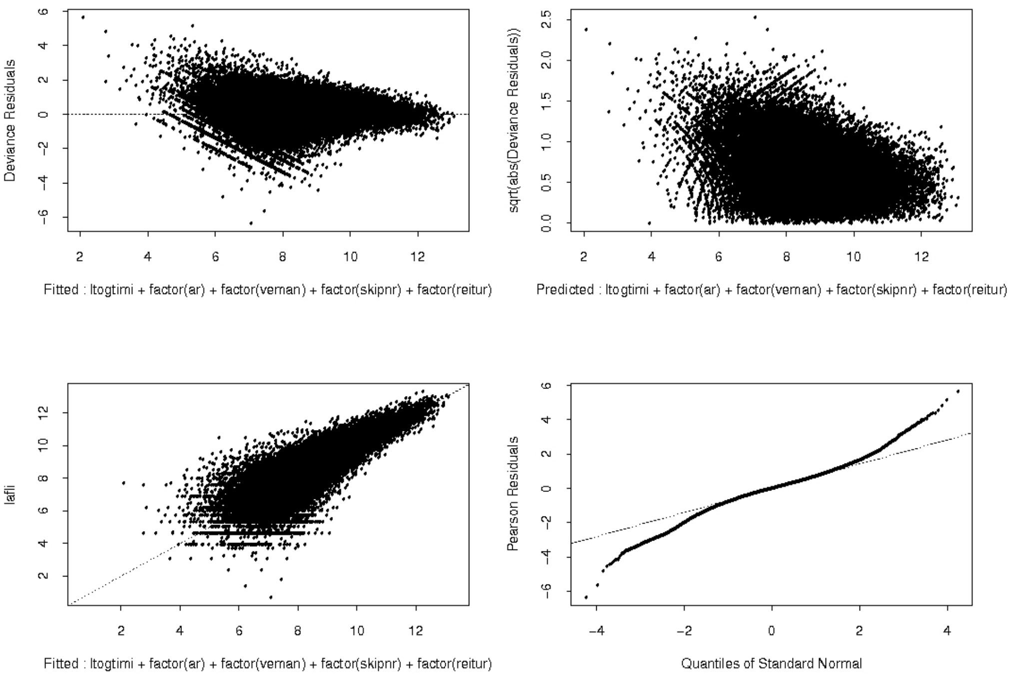


Figure 8.2.2. Residual of the GLM model (section 8.2.1) for the CPUE series of *S. marinus* in Va.

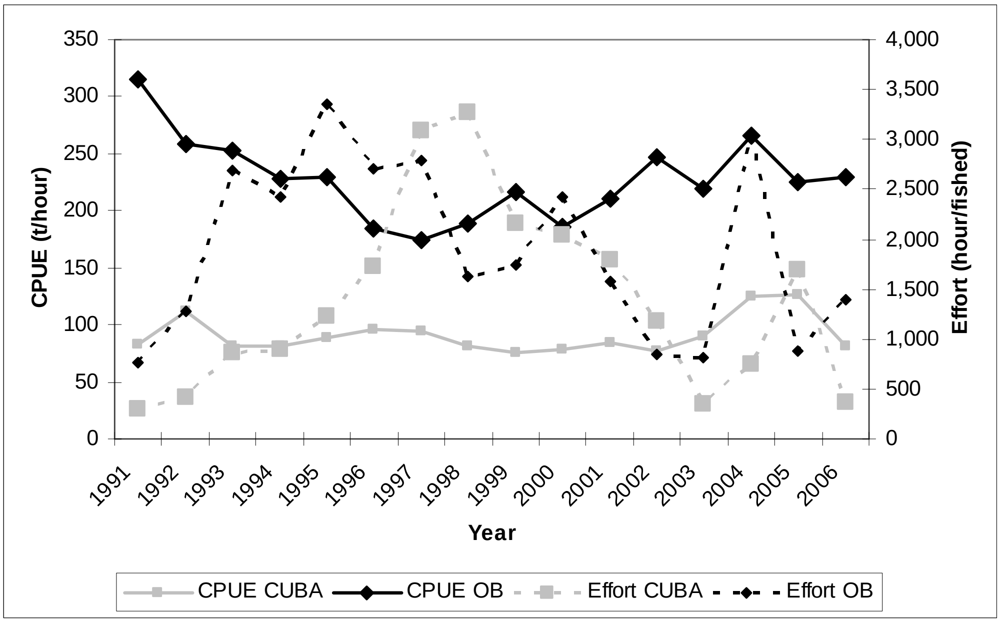


Figure 8.2.3 CPUE (solid lines) and effort (dotted lines) from the Faroese CUBA pair-trawlers (grey) and otterboard trawlers (black) in ICES Division Vb 1991-2006.

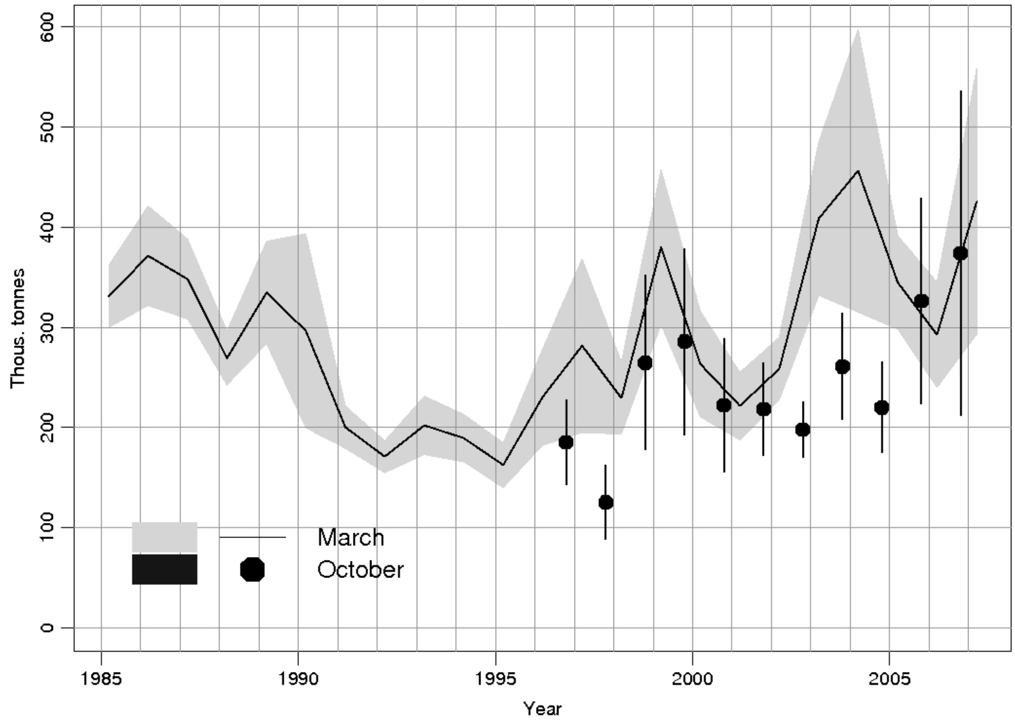


Figure 8.2.4 Total biomass indices from the groundfish surveys in March 1985-2007 (line, shaded area) and October 1996-2006 (points, vertical lines). The shaded area and the vertical bar show ±1 standard error of the estimate.

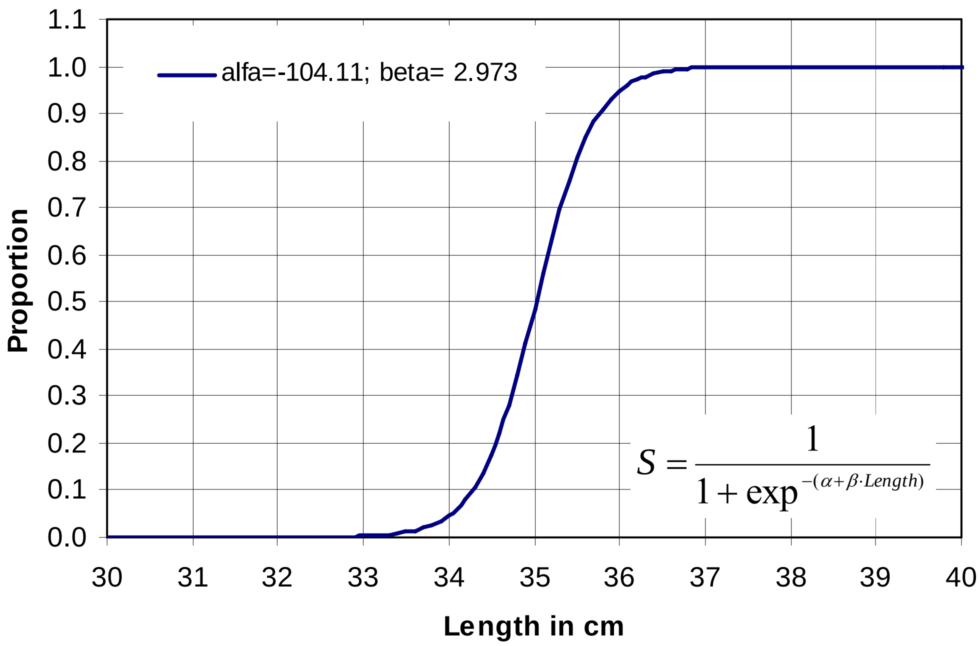


Figure 8.2.5 Selection pattern of *S. marinus* from the commercial fishery used to estimate the abundance of the fishable stock abundance. L_{50} = 35 cm.

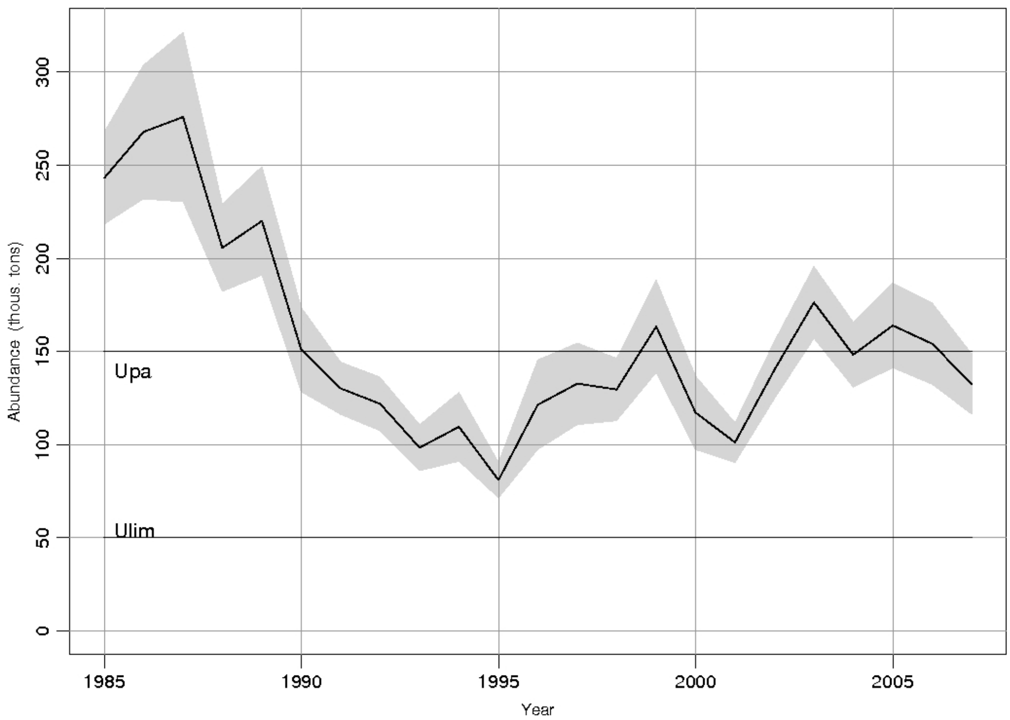


Figure 8.2.6 Index on fishable stock of *S. marinus* from Icelandic groundfish survey 1985-2007. The shaded area and the vertical bar show ±1 standard error of the estimate.

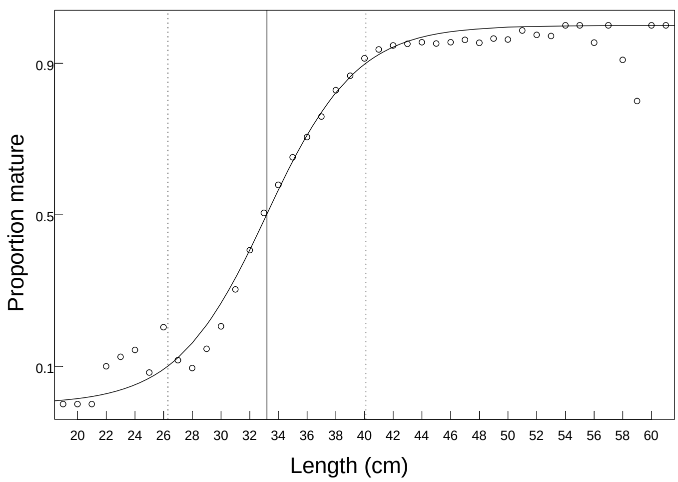


Figure 8.2.7 The proportion of mature *S. marinus* as a function of length from the commercial catch in Va 1995-2004 (all data pooled). The data points show the observed proportion mature and the lines the fitted maturity. The solid vertical line indicates the point where 50% of the fish mature and the two dotted lines indicate the 10% and 90% probability of being mature.

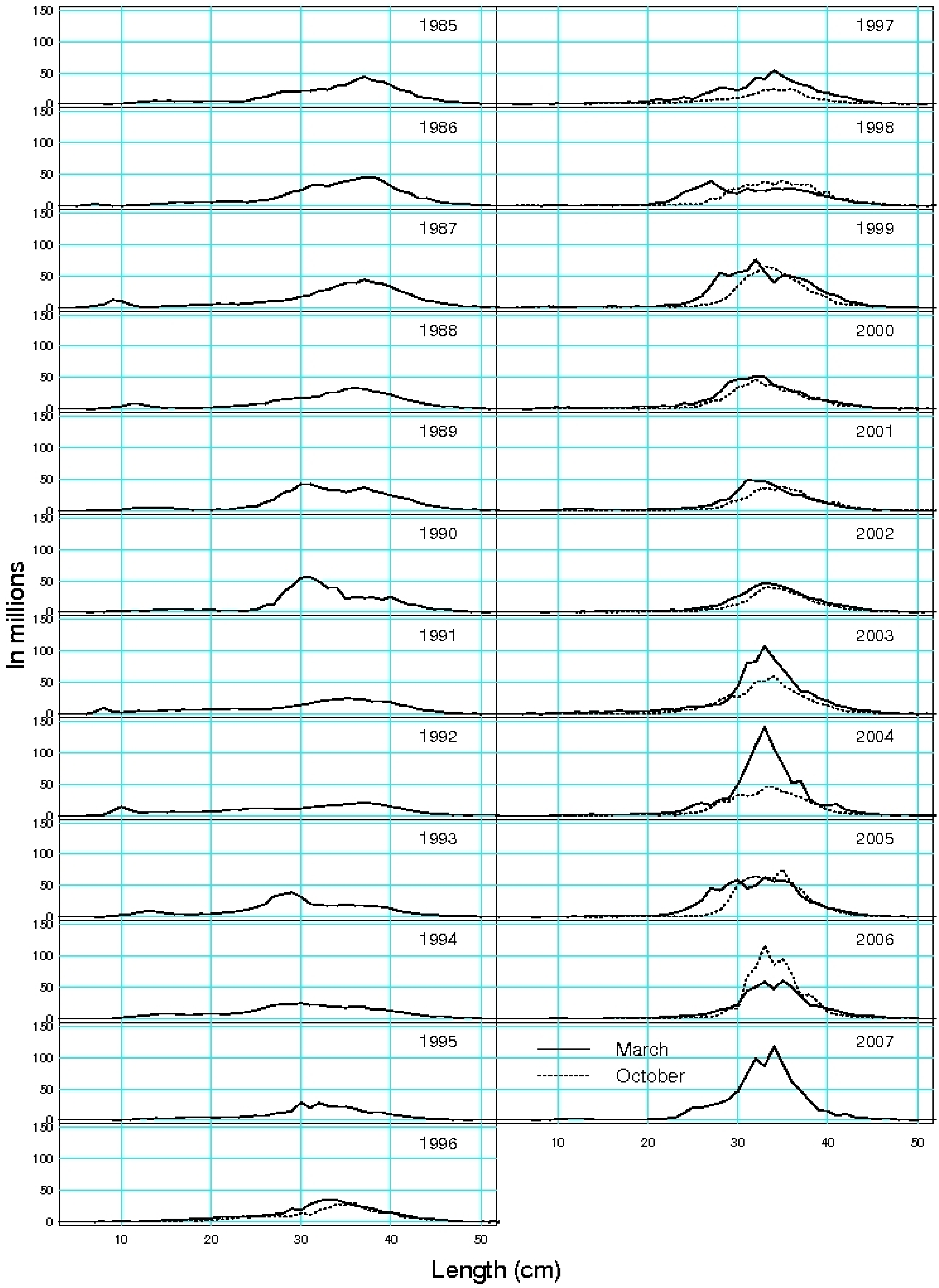


Figure 8.2.8 **Length distribution of *S. marinus* in the bottom trawl surveys in March 1985-2007 (solid line) and in October 1996-2006 (broken lines) conducted in Icelandic waters.**

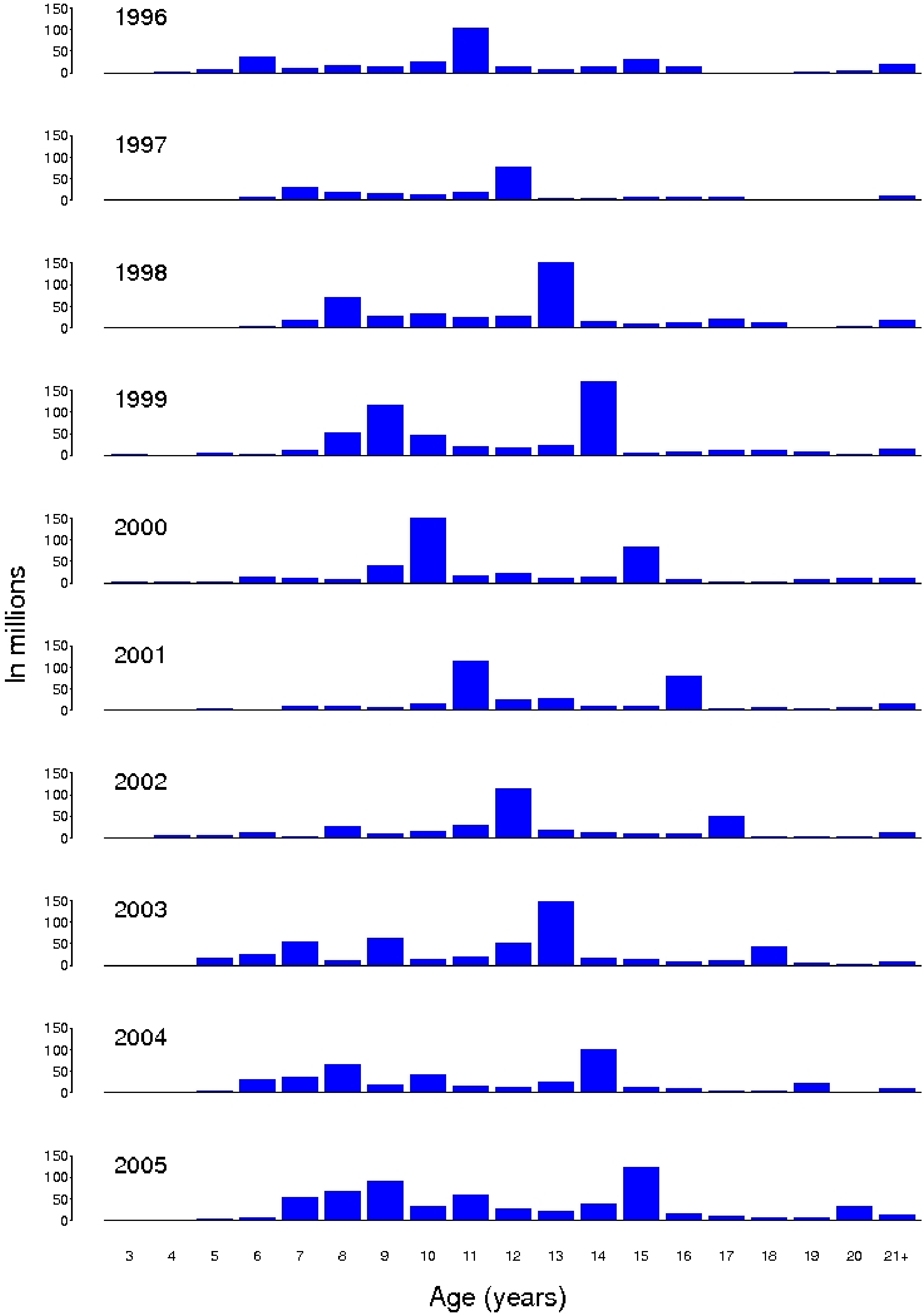


Figure 8.2.9 **Age distribution of *S. marinus* in the bottom trawl survey in October conducted in Icelandic waters 1996-2005. No age readings were available for 2006.**

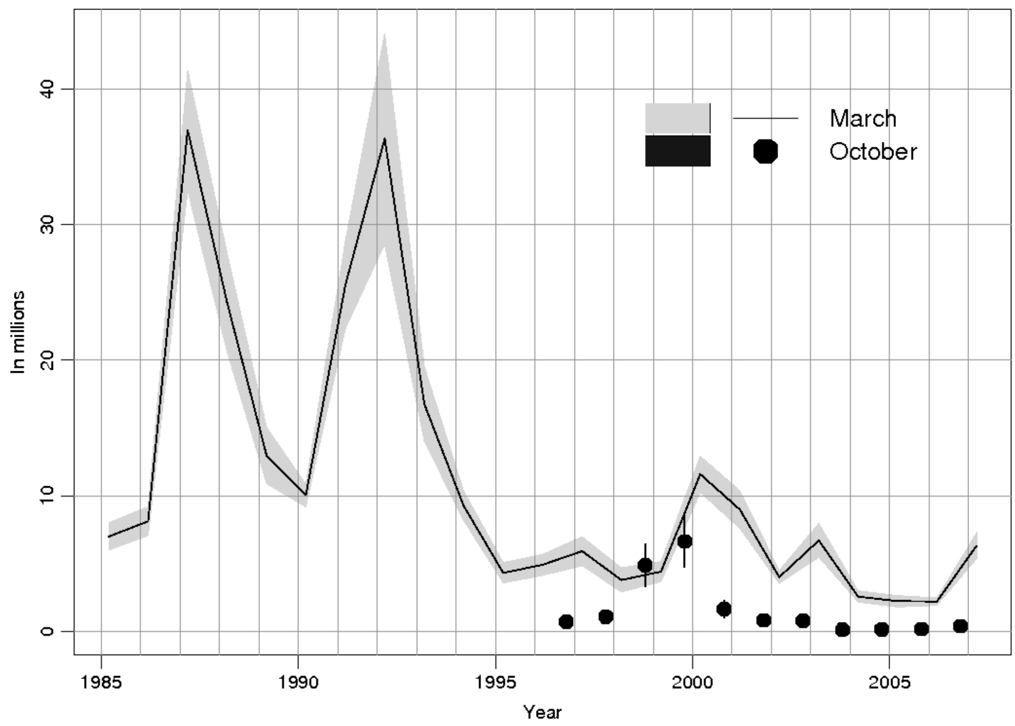


Figure 8.2.10 Indices of juvenile ***S. marinus*** (4-12) cm in millions from the grounfish surveys in March 1985-2007 (line, shaded area) and October 1996-2006 (points, vertical lines) conducted on the continental shelf and slope of Iceland The shaded area and the vertical bar show ±1 standard error in the estimate of the indices.

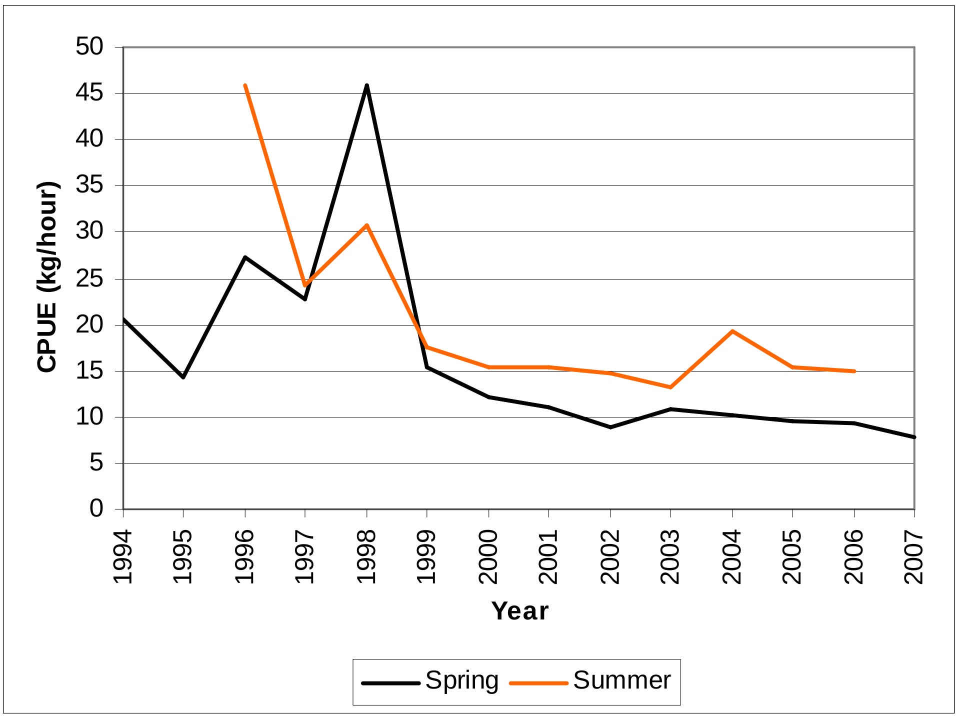


Figure 8.2.11 CPUE of ***S.marinus*** in the Faeroes spring groundfish survey 1994-2007 and the summer groundfish survey 1996-2006 in ICES Division Vb.

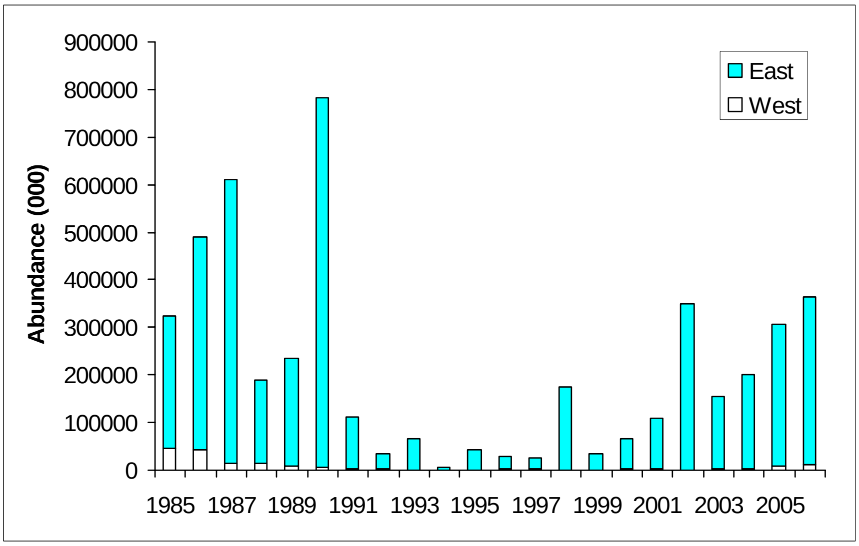


Figure 8.2.12 ***S. marinus*** **(≥17 cm). Survey abundance indices for East and West Greenland from the German groundfish survey 1985-2006.**

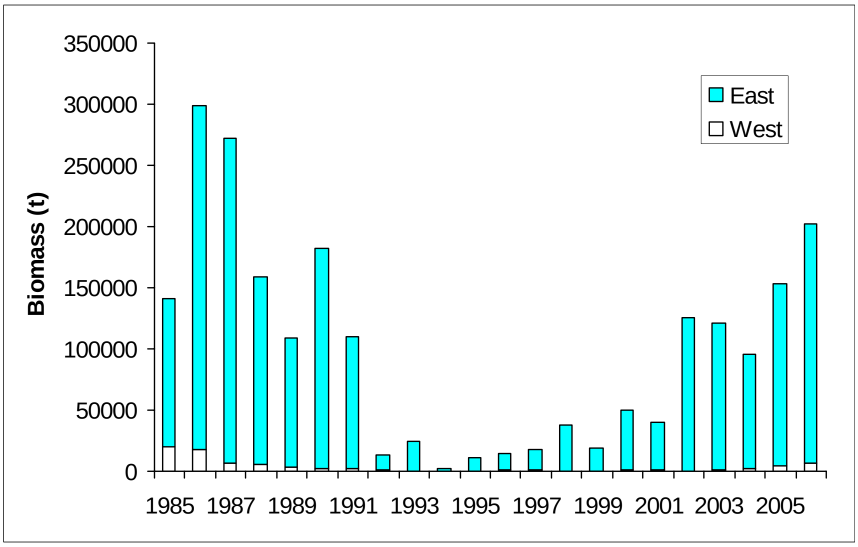


Figure 8.2.13 ***S. marinus*** **(≥17 cm). Survey biomass indices for East and West Greenland from the German groundfish survey1985-2006.**

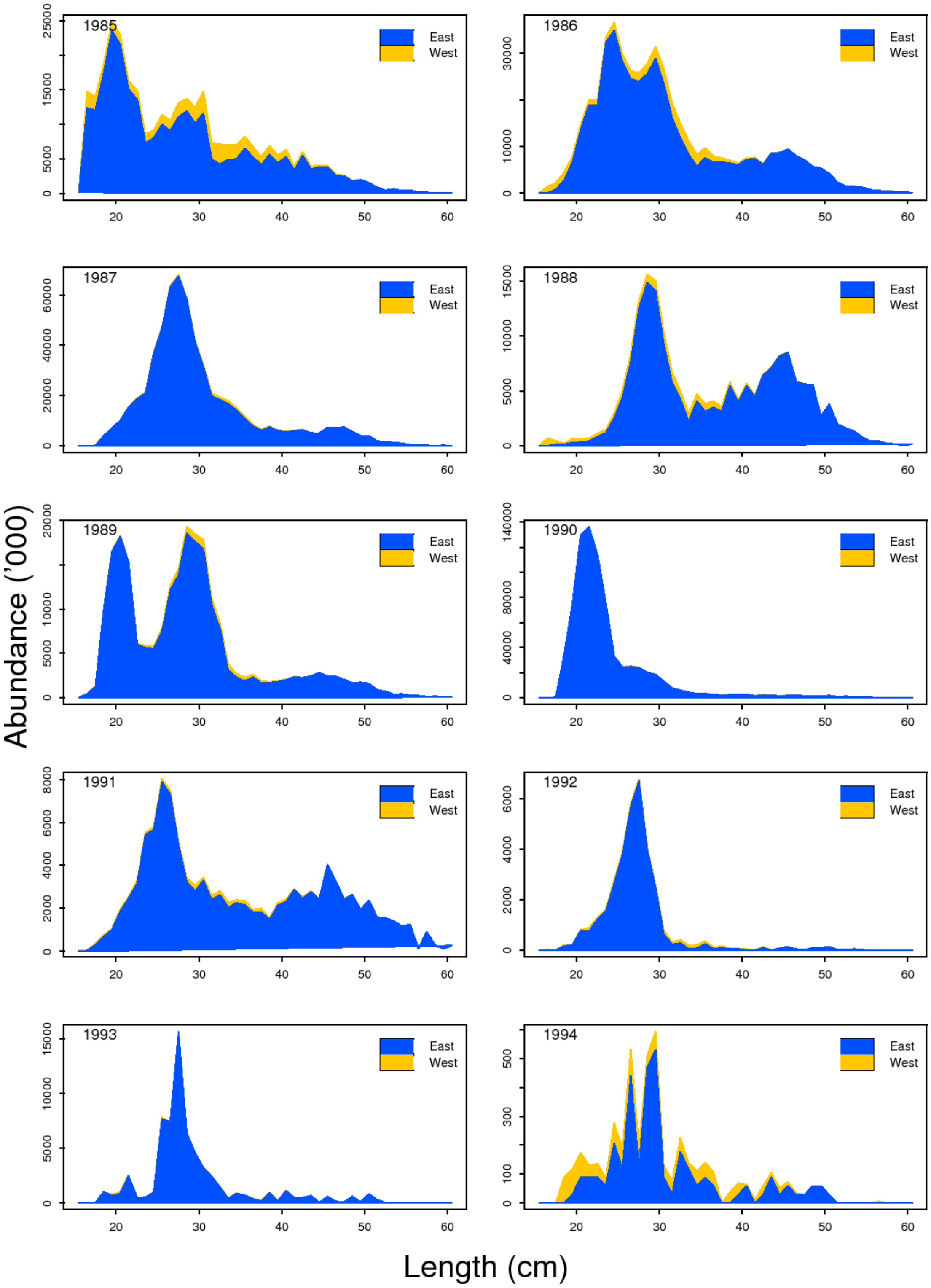


Figure 8.2.14 ***S. marinus*** **(>17 cm). Length frequencies for East and West Greenland 1985-1994.**

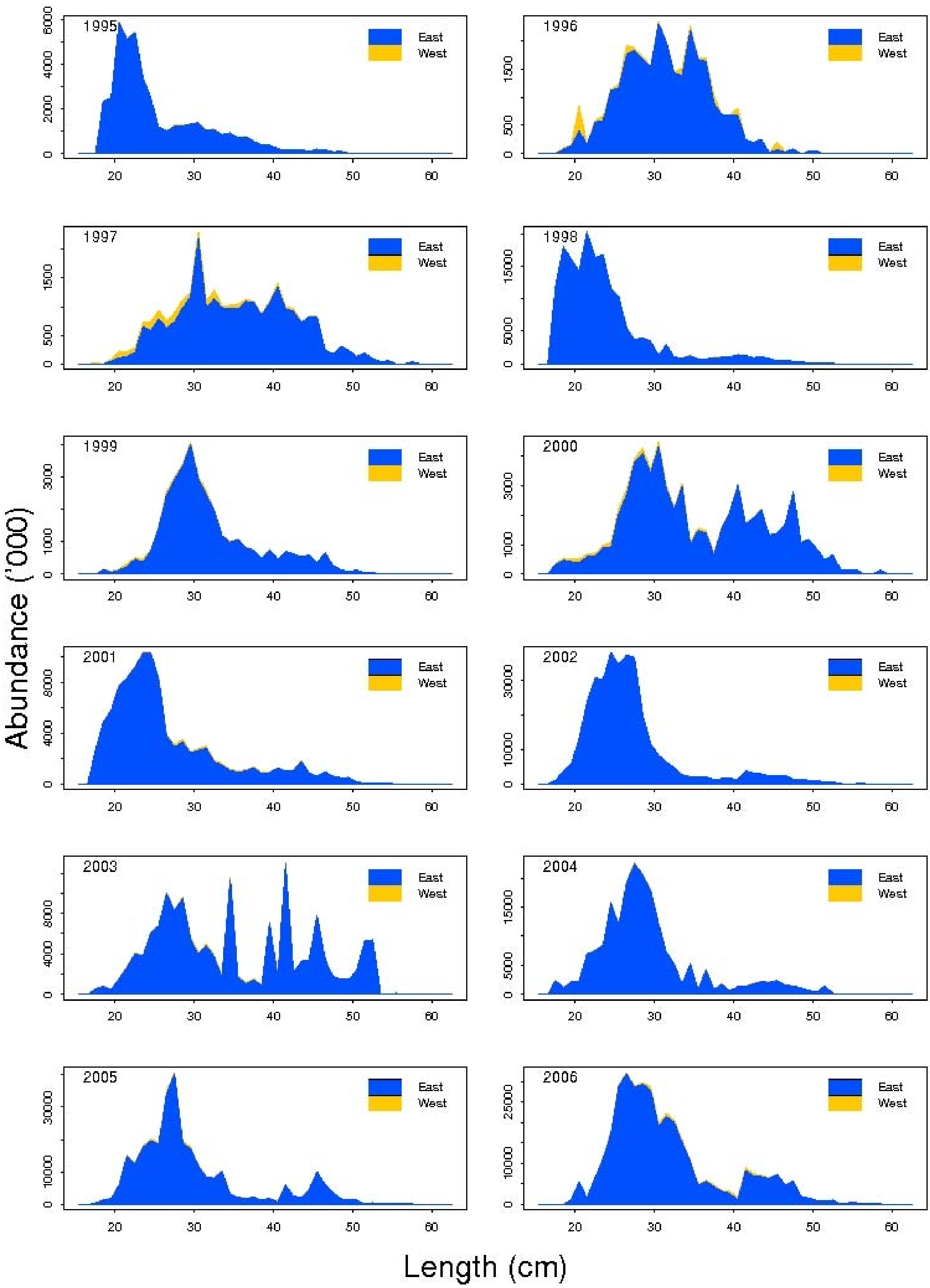


Figure 8.2.14 Continued. ***S. marinus*** **(>17 cm). Length frequencies for East and West Greenland 1995-2006.**

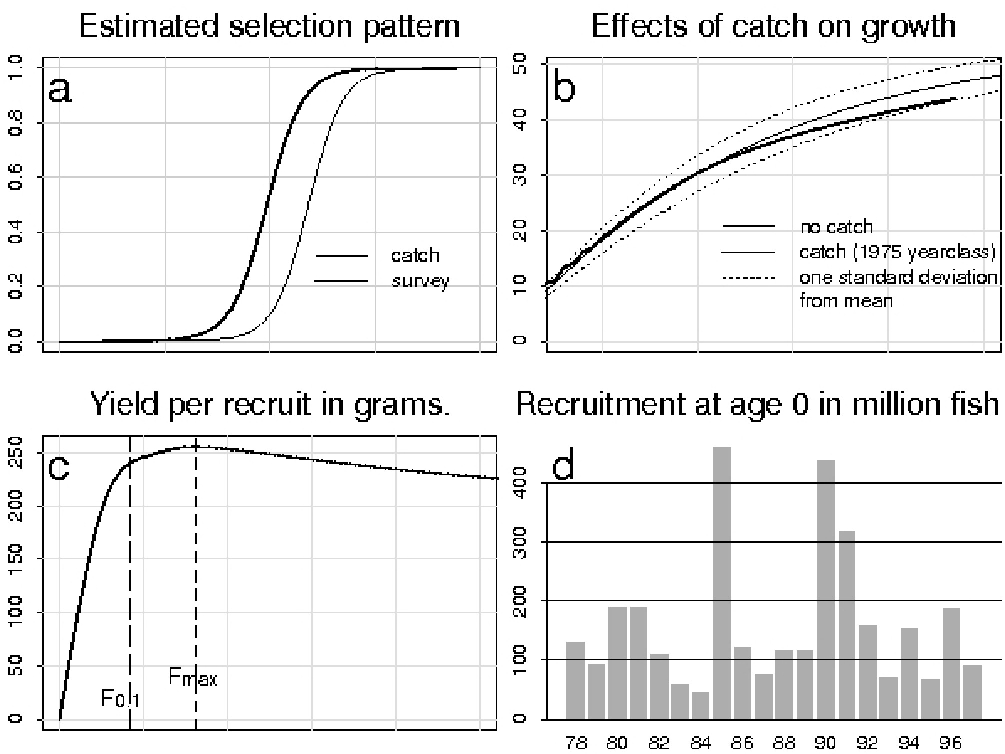


Figure 8.2.15 Results from the BORMICON model-BASE CASE, using catch data from ICES Division Va. a) Estimated selection pattern of the commercial fleet and the survey, b) Mean length (the Figure also demonstrates the effect of catch on length-at-age), c) Yield-per-recruit, and d) Estimated recruitment at age 0.

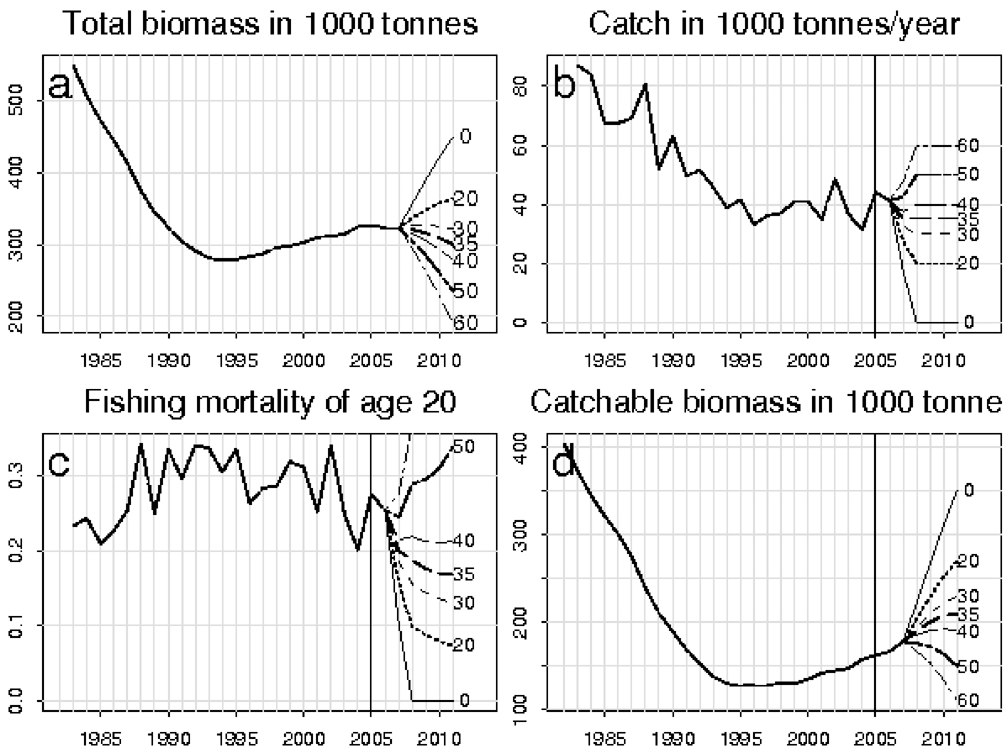


Figure 8.2.16 Results from the BASE CASE run, using catch data from ICES Division Va. The Figures show the development of biomass and F, using different catch options (0-60 000 t) after 2007.

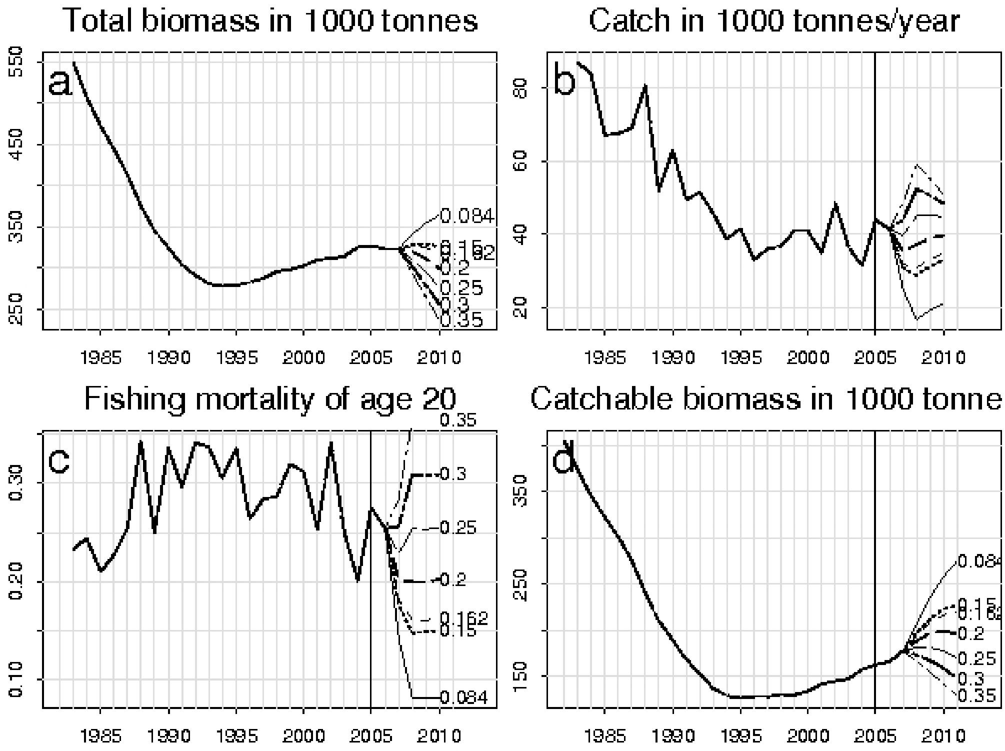


Figure 8.2.17 Results from the BASE CASE run, using catch data from ICES Division Va. The Figures show the development of biomass and F, using different effort after 2007.

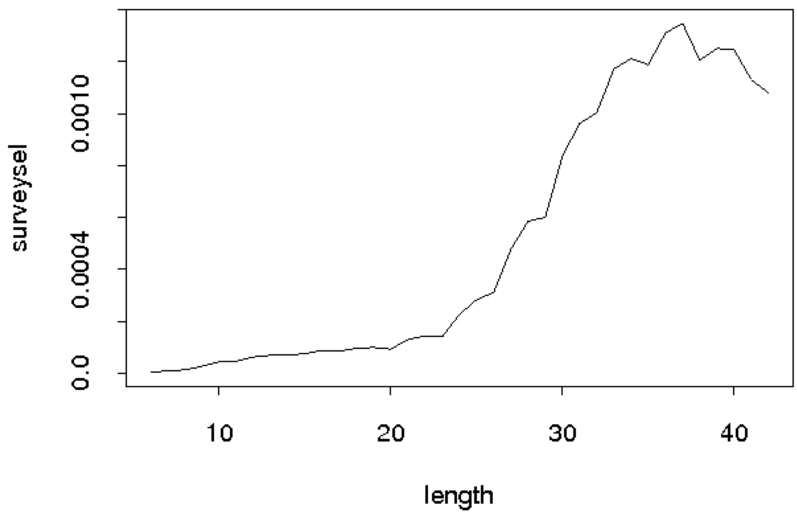


Figure 8.2.18 Estimated selection pattern as a function of length from the BASE CASE for *S. marinus* in the Icelandic groundfish survey.

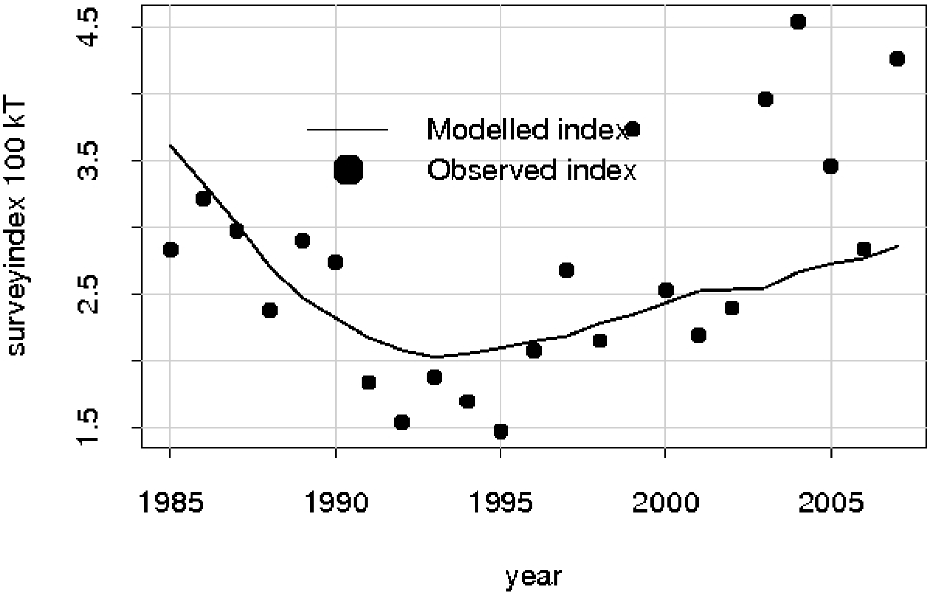


Figure 8.2.19 Results from the BASE CASE run, using only catch data from ICES Division Va. The Figure show comparison of observed and modelled survey biomass (total biomass) 1985-2007.

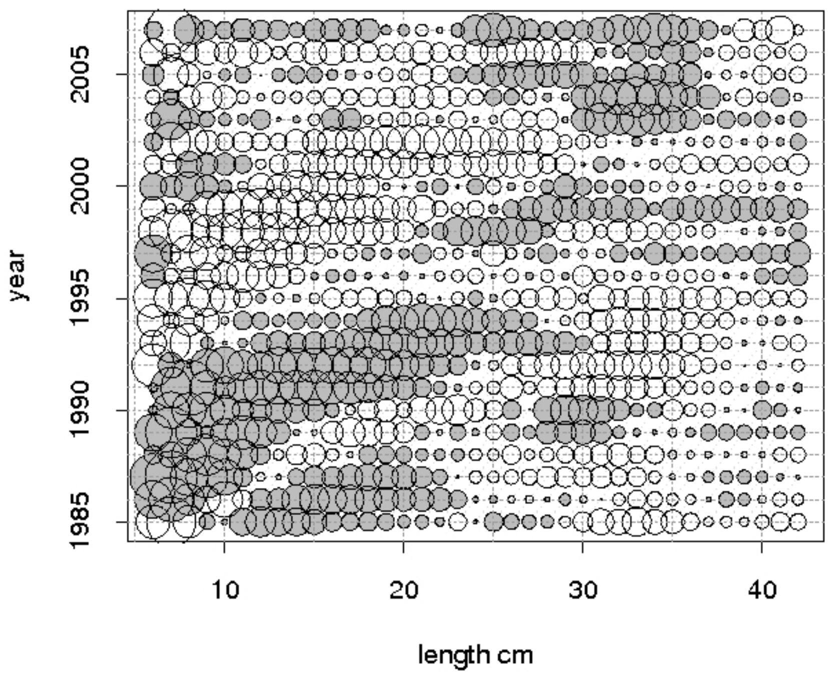


Figure 8.2.20 Results from the BASE CASE run, using catch data from ICES Division Va. Residuals from fit to survey data log(Isur/Imod). The shaded circles show positive residuals (survey results exceed model prediction).

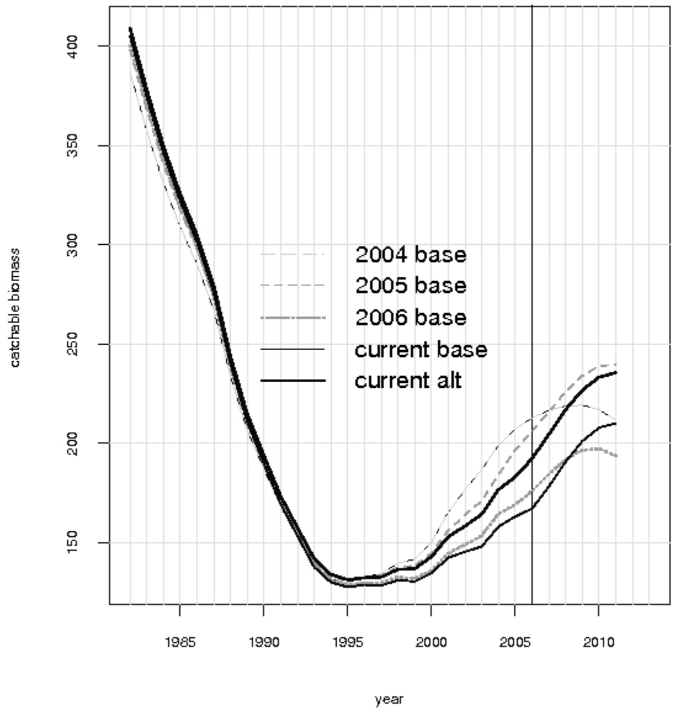


Figure 8.2.21 **Comparison of catchable biomass (in thousand tonnes) using the data obtained now and last year, for same settings. Results are obtained using only the catch history from ICES Division Va. Note the scale on y-axis does not start with 0.**

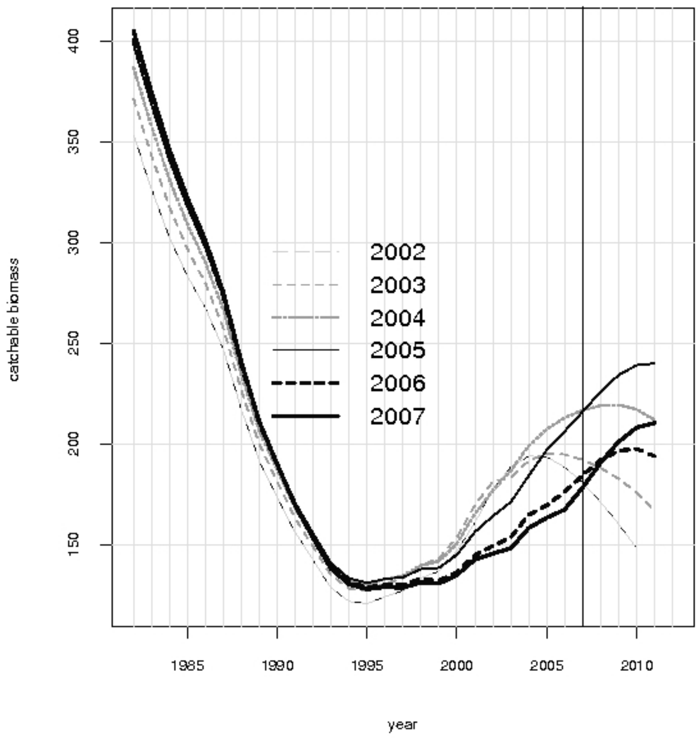


Figure 8.2.22 **Real-time retrospective analysis of catchable biomass (in thousand tonnes) 2002-2007. Older runs use predicted catches of 35 000 t after the assessment years. Real landings are somewhat larger. Results are obtained using only the catch history from ICES Division Va. Note the scale on y-axis does not start with 0.**

Figure 8.2.23 Comparison of catchable biomass (in thousand tonnes) using BORMCON model (thin line) and GADGET (thick lin). Results are obtained using only the catch history from ICES Division Va. Note the scale on y-axis does not start with 0.

9 Demersal *Sebastes Mentella* on the Continental Shelf

Demersal *S. mentella* on the continental shelves and slopes around the Faroe Islands, Iceland, and off East Greenland are 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 of East Greenland. The main fishing grounds of demersal *S. mentella* are in Icelandic waters.

The growth rate of demersal *S. mentella* in these areas was estimated around 3-4 cm/year until they reach maturity at about 30 cm length (10-12 years old) and around 2 cm/year thereafter, based on age validation results (Stransky et al. 2005a,b) and maturity data from surveys. Thus, demersal *S. mentella* is regarded as slow-growing and late maturing.

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 increased to about 31 000 t in 2003, mainly due to increased landings from Va. Annual landings in 2004-2006 were between 21 000 and 22 400 t, which were 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 to 28 500 t but have since then fluctuated between 17 000 t and 21 000 t (Table 9.1.1 and Figure 9.1.1). Most of the catches in recent years have been taken by bottom trawlers along the shelf and slope west, southwest, and southeast of Iceland at depths between 500 and 800 m (Figure 9.1.2). The proportion of demersal *S. mentella* catches taken by pelagic trawls 1991-2000 varied between 10 and 44% (Table 9.1.2). In 2001-2006, no pelagic fishery occurred or it was negligible, except in 2003 (see below). In general, the pelagic fishery of demersal *S. mentella* has mainly been in the same areas as the bottom trawl fishery (Figure 9.1.3), but usually in later months of the year (Figure 9.1.4). The catches in the third and fourth quarter of the year decreased considerable in 2001-2006 compared with earlier years, mainly due to decreased pelagic fishery (Figure 9.1.4). The catch pattern was different in 2003 than in previous years and in 2004-2006. The catches peaked in July, which was unusual compared with other years (Figure 9.1.4). This pattern is probably associated with the pelagic *S. mentella* fishery within the Icelandic EEZ (see Figure 7.1.1). 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 7.1.3). When the pelagic *S. mentella* crossed the redfish line to the east, it was recorded as demersal *S. mentella* and caught either with pelagic or bottom trawls resulting in increased landings in 2003 (Figures 9.1.2-9.1.3 and 7.1.1). Length distributions of demersal *S. mentella* from the bottom trawl fishery show an increase in the number of small fish in the catch in 1994 compared to previous years (Figure 9.1.5). The peak of about 32 cm in 1994 can been followed by approximately 1 cm annual growth in 1996-2002. The fish caught in 2004-2006 peaked around 37-39 cm and were on average bigger than in 2003. The length distribution of demersal *S. mentella* from the pelagic fishery, where available, showed that in most years the fish was on average bigger than taken in the bottom trawl fishery.

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). However, landings in 2005 decreased substantially to 2 000 t, but increased again to 3 500 t in 2006. The record high was reported in 1986 as 15 000 t. Length distributions from the landings in 2001-2006 indicate that the fish caught are on average slightly larger than 40 cm (Figure 9.1.6).

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 (6 t), the lowest recorded since 1978. They increased again to 111 t in 2005 and 179 t in 2006.

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, and 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. There was very little demersal *S. mentella* fishery in XIV in 2003-2005 (less than 400 t), and in 2006 only 12 t were reported.

The table below shows the 2006 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 2006.

Area	Nation	Landings	Nos. samples	Nos. fish measured
Va	Iceland	16,543	249	39,131
Vb	Faroe Islands	3,410	72	6,999

9.2 Assessment

9.2.1 CPUE indices

Data used to estimate CPUE for demersal *S. mentella* in Division Va 1986-2006 were obtained from log-books of the Icelandic bottom trawl fleet. Only those tows were used that were taken below 500 m depth and that were comprised of at least 50% *S. mentella*. CPUE indices 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. The output of the model is given in Table 9.2.1 and the model residuals in Figure 9.1.8.

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 did not change between 2004-2006.

Non-standardized CPUE indices in Division Vb for demersal *S. mentella* were obtained from the Faroese 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 300 kg/hour in 1993 and remained at that level until 2004 (Figure 9.1.9). In 2005, the CPUE decreased to the lowest level in the time series and remained low in 2006 and is now close to the Upa level. Fishing effort decreased between 2001 and 2003, but has since then varied between 6 000 and 12 000 hours.

Non-standardized CPUE data from Division XIV were available from 1998 to 2002 when the German fleet fished for *S. mentella* 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 2003-2006, 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 1989 at a mean length of 20 cm. The 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 2003-2006 show 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 Faeroe 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 Faroes waters.

The Greenland halibut survey is a random stratified bottom trawl survey, conducted on the continental shelf and slope of East Greenland 1998-2006 (no survey conducted in 2001) covers depths from 400 m down to 1 500 m (WD03). Although the survey series is relatively short, the trends in abundance and biomass have varied with the highest estimates in 1999 and lowest in 2005 (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 distributions in 2004-2006 are dominated by 20-25 cm fish (Figure 9.2.4) and length increases both by depth and from north to south. The area and depth coverage of this survey, however, changed from year to year, probably causing some of the variation in the biomass estimates and length distributions.

The Icelandic autumn survey on the continental shelf and slope in Va 2000-2006, covering depths down to 1 200 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, caused by one tow accounting for a large part of the total amount caught. The biomass index in 2002-2006 has been relatively stable. Because there may be high variance in the estimates and because the time series of the survey is short, it may be difficult to 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 modes ranging between 36-39 cm (Figure 9.2.6).

The Faroese spring and summer surveys in Division Vb are mainly designed for species inhabiting depths down to 500 m and do not cover the vertical distribution of demersal *S. mentella*. Therefore, the surveys will not be used in order to evaluate the status of the stock.

9.3 State of the stock

The Group concludes that the state of the stock is stable on a low level. With the 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 2002-2006 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 suggest a decrease in demersal *S. mentella* biomass from 2003 to 2005, but an increase in 2006. 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, CPUE stabilised close to the 50% of the maximum in the time series from 1993 to 2006,.

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 landings decreased in Division Va between 2003 and 2004 by about 10 000 t when the fishery of pelagic *S. mentella* merged with the demersal fishery at the redfish line. In 2001-2002 and 2004-2006 the landings were lower than the set quota between 22 000 t and 25 000 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 in the pelagic fishery on demersal *S. mentella*.

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 was presented with new information in WD16 (see chapter 7.3). The effect of sorting grids show that the by-catch rates of redfish in the shrimp fishery of <1% (average 0.64% in 2006 and 0.52% in 2006-2007). The Group recommends 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 1978-2006, 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	376	31 164
2004	17 564	3 931	6	0	389	21 890
2005	20 563	1 593	111	0	120	22 387
2006[1)]	17 412	3 421	179	0	12	21 023

1) Provisional

Table 9.1.2 Proportion of the landings of demersal *S. mentella* taken in Va by pelagic and bottom trawls 1991-2006.

Year	Pelagic trawl	Bottom trawl
1991	22%	78%
1992	27%	73%
1993	32%	68%
1994	44%	56%
1995	36%	64%
1996	31%	69%
1997	11%	89%
1998	37%	63%
1999	10%	90%
2000	24%	76%
2001	3%	97%
2002	3%	97%
2003	28%	72%
2004	0%	100%
2005	0%	100%
2006	0%	100%

Table 9.2.1 Results of the GLM model to calculate standardized CPUE for Icelandic demarsal redfish fishery in Va. Note that the residuals are shown in Fig. 9.1.8.

```
Call: glm(formula = lafli ~ ltogtimi + factor(ar) + factor(veman) + factor(skipnr) +
factor(reitur), family =
        gaussian(), data = tmp)
Deviance Residuals:
       Min         1Q     Median        3Q      Max
 -4.333763 -0.3174286 0.01142595 0.3406554 4.755249

factor(ar)1986  0.00000000 0.00000000   0.0000000 1986 1.0000000 1.0000000 1.0000000
factor(ar)1987  0.07928855 0.04539138   1.7467754 1987 1.0825166 1.0344782 1.1327858
factor(ar)1988 -0.02530800 0.04494941  -0.5630329 1988 0.9750096 0.9321539 1.0198356
factor(ar)1989 -0.06497082 0.04471074  -1.4531367 1989 0.9370948 0.8961195 0.9799438
factor(ar)1990 -0.09945126 0.04146031  -2.3987097 1990 0.9053341 0.8685661 0.9436585
factor(ar)1991 -0.07394190 0.03732685  -1.9809304 1991 0.9287257 0.8946983 0.9640472
factor(ar)1992 -0.31805650 0.03686524  -8.6275443 1992 0.7275617 0.7012283 0.7548839
factor(ar)1993 -0.42639512 0.03697929 -11.5306462 1993 0.6528583 0.6291570 0.6774525
factor(ar)1994 -0.53295093 0.03696610 -14.4172885 1994 0.5868706 0.5655724 0.6089709
factor(ar)1995 -0.51080243 0.03741935 -13.6507568 1995 0.6000139 0.5779767 0.6228914
factor(ar)1996 -0.50791475 0.03814827 -13.3142263 1996 0.6017491 0.5792257 0.6251482
factor(ar)1997 -0.47141226 0.03806105 -12.3856865 1997 0.6241202 0.6008119 0.6483328
factor(ar)1998 -0.46297480 0.04037470 -11.4669529 1998 0.6294085 0.6045025 0.6553407
factor(ar)1999 -0.40064354 0.03943781 -10.1588685 1999 0.6698888 0.6439840 0.6968356
factor(ar)2000 -0.34776415 0.03981172  -8.7352201 2000 0.7062654 0.6787001 0.7349503
factor(ar)2001 -0.37611809 0.04185777  -8.9856210 2001 0.6865213 0.6583781 0.7158674
factor(ar)2002 -0.40465521 0.04032968 -10.0336814 2002 0.6672068 0.6408340 0.6946650
factor(ar)2003 -0.33525111 0.04039119  -8.3001051 2003 0.7151585 0.6868480 0.7446359
factor(ar)2004 -0.39127333 0.04125420  -9.4844491 2004 0.6761953 0.6488670 0.7046746
factor(ar)2005 -0.38429105 0.04001842  -9.6028550 2005 0.6809332 0.6542214 0.7087357
factor(ar)2006 -0.40697509 0.04151210  -9.8037708 2006 0.6656608 0.6385935 0.6938753

Analysis of Deviance Table

Gaussian model

Response: lafli

Terms added sequentially (first to last)
                Df Deviance Resid. Df Resid. Dev  F Value Pr(F)
          NULL                  21855   40656.56
      ltogtimi   1 29413.86     21854   11242.70 77357.57     0
    factor(ar)  20   695.91     21834   10546.80    91.51     0
 factor(veman)  11   251.92     21823   10294.88    60.23     0
factor(skipnr) 141  1385.10     21682    8909.78    25.84     0
factor(reitur) 136   717.29     21546    8192.49    13.87     0
```

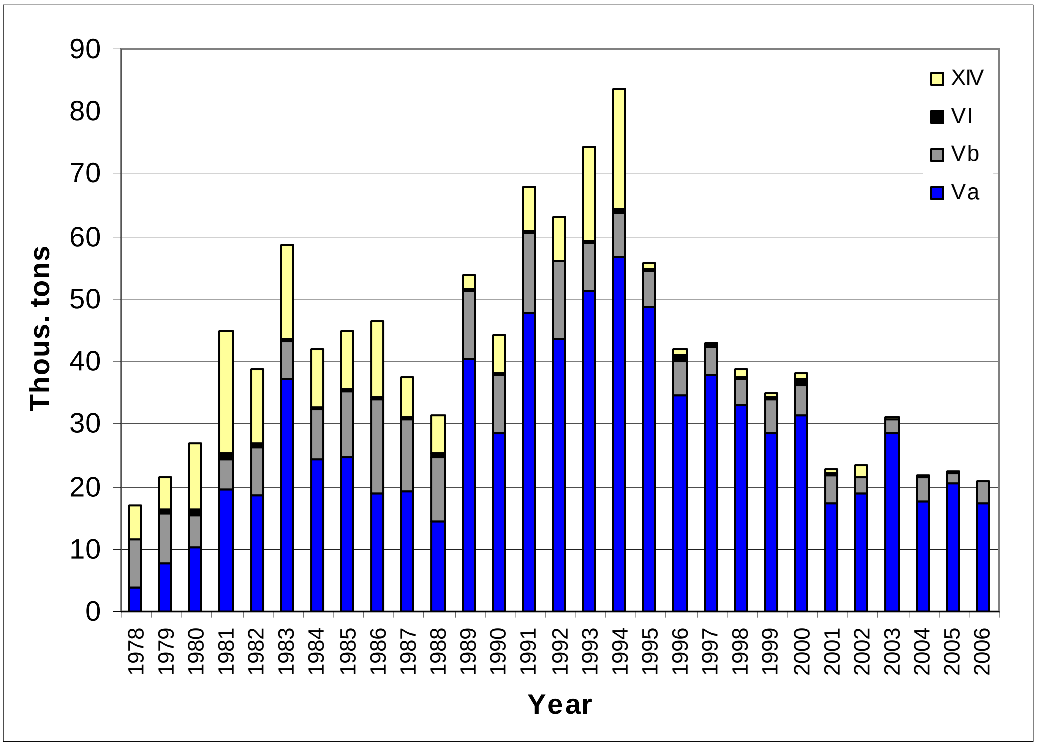


Figure 9.1.1 Nominal landings of demersal *S. mentella* (in tonnes) from ICES Divisions Va, Vb, VI and XIV 1978-2006.

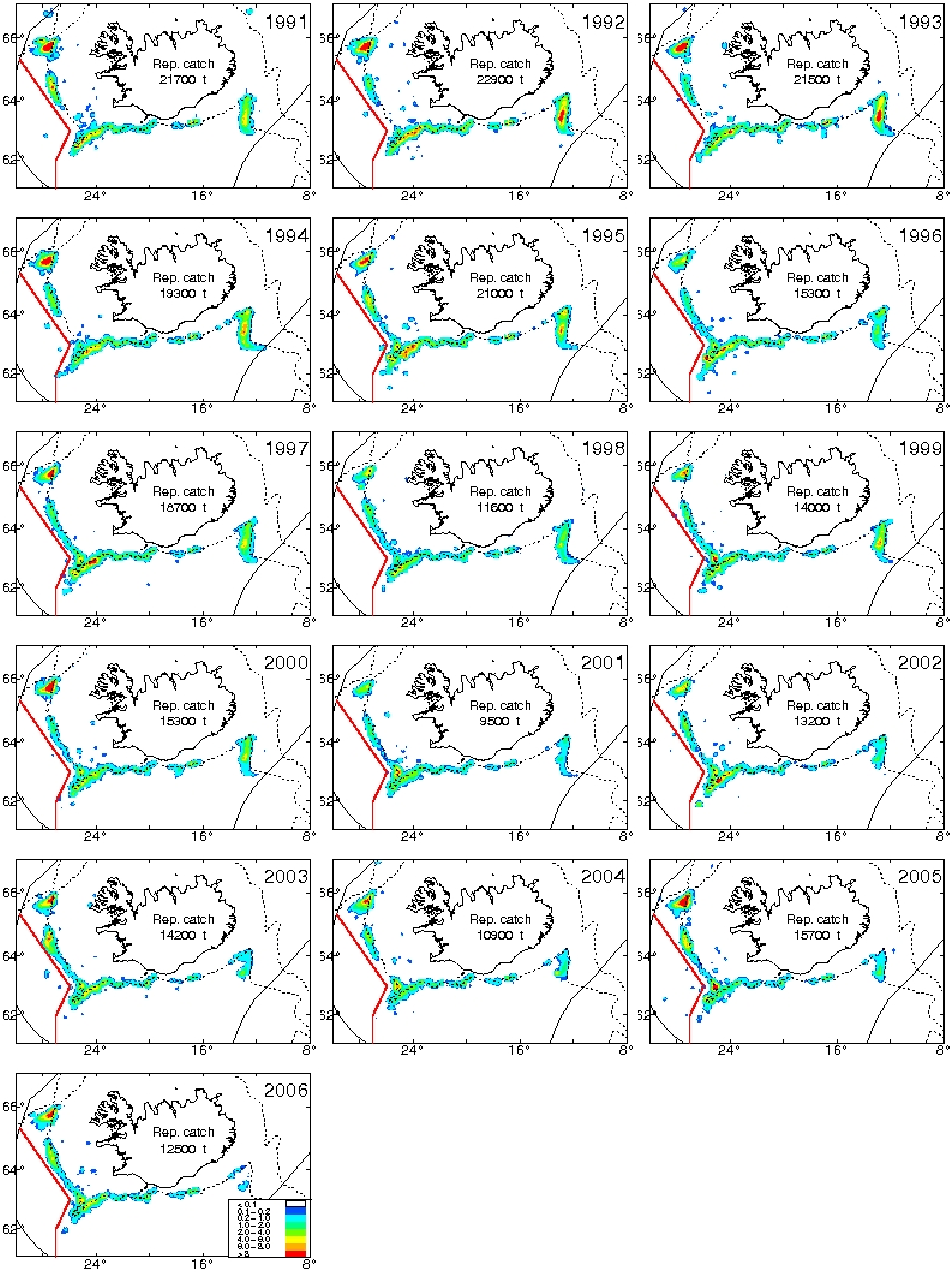


Figure 9.1.2 Geographical location of the demersal *S. mentella* catches in Icelandic waters 1991-2006 as reported in log-books of the Icelandic fleet using bottom trawl. The red line is the redfish line and the dotted line represents the 500 m isobaths.

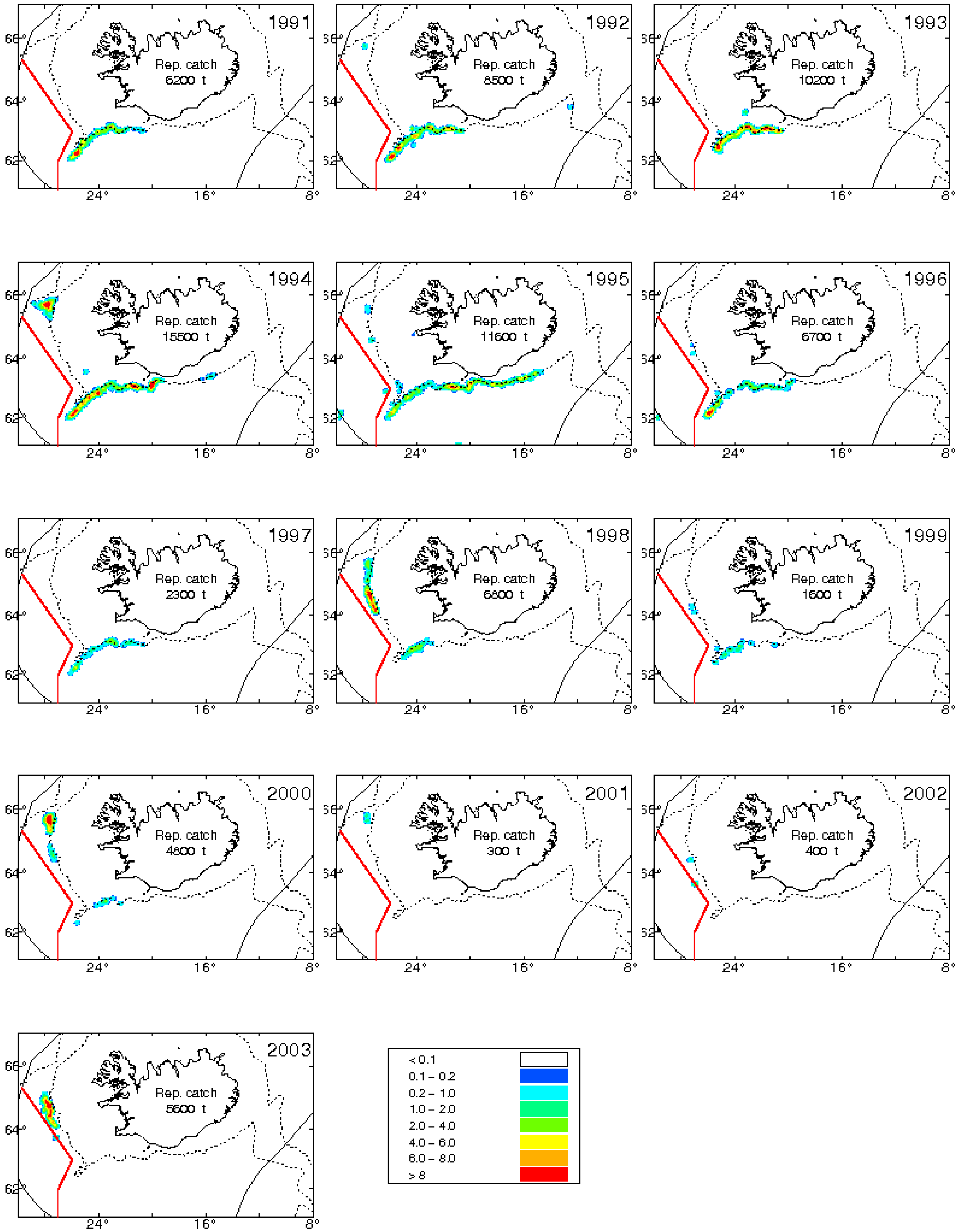


Figure 9.1.3 Geographical location of the demersal *S. mentella* catches in Icelandic waters 1991-2003 as reported in log-books of the Icelandic fleet using pelagic trawl. The red line is the redfish line and the dotted line represents the 500 m isobaths.

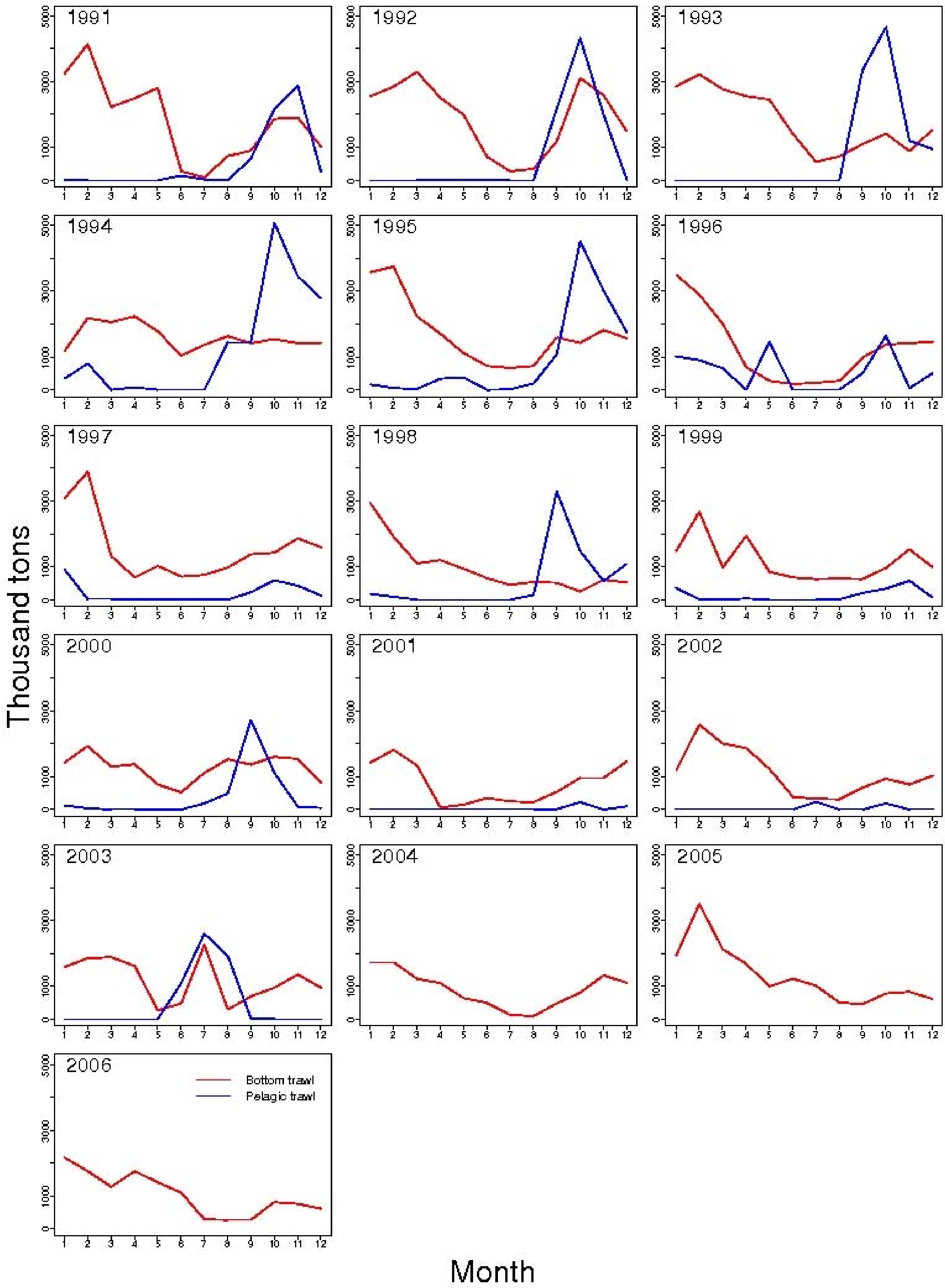


Figure 9.1.4 Nominal landings of demersal *S. mentella* (in tonnes) in Icelandic waters (ICES Division Va) of the Icelandic fleet using either bottom trawl (red line) or pelagic trawl (blue line) 1991-2006, divided by month.

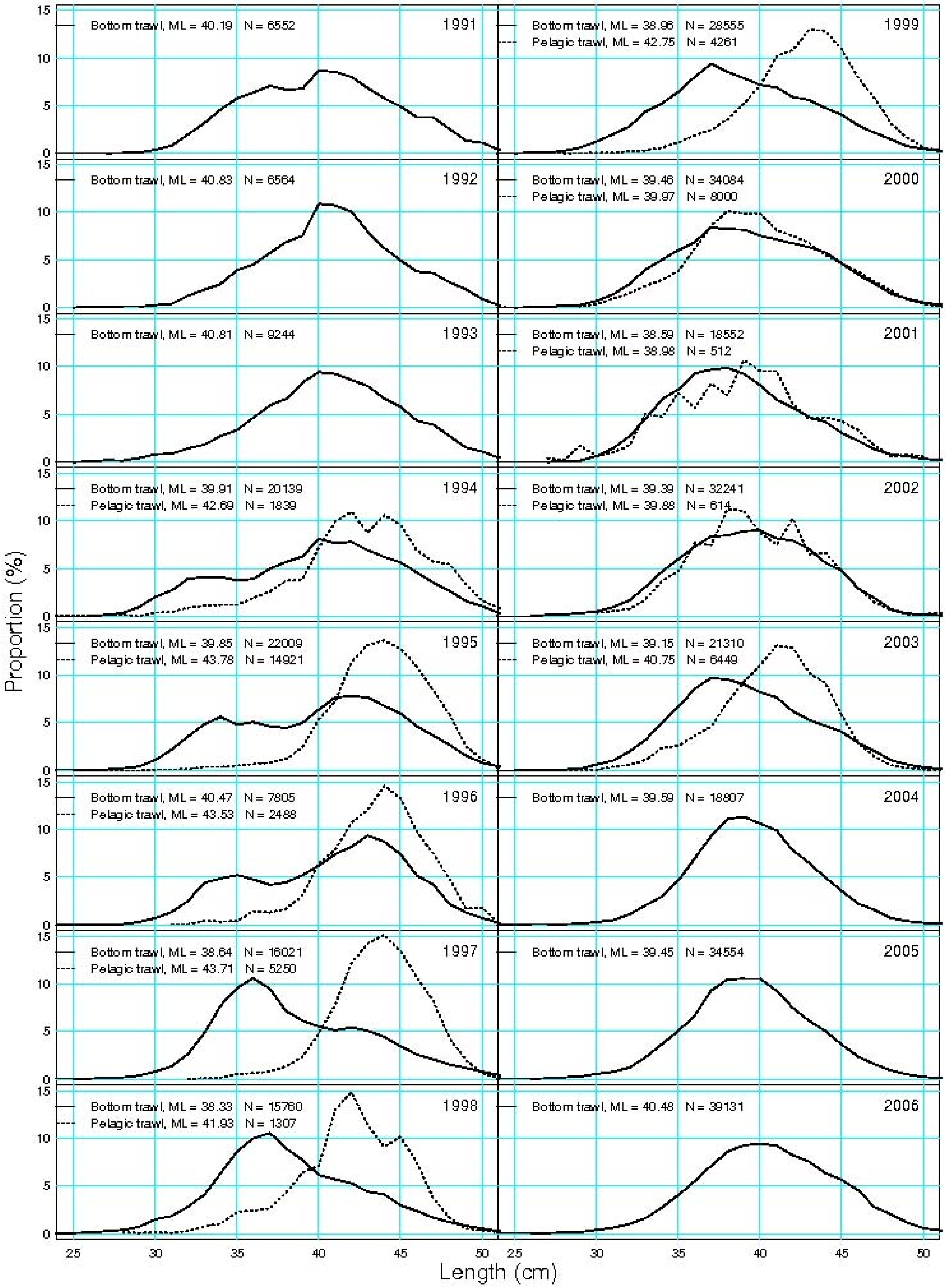


Figure 9.1.5 Length distributions of demersal *S. mentella* from the Icelandic landings taken with bottom trawl (solid line) and pelagic trawl (dotted line) in Division Va 1991-2006.

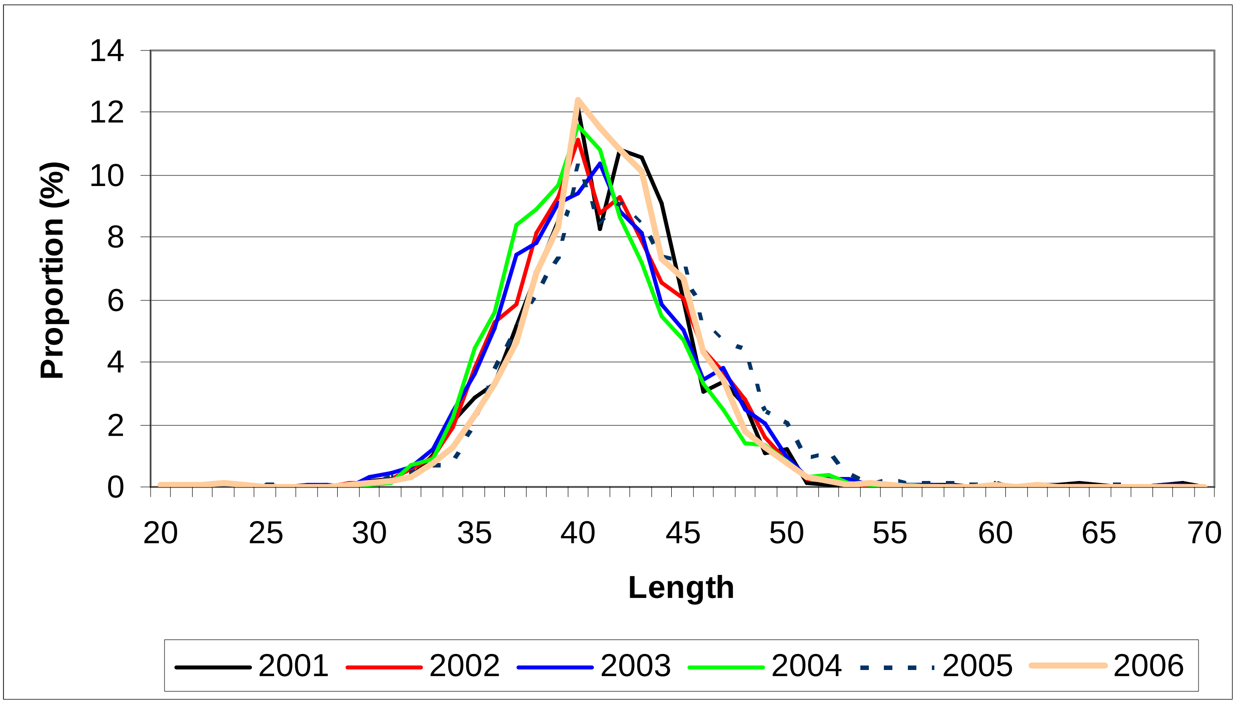
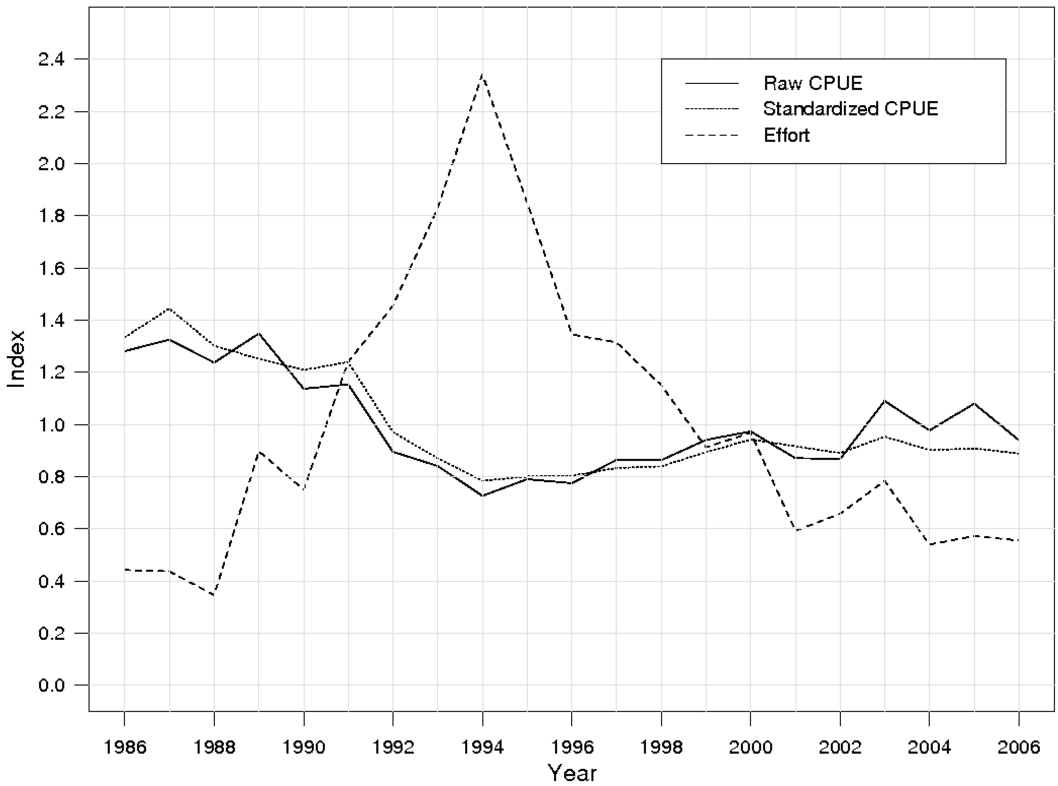


Figure 9.1.6 Length distribution of demersal *S. mentella* from landings of the Faeroese fleet in Division Vb 2001-2006.



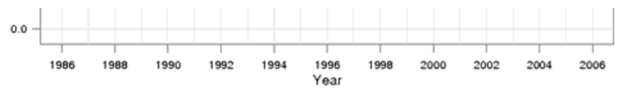


Figure 9.1.7 CPUE, relative to 1986, of demersal *S. mentella* from the Icelandic bottom trawl fishery in Division Va. CPUE based on a GLM model, based on data from log-books and where at least 50% of the total catch in each tow was demersal *S. mentella*. Also shown is fishing effort (hours fished in thousands).

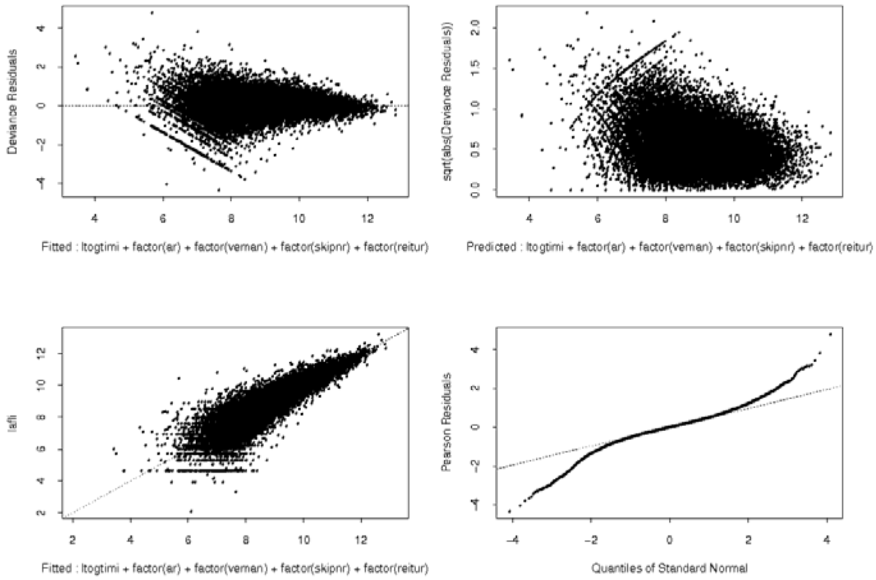


Figure 9.1.8 **Residual of the GLM model (section 9.2.1) for the CPUE series of demersal *S. mentella.***

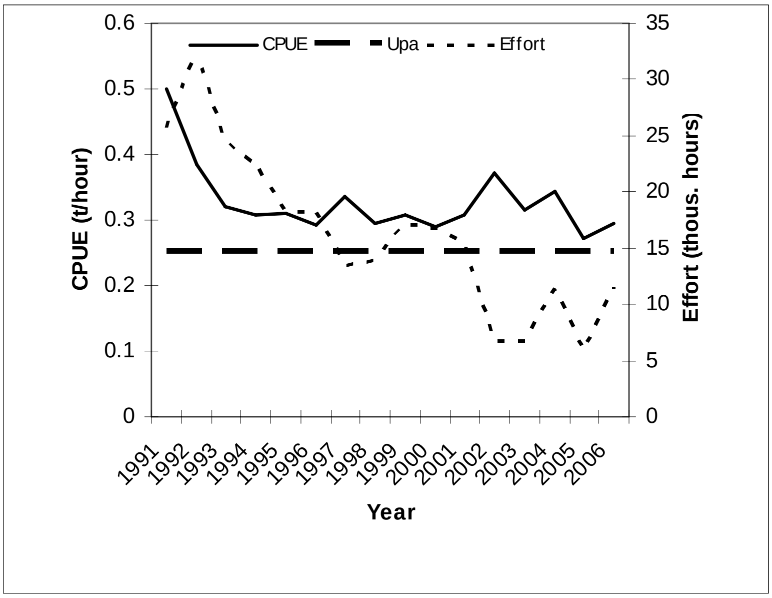


Figure 9.1.9 **Demersal *S. mentella.*. CPUE (t/hour) and fishing effort (in thousands hours) from the Faeroese CUBA fleet 1991-2006 and where 70% of the total catch was demersal *S. mentella*.**

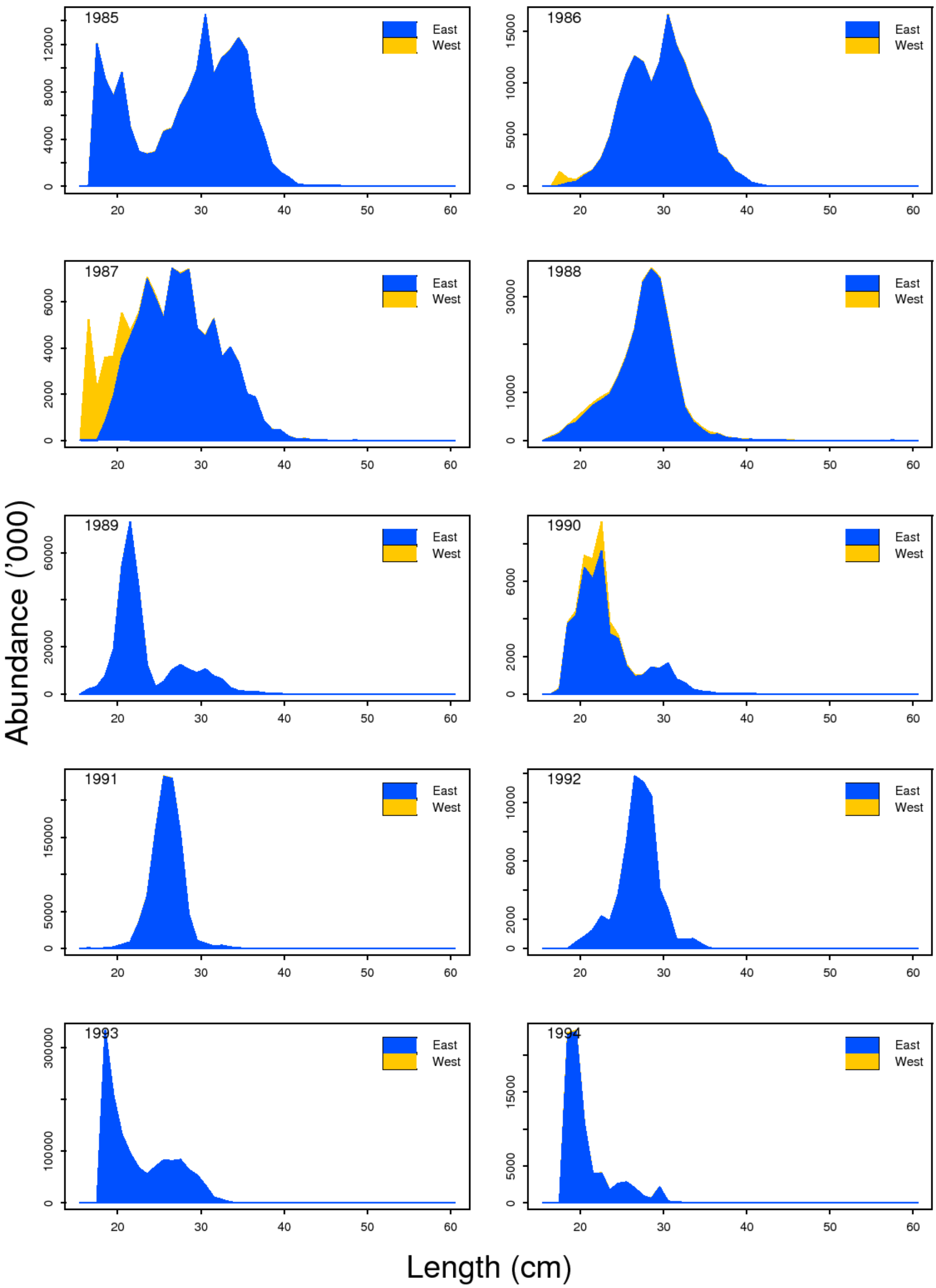


Figure 9.2.1 Demersal *S. mentella* (15-35 cm) on the continental shelves off West- and East-Greenland. Length composition off Greenland is derived from the German and groundfish survey 1985-2006. Note different scale on y-axis.

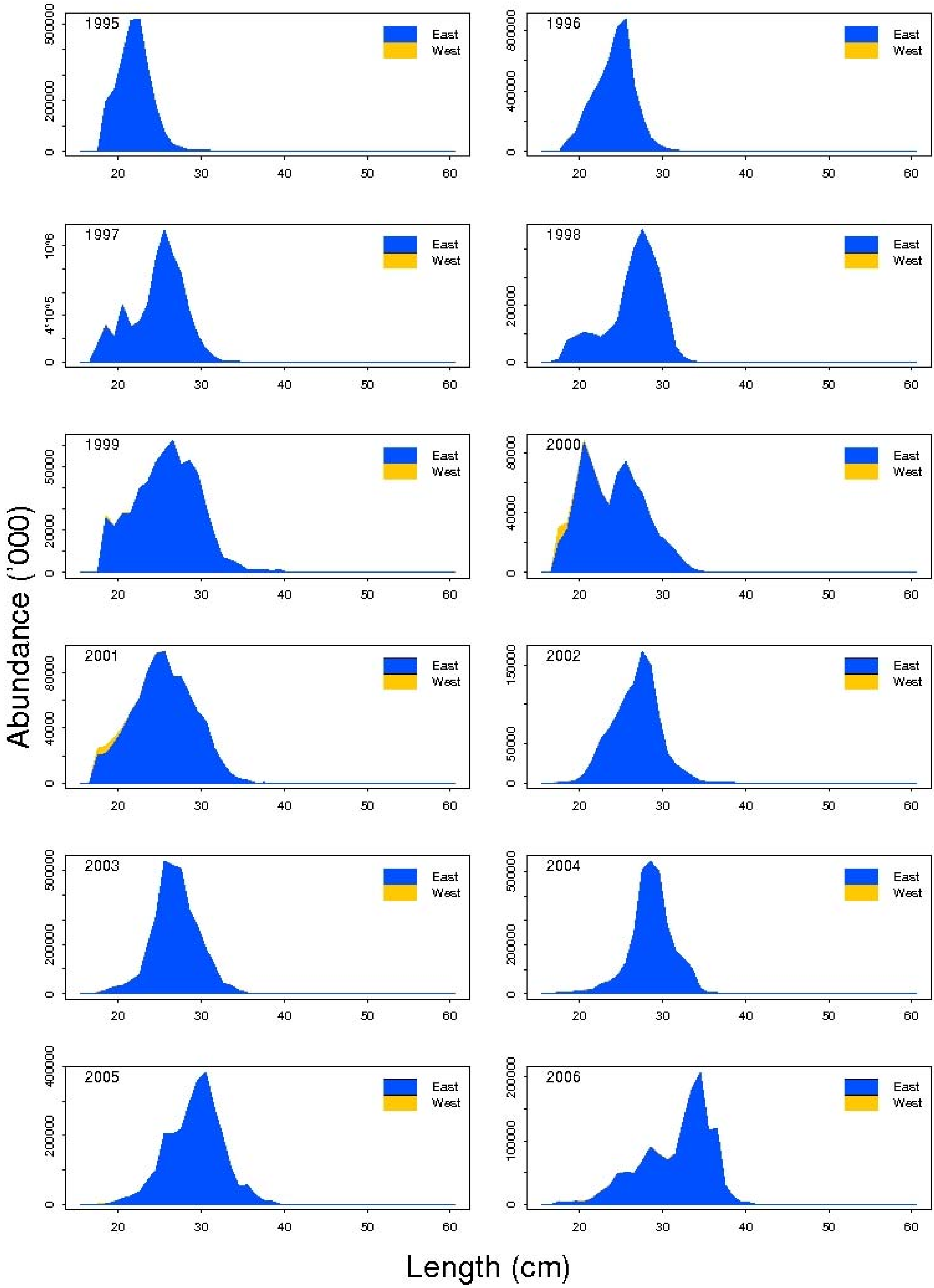


Figure 9.2.1 **Continued.**

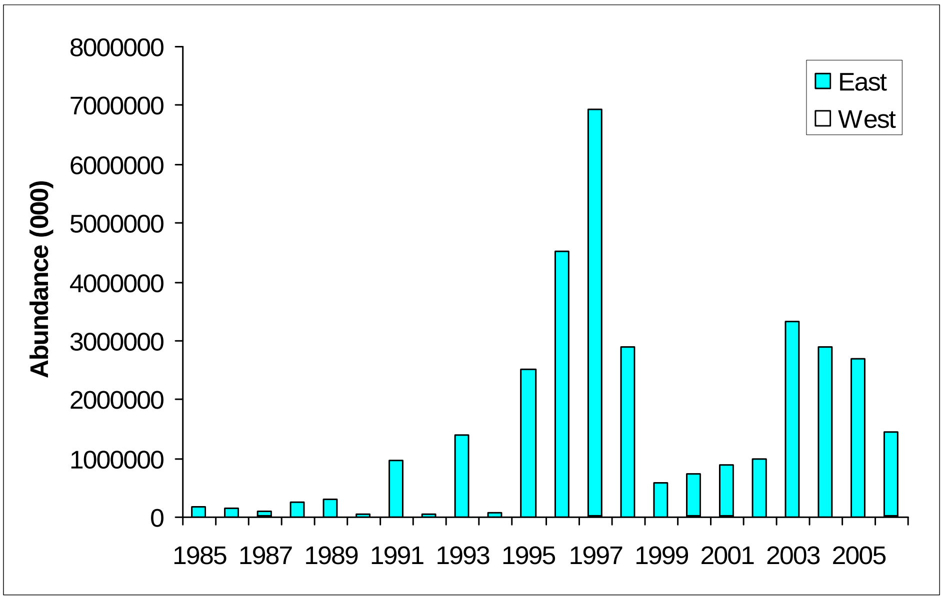


Figure 9.2.2 **Demersal *S. mentella* (>=17 cm) on the continental shelf. Survey abundance indices for East and West Greenland derived from the German groundfish survey 1985–2006.**

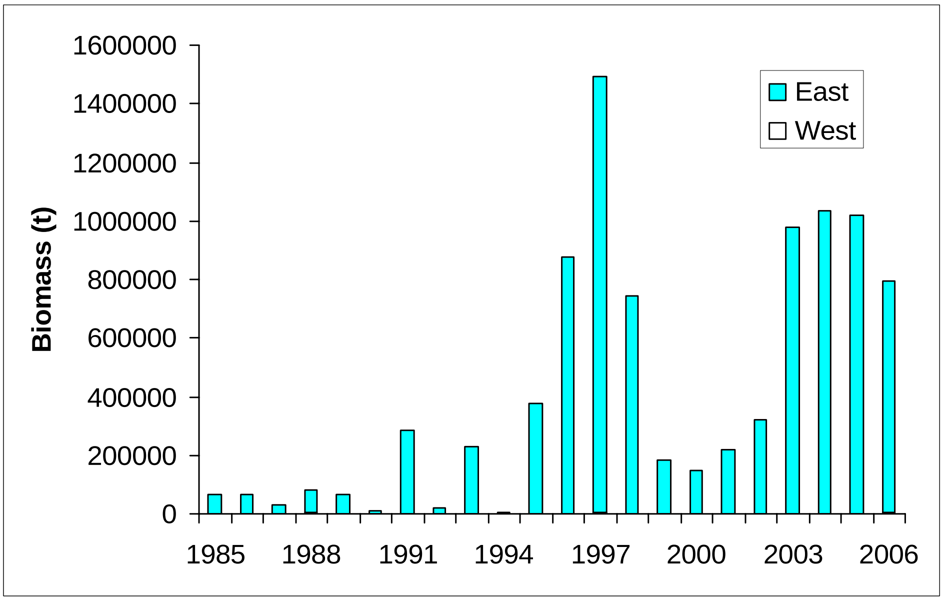


Figure 9.2.3 **Demersal *S. mentella* (>=17 cm) on the continental shelf. Survey biomass indices for East and West Greenland from the German groundfish surveys 1985-2006.**

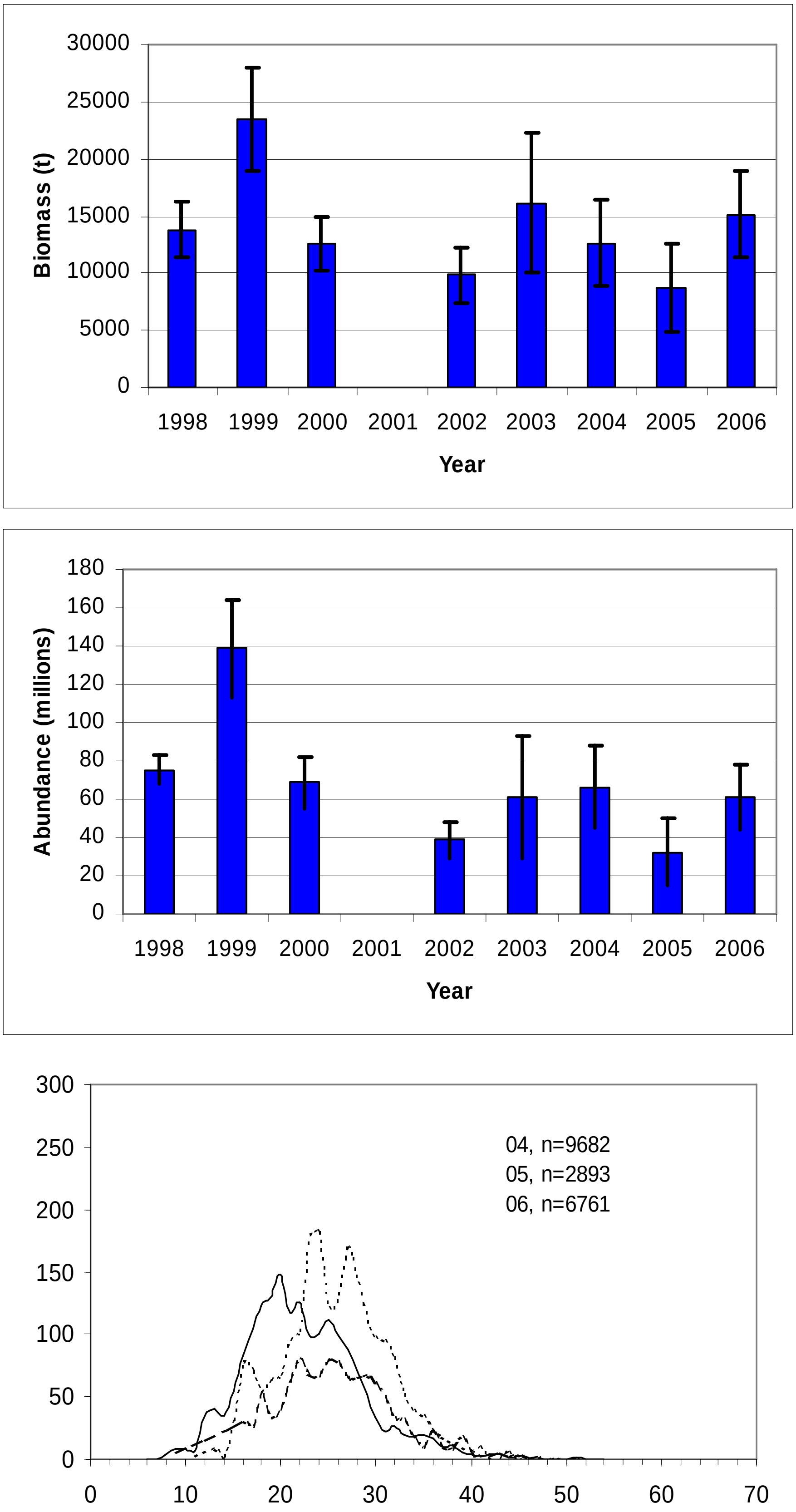


Figure 9.2.4 Total biomass (top), abundance (middle) estimates and associated standard error of demersal *S. mentella* from the Greenland halibut bottom trawl survey of East Greenland (ICES Division XIV) 1998-2006. No survey was conducted in 2001. Also shown is the overall length distribution (number per km^2) from the same surveys 2004-2006 (bottom). Dashed line 2004, dotted line 2005, and solid line 2006.

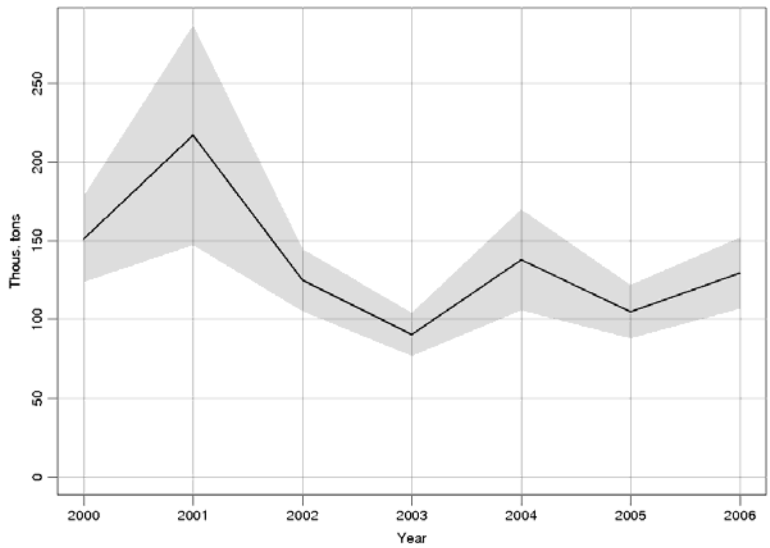


Figure 9.2.5 Total biomass index of the Icelandic demersal *S. mentella* in the autumn survey in Division Va 2003-2006.

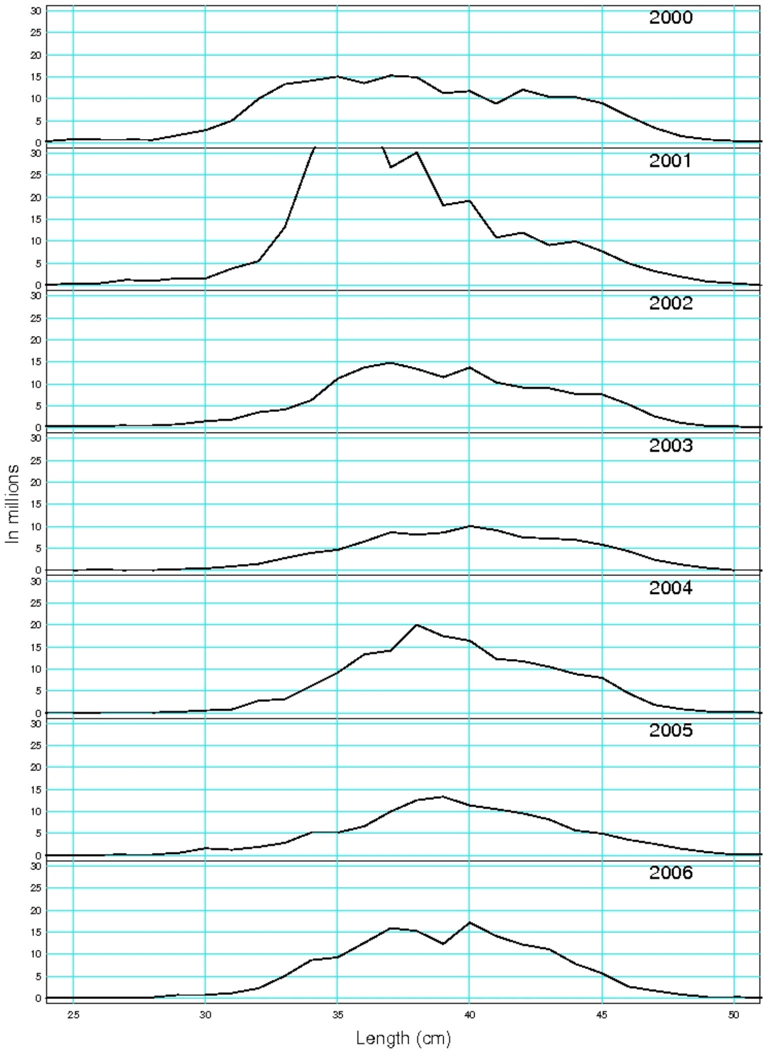


Figure 9.2.6 Length distribution of demersal *S. mentella* in the bottom trawl surveys in October 2000-2006 in ICES Division Va.

10 Pelagic Sebastes mentella

This section includes information on the pelagic fishery for pelagic *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 2.a) requesting new information on stock identity of *S. mentella* is dealt with in section 7.5, whereas the requested fishery and survey information on pelagic *S. mentella* (ToR d) and e)) is given in this chapter (sections 10.1 and 10.2). NEAFC requests 2.b), c) and d) regarding the management of pelagic *S. mentella* are addressed in section 7.4.

Pelagic redfish in the Irminger Sea and adjacent waters straddle in the ICES Div. Va, XII and XIV and NAFO Sub-areas 1 and 2. They occur 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 agreed among NEAFC and NAFO member states, but also autonomously set in addition, as some NEAFC parties have objected to the decision of NEAFC and set their own national TAC. The autonomous TAC set by Iceland for 2006 was 28 610 t, and the Russian autonomous TAC was 40 000 t. The NEAFC TAC for pelagic redfish for 2006 was 62 416 t (of which 3 901 t were allocated to NAFO and 166 t were available to co-operating non contracting parties). As the NEAFC contracting parties did not reach an unanimous decision on the total TAC and splitting of the TAC amongst them, the total TAC in force was about 99 000 t in 2006, based on splitting factors set for 2004 and taking into account the autonomous quotas of Iceland and Russia. The total landings in 2006 (83 000 t) were well below this total TAC in force. Taking the most recent estimates on IUU fisheries (chapter 10.1.4) into account, however, the actual removals in 2006 could have reached more than 100 000 t.

ACFM has advised for 2007 that no fishery should take place until clear indications of recovery of the stock. For 2007, NEAFC has set a TAC of 46 000 t, “of which 2 875 tonnes will be allocated to NAFO, and 123 tonnes will be available to co-operating non contracting parties”. For the same reasons as in 2005, the total TAC in force for 2006 is about 73 000 t. In addition, NEAFC Contracting Parties have agreed in 2006 that for the fishery in 2007 “In order to ensure particular protection of redfish in the northeastern part of the Irminger Sea a maximum of 29,900 tonnes, 65% of the catch limit set out in paragraph 1, can be taken before 15 July”. NEAFC has made particular reference to “the north-eastern area of the Irminger Sea and adjacent areas” being “important areas of larval extrusion” that “need particular protection to promote the recovery of pelagic redfish in the Irminger Sea and adjacent waters”. Considering that the peak of larval extrusion was observed during mid-April to mid-May (Saborido-Rey et al. 2004), reducing fishing effort in this area during this period should be evaluated.

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). From 2000 to 2004, the WG estimate of the catch has been between 126 000 and 161 000 t, highest in 2003. This is probably an underestimate due to incomplete reporting of catches (see section 10.1.4). The increase in the total figures since 2000 is mainly due to significant catches in NAFO Divisions 1F and 2J, up to 32 000 t (20% of total catches) in 2003. In 2005, the total landings decreased to 74 000 t, mainly due to decreased catches in ICES Sub-area XIV. In 2006, the total landings increased again slightly to 83 000 t. A small fraction of the catches reported as demersal catches in Division Va was caught with pelagic trawls in the past (see chapters 7.1 and 9.1).

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 eight 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. In 2005 and 2006, however, the fishery already stopped in early September, probably due to decreased catch rates in the southwestern area, and in 2006, also due to an increased effort in the pelagic redfish fishery in the Norwegian Sea (ICES Div. IIa) in autumn.

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 1998-2006, but mainly deeper than 600 m in the first and second quarter but at depths shallower than 500 m in third and fourth quarter.

Discarding is at present not considered to be significant for this fishery (see chapter 10.1.3). The WG acknowledges information on trawling depths as provided by some nations, but recommends that all nations should report 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 2006:

Faroes	2 factory trawlers
Germany	3 factory trawlers
Greenland	1 factory trawler
Iceland	16 factory trawlers
Poland	1 factory trawler
Portugal	7 factory trawlers
Russia	28 factory trawlers
Spain	11 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. During 2004 to 2006, this pattern has not changed.

10.1.2.2 Germany

The reported effort in 2006 was the lowest observed since 1995 and amounted to 3 700 hours (WD10). As observed in the previous two years, the 2006 effort was applied exclusively during the second and third quarters. During the second quarter in 2006, the hauls were almost exclusively distributed in NEAFC Regulatory Area of ICES Sub-area XIV between the Greenlandic and Icelandic EEZs. As in 2005, there was significant fishing effort exerted in the NAFO Division 1F in 2006, mainly within the Greenlandic EEZ. The overall decrease of annual landings continued in 2006 with a figure of 2 800 tons, representing the lowest value on record, due to a reallocation of effort to the Greenland halibut fishery off East Greenland. In 2006, 35 % or 990 tons of the total landings were taken in the NAFO area. The overall unstandardised CPUE decreased from 2 055 kg/h in 1995 to around 1 000 kg/h in 1999-2004 and dropped to only 542 kg/h in 2005. In 2006, it was 759 kg/h. 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, and the 2005 and 2006 record low CPUE give reason for concerns about diminishing stock size.

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 Greenlandic EEZ and the Reykjanes Ridge. Since 1996, the catches have mostly been taken close to or inside the Icelandic EEZ southwest of Iceland. In recent years, the fishery has started in April close to the Icelandic EEZ and then moved northwards 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 limitations. 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 mid-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 deeper than 600 m. From the mid-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, about 33% of the catch was taken south of Cape Farewell, 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. During 2002-2005, 10-16% of the Icelandic catches were taken in the “southwestern” fishing area in ICES Sub-area XII and NAFO Division IF shallower than 400 m depth. The total catch taken within the Icelandic EEZ in 2004 and 2005 were 36% and 65%, respectively. The remaining catch was taken just outside the Icelandic EEZ (50% and 15%, respectively). The total catch of the Icelandic fleet in 2006 was 22 138 t, which is about 6 000 t increase from 2005 (that was the lowest reported catch since 1992). About 74% of the total catch was caught inside the Icelandic EEZ and 19% just outside the EEZ at depths greater than 600 m. Only 7% were caught in NAFO Division 1F (the southwestern fishing area) at depths shallower than 400 m. In previous years, the fishery had extended into October, but in 2006, the Icelandic fishery stopped in mid-August.

A fraction of the catches reported as demersal *S. mentella* in Division Va was caught with pelagic trawls (see sections 7.1 and 9.1). As a pragmatic management measure in Iceland, the pelagic catches of *S. mentella* east of the ‘redfish line’ (section 9.1) were allocated to the demersal *S. mentella*, as both a pelagic and a bottom trawl fishery on *S. mentella* occur in the same area.

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 EEZ (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 2004 and 2005, 72% and 55% of the catches were taken in Subarea XIV, respectively. In 2006, the 79% of the catches were taken in Subarea XII.

10.1.2.6 Poland

The Group had a detailed description of the Polish fishery on pelagic redfish available for the first time in 2004. 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, and 2 410 t in 2005. 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. In 2005, Polish catches of pelagic redfish were conduced in four areas: ICES XII, XIVb and NAFO Divisions 1F, 2J and reached the amount of 2 410 tons . The catches of pelagic redfish lasted from late April to the beginning of September. Catches begun in April in the northeastern part of the fishing area (Div. XIVb). From April to July, a total of 1 240 tons of redfish were caught in this area at depths of 260 - 980 m (mean 654m). The average CPUE was 1.06 t/h. Starting in the last days in July, catches were continued in southwestern part of the fishing area (NAFO waters - Divisions 1F, 2J - and ICES area XII -Greenland waters). By the beginning of September, a total of 1 170 tons of redfish was caught. The mean depth of catches in NAFO area was 280 m, and in ICES XII 335 m. The average CPUE was 0,96 t/h. In 2006, Polish catches of pelagic redfish in the Irminger Sea and adjacent waters were conduced in ICES Division XIVb and NAFO Divisions 1F and reached the amount of 1 989 tons (WD08). Only one vessel was engaged in the redfish fishery, and the catches begun in May in the northeastern part of the fishing area (Div. XIVb) and were conducted in this area to the beginning of July. Since the last day of July until the end of August, catches of pelagic redfish were continued in the southwestern fishing area (NAFO Division 1F). The average CPUE in Division XIVb was 24.6 t/day and in the NAFO subdivision 1F - 22.3 t/day

10.1.2.7 Portugal

The Portuguese pelagic redfish fishery started in 1994, first in the Irminger Sea but now this fishery is wide-spread also into NAFO Divisions 1F. The Portuguese nominal redfish catches recorded a peak in 1995 (5 125 t), followed by a decreased to 2 379 t in 1996, and the same decreased was observed in effort (383 to 210 days). From 1997 to 2000, the catches stabilized around 4 000 t, both 1997 and 1998 years recorded the highest effort (405 days), the effort during 1999 and 2000 was around 370 days. In 2001, the redfish catches and effort decreased again to 2 577 t and 301 days. Since then, catches and effort increased, and in 2004, the redfish catches proceeding from all Divisions (including inside Greenland EEZ) recorded 4 419 t corresponding to 552 effort days. The effort was similar in 2005 and 2004 but the catches in 2005 decreased to 3 868 t . Effort and CPUE data for 2005 Portuguese trawl fishery in ICES Sub-area XII, Div. XIVb and NAFO Div. 1F were obtained through the revision of the skipper logbook from one trawler, kindly supplied by it owner. In 2006 (WD09), the effort decreased to 459 days and the catches decreased again to the level of 2001 (around 2,600 tons) when the same amount of catches was taken in 301 days.

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 10.1.4), distributed over a large area in the Irminger Sea (Figure 10.1.5). 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 2005, Russian fishery for pelagic *S. mentella* in the Irminger Sea and Divisions 1F, 2H and 2J of the NAFO Regulatory Area lasted from April to September . The fishery was conducted by 35 vessels of different types. Fishing of *S. mentella* spawning concentrations commenced in April in the traditional area close to the EEZ of Iceland in a depth range of 600 to 820 m. In the second quarter of the year, the fishery for *S. mentella* was carried out in the open part of ICES Subareas XIV and XII. In this period, 50% of catch and 60% of fishing effort were registered for the whole period of fishery in 2005, when CPUE made up 819 kg/hr. In June-July in the northeastern Irminger Sea, vessels remained at previous positions, not searching actively for *S. mentella* concentrations. Due to low catches some vessels moved to the NAFO Regulatory Area (Divs. 1F and 2J to depths of 200-380 m). In the middle of July, the fishery was conducted by 2 vessels in adjacent waters of the NAFO and NEAFC Regula-tory Areas and along the 200-mile zone of Greenland in a depth range of 230-300 m. In mid-August, the fishery was again concentrated on NAFO Div. 1F, 2H and 2J. In September, the fishery covered an extensive area between 54°20’-61°10’N and 41°40’-45°30’W in a depth range of 200 to 350 m. In the third quarter of the year, the CPUE constituted 737 kg/hr. Total Russian catch in 2005 in ICES Subareas XII and XIV was estimated at 19 523 tonnes and in the NAFO Regulatory area at 12 362 tonnes.

In 2006, in the Irminger Sea and Div. 1F, 2H, 2J of the NAFO Regulatory Area, the Russian fishery of pelagic deep-water redfish lasted from April to September (WD12). The fishery was carried out by 28 vessels of different types. Fishing of deep-water redfish spawning concentrations was commenced at 600-900 m depths of the traditional area near the Icelandic EEZ, in April. In the second quarter of the year, the fishery was carried out in the open part ICES Subareas XIV and XII. In that period, 66% of catch and 68% of effort were recorded for the whole period of fishing in 2006, when the CPUE was 789 kg/h. In June-July, in the northeast of the Irminger Sea, the vessels continued to be at the previous positions, and the range of hauling depths was widened to 540-980 m. Due to low catches, some vessels went to the NAFO Regulatory Area (Divs. 1F, 2JH, to 230-500 m depth) where the CPUE was 1 245 kg/hr, late July. In August, the fishery was conducted in the wide area, between 55-58ºN and 41º45’- 47º30’W, where the CPUE was equal to 701 kg/hr. The total Russian catch in ICES Subareas XII and XIV in 2006 was estimated at 23 853 t, and in the NAFO Regulatory Area at 4,770 t.

10.1.2.9 Spain

The Spanish pelagic redfish trawl fishery started in 1995 in the Irminger Sea. Since 2000, the fishery has extended to NAFO Divisions 1F and 2J. The Spanish pelagic fishery of redfish (ICES Subareas XII, XIV and NAFO Div. 1F, 2J) between 2000 and 2005 showed a significant seasonal pattern in terms of its geographical and depth distribution. The effort in the first and fourth quarter was occasional and very low. Effort in 2004 increased by more than 150 fishing days, and most of this increase took place inside the Greenland EEZ in the third quarter. The fishing season 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. 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. From 2000 to 2003, the catches stabilized around 10 500 tons. In 2004, catches was increased to 11 674 tons due to the effort increase (671 days). In 2005, the fishery was conducted by 11 vessels equipped with Gloria-type pelagic trawls with a vertical opening of 90-120 meters . The effort during 2005 was 627 days and it was applied principally during the second (97% Subarea XIV) and third quarters (31% Subarea XII and 50% NAFO Division 1F). In ICES

Subarea XIV, the overall unstandardised CPUE decreased from 1 053 kg/h in 2004 to 544 kg/h in 2005. The catches decreased to 5 428 tons in 2005. Effort in 2006 increased by more than 88 fishing days (WD15) with regard to the last year (715 fishing days), mainly in NAFO Div. 1F, and the catches increased to 10 249 tons (7 063 tons in ICES Subareas XII and XIV and 3 186 tons in the NAFO Div. 1F and 2J).

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. Measurements from 1998 show that the discard rate had decreased to 2%. Information from observers from 2000-2006 indicate that discards is negligible, and therefore no catches were added to the Icelandic landings during that period.

The reported discards of the German fleet in 2006 were negligible.

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. However, no recent information was given on this issue.

The Spanish discard estimates are based on measurements made by the scientific observers. Discards 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, 2001 and 2002 to 6% of total catches in 2003. This variability can also be observed by area, and in 2004, the discarded percentage was greater in the Subarea XII and NAFO Divisions 1F and 2J. In Subarea 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 large, 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 catch, even those infested, and there are not discards. In Subarea XII and NAFO Div. 1F and 2J, the discard rates were more related with the fraction of parasited fish. In 2006, the level of redfish discarded was negligible..

The level of redfish discarded by the Portuguese fleet, based on the observer reports, has been very small, between 0.6 and 3.8% of the catch. In 2006, discards amounted to 1.2%, 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 had, however, not been quantified as the number of nations not reporting and hence the effort of their vessels had been unknown. During the NWWG meeting in 2004, a presentation of an EU project (IMPAST; Chesworth and Lemoine 2004) dealing with this issue was given (WD29 of NWWG2004). Two studies were conducted by the EU Joint Research Centre (JRC) using a satellite imagery vessel detection system (VDS) to detect fishing vessels in the NEAFC regulated redfish fishery southwest of Iceland. Observations in June 2002, 2003 and 2004 indicated that the effort could have been 15-33% higher than reported to NEAFC (WD27 of NWWG2005). The latest information (Indregard 2006, Lemoine et al. 2006) confirms this order of magnitude with regard to IUU fisheries, as only 71 and 81% of the vessels visible in the VDS reported to the Vessel Monitoring System (VMS) in 2005 and 2006, respectively.

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). The pelagic *S. mentella* fishery in ICES Div. Va started in 1992. The landings varied from 2 000-14 000 from 1992-1995. From 1996 to 2000, the landings in Div. Va increased to about 45 000 t (Table 10.1.1) and have varied since. Landings in Va in the three most recent years decreased significantly from 47 000 t in 2003 to 12 000 t in 2005 and 16 380 t in 2006. Since 2000, considerable amounts of the landings were taken in NAFO Div. 1F, 2J and 2H, with a peak in 2003 at 32 300 t (20% of the total landings). In 2006, about 14 000 t (17% of the total landings) were caught in the NAFO Regulatory Area. The total catches decreased from 125 000 t in 2004 to 74 000 t in 2005 and 83 000 in 2006 (Table 10.1.1, Figure 10.1.1).

Total landings estimated for 2003 (about 161 000 t) were the highest since 1996. The landings for the most recent years might represent an underestimation due to the lack of reporting from some countries participating in the fishery. Furthermore, as described in section 10.1.4, there is information on vessels from nations not reporting catches to any international organisation. According to the data available to the Group, the total estimated reported landings in 2006 amounted to 83 000 t, not taking into account IUU and underreporting.

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 2006 (WD10, WD18, WD08, WD09, WD12, WD15). The length distributions by ICES and NAFO areas are given in Figures 10.1.6 and 10.1.6 for 2000-2006. 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 10.1.6). In 2004, the landed fish were generally slightly smaller than in previous years, and in 2005, a considerable decrease in mean length was observed, especially in Sub-areas XII and XIV (Figures 10.1.6 and 10.1.7). In 2006, however, the mean lengths generally increased again to values observed in 2003 and earlier.

The biological sampling from catches and landings of pelagic *S. mentella* in each Subarea/Division and by gear type in 2006 is shown in the text table below.

COUNTRY	AREA	LANDINGS (T)	NO. OF SAMPLES	NO. OF FISH MEASURED
Germany	XIV and NAFO 1F, 2H	2,825	87	70,284
Iceland	XII, XIV and NAFO 1F	16,005	89	19,557
Poland	XIV	2,019	?	13,658
Portugal	XIV	2,685	60	4,807
Russia	XII, XIV and NAFO 1F, 2J	28,623	165	43,632
Spain	XIV	10,249	48	7,412

Biological samples from the catches in recent years, and also the acoustic survey in 1999, suggested that new cohorts are entering into the fishable stock of pelagic redfish on an irregular basis (Stransky, 2000). Age readings within an otolith exchange between Germany, Iceland, Norway, and Spain, based on material collected in July 1999, showed that those cohorts (mean length 25-30 cm) are 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. In 2006, a Workshop on Age Determination of Redfish [WKADR] was held in Vigo, Spain, which collated the latest knowledge on age determination methodology, ageing error and growth estimates (ICES 2006). The next workshop is suggested to be held in 2008 in Canada.

10.2 Trends in survey and CPUE indices

10.2.1 Surveys

The international trawl-acoustic surveys on pelagic redfish have been conducted in international collaboration with Germany, Iceland, Norway (in 1994 and 2001) and Russia and in 2-3 years intervals (Table 10.2.1). In addition, several national surveys have been carried out. During the last decade, the horizontal and vertical coverage of the survey changed as the fishery explored new fishing grounds in southwesterly direction and deeper layers. Vertical coverage of the hydro-acoustic recording of redfish varied among years in relation to the upper boundary of the deep scattering layer (DSL), in which redfish echoes are difficult to identify. Since 2001, the varying depth layers within and deeper than the DSL were covered by standard trawl hauls to account for the incompletely covered vertical depth distribution of the pelagic redfish. These survey hauls were converted into hydro-acoustic measurement units (s_A values) by means of regression (Figure 10.2.1). The stock abundance estimates in these depths are considered highly uncertain. The next survey will be carried June/July 2007 (ICES 2007).

10.2.1.1 Survey acoustic data

Since 1994, the results of the acoustic estimate show a drastic decreasing trend from 2.2 mio t to 700 000 t in 2001 and 550 000 t in 2005 (Table 10.2.1). The 2003 estimate was considered as inconsistent with the time series due to a shift in the timing of the survey (see section 10.5).

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 mid-June to mid-July

2005. Approximately 386 000 NM^2 were covered. A total biomass of 551 000 t was estimated acoustically in the layer shallower than the DSL. The highest concentrations of redfish in this layer were found in Division XIVb within the Greenlandic EEZ and in NAFO Div. 1F, 2H and 2J (Fig. 10.2.1). Biological samples from identification trawls in these depths showed a mean length of 35.9 cm. Figure 10.2.4 (upper panel) shows the length distribution.

The main results of the 2005 trawl-acoustic survey (ICES CM 2005/D:03) are given in Tables 10.2.2 and 10.2.3. Table 10.2.4 shows the share between NAFO and NEAFC Convention Areas in the surveys 1999-2005. In the acoustic layer, the NAFO shares varied between 46-56%, with the exception of 2003 when it was around 12%.

10.2.1.2 Survey trawl estimates

In addition to the acoustic measurements, an attempt was made to estimate the redfish within and below the DSL. This was done by correlating catches and acoustic values at depths shallower than the DSL (Figure 10.2.1). The obtained correlation was used to convert the trawl data at greater depths to acoustic values and from there to abundance (ICES CM 2005/D:03). For that purpose, standardised trawl hauls were carried out at different depth intervals (four depth intervals in hauls ≥DSL and two depth intervals hauls <DSL), evenly distributed over the survey area (Figure 10.2.3). For the correlation calculations between trawl catches and the acoustic results, data from the trawl-acoustic surveys in 2001 and 2005 were used (Figure 10.2.1), as the extraordinarily low acoustic values in 2003 did not allow such regression during the survey. As the correlation between the catch and acoustic values is relatively 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. The quality of the trawl method can not be verified as the data series is very short. Such evaluation on the consistency of the method can therefore not be done until more data points are available. Therefore, the abundance estimation by the trawl method must only be considered as a rough attempt to measure the abundance within and deeper than the DSL.

The short time series from 1999-2005 (Table 10.2.1) does not show a clear trend in biomass estimates deeper than 500 m (within and deeper than the DSL in 2005).

Biological samples from the trawls within and deeper than the DSL showed a mean length of 36.5 cm, which represents a considerably lower value as observed in previous surveys (38.2-39.4 cm in 1999-2003). Figure 10.2.4 (lower panel) shows the corresponding length distribution. A part of this decrease in mean length can be explained by including samples from within the DSL (approx. 350-500 m depth) that were included in the estimation of redfish <500m in 1999-2003.

Table 10.2.4 shows the share between NAFO and NEAFC Convention Areas in the surveys 1999-2005. In the layer deeper than 500 m (within and deeper than the DSL in 2005), the NAFO shares varied between 6-35%.

10.2.2 CPUE

Non-standardised CPUE series for the largest fleets (representing about 80% of landings) are given in Figure 10.2.5. Since 1995, there is a slightly decreasing trend in CPUE, both in the northeastern and the southwestern area, except for the Icelandic fleet where the CPUE has been increasing slightly until 2003. 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 and 2005, the CPUE indices decreased markedly for all fleets. In 2006, however, this decrease was only present in the southwestern area (Figure 10.2.5.c), while in the northeastern area (Figure 10.2.5.b) and in total (Figure 10.2.5.a), a slight increase in unstandardised CPUE to the 2004 level was observed.

The time series of standardised CPUE, derived from a GLM CPUE model (Tables 10.2.5.a-c) incorporating data from Germany (1995-2006), Iceland (1995-2006), Greenland (1999-2003), Faroe Islands (1995-2006), Russia (1997-2006) and Norway (1995-2003) is given in Figure 10.2.6. The model takes into account year, month, vessel and area (North - South; see Figure 10.2.7) and was run on data from the joint database (WD17) and the outcome of three model runs are given in Tables 10.2.5.a-c. The model residuals are shown in Fig. 10.2.8. The model shows that the index is varying without a clear trend until 2003 and decreases considerably in 2004 and 2005, mostly caused by the decrease in the northeastern area. In 2006, all three CPUE series increased again slightly to the 2004 levels. The CPUE in the southwestern area remained relatively stable until 2003 and shows a less pronounced decrease in 2004 and 2005, but generally stays below the 1995 and 1996 level.

10.2.3 Ichthyoplankton assessment

The traditional ichthyoplankton survey, conducted by Russia in 1982-1995 has not been carried out since 1996. The historical series of ichthyoplankton surveys was presented in the 2000 Working Group report (ICES CM 2000/ACFM:15).

10.3 State of the stock

At present, the state of the stock is unknown.

Considering the entire time series of biomass estimates in the acoustic layer from the international trawl-acoustic survey since 1991, a drastic decreasing trend has been observed in the late 1990’s. The survey trawl estimates deeper than the acoustic layer, derived since 1999, are considered as highly uncertain due to the short time series and methodological difficulties. As the next survey will be carried out in June/July 2007, the state of the stock has to be re-evaluated after the availability of the survey results (expected in August 2007).

Although varying, the available commercial CPUE series has been relatively stable since 1995, has decreased markedly from 2003 to a record low in 2005 and increased slightly again in 2006. The decrease in 2004 and 2005 was most pronounced in the northeastern area. 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 (section 9.2.2), which is assumed to contribute to the pelagic stock. The mean lengths of pelagic *S. mentella* in the fishery both in the northeastern and in the southwestern area were relatively stable.

10.4 Management considerations

The Group had again difficulties in obtaining catch estimates from the various fleets, and new information available indicates that unreported catches might be of substantial amount. Furthermore, landings data were missing from some nations. The Group requests NEAFC and NAFO to provide ICES with all information that supports the Group with regard to more reliable catch statistics.

CPUE in the southwestern area (almost exclusively shallower than 500 m) have decreased slightly during 2004-2005, and decreased considerably in the northeastern area (deeper than 500 m). In 2006, however, the CPUE series increased again slightly to the 2004 levels. The main feature of the fishery since 1998 is a clear distinction between two widely separated fishing grounds with pelagic redfish fished at different seasons and different depths. Since

2000, the southwestern fishing grounds extended also into the NAFO Convention Area. Biological data, however, suggest that the aggregations in the NAFO Convention Area do not constitute a separate stock. The NAFO Scientific Council agreed with this conclusion (NAFO, 2005).

The Group concludes that at this time there is not enough scientific basis available to propose an appropriate split of the total TAC 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 (second quarter) is mainly targeting at larger and post-spawning fish.

The Group expects that under the current TAC regulations, a greater share of the catches in 2007 will be taken in the northeastern area.

10.5 Comments on the assessment

10.5.1 Data considerations

Preliminary official landings data were provided by the ICES Secretariat, NEAFC and NAFO, and various national data were reported to the Group. The Group, however, repeatedly faced problems in obtaining catch data. The Group has during the last years identified problems with of unreported catches of pelagic redfish. Current data available to the Group indicate that the reported effort (and consequently landings) could represent only around 80% of the real effort.

As in previous years, detailed descriptions on the horizontal, vertical and seasonal distribution of the fisheries were given, which was appreciated by the Review Group.

The Group will collate an international database with length distributions from the sampling of the fisheries for the next NWWG meeting to illustrate the horizontal and vertical differences in mean length by fishing areas as alternative to the portrayals by ICES/NAFO Divisions.

10.5.2 Assessment quality

The results of the international trawl-acoustic survey are given in sections 10.2.1.1 and 10.2.1.2. 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.

The reduction in biomass observed in the surveys in the hydroacoustic layer (about 2 mio. t in the last decade) cannot be explained by the reported removal by the fisheries (about 1.5 mio t in the entire depth range in 1995-2005) alone. 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 >600 m (Table 10.1.3). Thus, the acoustic estimates cannot be considered as accurate measures of absolute stock size of redfish in this layer, as availability may have changed during the surveyed period, both horizontally and vertically. A decreasing trend in the relative biomass indices in the acoustic layer, however, is visible since 1991.

The biomass estimates for depths within and deeper than the DSL have to be considered as highly uncertain (see section 10.2.1.2). Within the short time series from 1999 to 2005, the estimates in these depths have not shown a clear trend.

Taking the importance of the availability of fishery independent information about the pelagic redfish resource into account, the NWWG recommends a continuation of the international trawl-acoustic survey on pelagic redfish. **The next survey will be carried out in June/July 2007 (ICES 2007).** As the coverage of the large survey area with only three vessels currently participating in the survey, an official ICES request for participation in the survey had been sent to other nations which take part in the pelagic redfish fisheries. So far, however, the Study Group on Redfish Stocks (SGRS) has not succeeded in involving more countries (ICES 2007).

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.

10.6 Environmental conditions

10.6.1 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.

In June/July 2005, positive temperature anomalies were recorded in the upper 500 m in the Irminger Sea and adjacent waters. In particular, the water temperature on 200 m was between 0.3-0.5 °C higher in the peripheries of the Sub-polar Gyre and 1.5-1.7 °C higher in the central part, compared the long-term average, spanning from 1950-2003. At 300 m depth, temperature anomalies increased from +0.3-1.0 °C in the western and southwestern area to +1.0-2.5 °C in the northern and eastern area. A local extreme of temperature anomalies about 3 °C was recorded in both horizons south of 53°N between 41 an 44°W. Compared with 2003, a decrease in water temperature of the Irminger Current along the Reykjanes Ridge and off the East Greenland slope and a temperature increase in the central part of the Sub-polar Gyre in the survey area was observed in June/July 2005. Shallower than 500 m depth, the greatest negative difference of 0.5-1.5 °C was recorded at 400 m over the Reykjanes Ridge and off the West Iceland slope. Positive differences about 0.5-1.0 °C were prevailing in 200-300 m depth in the central part of the investigation area and locally off the Greenland slope. The temperature maximum increasing 2.0-3.0 °C on these horizons south of 53°N between 41° and 43°W was registered. In June/July 2005, the temperature of the water in the shallower layer (0-500 m) of the Irminger Sea was higher than normal. As in the surveys 1999-2003, the redfish were aggregating in the southwestern part of the survey area, partly influenced by these hydrographic conditions.

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 the Reykjanes Ridge (Pedchenko, 2000), off Iceland (Malmberg *et al*., 2001) 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, 2001). The increasing of temperature water in the Irminger Sea has an effect on spatial and vertical distributions of *S. mentella* in the feeding area (Pedchenko, 2005).

The results of the survey in 2003 were confirmed by the presented high water temperature anomalies of the 0-200 m layer in the Irminger Sea and adjacent waters. In 200-500 m depth and deeper, positive anomalies in most parts of the observation area were observed, but increasing temperature as compared to the survey in June-July 2001 was obtained only north of 60° N in the flow of the Irminger Current above the Reykjanes Ridge and the northwestern part of the Irminger Sea. These changes in oceanographic conditions might have an effect on the seasonal distribution of redfish and its aggregations in the layer shallower than 500 m in the survey area (ICES, 2003b).

10.6.2 Water masses deeper than 500 m

Deeper than 500 m, a positive anomaly on the most part of the observation area was observed in May-June 2003. 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 in depths below 400 m was observed.

In June/July 2005, deeper than 500 m, the temperature was also above normal. At 600 m depth, its anomalies varied from 0.3-0.5 °C in the outer limit of the Sub-polar Gyre to 1.0-1.2 °C in the central part of it. Negative anomalies up to 0.3-0.5 °C were recorded in locally in the Irminger water above the Reykjanes Ridge and southwest of Cape Farewell. Deeper than 500 m, the value of a variation in temperature from 2003 was less and recorded at the same places. At 600 m depth, decreasing of the temperature were 0.2-0.7 °C above Reykjanes Ridge and less 0.5 °C in northern and northwest Irminger Sea. The increasing of temperature in the central part of Sub-polar Gyre was up to 0.5 °C. In connection with the continuation of positive anomalies of temperature in the survey area, the redfish concentrations were distributed mainly in depths of 450-800 m, within and deeper than the DSL. Favourable conditions for aggregation of redfish in an acoustic layer have been marked only in the southwestern part of the survey area with temperatures between 3.6-4.5°C.

Table 10.1.1 Pelagic *S. mentella*. Catches (in tonnes) by area as used by the Working Group. Due to the lack of area reporting for some countries, the 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	19,826	87,698				122,825
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	11,052			126,313
2001	28,148	32,164	61,457	5,290	1,751	8	128,818
2002	37,279	24,026	66,194	15,702	3,143		146,344
2003	46,676	24,232	57,780	26,594	5,377	325	160,984
2004	14,456	9,679	76,656	20,336	4,778		125,905
2005	11,726	6,784	34,041	16,260	4,899	5	73,715
2006	16,380	6,795	45,943	12,939	593	260	82,910

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.
*** Prior to 1991, the figures for Russia included Estonian, Latvian and Lithuanian catches.**

Year	Bulgaria	Canada	Estonia	Faroes	France	Germany	Greenland	Iceland	Japan	Latvia	Lithuania	Netherlands	Norway	Poland	Portugal	Russia*	Spain	UK	Ukraine	Total
1982														581		60,000				60,581
1983						155										60,079				60,234
1984	2,961					989								239		60,643				64,832
1985	5,825					5,438								135		60,273				71,671
1986	11,385			5		8,574								149		84,994				105,107
1987	12,270			382		7,023								25		71,469				91,169
1988	8,455			1,090		16,848										65,026				91,419
1989	4,546			226		6,797	567	3,816						112		22,720				38,784
1990	2,690					7,957		4,537					7,085			9,632				31,901
1991			2,195	115		571		8,783					6,197			9,747				27,608
1992	628		1,810	3,765	2	6,447	9	15,478		780	6,656		14,654			15,733				65,962
1993	3,216		6,365	7,121		17,813	710	22,908		6,803	7,899		14,990			25,229			2,782	115,835
1994	3,600		17,875	2,896	606	17,152		53,332		13,205	7,404		7,357		1,887	17,814			5,561	148,689
1995	3,800	602	16,854	5,239	226	18,985	1,856	34,631	1,237	5,003	22,893	13	7,457		5,125	44,182	4,554		3,185	175,842
1996	3,500	650	7,092	6,271		21,245	3,537	62,903	415	1,084	10,649		6,842		2,379	45,748	7,229	260	518	180,322
1997		111	3,720	3,945		20,476		41,276	31				3,179	776	3,674	36,930	8,707			122,825
1998			3,968	7,474		18,047	1,463	48,519	31		1,768		1,139	12	4,133	25,837	4,577			116,968
1999			2,108	4,656		16,489	4,269	43,923					5,435	6	4,302	17,957	10,332	188		109,665
2000			11,951	2,837		12,499	4,283	45,232			430		5,232		3,731	29,224	10,894			126,313
2001			887	7,741		10,669	3,443	42,472			15,784		5,222		2,744	29,774	10,082			128,818
2002			15	4,383		13,212	4,099	44,492		1,841	21,823		5,291	428	3,086	39,267	8,407			146,344
2003				5,893		10,607	4,450	48,894		1,269	21,629		8,399	917	4,035	44,056	10,835			160,984
2004				5,447		3,377	3,169	36,826		1,114	3,698		8,998	2,907	4,419	44,275	11,675			125,905
2005				2,010		2,988	1,431	16,005		919	2,196		4,574	2,410	3,868	31,885	5,428			73,715
2006				3,832		2,824	744	22,138		1,803	1,760		6,233	2,019	2,685	28,623	10,249			82,910

Table 10.1.3 Pelagic *S. mentella* catches (in tonnes) in 2006 by countries and depth (A), and in 1996-2006 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	3,832	100 %		
Germany	2,824		44 %	56 %
Greenland	744	100 %		
Iceland	22,138		7 %	93 %
Latvia	1,803	100 %		
Lithuania	1,760	100 %		
Norway	6,233	100 %		
Poland	2,019		32 %	68 %
Portugal	2,685		55 %	45 %
Russia	28,623		16 %	84 %
Spain	10,249		35 %	65 %
Total	82,910			

B.	Total	Not splitted	Shallower than 600 m	Deeper than 600 m
1996	180,322	18 %	20 %	62 %
1997	122,825	7 %	24 %	69 %
1998	116,968	0 %	21 %	79 %
1999	109,665	5 %	20 %	75 %
2000	126,313	23 %	28 %	49 %
2001	128,818	23 %	27 %	50 %
2002	146,344	26 %	19 %	55 %
2003	160,984	10 %	25 %	65 %
2004	125,905	10 %	23 %	67 %
2005	73,715	14 %	32 %	53 %
2006	82,910	17 %	16 %	67 %

Table 10.2.1 Pelagic *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). [1]within and deeper than the deep-scattering layer (DSL) in 2005. *international surveys

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.)[1]	TRAWL ESTIMATES > 500 M (1000 T)[1]
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
2005*	386	940	551			1083	674

Table 10.2.2 Pelagic *S. mentella*. Results of the acoustic abundance and biomass estimation shallower than the DSL from the survey in June/July 2005.

Sub-area	A	B	C	D	E	F	Total
Area (NM^2)	126,403	84,020	25,694	64,533	73,693	11,921	386,264
No. fishes ('000)	206,228	212,506	3	141,432	350,639	28,952	939,761
Biomass (t)	120,823	122,744	0	86,986	203,791	17,146	**551,490**

Table 10.2.3. Pelagic *S. mentella*. Results of the trawl estimation within and deeper than the DSL from the survey in June/July 2005.

	A	B	C	D	E	F	Total
Area (NM^2)	126,403	84,020	25,694	64,533	73,693	11,920	386,263
No. fishes ('000)	401,374	259,187	1,498	89,750	320,874	10,459	1,083,142
Biomass (t)	275,527	160,708	1,076	52,588	179,145	5,294	**674,338**
Lower CL	218,344	99,509	763	28,001	95,387	2,819	444,823
Upper CL	332,710	221,908	1,388	77,175	262,903	7,769	903,853

Table 10.2.4 Pelagic *S. mentella*. Survey biomass estimates 1999-2005 and area splitting between NAFO and NEAFC Convention areas by depth. *acoustically measured

	NAFO (000 T)	NAFO %	NEAFC (000 T)	NEAFC %	SUM (000 T)
1999 < 500 m*	282	46	332	54	614
1999 > 500 m	58	12	439	88	497
1999 Sum	340	31	771	69	1111
2001 < 500 m*	377	53	338	47	716
2001 > 500 m	165	16	892	84	1057
2001 Sum	542	31	1230	69	1773
2003 < 500 m*	11	12	78	88	89
2003 > 500 m	41	6	637	94	678
2003 Sum	52	7	715	93	767
2005 < DSL*	308	56	244	44	551
2005 ≥ DSL	237	35	437	65	674
2005 Sum	545	44	681	56	1225

Table 10.2.5. a. Results of the GLM model to calculate standardized CPUE for pelagic redfish fishery, by depths shallower than 500 m (northeastern area) including single tow data from Germany (1995-2006), Iceland (1995-2006), Greenland (1999-2003), Faroe Islands (1995-2006), Russia (1997-2006) and Norway (1995-2003). Note that the residuals are shown in Fig. 10.2.8.

Call: glm(formula = lafli ~ ltogtimi + factor(yy) + factor(mm) + factor(skip), family = gaussian(), data = north)

Deviance Residuals:

Min	1Q	Median	3Q	Max
-2.348326	-0.251728	0.01053971	0.2687413	1.822983

Null Deviance: 2755.177 on 1489 degrees of freedom

Residual Deviance: 286.8405 on 1379 degrees of freedom

Number of Fisher Scoring Iterations: 1

Results

	Value	Std..Error	t.value	ar	index	lower	upper
factor(yy)1995	0.000	0.000	0.000	1995	1.000	1.000	1.000
factor(yy)1996	-0.034	0.084	-0.402	1996	0.967	0.889	1.051
factor(yy)1997	-0.437	0.076	-5.730	1997	0.646	0.598	0.697
factor(yy)1998	-0.176	0.077	-2.272	1998	0.839	0.776	0.906
factor(yy)1999	-0.245	0.080	-3.048	1999	0.783	0.723	0.848
factor(yy)2000	0.046	0.080	0.577	2000	1.047	0.967	1.134
factor(yy)2001	-0.342	0.078	-4.366	2001	0.710	0.657	0.768
factor(yy)2002	0.034	0.080	0.422	2002	1.034	0.955	1.120
factor(yy)2003	0.124	0.081	1.524	2003	1.132	1.043	1.227
factor(yy)2004	-0.401	0.083	-4.828	2004	0.669	0.616	0.727
factor(yy)2005	-0.733	0.086	-8.518	2005	0.481	0.441	0.524
factor(yy)2006	-0.329	0.090	-3.651	2006	0.720	0.658	0.788

Anova table

Analysis of Deviance Table

Gaussian model

Response: lafli

Terms added sequentially (first to last)

	Df	Deviance	Resid. Df	Resid. Dev	F Value	Pr(F)
NULL			1489	2755.177		
ltogtimi	1	2056.975	1488	698.202	9889.010	0
factor(yy)	11	63.069	1477	635.133	27.564	0
factor(mm)	11	50.677	1466	584.456	22.148	0
factor(skip)	87	297.615	1379	286.840	16.446	0

Table 10.2.5. b. Results of the GLM model to calculate standardized CPUE for pelagic redfish fishery, by depths shallower than 500 m (southwestern area) including single tow data from Germany (1995-2006), Iceland (1995-2006), Greenland (1999-2003), Faroe Islands (1995-2006), Russia (1997-2006) and Norway (1995-2003). Note that the residuals are shown in Fig. 10.2.8.

```
Call: glm(formula = lafli ~ ltogtimi + factor(yy) + factor(mm) + factor(skip),
family = gaussian(), data = south)

Deviance Residuals:
       Min         1Q        Median        3Q      Max
 -2.440766 -0.2562313 7.105427e-015 0.2634336 1.988311

    Null Deviance: 1607.77 on 656 degrees of freedom

Residual Deviance: 146.3032 on 560 degrees of freedom

Number of Fisher Scoring Iterations: 1


Results

                Value Std..Error t.value   ar index lower upper
factor(yy)1995  0.000      0.000   0.000 1995 1.000 1.000 1.000
factor(yy)1996 -0.004      0.297  -0.014 1996 0.996 0.740 1.340
factor(yy)1997 -0.345      0.105  -3.273 1997 0.708 0.638 0.787
factor(yy)1998 -0.316      0.112  -2.828 1998 0.729 0.652 0.815
factor(yy)1999 -0.706      0.102  -6.900 1999 0.494 0.445 0.547
factor(yy)2000 -0.361      0.120  -3.009 2000 0.697 0.618 0.786
factor(yy)2001 -0.182      0.101  -1.814 2001 0.833 0.754 0.921
factor(yy)2002 -0.360      0.111  -3.230 2002 0.698 0.624 0.780
factor(yy)2003 -0.236      0.112  -2.108 2003 0.790 0.706 0.883
factor(yy)2004 -0.553      0.117  -4.710 2004 0.575 0.512 0.647
factor(yy)2005 -0.662      0.118  -5.612 2005 0.516 0.458 0.580
factor(yy)2006 -0.499      0.139  -3.601 2006 0.607 0.529 0.697


Analysis of Deviance Table

Gaussian model

Response: lafli

Terms added sequentially (first to last)
             Df Deviance Resid. Df Resid. Dev  F Value Pr(F)
        NULL                   656   1607.770
    ltogtimi  1 1242.191       655    365.579 4754.693     0
  factor(yy) 11   62.875       644    302.704   21.879     0
  factor(mm) 10   45.636       634    257.068   17.468     0
factor(skip) 74  110.765       560    146.303    5.729     0
```

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 (1995-2006), Iceland (1995-2006), Greenland (1999-2003), Faroe Islands (1995-2006), Russia (1997-2006) and Norway (1995-2003). Note that the full output is not shown (lafli= log catch; ltogtimi=log trawling time). Note that the residuals are shown in Fig. 10.2.8.

```
Call: glm(formula = lafli ~ ltogtimi + factor(yy) + factor(mm) + factor(reitur)
+ factor(skip), family = gaussian(), data = testdata)

Deviance Residuals:
       Min         1Q      Median        3Q      Max
 -2.932461 -0.2698082 0.006419738 0.2816237 2.080682

    Null Deviance: 4418.978 on 2146 degrees of freedom

Residual Deviance: 491.6195 on 2030 degrees of freedom

Number of Fisher Scoring Iterations: 1

Results

                Value Std..Error t.value   ar index lower upper
factor(yy)1995  0.000      0.000   0.000 1995 1.000 1.000 1.000
factor(yy)1996 -0.100      0.068  -1.463 1996 0.905 0.845 0.969
factor(yy)1997 -0.457      0.056  -8.133 1997 0.633 0.598 0.670
factor(yy)1998 -0.233      0.058  -4.011 1998 0.792 0.747 0.839
factor(yy)1999 -0.400      0.058  -6.876 1999 0.671 0.633 0.711
factor(yy)2000 -0.065      0.060  -1.088 2000 0.937 0.882 0.995
factor(yy)2001 -0.318      0.058  -5.503 2001 0.728 0.687 0.771
factor(yy)2002 -0.090      0.060  -1.513 2002 0.914 0.861 0.970
factor(yy)2003 -0.001      0.060  -0.017 2003 0.999 0.940 1.061
factor(yy)2004 -0.454      0.064  -7.151 2004 0.635 0.596 0.677
factor(yy)2005 -0.721      0.065 -11.126 2005 0.486 0.456 0.519
factor(yy)2006 -0.403      0.071  -5.697 2006 0.668 0.623 0.717


Analysis of Deviance Table

Gaussian model

Response: lafli

Terms added sequentially (first to last)
               Df Deviance Resid. Df Resid. Dev  F Value      Pr(F)
          NULL                  2146   4418.978
      ltogtimi  1 3345.254      2145   1073.725 13813.26 0.00000000
    factor(yy) 11   82.059      2134    991.665    30.80 0.00000000
    factor(mm) 11   77.273      2123    914.393    29.01 0.00000000
factor(reitur)  1    1.020      2122    913.372     4.21 0.04024358
  factor(skip) 92  421.753      2030    491.619    18.93 0.00000000
```

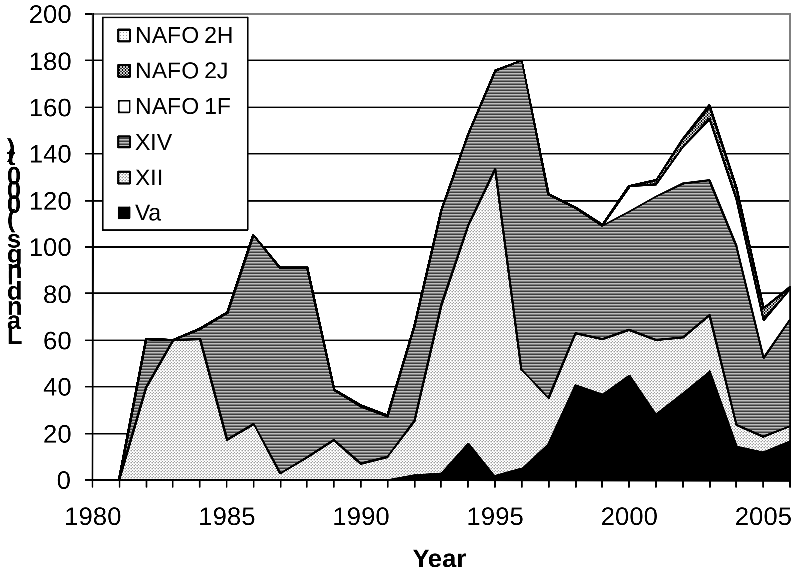


Figure 10.1.1 Landings of pelagic *S. mentella* (Working Group estimates, see Table 10.1.1).

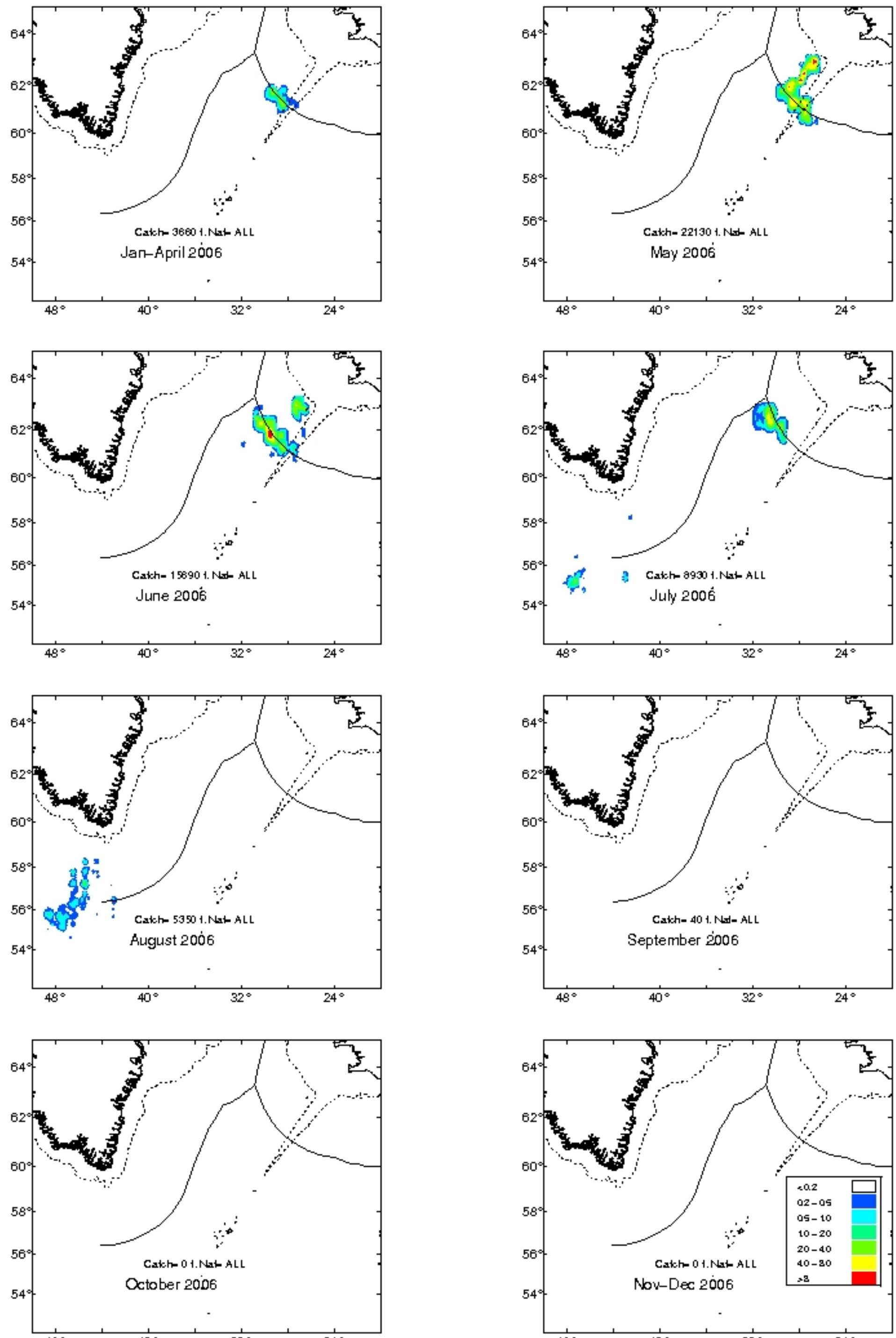


Figure 10.1.2 Fishing areas and total catch of pelagic redfish (*S. mentella*) by month(s) in 2006, derived from catch statistics provided by the Faroe Islands, Germany, Iceland and Russia. The catches are given as tonnes per square nautical mile.

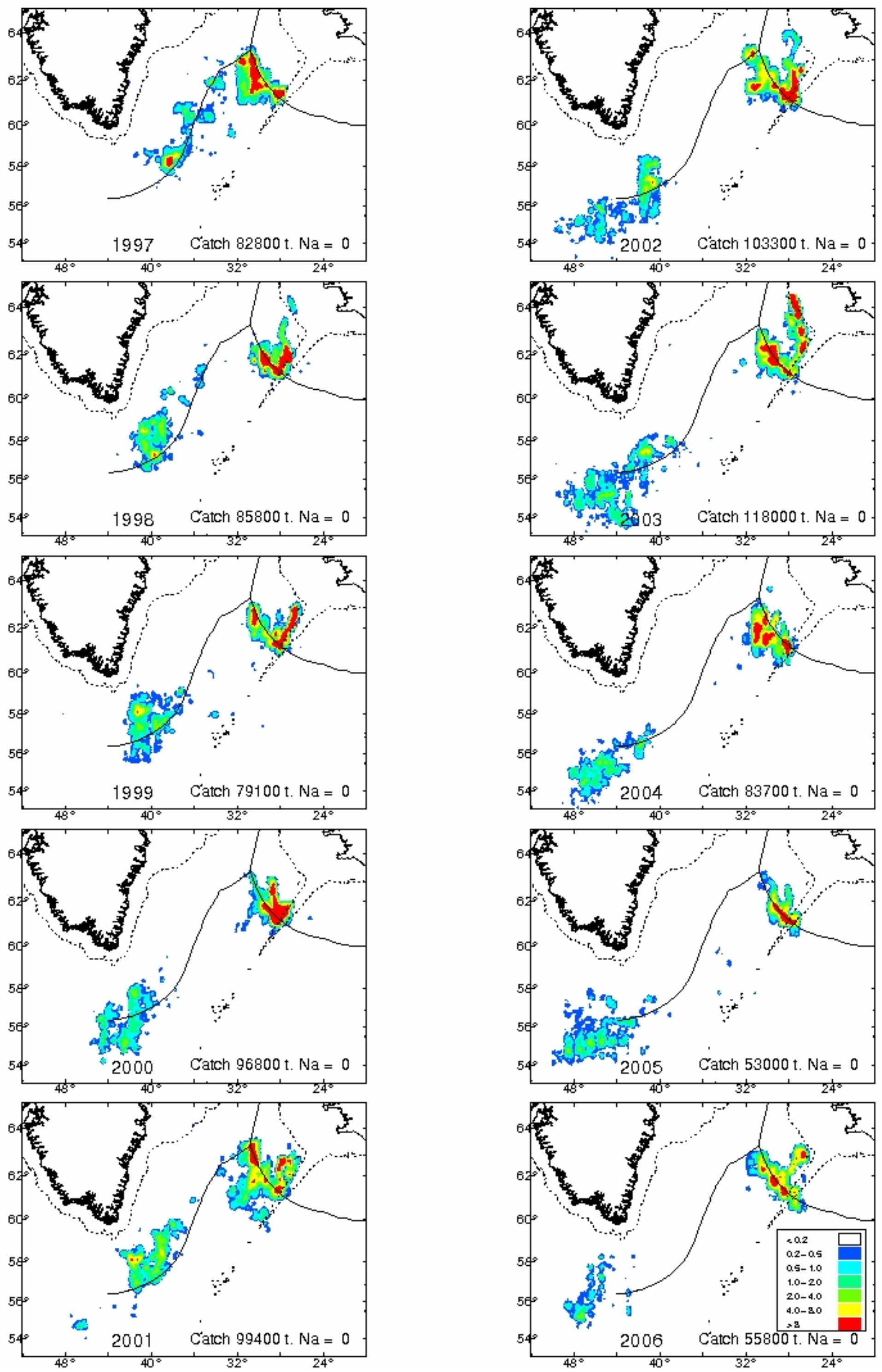


Figure 10.1.3 Fishing areas and total catch of pelagic redfish (*S. mentella*) in the Irminger Sea and adjacent waters 1997-2006. Data are from the Faroe Islands (1995-2006), Germany (1995-2006), Greenland (1999-2003), Iceland (1995-2006), Norway (1995-2003) and Russia (1997-2006). The catches are given as tonnes per square nautical mile.

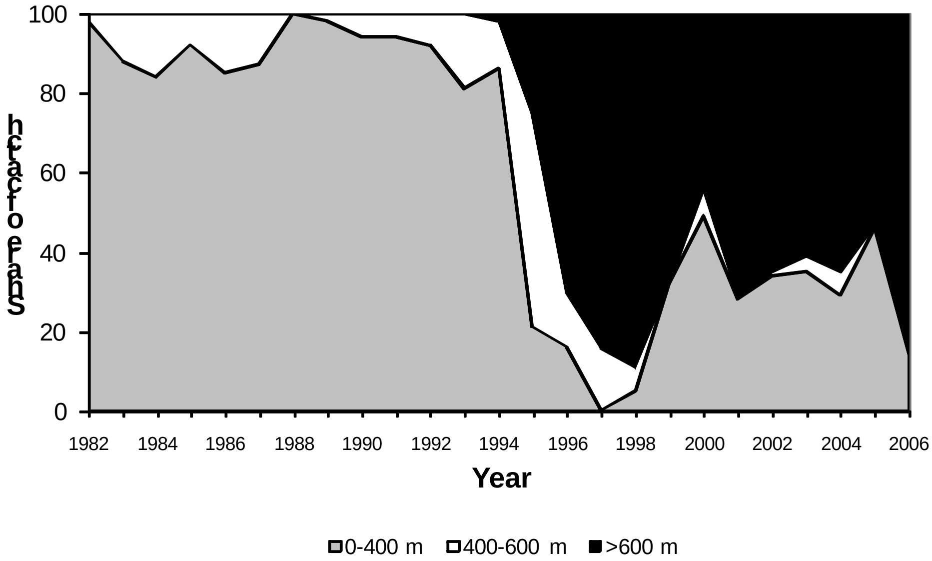


Figure 10.1.4 Percentage of the catch *of S. mentella* by Russian vessels by depth in the Irminger Sea in 1982-2006.

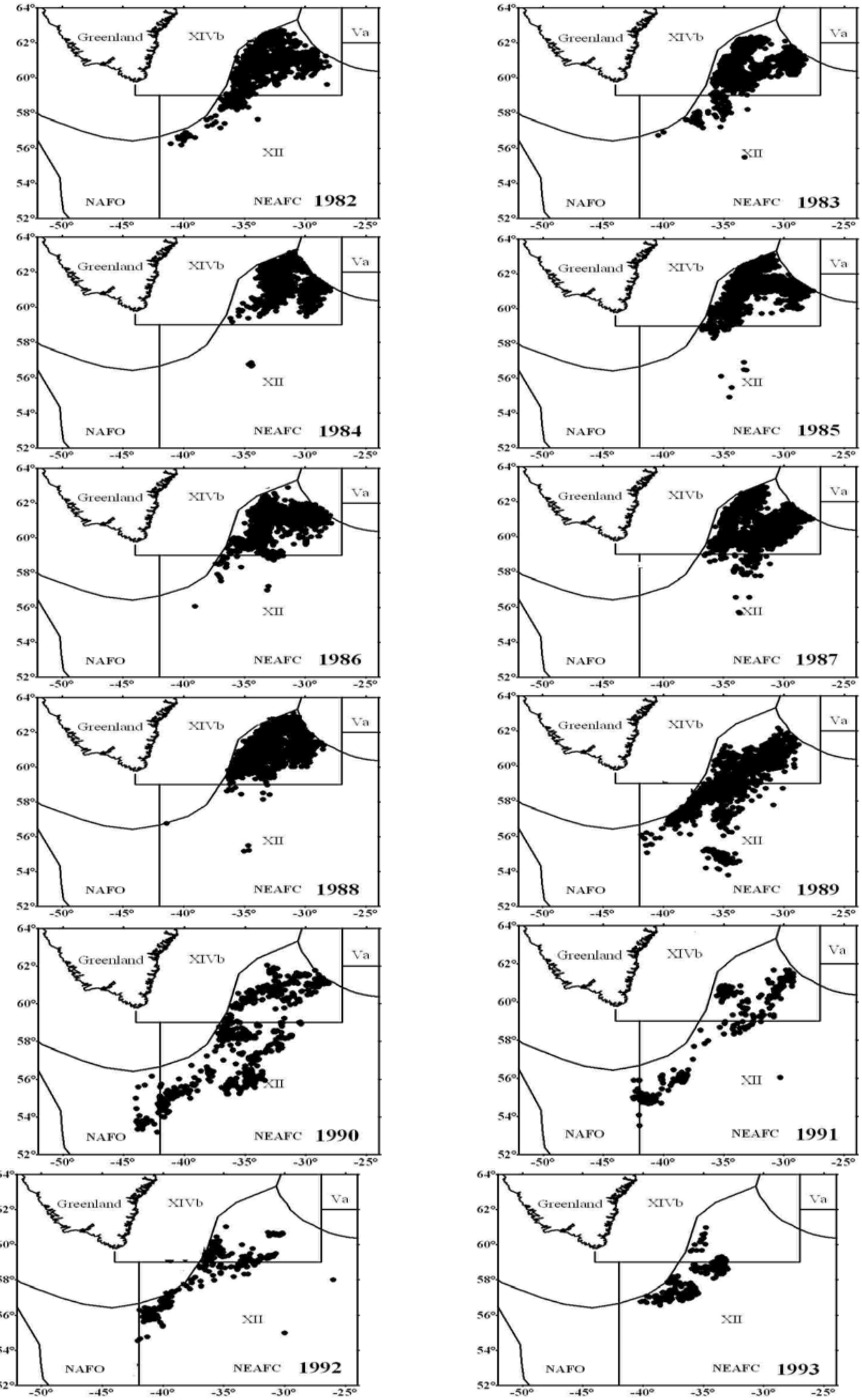


Figure 10.1.5 Location of the Russian fleet during fishery for *S. mentella* in the Irminger Sea in 1982-1993.

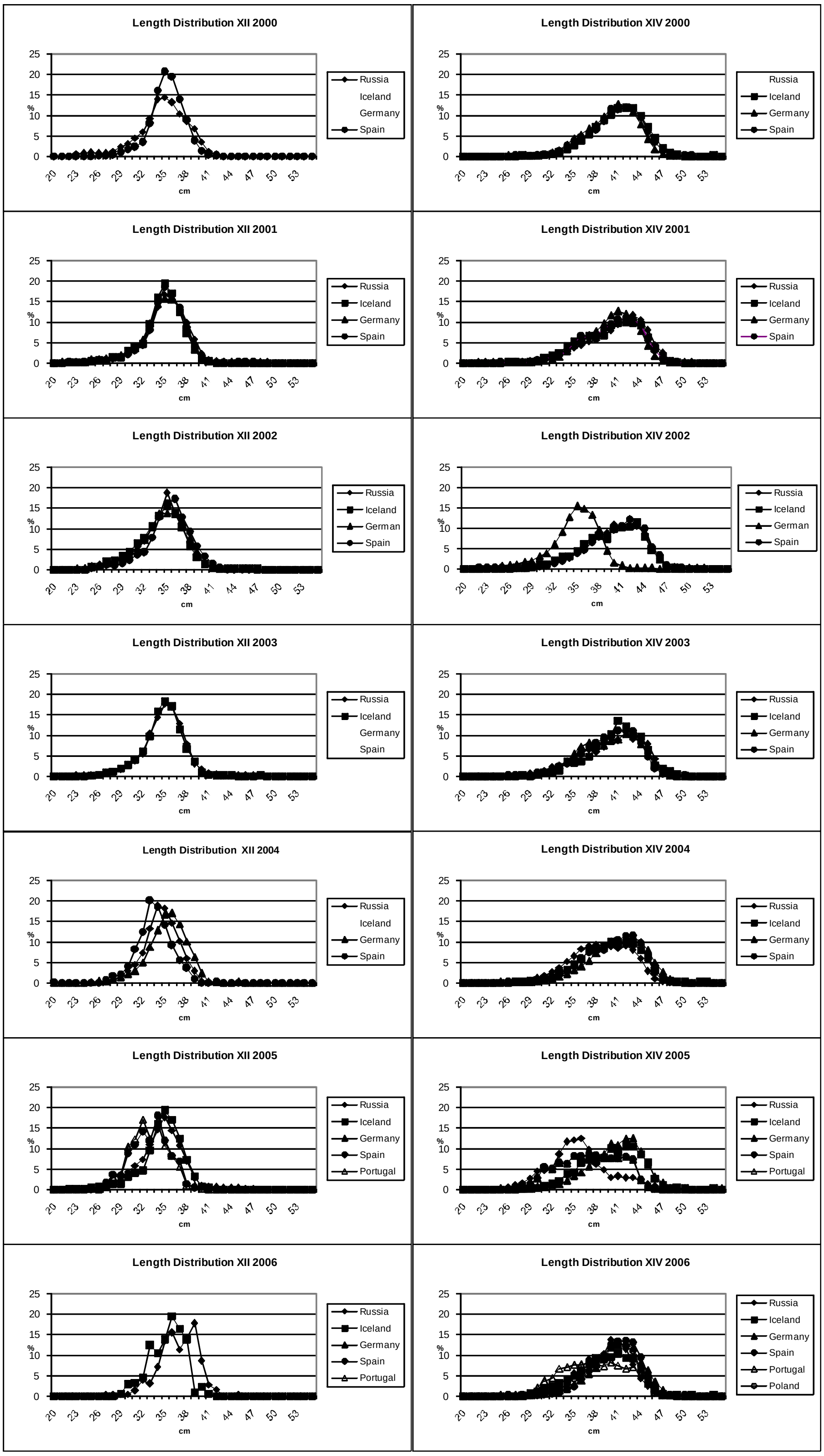


Figure 10.1.6 Length distributions from landings of pelagic *S. mentella* by ICES Sub-areas XII and XIV and country in 2000-2006.

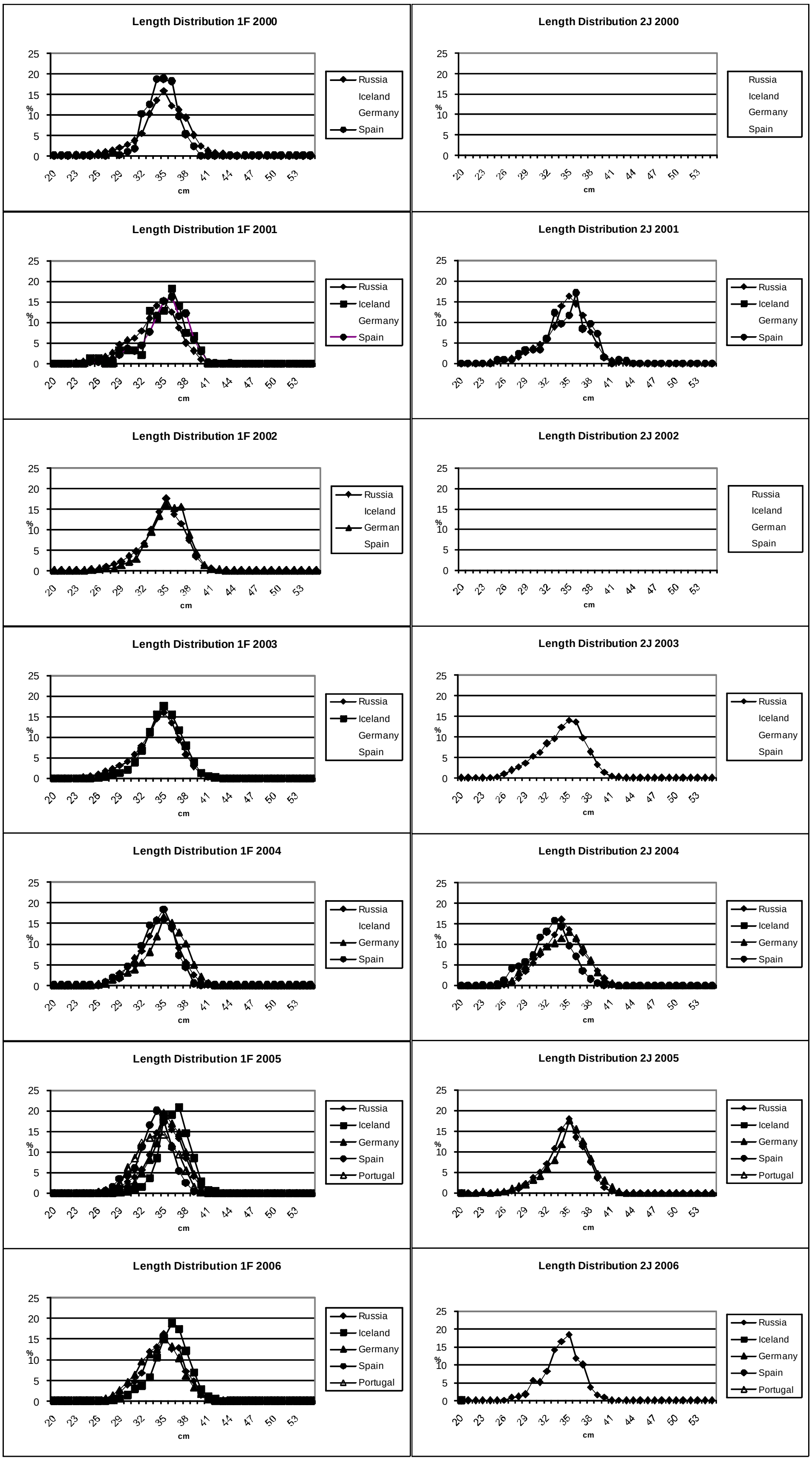


Figure 10.1.7 Length distributions from landings of pelagic *S. mentella* by NAFO Divisions 1F and 2J and country in 2000-2006.

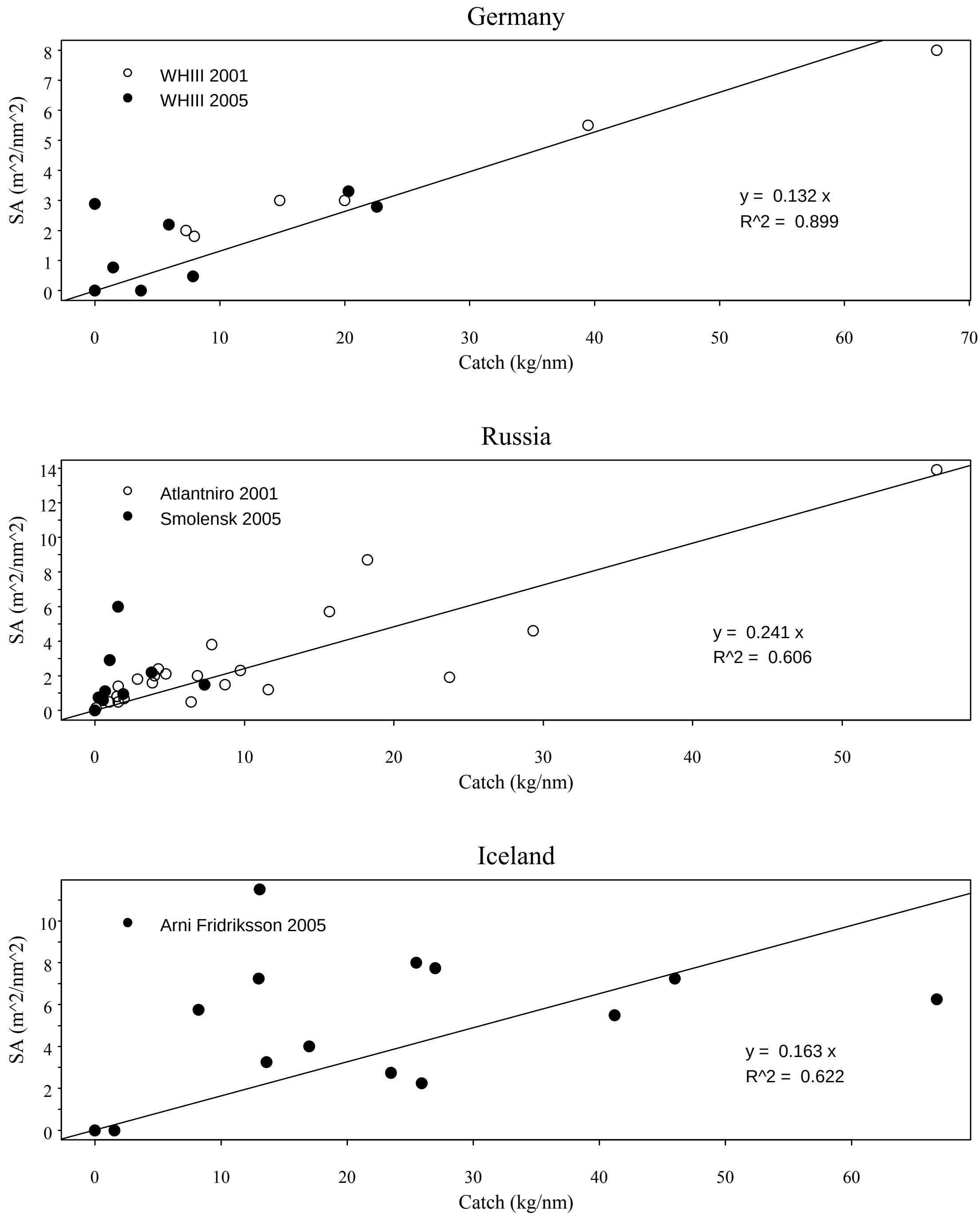


Figure 10.2.1 Regressions between catches and observed hydroacoustic s_A values, observed on the German, Russian and Icelandic vessel(s) shallower than the DSL and used in the biomass calculations.

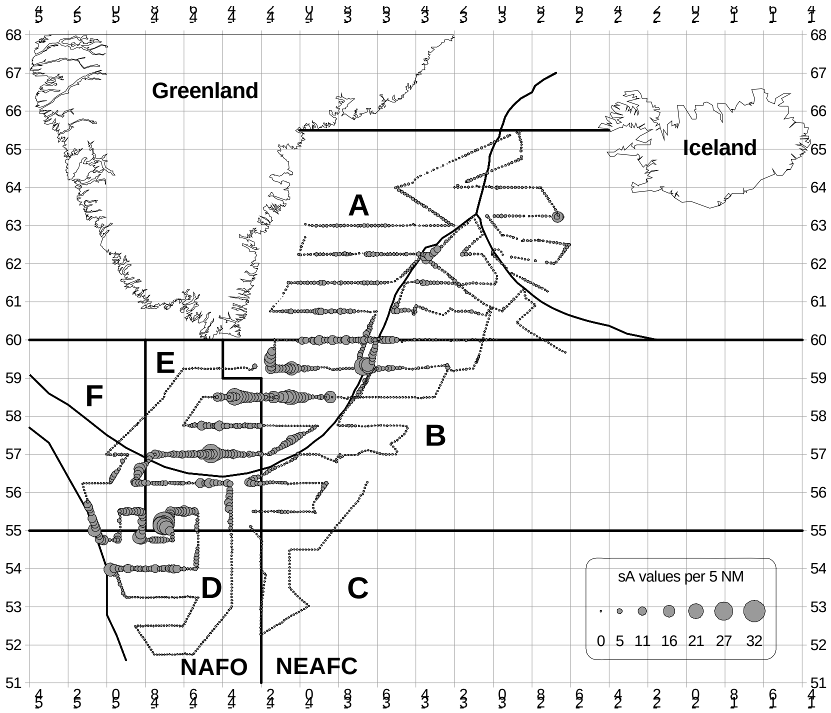


Figure 10.2.2 Pelagic *S. mentella*. Acoustic estimates (average s_A values by 5 NM sailed) shallower than the deep-scattering layer (DSL) from the joint trawl-acoustic survey in June/July 2005.

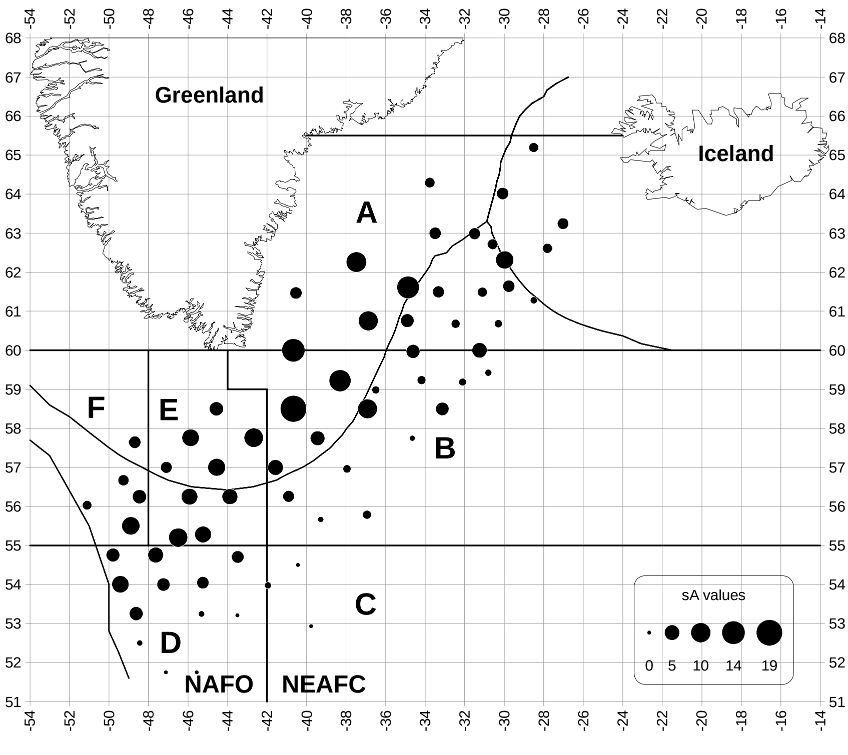
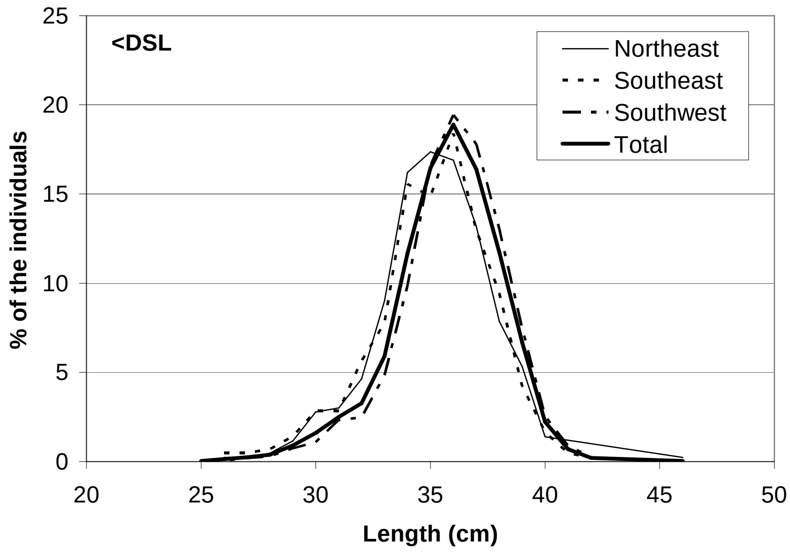


Figure 10.2.3 Pelagic *S. mentella*. Trawl estimates (s_A values calculated from trawls; ICES CM 2005/D:03) within and deeper than the deep-scattering layer (DSL) from the joint trawl-acoustic survey in June/July 2005.



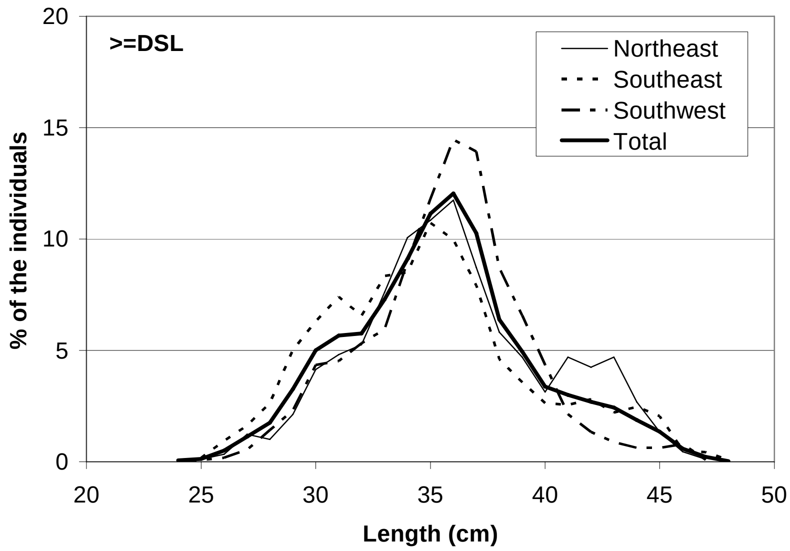


Figure 10.2.4 Length distribution of pelagic *S. mentella* redfish in the trawls, by geographical areas (ICES CM 2005/D:03) and total, shallower than the DSL, and within and deeper than the DSL from the joint trawl-acoustic survey in June/July 2005.

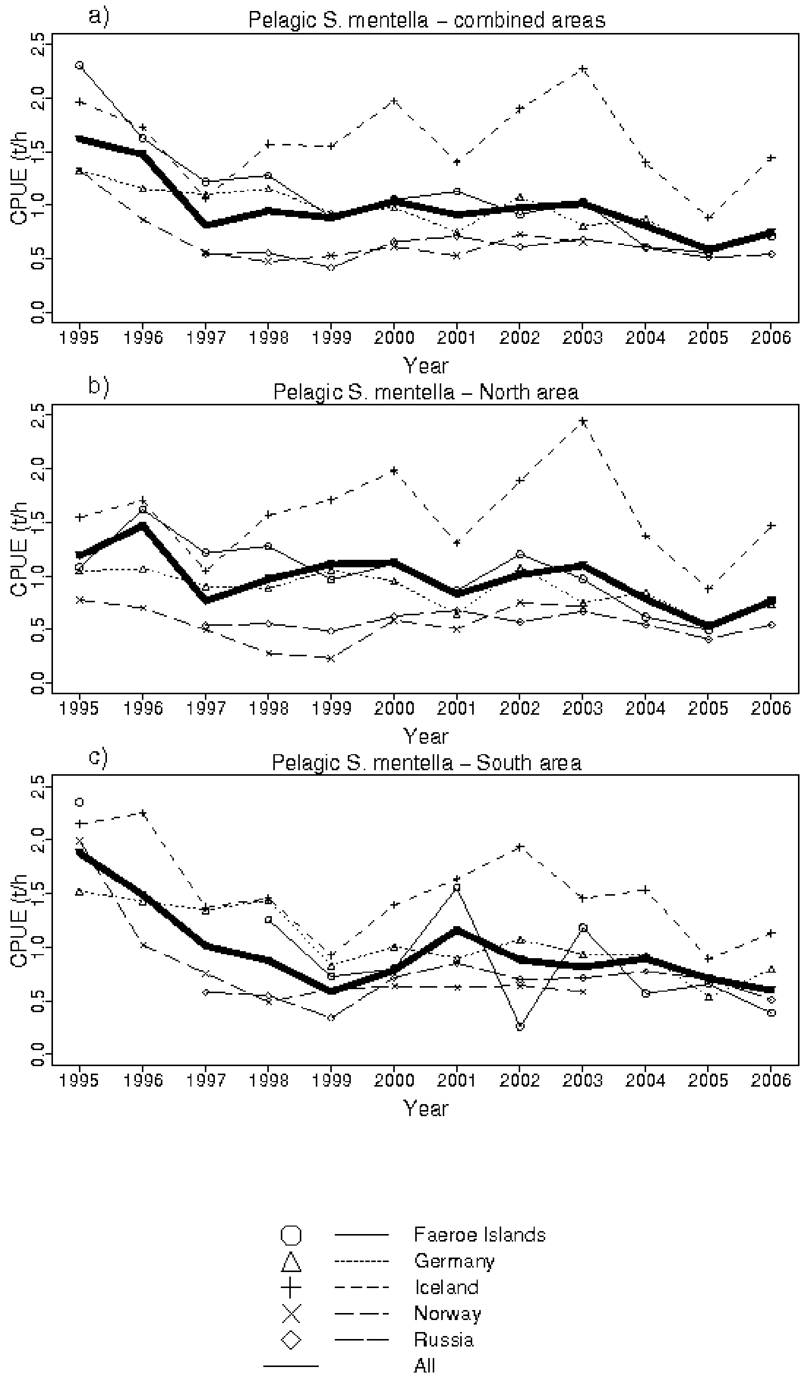


Figure 10.2.5 Trends in national non-standardised CPUE of the pelagic *S. mentella* fishery in the Irminger Sea and adjacent waters, based on log-book statistics in the joint international database. a) all areas, b) northeastern area, c) southwestern area.

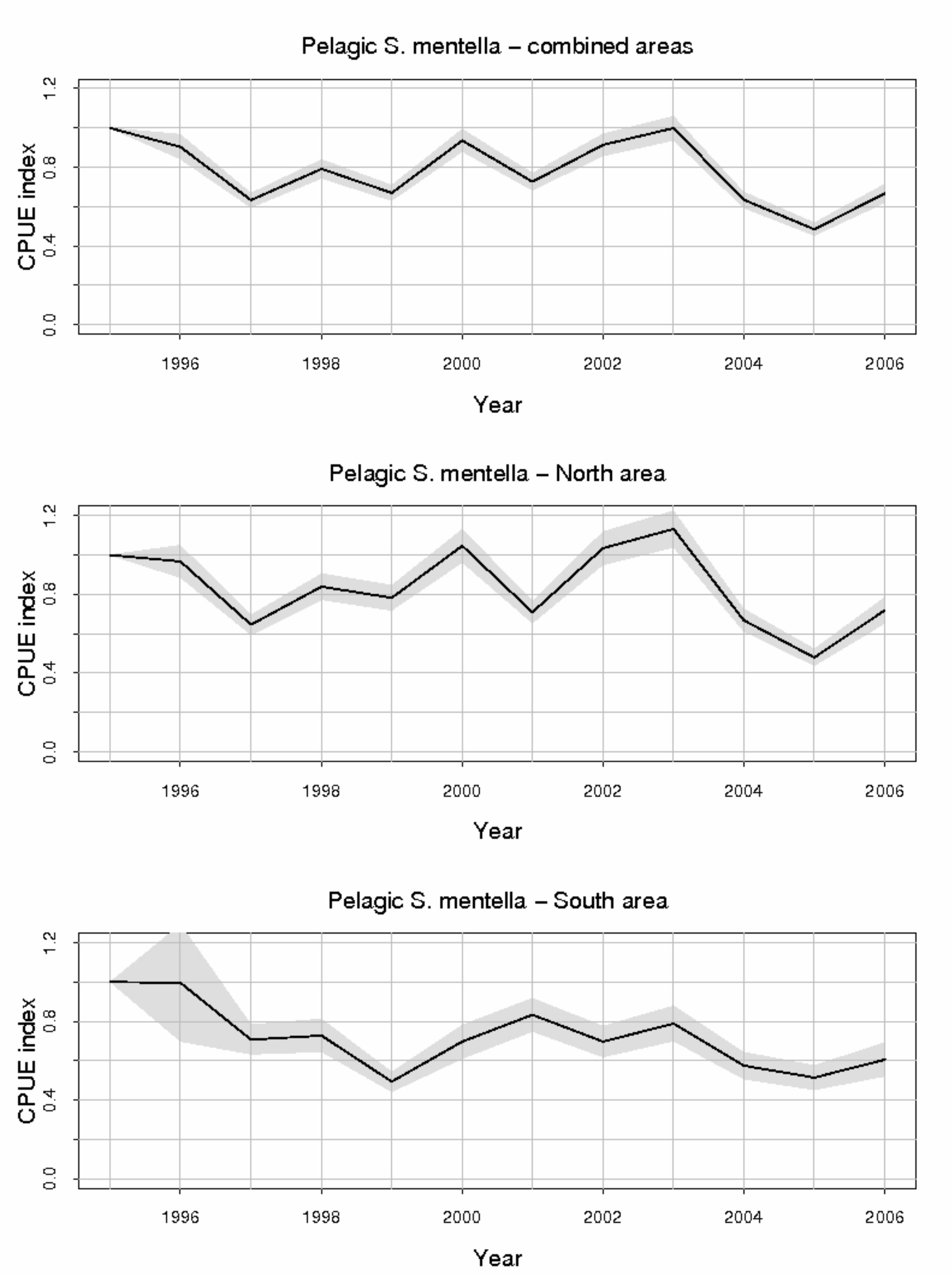


Figure 10.2.6 Standardised CPUE, as calculated by using data from Germany (1995-2006), Iceland (1995-2006), Greenland (1999-2003), Faroe Islands (1995-2006), Russia (1997-2006) and Norway (1995-2003) in the GLM model (see section 10.2.2), divided by depths shallower (southwestern area) and deeper than 500 m (northeastern 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.

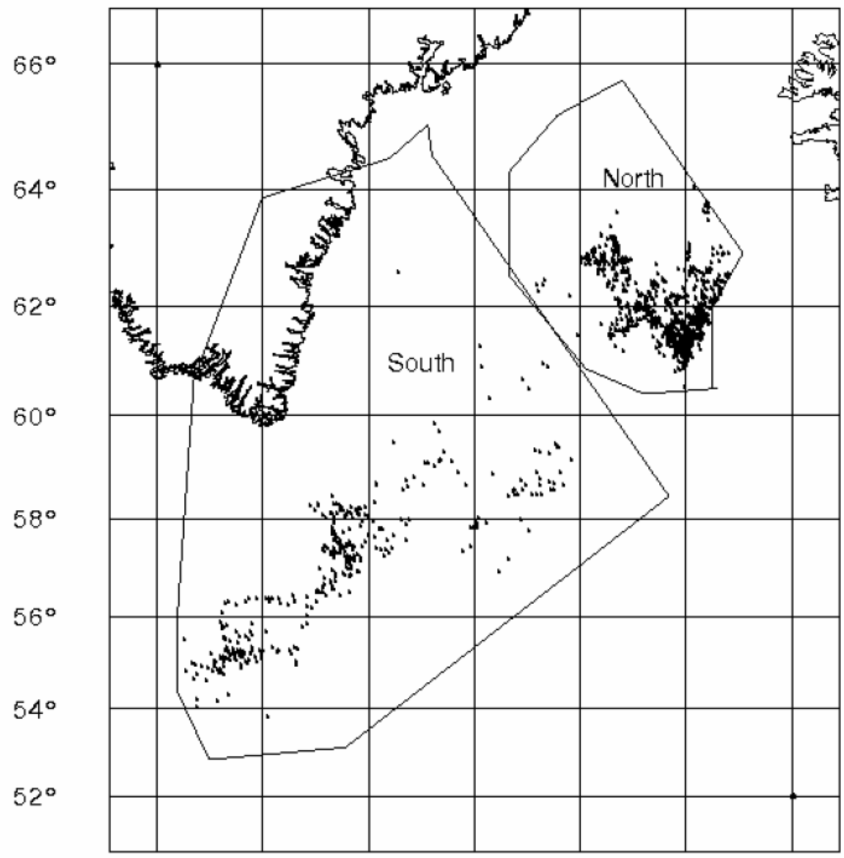


Figure 10.2.7. Division of areas between south an north. The points indicate positions of Icelandic available samples from the catches 1995-2005.

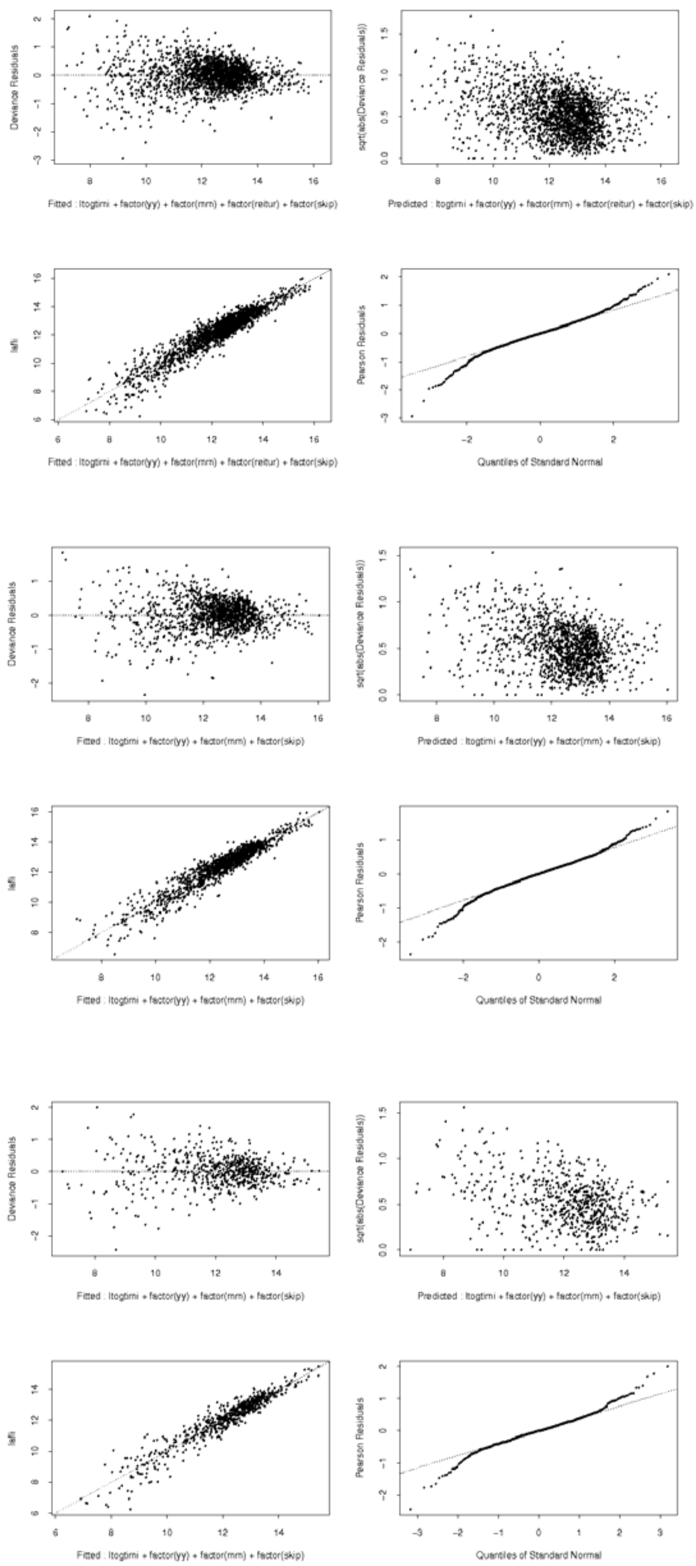


Figure 10.2.8 Residues of the GLM model (section 10.2.2) for the CPUE series for pelagic *S. mentella*. Upper panel: combined area, middle panel: northeastern area, lower panel: southwestern area.

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Annex 1: Participants List

NORTH-WESTERN WORKING GROUP

ICES, Headquarters, 24 April – 3 May 2006

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Annex 2: Technical Minutes. Faroe Review Group. Review of the Report of the North-Western Working Group [NWWG]

ICES HQ, Copenhagen, Denmark

23rd May 2007

Composition Of The Review Group

ACFM review group chair:	Alberto Murta (Portugal)
ICES NWWG chair:	Einar Hjörleifsson (Iceland)
Reviewers:	Johan Modin (Sweden) and Mauricio Ortiz (United States of America)

Additionally, the review group was assisted by the participation of Jákup Reinert (Faroe Islands).

General Considerations

(These refer to the latest report of the ICES NWWG, namely, document ICES CM 2007/ACFM:17)

RGNW2 commends the WG for the overall organisation of the report, and especially for the nice and very helpful executive summaries for each stock. Some suggestions for improvement are, nevertheless, given below.

1. The summaries should be further standardized for all stocks. Those summaries could also be extended to have some standard plots (biomass, F, recruits, stock size) that are linked to the executive summary. There is also the need, at the beginning of the report, to have a table indicating sampling levels by fleet, stock and year, to have better idea of the evolution and adequacy of sampling effort.

2. A concise description of the Faroe mixed-fisheries and fleet interactions should be provided as background information. The stocks revised here are exploited in mixed-fisheries, and in particular the management of plateau cod and haddock must be closely connected. The RGNW2 strongly recommends the WG to explore the available data from the mixed-fisheries point of view, and to explore how to implement reductions on fishing mortality/effort for cod and continue fishing for haddock. Also, a table/figure of the catch proportion of each main species in each fleet component along time would be useful in this context. The RGNW2 endorses the recommendation of the WG for a Study Group to be formed for the evaluation of the management plans for the Faroese stocks, and recommends that those management plans should take into account the fact that these are mixed-fisheries.

3. The WG uses XSA as the assessment model for the stocks from the Faroe Islands. The results of this model are then compared with those from NFS ADAPT, which is used to produce bootstrap simulations. Given these two models are just different ways of tuning VPAs, and also given the observed patterns in the catchability residuals for cod and haddock, with some marked year-effects, RGNW2 advises the WG to experiment other types of models besides VPA, such as statistical catch-at-age models.

4. Some plots could be improved and standardized for all stocks. For example, the slopes of the catch curves from survey data should be calculated and presented, in order to have a general view of mortality levels. The pie charts with relative contribution of each year class for the current SSB, which are presented for some stocks (e.g. haddock) are very helpful and should be presented for all stocks. The confidence intervals for the survey indices for all stocks should be calculated and plotted. Also the survey maps made for haddock (page 120 of the report) should be available for all stocks.

Stock Reviews

Faroe Plateau cod - update

1) 1. The update assessment was accepted by RGNW2 as the basis for a short-term forecast and advice.

2) 2. RGNW2 further encourages the NWWG to continue their analyses into the influence of environmental factors on stock parameters. These may help to explain some of the cyclical variations in recruitment (at age 2).

3) 3. The caption of fig 2.1.3 should explicit define what is referred as "average growth for ages 3 to 7". Is it increase of individual growth, or added biomass by each age-class?

4) 4. There remains an issue with the weight-at-age data which was raised by last year's review group but the NWWG have yet to respond. The weight estimates for projections are base on regressions, and it would be informative to have details of the model fits, residuals and diagnostics; together with options for a projection model. In the case of plateau cod, those weight estimates were greater than the average of last three years, which is an optimistic view on the upcoming years. RGNW2 carried out new projections using the average weights instead of the regression estimates, and concluded that the results were not significantly different. However, RGNW2 recommends using the same option to carry out projections for all stocks, considering the average weight at age of the last 3 years a more conservative option than the estimates obtained from regression.

Faroe Bank cod (no analytical assessment)

1) 1. There may be problems with the recording of catch statistics for the Faroe Bank as vessels may fish on both the Faroe Plateau and Faroe Bank during the same trip. Unless there are improvements in the recording, and assignment to area, of catch then the landings will continue to remain uncertain.

2) 2. The poor sampling for age composition has continued in 2006, particularly for pair trawlers (Table 2.3.2.1). This needs to be improved if a reliable scientific basis for assessment and advice is ever to be developed.

3) 3. There are age data available from the surveys, but not from the catches. Even with different selectivity patterns, these age data from surveys could be used to age catches, using methods based on inverse age-length keys (e.g. Hoenig and Heisey, 1987), as long as the distribution of length given age is the same for the surveys and commercial fleets (the apparent growth rate must be the same). [Reference: Hoenig, J.M. and Heisey, D.M. 1987. Use of a log-linear model with the EM algorithm to correct estimates of stock composition and to convert length to age. Trans. Amer. Fish. Soc. 116, 232-243.]

4) 4. The perception of the state of the stock is based on survey and exploitation ratio trends (Figures 2.3.2.1 and 2.3.2.5 in the WG report). It is necessary to find suitable methods that, based on the available data, can confirm the present bad status of the stock. Also there is the need to clarify the basis for the criterion used to check if the stock has recovered. The WG suggests that this criterion should be both survey indices being above historical average values, however this criterion should be further justified. A more conservative alternative would be, for example, using the average of the last 10 years.

Faroe haddock – update

1. Update assessment with addition of 1 years data. RGNW2 recommends adopting this year's assessment.

2. It appears that haddock disappears faster in the summer survey than in the spring survey, i.e. steeper catch curves in the summer than in the spring (Figures 2.4.11 and 2.4.12). An explanation for these trends would be welcome, to clarify if their origin is a biological one or if it is due to survey design (or both).

3. The weights-at-age used for the short-term forecasts were the ones from 2006, which are lower than the historical average. This resulted in a very conservative approach, and other options could have been explored.

4. The WG has not addressed TOR 7 (Evaluate existing management plans...) for haddock. The agreed F in the management plan is well above Flim, and therefore this evaluation is urgent. RGNW2 endorses the WG recommendation that a Study Group prior to NWWG 2008 should be formed to evaluate the current management plan.

Faroe saithe (no analytical assessment)

1. The RGNW2 has not accepted the assessment last year, mainly due to enormous changes in mean weights-at-age in the catches (e.g. 4 kg at age 7 in 1994 but 2 kg in 2006). Mean weight-at-age in the catch has varied by a factor of 2 during the period 1961-2005, and all ages have a declining trend since 1996. Catchability (q) may change as a result of changes in weight-at-age, given the high variability in the weight-at-age for saithe. This may have an effect on the assessment of this stock, which assumes a constant q within an age-based assessment model. Therefore the assessment was regarded as exploratory this year by RGNW2.

2. The problem of variability in weight-at-age is going to be dealt by the Methods WG in 2008. Nevertheless, RGNW2 discussed the possibility of using different modelling approaches that the WG could explore in the future:

- Catchability could be calculated from weight-at-age rather than from age only. Further explorations on catchability are encouraged. The WG is encouraged to explore if trends in catch efficiencies can be calculated.
- A production model with back catch history, until it can be assumed a virgin or very low exploitation level, could be used to estimate stock productive reference levels.
- Population models that can integrate information of size and age from the commercial fisheries and the scientific surveys in a forward age/size structured model.
- Alternative model(s) analyses of saithe catch and effort that accounts for annual changes in size/weight at age (e.g. length based models).

Also if recommendations are going to be based on catch and effort trends, it is suggested that size frequency distributions from surveys and commercial fisheries be compared, as well as spatial-temporal differences of sampling between surveys and commercial operations.

1) RGNW2 recommends that the standardisation by GLM for pair trawlers should be extended to the start of the time series (1985).

2) The WG should provide better information on survey indices, with regard to length distribution or relative length frequencies of commercial CPUE indices.

3) As already mentioned, there is the possibility that the assumptions underlying the assessment model used in the past may be violated and that there is now considerable uncertainty in the point estimates produced and their utility as inputs to predictions. In the absence of an accepted analytical assessment, the RGNW2

considered the use of CPUE and survey data as indicator of stock status and basis for advice.

Review Of Reference Points

In common with last year's report, the NWWG has again proposed a revision to the following reference points:

- For plateau cod, an increase in the fishing mortality reference points: Flim from 0.68/year to 1.0/year and Fpa from 0.35/year to 0.5/year;
- For haddock, a reduction in biomass reference points: Blim from 40000 tonnes to 23000 tonnes and Bpa from 55000 tonnes to 35000 tonnes;
- For saithe, to set Bloss = Bpa = 60000 tonnes, to set Blim arbitrarily between 45-50000 tonnes, and to set Fpa=1.0/year.

Regarding plateau cod, and assuming the biomass reference points are set at sensible values, RGNW2 accepted the procedure described in the WG report to recalculate the F reference points. However, the use of the “alternate Ricker curve” needs to be further motivated and the correspondence to the choice of biomass reference points needs to be described. In addition, the RGNW2 noticed that, while the yield-per-recruit calculations used recruits at age 2, the stock-recruitment plot in Figure 2.1.8 refers recruits at age 1. It is unclear if the values of the reference points calculated and proposed by the WG are wrong due to this data mismatch. Therefore, this has to be clarified and corrected before the final values for the reference points are accepted.

Regarding haddock, RGNW2 agrees with the technical minutes from last year, which stated that: "with the current Blim, of the 5 year-classes produced at SSBs below 40 kt, three were weak and two were strong. The two strong year-classes may be due to favourable environmental conditions, and there is no guarantee that similarly favourable environmental conditions would occur again should the SSB decrease below 40 kt". However, RGNW2 is aware that WKREF 2007, which has put a greater effort onto this matter, supported the WG's proposal, and also that the criteria to set haddock reference points should be consistent with those followed for cod. Therefore, RGNW2 supports the proposal of the WG to change the B points. However, the use of the “alternate Ricker curve” needs to be further motivated and therefore, the current WG proposal for deriving Flim from Blim was rejected by RGNW2.

Regarding saithe, RGNW2 has the opinion that, at present, the reference points should not be changed, given the absence of an analytical assessment and the total dependency on trends of CPUE and survey indices to base the advice. Moreover, the relationship between SSB and recruitment, in which the WG based its proposal, is fitted to an “alternate Ricker curve” without a full motivation. The SSB-R data includes estimates for years that should not be taken into account, because they are highly dependent on the last analytical assessment that has been considered unreliable.

23rd May 2007

Annex 3: Technical minutes. Iceland and Greenland Review Group. Review of NWWG 2007 Report

Review group (RG), 21-22 May 2007:

Dankert Skagen (chair)

Einar Hjörleifsson (WG chair)

Pablo Abaunza,

Jesper Boje,

Mauricio Ortiz,

Secretariat: Henrik Sparholt.

The report was presented by Einar Hjörleifsson.

General comments.

The WG has produced a very good report. The RG noted in particular that much work has been put into producing very good maps of distribution of catches and effort, which were very informative.

The chair informed that the Saithe stock in Iceland had not been assessed, due to a sequence of unlucky circumstances out of control of the WG.

- In some sections, figure text were incomplete or labeling was missing. In some cases, figures that should be comparable (e.g. yearly length distributions) have different scales, which makes it difficult to grasp the information in them. Likewise, in some cases the fonts are too small to be readable.
- There were short, but concise and informative sections on hydrographical conditions for each area. Maps outlining the main current systems would be a useful supplement, and the WG should consider to highlight links between the environmental conditions and the behaviour of the stocks, in qualitative terms if quantitative links are uncertain, and if possible, link this with the findings by WGRED.
- There are several extensive surveys that produce results relevant for several socks. A brief description of these surveys together with maps of the stations and/or cruise tracks, might be assembled in a separate section, with a listing of where the results are used.
- It would be usefule for outside readers to have a brief overview table with the main biological characteristics (life span, growth rates etc) of the species covered by this report.
- The assessment work that is being done by this WG is at a very high level, which is both appreciated and encouraged. The widespread use of non-standard software and innovative approaches calls for more extensive documentation than for routine assessments. That is sometimes lacking. As a general guideline, there should be sufficient documentation of data and methods to allow reviewers to reproduce the assessments, at least in principle, and to enable the reviewers to a critical evaluation of the choices that are made.

Iceland cod

The assessment appeared to be sound, and was accepted, although some problems exist. In particular, there has been retrospective bias in some periods, which seems to have disappeared now. Also, the surveys are not very informative on the size of incoming strong year classes.

The harvest rule has again been revised. ICES has not evaluated this rule in relation to the precautionary approach. In the past, the actual exploitation rate has been higher than intended, leading to a rather high fishing mortality about 0.6. Some reasons for this are known (catches above the quotas derived from the rule, assessment bias, possible shifts in selection at age in the fishery, changes in growth), but in a full evaluation of the rule, a more comprehensive explorations of the causes should be done, and accounted for. There was a shift to lower recruitments about 1984. The reasons for this are not clear, but management rules should be adapted to the recent low recruitment.

Iceland haddock.

This stock has been assessed with ADCAM in recent years. This year, it was realized that the spring survey, which so far has been the only survey that goes into the assessment, might have overestimated the stock. To compensate for that, the WG decided to include also the autumn survey, which by now should have enough years to establish catchabilities properly. The ADCAM method failed when both surveys were included, for reasons not clear to the RG. Therefore, the WG used a version of ADAPT to assess the stock. The RG had some doubts about this solution, but agreed that it would be appropriate to apply both surveys, and noticed that, except for the last year, the results with the various approaches were very close. Hence, the ADAPT assessment was accepted as basis for the advise, giving a reasonable compromise between the conflicting signals from the two surveys. The RG recommends, however that the problems with including both surveys in the ADCAM method is further explored.

The assessment at present does not include discards. If reasonable estimates of discards back in time are available, the should be included.

Iceland herring.

The assessment of this stock has been problematic for may years, and it has not been accepted as basis for advise the last years. The main problem has been a consistent retrospective bias, which over the years has led to advise implying a far higher realized mortality than intended. Major revisions have been done to the catch data. in recent years. The RG considers this a major improvement in its own, even though it has not removed the retrospective bias. The surveys appear to be problematic, with large year effects, which may have to do with accessibility of the herring to the survey. The RG also noticed as a matter of concern the large contributions to the total biomass by very small dense concentrations. The RG suggests that the survey design is considered carefully. From a methodological point of view, this stock should be a good case for studying retrospective problems in more general terms, with a strong and consistent bias, and the WG is encouraged to continue its work to explore the problems with this assessment.

The assessments presented by the WG indicated a strong reduction if fishing mortality in recent years, and a corresponding increase in biomass. There are no such signals in the catch data, where the catch curves indicate a stable total mortality around 0.4, with a possible increase in the last few years. Accordingly, the RG did not accept any of the assessments as basis for advise, and did not consider it indicative of recent trends.

Iceland – Greenland – Jan Mayen capelin.

Capelin in this area is managed by an escapement strategy, aiming at leaving 400 000 tonnes spawning biomass behind to spawn. The advice is given in two stages, based on surveys. A preliminary TAC is set by projecting forwards measurements of the stock in the autumn, and a final TAC is set after a survey during the spawning season in the spring. The survey in November 2006 measured an abundance of age 1 fish that would allow a relatively small quota in 2007-8.

The procedures for giving advise on capelin have been practiced for many years. Most of the time, the stock has been relatively stable and the procedure has apparently worked well. In recent years, there has been problems finding the fish, which may have natural causes, but nevertheless casts some doubt over the surveys in their present form as an adequate basis for the advise. The RG suggests that a thorough revision of the capelin management should be undertaken, including the survey design, the procedures to project the survey results forwards, uncertainties in the measurements and procedures, ways to take the role of the capelin in the ecosystem into account and the adequacy of the escapement target biomass.

Greenland cod.

The stock structure of cod in this area is complex, with both inshore local stocks, a genuine Greenland spawning stock and Icelandic god that drifts over to Greenland early in life but probably returns to Iceland when mature. The fishery has been closed since the collapse in 1993, except for a small inshore fishery and a small experimental fishery off-shore. The recent development is the appearance of a strong 2003 year class, with some indications that this may originate form Iceland, and the finding of dense concentrations of large spawning fish off East Greenland. No analytic assessment is possible, and the perception of the state of the stock relies on survey information. The RG appreciated the clear and thorough descriptions in the report of this complex field.

The view by the WG is that the spawning grounds off East Greenland should be protected, to fully utilize the potential for recruitment from that component, in particular because the climatic conditions at present are favourable. It has more doubts about exploiting the 2003 year class. The RG shares the views by the WG. As to a possible fishery on the 2003 year class, important elements in the discussion would be how certain it is that it is of Icelandic origin, how well a fishery on that year class can be separated from fishery on the rest of the stock, and concerns for the Icelandic cod, there the recruitment is low at present.

The Greenland area represent the outskirts of the cod distribution, making it sensitive to fluctuations in environmental conditions. In the past, the catches have fluctuated over a very large range, indicating a highly variable productivity. In particular for future management strategies, insight in how the productivity has varied in a long time perspective would be very valuable, and further studies in that field are strongly encouraged.

Greenland halibut.

Management advice in recent years has been problematic due to lack of consistent and reliable information about the abundance, and uncertainty as to the level of sustainable exploitation. Attempts have been made in the past to apply the production model ASPIC, but in recent years, this model could not be fitted adequately to the data. An attempt was made this year to apply a different production model in a Bayesian framework. The RG appreciated this attempt, but did not consider the results convincing, in particular because the information needed to estimate the virgin stock abundance appeared to be insufficient. The estimates of the remaining parameters then become conditional on assumptions that have to be made about the virgin biomass. The results were therefore not accepted as basis for the advise.

The RG recommends that the efforts to establish an analytic assessment is continued along at least two lines:

1) To extend the catch data backwards in time to a period where the stock can be considered to be in a near virgin stateeven if there may be concerns about the precision of such data.
2) Continue work to apply catch at length type methods.

In response to a previous request by the RG, the WG produced maps showing catch and effort distribution over the entire distribution area. The RG found these maps very well designed and very informative, and a good example for other WGs.

Redfish general

The advise on Pelagic S. mentella is given in the autumn, as the survey which is the main basis for advise will take place in June-July.

The RG notices the still unresolved problems with stock structure. In that context, the allocation to stocks, in particular the 'redfish line' to the West of Iceland is problematic. If the demersal and pelagic S. mentella really are distinct stocks, the allocation of catches to stock can become rather arbitrary in that area.

Sebastes marinus

This stock is at present managed according to the index of the Icelandic spring survey, which has fluctuated around Upa in recent years. Two prominent year classes are present in the stock (1985 and 1990), and there are no indications of further strong year classes. The Bormicon/Gadget models have been used for several years as a supplement. As on previous occasions, the RG wellcomes this development, and expect analytic assessments with such tools to take over as basis for the advise in the future. The RG notes that the WG has this as a goal for next year. Hence, the present analytic assessment has not been evaluated in depth. The RG notices, however, that the fishing mortality may be as high as 0.25 according to the provisional assessment. Hence, the current catches may be obtained only by depeleting the strong year classes quite rapidly. It is not quite clear how the Bormicon can predict decreasing F in the coming years with stable catches at the present level in that situation.

Demersal S. mentella.

The only data to support the advise for this stock is short survey series and a longer CPUE series. The latter is not considered a reliable indicator of the stock abundance. It has been stable at a low level in recent years. Some information of incoming year classes are inferred from Greenland surveys, but the link between abundance there and recruitment to the (postulated) demersal component of S. mentella is not clear. There is no indication in the data to suggest a change in the current advise.

The RG agrees that the CPUE is not a reliable indicator of stock size. A better description of the actual effort units, and of the GLM procedure to obtain a common index (in English) would be welcome. The RG suggests that the choice of explanatory variables may be revisited, as the current procedure does not account for e.g. changes in trawl size or engine power. Likewise, the selection criteria for hauls to be included may be revisited.

Annex 4: List of working documents tabled during the NWWG 2007 meeting

WD 01: J. Boje. The fishery for Greenland halibut in ICES Div. XIVb in 2006.

WD 02: Agnes C. Gundersen, Wenche E. Larssen and Åge S. Høines. Norwegian fishery for Greenland halibut and Sebastes sp. in East Greenland waters during 2006.

WD 03: K. Sünksen and O.A. Jørgensen. Survey for Greenland halibut in ICES Division 14B, June 2006.

WD 04: Heino Fock, Christoph Stransky and Hans-Joachim Rätz. 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, 1995-2006.

WD 05: Heino Fock, Christoph Stransky and Hans-Joachim Rätz. Update of Groundfish Survey Results for the Atlantic Cod Greenland offshore component, 1982-2006.

WD06: Heino Fock, Hans-Joachim Rätz, Christoph Stransky and Phil Large. Comparative Groundfish Survey Results for the Atlantic Cod East Greenland Offshore Component by Germany and UK in 2005.

WD07: Heino Fock, Christoph Stransky and Hans-Joachim Rätz. Abundance and length composition for Sebastes marinus L., deep sea S. mentella and juvenile redfish (Sebastes spp.) off Greenland based on groundfish surveys 1985-2006.

WD08: Jerzy Janusz and Kordian Trella. Description of Polish fishery of pelagic redfish (Sebastes mentella) in the Irminger Sea and adjacent waters in 2006.

WD09: R. Alpoim, J. Vargas and E. Santos. Report of the Portuguese Sebastes mentella fishery in 2006 ICES Div. XII, XIVb and NAFO Div. 1F.

WD 10: Christoph Stransky and Hans-Joachim Rätz. On the German fishery and biological characteristics of pelagic redfish (Sebastes mentella Travin) 1991-2006.

WD 11: Christoph Stransky, Kjell Nedreaas, Alf Harbitz, Hans Høie. Geographic variation in otolith shapes of deep-sea redfish (Sebastes mentella) in ICES Sub-areas I and II and Sub-areas V, XII and XIV: preliminary results.

WD 12: S.P. Melnikov and V. I. Popov. Preliminary Information About Russian Fishery For The Oceanic S. Mentella In Ices Subareas Xii, Xiv, In Nafo Divisions 1f, 2jh In 2006 And Biological Sampling From Commercial Catches.

WD 13: S.Melnikov, S.Golovanov and V.Popov. The results of standardizing Russian indices of deep-water redfish pelagic fishing efficiency in the Irminger Sea and adjacent waters in 1995-2006: information based on log-book data.

WD 14: Einar Hjörleifsson. A NOTE ON THE STATE OF THE COD IN GREENLANDIC WATERS.

WD 15: José Luis del Río. Description of the Spanish pelagic fishery of oceanic redfish (Sebastes mentella Travin) in the North Atlantic (ICES Div. XII, XIV and NAFO Div. 1F, 2J) in 2006.

WD 16: K. Sünksen. By-catch in the Greenlandic off shore shrimp fisheries 2006-2007.

WD 17: KristJan Kristinsson, Thorsteinn Sigurdsson, Christoph Stransky, Hans-Joachim Rätz, Kjell Nedreaas, Sergei P. Melnikov and Jákup Reinert. Fishery on pelagic redfish (S.mentella, Travin): Information based on log-book data from Faroe Islands, Germany, Greenland, Iceland, Norway and Russia.

WD 18: Kristjan Kristinsson And Thorsteinn Sigurdsson. Information On The Icelandic Fishery Of Pelagic Sebastes Mentella Travin. Information Based On Log-Book Data And Sampling From The Commercial Fishery.

WD 19: Holger Hovgård and Kaj Sünksen. Greenland survey results and commercial data for Atlantic cod in Greenland inshore and offshore waters for 2006 and 2007.

WD 20: Christophe Pampoulie, Einar Hjörleifsson & Björn Ævarr Steinarsson. Genetic divergence among local populations of the Atlantic cod Gadus morhua in Greenland waters.

WD 21: Pampoulie C. & Hjörleifsson E. Results Iceland vs. Greenland plus additional samples from year class 2003 of Iceland.

WD 22: Magnús Örn Stefánsson, Jákup Reinert, Þorsteinn Sigurðsson, Kristján Kristinsson & Kjell Nedreaas. Population structure of S. mentella in the North Atlantic with regard to international waters in the Norwegian Sea.

WD 23: Guðmundur J. Óskarsson and Ásta Guðmundsdóttir. Exploration of different assessment models for Icelandic summer-spawning herring in 2007 assessment.

WD 24: Gudmundur Gudmundsson. Time series analysis of catch-at-age and survey data.

WD 25: Carsten Hvingel, Jesper Boje and Kaj Sünksen. A quantitative assessment framework for the Greenland halibut (Reinhardtius hippoglossoides) stock off East Greenland, Iceland and the Faroe Islands using a production model in a state-space structure and Bayesian inference.

WD 26: O.A. Jørgensen, Kristján Kristinsson and Michael Rossing. Bottom trawl survey in ICES Division 14AS (67°N - 72°N), September 2006.