ICES NWWG Report 2006

ICES Advisory Committee on Fishery Management

ICES CM 2006/ACFM:26

Report of the North-Western Working Group (NWWG)

25 April - 4 May 2006

ICES Headquarters

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

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Recommended format for purposes of citation:

ICES. 2006. Report of the North-Western Working Group (NWWG), 25 April - 4 May 2006, ICES Headquarters. ICES CM 2006/ACFM:26. 604 pp.

Contents

1 INTRODUCTION

1.1 Terms of reference

2005/2/ACFM08 The North-Western Working Group [NWWG]:

a) assess the status of and provide management options for 2007 for the stocks of redfish in Subareas V, XII and XIV, Greenland halibut in Subareas V and XIV, cod in Subarea XIV, NAFO Subarea 1, and Division Va, saithe in Division Va, haddock in Division Va, Icelandic summer spawning herring and capelin in Subareas V and XIV;

b) assess the status of and provide effort options and expected corresponding catches for 2007 for cod, haddock, and saithe in Division Vb as these stocks are under effort control;

c) submit new information on stock identity of the components of redfish such as pelagic deep-sea Sebastes mentella, oceanic Sebastes mentella fished in the pelagic fisheries and the deep-sea Sebastes mentella fished in demersal fisheries on the continental shelf and slope.

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

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

f) for the stocks mentioned in a) and b) perform the tasks described in C.Res. 2005/2/ACFM01.

In ToR f referring to C.Res.2005/2ACFM01 is given below:

WGNSSK, WGSSDS, WGHMM, WGMHSA, WGBFAS, WGNSDS, AFWG, HAWG, NWWG, WGNPBW and WGPAND will, in addition to the tasks listed by individual group in 2006:

(1) based on input from e.g. WGRED and for the North Sea NORSEPP, consider existing knowledge on important environmental drivers for stock productivity and management and if such drivers are considered important for management advice incorporate such knowledge into assessment and prediction, and important impacts of fisheries on the ecosystem;

(2) Evaluate existing management plans to the extent that they have not yet been evaluated. Develop options for management strategies including target reference points if management has not already agreed strategies or target reference points (or HCRs) and where it is considered relevant review limit reference points (and come forward with new ones where none exist) following the guidelines from SGMAS (2005, 2006), AGLTA (2005) and AMAWGC (2004, 2005, and 2006);

If mixed fisheries are considered important consider the consistence of options for target reference points and management strategies. If the WG is not in a position to perform this evaluation then identify the problems involved and suggest and initiate a process to perform the management evaluation;

(3) where mixed catches are an important feature of the fisheries assess the influence of individual fleet activities on the stocks and the technical interactions;

(4) update the description of fisheries exploiting the stocks, including major regulatory changes and their potential effects. Comment on the outcome of existing management measures including technical measures, TACs, effort control and management plans. The description of the fisheries should include an enumeration of the number, capacity and effort of vessels prosecuting the fishery by country;

(5) where misreporting is considered significant provide qualitative and where possible quantitative information, for example from inspection schemes, on its distribution on fisheries and the methods used to obtain the information; document the nature of the information and its influence on the assessment and predictions.

(6) provide for each stock and fishery information on discards (its composition and distribution in time and space) and the method used to obtain it. Describe how it has been considered in the assessments;

(7) report as prescribed by the Secretariat on a national basis an overview of the sampling of the basic assessment data for the stocks considered;

(8) provide specific information on possible deficiencies in the 2006 assessments including, at least, any major inadequacies in the data on landings, effort or discards; any major inadequacies in research vessel surveys data, and any major difficulties in model formulation; including inadequacies in available software. The consequences of these deficiencies for both the assessment of the status of the stocks and the projection should be clarified.

(9) Further develop and implement the roadmap for medium and long term strategy of the group as developed by AMAWGC.

(10) Working Group Chairs will set appropriate deadlines for submission of the basic assessment data. Data submitted after the deadline will be considered at a later meeting at the discretion of the WG Chair.

Within the timeframe of the working group meeting the WG principally focused on addressing ICES ToR a, b, d, and e and NEAFC ToR a and b. The answer to these ToR can be found in the relevant chapters. ToRc on the S. mentella stock identity was not addressed in detail due to reasons that have been repeated expressed by the WG in the past.

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: WGRED 2006 stated [find the exact quote] that reduction in capelin availability should be taken into account in the prediction of weight at age in the Icelandic cod. This was done in a qualitative sense. 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 give the hypothesis credence, they have not been used directly in the assessment, let alone predictions.

ToR2: The focus of the group related to ToR2 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 experts from other fields.

ToR3. This ToR was only addressed briefly by the group and are given in the overview chapters of each region. Again the issue on individual fleet activities is likely to be more complex than can be addressed by fisheries biologist alone. Some observed patterns in the Icelandic fisheries are e.g. 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.

ToR4. Description of the fisheries, number, capacity and effort of vessels are given in the overview chapters as well as in chapters dealing with individual stocks. Management measures are dealt with in relevant overviews. Outcome of existing management measures where not dealt with in a synthetic manner in the present report.

ToR5. Misreporting is considered to be relatively insignificant in the North-Western region, although little quantitative information is available to substantiate such a conclusion.

ToR6. Discard information is available from some fisheries in recent years. All information indicate that this issue is of minor importance in the North-Western region relative to the cultural behaviour in more southerly waters. Available information have been compiled by the working group and are presented in relevant sections. In all cases these information have not been considered in the analytical assessment, both because they are considered of minor importance and because of the short times series available.

ToR7. The working group attempted to fill in the prescribed report, this however being given low priority. Both because more detailed information have been made available in the report itself, because the fisheries of most stocks in the North-West are truly national and thus not within the realm of the EU protocol, and because the group did not get a sense that these forms addressed the states purpose (quality control/assurance).

ToR8. This ToR was addressed in an ad hoc manner within each stock section. A broad overview on issues related to this ToR is given later in this section. The quality of scientific surveys for the analytically assessed gadoid stocks are considered to be relatively good, at least for cod and haddock. For these stocks, no major systematic discrepancies are observed in the catch and surveys measurements. These conclusions should however be evaluated in the light of the length of the time series available. Model formulation can however not be excluded, particularly since most models used assume constant catchability, which goes contrary the observed decline in weight at age in some stocks. The consequences of these, in relation to stock status and projection were not formally evaluated. Of the stocks assessed analytically it is most likely to be of most significance in the Faroe Saithe. The total annual catches of pelagic redfish cannot be quantified accurately due to an unknown dimension of IUU activities and often lacking landings statistics from some countries.

ToR9. The Working Group was introduced to the AMAWGC road map concept and expressed general appreciation for a medium and long term strategy. It was decided that the group would adopt the AMAWGC 2006 proposal on allotting particular attention on environmental drivers next year but that the long term strategy of the group would be developed intersessionally.

ToR10. Setting deadlines for submission of basic assessment data is not considered to be of high priority 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, compilator of individual measurement into suitable form for assessment purposes, performs the assessment, presents it to the group and writes up the report.

1.2 Overview of NWWG assessment

The stocks dealt with by NWWG can be divided into two classes: those for which observations are sufficient to allow an age-based analytical assessment, and those for which either the data is limited (spatially and temporary), the quality of the data is poor, impeding analytical assessments. The Icelandic herring, *S. marinus* and all gadoid stocks except for Faroe Bank cod fall into the first class. For the remaining stocks, that fall into the second category, various reasons impede an analytical assessment. For the Faroe bank cod and the Inshore Greenland cod the reason is relatively short time-series, incomplete biological sampling of the landings and relatively imprecise survey. For the offshore cod in Greenland, the long term history catch at age history is known but only survey information is available from the past 24 years. The assessment of the long lived Greenland halibut is in part limited because of the life cycle history is not fully understood, unresolved age reading issues, expansion of the fisheries throughout the historical times series as well as for conflicting information about recent stock development in different fishing areas. An analytical assessment of the long lived S.*mentella* is hampered by relatively short time history, sparse and unreliable are data, expansion/change of the stock distribution and fisheries throughout the time series, lack of precise survey indices covering the whole pelagic advisory unit, in addition to competing hypothesis about the life cycle history. The S. *mentella* is in principle assessed in a subgroup within the NWWG with plenary discussions limited to the main issues. The subgroup focused on providing assessments according to presently set management units, the demersal S. *mentella* and the pelagic S. *mentella*. However, different perception on the stock structure of the S. *mentella* within the group often hampers the work process and makes the reaching of a consensus often difficult. Repeated requests for reviewing material related to the stock structure, an issue that is not suitable to address in an annual assessment working group environment, does not help.

For most of the stocks for which age-based analytical assessments were carried out, the terminal fishing mortality was estimated by tuning aged catch data with selected fleet age-disaggregated commercial or survey indices. In “the final runs” only the Faroe saithe was based on a commercial tuning series since the available survey index needs to be evaluated further. The Faroe Plateau cod and haddock are tuned with two scientific surveys, one of them taking place just prior to the working group meeting. For the Icelandic gadoids there are two reasonable surveys available, the fall and spring groundfish surveys, the latter being completed just prior to the meeting. Although only the longer spring survey is used in the point estimates for forward predictions, both are effectively a part of the overall assessment evaluation. Overview of the observables, models and a short version of the principal assumptions used for the gadoid stocks that are analytically assessed by the NWWG are shown in table 1.1. No changes were made to model configuration for the historical assessment part in this year compared with that of last year. The working group has conventionally refers to such runs as SPALY runs, the acronym stands for Same Procedure As Last Year. Some changes were however made in some stock regarding the basis of the inputs for the short term prediction.

The assessment on the Faroese stocks has historically been based on the Lowestoft software (XSA). This year the working group continued experimenting with the ADAPT as implemented in the NOOA Fisheries Toolbox (http://nft.nefsc.noaa.gov), in particular since it provides some indication of the noise in the observables (given the model assumption) thorough easily executable bootstrapping. The NFT ADAPT software is a classical VPA model that assumes that there are no errors in the catch at age matrix. The working group thought this tool was of great value to judge the quality of the assessment although point estimators used as the basis of forward projections were still based on the XSA. The main emphasis on the benchmark classified Faroe haddock stock was on evaluating the historical time series of observations. The results of the updated assessment of the Faroe saithe suffers most likely from model misconfigurations, but time did not permit the working group to explore an alternative setting.

In recent years Icelandic stocks have been assessed by using various approaches. The reason for the use of other software platforms than the standard ICES packages is a result of the preference and expertise of the individual user that does the assessment. The limitation of the input control and the archaic output of the Lowestoft software when it comes to exploratory work on the diagnostic, model results and predictions has helped this move. All the models are based on textbook derived catch-at-age analysis (i.e. using the stock and the catch equation) using survey information as additional information. The model configuration may however deviate from the general know how when it comes to configuration of changes in selection in time. Since that field of stock assessment is still in an experimental phase assessments using approved standard model configurations were run in parallel for comparison.

Last year the WG concluded that due to major discrepancies in the catch and survey at age matrix in the herring stock no reasonable point estimators could be used as a basis for forward projection. Part of the historical time series of observables have been re-evaluated intersessionally. Although some diagnostic problems exist the WG concluded, after running some sensitivity analysis, that the quality of the assessment was sufficient to warrant advice being based on point estimators. The capelin will this year be assessed by the WGNPBW group that meets this fall. The NWWG only considered the state of this resource in relation to the ecosystem, in particular when making judgement on the likely growth of cod in the prediction period.

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

1.3 On selection of F0.1 or Fmax as candidates of management targets

Last year ACFM introduced a subheading in the single stock summary report saying “Exploitation boundaries in relation to high long-term yield, low risk of depletion of production potential and considering ecosystem effects”. In that section the terminal fishing mortality estimates are related to either F0.1 or Fmax, the reference points being flagged as being one candidate for a management target rule. It is the understanding of the WG that choices of F0.1 or Fmax as a reference point for different stocks were made in relation to how well Fmax was defined. In cases when a maximum on the Y/R was clear, the relation of the current F was made to Fmax, in cases when a maximum was ill defined, the relation of the current F was made to F0.1.

A working document (WD30, Thordarson et.al. Are Fmax and F0.1 really illusive as fisheries reference points?), presented at the NWWG meeting demonstrated through the use of an individual based growth model with selection to the fisheries being based on length rather than age, that Fmax and F0.1 are located at lower F-values and give higher gain in yield when F is reduced compared with traditional methods for calculating the Y/R-curve (Figure 1.1). The biological basis for the individual growth model is that fishing pressure has an effect of the size of the survivors in the cohort, higher fishing mortality means that smaller portion of larger sized individuals survive into the next time period. In addition, modelling selection by length is also more likely to resemble the true fishing operation. Since in the individual based model the Y/R-curve has a much better defined maxima the issue of the choice of Fmax or F0.1 from the conventional models, as presently practiced, may be an artefact of unrealistic model assumptions.

1.4 Recommendation

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

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.

			Survey at age							Catch at age								
Stock	Assessment year	Assessment model	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	F inertia	Plus group	Plus group model
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		No	N/A
			Spring survey	1994-2004	2-9	2	3-9	6+	None								No	
	2005	XSA	Summer survey	1996-2004	2-8		2-8	6+	None				5	5	2		No	N/A
			Spring survey	1994-2005	2-9		2-9	6+	None								No	
	2006	XSA	Summer survey	1996-2005	2-8		2-8	6+	None				5	5	2		No	N/A
			Spring survey	1994-2006	2-9		2-9	6+	None								No	
Faroe haddock	2003	XSA	Summer survey	1996-2002	1-8	1-2	3-8	6+	None				5	5	0.5			Not modelled
			Spring survey	1994-2003	1-5	1-2	3-5	None	None									
	2004	XSA	Summer survey	1996-2003	1-8	1-2	3-8	6+	None				5	5	0.5		10+	Not modelled
			Spring survey	1994-2004	1-5	1-2	3-5	None	None									
	2005	XSA	Summer survey	1996-2004	1-8		1-8	6+	None				5	5	0.5		10+	Not modelled
			Spring survey	1994-2005	1-5		1-5	None	None									
	2006	XSA	Summer survey	1996-2005	1-8		1-8	6+	None				5	5	0.5		10+	Not modelled
			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		12+	Not modelled
	2004	XSA	Cuba log books	1985-2003	3-11	3,4	5-11	9+	Yes				5	3	0.5		12+	Not modelled
	2005	XSA	GLM log books	1995-2004	3-11		3-11	8+	None				5	3	2		12+	Not modelled
	2006	XSA	GLM log books	1995-2004	3-11		3-11	8+	None				5	3	2		12+	Not modelled
Icelandic saithe	2003	Camera	March survey	1985-2003	2-8		2-8	6+	None	parametric	Fixed	8+ platau				None	No	N/A
	2004	Camera	March survey	1985-2004	2-8		2-8	6+	None	parametric	Fixed	8+ platau				None	No	N/A
	2006	Camera	March survey	1985-2005	2-8		2-8	6+	None	parametric	Fixed	8+ platau				None	No	N/A
	2005	Camera	March survey	1985-2006	2-8		2-8	6+	None	parametric	Fixed	8+ platau				None	No	N/A
Icelandic cod	2003	ADCAM	March survey	1985-2003	1-10	1-5	6-10	None	None	parametric	RW	None				RW	No	N/A
	2004	ADCAM	March survey	1985-2004	1-10	1-5	6-10	None	None	parametric	RW	None				RW	No	N/A
	2005	ADCAM	March survey	1985-2005	1-10	1-5	6-10	None	None	parametric	RW	None				RW**	No	N/A
	2005	ADCAM	March survey	1985-2005	1-10	1-5	6-10	None	None	parametric	RW	None				RW**	No	N/A
Icelandic haddock	2003	ADCAM	March survey	1985-2003	1-9		1-9	None	None	parametric	RW	None				RW	No	N/A
	2004	ADCAM	March survey	1985-2004	1-9		1-9	None	None	parametric	RW	None				RW**	No	N/A
	2005	ADCAM	March survey	1985-2005	1-9		1-9	None	None	parametric	RW	None				RW	No	N/A
	2006	ADCAM	March survey	1985-2006	1-9		1-9	None	None	parametric	RW	None				RW	No	N/A
Icelandic herring	2004	AMCI	Accustic survey	1981-2003	3-9		3-9	5+		parametric	RW	5+				None		
	2005	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.

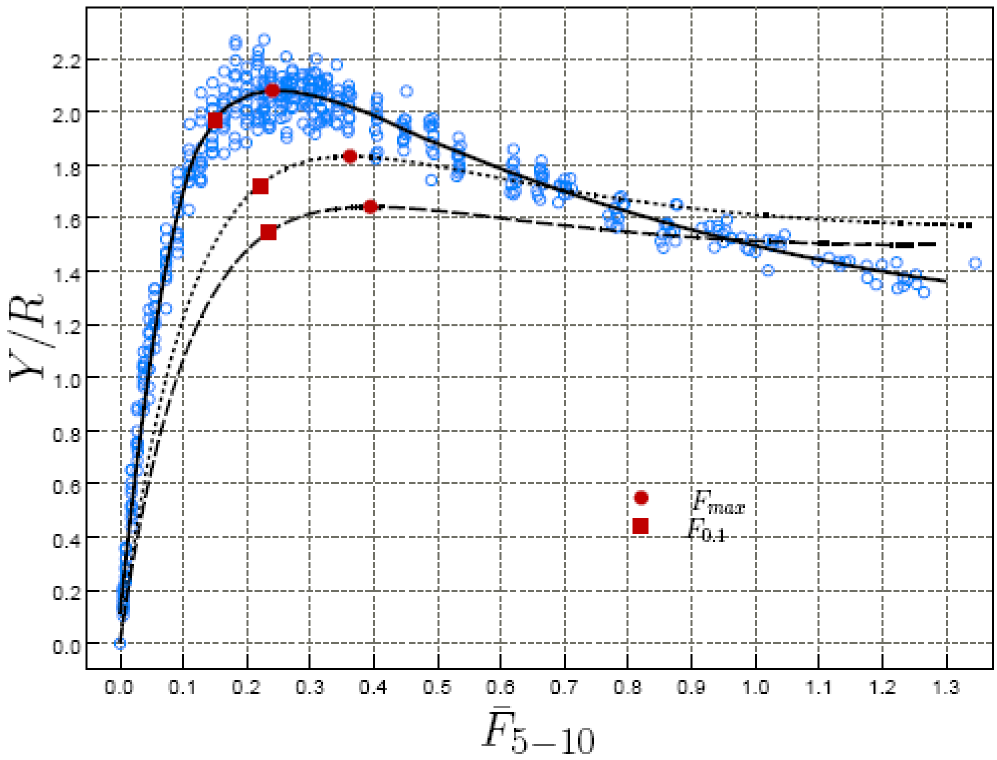


Figure 1.1 Figure 4: Y/R-curve from an individually based growth model (solid line), from traditional method, assuming growth fishing at F_{5-10} = 0.26 (broken line) and at F_{5-10} = 0.65 (dotted line). Blue circles are estimates from single runs of 10,000 individuals.

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 and in recent years jigging effort has decreased as compared to longlines.

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

Foreign trawlers. These are mainly otter board trawlers of the same type as the Faroese otter board trawlers larger than 1 000 HP. Participating nations are United Kingdom, France, Germany and Greenland. The smaller vessels, mainly from the United Kingdom and Greenland, target cod, haddock and saithe, whereas the larger vessels, mainly French and German trawlers, target saithe and deep-see species like redfish, blue ling, grenadier and black scabbardfish. As for the 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 100 GRT, the jiggers, and the single trawlers less than 400 HP, 2) the pair trawlers and 3) the longliners greater than 100 GRT. The single trawlers greater than 400 HP do not have effort limitations, but they are not allowed to fish within the 12 nautical mile limit and the areas closed to them, as well as to the pair trawlers, have increased in area and time. Their catch of cod and haddock is limited by maximum by-catch allocation. The single trawlers less than 400 HP are given special licences to fish inside 12 nautical miles with a by-catch allocation of 30% cod and 10% haddock. In addition, they are obliged to use sorting devices in their trawls in order to minimize their cy-catches. One fishing day by longliners less than 100 GRT is considered equivalent to two fishing days for jiggers in the same gear category. Longliners less than 100 GRT could therefore double their allocation by converting to jigging. Table 2.1.1 shows the number of fishing days used by fleet category for 1985–1995 and 1998–2005 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 100 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). In the section below on catchability analysis this is further discussed.

2.1.4 Catchability analysis

In an effort management regime with a limited numbers of fishing days, it is expected that vessels will try to increase their efficiency (catchability) as much as possible in order to optimise the catch and its value within the number of days allocated. “Technological creeping” should therefore be monitored closely in such a system. However, catchability of the fleets can change for other reasons, e.g. availability of the fish to the gears. If such effects are known or believed to exist, catchability changes may need to be incorporated in the advice on fisheries.

The primary production of the Faroe Shelf ecosystem may vary by as much as a factor of five and given the link between primary production and recruitment and growth (production) of cod as demonstrated by Steingrund & Gaard (2005), this could have pronounced effects on catchability and stock assessment as a whole. Below are the results from an analysis regarding Faroe Plateau cod, Faroe haddock and Faroe saithe.

For cod there seems to be a link between the primary production and growth of cod (Fig. 2.1.2). The growth of cod seems to be negatively correlated with the catchability of longlines (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 cod growth 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 growth 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; 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 in 2005 and 2006 is low, there is the potential for very high fishing mortality to be exerted on cod. It could therefore be prudent to consider substantial reductions in fishing effort for the next fishing season.

2.1.5 Summary of the 2006 assessment of Faroe Plateau cod, haddock and saithe

A summary of selected parameters from the 2006 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 0.27 in 2005. The most recent biomass estimates, however, are most likely to change in future assessments, and the trend could therefore change as a result of future stock assessments.

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

2.1.6 Medium term projections and reference points for Faroe Stocks

In recent years, the NWWG has noted the inappropriateness of existing reference points for Faroe Plateau cod, Faroe haddock and Faroe saithe and the need to revise them. In particular, 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.

Existing reference points for Faroe stocks and their technical basis are provided in the table below:

	BLIM	TECH. BASIS	BPA	TECH. BASIS	FLIM	TECH. BASIS	FPA	TECH. BASIS
Faroe Plateau cod	21 000t	Bloss	40 000t	From Blim assuming sigma of 0.40	0.68	From Fpa assuming sigma of 0.40	0.35	Close to Fmax and Fmed in 1998 assessment
Faroe haddock	40 000t	Former MBAL	55 000t	Based on inspection of S and R	0.40	From Fpa assuming 2 st. dev.	0.25	Fmed in 1998 assessment
Faroe saithe	60 000t	Bloss in 1999 assessment	85 000t	Former MBAL	0.40	Consistent with Blim of 60 000t	0.28	Consistent with Flim and previous estimate of Fmed

Data and methodology (update to the 2005 report of the NWWG)

One hundred years projections using the results of the 2004 assessments were made for the stocks of Faroe Plateau cod, Faroe haddock and Faroe saithe under similar assumptions. Natural mortality was assumed fixed at M = 0.20 for all ages and all years. The average of the values for 1996 to 2003, the period covered by the effort management regime, were used for the average weights at age, maturity at age and for the exploitation pattern. Weights at age in the stock were assumed equal to weights at age in the catch. Future recruitment was modelled from a Ricker stock – recruitment relationship fitted using the USA National Marine Fisheries Service NFT SRFIT software. The form used by SRFIT is R = S*exp(alpha + beta *S). The line goes nicely through the cloud of points for the three stocks, and the scatter of points supports the choice of a Ricker relationship over a Beverton and Holt one (Figure 2.1.7).

Stochasticity was introduced in the projections by randomly selecting residuals from the fits and adding them to the predicted recruitment. If the residual added to the recruitment calculated from the equation was negative and larger than the predicted recruitment, the resulting negative value was replaced with zero in order to avoid producing negative recruits.

Four scenarios of fishing mortality were investigated: F status quo, F target = 0.45 corresponding to 33% exploitation rate in numbers, increasing F at 3% per year, and decreasing F at 3% per year until F had been reduced by 50%. The increasing F scenario is considered plausible in the effort management system extant on the Faroes since 1996.

Each scenario was run 250 times in an excel spreadsheet using the FishLab software. In the 2005 NWWG report, the yearly SSB and Catches were recorded, and the median catch, the coefficient of variation of the catch, the median SSB, and the probability that the SSB will be lower than reference points were examined. These are not reproduced here. The spreadsheet was re-run this year record the Recruits under the F target scenario. Otherwise, results from last years simulations were re-examined.

Few details of the simulations were reported in the 2005 NWWG report and ACFM may have been concerned that the recruitment values used in the 100 year simulations had a different distribution than what had been observed in reality. Figure 2.1.8 shows that the frequency distribution of recruitment observed in the assessments, and that generated for the 100 year simulations are very close for cod and haddock. For saithe, the weak to moderately strong (stronger than average but not exceptional) are more frequent in the observed than in the predicted year classes. This is reflected in the medians: 23.75 million in the observed series vs 28 millions in the predicted series for saithe. The frequency of moderately strong to very strong year classes is similar in the two saithe series. For cod, the observed median recruits is 15 million fish and the one in the simulations is 15.2 millions. For haddock, the observed median recruits is 24.9 million and the one in the simulations is 23.5 millions.

Biomass reference points

As indicated in the 2005 report of the NWWG, the existing Blim for Faroe cod is supported by the data, but those for haddock and saithe are not.

The 1998 Study Group on the Precautionary Approach to Fishery Management (SGPAFM) suggested that Blim for haddock be set at the lowest biomass observed, that is 21 000t. Instead, ACFM choose to set Blim at the previously established MBAL above which the probability of good recruitment was said to be high. New stock and recruitment data pairs have been added since Blim for haddock has been set in the 1998 ACFM advice and recruitment has not been particularly low when SSB was below Blim (Figure 2.1.9). In fact, the 1993 yc, the second strongest on record was produced at an SSB below Blim. This is consistent with the results of the SGPRP 2003 where segmented regression on the data available at the time suggested a break point in the order of 23 000t. **The NWWG recommends that Blim for Faroe haddock be set at 23 000t.** Assuming sigma equal to 0.40, this would imply a Bpa of 35 000t as suggested in the SGPAFM 1998.

For saithe, the 1998 SGPAFM suggested Blim of 70 000t (the lowest observed at the time). ACFM advice in 1998 raised Blim to 85 000t, the 1999 ACFM advice also used Blim = 85 000t but Blim becomes 60 000t in the 2000 ACFM advice as the lowest observed SSB. The SGPRP 2003 indicated that in cases where recruitment seemed to increase with decreasing biomass, as is clearly the case for Faroe saithe, it was more appropriate to use Bloss as an estimate of Bpa rather than as an estimate of Blim (Figure 2.1.10). **The NWWG recommends that 60 000t be the new Bpa for saithe** as it is clear that recruitment has not been impaired below Bpa or near Blim, on the contrary. Assuming a sigma of 0.3 as a precautionary measure, this would imply a Bpa of 45 000t.

Fishing mortality reference points and development of the Faroese demersal stocks

Figure 2.1.11 shows the recruitment and SSB time trends for the three main Faroese demersal stocks. Variability of the recruitment is the dominant feature, but no downward trends in recruitment are apparent. For haddock and saithe, recruitment seems to have improved in recent years. For cod, it seems to continue to fluctuate in the range observed in the past. SSB for cod seems to be trending downwards, that of haddock seems to be trending upwards, while that for saithe appears to be slowly increasing. It should be noted that the 2006 saithe assessment is possibly underestimating stock size if the development of the fishery in 2006 is reflective of stock size. See section 2.5 on the Faroe saithe assessment for further information. It is noteworthy that strong year classes for the three species have been produced at low biomasses.

Figure 2.1.12 shows the time trends in estimated fishing mortality. It should be noted that the average F's on the graphs may not be the best nor the most stable indicators of the effect of exploitation on the stocks. Nevertheless, since they are the currency in which Fpa has been set, the time trends are presented to show that the existing Flim does not possess the characteristics of a limit reference point, that is Flim has been breached for the three stocks on numerous occasions, yet the productivity does not seem to have been affected.

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 preached 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.

The frequency distributions of the SSB's for the target F's and the time trends of SSB's under various F scenarios are shown in figure 2.4.13. The left hand panel of the figures, showing the time trends under various F scenarios, shows that the F status quo, the F target (as defined in these simulations, i.e. the average F's at age of 2001 to 2003 as estimated in the 2004 assessment) and the decreasing F scenarios are all sustainable, but that the scenario where F was increased at 3% per year will eventually lead to a collapse of the SSB and of the stocks. The right hand panel shows the frequency distributions of the SSB at the target F = 0.45 compared with the Bpa and Blim proposed above. For cod and saithe, there is a zero probability that SSB will get below the existing (and supported) Blim if F is maintained at Ftarget or below. For haddock, there is a small probability that Ftarget could push SSB below the suggested Blim. Based on the 100 year simulations, the NWWG concludes that Ftarget is sustainable for the three Faroese demersal stocks. However, the increasing F scenario is not sustainable, and the NWWG believes that the existing effort management system will result in increasing F's over time, although the magnitude of the yearly increase is unknown.

Conclusion

The NWWG concludes that the effort management system for demersal fishes on the Faroes has been consistent with the precautionary approach and it is expected that it will continue to be consistent with the PA in the short to medium term when SSB is above the Blim proposed herein. Based on the history of the fishery and on 100 years simulations, the NWWG also concludes that the target exploitation rates of 33% of the exploitable stock in numbers of each species, corresponding approximately to F = 0.45 are sustainable for cod, haddock and saithe. Generally, however, the fishing mortality on saithe has been less than the target, although F on saithe has had a tendency to increase in the recent past (although the most recent F estimate is considered to be an overestimate).

Under the effort management system applied on the Faroes the NWWG expects that the effectiveness of fishing will increase. This implies that the fishing mortality exerted by one day's fishing will progressively increase over time. As a result, the number of days currently allocated, which result in what seems to be sustainable fishing mortality, will result in progressively higher F's which are unlikely to remain sustainable in the medium to long term.

The NWWG has no basis to evaluate if the effort management system is consistent with the Precautionary Approach when SSB is below Blim because actions to be taken in those cases, if any, are not documented. According to the current assessment, the SSB for cod is decreasing towards Blim, and unless strong recruitment is produced, the probability to reach Blim in the near term is sufficient to justify deciding what management measures will be taken should the event occur.

If the hypothesis underpinning the management system that fishing effort will be directed towards haddock and saithe actually materialise, F on cod could decrease. But should an unfortunate combination of increase in catchability due to low food availability (or some other factor out of the control of fishery management) and high prices due to high demand for cod could result in a targeting of fishing effort on cod, producing very high fishing mortalities that could deplete the remaining biomass very rapidly.

The NWWG believes that 10 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. A Study Group, to be held in advance of the 2007 meeting of the NWWG, could evaluate scientifically the proposals for improvements.

2.1.7 References:

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

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

Table 2.1.1. Number of fishing days used by various fleet groups in Vb1 1985-95 and 1998-05. 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
Average(98-05)	25176	2575	6761

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.

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
No. of licenses	13	28	19	106	> 1400 (696)

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.

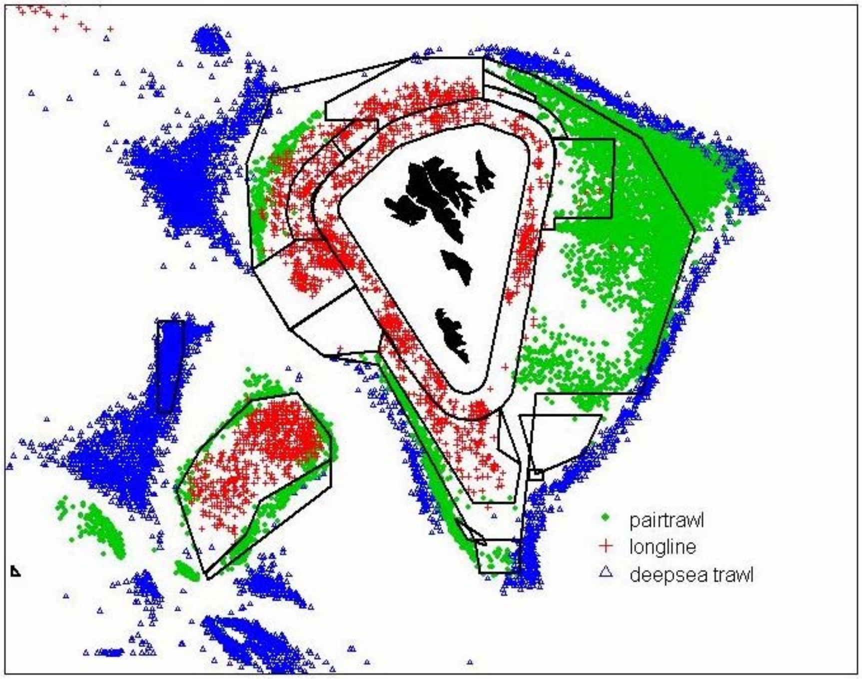
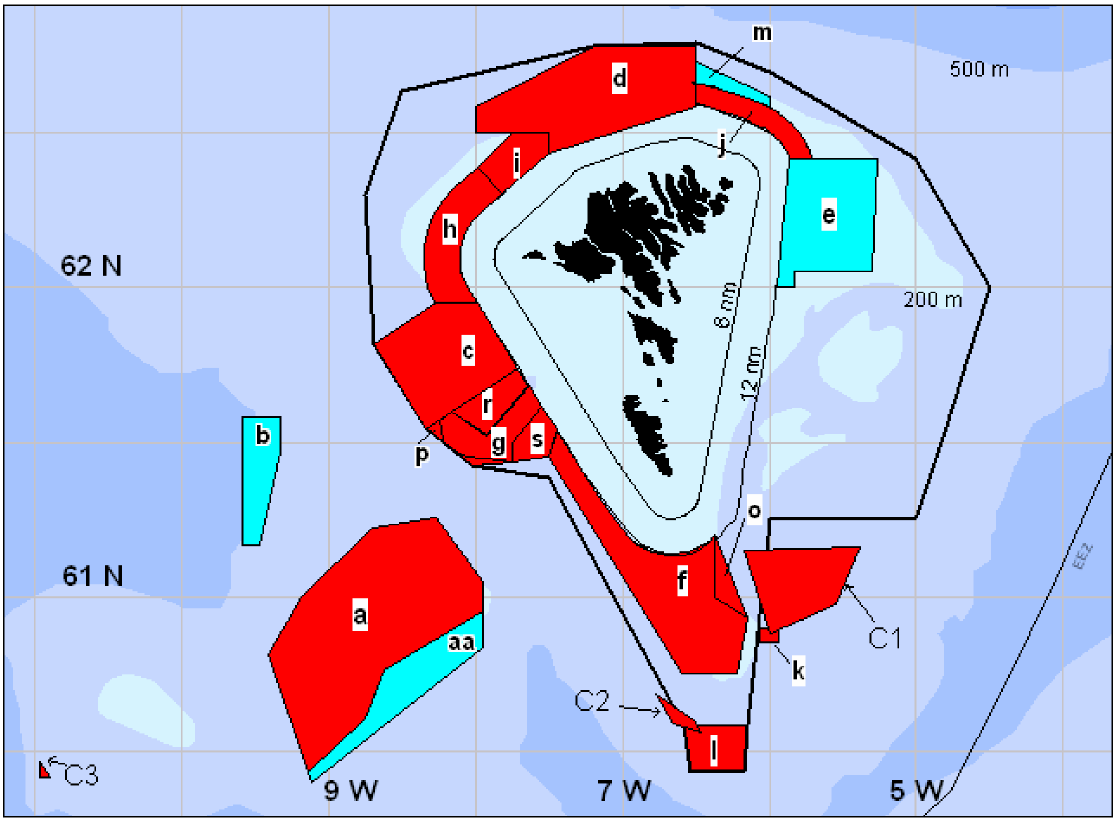


Figure 2.1.0. The 2000-2005 distribution of fishing activities by some major fleets.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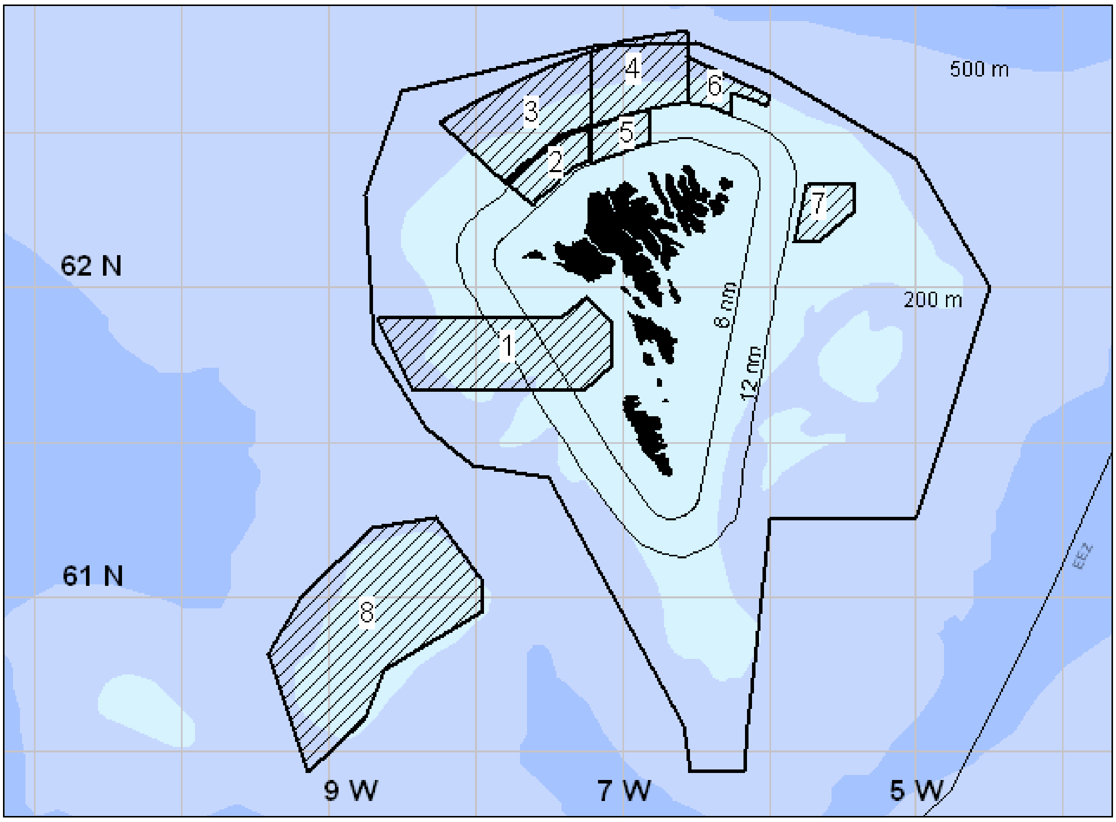
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Exclusion zones for trawling

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

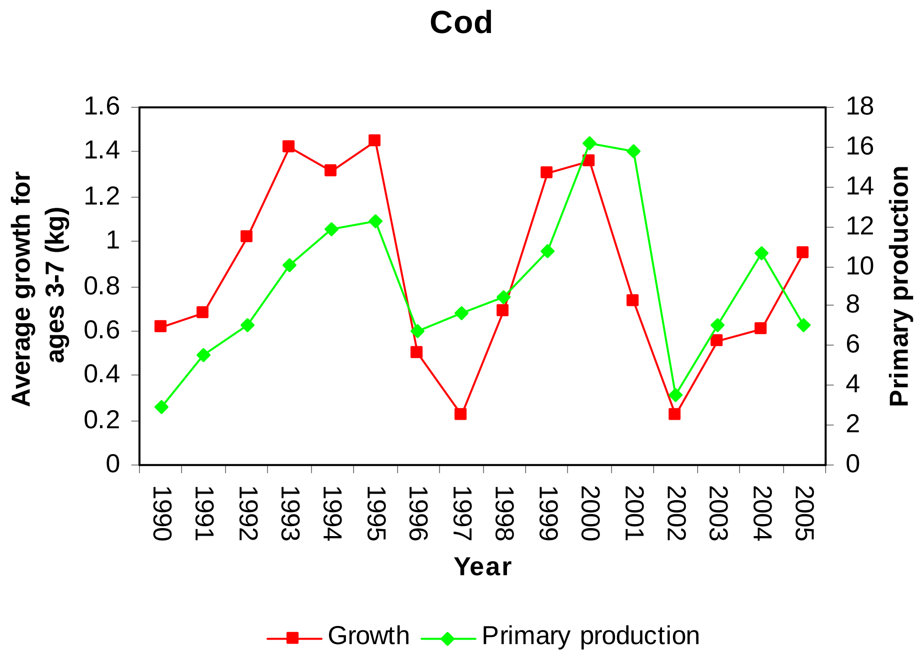


Figure 2.1.2. Faroe Plateau Cod. Relationship between primary production and growth of cod during the last 12 months.

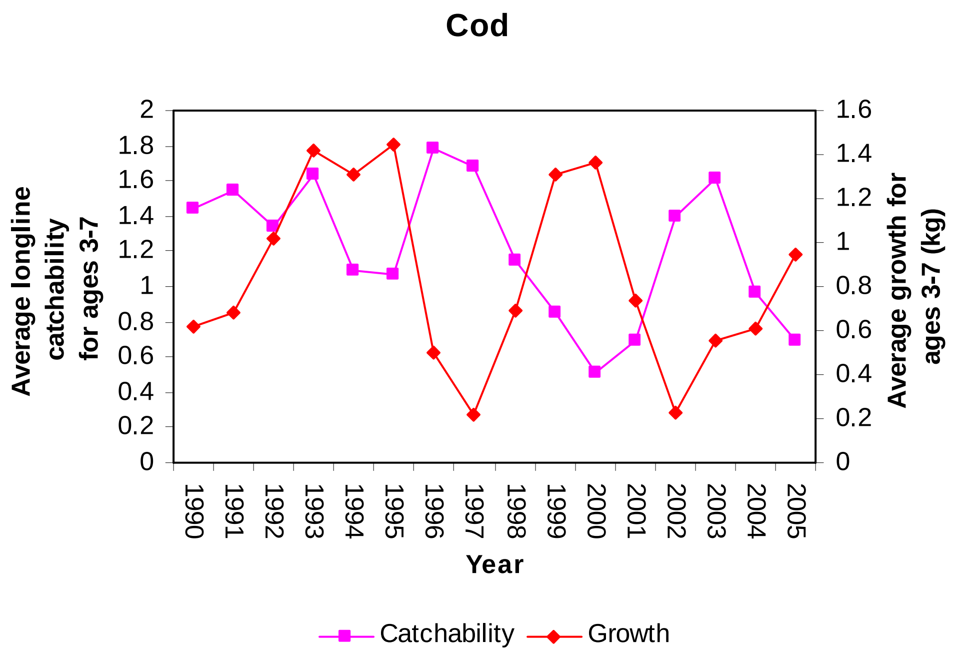


Figure 2.1.3. Faroe Plateau Cod. Relationship between long line catchability and growth of cod during the last 12 months.

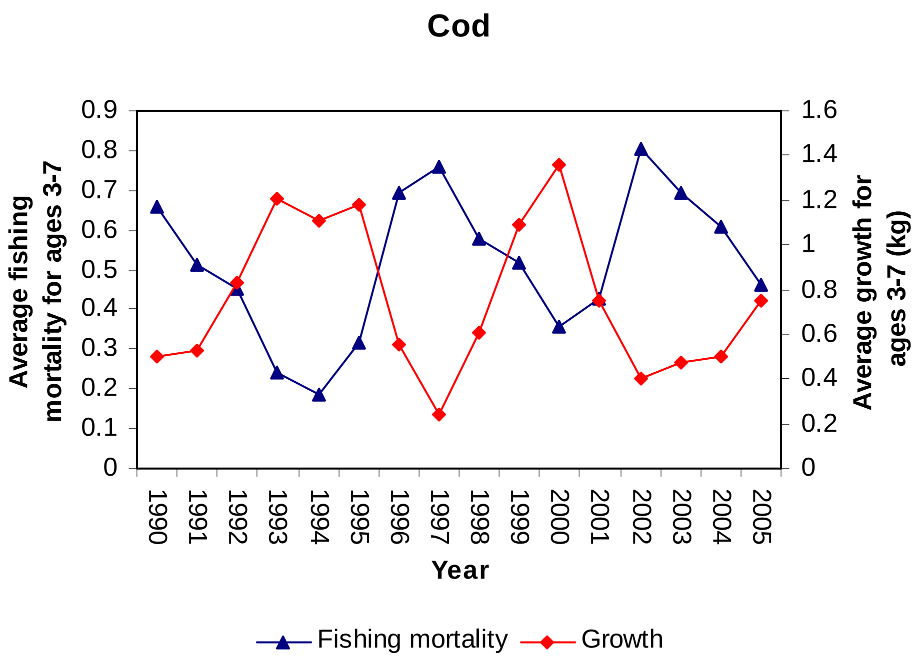


Figure 2.1.4. Faroe Plateau Cod. Relationship between fishing mortality and growth of cod during the last 12 months.

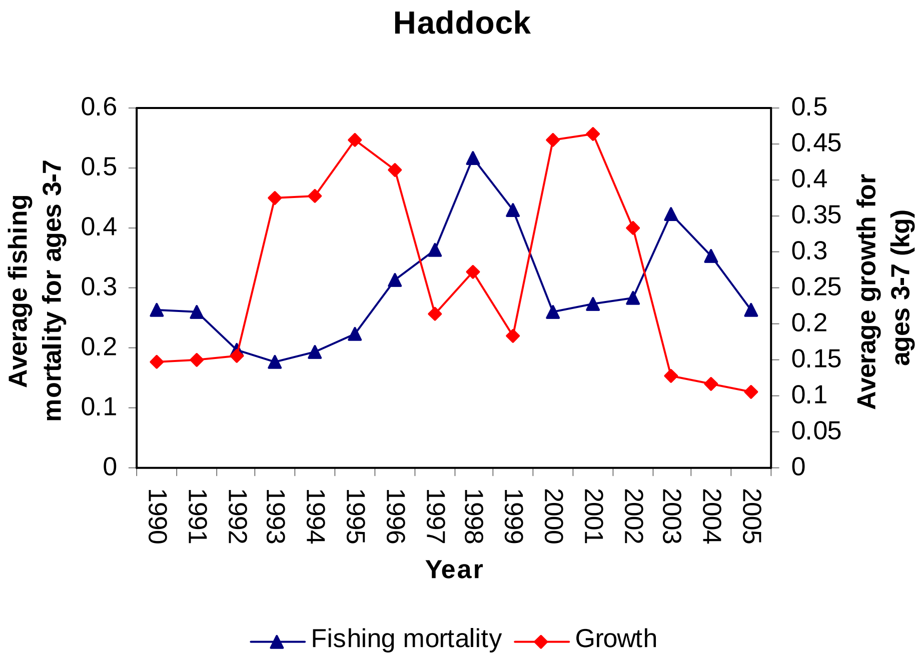


Figure 2.1.5. Faroe Haddock. Relationship between fishing mortality and growth of haddock during the last 12 months.

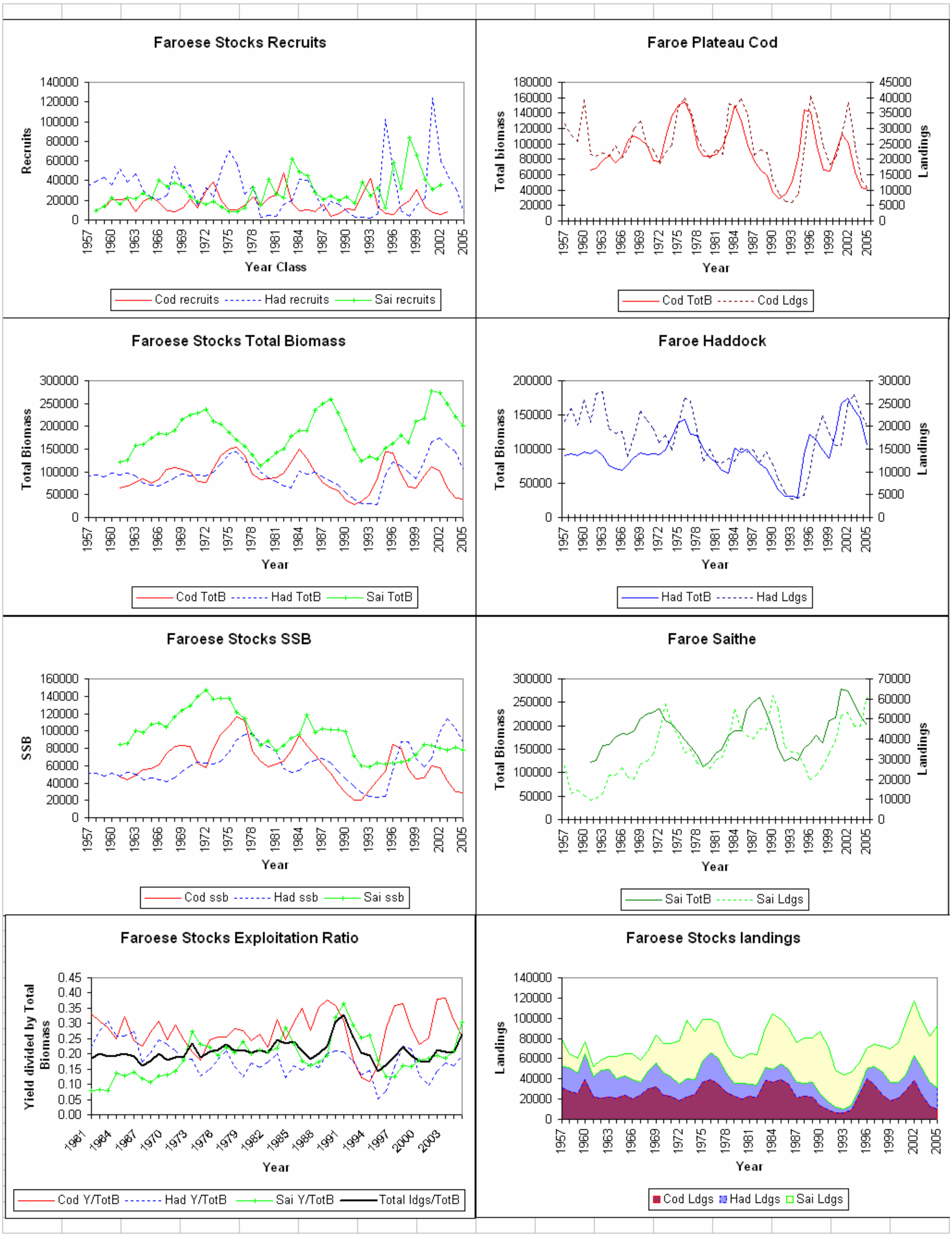


Figure 2.1.6. Faroe Plateau cod, Faroe haddock and Faroe saithe. 2006 stock summary.

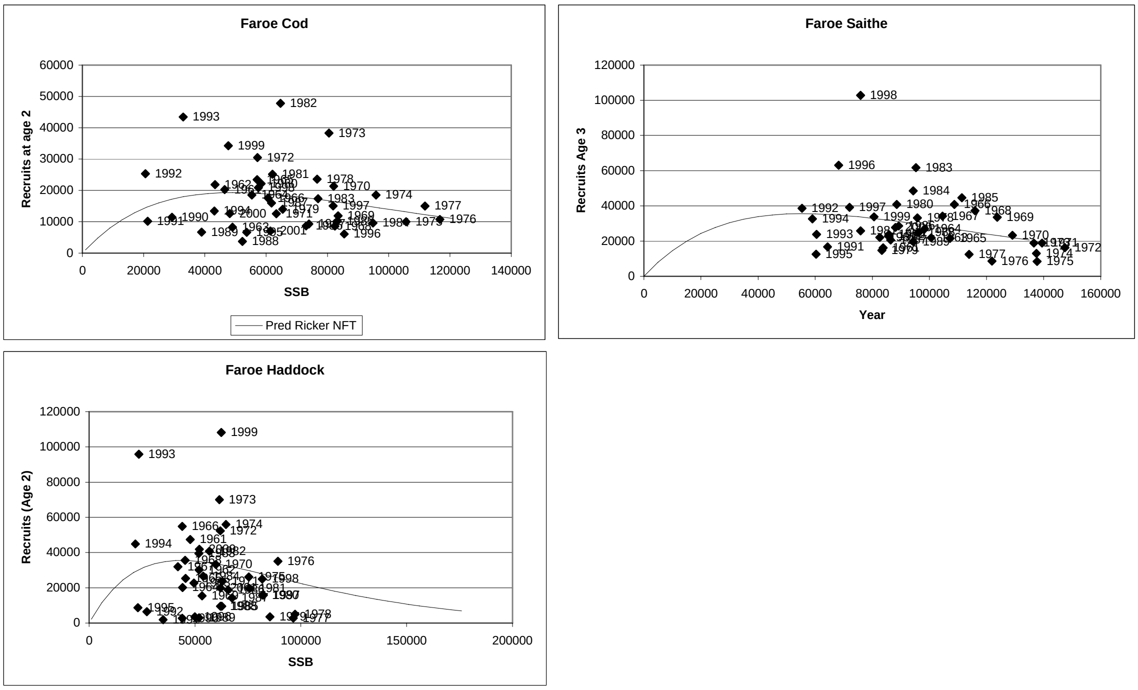


Figure 2.1.7: Stock and recruitment fits for Faroese demersal stocks using the NMFS SRFIT software. The lines go nicely through the cloud of points, and the scatter of points suggest a Ricker relationship over a Beverton and Holt type.

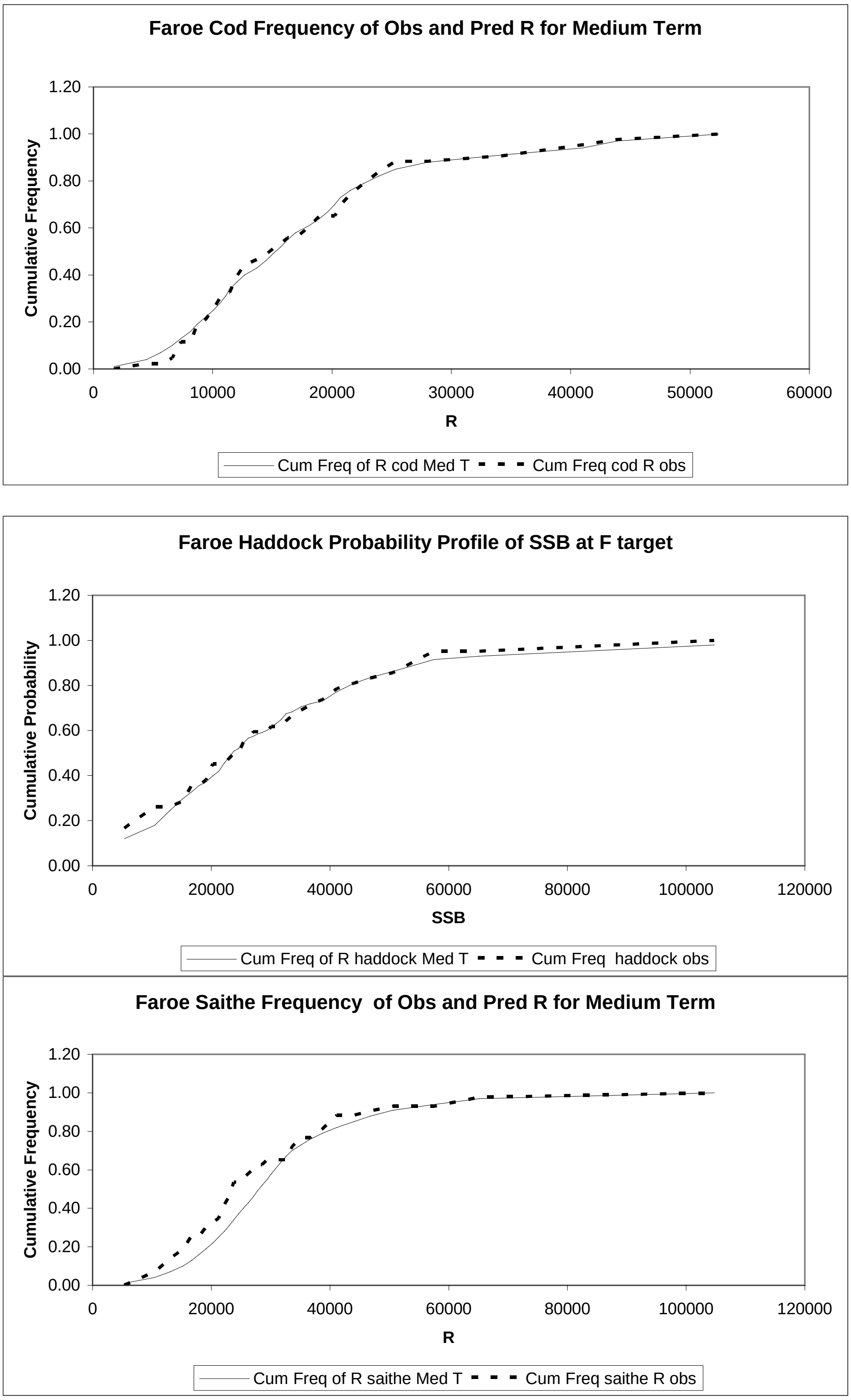


Figure 2.1.8: Frequency Distribution of year class sizes observed in the assessment and used in the 100 year simulations for Faroe cod, haddock and saithe.

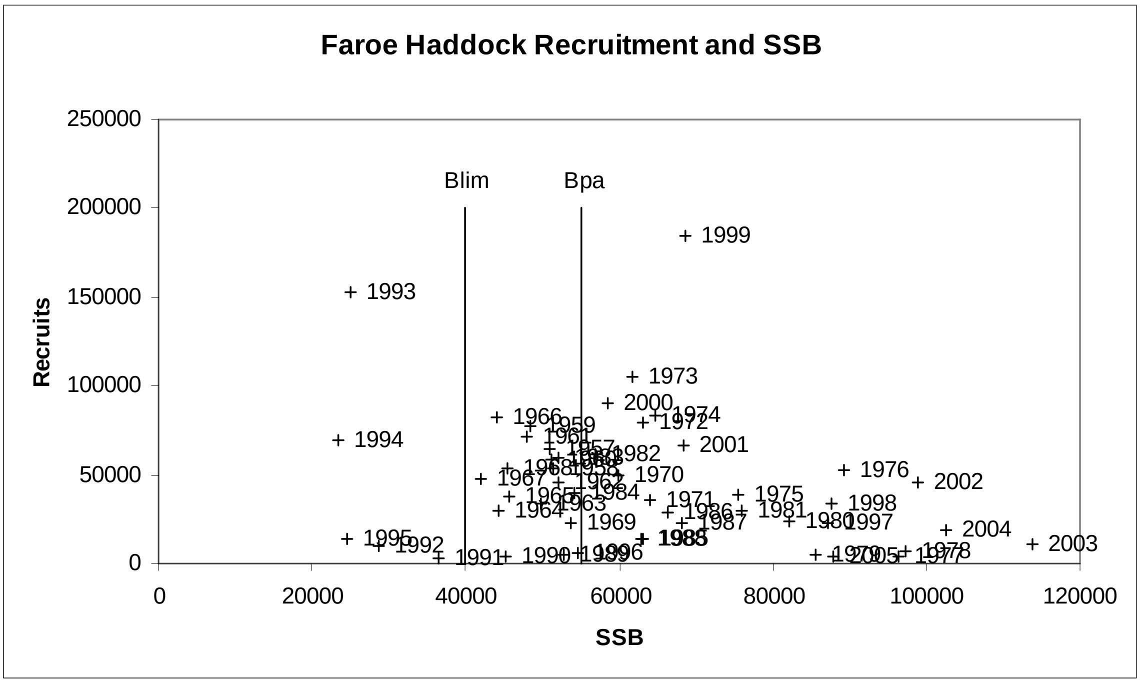


Figure 2.1.9:Stock and recruitment data for Faroe haddock based on the 2006 assessment. Data points to the left of Blim suggest that recruitment is not impaired between 20 000t and 40 000t.

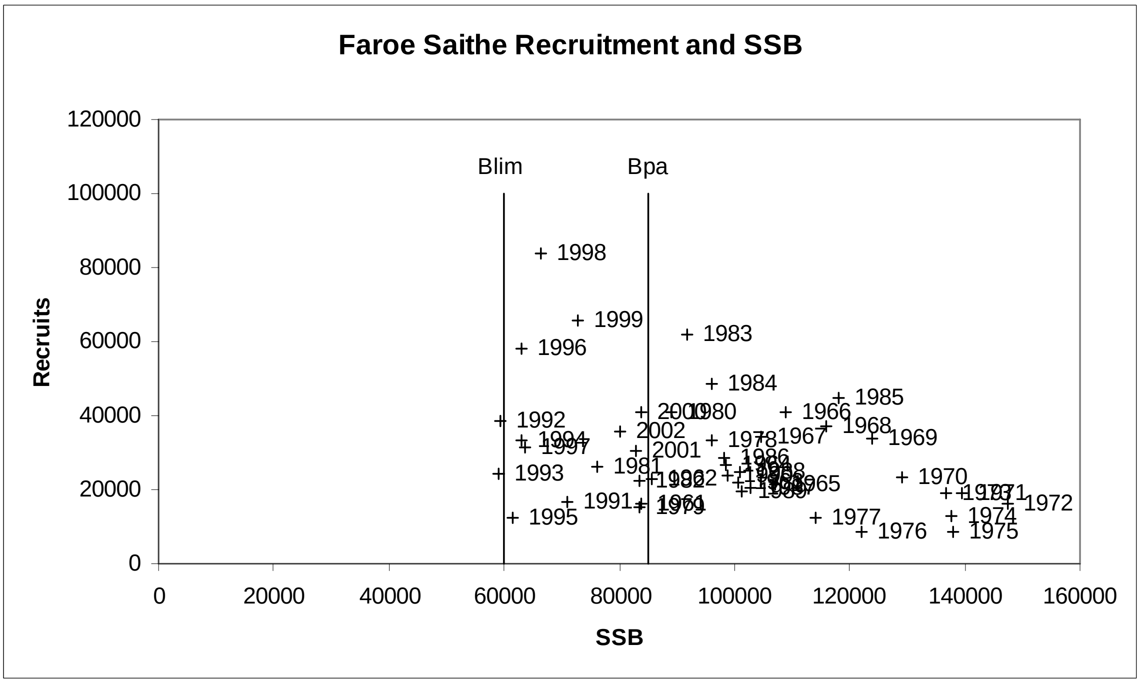
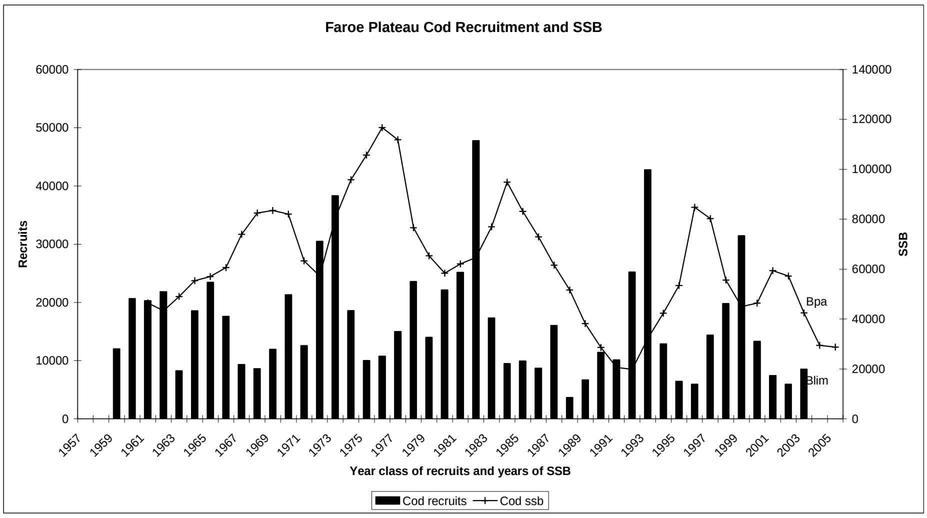
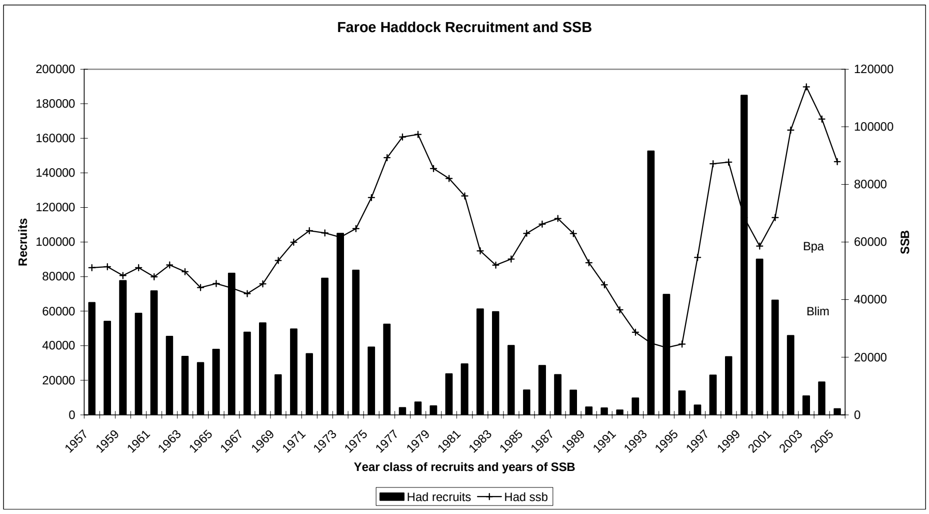


Figure 2.1.10: Stock and recruitment data for Faroe saithe based on the 2006 assessment. The highest recruitment is at the lowest SSB. In these cases, SGPRP 2003 suggested that Bloss be used as Bpa.





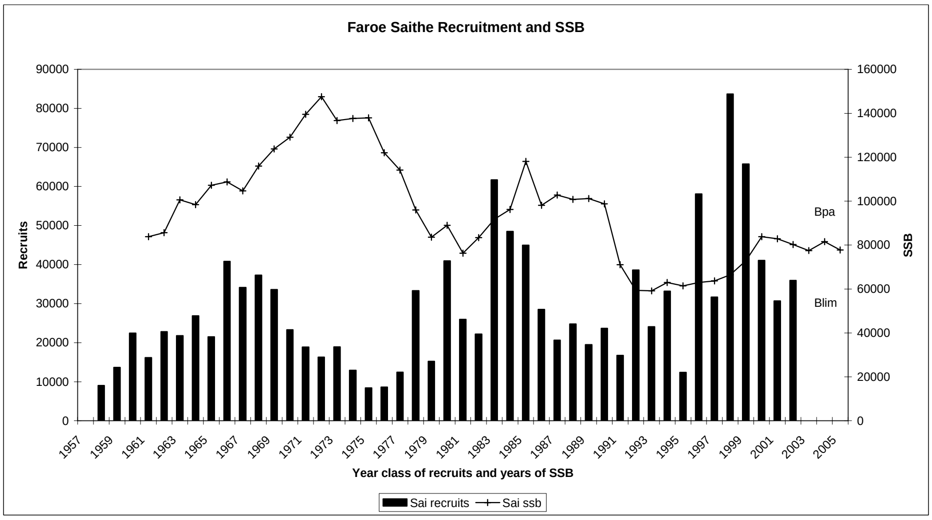


Figure 2.1.11: Development of the dermersal stocks at the Faroes. No long term decrease in the productivity are apparent.

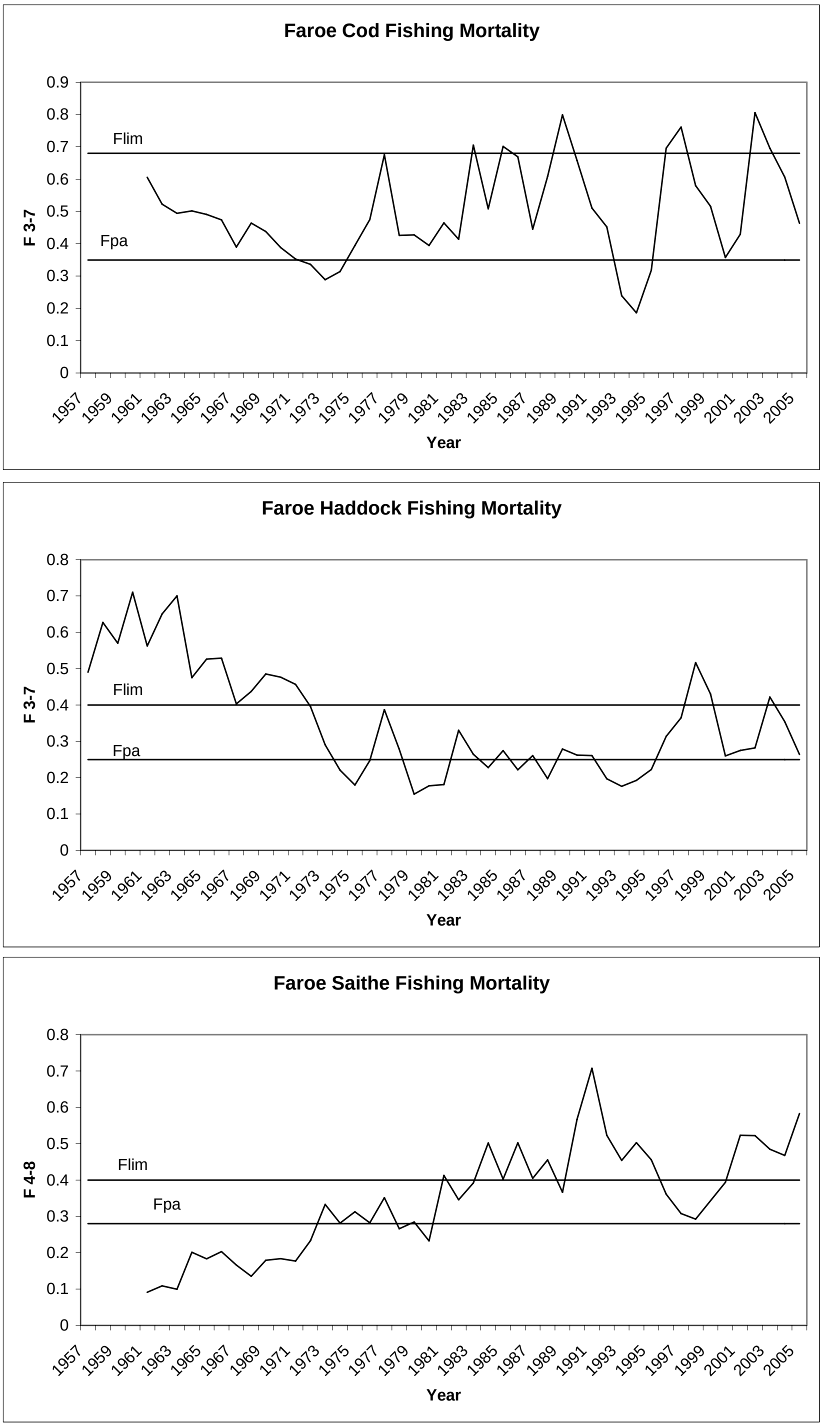


Figure 2.1.12: Time trends in fishing mortality estimates from the 2006 assessment. The figure shows that the existing Flim's do not possess the characterisitics of a limit reference point.

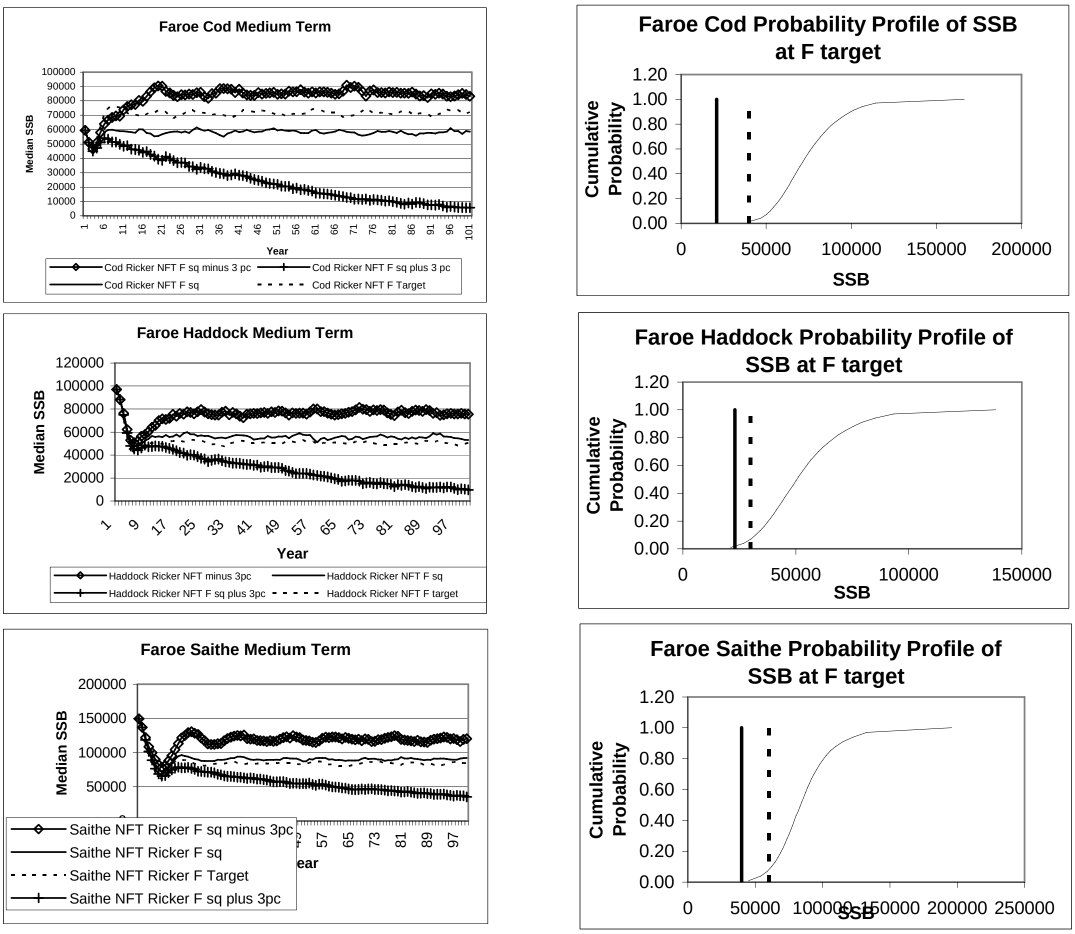


Figure 2.1.13: Results of 100 simulations for Faroese demersal stocks. Left panel shows the time trends of SSB under various F scenarios. It shows that the F status quo, F target and decreasing F are all sustainable, but that the increasing F at 3% per year is not. The right panel shows the frequency distributions of the SSB at the target F = 0.45, compared with the Bpa and Blim proposed herein. These results suggest that Ftarget and Fsq (as defined in these simulations, i.e. the average F's at age of 2001 to 2003 as estimated in the 2004 assessment) are sustainable. The frequency distributions in the right hand panel have been recorded from the 10th to the 100th year of the simulation to reduce the effect of initial conditions.

2.2 Faroe Plateau Cod

2.2.1 Stock definition

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

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). Ten have been recaptured so far, 5 at Iceland, 3 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 have been recaptured so far. 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 dropped to only 10 thousand tonnes in 2005.

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 (1986-2005) 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 2005, 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 1999-2005. Landings-at-age for 2005 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 2005 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 2005.

Fleet	Size	Samples	Lengths	Otoliths	Weights
Open boats		16	1,089	300	1,503
Longliners	<100 GRT	60	3,284	1,077	9,267
Longliners	>100 GRT	54	4,085	809	6,951
Jiggers		4	235	120	316
Sing. trawlers	<400 HP	1	257	0	0
Sing. trawlers	400-1000 HP	17	2,192	479	1,392
Sing. trawlers	>1000 HP	3	655	0	0
Pair trawlers	<1000 HP	10	1,781	240	412
Pair trawlers	>1000 HP	46	9,140	958	958
Total		195	21,629	3,683	19,296

2.2.4 Weight-at-age

Mean weight-at-age data for 1961-2005 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 2005 showed a discrepancy of 4 %.

Figure 2.2.4.1 shows the mean weight-at-age for 1961 to 2005. For 2006-2008 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 2006. The expected weights in the commercial catches in 2006 (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 1996-2004 and between the CW and the SW for the years 1996-2004 by each age. The correlation that was higher was chosen for prediction of the value in 2006.

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 - 2005) and shown in Figure 2.2.5.1 (1983 - 2005). The observed values in 2006 and the estimated values in 2007-2008 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 1994-2006 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 have been low in 2005 and 2006. 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 1996-2006.

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) 1996-2005 is shown in Figure 2.2.6.2, and catch curves in Figure 2.2.6.3. The catch curves show that the fish are fully recruited to the survey gear at an age of 3 or 4 years.

The abundance index was calculated as the stratified mean number of cod at age. The age length key was based on otolith samples pooled for all stations since there seemed to be a homogeneous size at age by strata and depth. Due to incomplete otolith samples for the youngest age groups, all cod less than 15 cm were considered being 0 years and between 15-34 cm 1 year **(**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.

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.

Since the current assessment is an update assessment, the same procedure is followed as in the 2005 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 2005 assessment, the ADAPT assessment package was used for comparison with the XSA.

The log catchability residuals from the adopted XSA run are shown in Figure 2.2.7.1.2. The spring survey shows no overall trends although there seems to be a year effect for the years 1993 (actually 1994 because the survey was shifted back to the previous year) and 2003 (actually 2004). For the summer survey there was a clear year effect in 2003. In addition there seemingly is an effect of year class..

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

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

The estimated fishing mortalities are shown in Tables 2.2.7.1.3 and 2.2.7.1.5 and Figure 2.2.7.1.5. The average F for age groups 3 to 7 in 2005 (F3-7) is estimated at 0.46, equal to Fmax = 0.47.

The F3-7 seems to be a problematic measure of fishing mortality for two reasons. Firstly, the fishing mortalities for ages 6-7 are generally overestimated in the terminal year leading to an overestimation of F3-7 for the terminal year. Secondly, the proportion of 6-7 year old cod in the stock or catch is small (normally less than 20%) and therefore get a disproportionate influence on the F3-7. The yield over exploitable biomass (3 years and older) was introduced in the 2004 assessment, but has the drawback not being proportional to fishing effort. Another approach is to weight the fishing mortalities and three weighting procedures are presented in Figure 2.2.7.1.7: weighting by stock numbers, stock biomasses or catch weights. All measures of fishing mortality show high values for 2002-2003, but a decrease since then. The weighted fishing mortalities show that the fishing mortality in 2005 was low compared to other years, but was not as low as values estimated for 2000 and 1993-1994.

2.2.7.2 Stock estimates and recruitment

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

Figure 2.2.7.2.2 shows the F and SSB's from a 1000 bootstraps of the ADAPT with the two surveys. The figure also shows the F and SSB from the XSA assessment. The XSA results fall in the cloud of the bootstrapped F and SSB pairs with the SSB and F close to the median of the bootstrapped values. From the NFT Adapt results, there is a zero probability that the Faroe cod 2005 SSB was less than Blim = 21 000t and there is a 100% probability that it was less than Bpa = 40 000t. There is a 50% probability that F 3-7 is higher than the target exploitation rate F = 045, a nearly 100% probability that it is higher than the existing Fpa = 0.35, but close to 100% probability that it is less 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 1998 year class is slightly above average strength and the 1999 year class well above. The 2000-2003 year classes are estimated to be below average strength, and the 2004 year class seems also to be below average strength according to the XSA run.

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 XSA retrospective pattern of the recruitment looked consistent so the recruitment of 2 year old cod in 2005 (2003 year class) was obtained from the XSA. The 2005-2006 year classes were estimated as the geometric mean for the period 1961-2005. Estimates of stock size (ages 2+) were taken directly from the VPA stock numbers. The exploitation pattern was estimated as the average fishing mortality for 2003-2005 and rescaled to the 2005 because the reduction in F is believed to be true. The weights at age in the catches in 2006 were estimated from the commercial catches in January-February or the spring survey (ages 2 and 4). Regression analyses were made between weights in January-February (or March), and the weights during the whole year 1996-2005. The weights in the catches in 2006 were predicted from the regressions. The weights in the catches in 2007-2008 were set to the values in 2006. The proportion mature in 2006 was set to the 2006 values from the spring groundfish survey, and for 2007-2008 to the average values for 2004-2006.

Table 2.2.8.1.2 shows that the landings in 2006 are expected to be 12 000 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 33 000 tonnes in 2006, 30 000 tonnes in 2007 and eventually 34 000 tonnes in 2008. The current short term prediction is therefore quite pessimistic.

2.2.8.2 Biological reference points

The stock trajectory with respect to existing reference points is illustrated in Figure 2.2.8.2.1. The reference points are dealt with in the general section of Faroese stocks.

2.2.8.3 Medium-term prediction

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

2.2.8.4 Long-term prediction

The input data for the yield-per-recruit calculations (long-term predictions) are given in Table 2.2.8.4.1. The exploitation pattern was taken as an average for the years 2000-2005. The weights at age were set to the average values for 1978-2005, since no long term trend was present. The proportion mature was set to the average for 1983-2006.

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 0.26 and F_{max} as 0.47. The present average fishing mortality (F3-7) in 2005 of 0.46 is the same as F_{max} = 0.47 and above F_{med} = 0.34 (Figure 2.2.8.2.1).

2.2.9 Management considerations

The current assessment shows that fishing mortality on cod decreased from 0.70 in 2003 to 0.46 in 2005, which is consistent with the reduction anticipated in the 2005 report of the NWWG based on the hypothesis that catchability in the longline fishery is linked to the primary production. The number of fishing days allocated and used are similar between 2004 and 2005 and changes in F are therefore likely related to changes in catchability, whatever the explaining mechanism, rather than to changes in fishing effort. If the catchability hypothesis is true and if primary productivity in 2006 is low, F could increase or continue to decrease if productivity is high.

According to the short term prediction the landings (excluding the Faroe-Icelandic ridge) in 2006 and 2007 will be similar to those in 2005, in the order of 10 000 – 12 000 tonnes. The short term prediction is based on the assumption that recruitment in 2007 and 2008 will be equal to the geometric mean of 1961 to 2005, 14 millions fish at age 2, about two times higher than the estimated recruitment in 2003-2006. Unusually low catches of cod on the Faroe Plateau can therefore be expected for the next few years, unless productivity increases substantially and results in strong cod year classes.

The collapse of the cod fishery in 1990-1994 was the first in at least a century, it can therefore be considered an exceptional, but explainable, event: seven of the eight year classes that recruited during 1986 to 1991 were below average and fishing mortality was high, which resulted in a precipitous decline in biomass and in catches. Although fishing mortality is now considered to be somewhat lower, the three most recent year classes are smaller than average and a decline in catches in 2006 and 2007 is possible if the assumed recruits for 2007 and 2008 turn out to be smaller than assumed (the 2006 spring survey suggest that the 2004 year class, the recruitment in 2006, is below average). The current assessment shows that a second collapse, 14 years after the first one is possible. Overall, however, the decrease in cod biomass may not cause as intense a crisis in the fishery sector as occurred in the early 1990s because the biomass of the other two important demersal fish stocks, haddock and saithe, is higher than it was in the early 1990s.

Given the above, it would seem prudent to decrease fishing mortality in the short term in order to have sufficient spawning cod to take advantage of improved production conditions should they occur (Steingrund and Gaard, 2005).

2.2.10 Comments on the assessment

New or changed things compared to last years report: the catches in 1999-2004 were changed by excluding the Faroese catches on the Faroe-Icelandic ridge (within the Vb1 area). The effect is investigated in Figure 2.2.7.1.8. It shows that the fishing mortality, total biomass and the spawning biomass decreased, whereas the perception of recruitment changed little. The assessment settings were the same as last year.

2.2.10.1 References

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Table 2.2.2.1. Faroe Plateau (Sub-division Vb1) COD. Nominal catches (tonnes) by countries,

	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 *
Denmark	-						
Faroe Islands	19,156		29,762	40,602	30,259	17,540	15,063
France	- *	1	9 [2]	20	14	2	0
Germany	39	2	9	6	7	3 [2]	
Iceland	-	-	-	5	-		
Norway	450	374	531 *	573	527	414	201
Greenland	-	-	-	29 [2]	-		
Portugal						1	
UK (E/W/NI)[2]	51	18	50	42	15	15	
UK (Scotland)[1]	-	-	-	-	-	-	-
United Kingdom							[1]
Total	19,696	395	30,361	41,277	30,822	17,975	15,264

* Preliminary
1) Included in Vb2.
2) Reported as Vb.

1986-2005, as officially reported to ICES.

Table 2.2.2.2. Nominal catch (tonnes) of COD in sub-division Vb1 (Faroe Plateau) 1986-2005, 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 *
Officially reported	19,696	395	30,361	41,277	30,822	17,975	15,264
Faroese catches in Vb1		21,793 *					
Correction of Faroese catches in Vb1 [1]			-1,766	-2,409	-1,795	-1,041	-894
Faroese catch on the Faroe-Icelandic ridge	-1,600	-1,400	-700	-600	-4,700	-4,000	-4,200
Greenland[2]						35	
France[2]						2	
Catches reported as Vb2:							
UK (E/W/NI)	-	-	-	-	-	-	
UK (Scotland)	210	245	288	218	254	244	
United Kingdom				-	-	-	329
Used in the assessment	18,306	21,033	28,183	38,486	24,581	13,215	10,499

*) 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

Table 2.2.2.4. Faroe Plateau (sub-division Vb1) COD. The landings of Faroese fleets (in percents) of total catch.

Year	Open boats	Longliners <100 GRT	Singletrawl <400 HP	Gill net	Jiggers	Singletrawl 400-1000 HP	Singletrawl >1000 HP	Pairtrawl <1000 HP	Pairtrawl >1000 HP	Longliners >100 GRT	Industrial trawlers	Others	Faroe catch Round.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
Average	**4.1**	**24.2**	**6.3**	**1.0**	**9.8**	**4.8**	**7.9**	**9.5**	**13.2**	**18.6**	**0.5**	**0.2**	

Table 2.2.3.1. Faroe Plateau COD. Catch in numbers at age per fleet in 2005. Numbers are in thousands and the catch is in tonnes, round weight.

Age\Fleet	Open boats longline	Open boats jiggers	Longliners < 100 GRT	Jiggers	Single trwl 0-399HP	Single trwl 400-1000H	Single trwl > 1000 HP	Pair trwl 700-999 HI	Pair trwl > 1000 HP	Longliners > 100 GRT	Gillnetters	Others (scaling)	Catch-at-age
2	50	25	428	44	21	6	1	0	3	17	0	-72	523
3	41	35	339	108	73	29	6	5	22	55	0	-86	627
4	57	42	593	54	83	37	6	10	35	139	0	-126	930
5	55	44	541	84	119	59	15	27	109	296	1	-161	1189
6	31	24	355	52	48	28	14	22	94	319	7	-122	872
7	4	3	48	21	11	6	4	6	23	115	6	-31	216
8	0	0	1	4	1	0	1	1	6	32	3	-6	43
9	0	0	1	2	0	0	0	0	2	15	1	-1	20
10+	1	1	18	1	0	0	0	0	1	15	0	-5	32
Sum	239	174	2324	370	356	165	47	71	295	1003	18	-610	4452
G.weight	376	268	3839	749	715	338	134	233	891	3085	119	-1288	9459

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 1961-2005.

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

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

YEAR,	1966,	1967,	1968,	1969,	1970,	1971,	1972,	1973,	1974,	1975,
AGE										
1,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
2,	1337,	1609,	1529,	878,	402,	328,	875,	723,	2161,	2584,
3,	970,	2690,	3322,	3106,	1163,	757,	1176,	3124,	1266,	5689,
4,	2080,	860,	2663,	3300,	2172,	821,	810,	1590,	1811,	2157,
5,	1339,	1706,	945,	1538,	1685,	1287,	596,	707,	934,	2211,
6,	606,	847,	1226,	477,	752,	1451,	1021,	384,	563,	813,
7,	197,	309,	452,	713,	244,	510,	596,	312,	452,	295,
8,	104,	64,	105,	203,	300,	114,	154,	227,	149,	190,
9,	33,	27,	11,	92,	44,	179,	25,	120,	141,	118,
TOTALNUM,	6666,	8112,	10253,	10307,	6762,	5447,	5253,	7187,	7477,	14057,
TONSLAND,	20418,	23562,	29930,	32371,	24183,	23010,	18727,	22228,	24581,	36775,
SOPCOF %,	109,	102,	106,	109,	99,	123,	125,	105,	104,	100,

YEAR,	1976,	1977,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,
AGE										
1,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
2,	1497,	425,	555,	575,	1129,	646,	1139,	2149,	4396,	998,
3,	4158,	3282,	1219,	1732,	2263,	4137,	1965,	5771,	5234,	9484,
4,	3799,	6844,	2643,	1673,	1461,	1981,	3073,	2760,	3487,	3795,
5,	1380,	3718,	3216,	1601,	895,	947,	1286,	2746,	1461,	1669,
6,	1427,	788,	1041,	1906,	807,	582,	471,	1204,	912,	770,
7,	617,	1160,	268,	493,	832,	487,	314,	510,	314,	872,
8,	273,	239,	201,	134,	339,	527,	169,	157,	82,	309,
9,	120,	134,	66,	87,	42,	123,	254,	104,	34,	65,
TOTALNUM,	13271,	16590,	9209,	8201,	7768,	9430,	8671,	15401,	15920,	17962,
TONSLAND,	39799,	34927,	26585,	23112,	20513,	22963,	21489,	38133,	36979,	39484,
SOPCOF %,	103,	70,	102,	101,	107,	107,	104,	99,	99,	97,

YEAR,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,
AGE										
1,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
2,	210,	257,	509,	2237,	243,	192,	205,	120,	573,	2615,
3,	3586,	1362,	2122,	2151,	2849,	451,	455,	802,	788,	2716,
4,	8462,	2611,	1945,	2187,	1481,	2152,	466,	603,	1062,	2008,
5,	2373,	3083,	1484,	1121,	852,	622,	911,	222,	532,	1012,
6,	907,	812,	2178,	1026,	404,	303,	293,	329,	125,	465,
7,	236,	224,	492,	997,	294,	142,	132,	96,	176,	118,
8,	147,	68,	168,	220,	291,	93,	53,	33,	39,	175,
9,	47,	69,	33,	61,	50,	53,	30,	22,	23,	44,
0 TOTALNUM,	15968,	8486,	8931,	10000,	6464,	4008,	2545,	2227,	3318,	9153,
TONSLAND,	34595,	21391,	23182,	22068,	13487,	8750,	6396,	6107,	9046,	23045,
SOPCOF %,	97,	98,	102,	98,	101,	109,	108,	107,	103,	103,

YEAR,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	2005,
AGE										
1,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
2,	351,	200,	455,	1185,	2091,	3912,	2080,	681,	101,	523,
3,	5164,	1278,	745,	993,	2637,	3759,	7288,	2135,	693,	627,
4,	4608,	6710,	1558,	799,	782,	2101,	3374,	4587,	1266,	930,
5,	1542,	3731,	5140,	1107,	426,	367,	1673,	1933,	2111,	1189,
6,	1526,	657,	1529,	2225,	674,	367,	470,	642,	738,	872,
7,	596,	639,	159,	439,	809,	718,	533,	178,	241,	216,
8,	147,	170,	118,	59,	104,	437,	413,	91,	65,	43,
9,	347,	51,	28,	17,	7,	36,	290,	115,	42,	20,
0 TOTALNUM,	14281,	13436,	9732,	6824,	7530,	11697,	16121,	10362,	5257,	4420,
TONSLAND,	40422,	34304,	24005,	18306,	21033,	28183,	38486,	24581,	13215,	10499,
SOPCOF %,	100,	104,	104,	102,	104,	101,	100,	101,	103,	103,

Table 2.2.4.1. Faroe Plateau COD. Catch weight at age 1961-2005.

Table 2 Catch weights at age (kg)

YEAR,	1961,	1962,	1963,	1964,	1965,
AGE					
1,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	1.0800,	1.0000,	1.0400,	.9700,	.9200,
3,	2.2200,	2.2700,	1.9400,	1.8300,	1.4500,
4,	3.4500,	3.3500,	3.5100,	3.1500,	2.5700,
5,	4.6900,	4.5800,	4.6000,	4.3300,	3.7800,
6,	5.5200,	4.9300,	5.5000,	6.0800,	5.6900,
7,	7.0900,	9.0800,	6.7800,	7.0000,	7.3100,
8,	9.9100,	6.5900,	8.7100,	6.2500,	7.9300,
9,	8.0300,	6.6600,	11.7200,	6.1900,	8.0900,
SOPCOFAC,	.9068,	.9444,	.9573,	.9824,	1.1262,

YEAR,	1966,	1967,	1968,	1969,	1970,	1971,	1972,	1973,	1974,	1975,
AGE										
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.9800,	.9600,	.8800,	1.0900,	.9600,	.8100,	.6600,	1.1100,	1.0800,	.7900,
3,	1.7700,	1.9300,	1.7200,	1.8000,	2.2300,	1.8000,	1.6100,	2.0000,	2.2200,	1.7900,
4,	2.7500,	3.1300,	3.0700,	2.8500,	2.6900,	2.9800,	2.5800,	3.4100,	3.4400,	2.9800,
5,	3.5100,	4.0400,	4.1200,	3.6700,	3.9400,	3.5800,	3.2600,	3.8900,	4.8000,	4.2600,
6,	4.8000,	4.7800,	4.6500,	4.8900,	5.1400,	3.9400,	4.2900,	5.1000,	5.1800,	5.4600,
7,	6.3200,	6.2500,	5.5000,	5.0500,	6.4600,	4.8700,	4.9500,	5.1000,	5.8800,	6.2500,
8,	7.5100,	7.0000,	7.6700,	7.4100,	10.3100,	6.4800,	6.4800,	6.1200,	6.1400,	7.5100,
9,	10.3400,	11.0100,	10.9500,	8.6600,	7.3900,	6.3700,	6.9000,	8.6600,	8.6300,	7.3900,
SOPCOFAC,	1.0905,	1.0224,	1.0598,	1.0851,	.9943,	1.2264,	1.2481,	1.0485,	1.0432,	1.0033,

YEAR,	1976,	1977,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,
AGE										
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.9400,	.8700,	1.1120,	.8970,	.9270,	1.0800,	1.2300,	1.3380,	1.1950,	.9050,
3,	1.7200,	1.7900,	1.3850,	1.6820,	1.4320,	1.4700,	1.4130,	1.9500,	1.8880,	1.6580,
4,	2.8400,	2.5300,	2.1400,	2.2110,	2.2200,	2.1800,	2.1380,	2.4030,	2.9800,	2.6260,
5,	3.7000,	3.6800,	3.1250,	3.0520,	3.1050,	3.2100,	3.1070,	3.1070,	3.6790,	3.4000,
6,	5.2600,	4.6500,	4.3630,	3.6420,	3.5390,	3.7000,	4.0120,	4.1100,	4.4700,	3.7520,
7,	6.4300,	5.3400,	5.9270,	4.7190,	4.3920,	4.2400,	5.4420,	5.0200,	5.4880,	4.2200,
8,	6.3900,	6.2300,	6.3480,	7.2720,	6.1000,	4.4300,	5.5630,	5.6010,	6.4660,	4.7390,
9,	8.5500,	8.3800,	8.7150,	8.3680,	7.6030,	6.6900,	5.2160,	8.0130,	6.6280,	6.5110,
SOPCOFAC,	1.0285,	.7026,	1.0228,	1.0055,	1.0680,	1.0674,	1.0428,	.9901,	.9872,	.9695,

YEAR,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,
AGE										
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	1.0990,	1.0930,	1.0610,	1.0100,	.9450,	.7790,	.9890,	1.1550,	1.1940,	1.2180,
3,	1.4590,	1.5170,	1.7490,	1.5970,	1.3000,	1.2710,	1.3640,	1.7040,	1.8430,	1.9860,
4,	2.0460,	2.1600,	2.3000,	2.2000,	1.9590,	1.5700,	1.7790,	2.4210,	2.6130,	2.6220,
5,	2.9360,	2.7660,	2.9140,	2.9340,	2.5310,	2.5240,	2.3120,	3.1320,	3.6540,	3.9250,
6,	3.7860,	3.9080,	3.1090,	3.4680,	3.2730,	3.1850,	3.4770,	3.7230,	4.5840,	5.1800,
7,	4.6990,	5.4610,	3.9760,	3.7500,	4.6520,	4.0860,	4.5450,	4.9710,	4.9760,	6.0790,
8,	5.8930,	6.3410,	4.8960,	4.6820,	4.7580,	5.6560,	6.2750,	6.1590,	7.1460,	6.2410,
9,	9.7000,	8.5090,	7.0870,	6.1400,	6.7040,	5.9730,	7.6190,	7.6140,	8.5640,	7.7820,
0 SOPCOFAC,	.9715,	.9755,	1.0153,	.9810,	1.0064,	1.0857,	1.0770,	1.0652,	1.0303,	1.0299,

YEAR,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	2005,
AGE										
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	1.0160,	.9010,	1.0040,	1.0500,	1.4160,	1.1640,	1.0170,	.8200,	1.0370,	.9860,
3,	1.7370,	1.3410,	1.4170,	1.5860,	2.1700,	2.0760,	1.7680,	1.3620,	1.1540,	1.3730,
4,	2.7450,	1.9580,	1.8020,	2.3500,	3.1870,	3.0530,	2.8050,	2.1270,	1.6930,	1.7600,
5,	3.8000,	3.0120,	2.2800,	2.7740,	3.7950,	3.9760,	3.5290,	3.3290,	2.3630,	2.2930,
6,	4.4550,	4.1580,	3.4780,	3.2140,	4.0480,	4.3940,	4.0950,	4.0920,	3.8300,	3.1380,
7,	4.9780,	4.4910,	5.4330,	5.4960,	4.5770,	4.8710,	4.4750,	4.6700,	5.1910,	5.2870,
8,	5.2700,	5.3120,	5.8510,	8.2760,	8.1820,	5.5630,	4.6500,	6.0000,	6.3260,	8.2850,
9,	5.5930,	6.1720,	7.9700,	9.1290,	11.8950,	7.2770,	6.2440,	6.7270,	7.6560,	8.7030,
0 SOPCOFAC,	1.0026,	1.0367,	1.0376,	1.0184,	1.0434,	1.0053,	1.0020,	1.0059,	1.0287,	1.0346,

Table 2.2.5.1. Faroe Plateau (sub-division Vb1) COD. Proportion mature at age 1983-2005. From 1961-1982 the average from 1983-1996 is used.

Table 5 Proportion mature at age

YEAR,	1961,	1962,	1963,	1964,	1965,
AGE					
1,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.1700,	.1700,	.1700,	.1700,	.1700,
3,	.6400,	.6400,	.6400,	.6400,	.6400,
4,	.8700,	.8700,	.8700,	.8700,	.8700,
5,	.9500,	.9500,	.9500,	.9500,	.9500,
6,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
7,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
8,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
9,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,

YEAR,	1966,	1967,	1968,	1969,	1970,	1971,	1972,	1973,	1974,	1975,
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,

YEAR,	1976,	1977,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,
AGE										
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.1700,	.1700,	.1700,	.1700,	.1700,	.1700,	.1700,	.0300,	.0700,	.0000,
3,	.6400,	.6400,	.6400,	.6400,	.6400,	.6400,	.6400,	.7100,	.9600,	.5000,
4,	.8700,	.8700,	.8700,	.8700,	.8700,	.8700,	.8700,	.9300,	.9800,	.9600,
5,	.9500,	.9500,	.9500,	.9500,	.9500,	.9500,	.9500,	.9400,	.9700,	.9600,
6,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
7,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
8,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
9,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,

YEAR,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,
AGE										
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.0000,	.0000,	.0600,	.0500,	.0000,	.0000,	.0600,	.0300,	.0500,	.0900,
3,	.3800,	.6700,	.7200,	.5400,	.6800,	.7200,	.5000,	.7300,	.3300,	.3500,
4,	.9300,	.9100,	.9000,	.9800,	.9000,	.8600,	.8200,	.7800,	.8800,	.3300,
5,	1.0000,	1.0000,	.9700,	1.0000,	.9900,	1.0000,	.9800,	.9100,	.9600,	.6600,
6,	1.0000,	1.0000,	1.0000,	1.0000,	.9600,	1.0000,	1.0000,	.9900,	1.0000,	.9700,
7,	.9600,	1.0000,	1.0000,	1.0000,	.9800,	1.0000,	1.0000,	1.0000,	.9600,	1.0000,
8,	.9400,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
9,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,

YEAR,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	2005,
AGE										
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.0400,	.0000,	.0000,	.0200,	.0200,	.0700,	.0400,	.0000,	.0000,	.0500,
3,	.4300,	.6400,	.6200,	.4300,	.3900,	.4700,	.3700,	.2900,	.5100,	.6600,
4,	.7400,	.9100,	.9000,	.8800,	.6900,	.8600,	.7600,	.7900,	.7800,	.9000,
5,	.8500,	.9700,	.9900,	.9800,	.9200,	.9400,	.9700,	.8800,	.9200,	.9300,
6,	.9400,	1.0000,	.9900,	1.0000,	.9900,	1.0000,	.9300,	.9800,	.8900,	.9800,
7,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	.9700,	1.0000,	.8700,	.9200,
8,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
9,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,

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

```
FAROE PLATEAU COD (ICES SUBDIVISION VB1)        Surveys.TXT
102
SUMMER SURVEY
1996 2005
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
SPRING SURVEY (shifted back to december)
1993 2005
1 1 0.9 1.0
1 8
 100   565.8    328.1     888.5     493.1     125.3    180.9    28       0.1
 100   707.7    778.5    1438      1490.8    1211.2    287.3   353.1    48.7
 100   395.8   3988.4    3612.4    1769.3    1315.5    403.8    79.8   160.7
 100    91.1    933.8    5492.1    2331.6     332.8    226.7    58.2     5.2
 100    75.9    428.7    1572.1    4927.7    1127.9     80.2    39.6    33.9
 100   528      636.9     956.4    1181.7    2005.5    243.5    24.2    12.9
 100   291.5   1413.4     730.2     430       494      815.2    61.2     3
 100   873.5   2266      1917.8     439.6     314.6    562.8   126.8     3.8
 100   343.9   4154.7    2708.1    1486.3     311.9    217.9   168.3   124.1
 100    79.4    703.7    4250.5    1326.7     541.8     63.4    48.1    36.8
 100   427.1    451       784.7    1197.6     299.5     66.5    22.2    11.9
 100   294.7    390.1    1046.6    1328.1     791.1    133.6    13.4     3.6
 100   130.3    433.4     634.4    1129.7     688.4    178.2    24       5.5
```

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

Lowestoft VPA Version 3.1

22/04/2006 14:29

Extended Survivors Analysis

COD FAROE PLATEAU (ICES SUBDIVISION Vb1) COD_ind_Surveys.txt

CPUE data from file Surveys.TXT

Catch data for 45 years. 1961 to 2005. Ages 1 to 9.

Fleet,	First, year,	Last, year,	First, age ,	Last, age	Alpha,	Beta
SUMMER SURVEY ,	1996,	2005,	2,	8,	.600,	.700
SPRING SURVEY (shift,	1993,	2005,	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 49 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,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	2005
1,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000
2,	.031,	.035,	.088,	.095,	.124,	.148,	.190,	.107,	.019,	.070
3,	.192,	.149,	.176,	.283,	.318,	.343,	.451,	.304,	.151,	.157
4,	.452,	.410,	.273,	.290,	.378,	.452,	.595,	.576,	.298,	.311
5,	.805,	.831,	.643,	.318,	.247,	.305,	.812,	.841,	.575,	.507
6,	.903,	1.031,	1.046,	.648,	.326,	.350,	.816,	.884,	.954,	.498
7,	1.129,	1.385,	.762,	1.043,	.519,	.696,	1.358,	.876,	1.053,	.845
8,	.881,	1.308,	1.127,	.730,	.758,	.596,	1.226,	.923,	.982,	.522
9,	1.083,	.914,	.782,	.457,	.169,	.653,	1.081,	1.711,	1.931,	.987

1

Table 2.2.7.1.2 (Cont'd)

XSA population numbers (Thousands)

YEAR	AGE 1	2	3	4	5	6	7	8	9
1996	7.89E+03	1.29E+04	3.26E+04	1.40E+04	3.08E+03	2.84E+03	9.73E+02	2.77E+02	5.80E+02
1997	7.26E+03	6.46E+03	1.02E+04	2.20E+04	7.31E+03	1.13E+03	9.42E+02	2.58E+02	9.41E+01
1998	1.76E+04	5.94E+03	5.11E+03	7.21E+03	1.20E+04	2.61E+03	3.29E+02	1.93E+02	5.70E+01
1999	2.42E+04	1.44E+04	4.45E+03	3.51E+03	4.49E+03	5.16E+03	7.49E+02	1.26E+02	5.12E+01
2000	3.84E+04	1.98E+04	1.07E+04	2.75E+03	2.15E+03	2.68E+03	2.21E+03	2.16E+02	4.97E+01
2001	1.62E+04	3.14E+04	1.43E+04	6.38E+03	1.54E+03	1.37E+03	1.58E+03	1.08E+03	8.30E+01
2002	9.07E+03	1.33E+04	2.22E+04	8.32E+03	3.33E+03	9.31E+02	7.93E+02	6.46E+02	4.85E+02
2003	7.27E+03	7.43E+03	9.00E+03	1.16E+04	3.76E+03	1.21E+03	3.37E+02	1.67E+02	1.55E+02
2004	1.04E+04	5.95E+03	5.46E+03	5.44E+03	5.33E+03	1.33E+03	4.09E+02	1.15E+02	5.43E+01
2005	6.94E+03	8.54E+03	4.78E+03	3.85E+03	3.31E+03	2.46E+03	4.19E+02	1.17E+02	3.52E+01

Estimated population abundance at 1st Jan 2006

,	0.00E+00	5.68E+03	6.52E+03	3.35E+03	2.31E+03	1.63E+03	1.22E+03	1.47E+02	5.67E+01

Taper weighted geometric mean of the VPA populations:

,	1.71E+04	1.43E+04	1.07E+04	6.75E+03	3.67E+03	1.77E+03	7.88E+02	3.17E+02	1.31E+02

Standard error of the weighted Log(VPA populations) :

,	.5827	.5668	.5546	.5358	.5303	.5645	.6201	.7024	.8116

1

Log catchability residuals.

Fleet : SUMMER SURVEY

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	No data for this fleet at this age									
2	-.30	.07	.22	-1.01	-.01	.46	.96	-.39	-.02	.00
3	.20	-.15	-.52	.59	-.35	.13	.58	-.29	-.10	-.10
4	.23	.34	-.56	-.10	.09	.12	.12	-.03	-.17	-.03
5	.73	-.01	.30	-.64	-.73	-.06	.17	-.30	.19	.34
6	.30	-.07	.73	.23	-.51	-.45	-.22	-.62	.36	.24
7	.41	.08	-.29	.63	.13	-.18	-.28	-1.29	.15	.56
8	-.07	-.19	.18	.43	-.22	-.01	-.34	-.95	.23	.47

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	-7.7521	-6.8407	-6.4190	-6.2197	-6.2614	-6.2614	-6.2614
S.E(Log q)	.5217	.3747	.2484	.4498	.4406	.5559	.4225

Regression statistics :

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2	.89	.361	7.91	.60	10	.49	-7.75
3	.85	.989	7.20	.84	10	.32	-6.84
4	.87	1.188	6.73	.92	10	.21	-6.42
5	.85	.673	6.53	.71	10	.39	-6.22
6	.74	1.385	6.60	.78	10	.31	-6.26
7	.80	.872	6.33	.70	10	.45	-6.27
8	1.21	-.898	6.48	.70	10	.51	-6.31

Fleet : SPRING SURVEY (shift

Age	1993	1994	1995
1	-.02	-.33	.29
2	-.81	-.85	.30
3	-.60	.01	.08
4	-.56	.01	.56
5	-.62	.78	.35
6	-.63	.85	.46
7	-.36	.41	.09
8	-4.77	.74	.06

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	-.49	-.59	.47	-.44	.19	.12	-.76	1.14	.41	.00
2	.01	-.08	.45	.37	.55	.72	-.15	-.10	-.10	-.31
3	.04	-.09	.13	.10	.22	.30	.42	-.51	.13	-.23
4	-.03	.23	-.21	-.48	-.14	.31	.07	-.38	.21	.41
5	-.13	.25	.16	-.57	-.35	.02	.29	-.40	-.03	.25
6	-.12	-.11	.18	.32	.30	.04	-.36	-.51	.16	-.60

7 ,	-.19,	-.30,	-.33,	.04,	-.81,	-.03,	.04,	-.33,	-.87,	-.50
8 ,	-1.59,	.77,	-.08,	-1.49,	-1.77,	-.04,	-.15,	-.21,	-.98,	-1.01

Table 2.2.7.1.2 (Cont'd)

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

Age ,	1,	2,	3,	4,	5,	6,	7,	8
Mean Log q,	-8.3903,	-7.0183,	-6.0555,	-5.7543,	-5.7481,	-5.9684,	-5.9684,	-5.9684,
S.E(Log q),	.5237,	.4822,	.2946,	.3462,	.4055,	.4426,	.4394,	1.6791,

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,	1.04,	-.161,	8.34,	.62,	13,	.57,	-8.39,
2,	.86,	.780,	7.37,	.72,	13,	.42,	-7.02,
3,	.89,	.897,	6.40,	.86,	13,	.26,	-6.06,
4,	.91,	.588,	6.04,	.78,	13,	.32,	-5.75,
5,	.84,	1.057,	6.15,	.79,	13,	.34,	-5.75,
6,	1.04,	-.170,	5.90,	.58,	13,	.48,	-5.97,
7,	.90,	.659,	6.24,	.81,	13,	.33,	-6.21,
8,	.55,	1.734,	6.18,	.57,	13,	.73,	-6.78,

1

Terminal year survivor and F summaries :

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

Year class = 2004

Fleet,	Estimated,	Int,	Ext,	Var,	N,	Scaled,	Estimated
,	Survivors,	s.e,	s.e,	Ratio,	,	Weights,	F
SUMMER SURVEY ,	1.,	.000,	.000,	.00,	0,	.000,	.000
SPRING SURVEY (shift,	5682.,	.543,	.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,	
5682.,	.54,	.00,	1,	.000,	.000

1

Age 2 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 ,	6524.,	.547,	.000,	.00,	1,	.304,	.070
SPRING SURVEY (shift,	6644.,	.368,	.359,	.97,	2,	.672,	.069
F shrinkage mean ,	3780.,	2.00,,,,				.024,	.118

Weighted prediction :

Survivors,	Int,	Ext,	N,	Var,	F
at end of year,	s.e,	s.e,	,	Ratio,	
6517.,	.30,	.18,	4,	.586,	.070

Age 3 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 ,	3120.,	.319,	.039,	.12,	2,	.348,	.167
SPRING SURVEY (shift,	3522.,	.235,	.369,	1.57,	3,	.641,	.149
F shrinkage mean ,	1532.,	2.00,,,,				.010,	.315

Weighted prediction :

Survivors,	Int,	Ext,	N,	Var,	F
at end of year,	s.e,	s.e,	,	Ratio,	
3347.,	.19,	.19,	6,	1.020,	.157

1

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

Table 2.2.7.1.2 (Cont'd)

```
 Year class = 2001

 Fleet,                  Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                   Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SUMMER SURVEY       ,      2088.,   .220,       .084,    .38,    3,  .456,     .339
 SPRING SURVEY (shift,      2530.,   .198,       .204,   1.03,    4,  .536,     .287

   F shrinkage mean  ,      1429.,   2.00,,,,                         .008,     .463


 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      2307.,       .15,      .11,    8,    .747,   .311

 Age  5   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       ,      1680.,   .204,       .214,   1.05,    4,  .459,     .495
 SPRING SURVEY (shift,      1593.,   .186,       .163,    .88,    5,  .531,     .516

   F shrinkage mean  ,      1431.,   2.00,,,,                         .011,     .561

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      1630.,       .14,      .12,   10,    .839,   .507


1
 Age  6   Catchability constant w.r.t. time and dependent on age

 Year class = 1999

 Fleet,                  Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                   Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SUMMER SURVEY       ,      1490.,   .218,       .092,    .42,    5,  .470,     .425
 SPRING SURVEY (shift,      1030.,   .204,       .187,    .91,    6,  .515,     .569

   F shrinkage mean  ,       823.,   2.00,,,,                         .015,     .672

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      1221.,       .15,      .11,   12,    .755,   .498


 Age  7   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       ,       202.,   .277,       .123,    .44,    6,  .416,     .676
 SPRING SURVEY (shift,       117.,   .256,       .138,    .54,    7,  .550,     .985

   F shrinkage mean  ,       132.,   2.00,,,,                         .034,     .910

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
       147.,       .19,      .11,   14,    .584,   .845

1
 Age  8   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       ,        74.,   .303,       .145,    .48,    7,  .645,     .422
 SPRING SURVEY (shift,        36.,   .266,       .198,    .75,    8,  .320,     .734

   F shrinkage mean  ,        26.,   2.00,,,,                         .035,     .907
```

Table 2.2.7.1.2 (Cont'd)

```
Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
       57.,       .22,      .14,   16,    .636,   .522

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

Year class = 1996

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
SUMMER SURVEY       ,        11.,   .258,       .211,    .82,   7,  .552,    1.001
SPRING SURVEY (shift,         9.,   .212,       .110,    .52,   8,  .344,    1.133

  F shrinkage mean  ,        25.,   2.00,,,,                        .104,     .541

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
       11.,       .26,      .14,   16,    .520,   .987
```

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

Table 8 Fishing mortality (F) at age

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

YEAR,	1966,	1967,	1968,	1969,	1970,	1971,	1972,	1973,	1974,	1975,
AGE										
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.0829,	.0789,	.1010,	.1099,	.0530,	.0309,	.0464,	.0657,	.0816,	.0774,
3,	.1969,	.2389,	.2318,	.3063,	.2081,	.1337,	.1476,	.2322,	.1568,	.3193,
4,	.2552,	.2687,	.3949,	.3806,	.3654,	.2225,	.2070,	.3048,	.2046,	.4359,
5,	.4499,	.3442,	.5339,	.4180,	.3409,	.3845,	.2497,	.2813,	.2953,	.4134,
6,	.5016,	.5779,	.4472,	.5709,	.3709,	.5572,	.6058,	.2526,	.3797,	.4544,
7,	.9680,	.5203,	.7132,	.5118,	.6559,	.4651,	.4686,	.3722,	.5330,	.3504,
8,	.8520,	1.0438,	.3331,	.8457,	.4208,	.7528,	.2464,	.3259,	.3052,	.4485,
9,	.6106,	.5556,	.4882,	.5499,	.4339,	.4800,	.3578,	.3091,	.3457,	.4235,
FBAR 3- 7,	.4743,	.3900,	.4642,	.4375,	.3882,	.3526,	.3358,	.2886,	.3139,	.3947,

YEAR,	1976,	1977,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,
AGE										
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.0933,	.0481,	.0588,	.0433,	.0544,	.0523,	.0586,	.0992,	.1073,	.0658,
3,	.1723,	.3036,	.1896,	.2623,	.2391,	.2877,	.2227,	.4673,	.3712,	.3544,
4,	.3665,	.4748,	.4291,	.4309,	.3695,	.3409,	.3602,	.5585,	.5791,	.5077,
5,	.5568,	.7532,	.4289,	.5049,	.4337,	.4369,	.3887,	.6411,	.6609,	.6135,
6,	.5167,	.7333,	.4851,	.4906,	.5182,	.5644,	.4047,	.7836,	.4534,	.9236,
7,	.7619,	1.1138,	.5968,	.4480,	.4119,	.6940,	.6926,	1.0780,	.4761,	1.1084,
8,	.6429,	.7776,	.5674,	.6903,	.6437,	.5015,	.5526,	.9417,	.4792,	1.3206,
9,	.5738,	.7783,	.5054,	.5170,	.4790,	.5115,	.4834,	.8088,	.5341,	.9044,
FBAR 3- 7,	.4749,	.6757,	.4259,	.4273,	.3945,	.4648,	.4138,	.7057,	.5082,	.7015,

YEAR,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,
AGE										
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.0247,	.0291,	.0671,	.1675,	.0759,	.0323,	.0201,	.0132,	.0254,	.0700,
3,	.3547,	.2209,	.3530,	.4432,	.3335,	.1969,	.0998,	.1018,	.1126,	.1616,
4,	.6229,	.4757,	.5643,	.7614,	.6329,	.4545,	.3210,	.1861,	.1903,	.4634,
5,	.7035,	.4855,	.5497,	.7631,	.7831,	.6033,	.3531,	.2488,	.2490,	.2797,
6,	.8259,	.5562,	.7748,	.9644,	.7011,	.7259,	.6472,	.2068,	.2160,	.3593,
7,	.8403,	.4899,	.7999,	1.0621,	.8397,	.5730,	.8383,	.4529,	.1627,	.3257,
8,	.5411,	.6227,	.8652,	1.1062,	1.1230,	.7099,	.4349,	.5121,	.3345,	.2414,
9,	.7135,	.5302,	.7176,	.9417,	.8244,	.6188,	.5231,	.3233,	.8423,	.7925,
FBAR 3- 7,	.6694,	.4456,	.6084,	.7988,	.6581,	.5107,	.4519,	.2393,	.1861,	.3179,

YEAR,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	2005,	FBAR **-**
AGE											
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.0306,	.0348,	.0884,	.0954,	.1241,	.1479,	.1899,	.1069,	.0189,	.0701,	.0653,
3,	.1922,	.1487,	.1758,	.2828,	.3175,	.3428,	.4507,	.3041,	.1510,	.1566,	.2039,
4,	.4516,	.4101,	.2728,	.2900,	.3775,	.4521,	.5948,	.5757,	.2976,	.3109,	.3947,
5,	.8049,	.8311,	.6430,	.3178,	.2473,	.3050,	.8118,	.8408,	.5755,	.5067,	.6410,
6,	.9026,	1.0312,	1.0460,	.6481,	.3260,	.3498,	.8162,	.8839,	.9537,	.4985,	.7787,
7,	1.1295,	1.3854,	.7622,	1.0426,	.5192,	.6961,	1.3584,	.8764,	1.0534,	.8446,	.9248,
8,	.8814,	1.3075,	1.1265,	.7298,	.7581,	.5962,	1.2264,	.9230,	.9820,	.5224,	.8091,
9,	1.0829,	.9145,	.7822,	.4571,	.1693,	.6530,	1.0811,	1.7107,	1.9312,	.9875,	1.5431,
FBAR 3- 7,	.6961,	.7613,	.5800,	.5163,	.3575,	.4292,	.8064,	.6962,	.6062,	.4635,	

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

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

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

YEAR,	1966,	1967,	1968,	1969,	1970,	1971,	1972,	1973,	1974,	1975,
AGE										
1,	28643,	21475,	11390,	10514,	14569,	26041,	15356,	37229,	46803,	22687,
2,	18566,	23451,	17582,	9325,	8608,	11928,	21320,	12573,	30480,	38319,
3,	5999,	13990,	17744,	13012,	6840,	6684,	9469,	16664,	9639,	23000,
4,	10207,	4034,	9020,	11522,	7843,	4548,	4788,	6689,	10816,	6747,
5,	4085,	6475,	2525,	4976,	6447,	4456,	2981,	3187,	4037,	7217,
6,	1698,	2133,	3757,	1212,	2682,	3754,	2483,	1901,	1969,	2460,
7,	351,	842,	980,	1967,	561,	1516,	1760,	1109,	1209,	1103,
8,	200,	109,	410,	393,	965,	238,	779,	902,	626,	581,
9,	80,	70,	31,	240,	138,	519,	92,	499,	533,	378,
TOTAL,	69829,	72579,	63439,	53161,	48654,	59683,	59029,	80752,	106115,	102492,

YEAR,	1976,	1977,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,
AGE										
1,	12208,	13128,	18318,	28803,	17100,	27026,	30727,	58328,	21148,	11611,
2,	18575,	9995,	10748,	14997,	23582,	14000,	22127,	25157,	47755,	17315,
3,	29035,	13853,	7799,	8298,	11759,	18286,	10878,	17086,	18653,	35121,
4,	13683,	20010,	8372,	5282,	5226,	7579,	11228,	7128,	8767,	10535,
5,	3572,	7765,	10190,	4463,	2811,	2957,	4413,	6412,	3339,	4022,
6,	3908,	1676,	2993,	5433,	2206,	1491,	1564,	2449,	2765,	1411,
7,	1279,	1909,	659,	1509,	2723,	1076,	694,	854,	916,	1439,
8,	636,	489,	513,	297,	789,	1477,	440,	284,	238,	466,
9,	304,	274,	184,	238,	122,	339,	732,	207,	91,	121,
TOTAL,	83200,	69098,	59776,	69320,	66318,	74232,	82804,	117907,	103671,	82041,

YEAR,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,
AGE										
1,	12109,	10593,	19582,	4489,	8160,	13938,	12365,	30789,	52212,	15720,
2,	9506,	9914,	8673,	16032,	3675,	6681,	11412,	10124,	25208,	42748,
3,	13273,	7593,	7884,	6640,	11102,	2789,	5296,	9158,	8180,	20120,
4,	20173,	7622,	4984,	4535,	3490,	6511,	1876,	3925,	6772,	5984,
5,	5192,	8860,	3878,	2321,	1734,	1517,	3384,	1114,	2668,	4583,
6,	1783,	2104,	4464,	1832,	886,	649,	680,	1946,	711,	1703,
7,	459,	639,	988,	1684,	572,	360,	257,	291,	1296,	469,
8,	389,	162,	321,	363,	477,	202,	166,	91,	152,	902,
9,	102,	185,	71,	111,	98,	127,	81,	88,	45,	89,
TOTAL,	62986,	47672,	50845,	38008,	30195,	32775,	35517,	57525,	97243,	92317,

YEAR,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	2005,	2006,	GMST 61-**	AMST 61-**
AGE													
1,	7890,	7260,	17580,	24176,	38400,	16233,	9070,	7269,	10428,	6939,	0,	17688,	20707,
2,	12870,	6460,	5944,	14393,	19793,	31439,	13291,	7426,	5951,	8538,	5682,	14720,	17094,
3,	32633,	10220,	5108,	4455,	10712,	14314,	22200,	9000,	5463,	4781,	6517,	11100,	12808,
4,	14015,	22045,	7211,	3508,	2749,	6384,	8318,	11582,	5436,	3846,	3347,	6877,	7939,
5,	3083,	7305,	11977,	4494,	2149,	1543,	3326,	3757,	5332,	3305,	2307,	3650,	4208,
6,	2837,	1129,	2605,	5155,	2678,	1374,	931,	1209,	1327,	2455,	1630,	1770,	2070,
7,	973,	942,	329,	749,	2208,	1582,	793,	337,	409,	419,	1221,	812,	971,
8,	277,	258,	193,	126,	216,	1075,	646,	167,	115,	117,	147,	333,	419,
9,	580,	94,	57,	51,	50,	83,	485,	155,	54,	35,	57,	138,	191,
0 TOTAL,	75158,	55711,	51004,	57107,	78954,	74027,	59059,	40900,	34516,	30435,	20908,		

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

	RECRUITS (AGE 2)	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 3- 7
1961	12019	65428	46439	21598	0.4651	0.6059
1962	20654	68225	43326	20967	0.4839	0.5226
1963	20290	77602	49054	22215	0.4529	0.4944
1964	21834	84666	55362	21078	0.3807	0.5017
1965	8269	75043	57057	24212	0.4244	0.4909
1966	18566	83919	60629	20418	0.3368	0.4743
1967	23451	105289	73934	23562	0.3187	0.39
1968	17582	110433	82484	29930	0.3629	0.4642
1969	9325	105537	83487	32371	0.3877	0.4375
1970	8608	98398	82035	24183	0.2948	0.3882
1971	11928	78218	63308	23010	0.3635	0.3526
1972	21320	76439	57180	18727	0.3275	0.3358
1973	12573	107682	80516	22228	0.2761	0.2886
1974	30480	136663	95831	24581	0.2565	0.3139
1975	38319	149774	105676	36775	0.348	0.3947
1976	18575	154919	116736	39799	0.3409	0.4749
1977	9995	136017	111863	34927	0.3122	0.6757
1978	10748	94338	76608	26585	0.347	0.4259
1979	14997	83769	65380	23112	0.3535	0.4273
1980	23582	84536	58386	20513	0.3513	0.3945
1981	14000	86907	62058	22963	0.37	0.4648
1982	22127	96624	64695	21489	0.3322	0.4138
1983	25157	121638	76931	38133	0.4957	0.7057
1984	47755	150219	94846	36979	0.3899	0.5082
1985	17315	129603	83164	39484	0.4748	0.7015
1986	9506	98517	72949	34595	0.4742	0.6694
1987	9914	77641	61522	21391	0.3477	0.4456
1988	8673	65636	51640	23182	0.4489	0.6084
1989	16032	58633	38173	22068	0.5781	0.7988
1990	3675	37620	28631	13487	0.4711	0.6581
1991	6681	28242	20613	8750	0.4245	0.5107
1992	11412	34864	19886	6396	0.3216	0.4519
1993	10124	50212	32180	6107	0.1898	0.2393
1994	25208	83790	42324	9046	0.2137	0.1861
1995	42748	143695	53448	23045	0.4312	0.3179
1996	12870	142132	84752	40422	0.4769	0.6961
1997	6460	95563	80264	34304	0.4274	0.7613
1998	5944	65941	55560	24005	0.4321	0.58
1999	14393	65084	45008	18306	0.4067	0.5163
2000	19793	91491	46369	21033	0.4536	0.3575
2001	31439	112266	59387	28183	0.4746	0.4292
2002	13291	101227	57199	38486	0.6728	0.8064
2003	7426	64053	42489	24581	0.5785	0.6962
2004	5951	42626	29498	13215	0.448	0.6062
2005	8538	40522	28754	10499	0.3651	0.4635
Arith. Mean	20172	90259	62170	24243	0.3974	0.4988
Units	(Thousands)	(Tonnes)	(Tonnes)		(Tonnes)	

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

Recruitment

	XSA	RCT3	Geomean 61-05
YC2003	8538		
YC2004	5682		
YC2005			14253
YC2006			14253

Stock size

2006
5682
6517
3347
2307
1630
1221
147
57

Directly from XSA output

Maturity

Age	Observed 2006	Av.04-06 2007	Av.04-06 2008
2	0.04	0.03	0.03
3	0.59	0.59	0.59
4	0.8	0.83	0.83
5	0.99	0.95	0.95
6	0.99	0.95	0.95
7	1	0.93	0.93
8	1	1	1
9	1	1	1

Exploitation pattern
(rescaled to 2005 level)

Av03-05 2006	Av03-05 2007	Av03-05 2008
0.0514	0.0514	0.0514
0.1605	0.1605	0.1605
0.3108	0.3108	0.3108
0.5047	0.5047	0.5047
0.6131	0.6131	0.6131
0.7281	0.7281	0.7281
0.6371	0.6371	0.6371
1.2150	1.2150	1.2150

Weights

Est.from Jan-Feb 2006	As2005 2007	As2005 2008
0.9920	0.9920	0.9920
1.8070	1.8070	1.8070
2.1000	2.1000	2.1000
2.8680	2.8680	2.8680
3.7500	3.7500	3.7500
4.8460	4.8460	4.8460
6.7250	6.7250	6.7250
9.0940	9.0940	9.0940

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

MFDP VERSION 1

Run: Shortterm3

Index file 28/4-2006

Time and date: 15:22 29/04/2006

Fbar age range: 3-7

2006

Biomass	**SSB**	**FMult**	**FBar**	**Landings**

2007					**2008**	
Biomass	**SSB**	**FMult**	**FBar**	**Landings**	**Biomass**	**SSB**
49032	29674	0.0000	0.0000	0	71759	46948
.	29674	0.0750	0.0348	1056	70529	45806
.	29674	0.1500	0.0695	2072	69344	44705
.	29674	0.2250	0.1043	3052	68200	43644
.	29674	0.3000	0.1390	3996	67096	42623
.	29674	0.3750	0.1738	4907	66031	41638
.	29674	0.4500	0.2086	5785	65003	40689
.	29674	0.5250	0.2433	6632	64010	39773
.	29674	0.6000	0.2781	7449	63051	38891
.	29674	0.6750	0.3128	8239	62125	38039
.	29674	0.7500	0.3476	9001	61230	37217
.	29674	0.8250	0.3824	9737	60364	36425
.	29674	0.9000	0.4171	10449	59528	35659
.	29674	0.9750	0.4519	11137	58719	34920
.	29674	1.0500	0.4866	11802	57936	34206
.	29674	1.1250	0.5214	12445	57179	33517
.	29674	1.2000	0.5562	13068	56446	32851
.	29674	1.2750	0.5909	13671	55737	32207
.	29674	1.3500	0.6257	14254	55050	31584
.	29674	1.4250	0.6604	14819	54385	30983
.	29674	1.5000	0.6952	15367	53740	30401

Input units are thousands and kg - output in tonnes

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

	EXPLOITATION pattern	**WEIGHTATAGE**	**PROPMATURE**
	Average 2000-2005 Not rescaled	Average 1978-2005	Average 1983-2006
Age 2	0.1096	1.0603	0.0304
Age 3	0.2871	1.5947	0.5496
Age 4	0.4348	2.2868	0.8404
Age 5	0.5479	3.0916	0.9450
Age 6	0.638	3.8638	0.9838
Age 7	0.8914	4.8684	0.9858
Age 8	0.8347	6.0102	0.9975
Age 9	0.7228	7.5277	1.0000

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

MFYPR version 1
Run: YLD1
Time and date: 19:33 28/04/2006
Yield per results

FMult	Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNosJan	SSBJan	SpwnNosSpwn	SSBSpwn
0.0000	0.0000	0.0000	0.0000	4.4029	12.7892	2.9141	10.7770	2.9141	10.7770
0.1000	0.0560	0.1523	0.5533	4.0459	10.9925	2.5699	9.0132	2.5699	9.0132
0.2000	0.1120	0.2622	0.8976	3.7566	9.5940	2.2924	7.6448	2.2924	7.6448
0.3000	0.1679	0.3432	1.1093	3.5190	8.4925	2.0661	6.5712	2.0661	6.5712
0.4000	0.2239	0.4044	1.2367	3.3213	7.6143	1.8791	5.7188	1.8791	5.7188
0.5000	0.2799	0.4518	1.3110	3.1548	6.9055	1.7227	5.0341	1.7227	5.0341
0.6000	0.3359	0.4894	1.3519	3.0129	6.3264	1.5905	4.4776	1.5905	4.4776
0.7000	0.3919	0.5198	1.3719	2.8906	5.8474	1.4775	4.0198	1.4775	4.0198
0.8000	0.4479	0.5451	1.3790	2.7842	5.4467	1.3799	3.6391	1.3799	3.6391
0.9000	0.5038	0.5666	1.3782	2.6907	5.1077	1.2948	3.3189	1.2948	3.3189
1.0000	0.5598	0.5850	1.3728	2.6078	4.8179	1.2200	3.0470	1.2200	3.0470
1.1000	0.6158	0.6012	1.3648	2.5337	4.5676	1.1538	2.8137	1.1538	2.8137
1.2000	0.6718	0.6155	1.3553	2.4670	4.3495	1.0947	2.6118	1.0947	2.6118
1.3000	0.7278	0.6283	1.3453	2.4066	4.1579	1.0415	2.4355	1.0415	2.4355
1.4000	0.7837	0.6400	1.3350	2.3516	3.9881	0.9936	2.2805	0.9936	2.2805
1.5000	0.8397	0.6505	1.3249	2.3013	3.8367	0.9500	2.1432	0.9500	2.1432
1.6000	0.8957	0.6603	1.3151	2.2549	3.7008	0.9102	2.0208	0.9102	2.0208
1.7000	0.9517	0.6692	1.3056	2.2121	3.5781	0.8737	1.9111	0.8737	1.9111
1.8000	1.0077	0.6775	1.2965	2.1723	3.4667	0.8401	1.8122	0.8401	1.8122
1.9000	1.0637	0.6853	1.2878	2.1353	3.3650	0.8091	1.7225	0.8091	1.7225
2.0000	1.1196	0.6925	1.2795	2.1007	3.2719	0.7803	1.6410	0.7803	1.6410

Reference point	F multiplier	Absolute F
Fbar(3-7)	1.0000	0.5598
FMax	0.8359	0.468
F0.1	0.4604	0.2577
F35%SPR	0.763	0.4272
Flow	0.0465	0.026
Fmed	0.6075	0.3401
Fhigh	1.7107	0.9577

Weights in kilograms

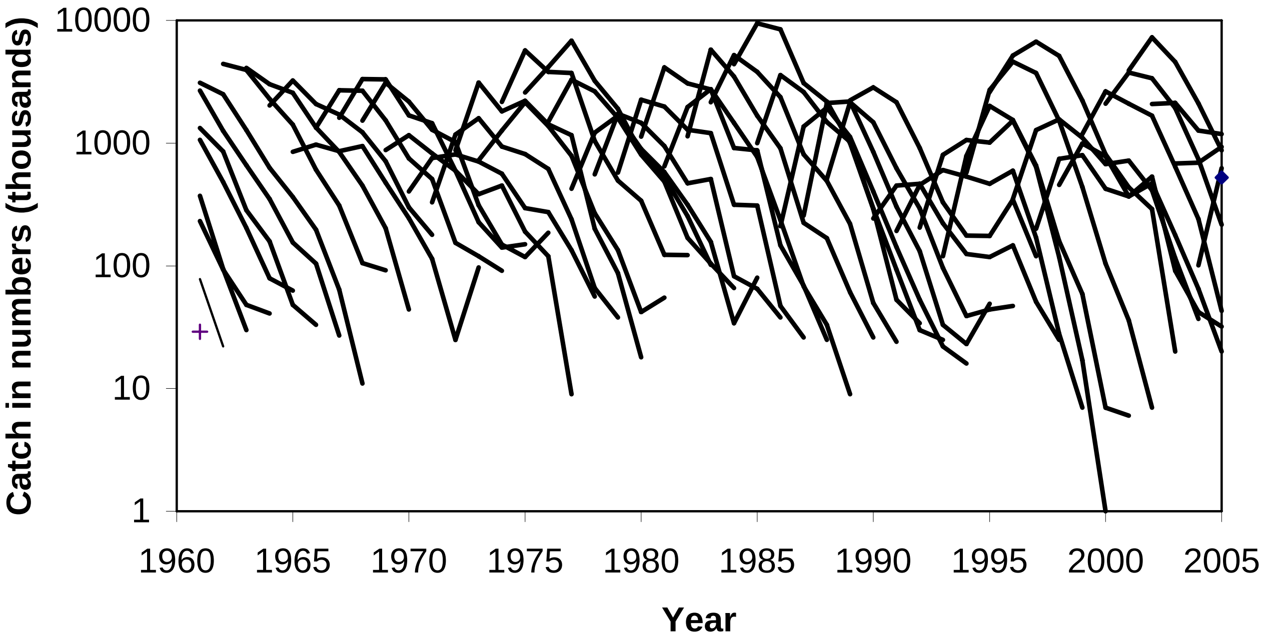


Figure 2.2.3.1. Faroe Plateau (sub-division VB1) COD. Catch in numbers.

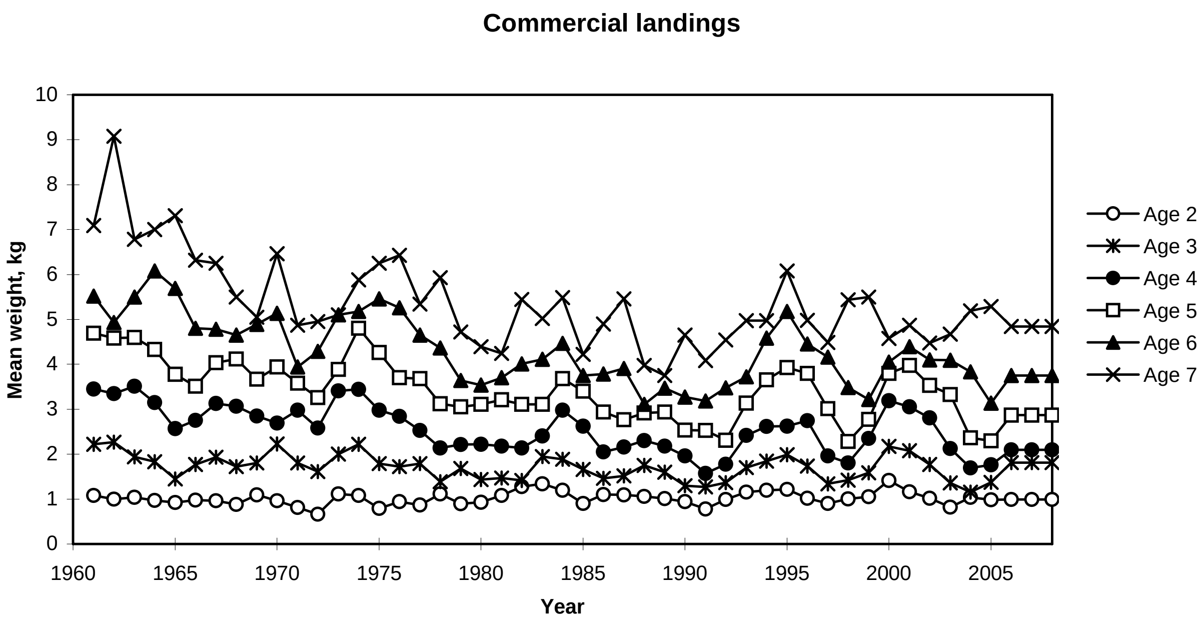


Figure 2.2.4.1. Faroe Plateau (sub-division VB1) COD. Mean weight at age 1961-2005. The estimated weights in 2006 are also shown. The weights in 2007 and 2008 are set to the 2006 value.

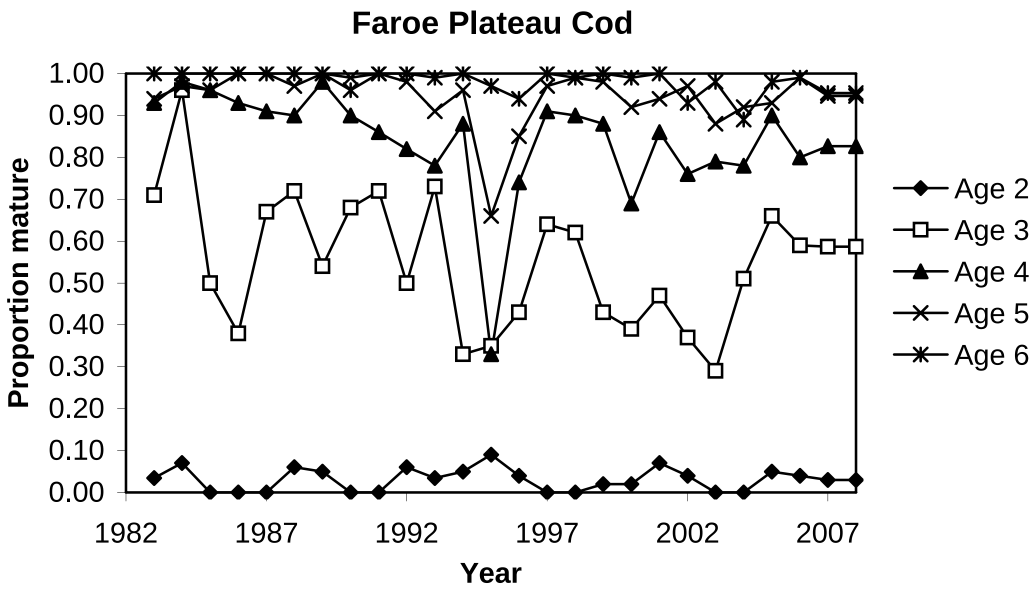


Figure 2.2.5.1. Faroe Plateau (sub-division VB1) COD. Proportion mature at age as observed in the spring groundfish survey. The values in 2007 and 2008 are estimated as the average of the 2004-2006 values.

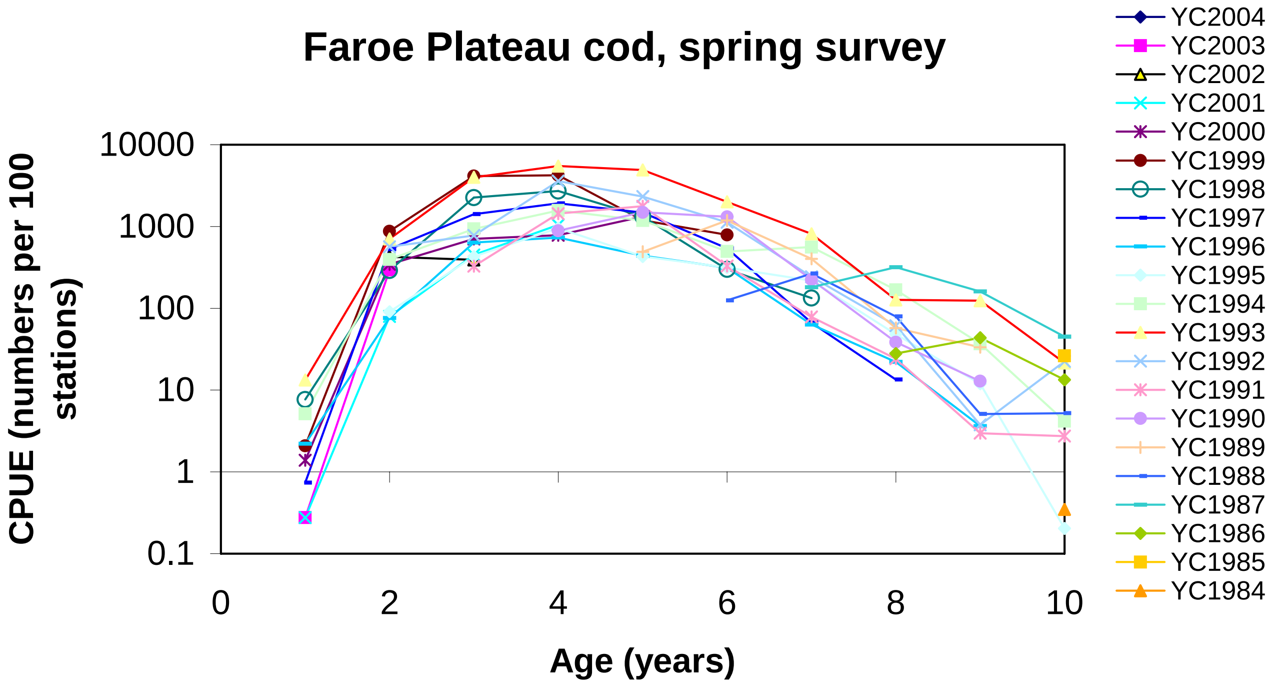


Figure 2.2.6.1. Faroe Plateau (sub-division VB1) COD. Catch curves from the spring groundfish survey.

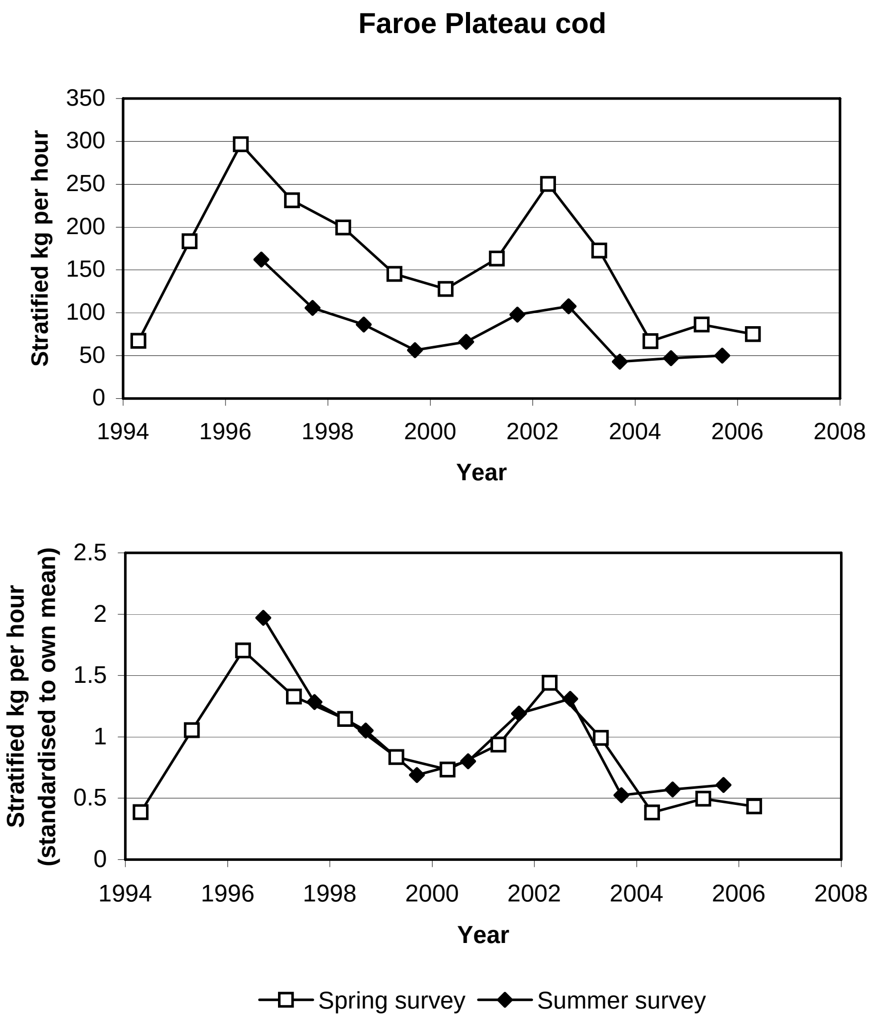


Figure 2.2.6.2. Faroe Plateau (sub-division VB1) COD. Stratified kg/hour in the spring and summer surveys.

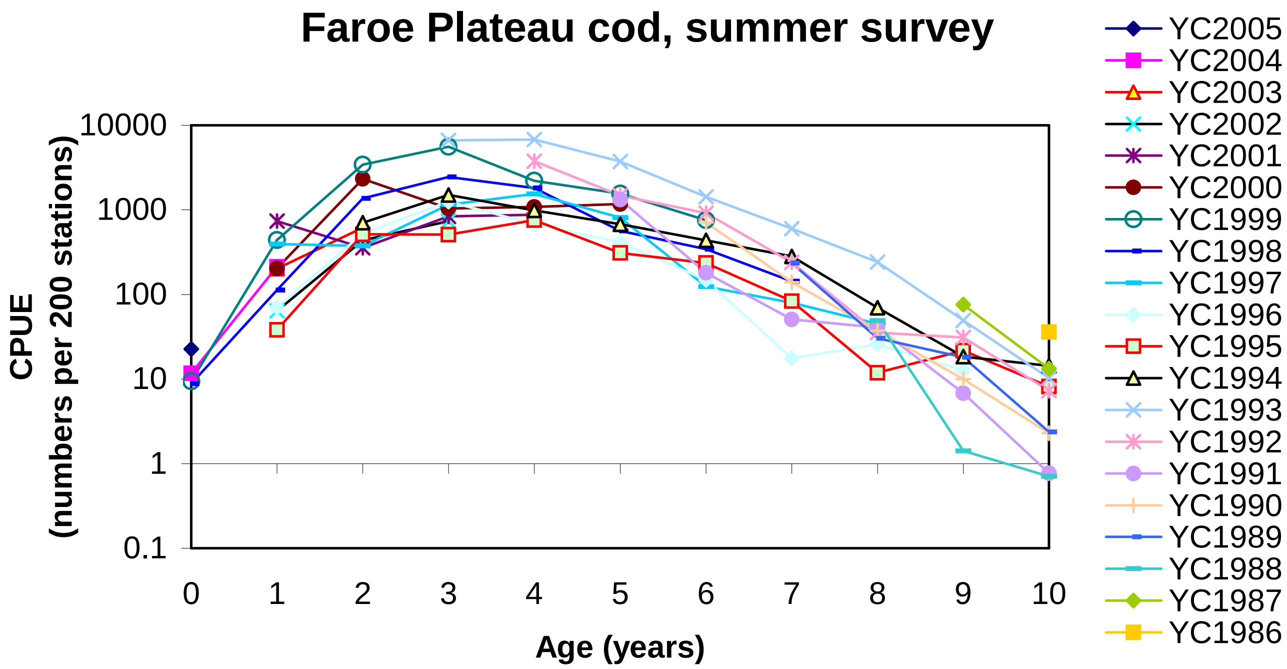


Figure 2.2.6.3. Faroe Plateau (sub-division VB1) COD. Catch curves from the summer groundfish survey.

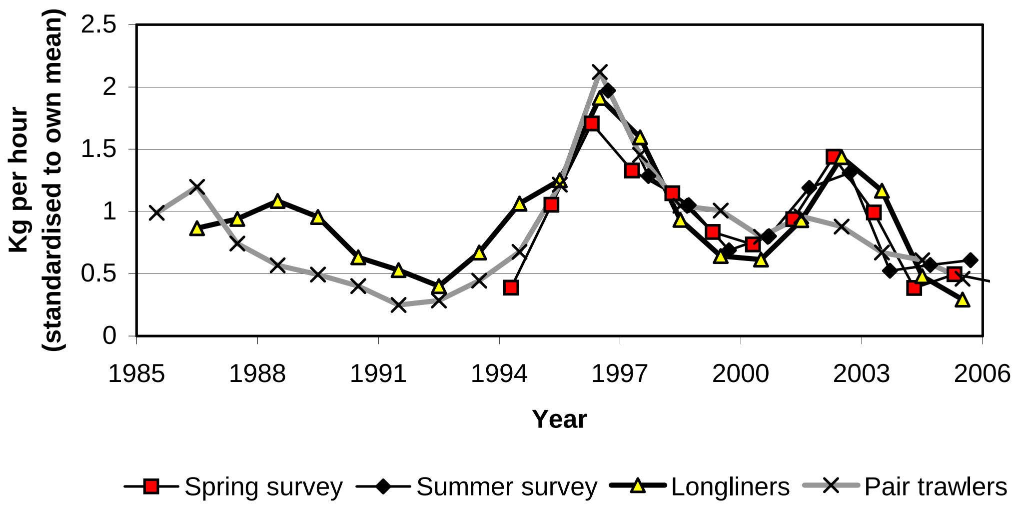
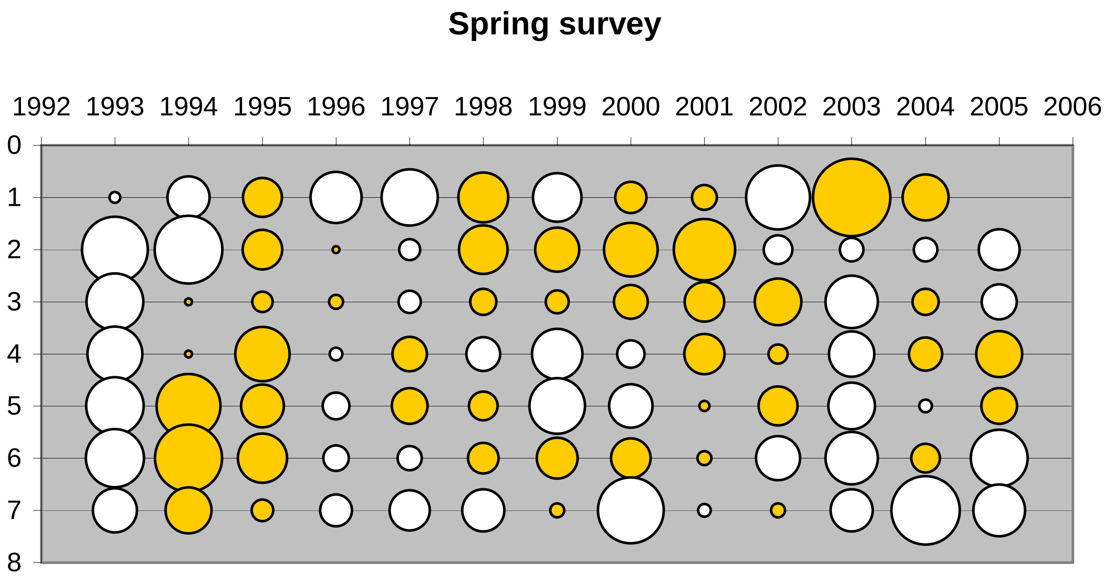


Figure 2.2.7.1.1. Faroe Plateau (sub-division VB1) COD. Standardised catch per unit effort for pair trawlers and longliners. The two surveys are shown as well.



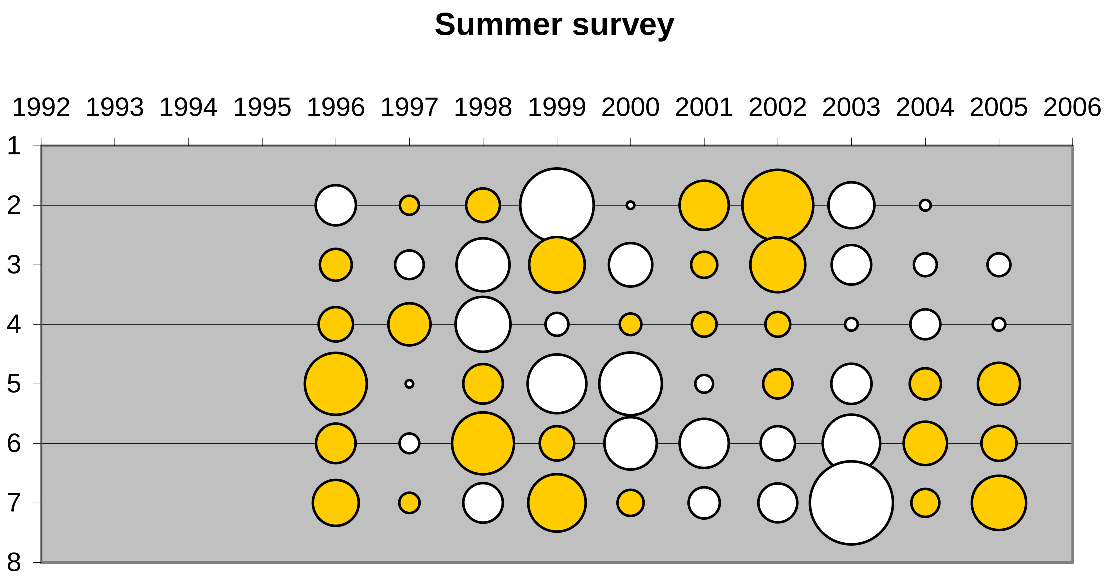


Figure 2.2.7.1.2. Faroe Plateau (sub-division VB1) COD. Log catchability residuals for the spring and summer survey. The residuals for age 8 are not presented because some values were off scale. White bubbles indicate negative residuals.

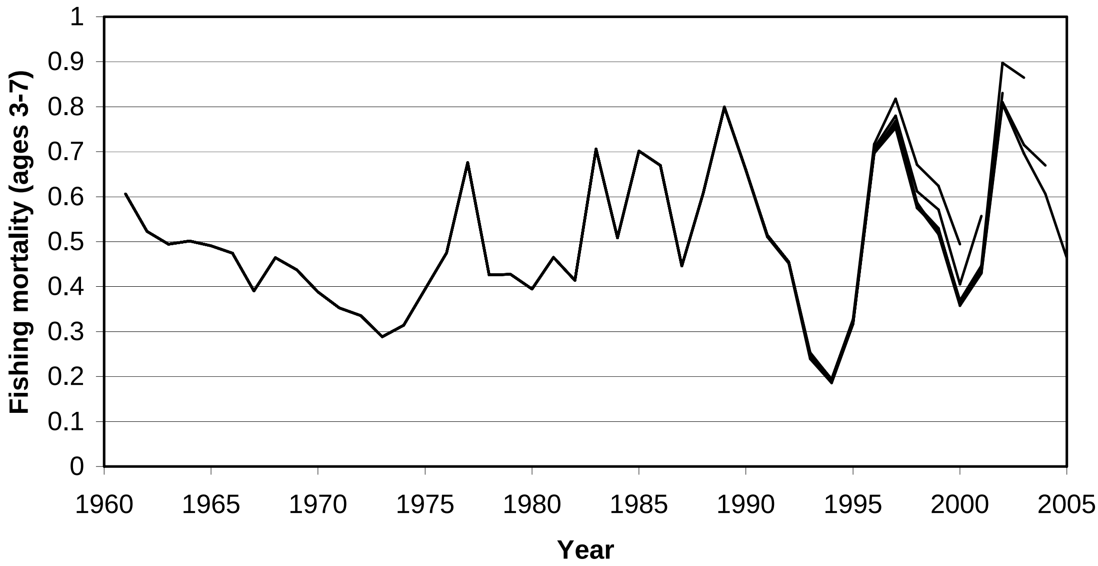
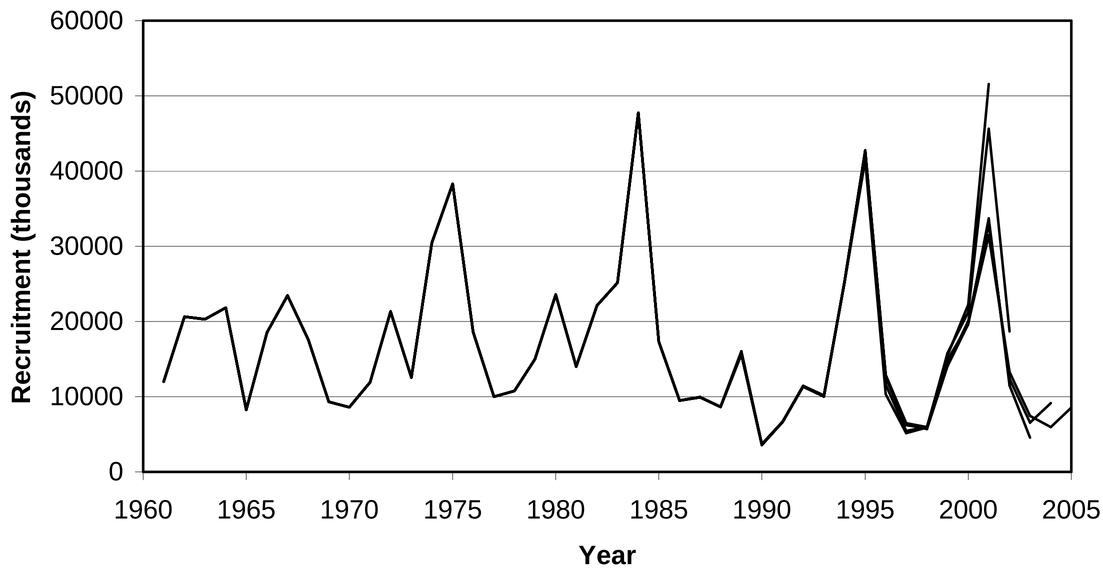


Figure 2.2.7.1.3. Faroe Plateau (sub-division VB1) COD. Results from the XSA retrospective analysis.



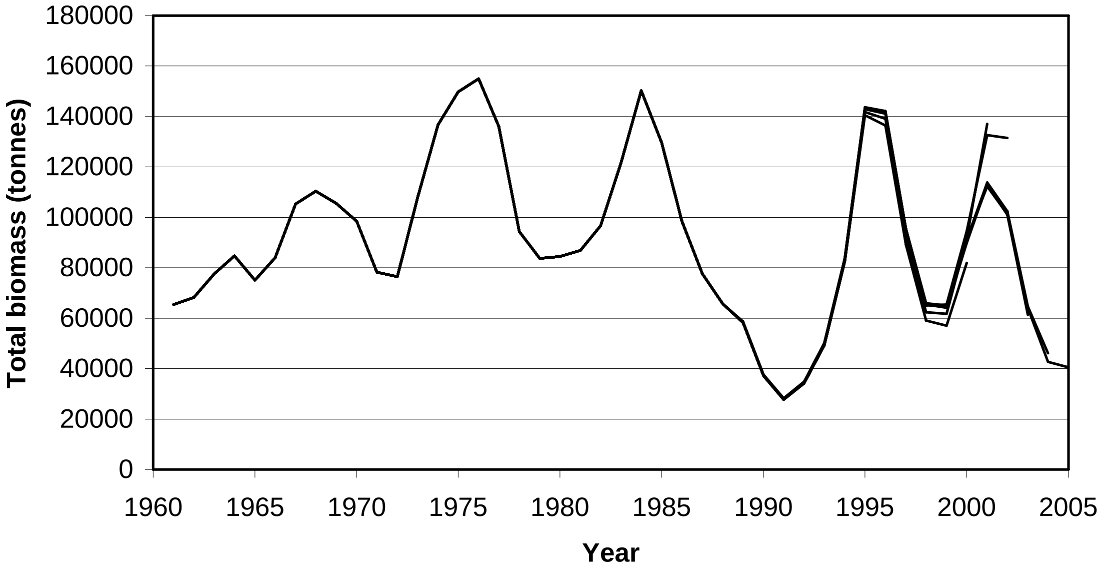


Figure 2.2.7.1.3. Faroe Plateau (sub-division VB1) COD. Results from the XSA retrospective analysis. Continued.

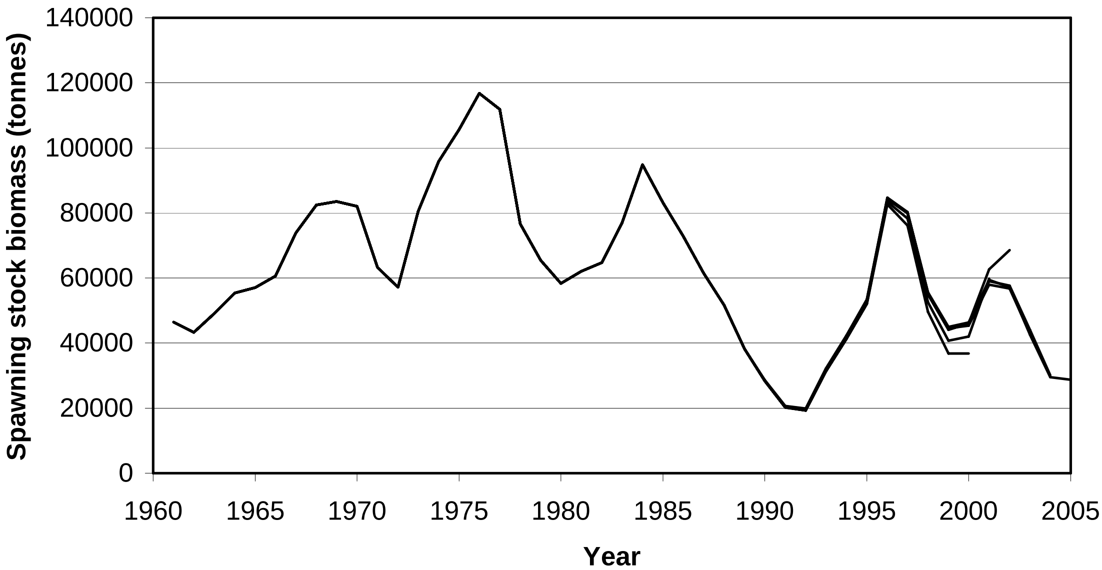


Figure 2.2.7.1.3. Faroe Plateau (sub-division VB1) COD. Results from XSA retrospective analysis. Continued.

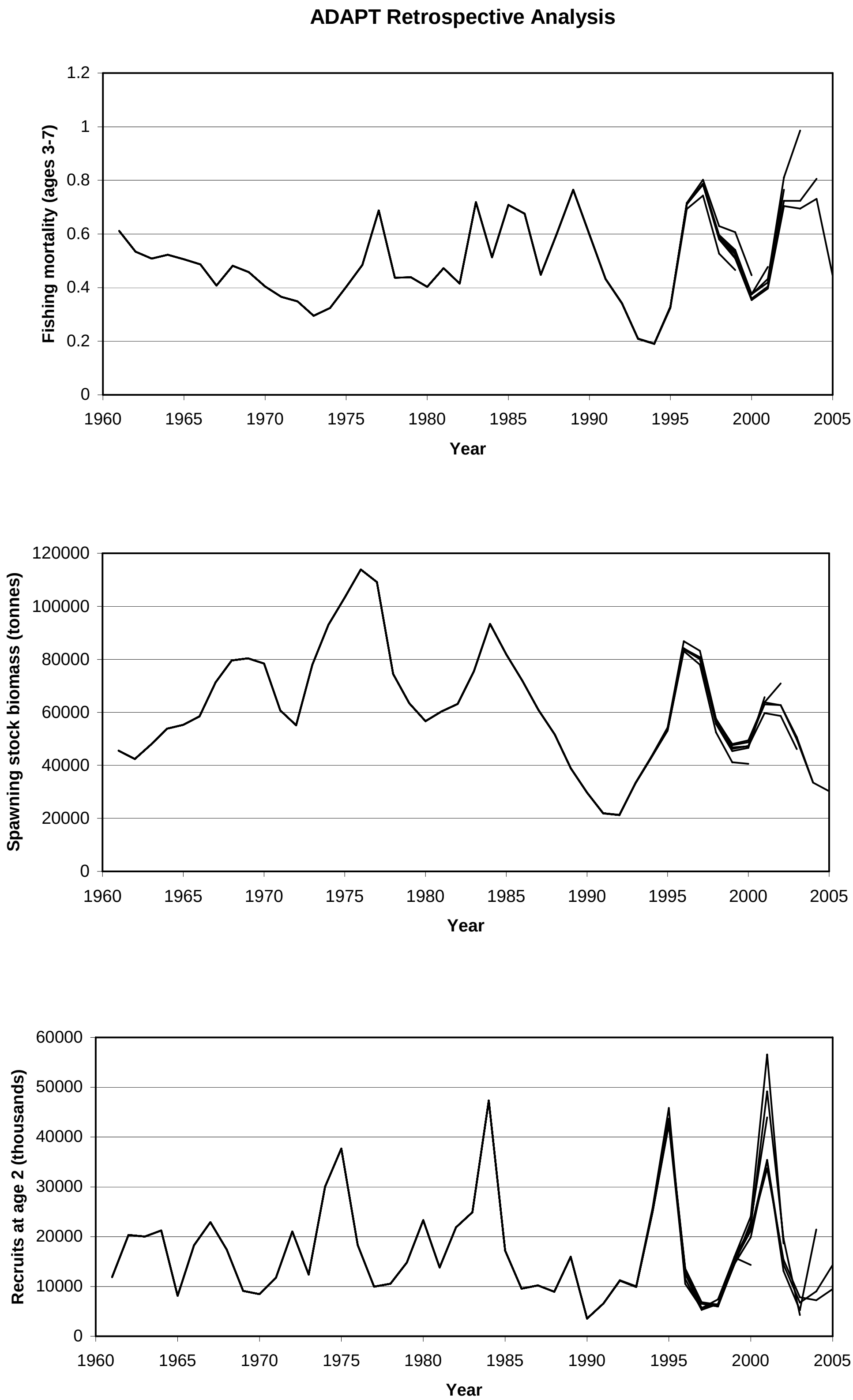
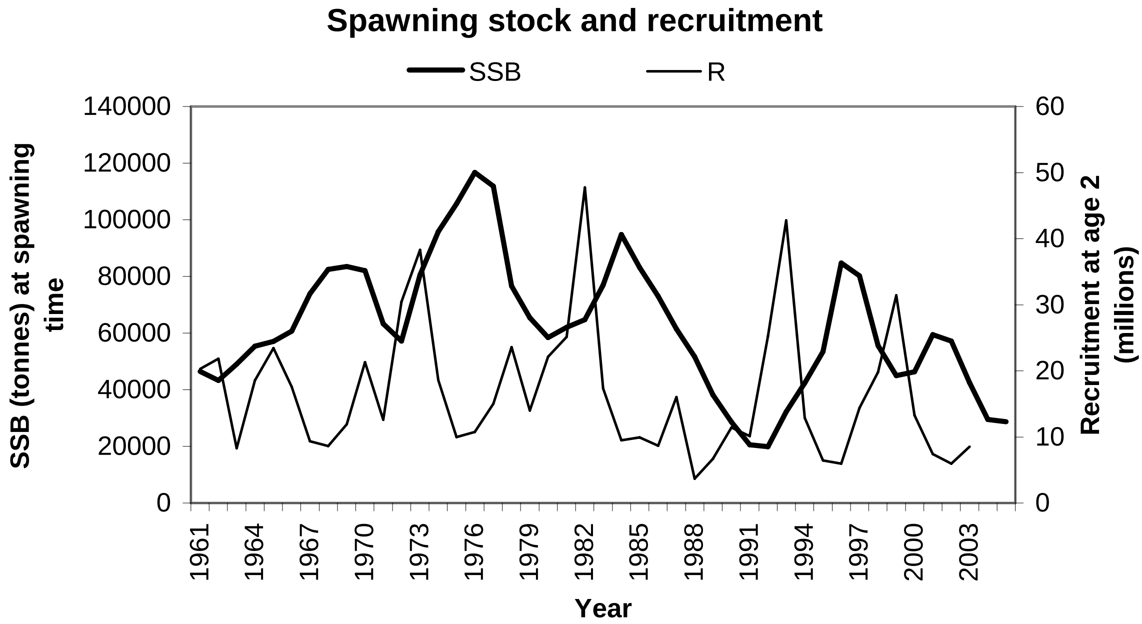


Figure 2.2.7.1.4. Retrospective pattern from the ADAPT calibrated with the summer and the spring surveys ages 2 to 8.



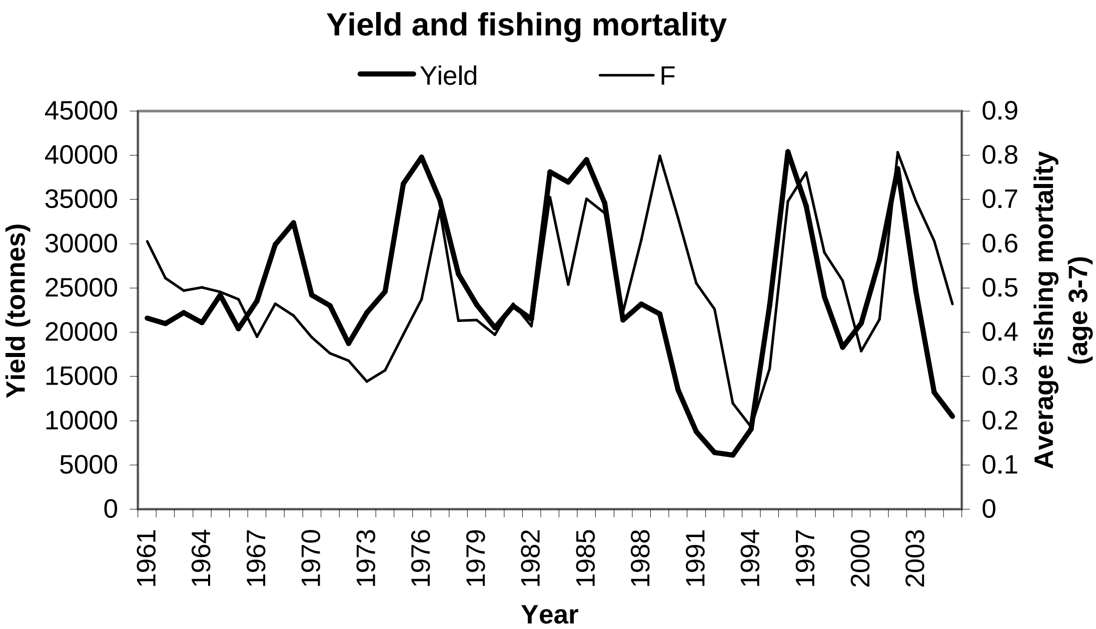


Figure 2.2.7.1.5. Faroe Plateau (sub-division VB1) COD. Yield and fishing versus year. Spawning stock biomass (SSB) and recruitment (year class) versus year.

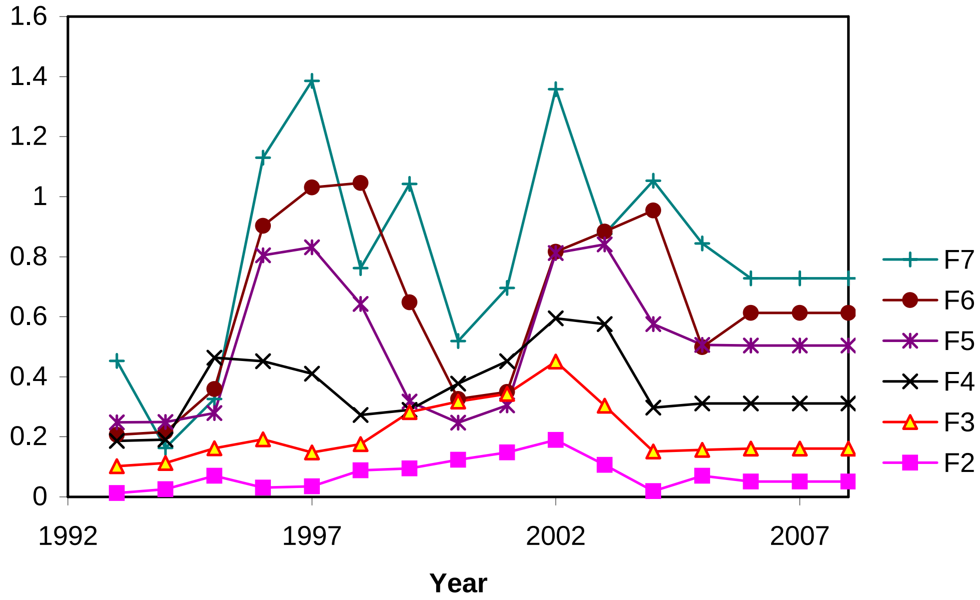


Figure 2.2.7.1.6. Faroe Plateau (sub-division VB1) COD. Fishing mortalities by age. The F-values in 2006-2008 are set to the average values in 2003-2005 rescaled to the 2005 level.

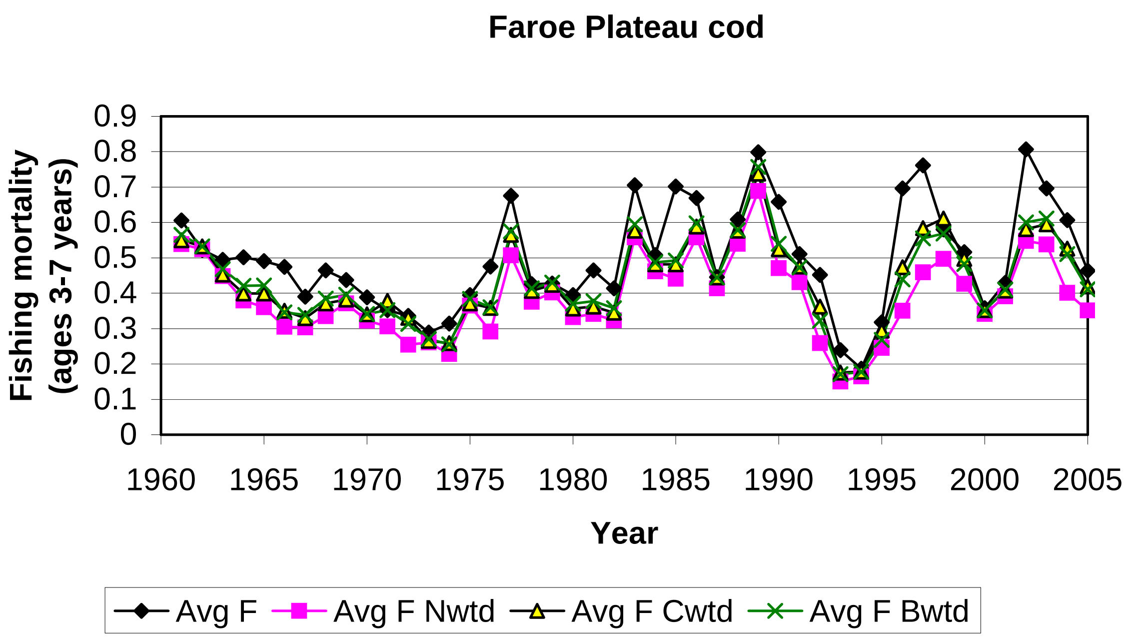


Figure 2.2.7.1.7. Faroe Plateau (sub-division VB1) COD. Different measures of fishing mortality: straight arithmetic average (Avg F), weighted by stock numbers (Nwtd), weighted by stock biomass (Bwtd) or weighted by catch (Cwtd).

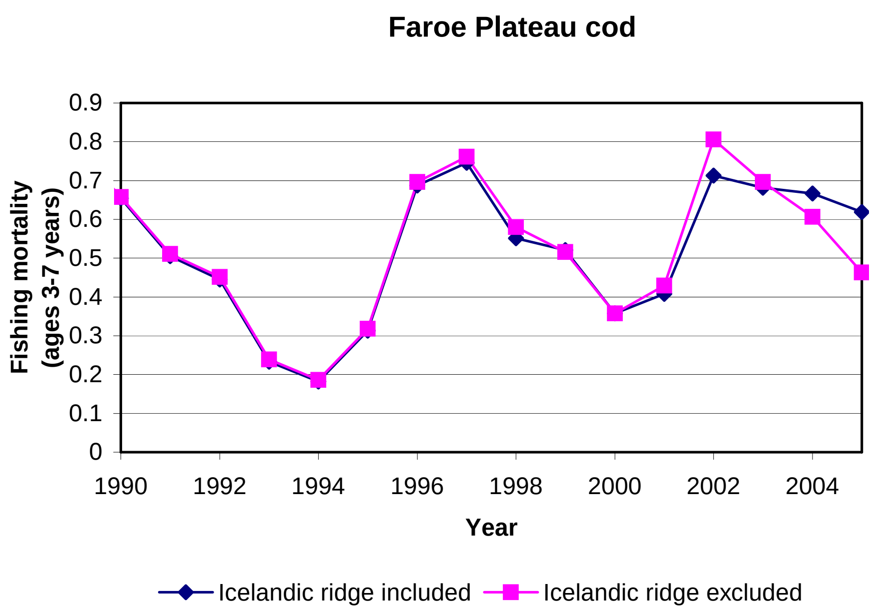


Figure 2.2.7.1.8. Faroe Plateau cod. Fishing mortalities from the XSA runs having the Faroese catches on the Faroe-Icelandic ridge included or excluded.

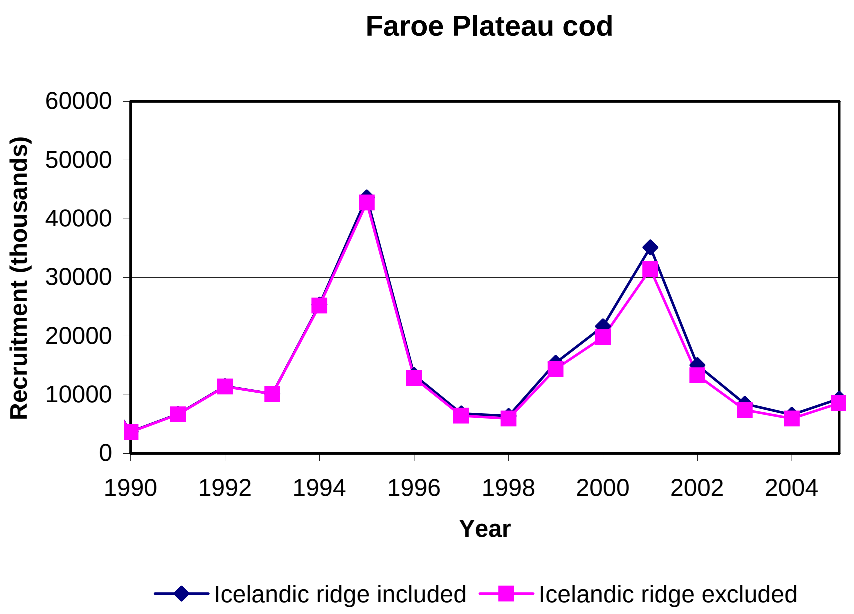


Figure 2.2.7.1.8 (continued). Faroe Plateau cod. Recruitment from the XSA runs having the Faroese catches on the Faroe-Icelandic ridge included or excluded.

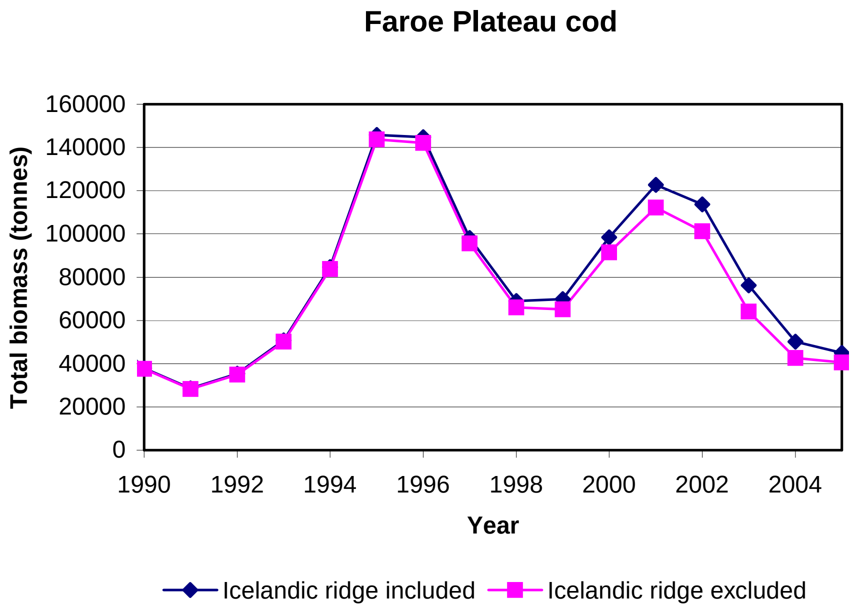


Figure 2.2.7.1.8 (continued). Faroe Plateau cod. Total biomass from the XSA runs having the Faroese catches on the Faroe-Icelandic ridge included or excluded.

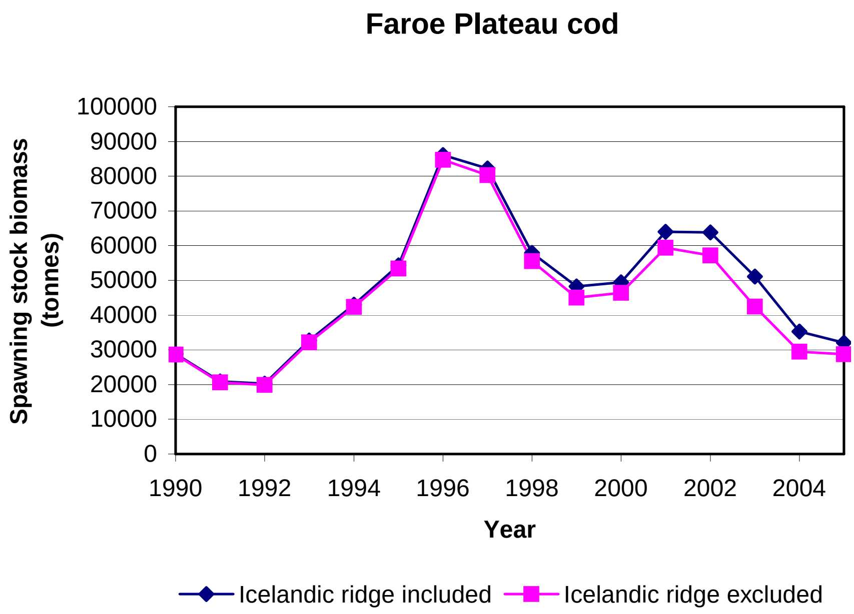


Figure 2.2.7.1.8 (continued). Faroe Plateau cod. Spawning stock biomass from the XSA runs having the Faroese catches on the Faroe-Icelandic ridge included or excluded.

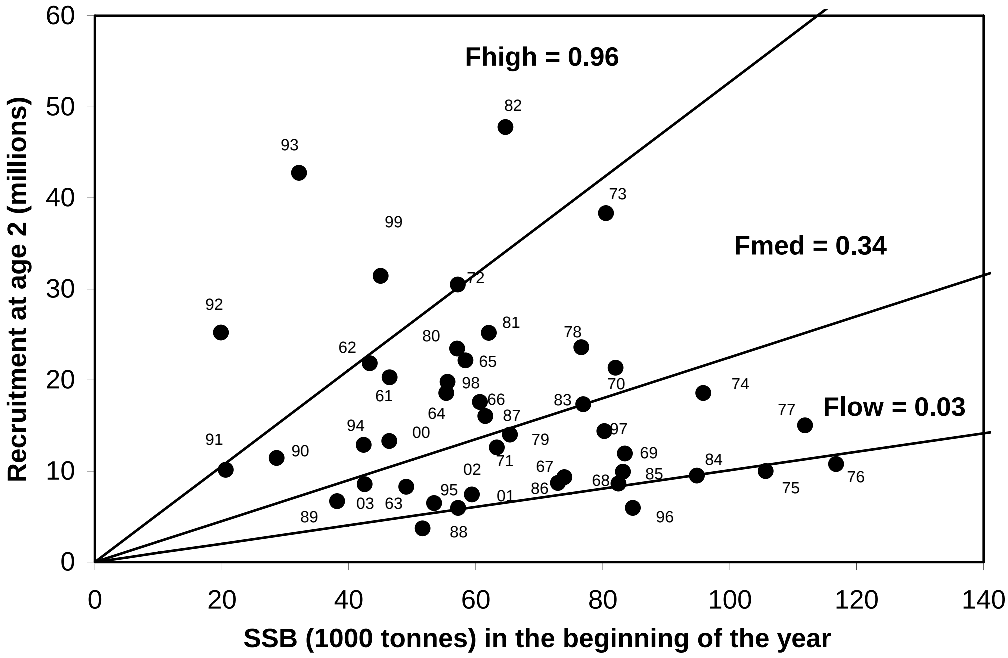


Figure 2.2.7.2.1. Faroe Plateau (sub-division VB1) COD. Spawning stock – recruitment relationship 1961-2002. Years are shown at each data point.

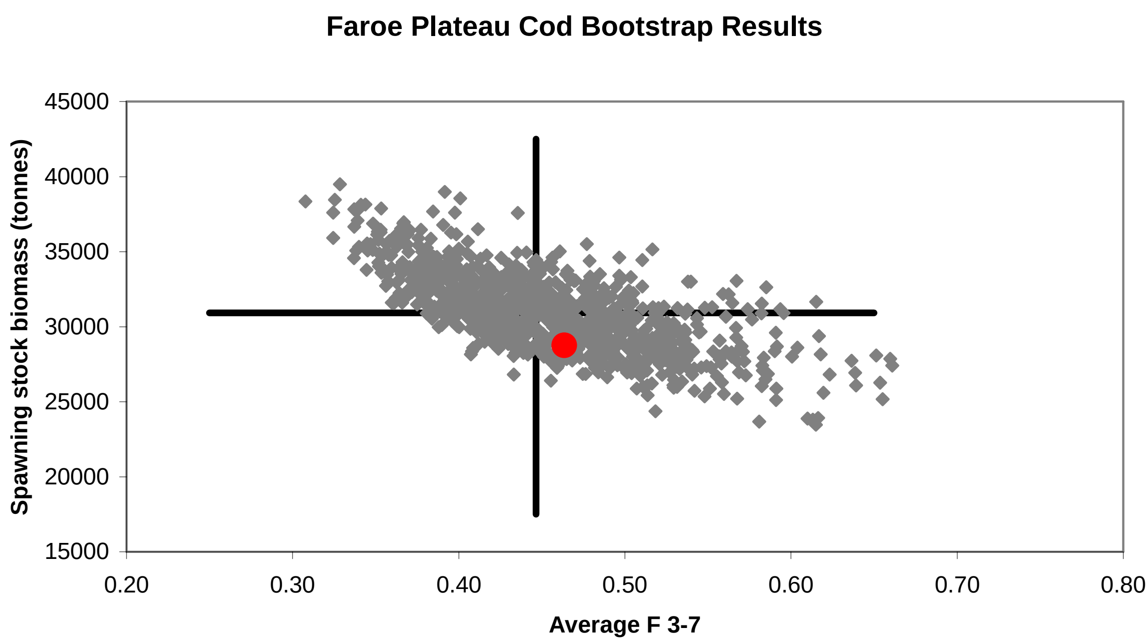


Figure 2.2.7.2.2. F and SSB's for 2004 from a 1000 bootstraps of the ADAPT with the two surveys. The XSA estimate is shown as a red point.

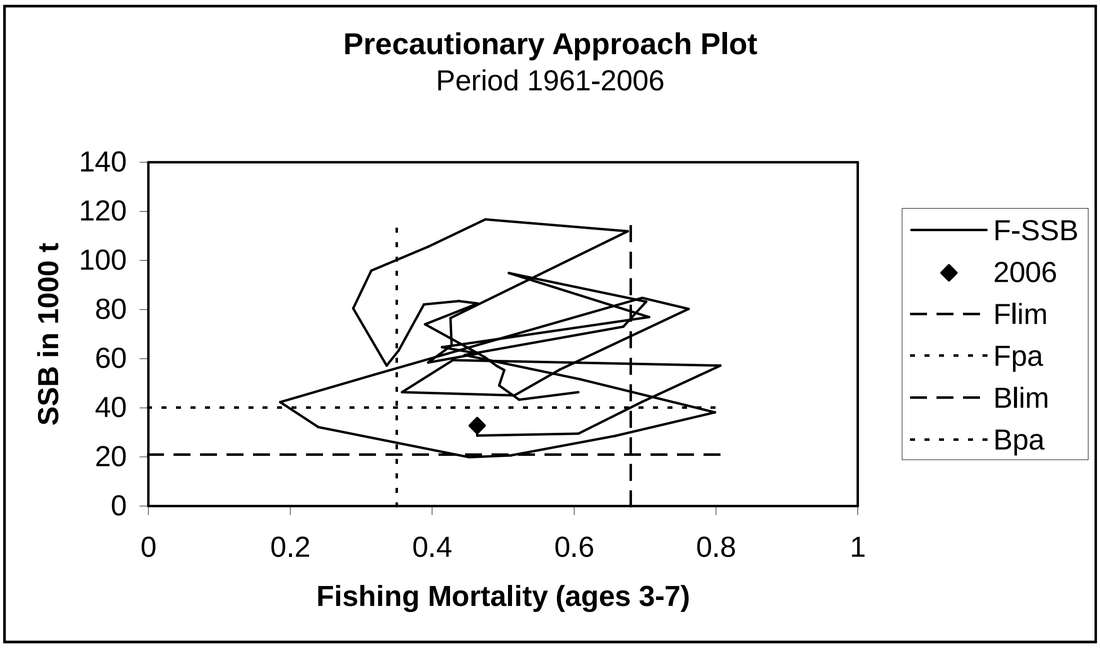
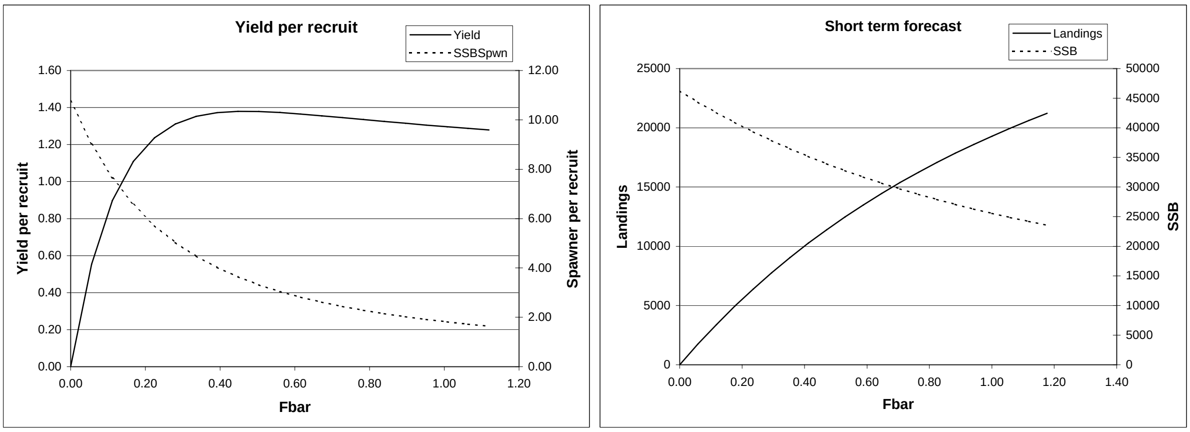


Figure 2.2.8.2.1. Faroe Plateau (sub-division VB1) COD. Spawning stock biomass versus fishing mortality 1961-2006.



MFYPR version 1
Run: YLD1
Time and date: 19:33 28/04/2006

Reference point	F multiplier	Absolute F
Fbar(3-7)	1.0000	0.5598
FMax	0.8359	0.4680
F0.1	0.4604	0.2577
F35%SPR	0.7630	0.4272
Flow	0.0465	0.0260
Fmed	0.6075	0.3401
Fhigh	1.7107	0.9577

Weights in kilograms

MFDP version 1
Run: Sprediction2
Index file 28/4-2006
Time and date: 18:48 28/04/2006
Fbar age range: 3-7

Input units are thousands and kg - output in tonnes

Figure 2.2.8.4.1. Faroe Plateau (subdivision VB1) COD. Yield per recruit and spawning stock biomass (SSB) per recruit versus fishing mortality (left figure). Landings and SSB versus Fbar (3-7).

2.3 Faroe Bank Cod

Answers to terms of reference for the working group will be marked with square brackets.

Terms of reference which apply to the Faroe Bank Cod are:

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

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

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

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

(8) provide specific information on possible deficiencies in the 2006 assessments including, at least, any major inadequacies in the data on landings, effort or discards; any major inadequacies in research vessel surveys data, and any major difficulties in model formulation; including inadequacies in available software. The consequences of these deficiencies for both the assessment of the status of the stocks and the projection should be clarified.

2.3.1 Trends in landings and effort

[ToR 4] Total nominal catches of the Faroe Bank cod from 1986 to 2005 as officially reported to ICES are given in Table 2.3.1.1 and since 1965 in Figure 2.3.1.1. British catches reported to be taken on the Faroe Bank are all assumed to be taken on the Faroe Plateau and are therefore not used in the assessment. Landings have been highly irregular from 1965 to the mid 1980s, reflecting the opportunistic nature of the cod fishery on the Bank, with peak landings slightly exceeding 5 000t in 1973. The trend of landings has been smoother since 1987, declining from about 3 500t in 1987 to only 330 t in 1992 before increasing to 3 600t in 1997. In 2005 landings were estimated at 1 000t about 2 400 t less than in 2004 (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).

[ToR 8] There may be problems with the catch figures for Faroe Bank. The vessels may fish on both Faroe Plateau and Faroe Bank during the same trip. The catches of cod on Faroe Bank are sometimes reported on the landing slips and vessels larger than 15 GRT are obliged to have logbooks. The Faroes Coastal Guard is splitting the landings into Vb1 and Vb2 on the basis of landing slips and logbooks. Since small boats 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 4] For the fishing year 1 Sep 2004 to 31 Aug 2005 the number of allocated fishing days has been reduced by 10%. However the reduction did not materialise in a decrease of realised fishing days. In 2005 the authorities have introduced a total fishing ban during the spawning period, i.e. 1 March to 1 May.

2.3.2 Stock assessment

[ToR 7] Biological samples have been taken from commercial landings since 1974 (the 2005 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.

Fleet	Size	Samples	Length	Otoliths	Weights
Longliners	>100 GRT	18	3,877	478	1,460
Pair trawlers	>1000 HP	2	351	0	0
Total		20	4,228	478	1,460

Table 2.3.2.1. Samples of lengths, otoliths, and individual weights of Faroe Bank cod in 2005

[ToR 7] The Faroese groundfish surveys (spring and summer) cover the Faroe Bank and cod is mainly taken within the 200 m depth contour. The catches of cod per trawl hour in depths shallower than 200 meter are shown in Figure 2.3.2.1.

The spring survey was initiated in 1983 and discontinued in 2003 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 2006 index is 63 kg per tow, which is the lowest since 1994 and very similar to the 2005 summer index (62 kg per tow). The agreement between the summer and spring index is good during 1996 to 2001, but they diverged in 2002 and 2003.

The figure of length distributions (figure 2.3.2.2 and figure 2.3.2.3) show in general good recruitment of 1 year old in the summer survey from 2000 – 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 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 2005.

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 decreased in 2005 but 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 on landings. If the fishery management agency intends to manage the two fisheries to protect the productive capacity of each individual unit, then it is necessary to regulate the catch removed from each stock. Simple measures should make it possible to identify if the catch is originating from the Bank or from the Plateau e.g. by storing in different section of the hold.

[Tor 2] The effort has been extremely high in 2003 and is still fairly high in 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 due too poor data from the surveys, there is no doubt, that the exploitation rate is very high and may not be sustainable.

[ToR b] The recruitment of the 2001 years class seems to be good, while there are indications of bad recruitment of the 2002 to 2004 year classes.

2.3.5 Annex

Stock definition

The Faroe Bank cod is distributed in the Bank South-West of the Faroe Islands (60º15’ S, 61º30’ N, 9º 40’W, 7º40’ E). 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 1986-2005 as officially reported to ICES. From 1992 the catches by Faroe Islands and Norway are used in the assessment.

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Faroe Islands	1836	3409	2960	1270	289	297	122	264	717	561
Norway	6	23	94	128	72	38	32	2	8	40
UK (E/W/NI)	-	-	-	-	-	-	+	1	1	- [2]
UK (Scotland) [1]	63	47	37	14	205	90	176	118	227	551 [3]
United Kingdom										
Total	1905	3479	3091	1412	566	425	330	385	953	1152
Used in assessment					289	297	154	266	725	601

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005 *
Faroe Islands	2051	3459	3092	1001		1094	1840	5957	3607	1106
Norway	55	135	147	88	49	51	25	72	18	37 *
UK (E/W/NI)	- [2]	- [2]	- [2]	-	-	-	-	-	-	
UK (Scotland)	382	277	265	210	245	288	218	254	-	
United Kingdom				-	-	-	-	-	259 [3]	329 [3]
Total	2488	3871	3504	1299	294	1433	2083	6283	3884	1472
Correction of Faroese catches in Vb2						-65	-109	-353	-214	-66
Used in assessment	2106	3594	3239	1089	1194	1080	1756	5676	3411	1077

***) Preliminary**

1) Includes Vb1

2) Included in Vb1

3) Reported as Vb

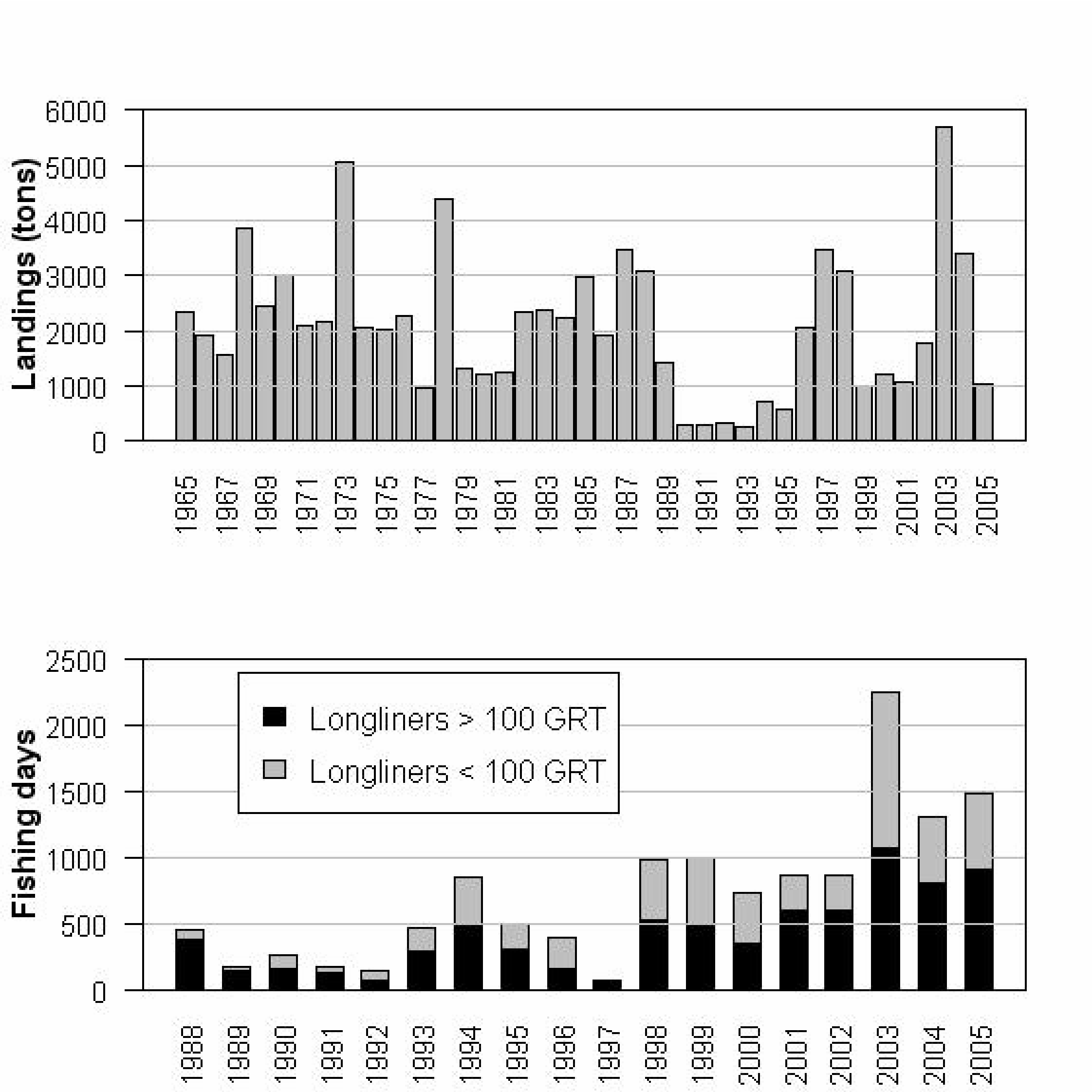


Figure 2.3.1.1. Faroe Bank (sub-division Vb2) cod. Reported landings 1965-2005. Since 1992 only catches from Faroese and Norwegian vessels are considered to be taken on Faroe Bank. Lower plot: fishing days 1988-2005 for long line gear type in the Faroe Bank (exerted).

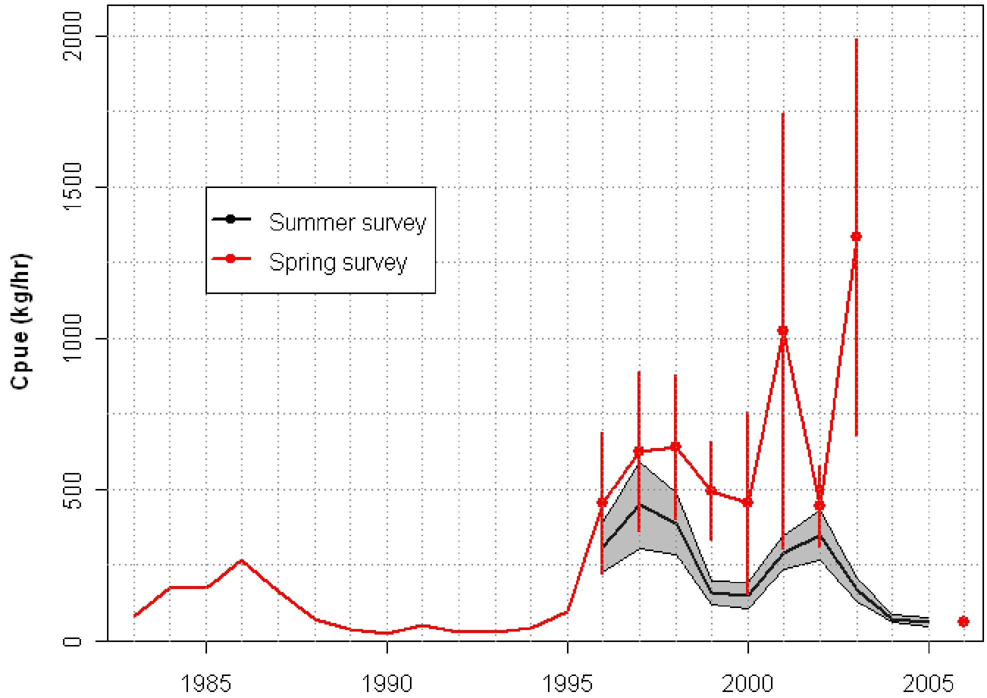


Figure 2.3.2.1. Faroe Bank (sub-division Vb2) cod. Catch per unit of effort in the spring groundfish survey and summer survey. Vertical bars and shaded areas show the standard error in the estimation of indexes.

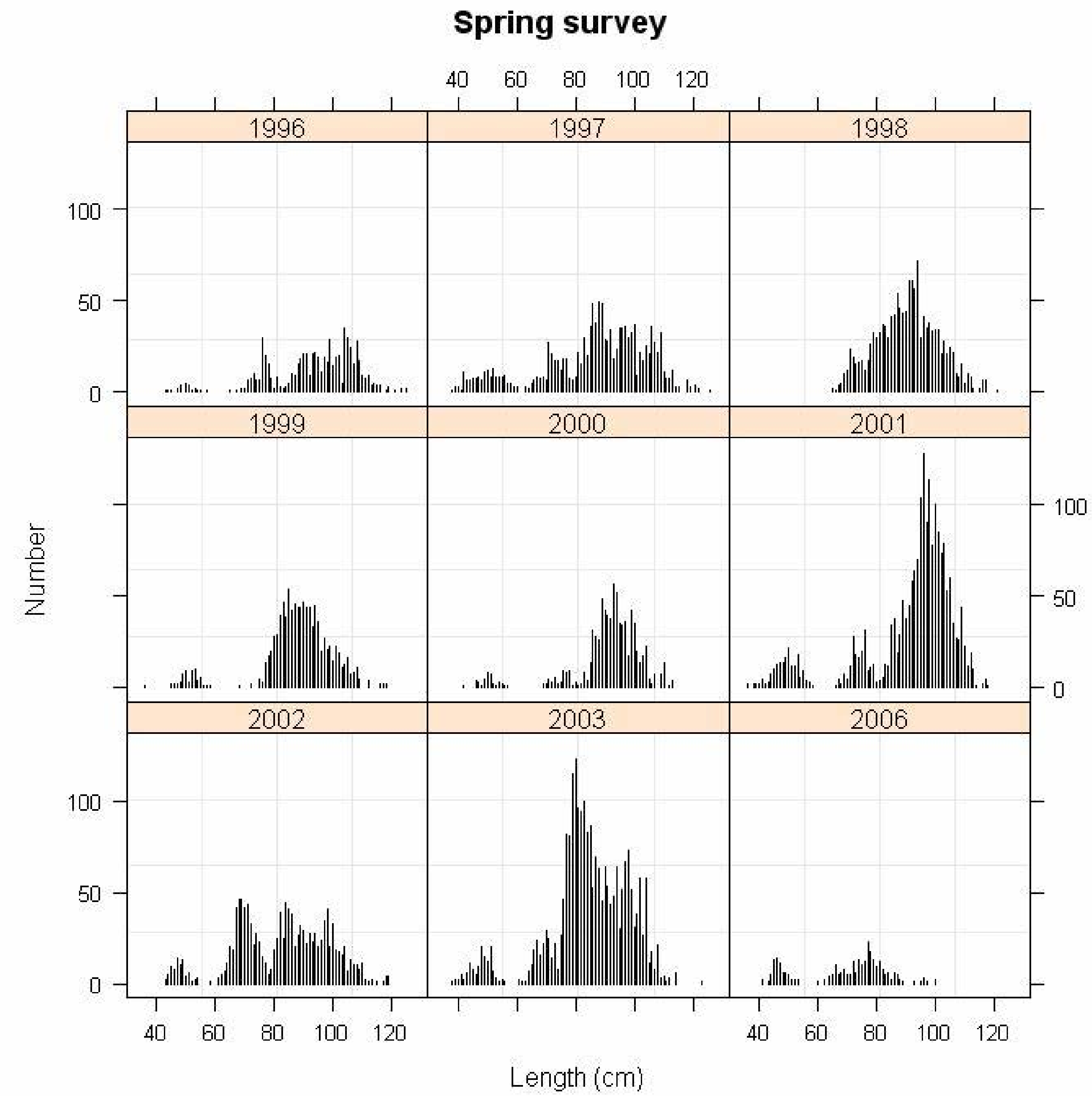


Figure 2.3.2.2. Faroe Bank (sub-division Vb2) cod. Length distributions in the spring survey.

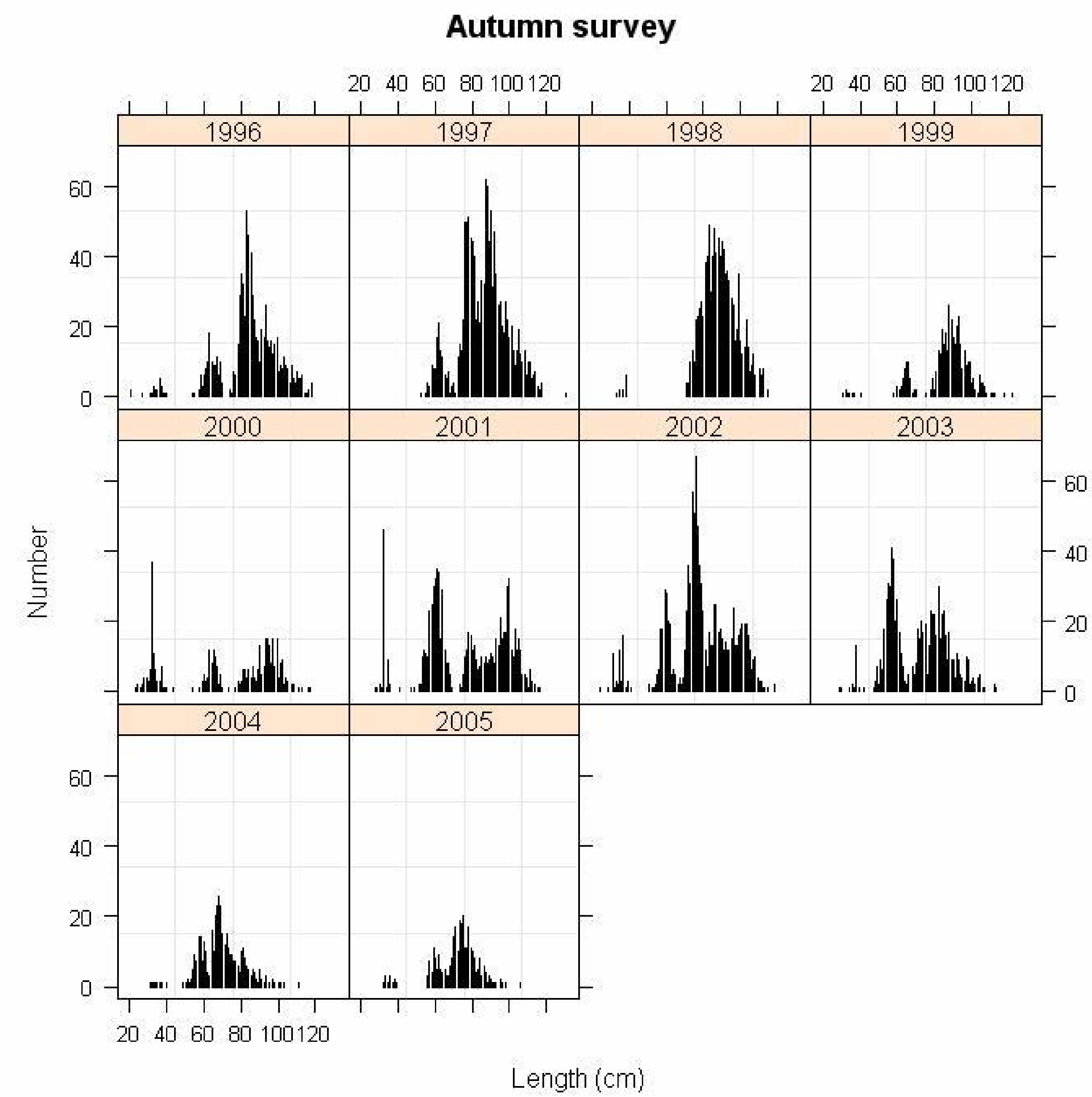


Figure 2.3.2.3. Faroe Bank (sub-division Vb2) cod. Length distributions in the summer survey.

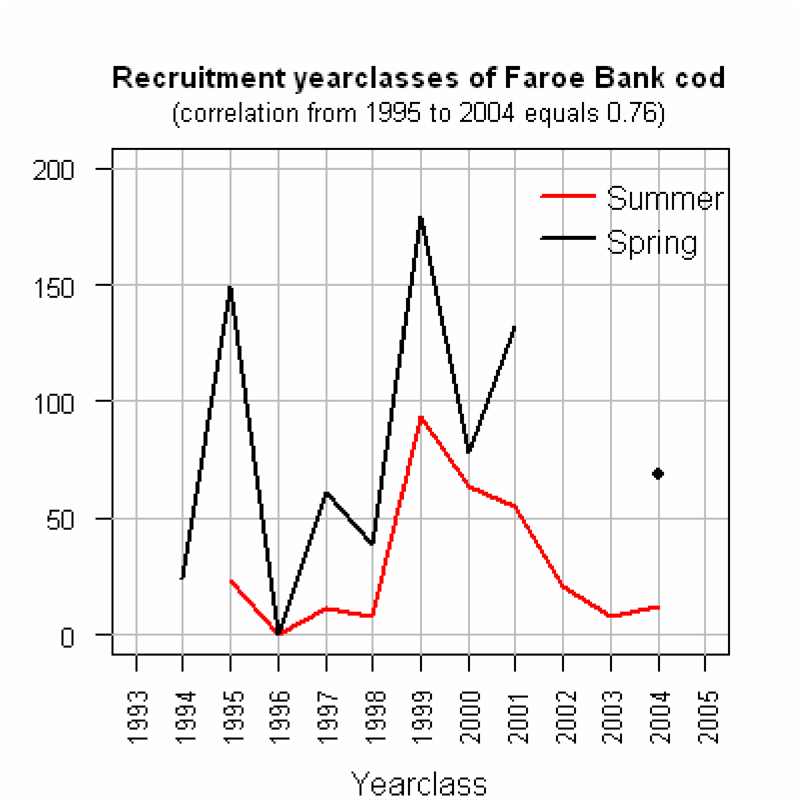


Figure 2.3.2.4. Estimated recruitment from surveys. In summer surveys the 1 year old recruitment is estimated. In spring surveys the recruitment of 2 year old is estimated.

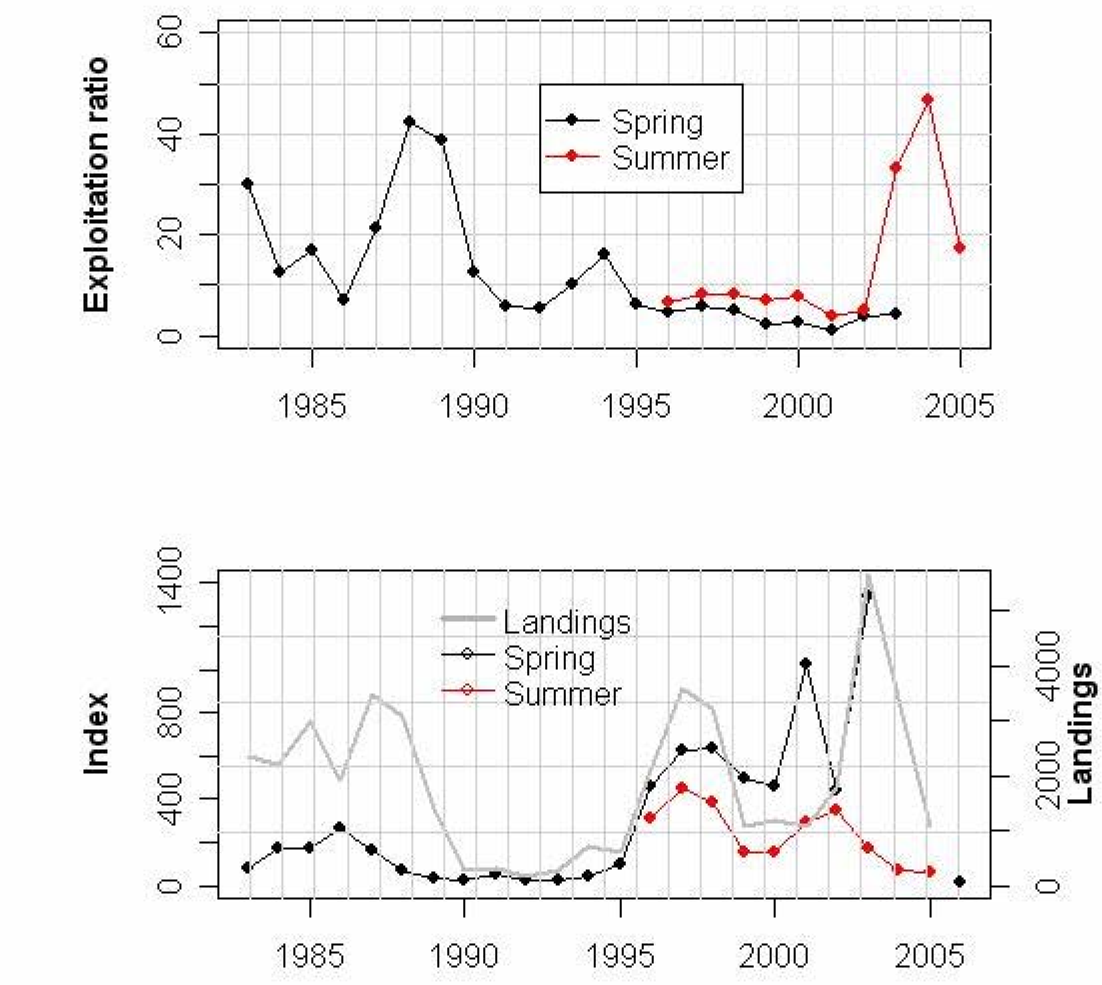


Figure 2.3.2.5. Faroe Bank (Sub-division Vb2) cod. Exploitation ratio (ratio of landings to survey interpreted as an index of exploitation rate). Lower plot: Landings and cpue (kg/hr) in spring and summer survey.

2.4 Faroe Haddock

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 almost 27 000 t in 2003; they have declined somewhat since and amounted in 2005 to about 20 000t but are still wel above average. Most of the landings are taken from the Faroe Plateau; the landings from the Faroe Bank (Sub-Division Vb2) in 2005 were about 2 000 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 2006 are expected to stay at the 2005 level.

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

The 2005 monthly Faroese landings of haddock by fleet category from Subdivisions Vb1 and Vb2, are shown in Figure 2.4.3. As usual, the landings from the Plateau were high in the first month of the year until the end of the spawning time in April/May, stayed low during the summer and increased again in late autumn. On the Faroe Bank, the monthly landings in 2005 were relatively low in the first months of the year, reflecting a closure of the Bank during the spawning time (1 March – 1 May), was in general high during summer and again in Nov-Dec.

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 2005, which has decreased somewhat as compared to 2004 (except for weight measurements which have increased considerably), is shown in the table below.

	Open boats	Lliners <100GRT	Lliners <100GRT	OB trawl <400HP	OB trawl >400HP	Pairtrawl <1000HP	Pairtrawl >1000HP	Total
No. of samples	11	61	76	1	22	10	37	218
No. of length measurements	2223	13911	16112	262	4540	2535	8395	47978
No. of age measurements	180	1440	1798	0	420	180	840	4858
No. of weighted fish	1025	9008	10470	0	3249	347	840	24939

As has been the practise in the past, samples from each fleet category were disaggregated by season and then raised by the catch proportions to give the 2005 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. In addition, catch figures for age 1 have been added to the c@age matrix as well as some missing values for the 10+ group in earlier years, and the whole c@age series were extended back to 1957 included. No attempts were made in order to adjust total landings by adding these data for age 1 and 10+ because based on old/earlier ICES reports this never was made when the values were omitted originally. The SOP check was marginally improved by this procedure. The resulting total catch-at-age in numbers is given in Tables 2.4.4 and 2.4.5, and in Figure 2.4.4 the LN (catch-at-age in numbers) is shown for the whole period of analytical assessments.

In general the catch-at-age matrix in recent years appears consistent, except for the behaviour of a few small year classes, both in numbers and mean weights at age. Also there are some problems with what ages should be included in the plus group; there are some periods where 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). Compared to last years report, values for age 1 and age 10+ have been added as explained in section 2.4.3. 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 3-4 years except for age 2 and 3 to very low values in 2005.

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 1982–2006. The survey is carried out in February-March, so the maturity-at-age is determined just prior to the spawning of haddock in Faroese waters and the determinations of the different maturity stages is relatively easy.

In order to reduce eventual year-to-year effects due to possible inadequate sampling and at the same time allow for trends in the series, the routine by the WG has been to use a 3-year running average in the assessment. For the years prior to 1982, average maturity-at-age from the surveys 1982–1995 was adopted (Table 2.4.7 and Figure 2.4.6). The proportion mature for the youngest ages has been declining during the last 4-5 years.

2.4.6 Assessment

Since this is a benchmark assessment, input data for the VPA have been analysed and revised where appropriate (see sections 2.4.2-2.4.5) and so have the data from the two surveys. The settings of the XSA have also been explored. In addition, alternative assessment models have been investigated, see section 2.4.10.

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 there is agreement between the two series 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 1994-2006) and Figure 2.4.10 (summer surveys 1996-2005). 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 ara 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.

A spaly run with 2005 data included and some minor revisions of recent catch figures gave almost identical 2004 estimates as the 2005 assessment. A similar run where the year range were expanded back to 1957 included, an the age range was expanded to include where possible age 1 and missing data for age 10+, gave almost the same estimates of F and B but some diagnostics like SOP's were marginally improved.

The survey series have been rather noisy for some ages. Especially for the youngest ages this has been disappointing because the length distribution for those ages are almost non-overlapping. This was looked after this year and some of the difficulties were detected. 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. This 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).

The revised surveys give improved diagnostics, e.g. log q residuals, and it is proposed to keep the spring survey series for ages 0-6, and to include age 1 in the summer series so it now covers the ages 1-8.

The settings of the XSA were then explored; this has been done to some details every year and the results can be found in earlier NWWG reports.

Last year the age where catchability is independent of stock size was set at age zero meaning that catchability is independent of stock size for all ages. Trials this year with age 0, 1 and 2 were made and the VPA converged fastest in the case of 0, somewhat slower for age 1 but for age 2 the VPA didn't converge. The differences in diagnostics were small. The choice last year seems reasonable.

The ages where catchability is independent of age has been set at ages >= 6 in former years. By inspecting selection patterns in the SepVPA this seems reasonable since a younger age will result in dome shaped exploitation pattern where as for age 6 and older the selection pattern becomes almost flat for these ages.

An XSA with the same settings as in last years report and tuned with the two surveys combined were performed (Table 2.4.9). The retrospective pattern for fishing mortality, recruitment and spawning stock biomass of this XSA is shown in Figure 2.4.15. 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 2.4.16B. 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 0.26 in 2005.

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 2.4.18 and in Figure 2.4.16. According to this assessment, the spawning stock biomass has shown big changes in recent years. It decreased from 68 000 t in 1987 to 24 000 t in 1994, increased again to 88 000 t in 1998, decreased to 59 000 t in 2000 and has increased since to above 114 000 t in 2003; the 2005 point estimate is 88 000t (Figure 2.4.22). The decline in the spawning stock began in the late 1970s due to very poor recruitment in the years before. The stabilization at relatively high SSB's in the mid–1980s was due to the relatively good 1982 and 1983 year classes, but the decline since was partly due to poor year classes since the mid–1980s, as well as the pronounced decline in the mean weights-at-age in the stock. The main reason for the very abrupt increase in the spawning stock biomass is the recruitment and growth of the very large 1993 year class and the well-above-average 1994 year class. The most recent increase in the spawning stock is due to new strong year classes entering the fishery of which the 1999 year class is the highest on record. In the past there have been considerable doubts about the sizes of incoming year classes. The 1999 YC is now confirmed being the highest on record at age 2 (124 mio.), the YC's from 2000 and 2001 are estimated above average and the 2002 YC slightly below average, Tables 2.4.12, 2.4.18 and Figure 2.4.16. 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 given in Tables 2.4.13-14. All year classes up to 2004 are from the final VPA, the 2005-2006 year classes at age 2 are estimated from the XSA at ages 0 and 1 and applying a natural mortality of 0.2 in a forward calculation of the numbers using basic VPA equations. The YC 2006 at age 2 in 2008 is estimated as the geometric mean of the 2-year-olds in 1980-2007. This period was 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 2003–2005 fishing mortality matrices from the final VPA and rescale it to the recent value (2005). The same exploitation pattern was used for all three years.

The cohort approach as described in the 2003 WG report was not used this year because when comparing the model results with the observed values for 2005, the fit was poor. A tentative modelling of the weights in 2006 taking into account the primary production in 2005 indicate that weights will stay low in 2006. Correspondingly, the mean weight-at-age for ages 2-10 in 2006-2008 was simply set equal to the observed weights in 2005.

The maturity ogive for 2006 is based on samples from the Faroese Groundfish Spring Survey 2006 and the ogives in 2007-2008 are estimated as the average of the smoothed 2004-2006 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 1977–2005 period. The maturity ogives are averages for the years 1982-2005. 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 2.4.18. $\mathbf{F}_{max}$ and $\mathbf{F}_{0.1}$ are indicated here as 0.64 and 0.16, respectively. From Figure 2.4.17, showing the recruit/spawning stock relationship, and from Table 2.4.17, $\mathbf{F}_{med}$, and $\mathbf{F}_{high}$ were calculated at 0.33 and 1.52, 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 2.4.18) 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 $\mathbf{B}_{\mathrm{lim}}$, three were very small, and two strong. The strong year classes are believed to be due to favourable environmental conditions, and there are no guarantee that similarly good environmental conditions would occur again should the SSB decrease below $\mathbf{B}_{\mathrm{lim}}$.

2.4.7.3 Projections of catch and biomass

2.4.7.3.1 Short-term prediction

In the light of the performance of the management system, it is not unrealistic to assume fishing mortalities in 2006 as the average of some recent years, here the scaled average of F(2003-2005); however, possible changes in the catchability of the fleets (which seem to be linked to productivity changes in the environment) could undermine this assumption. The fleet is almost the same and the number of fishing days per fleet was only reduced marginal for the fishing year 1 Sept 2005 – 31 Aug 2006. The landings in 2006 are then predicted to be about 22 000 t, and continuing with this fishing mortality will result in 2007 landings of about 20 000 t. The SSB will decrease to 83 000 t in 2006, 67 000 t in 2007, and to 51 000 t in 2008. The results of the short-term prediction are shown in Table 2.4.15 and in Figure 2.4.18. The contribution by yearclasses to the age composition of the predicted 2007 catch and the 2008 SSB is shown in Figure 2.4.21.

2.4.8 Medium-term projections

No such projections were made this year.

2.4.9 Management considerations

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

2.4.10 Comments on the assessment

As explained previously in the report, e.g. in section 3.4.6.1, the tuning fleets this year have been revised. Also the input files for the VPA (c@age, w@age and mat@age) have been revised and data for the years 1957-60 have been added. No changes have been made in the settings of the XSA. Following differences in the 2004 estimates were observed as compared to last year:

Assessment year	Recruitment age 2	Exploitable biomass	Spawning stock biomass	Fishing mortality (F_{3-7})
2005	36 000 000	153 000 t	115 000 t	0.40
2006	31 000 000	144 000 t	103 000 t	0.35

As in 2004-05, 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 2.4.19 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 2.4.20 shows the retrospective pattern of the ADAPT. It is comparable with the XSA retro.

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

From the NFT Adapt results, there is zero probability that the Faroe haddock 2005 SSB was less than the existing Bpa = 55 000t and Blim = 40 000t. There is an 80% probability that the F(3-7) is greater than the existing Fpa = 0.25, a 99% probability that it is less than the existing Flim 0.40, and a 100% probability that it is less than Ftarget = 0.45.

Other alternative assessment models were also explored, e.g. a separable model in AD Model Builder (Lewy and Nielsen 2003) and AMCI. The working group wants to explore these models further next year.

Table 2.4.1 Faroe Plateau (Sub-division Vb1) HADDOCK. Nominal catches (tonnes) by countries 1982-2005, 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]
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	18,022
France[1]					2 [2,]	- [2]	6	8 [7]	2	4	1	+
Germany		5	-	-		33	1	2	6	1	6	
Greenland						*30* [6]	*22* [6]	*0* [6]	*4* [6]			
Iceland									4			
Norway	22	28	45	45 [2]	71	411	355	257 [2]	227	292	229	212
UK (Engl. and Wales)	31	23	5	22	30 [1]	59 [7]	19 [7]	4 [7]	11 [7]	14 [7]	8	
UK (Scotland)[11]	-	-	…	…	…							
United Kingdom												127 [4]
Total	3,728	4,605	9,202	16,652	19,238	17,176	14,023	13,728	21,030	21,926	19,239	18,361
Working Group estimate[4,5,8]	4,252	4,948	9,642	17,924	22,210	18,482	15,821	15,890	24,933	26,970	23,036	20,305

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, 1982-2005, 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
France[1]	-	-	-	-	-	-	-	-	-	-	-	-
Norway	1	2	5	3	10	5	43	16	97	4	23	8
UK (Engl. and Wales)	-	-	-	-	-	-	-	-	-	-	+	+
UK (Scotland)[3]	48	13	+	25	26	45	15	30	725	287	869	102
Total	1,582	982	930	1,502	1,086	882	1,218	705	1,147	508	1,230	295

Country	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004 [2]	2005
Faroe Islands	353	303	338	1,133	2,810	1,110	1,565 [5]	1,948	3,698	4,804	3,594	1899
France[1]	-	-	-	-								+
Norway	1	1	40	4	60	3	48	66	28	55	17	45
UK (Engl. and Wales)	+	... [1]	… [1]	… [1]	… [1]	[1]	[1]	[1]		[1]	[1]	[1]
UK (Scotland)[3]	170	39	62	135	102	193	185	148	177	185 [4]	186 [1]	[4]
Total	524	343	440	1,272	2,972	1,306	1,798	2,162	3,903	5,044	3,797	1,944

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 1985-2004 and the contribution (%) by each fleet category (metier). Total catch in this table may deviate from official landings.

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Open boats	7	7	11	2	3	2	3	2	1	1	1	2	2	2	2	1	2	3	4	4	4
Longliners < 100GRT	39	39	39	49	58	60	56	46	24	18	23	28	31	30	23	24	29	31	34	40	41
Longliners > 100GRT	13	12	13	19	18	18	18	22	25	25	38	36	38	40	40	36	38	34	42	42	43
Otterboard trawlers < 400HP	1	2	2	2	1	1	2	2	8	8	7	6	3	2	2	4	2	2	1	1	1
Otter board trawlers 400-999HP	6	3	5	4	3	3	1	1	3	2	5	7	6	6	5	5	5	4	3	2	2
Otterboard trawlers > 1000HP	8	5	2	2	2	2	2	1	1	3	2	2	3	3	7	5	5	11	3	1	1
Pairtrawlers < 1000HP	19	20	17	11	7	5	7	11	13	10	8	7	6	5	6	7	6	4	4	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
Nets	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
Other gears	0	1	1	2	1	1	1	1	3	3	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

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Table 2.4.4 Haddock in ICES Division Vb 2005

Catch at age in numbers by fleet category

Age	Vb1 Open Boats	Vb1 LLiners < 100GRT	Vb1 LLiners > 100GRT	Vb1 OB. trawl. < 400HP	Vb1 OB. trawl. 400-999HP	Vb1 OB. trawl. > 1000HP	Vb1 Pair trawl. < 1000HP	Vb1 Pair trawl. > 1000HP	Vb 1 Others	Vb1 All Faroese Fleets	Vb2 All Faroese LLiners	Vb2 All Faroese Pairtrawlers	Vb2 Others	Vb2 All Faroese Fleets	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	0
2	4	44	27	0	0	0	0	0	3	83	0	0	0	0	0	1	0	84
3	83	745	483	5	6	10	9	17	93	1508	97	30	0	127	6	14	6	1655
4	192	1715	993	25	51	46	59	117	354	3551	167	40	1	208	28	29	10	3817
5	266	2644	2311	51	106	67	124	234	615	6448	105	26	0	131	41	67	7	6688
6	190	1936	2331	69	140	70	148	261	648	5720	180	56	1	237	43	68	11	6068
7	22	184	221	3	6	6	8	16	57	519	6	2	0	8	4	6	0	537
8	3	41	60	1	2	2	4	9	16	136	5	2	0	7	1	2	0	146
9	1	7	11	0	1	1	1	2	6	27	0	0	0	1	1	0	0	28
10	0	3	11	0	0	0	1	1	3	19	2	1	0	3	0	0	0	22
11	1	13	27	0	1	1	2	4	9	55	1	1	0	2	1	1	0	59
12	1	10	44	1	1	1	1	2	9	68	1	1	0	1	1	1	0	72
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total no.	763	7343	6517	155	314	204	357	665	1813	18134	564	159	3	726	125	190	35	19175
Catch, t.	694	6636	6548	135	272	186	324	584	1720	17098	654	191	4	849	114	191	41	18293

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

Tabel 2.4.5 Faroe haddock. Catch number-at-age

Run title : FAROE HADDOCK (ICES DIVISION Vb) HAD1_IND

At 1/05/2006 19:29

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

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

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

YEAR,	1966,	1967,	1968,	1969,	1970,	1971,	1972,	1973,	1974,	1975,
AGE										
0,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
1,	90,	70,	49,	95,	57,	55,	43,	665,	253,	94,
2,	1081,	1425,	5881,	2384,	1728,	717,	750,	3311,	5633,	7337,
3,	3304,	2405,	4097,	7539,	4855,	4393,	3744,	8416,	2899,	7952,
4,	4804,	2599,	2812,	4567,	6581,	4727,	4179,	1240,	3970,	2097,
5,	2710,	1785,	1524,	1565,	1624,	3267,	2706,	2795,	451,	1371,
6,	1112,	1426,	1526,	1485,	1383,	1292,	1171,	919,	976,	247,
7,	740,	631,	923,	1224,	1099,	864,	696,	1054,	466,	352,
8,	180,	197,	230,	378,	326,	222,	180,	150,	535,	237,
9,	54,	52,	68,	114,	68,	147,	113,	68,	68,	419,
+gp,	9,	13,	12,	20,	10,	102,	95,	11,	147,	187,
0 TOTALNUM,	14084,	10603,	17122,	19371,	17731,	15786,	13677,	18629,	15398,	20293,
TONSLAND,	18766,	13381,	17852,	23272,	21361,	19393,	16485,	18035,	14773,	20715,
SOPCOF %,	109,	101,	102,	108,	102,	97,	96,	97,	97,	117,

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

YEAR,	1976,	1977,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,
AGE										
0,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
1,	40,	0,	0,	1,	0,	0,	0,	0,	25,	0,
2,	4396,	255,	32,	1,	143,	74,	539,	441,	1195,	985,
3,	7858,	4039,	1022,	1162,	58,	455,	934,	1969,	1561,	4553,
4,	6798,	5168,	4248,	1755,	3724,	202,	784,	383,	2462,	2196,
5,	1251,	4918,	4054,	3343,	2583,	2586,	298,	422,	147,	1242,
6,	1189,	2128,	1841,	1851,	2496,	1354,	2182,	93,	234,	169,
7,	298,	946,	717,	772,	1568,	1559,	973,	1444,	42,	91,
8,	720,	443,	635,	212,	660,	608,	1166,	740,	861,	61,
9,	258,	731,	243,	155,	99,	177,	1283,	947,	388,	503,
+gp,	318,	855,	312,	74,	86,	36,	214,	795,	968,	973,
0 TOTALNUM,	23126,	19483,	13104,	9326,	11417,	7051,	8373,	7234,	7883,	10773,
TONSLAND,	26211,	25555,	19200,	12424,	15016,	12233,	11937,	12894,	12378,	15143,
SOPCOF %,	107,	98,	99,	104,	100,	109,	92,	106,	106,	106,

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

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

	YEAR,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,
	AGE										
	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
	1,	0,	0,	0,	0,	0,	0,	0,	43,	1,	0,
	2,	230,	283,	655,	63,	105,	77,	40,	113,	277,	804,
	3,	2549,	1718,	444,	1518,	1275,	1044,	154,	298,	191,	452,
	4,	4452,	3565,	2463,	658,	1921,	1774,	776,	274,	307,	235,
	5,	1522,	2972,	3036,	2787,	768,	1248,	1120,	554,	153,	226,
	6,	738,	1114,	2140,	2554,	1737,	651,	959,	538,	423,	132,
	7,	39,	529,	475,	1976,	1909,	1101,	335,	474,	427,	295,
	8,	130,	83,	151,	541,	885,	698,	373,	131,	383,	290,
	9,	71,	48,	18,	133,	270,	317,	401,	201,	125,	262,
	+gp,	712,	334,	128,	81,	108,	32,	162,	185,	301,	295,
0	TOTALNUM,	10443,	10646,	9510,	10311,	8978,	6942,	4320,	2811,	2588,	2991,
	TONSLAND,	14477,	14882,	12178,	14325,	11726,	8429,	5476,	4026,	4252,	4948,
	SOPCOF %,	101,	102,	97,	100,	102,	106,	106,	103,	100,	103,

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

	YEAR,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	2005,
	AGE										
	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
	1,	1,	0,	0,	9,	73,	19,	0,	0,	3,	0,
	2,	326,	77,	106,	174,	1461,	4380,	1515,	133,	243,	84,
	3,	5234,	2913,	1055,	1142,	3061,	3128,	14039,	3423,	2002,	1658,
	4,	1019,	10517,	5269,	942,	210,	2423,	2879,	13599,	4789,	3823,
	5,	179,	710,	9856,	4677,	682,	173,	1200,	2216,	10397,	6702,
	6,	163,	116,	446,	6619,	2685,	451,	133,	946,	1159,	6081,
	7,	161,	123,	99,	226,	2846,	1151,	239,	162,	407,	538,
	8,	270,	93,	87,	26,	79,	1375,	843,	333,	89,	146,
	9,	234,	220,	95,	20,	1,	17,	1095,	855,	165,	28,
	+gp,	394,	516,	502,	192,	71,	18,	33,	934,	809,	152,
0	TOTALNUM,	7981,	15285,	17515,	14027,	11169,	13135,	21976,	22601,	20063,	19212,
	TONSLAND,	9642,	17924,	22210,	18482,	15821,	15890,	24933,	26970,	23036,	20305,
	SOPCOF %,	100,	103,	101,	100,	103,	100,	100,	100,	99,	100,

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

Run title : FAROE HADDOCK (ICES DIVISION Vb) HAD1_IND

At 1/05/2006 19:29

Table 2 Catch weights at age (kg)

	YEAR,	1957,	1958,	1959,	1960,	1961,	1962,	1963,	1964,	1965,
	AGE									
	0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
	1,	.2500,	.2500,	.2500,	.2500,	.2500,	.2500,	.2500,	.2500,	.2500,
	2,	.4700,	.4700,	.4700,	.4700,	.4700,	.4700,	.4700,	.4700,	.4700,
	3,	.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,
	5,	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,
	7,	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,
	9,	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,
0	SOPCOFAC,	.8937,	.8983,	.9034,	.8832,	.8832,	.8929,	.8915,	1.0111,	.9383,

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

Table 2 Catch weights at age (kg)

YEAR,	1966,	1967,	1968,	1969,	1970,	1971,	1972,	1973,	1974,	1975,
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,	1.0885,	1.0117,	1.0246,	1.0787,	1.0249,	.9688,	.9597,	.9690,	.9678,	1.1696,

Table 2 Catch weights at age (kg)

YEAR,	1976,	1977,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.2500,	.0000,	.0000,	.3000,	.0000,	.0000,	.0000,	.0000,	.3590,	.0000,
2,	.4700,	.3110,	.3570,	.3570,	.6430,	.4520,	.7000,	.4700,	.6810,	.5280,
3,	.7300,	.6330,	.7900,	.6720,	.7130,	.7250,	.8960,	.7400,	1.0110,	.8590,
4,	1.1300,	1.0440,	1.0350,	.8940,	.9410,	.9570,	1.1500,	1.0100,	1.2550,	1.3910,
5,	1.5500,	1.4260,	1.3980,	1.1560,	1.1570,	1.2370,	1.4440,	1.3200,	1.8120,	1.7770,
6,	1.9700,	1.8250,	1.8700,	1.5900,	1.4930,	1.6510,	1.4980,	1.6600,	2.0610,	2.3260,
7,	2.4100,	2.2410,	2.3500,	2.0700,	1.7390,	2.0530,	1.8290,	2.0500,	2.0590,	2.4400,
8,	2.7600,	2.2050,	2.5970,	2.5250,	2.0950,	2.4060,	1.8870,	2.2600,	2.1370,	2.4010,
9,	3.0700,	2.5700,	3.0140,	2.6960,	2.4650,	2.7250,	1.9610,	2.5400,	2.3680,	2.5320,
+gp,	3.5500,	2.5910,	2.9200,	3.5190,	3.3100,	3.2500,	2.8560,	3.0400,	2.6860,	2.6860,
0 SOPCOFAC,	1.0741,	.9784,	.9947,	1.0380,	1.0017,	1.0870,	.9238,	1.0554,	1.0593,	1.0559,

Table 2 Catch weights at age (kg)

YEAR,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.3600,	.0000,	.0000,
2,	.6080,	.6050,	.5010,	.5800,	.4380,	.5470,	.5250,	.7550,	.7540,	.6660,
3,	.8870,	.8310,	.7810,	.7790,	.6990,	.6930,	.7240,	.9820,	1.1030,	1.0540,
4,	1.1750,	1.1260,	.9740,	.9230,	.9390,	.8840,	.8170,	1.0270,	1.2540,	1.4890,
5,	1.6310,	1.4620,	1.3630,	1.2070,	1.2040,	1.0860,	1.0380,	1.1920,	1.4650,	1.7790,
6,	1.9840,	1.9410,	1.6800,	1.5640,	1.3840,	1.2760,	1.2490,	1.3780,	1.5930,	1.9400,
7,	2.5190,	2.1730,	1.9750,	1.7460,	1.5640,	1.4770,	1.4300,	1.6430,	1.8040,	2.1820,
8,	2.5830,	2.3470,	2.3440,	2.0860,	1.8180,	1.5740,	1.5640,	1.7960,	2.0490,	2.3570,
9,	2.5700,	3.1180,	2.2480,	2.4240,	2.1680,	1.9300,	1.6330,	1.9710,	2.2250,	2.4900,
+gp,	2.9220,	2.9330,	3.2950,	2.5140,	2.3350,	2.1530,	2.1260,	2.2400,	2.4230,	2.6780,
0 SOPCOFAC,	1.0141,	1.0197,	.9695,	1.0025,	1.0195,	1.0635,	1.0554,	1.0320,	.9969,	1.0331,

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

Table 2 Catch weights at age (kg)

YEAR,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	2005,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.3600,	.0000,	.0000,	.2780,	.2800,	.2800,	.0000,	.0000,	.3670,	.0000,
2,	.5340,	.5190,	.6220,	.5040,	.6610,	.6080,	.5840,	.5710,	.5740,	.5380,
3,	.8580,	.7710,	.8460,	.6240,	.9360,	.9400,	.8570,	.7150,	.7700,	.6490,
4,	1.4590,	1.0660,	1.0160,	.9740,	1.1660,	1.3740,	1.4050,	1.0080,	.8870,	.7970,
5,	1.9930,	1.7990,	1.2830,	1.2200,	1.4830,	1.7790,	1.7990,	1.5370,	1.1590,	1.0200,
6,	2.3300,	2.2700,	2.0800,	1.4900,	1.6160,	1.9710,	1.9740,	1.9110,	1.6380,	1.2450,
7,	2.3510,	2.3400,	2.5560,	2.4560,	1.8930,	2.1190,	2.3010,	2.0910,	1.8700,	1.8430,
8,	2.4690,	2.4750,	2.5720,	2.6580,	2.8210,	2.3730,	2.3700,	2.3010,	2.4380,	2.0610,
9,	2.7770,	2.5010,	2.4520,	2.5980,	3.7490,	2.7500,	2.6260,	2.4060,	2.3570,	2.2630,
+gp,	2.5820,	2.6760,	2.7530,	2.9530,	3.1960,	3.9660,	3.1300,	2.5350,	2.4170,	2.5790,
0 SOPCOFAC,	1.0043,	1.0250,	1.0106,	.9973,	1.0349,	.9960,	1.0010,	.9998,	.9929,	.9991,

1

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

Run title : FAROE HADDOCK (ICES DIVISION Vb) HAD1_IND

At 1/05/2006 19:29

Table 5 Proportion mature at age

YEAR,	1957,	1958,	1959,	1960,	1961,	1962,	1963,	1964,	1965,
AGE									
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.0600,	.0600,	.0600,	.0600,	.0600,	.0600,	.0600,	.0600,	.0600,
3,	.4800,	.4800,	.4800,	.4800,	.4800,	.4800,	.4800,	.4800,	.4800,
4,	.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,
6,	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,
8,	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,
+gp,	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,	1966,	1967,	1968,	1969,	1970,	1971,	1972,	1973,	1974,	1975,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.0600,	.0600,	.0600,	.0600,	.0600,	.0600,	.0600,	.0600,	.0600,	.0600,
3,	.4800,	.4800,	.4800,	.4800,	.4800,	.4800,	.4800,	.4800,	.4800,	.4800,
4,	.9100,	.9100,	.9100,	.9100,	.9100,	.9100,	.9100,	.9100,	.9100,	.9100,
5,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
6,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
7,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
8,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
9,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
+gp,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,

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

Table 5 Proportion mature at age

YEAR,	1976,	1977,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,
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,	.0800,	.0800,	.0800,	.0300,
3,	.4800,	.4800,	.4800,	.4800,	.4800,	.4800,	.6200,	.6200,	.7600,	.6200,
4,	.9100,	.9100,	.9100,	.9100,	.9100,	.9100,	.8900,	.8900,	.9800,	.9600,
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,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.0300,	.0500,	.0500,	.0200,	.0800,	.1600,	.1800,	.1100,	.0500,	.0300,
3,	.4300,	.3200,	.2400,	.2200,	.3700,	.5800,	.6500,	.5000,	.4200,	.4700,
4,	.9500,	.9100,	.8900,	.8700,	.9000,	.9300,	.9100,	.8500,	.8600,	.9100,
5,	.9900,	.9800,	.9800,	.9900,	1.0000,	1.0000,	1.0000,	.9700,	.9600,	.9600,
6,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	.9900,	.9900,	.9900,
7,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
8,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
9,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
+gp,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,

Table 5 Proportion mature at age

YEAR,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	2005,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.0300,	.0100,	.0100,	.0100,	.0200,	.0900,	.0800,	.0700,	.0000,	.0100,
3,	.4700,	.4700,	.3600,	.3500,	.3600,	.5400,	.4900,	.4500,	.3500,	.3400,
4,	.9300,	.9100,	.8700,	.8600,	.8700,	.9300,	.9700,	.9700,	.9400,	.9100,
5,	.9800,	1.0000,	.9900,	.9900,	.9900,	1.0000,	1.0000,	.9900,	.9900,	.9900,
6,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
7,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
8,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
9,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
+gp,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,

Table 2.4.8 Faroe haddock. 2006 tuning file.

```
FAROE Haddock (ICES SUBDIVISION VB)       COMB-SURVEY-SPALY-REV06-jr.txt
102
SUMMER SURVEY
1996 2005
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  15117.67 16561.09   885.34  185.66   24.20
200   14574.15  7694.99 12936.61  16513.01 11635.42 11938.45  493.44   35.53
SPRING SURVEY SHIFTED
1993 2005
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
```

Table 2.4.9 Faroe haddock 2005 xsa.

```
Lowestoft VPA Version 3.1                                            1/05/2006  19:27

Extended Survivors Analysis

 FAROE HADDOCK (ICES DIVISION Vb)                HAD1_IND

 CPUE data from file D:\Vpa\vpa2006\Tuning\comb-survey-spaly-rev06-jr.txt

 Catch data for  49 years. 1957 to 2005. Ages  0 to  10.

      Fleet,            First, Last, First, Last, Alpha,  Beta
                    ,    year, year,  age ,  age
 SUMMER SURVEY       ,   1996, 2005,   1,     8,   .600,   .700
 SPRING SURVEY SHIFTE,   1993, 2005,   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   36 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,  1996,  1997,  1998,  1999,  2000,  2001,  2002,  2003,  2004,  2005

      0,  .000,  .000,  .000,  .000,  .000,  .000,  .000,  .000,  .000,  .000
      1,  .000,  .000,  .000,  .000,  .001,  .000,  .000,  .000,  .000,  .000
      2,  .008,  .009,  .032,  .013,  .074,  .040,  .028,  .003,  .009,  .013
      3,  .072,  .089,  .168,  .553,  .318,  .225,  .173,  .082,  .063,  .076
      4,  .361,  .203,  .229,  .223,  .181,  .449,  .334,  .254,  .158,  .164
      5,  .417,  .462,  .298,  .327,  .250,  .223,  .420,  .466,  .314,  .346
      6,  .374,  .527,  .600,  .335,  .317,  .260,  .267,  .699,  .477,  .306
      7,  .342,  .541, 1.287,  .711,  .235,  .217,  .214,  .609,  .758,  .426
      8,  .310,  .340,  .968, 1.841,  .583,  .170,  .245,  .520,  .827,  .687
      9,  .239,  .449,  .702,  .613,  .287,  .233,  .198,  .420,  .532,  .682
```

Table 2.4.9 Faroe haddock 2005 xsa (cont.).

XSA population numbers (Thousands)

YEAR	AGE 0	1	2	3	4	5	6	7	8	9
1996	5.59E+03	1.13E+04	4.67E+04	8.30E+04	3.71E+03	5.80E+02	5.77E+02	6.14E+02	1.12E+03	1.22E+03
1997	2.29E+04	4.58E+03	9.28E+03	3.80E+04	6.32E+04	2.12E+03	3.13E+02	3.25E+02	3.57E+02	6.72E+02
1998	3.37E+04	1.88E+04	3.75E+03	7.53E+03	2.84E+04	4.23E+04	1.09E+03	1.51E+02	1.55E+02	2.08E+02
1999	1.85E+05	2.76E+04	1.54E+04	2.97E+03	5.21E+03	1.85E+04	2.57E+04	4.91E+02	3.42E+01	4.82E+01
2000	9.00E+04	1.51E+05	2.26E+04	1.24E+04	1.40E+03	3.41E+03	1.09E+04	1.50E+04	1.98E+02	4.44E+00
2001	6.64E+04	7.37E+04	1.24E+05	1.71E+04	7.40E+03	9.56E+02	2.18E+03	6.52E+03	9.74E+03	9.02E+01
2002	4.58E+04	5.44E+04	6.03E+04	9.75E+04	1.12E+04	3.87E+03	6.26E+02	1.37E+03	4.29E+03	6.73E+03
2003	1.09E+04	3.75E+04	4.45E+04	4.80E+04	6.71E+04	6.57E+03	2.08E+03	3.93E+02	9.08E+02	2.75E+03
2004	1.90E+04	8.91E+03	3.07E+04	3.63E+04	3.62E+04	4.26E+04	3.38E+03	8.46E+02	1.75E+02	4.42E+02
2005	3.50E+03	1.56E+04	7.29E+03	2.49E+04	2.79E+04	2.53E+04	2.55E+04	1.72E+03	3.25E+02	6.26E+01

Estimated population abundance at 1st Jan 2006

0.00E+00	2.87E+03	1.28E+04	5.89E+03	1.89E+04	1.94E+04	1.47E+04	1.54E+04	9.17E+02	1.34E+02

Taper weighted geometric mean of the VPA populations:

2.92E+04	2.53E+04	2.11E+04	1.66E+04	1.09E+04	6.29E+03	3.59E+03	1.89E+03	9.16E+02	4.35E+02

Standard error of the weighted Log(VPA populations) :

1.0506	1.0084	1.0073	.9748	.9826	.9709	.9547	.9595	1.1411	1.4224

Log catchability residuals.

Fleet : SUMMER SURVEY

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
0	No data for this fleet at this age									
1	1.06	.14	-.26	-.40	-.20	.03	.23	-.03	-.25	-.33
2	-.08	.41	-.16	-.35	-.01	-.10	-.01	-.09	.21	.18
3	.11	-.02	-.60	1.36	.05	.16	-.04	-.32	-.46	-.23
4	-.32	.46	.11	-.44	-.58	.40	.14	.17	-.14	.21
5	-.06	.07	.04	.14	-.12	-.87	.25	.48	-.06	.13
6	.30	.54	-.19	.02	.11	-.31	-.41	.01	-.27	.20
7	.04	-.27	1.07	.35	-.06	-.01	-.34	-.19	-.26	-.21
8	-.02	.20	.65	.49	.31	-.24	-.31	.35	-.68	-1.00

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	-4.9052	-5.2860	-5.5403	-5.7950	-5.8504	-5.9300	-5.9300	-5.9300
S.E(Log q)	.4248	.2167	.5390	.3555	.3527	.2995	.4245	.5309

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,	1.08,	-.557,	4.47,	.85,	10,	.48,	-4.91,
2,	1.04,	-.545,	5.10,	.96,	10,	.23,	-5.29,
3,	1.32,	-1.578,	4.09,	.75,	10,	.66,	-5.54,
4,	.84,	2.880,	6.41,	.97,	10,	.22,	-5.80,
5,	.92,	1.256,	6.10,	.96,	10,	.31,	-5.85,
6,	1.01,	-.128,	5.91,	.96,	10,	.32,	-5.93,
7,	1.14,	-1.246,	5.78,	.91,	10,	.47,	-5.92,
8,	1.11,	-.917,	5.93,	.90,	10,	.59,	-5.96,

Fleet : SPRING SURVEY SHIFTED

Age	1993	1994	1995
0	-.65,	.92,	.86
1	-.37,	-.84,	.48
2	-.39,	-.49,	.02
3	.03,	.02,	-.20
4	-.16,	-.02,	.05
5	-.11,	-.90,	-.05
6	.49,	-.10,	-.01
7	No data for this fleet at this age		
8	No data for this fleet at this age		

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
0	-1.11,	-.28,	-.42,	-.36,	.33,	.46,	.02,	-.18,	.41,	.00
1	.69,	-.06,	.00,	-.17,	-.40,	-.40,	.13,	.18,	.63,	.12
2	.59,	.67,	-1.80,	.54,	-.15,	.15,	.19,	.22,	.31,	.16
3	.61,	.49,	.29,	-.45,	-.43,	-.24,	-.14,	-.06,	.01,	.08
4	.61,	.63,	.40,	-.21,	-1.75,	.09,	-.31,	.49,	.12,	.05
5	1.24,	.82,	-.10,	.12,	-1.01,	-.73,	-.20,	.06,	.36,	.50
6	.21,	-.35,	.07,	.34,	-.34,	-.22,	-.63,	.01,	.41,	.11
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,	-6.0124,	-5.4345,	-6.0867,	-6.1331,	-6.4461,	-6.6212,	-7.0037,
S.E(Log q),	.5892,	.4431,	.6432,	.3173,	.6063,	.6482,	.3239,

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,	.95,	.392,	6.24,	.83,	13,	.58,	-6.01,
1,	1.22,	-1.696,	4.36,	.84,	13,	.50,	-5.43,
2,	.80,	1.899,	6.83,	.89,	13,	.47,	-6.09,
3,	.92,	1.278,	6.39,	.96,	13,	.29,	-6.13,
4,	.83,	2.046,	6.89,	.93,	13,	.45,	-6.45,
5,	.96,	.340,	6.70,	.85,	13,	.64,	-6.62,
6,	.92,	1.413,	7.07,	.96,	13,	.29,	-7.00,

Terminal year survivor and F summaries :

Age 0 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 ,	1.,	.000,	.000,	.00,	0,	.000,	.000
SPRING SURVEY SHIFTE,	2867.,	.611,	.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
2867.,	.61,	.00,	1,	.000,	.000

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

Year class = 2004

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
SUMMER SURVEY ,	9172.,	.445,	.000,	.00,	1,	.405,	.000
SPRING SURVEY SHIFTE,	15957.,	.367,	.143,	.39,	2,	.595,	.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
12752.,	.28,	.21,	3,	.732,	.000

Table 2.4.9 Faroe haddock 2005 xsa (cont.).

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

Year class = 2003

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
SUMMER SURVEY ,	6175.,	.249,	.198,	.80,	2,	.541,	.012
SPRING SURVEY SHIFTE,	7921.,	.322,	.249,	.77,	3,	.323,	.010
F shrinkage mean ,	2419.,	.50,,,,				.136,	.031

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
5893.,	.18,	.21,	6,	1.140,	.013

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

Year class = 2002

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
SUMMER SURVEY ,	20441.,	.228,	.122,	.53,	3,	.453,	.071
SPRING SURVEY SHIFTE,	21321.,	.230,	.050,	.22,	4,	.445,	.068
F shrinkage mean ,	7943.,	.50,,,,				.102,	.173

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
18910.,	.15,	.13,	8,	.823,	.076

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

Year class = 2001

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
SUMMER SURVEY ,	19660.,	.194,	.130,	.67,	4,	.503,	.162
SPRING SURVEY SHIFTE,	21856.,	.216,	.072,	.33,	5,	.403,	.147
F shrinkage mean ,	10852.,	.50,,,,				.094,	.277

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
19403.,	.14,	.09,	10,	.656,	.164

Table 2.4.9 Faroe haddock 2005 xsa (cont.).

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

Year class = 2000

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
SUMMER SURVEY ,	14308.,	.173,	.066,	.38,	5,	.534,	.353
SPRING SURVEY SHIFTE,	15088.,	.207,	.123,	.60,	6,	.359,	.338
F shrinkage mean ,	15146.,	.50,,,,				.107,	.337

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
14672.,	.13,	.06,	12,	.447,	.346

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

Year class = 1999

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
SUMMER SURVEY ,	16126.,	.159,	.066,	.42,	6,	.521,	.294
SPRING SURVEY SHIFTE,	15708.,	.187,	.101,	.54,	7,	.379,	.300
F shrinkage mean ,	10957.,	.50,,,,				.100,	.407

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
15364.,	.12,	.06,	14,	.512,	.306

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

Year class = 1998

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
SUMMER SURVEY ,	855.,	.167,	.109,	.65,	7,	.540,	.451
SPRING SURVEY SHIFTE,	1015.,	.197,	.130,	.66,	7,	.297,	.392
F shrinkage mean ,	962.,	.50,,,,				.164,	.409

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
917.,	.14,	.07,	15,	.540,	.426

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 = 1997

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
SUMMER SURVEY ,	96.,	.205,	.180,	.88,	8,	.483,	.863
SPRING SURVEY SHIFTE,	124.,	.203,	.086,	.43,	7,	.173,	.723
F shrinkage mean ,	219.,	.50,,,,				.345,	.473

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
134.,	.20,	.15,	16,	.724,	.687

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

Year class = 1996

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
SUMMER SURVEY ,	17.,	.164,	.152,	.93,	8,	.402,	.906
SPRING SURVEY SHIFTE,	13.,	.193,	.185,	.96,	7,	.185,	1.105
F shrinkage mean ,	53.,	.50,,,,				.413,	.388

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
26.,	.22,	.22,	16,	1.013,	.682

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

Run title : FAROE HADDOCK (ICES DIVISION Vb) HAD1_IND

At 1/05/2006 19:29

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

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

Table 8 Fishing mortality (F) at age

YEAR,	1966,	1967,	1968,	1969,	1970,	1971,	1972,	1973,	1974,	1975,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0032,	.0012,	.0014,	.0024,	.0033,	.0015,	.0016,	.0114,	.0033,	.0015,
2,	.0610,	.0641,	.1261,	.0860,	.0551,	.0526,	.0253,	.1677,	.1266,	.1229,
3,	.2370,	.1873,	.2647,	.2363,	.2528,	.1936,	.4224,	.4319,	.2172,	.2649,
4,	.4515,	.2971,	.3483,	.5320,	.3343,	.4185,	.2852,	.2391,	.3729,	.2412,
5,	.5006,	.2997,	.2847,	.3330,	.3639,	.2754,	.4516,	.3142,	.1278,	.2115,
6,	.5421,	.5406,	.4540,	.4975,	.5561,	.5560,	.1494,	.2702,	.1713,	.0956,
7,	.9128,	.6906,	.8367,	.8276,	.8739,	.8384,	.6719,	.1950,	.2134,	.0859,
8,	.7509,	.6634,	.5851,	1.0631,	.5430,	.4223,	.4065,	.2906,	.1433,	.1599,
9,	.6373,	.5022,	.5057,	.6566,	.5386,	.5061,	.3956,	.2632,	.2067,	.1595,
+gp,	.6373,	.5022,	.5057,	.6566,	.5386,	.5061,	.3956,	.2632,	.2067,	.1595,
0 FBAR 3- 7,	.5288,	.4031,	.4377,	.4853,	.4762,	.4564,	.3961,	.2901,	.2205,	.1798,

Table 8 Fishing mortality (F) at age

YEAR,	1976,	1977,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0014,	.0000,	.0000,	.0002,	.0000,	.0000,	.0000,	.0000,	.0006,	.0000,
2,	.0907,	.0108,	.0010,	.0004,	.0324,	.0237,	.0382,	.0250,	.0327,	.0276,
3,	.1876,	.1127,	.0546,	.0457,	.0284,	.1371,	.4606,	.1910,	.1159,	.1681,
4,	.3809,	.1812,	.1663,	.1253,	.2021,	.1309,	.3700,	.3468,	.3879,	.2372,
5,	.2216,	.5270,	.2112,	.1910,	.2745,	.2107,	.2904,	.3486,	.2161,	.3452,
6,	.2870,	.7243,	.3816,	.1406,	.2131,	.2259,	.2767,	.1375,	.3320,	.4135,
7,	.1600,	.3901,	.5755,	.2718,	.1698,	.2000,	.2517,	.2979,	.0848,	.2071,
8,	.2537,	.3785,	.4963,	.3298,	.3947,	.0917,	.2259,	.3090,	.2914,	.1707,
9,	.2620,	.4434,	.3686,	.2127,	.2521,	.1726,	.2845,	.2896,	.2638,	.2762,
+gp,	.2620,	.4434,	.3686,	.2127,	.2521,	.1726,	.2845,	.2896,	.2638,	.2762,
0 FBAR 3- 7,	.2474,	.3871,	.2778,	.1549,	.1776,	.1809,	.3299,	.2644,	.2273,	.2742,

Table 8 Fishing mortality (F) at age

YEAR,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0060,	.0000,	.0000,
2,	.0095,	.0330,	.0386,	.0045,	.0122,	.0283,	.0166,	.0708,	.0486,	.0087,
3,	.0927,	.0912,	.0664,	.1182,	.1176,	.1616,	.0728,	.1647,	.1643,	.1045,
4,	.2466,	.1813,	.1830,	.1327,	.2155,	.2384,	.1734,	.1792,	.2553,	.3124,
5,	.2569,	.2588,	.2317,	.3251,	.2260,	.2117,	.2326,	.1805,	.1437,	.3032,
6,	.3556,	.3037,	.3009,	.3118,	.3459,	.3046,	.2502,	.1669,	.2039,	.1778,
7,	.1559,	.4682,	.2043,	.5040,	.4065,	.3856,	.2534,	.1883,	.1936,	.2140,
8,	.5132,	.5772,	.2334,	.3788,	.4439,	.2536,	.2165,	.1482,	.2287,	.1951,
9,	.3074,	.3602,	.2318,	.3325,	.3296,	.2803,	.2263,	.1733,	.2060,	.2417,
+gp,	.3074,	.3602,	.2318,	.3325,	.3296,	.2803,	.2263,	.1733,	.2060,	.2417,
0 FBAR 3- 7,	.2215,	.2607,	.1973,	.2783,	.2623,	.2604,	.1965,	.1759,	.1922,	.2224,

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

Table 8 Fishing mortality (F) at age

YEAR,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	2005,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0001,	.0000,	.0000,	.0004,	.0005,	.0003,	.0000,	.0000,	.0004,	.0000,
2,	.0077,	.0092,	.0318,	.0126,	.0743,	.0399,	.0281,	.0033,	.0088,	.0128,
3,	.0722,	.0886,	.1684,	.5528,	.3180,	.2251,	.1734,	.0820,	.0629,	.0763,
4,	.3612,	.2031,	.2291,	.2231,	.1812,	.4493,	.3339,	.2537,	.1579,	.1641,
5,	.4173,	.4625,	.2980,	.3273,	.2498,	.2231,	.4202,	.4662,	.3142,	.3459,
6,	.3739,	.5274,	.5999,	.3352,	.3169,	.2603,	.2674,	.6989,	.4772,	.3061,
7,	.3423,	.5411,	1.2873,	.7107,	.2346,	.2172,	.2137,	.6090,	.7582,	.4257,
8,	.3103,	.3396,	.9681,	1.8412,	.5835,	.1696,	.2446,	.5200,	.8273,	.6873,
9,	.2386,	.4495,	.7023,	.6134,	.2866,	.2335,	.1982,	.4204,	.5324,	.6824,
+gp,	.2386,	.4495,	.7023,	.6134,	.2866,	.2335,	.1982,	.4204,	.5324,	.6824,
0 FBAR 3- 7,	.3134,	.3645,	.5165,	.4298,	.2601,	.2750,	.2817,	.4220,	.3541,	.2636,

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

Run title : FAROE HADDOCK (ICES DIVISION Vb) HAD1_IND

At 1/05/2006 19:29

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,
AGE									
0,	64927,	54061,	77651,	58761,	71715,	45400,	33844,	30193,	37949,
1,	47944,	53158,	44261,	63576,	48110,	58715,	37170,	27709,	24720,
2,	35106,	39212,	43417,	35763,	51279,	38537,	47362,	30110,	22644,
3,	25440,	25003,	26445,	31954,	23796,	34806,	22837,	26515,	22586,
4,	20280,	14377,	13213,	14717,	16517,	12850,	15850,	10638,	14961,
5,	5517,	8965,	6632,	6706,	6028,	8877,	5786,	6278,	5182,
6,	2786,	3055,	4284,	3570,	3245,	3182,	5132,	2708,	3005,
7,	1377,	1472,	1326,	1839,	1512,	1476,	1332,	2809,	1204,
8,	585,	598,	466,	433,	448,	480,	423,	313,	1641,
9,	252,	274,	224,	168,	135,	153,	148,	114,	77,
+gp,	154,	227,	106,	54,	29,	46,	45,	16,	14,
0 TOTAL,	204367,	200401,	218024,	217540,	222812,	204522,	169929,	137403,	133982,

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

YEAR,	1966,	1967,	1968,	1969,	1970,	1971,	1972,	1973,	1974,	1975,
AGE										
0,	81929,	47771,	53244,	23141,	49629,	35423,	78987,	104943,	83710,	39176,
1,	31070,	67078,	39111,	43593,	18946,	40633,	29002,	64669,	85920,	68536,
2,	20203,	25356,	54856,	31977,	35605,	15460,	33218,	23706,	52345,	70116,
3,	17302,	15563,	19471,	39591,	24024,	27587,	12009,	26518,	16413,	37760,
4,	14613,	11176,	10566,	12234,	25592,	15276,	18612,	6444,	14096,	10814,
5,	7605,	7618,	6798,	6106,	5884,	14999,	8230,	11457,	4154,	7948,
6,	2937,	3774,	4622,	4187,	3583,	3348,	9324,	4289,	6851,	2993,
7,	1366,	1398,	1800,	2403,	2084,	1682,	1572,	6574,	2680,	4726,
8,	377,	449,	574,	638,	860,	712,	596,	657,	4429,	1773,
9,	127,	146,	189,	262,	180,	409,	382,	325,	402,	3142,
+gp,	21,	36,	33,	45,	26,	281,	319,	52,	866,	1396,
0 TOTAL,	177550,	180364,	191264,	164177,	166414,	155810,	192249,	249634,	271865,	248380,

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,	1976,	1977,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,
AGE										
0,	52445,	4167,	7389,	5217,	23689,	29451,	61240,	59665,	40064,	14383,
1,	32074,	42938,	3412,	6049,	4272,	19395,	24113,	50139,	48849,	32802,
2,	56027,	26224,	35155,	2794,	4952,	3497,	15879,	19742,	41050,	39972,
3,	50768,	41894,	21240,	28753,	2286,	3925,	2796,	12513,	15764,	32528,
4,	23720,	34455,	30645,	16465,	22490,	1819,	2802,	1444,	8463,	11494,
5,	6957,	13269,	23533,	21246,	11892,	15044,	1307,	1584,	836,	4702,
6,	5267,	4564,	6414,	15599,	14370,	7399,	9977,	800,	915,	551,
7,	2227,	3236,	1811,	3585,	11096,	9507,	4833,	6194,	571,	538,
8,	3551,	1554,	1794,	834,	2237,	7666,	6373,	3076,	3765,	430,
9,	1237,	2256,	871,	894,	491,	1234,	5726,	4163,	1849,	2303,
+gp,	1516,	2615,	1110,	425,	424,	250,	949,	3472,	4586,	4427,
0 TOTAL,	235788,	177171,	133373,	101862,	98200,	99188,	135995,	162792,	166713,	144129,

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

YEAR,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,
AGE										
0,	28509,	23245,	14263,	4544,	4017,	2725,	9692,	152627,	69693,	13840,
1,	11776,	23341,	19031,	11678,	3721,	3289,	2231,	7935,	124960,	57060,
2,	26856,	9641,	19110,	15581,	9561,	3046,	2693,	1827,	6458,	102308,
3,	31835,	21780,	7637,	15054,	12700,	7733,	2424,	2169,	1393,	5037,
4,	22512,	23758,	16277,	5851,	10951,	9244,	5387,	1846,	1506,	968,
5,	7424,	14403,	16225,	11098,	4195,	7228,	5963,	3708,	1263,	955,
6,	2725,	4701,	9103,	10537,	6564,	2740,	4789,	3869,	2535,	896,
7,	299,	1564,	2841,	5516,	6316,	3803,	1654,	3053,	2681,	1692,
8,	358,	209,	802,	1896,	2728,	3444,	2117,	1051,	2070,	1808,
9,	296,	175,	96,	520,	1063,	1433,	2188,	1396,	742,	1349,
+gp,	2953,	1211,	680,	314,	422,	144,	879,	1279,	1778,	1510,
0 TOTAL,	135542,	124027,	106066,	82590,	62239,	44829,	40017,	180758,	215079,	187422,

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

YEAR,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	2005,	2006,
AGE											
0,	5590,	22919,	33666,	184888,	90042,	66397,	45824,	10881,	19023,	3502,	0,
1,	11331,	4577,	18764,	27563,	151373,	73720,	54361,	37517,	8908,	15575,	2867,
2,	46717,	9276,	3747,	15363,	22559,	123868,	60340,	44507,	30717,	7291,	12752,
3,	83035,	37953,	7525,	2972,	12421,	17148,	97451,	48031,	36319,	24929,	5893,
4,	3715,	63247,	28438,	5206,	1400,	7399,	11209,	67083,	36227,	27924,	18910,
5,	580,	2119,	42266,	18515,	3410,	956,	3866,	6572,	42618,	25327,	19403,
6,	577,	313,	1093,	25687,	10927,	2175,	626,	2079,	3376,	25485,	14672,
7,	614,	325,	151,	491,	15041,	6517,	1373,	393,	846,	1715,	15364,
8,	1119,	357,	155,	34,	198,	9740,	4294,	908,	175,	325,	917,
9,	1218,	672,	208,	48,	4,	90,	6730,	2753,	442,	63,	134,
+gp,	2040,	1561,	1085,	457,	313,	95,	202,	2981,	2143,	335,	165,
0 TOTAL,	156536,	143320,	137099,	281226,	307689,	308105,	286276,	223706,	180795,	132471,	91077,

Table 2.4.12 Faroe haddock. Stock summary of the VPA 2006.

	Table	16	Summary	(without	SOP	correction)	
Terminal	Fs	derived	using	XSA	(With F shrinkage)		
	Recruits	**Recruits**	**Total**	**Total**	**Landings**	**Yield/SSB**	**FBAR(3-7)**
Year	**Age 0**	**Age 2**	**Biomass**	**SSB**			
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	33844	47362	90205	49706	27571	0.5547	0.7002
1964	30193	30110	75561	44185	19490	0.4411	0.4753
1965	37949	22644	71885	45605	18479	0.4052	0.526
1966	81929	20203	68774	44027	18766	0.4262	0.5288
1967	47771	25356	77103	42086	13381	0.3179	0.4031
1968	53244	54856	87974	45496	17852	0.3924	0.4377
1969	23141	31977	94884	53585	23272	0.4343	0.4853
1970	49629	35605	92151	59962	21361	0.3562	0.4762
1971	35423	15460	92942	63928	19393	0.3034	0.4564
1972	78987	33218	91521	63144	16485	0.2611	0.3961
1973	104943	23706	98997	61635	18035	0.2926	0.2901
1974	83710	52345	116918	64648	14773	0.2285	0.2205
1975	39176	70116	138974	75429	20715	0.2746	0.1798
1976	52445	56027	143719	89263	26211	0.2936	0.2474
1977	4167	26224	121145	96452	25555	0.265	0.3871
1978	7389	35155	120721	97344	19200	0.1972	0.2778
1979	5217	2794	99649	85524	12424	0.1453	0.1549
1980	23689	4952	87788	82042	15016	0.183	0.1776
1981	29451	3497	79130	76008	12233	0.1609	0.1809
1982	61240	15879	68480	56947	11937	0.2096	0.3299
1983	59665	19742	64195	51980	12894	0.2481	0.2644
1984	40064	41050	101369	54076	12378	0.2289	0.2273
1985	14383	39972	94738	63009	15143	0.2403	0.2742
1986	28509	26856	99600	66222	14477	0.2186	0.2215
1987	23245	9641	88852	68175	14882	0.2183	0.2607
1988	14263	19110	78747	62932	12178	0.1935	0.1973
1989	4544	15581	71676	52837	14325	0.2711	0.2783
1990	4017	9561	55613	45139	11726	0.2598	0.2623
1991	2725	3046	40655	36433	8429	0.2314	0.2604
1992	9692	2693	30859	28690	5476	0.1909	0.1965
1993	152627	1827	30532	24913	4026	0.1616	0.1759
1994	69693	6458	29220	23324	4252	0.1823	0.1922
1995	13840	102308	93680	24559	4948	0.2015	0.2224
1996	5590	46717	121046	54606	9642	0.1766	0.3134
1997	22919	9276	113522	87179	17924	0.2056	0.3645
1998	33666	3747	98373	87693	22210	0.2533	0.5165
1999	184888	15363	85966	68496	18482	0.2698	0.4298
2000	90042	22559	123317	58616	15821	0.2699	0.2601
2001	66397	123868	165774	68472	15890	0.2321	0.275
2002	45824	60340	174334	98849	24933	0.2522	0.2817
2003	10881	44507	158541	113889	26970	0.2368	0.422
2004	19023	30717	144155	102654	23036	0.2244	0.3541
2005	3502	7291	104756	87933	20305	0.2309	0.2636
Arith.							
Mean	44409	30878	94882	61827	17170	0.2877	0.3562
Units	(Thousands)	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

Table 2.4.13 **Management option tables INPUT DATA** **FAROE HADDOCK**

Stock size

The yearclasses up to 2004 included are derived from the final 2006 XSA.
The yearclasses 2006-2007 at age 2 are estimated from the 2006 XSA
applying a natural mortality of 0.2 in forward calculations of the numbers using standard VPA equations
The yearclass 2006 at age 2 in 2008 is estimated as the geomean of the yearclasses since 1980

	Age0	Age1	Age2
YC2004	19023	15576	12752
YC2005	3502	2867	2347
YC2006			
0.818731			

Age	2006	2007	2008
2	12752	2350	13795
3	5893		
4	18910		
5	19403		
6	14672		
7	15364		
8	917		
9	134		
10+	165		

Predicted values rounded

Year	age 2	Geomean(1980-2007)
1980	4952	
1981	3497	
1982	15879	
1983	19742	
1984	41050	
1985	39972	
1986	26856	
1987	9641	
1988	19110	13795
1989	15581	
1990	9561	
1991	3046	
1992	2693	
1993	1827	
1994	6458	
1995	102308	
1996	46717	
1997	9276	
1998	3747	
1999	15363	
2000	22559	
2001	123868	
2002	60340	
2003	44507	
2004	30717	
2005	7291	
2006	12752	
2007	2350	
2008	13795	

Proportion mature at age

Age	2006	2007	2008	2004	2005	2006	Avg(04-06)
2	0.02	0.01	0.01	0.00	0.01	0.02	0.01
3	0.31	0.33	0.33	0.35	0.34	0.31	0.33
4	0.88	0.91	0.91	0.94	0.91	0.88	0.91
5	0.99	0.99	0.99	0.99	0.99	0.99	0.99
6	1.00	1.00	1.00	1.00	1.00	1.00	1.00
7	1.00	1.00	1.00	1.00	1.00	1.00	1.00
8	1.00	1.00	1.00	1.00	1.00	1.00	1.00
9	1.00	1.00	1.00	1.00	1.00	1.00	1.00
10+	1.00	1.00	1.00	1.00	1.00	1.00	1.00

The maturity at age 2007-2008 is estimated as the
average of the maturity at age 2004-2006

Catch/stock weights at age

Age	2006	2007	2008
2	0.538	0.538	0.538
3	0.649	0.649	0.649
4	0.797	0.797	0.797
5	1.020	1.020	1.020
6	1.245	1.245	1.245
7	1.843	1.843	1.843
8	2.061	2.061	2.061
9	2.263	2.263	2.263
10+	2.579	2.579	2.579

Prediction using 2005 mean catch weight at age from the 2006 assessment

	2005	2006	2007	2008
2	0.538	0.538	0.538	0.538
3	0.649	0.649	0.649	0.649
4	0.797	0.797	0.797	0.797
5	1.02	1.02	1.02	1.02
6	1.245	1.245	1.245	1.245
7	1.843	1.843	1.843	1.843
8	2.061	2.061	2.061	2.061
9	2.263	2.263	2.263	2.263
10+	2.579	2.579	2.579	2.579

Exploitation pattern

Age	2006	2007	2008	2003	2004	2005	Average F for 2003-05		Age	Rescaled to Fbar2005 Average F for 2003-05
2	0.0063	0.0063	0.0063	0.0033	0.0088	0.0128	2	0.0083	2	0.0063
3	0.0561	0.0561	0.0561	0.082	0.0629	0.0763	3	0.0737	3	0.0561
4	0.1460	0.1460	0.1460	0.2537	0.1579	0.1641	4	0.1919	4	0.1460
5	0.2856	0.2856	0.2856	0.4662	0.3142	0.3459	5	0.3754	5	0.2856
6	0.3758	0.3758	0.3758	0.6989	0.4772	0.3061	6	0.4941	6	0.3758
7	0.4546	0.4546	0.4546	0.609	0.7582	0.4257	7	0.5976	7	0.4546
8	0.5159	0.5159	0.5159	0.52	0.8273	0.6873	8	0.6782	8	0.5159
9	0.4146	0.4146	0.4146	0.4204	0.5324	0.6824	9	0.5451	9	0.4146
10+	0.4146	0.4146	0.4146	0.4204	0.5324	0.6824	10+	0.5451	10+	0.4146
Avg3-7	0.2636	0.2636	0.2636	0.422	0.3541	0.2636	Fbar(3-7)	0.3466	Fbar(3-7)	0.2636

The exploitation pattern is estimated from the average fishing mortality matrix 2003-2005 from the final VPA in 2006 (re-scaled to 2005)

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

MFDP version 1
Run: STP2006
Time and date: 22:05 5/1/2006
Fbar age range: 3-7

2006

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
2	12752	0.2	0.02	0	0	0.538	0.0063	0.538
3	5893	0.2	0.31	0	0	0.649	0.0561	0.649
4	18910	0.2	0.88	0	0	0.797	0.1460	0.797
5	19403	0.2	0.99	0	0	1.020	0.2856	1.020
6	14672	0.2	1.00	0	0	1.245	0.3758	1.245
7	15364	0.2	1.00	0	0	1.843	0.4546	1.843
8	917	0.2	1.00	0	0	2.061	0.5159	2.061
9	134	0.2	1.00	0	0	2.263	0.4146	2.263
10	165	0.2	1.00	0	0	2.579	0.4146	2.579

2007

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
2	2350	0.2	0.01	0	0	0.538	0.0063	0.538
3	.	0.2	0.33	0	0	0.649	0.0561	0.649
4	.	0.2	0.91	0	0	0.797	0.1460	0.797
5	.	0.2	0.99	0	0	1.020	0.2856	1.020
6	.	0.2	1.00	0	0	1.245	0.3758	1.245
7	.	0.2	1.00	0	0	1.843	0.4546	1.843
8	.	0.2	1.00	0	0	2.061	0.5159	2.061
9	.	0.2	1.00	0	0	2.263	0.4146	2.263
10	.	0.2	1.00	0	0	2.579	0.4146	2.579

2008

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
2	13795	0.2	0.01	0	0	0.538	0.0063	0.538
3	.	0.2	0.33	0	0	0.649	0.0561	0.649
4	.	0.2	0.91	0	0	0.797	0.1460	0.797
5	.	0.2	0.99	0	0	1.020	0.2856	1.020
6	.	0.2	1.00	0	0	1.245	0.3758	1.245
7	.	0.2	1.00	0	0	1.843	0.4546	1.843
8	.	0.2	1.00	0	0	2.061	0.5159	2.061
9	.	0.2	1.00	0	0	2.263	0.4146	2.263
10	.	0.2	1.00	0	0	2.579	0.4146	2.579

Input units are thousands and kg - output in tonnes

Table 2.4.15 Faroe haddock. Management option table - Results

MFDP version 1
Run: STP2006
Index file 01/05/2006
Time and date: 22:05 5/1/2006
Fbar age range: 3-7

2006				
Biomass	**SSB**	**FMult**	**FBar**	**Landings**
94749	83380	1	0.2636	22153

2007					2008	
Biomass	**SSB**	**FMult**	**FBar**	**Landings**	**Biomass**	**SSB**
73234	67007	0	0	0	80879	72071
.	67007	0.1	0.0264	2344	78321	69518
.	67007	0.2	0.0527	4596	75868	67069
.	67007	0.3	0.0791	6758	73513	64719
.	67007	0.4	0.1054	8836	71253	62463
.	67007	0.5	0.1318	10831	69084	60298
.	67007	0.6	0.1582	12749	67001	58220
.	67007	0.7	0.1845	14591	65002	56225
.	67007	0.8	0.2109	16362	63082	54310
.	67007	0.9	0.2373	18064	61239	52470
.	67007	1	0.2636	19701	59468	50704
.	67007	1.1	0.29	21274	57768	49008
.	67007	1.2	0.3163	22787	56134	47379
.	67007	1.3	0.3427	24242	54565	45814
.	67007	1.4	0.3691	25642	53058	44310
.	67007	1.5	0.3954	26988	51609	42866
.	67007	1.6	0.4218	28284	50217	41478
.	67007	1.7	0.4482	29530	48878	40144
.	67007	1.8	0.4745	30730	47592	38861
.	67007	1.9	0.5009	31885	46356	37629
.	67007	2	0.5272	32997	45167	36444

Input units are thousands and kg - output in tonnes

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

MFYPR version 1
Run: YPR2006
Index file 01/05/2006
Time and date: 21:42 5/1/2006
Fbar age range: 3-7

Age	M	Mat	PF	PM	SWt	Sel	CWt
2	0.2	0.06	0	0	0.558	0.0063	0.558
3	0.2	0.46	0	0	0.812	0.0561	0.812
4	0.2	0.91	0	0	1.084	0.1460	1.084
5	0.2	0.99	0	0	1.422	0.2856	1.422
6	0.2	1.00	0	0	1.741	0.3758	1.741
7	0.2	1.00	0	0	2.040	0.4546	2.040
8	0.2	1.00	0	0	2.261	0.5159	2.261
9	0.2	1.00	0	0	2.487	0.4146	2.487
10	0.2	1.00	0	0	2.802	0.4146	2.802

Weights in kilograms

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

MFYPR version 1
Run: YPR2006
Time and date: 21:42 5/1/2006
Yield per results

FMult	Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNosJan	SSBJan	SpwnNosSpwn	SSBSpwn
0	0	0	0	5.5167	8.6779	4.0638	7.7173	4.0638	7.7173
0.1	0.0264	0.1024	0.2089	5.0069	7.3529	3.5548	6.3932	3.5548	6.3932
0.2	0.0527	0.1749	0.3429	4.646	6.4369	3.1947	5.478	3.1947	5.478
0.3	0.0791	0.2292	0.433	4.3764	5.7695	2.9259	4.8114	2.9259	4.8114
0.4	0.1054	0.2715	0.4958	4.1667	5.2637	2.717	4.3064	2.717	4.3064
0.5	0.1318	0.3055	0.5408	3.9985	4.8683	2.5496	3.9118	2.5496	3.9118
0.6	0.1582	0.3335	0.5737	3.8601	4.5512	2.412	3.5955	2.412	3.5955
0.7	0.1845	0.3571	0.5981	3.7439	4.2915	2.2965	3.3366	2.2965	3.3366
0.8	0.2109	0.3772	0.6166	3.6445	4.075	2.1978	3.1209	2.1978	3.1209
0.9	0.2373	0.3948	0.6307	3.5583	3.8917	2.1124	2.9384	2.1124	2.9384
1	0.2636	0.4102	0.6416	3.4826	3.7344	2.0375	2.7819	2.0375	2.7819
1.1	0.29	0.4239	0.6501	3.4155	3.5978	1.971	2.6461	1.971	2.6461
1.2	0.3163	0.4362	0.6567	3.3552	3.478	1.9116	2.5271	1.9116	2.5271
1.3	0.3427	0.4473	0.662	3.3009	3.3719	1.8579	2.4217	1.8579	2.4217
1.4	0.3691	0.4574	0.6661	3.2514	3.2772	1.8091	2.3278	1.8091	2.3278
1.5	0.3954	0.4667	0.6693	3.206	3.1921	1.7645	2.2434	1.7645	2.2434
1.6	0.4218	0.4753	0.6719	3.1643	3.115	1.7235	2.167	1.7235	2.167
1.7	0.4482	0.4832	0.6739	3.1257	3.0447	1.6856	2.0975	1.6856	2.0975
1.8	0.4745	0.4906	0.6754	3.0897	2.9804	1.6504	2.0339	1.6504	2.0339
1.9	0.5009	0.4975	0.6766	3.0562	2.9213	1.6175	1.9755	1.6175	1.9755
2	0.5272	0.504	0.6775	3.0248	2.8666	1.5868	1.9215	1.5868	1.9215

Reference point	F multiplier	Absolute F
Fbar(3-7)	1	0.2636
FMax	2.4588	0.6482
F0.1	0.6233	0.1643
F35%SPR	1.0579	0.2789
Flow	-99	
Fmed	1.2567	0.3313
Fhigh	5.7608	1.5187

Weights in kilograms

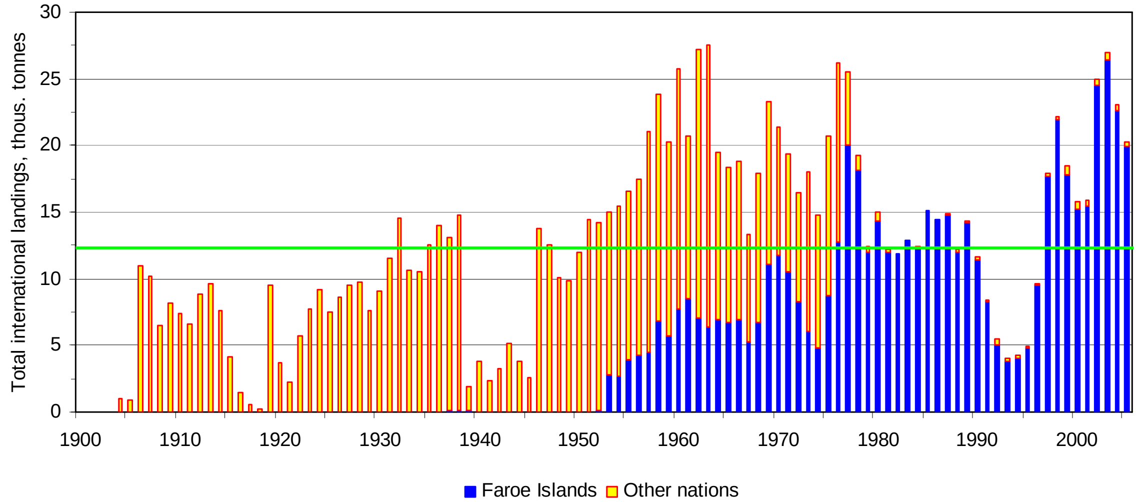

Figure 2.4.1. Haddock in ICES Division Vb. Landings by all nations 1904-2005.

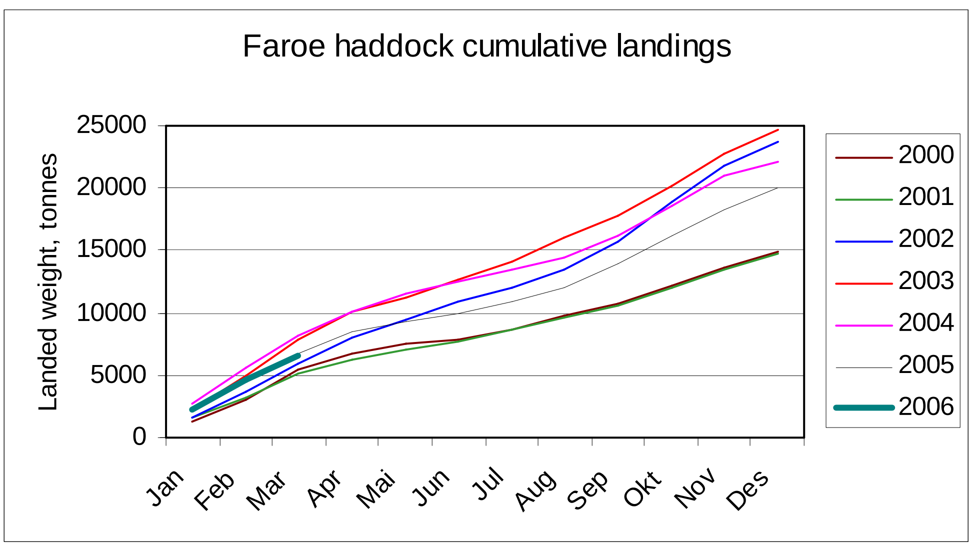

Figure 2.4.2. Faroe haddock. Cumulative Faroese landings from Vb.

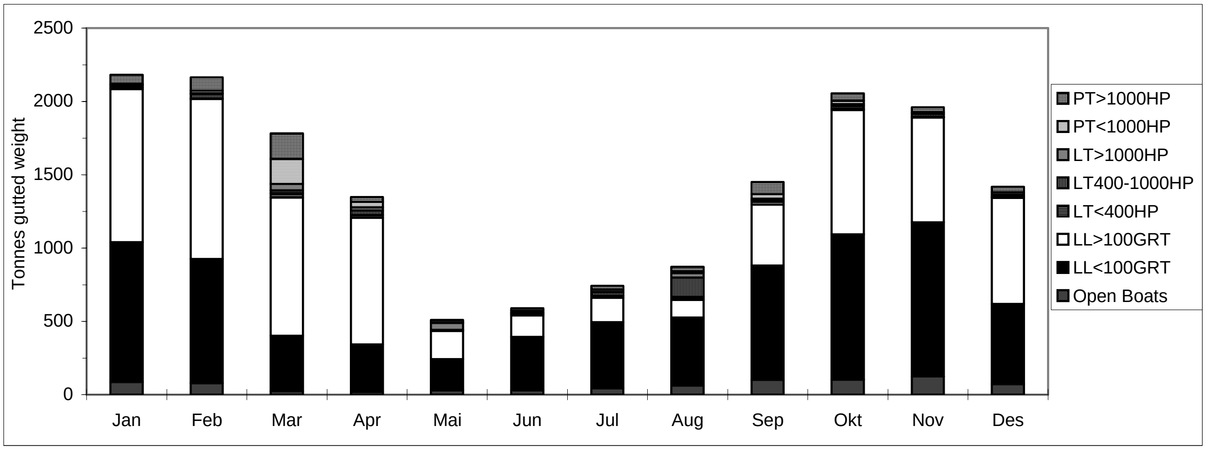

Figure 2.4.3.A. Faroese landings of haddock from Vb1 in 2005 by fleet. Tonnes ungutted weight.

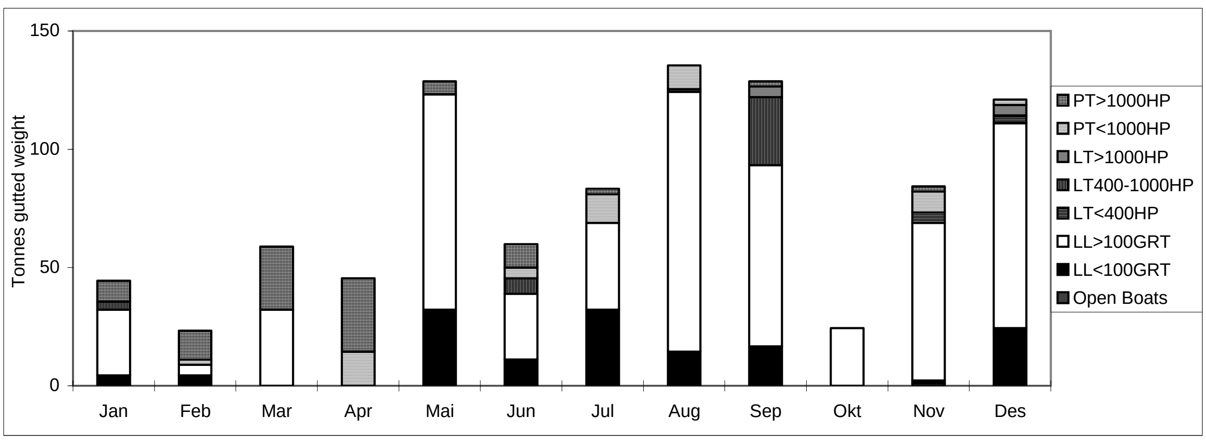

Figure 2.4.3.B. Faroese landings of haddock from Vb2 in 2005 by fleet. Tonnes ungutted weight.

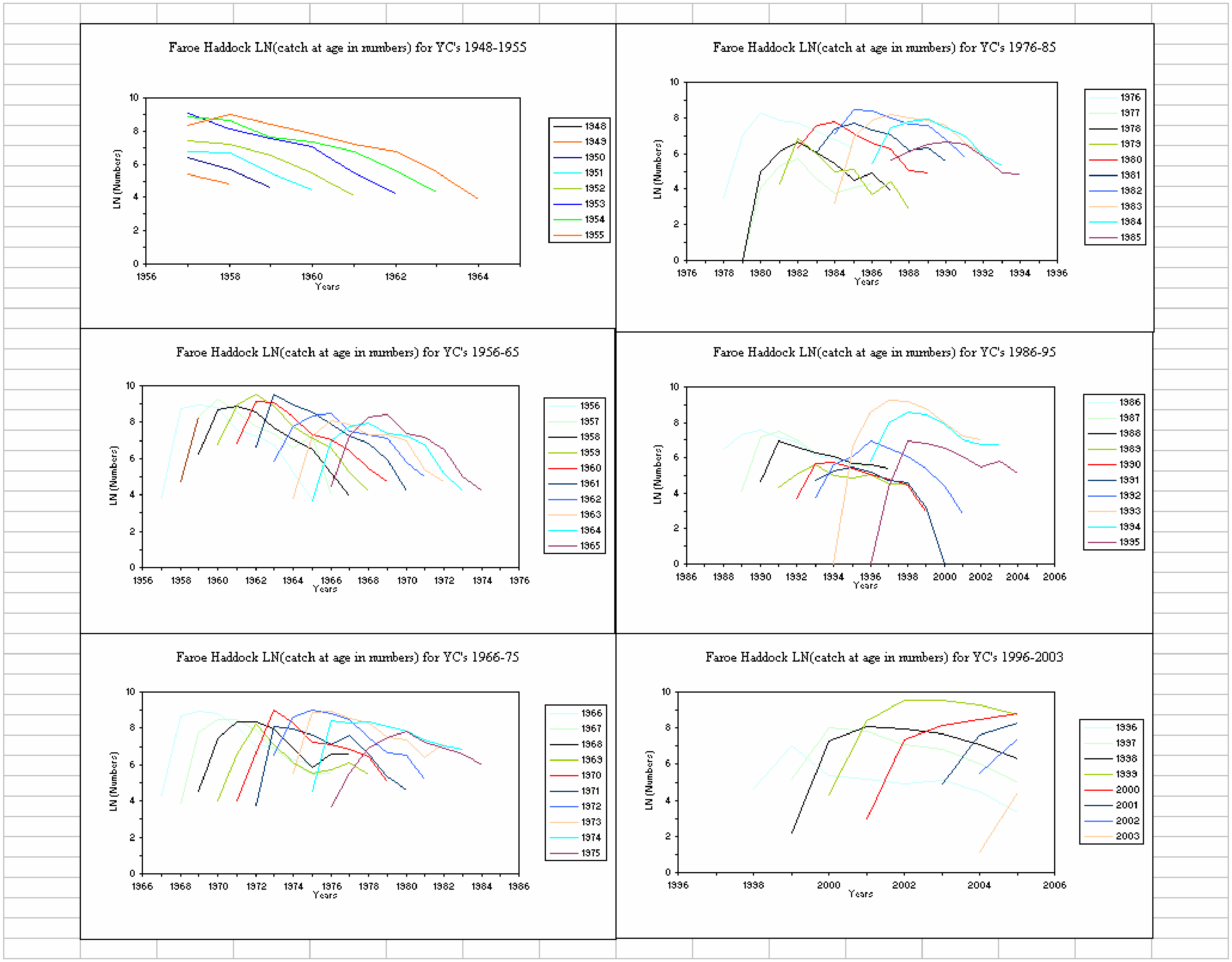

Figure 2.4.4. Faroe haddock. LN(catch@age in numbers) for YC's 1953 onwards.

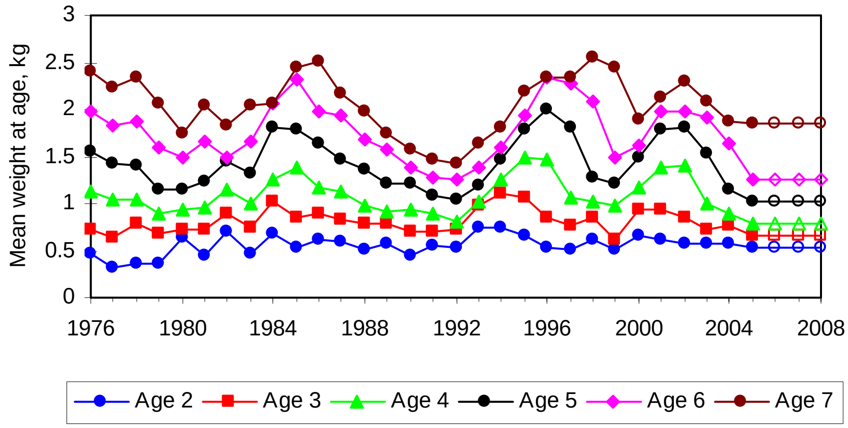

Figure 2.4.5. Faroe haddock. Mean weight at age (2-7). 2006-2008 are predicted values used in the short term prediction (open symbols).

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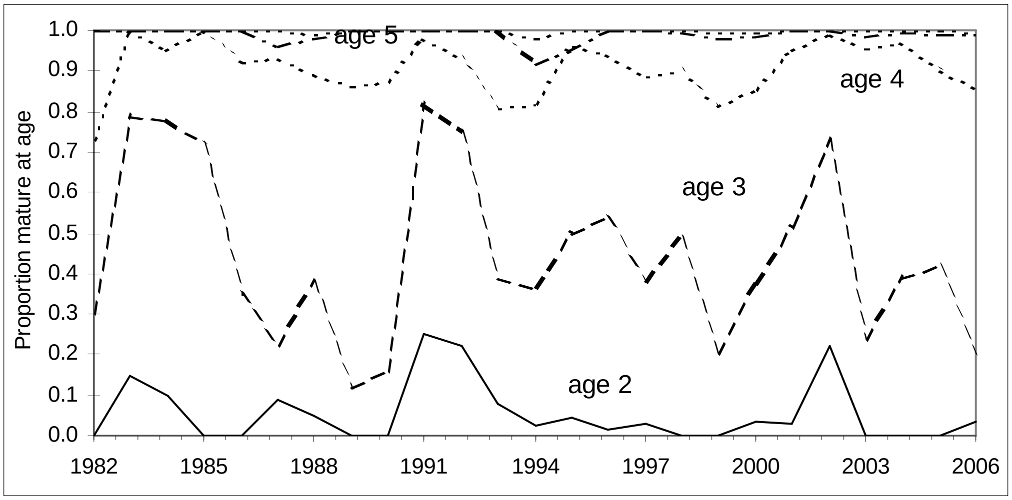


Figure 2.4.6A. Faroe haddock. Maturity at age. Observed values from the spring survey.

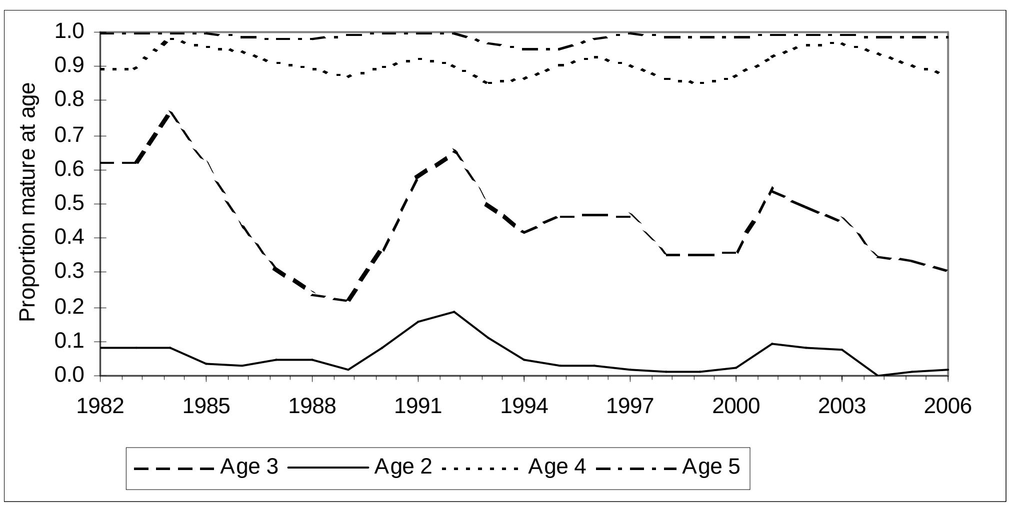


Figure 2.4.6B. Faroe haddock. Maturity at age. Running 3 years average from the spring survey.

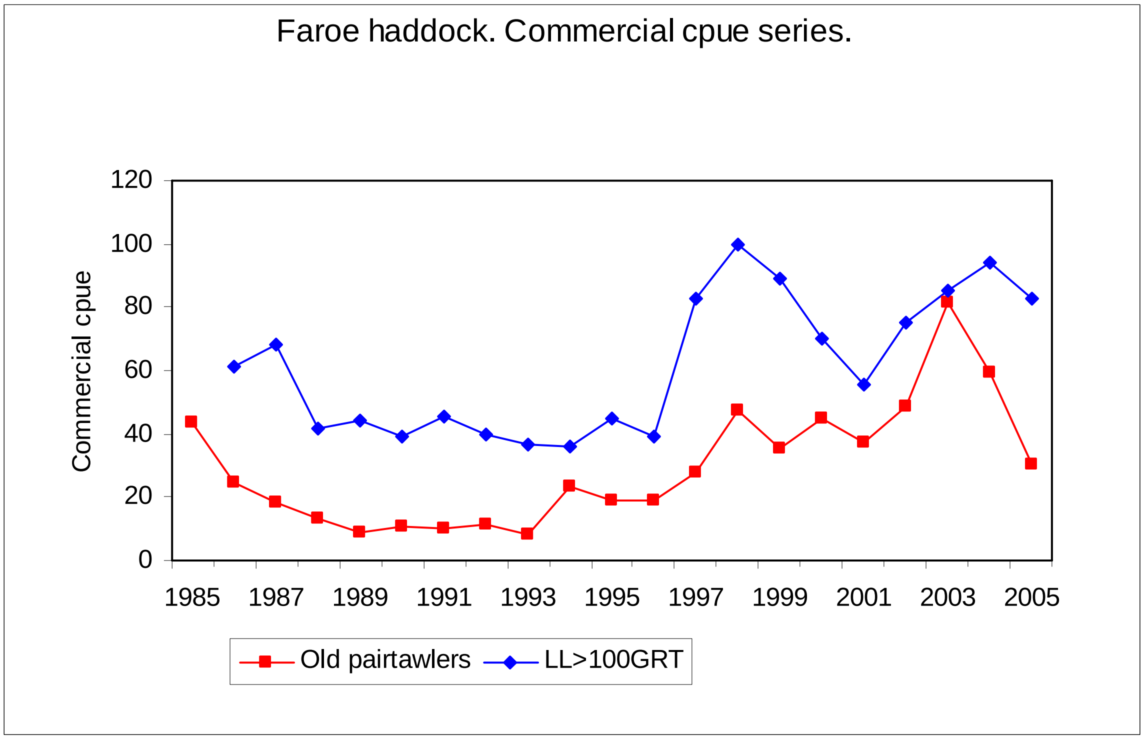


Figure 2.4.7. Pair trawlers > 1000HP and longliners > 100 HP.

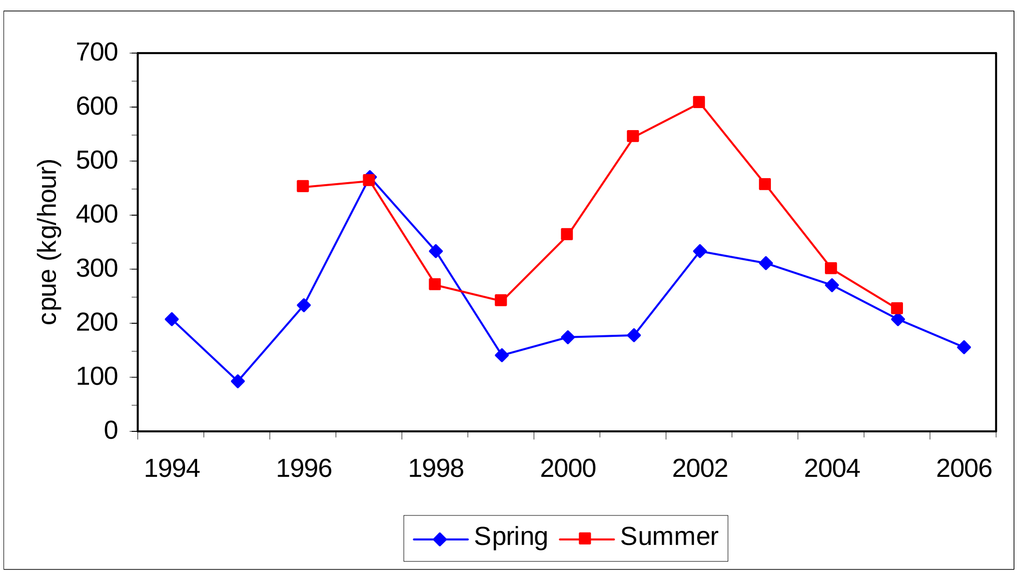
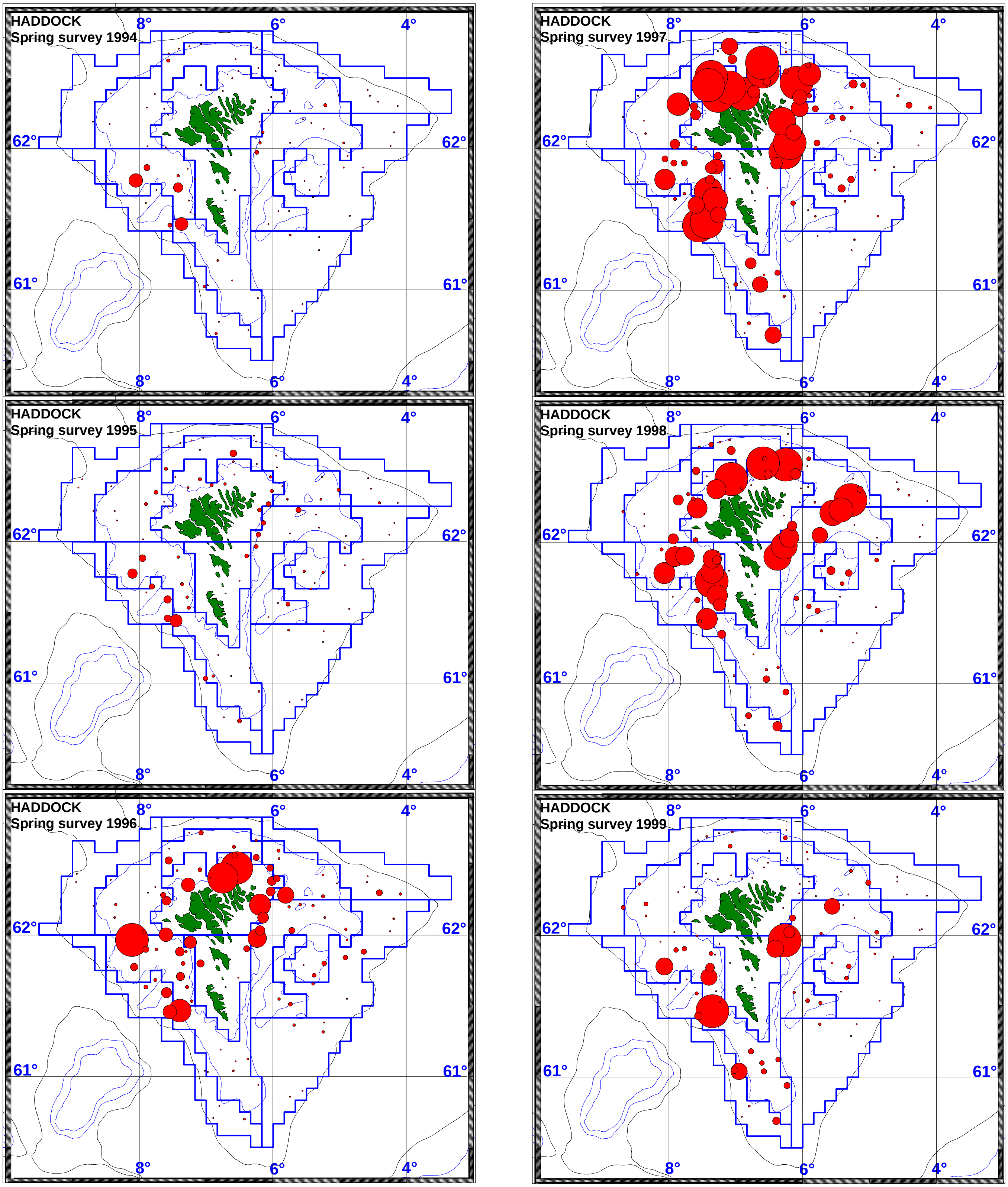
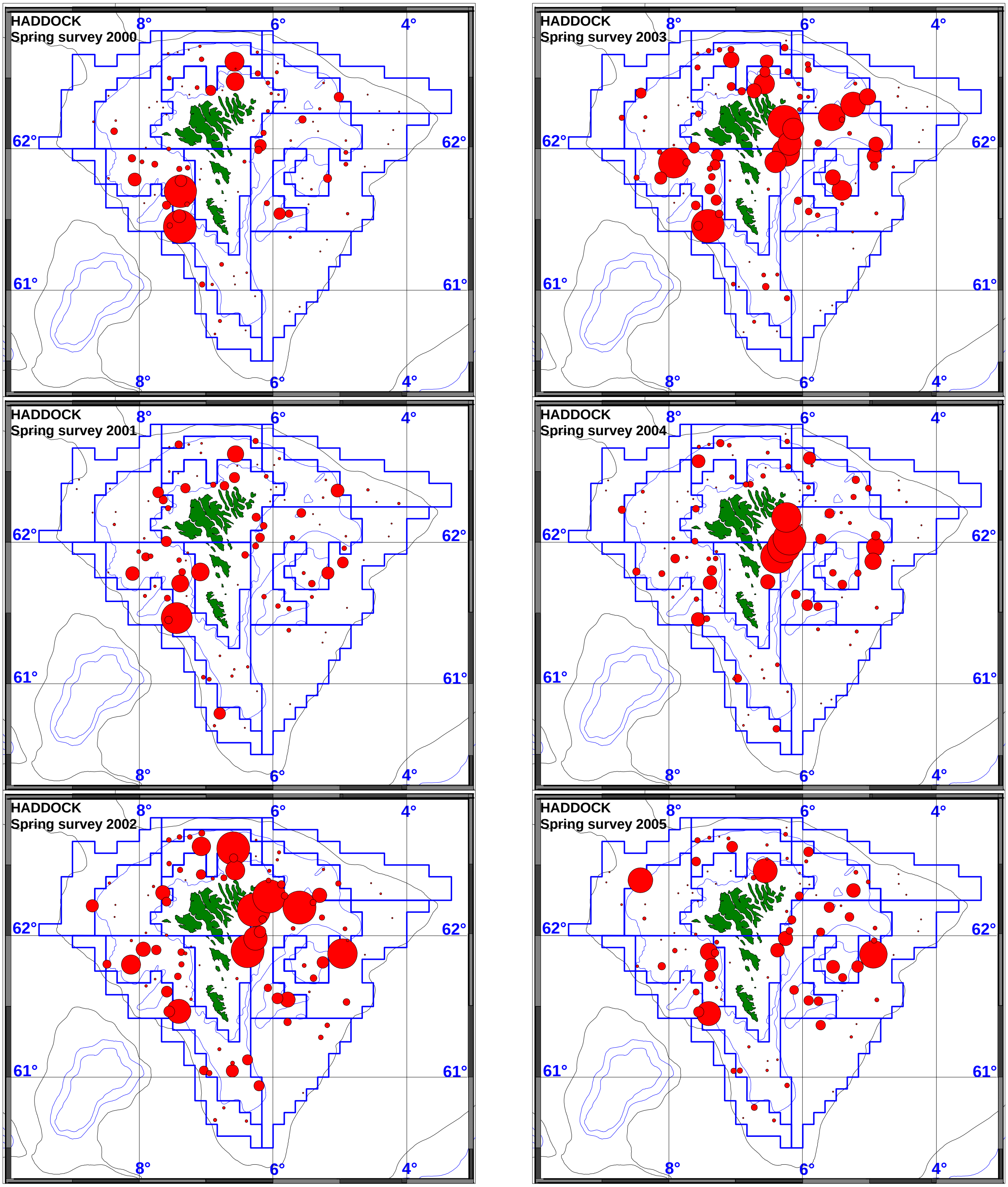


Figure 2.4.8. Faroe haddock. CPUE (kg/trawlhour) in the spring and summer surveys.


HADDOCK
Spring survey 1994
HADDOCK
Spring survey 1997
HADDOCK
Spring survey 1995
HADDOCK
Spring survey 1998
HADDOCK
Spring survey 1996
HADDOCK
Spring survey 1999
8°
6°
4°
62°
61°


HADDOCK
Spring survey 2000
HADDOCK
Spring survey 2003
HADDOCK
Spring survey 2001
HADDOCK
Spring survey 2004
HADDOCK
Spring survey 2002
HADDOCK
Spring survey 2005
8°
6°
4°
62°
61°

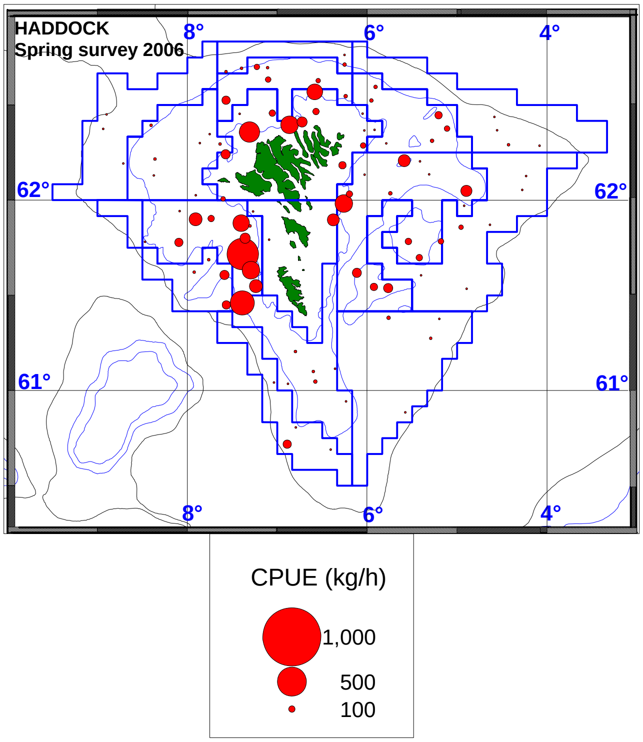
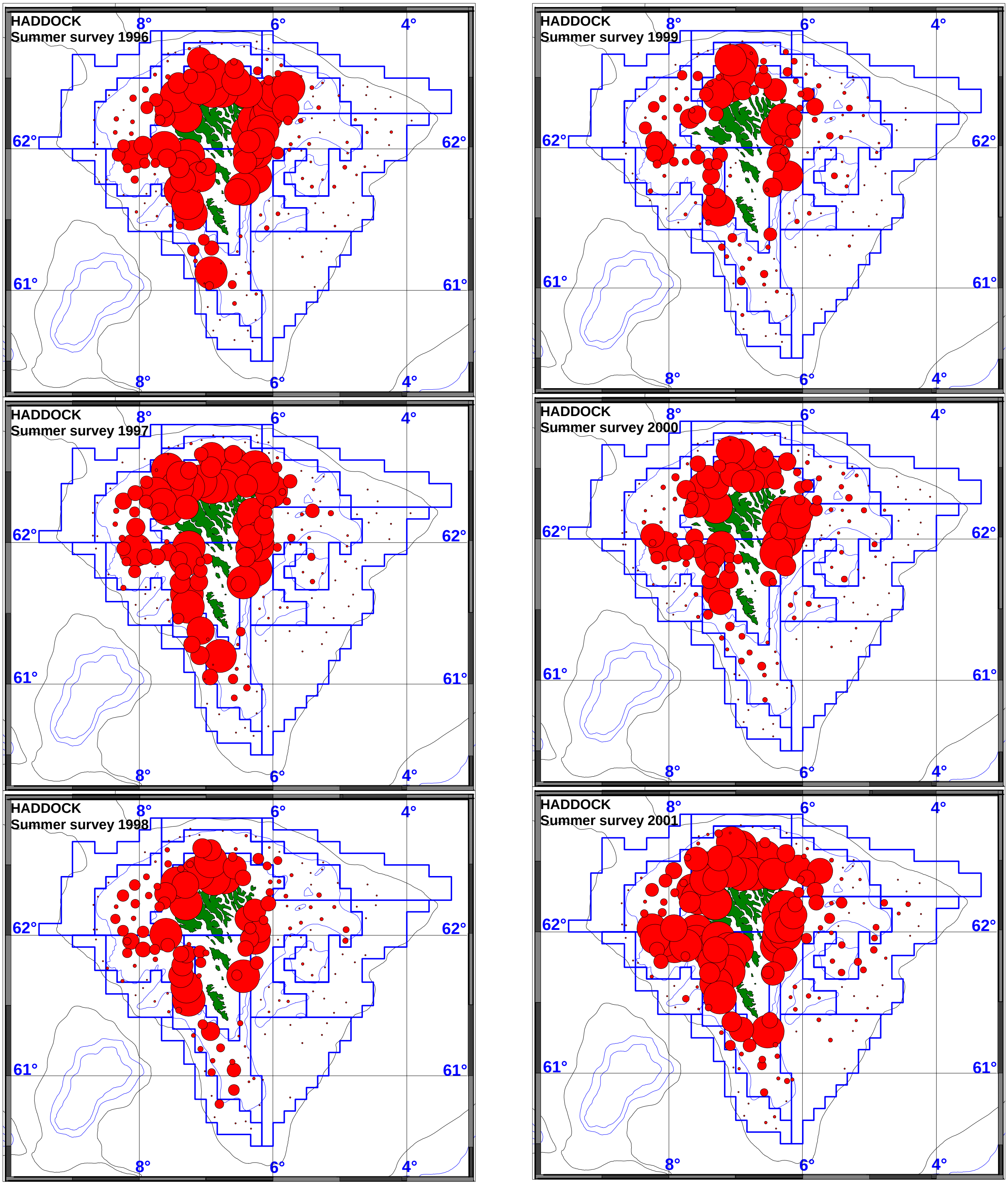


Figure 2.4.9. Distribution of Faroe haddock catches by year in the spring surveys.


HADDOCK
Summer survey 1996
HADDOCK
Summer survey 1999
HADDOCK
Summer survey 1997
HADDOCK
Summer survey 2000
HADDOCK
Summer survey 1998
HADDOCK
Summer survey 2001
8°
6°
4°
62°
61°

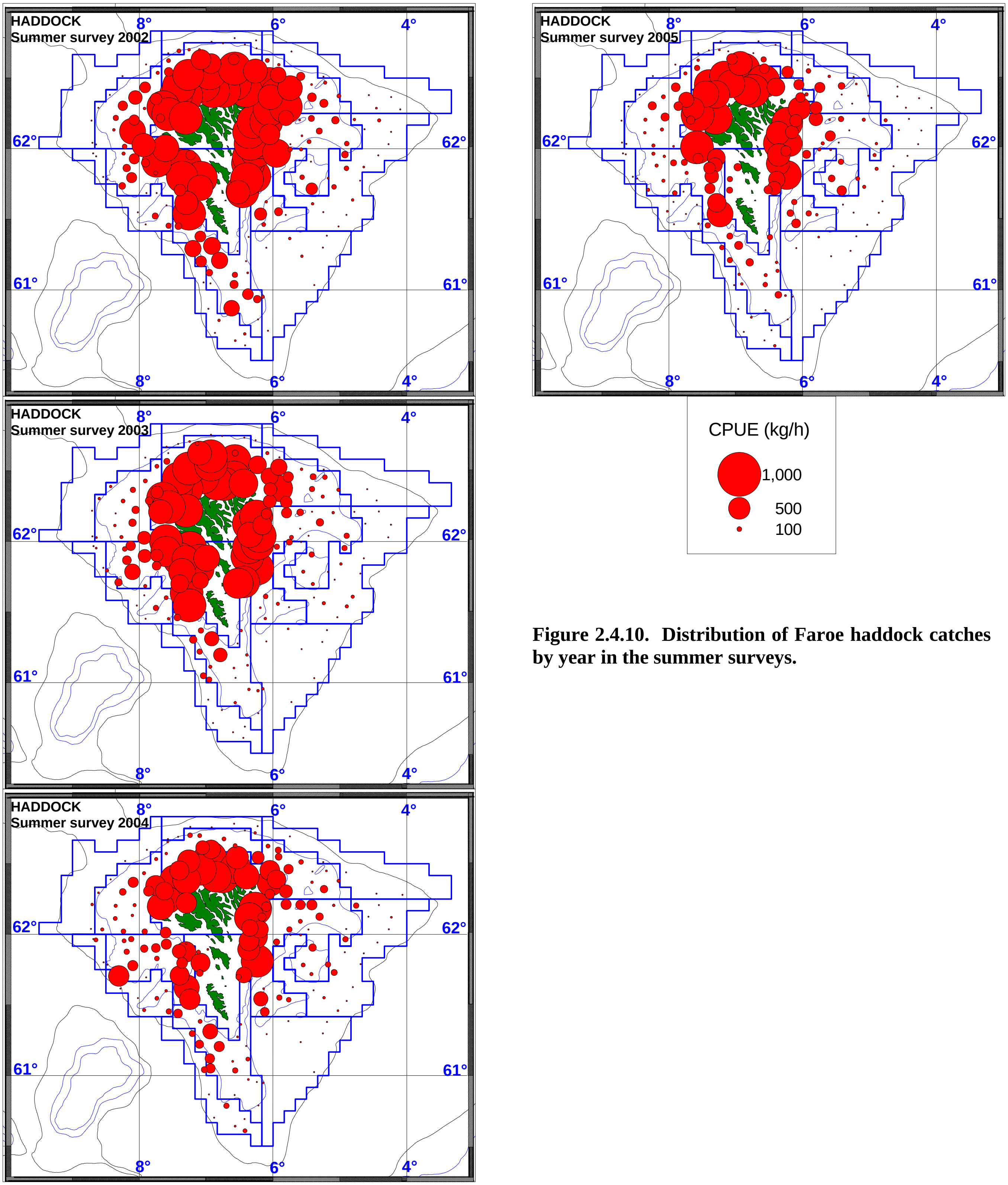


Figure 2.4.10. Distribution of Faroe haddock catches by year in the summer surveys.

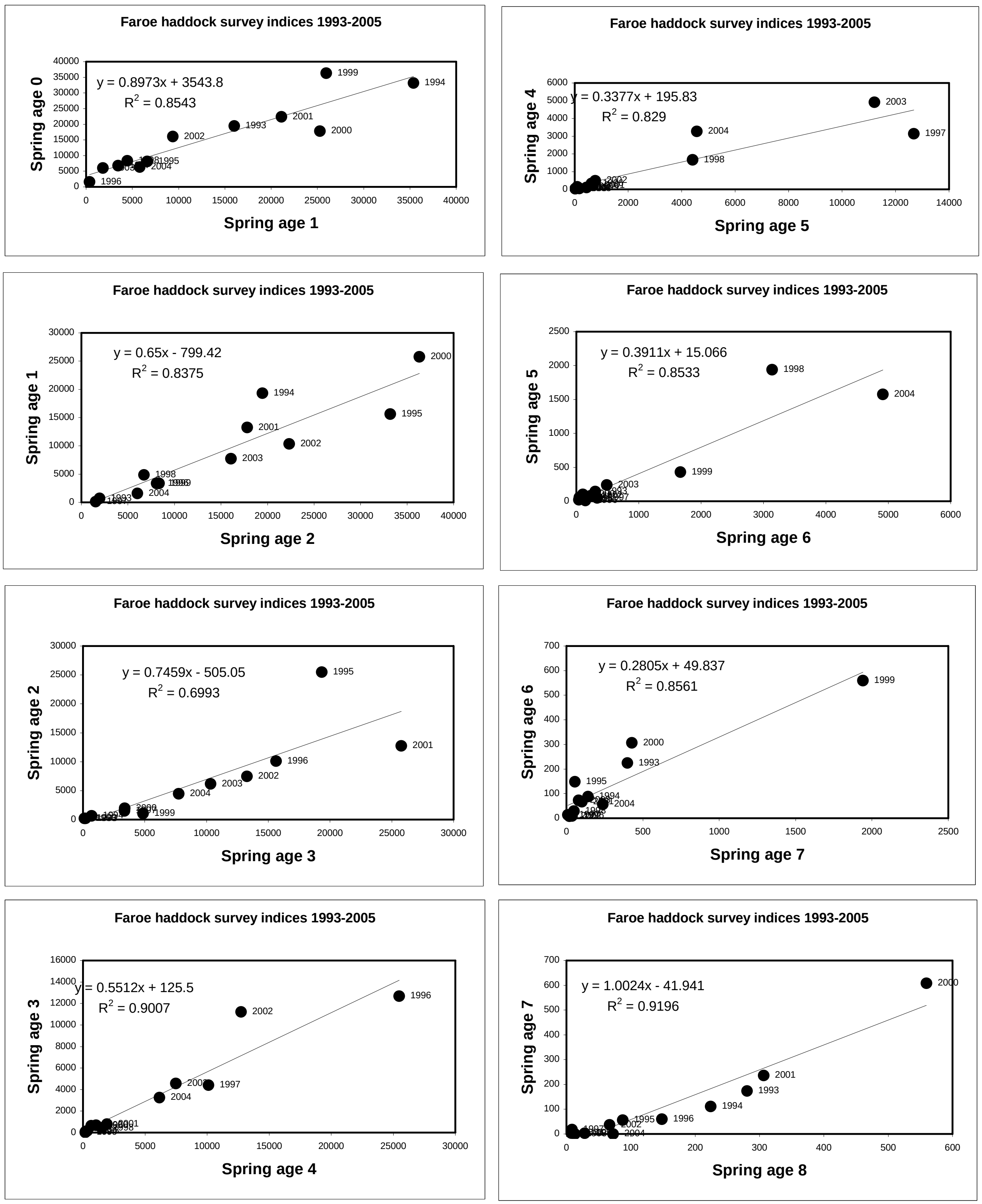


Figure 2.4.11. Faroe haddock. Comparison between spring survey indices at age and the indices of the same YC one year later.

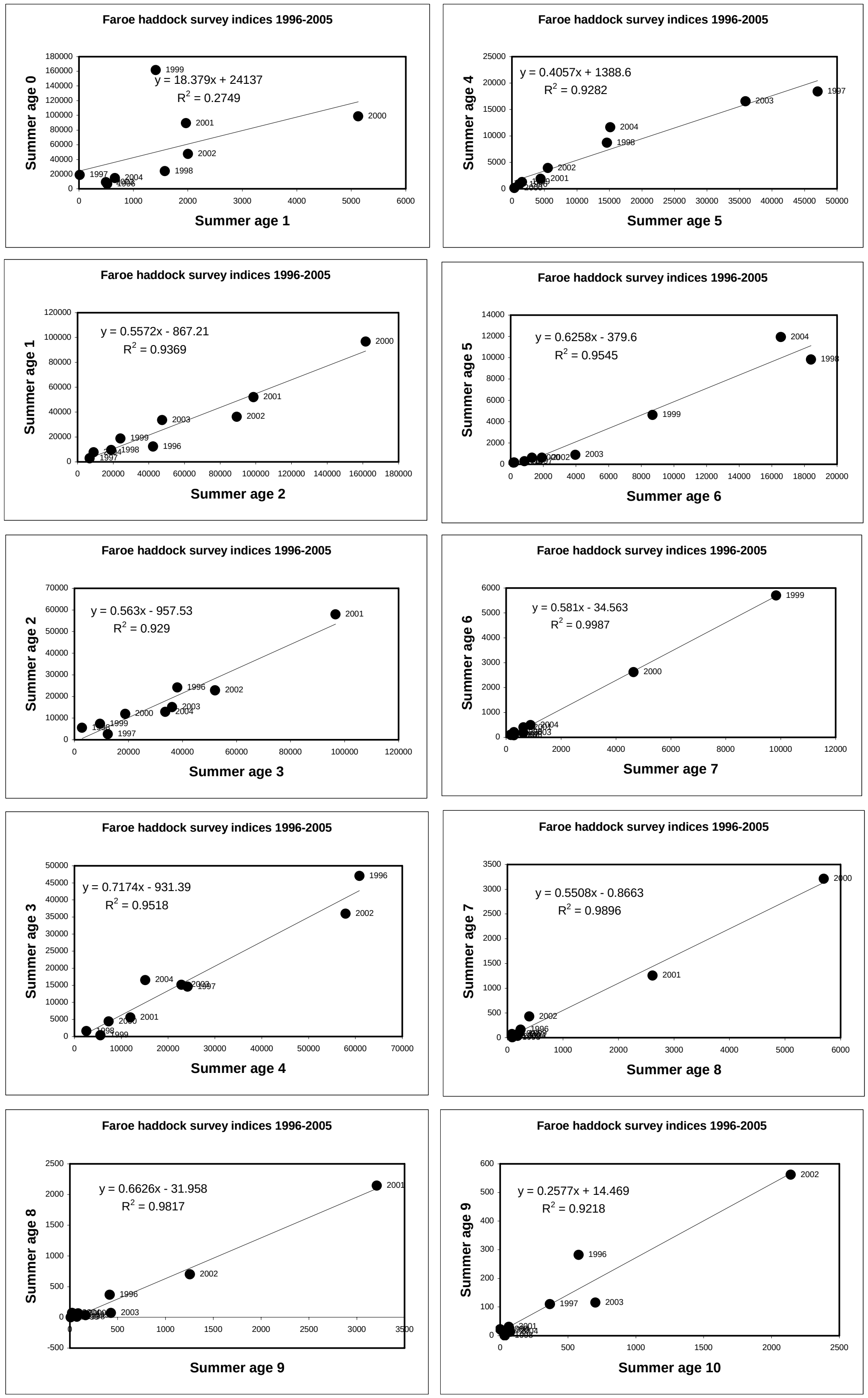


Figure 2.4.12. Faroe haddock. Comparison between summer survey indices at age and the indices of the same YC one year later.

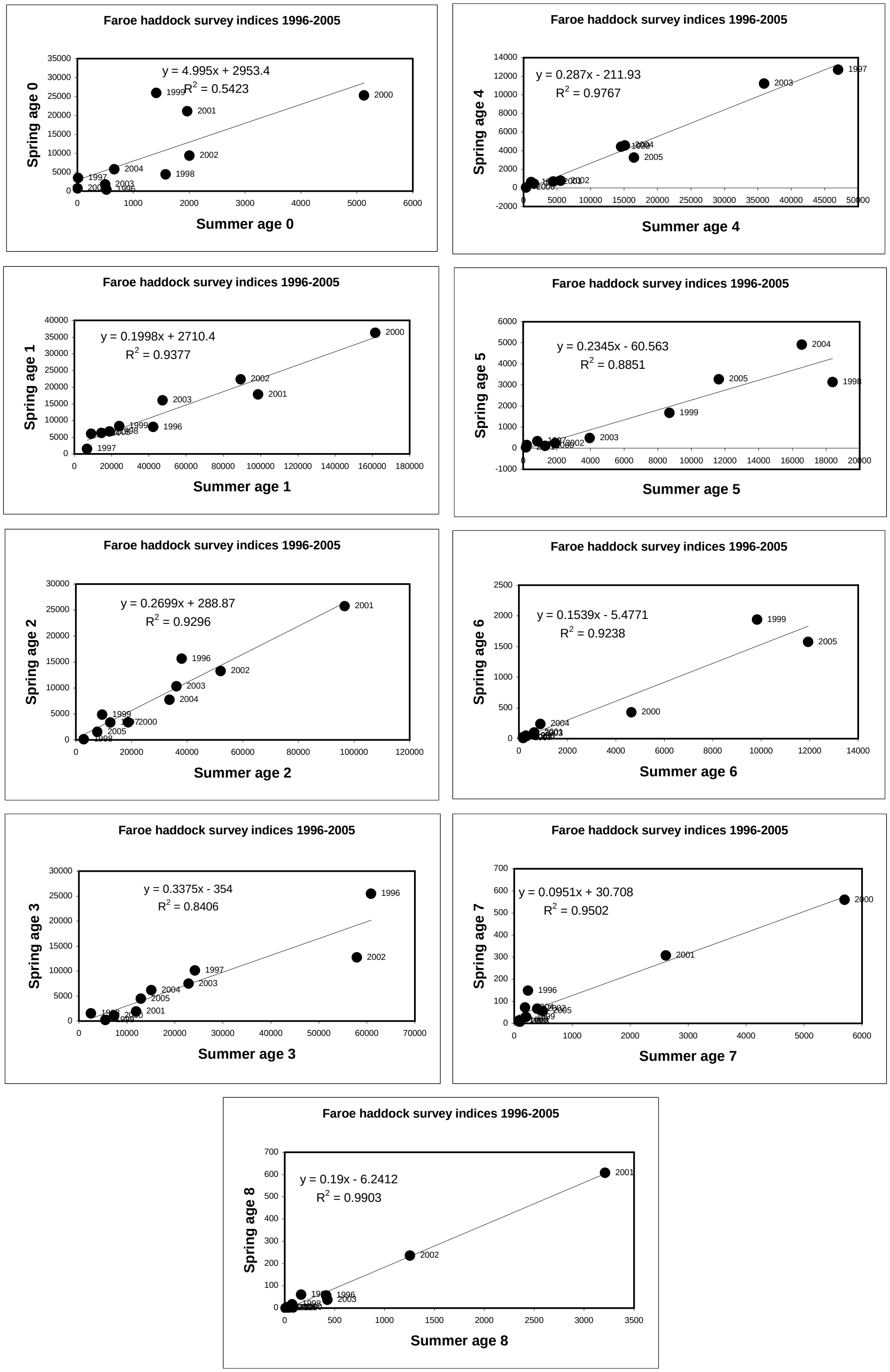
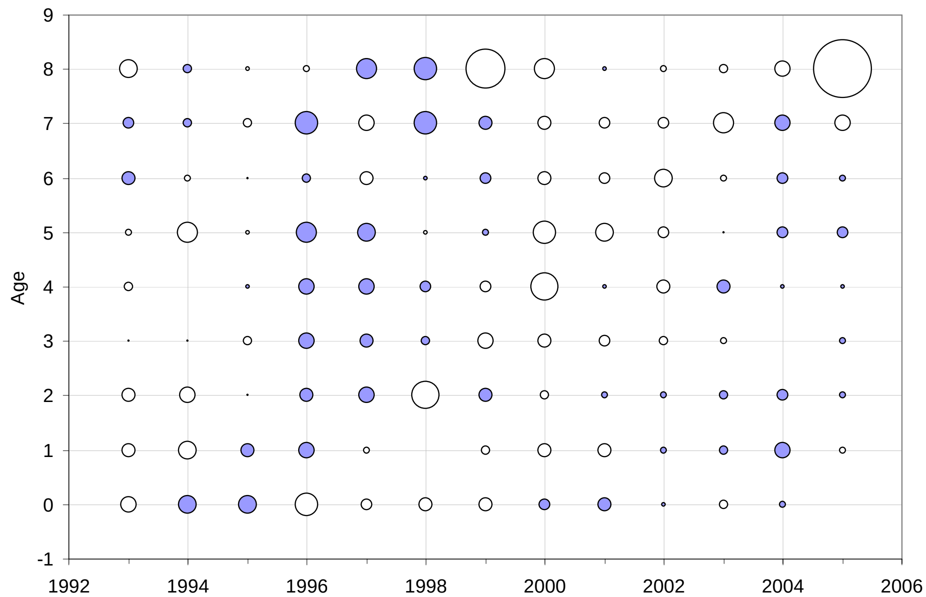


Figure 2.4.13. Faroe haddock. Comparison between indices at age from the spring and summer surveys.

Faroe haddock. Spring survey log q residuals.



Faroe haddock. Summer survey log q residuals.

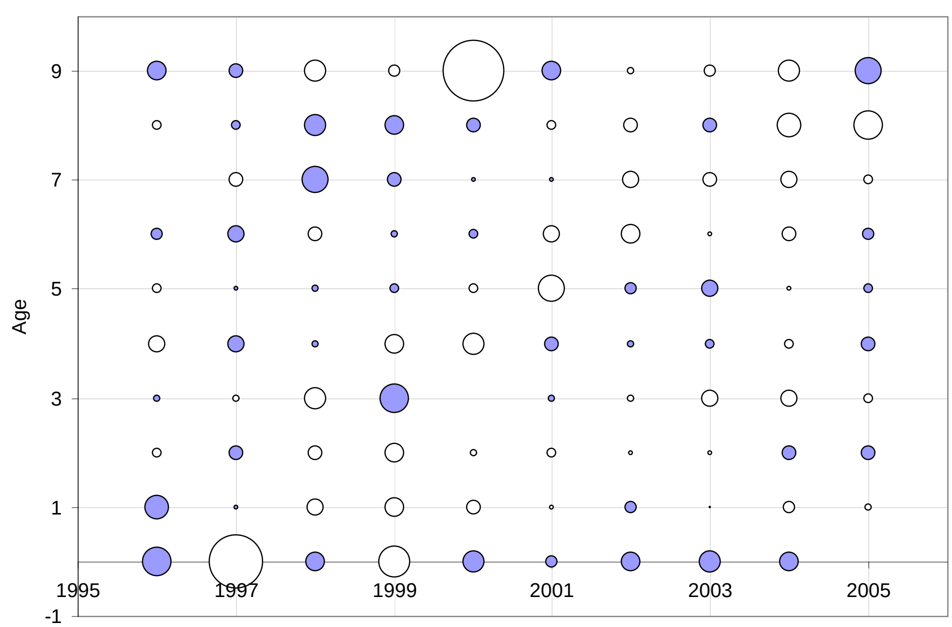


Figure 2.4.14. Faroe haddock survey log q residuals.

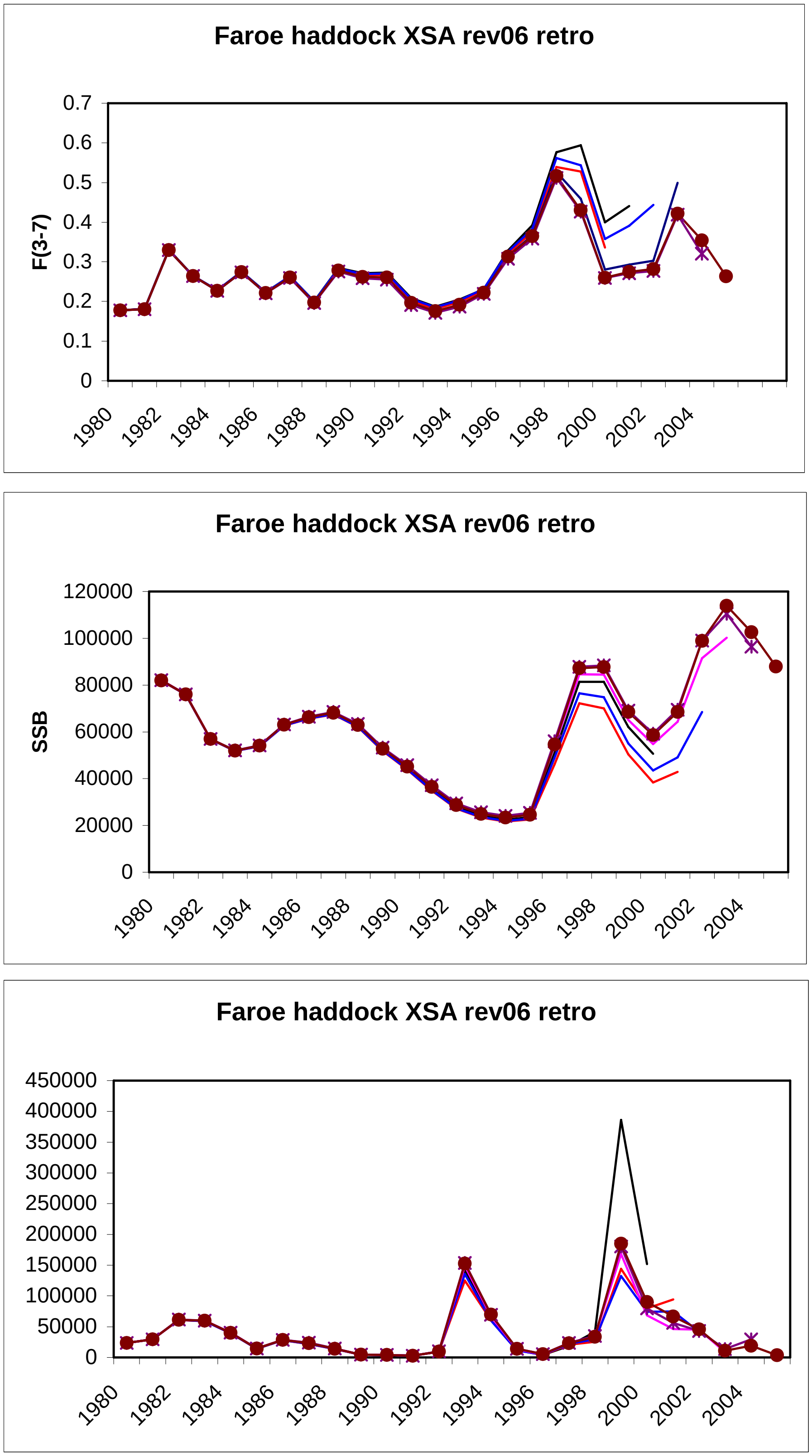


Figure 2.4.15. Faroe haddock. Retrospective analysis on the 2006 XSA.

Figure 2.4.16. Faroe haddock (Division Vb) standard graphs from the 2006 assessment

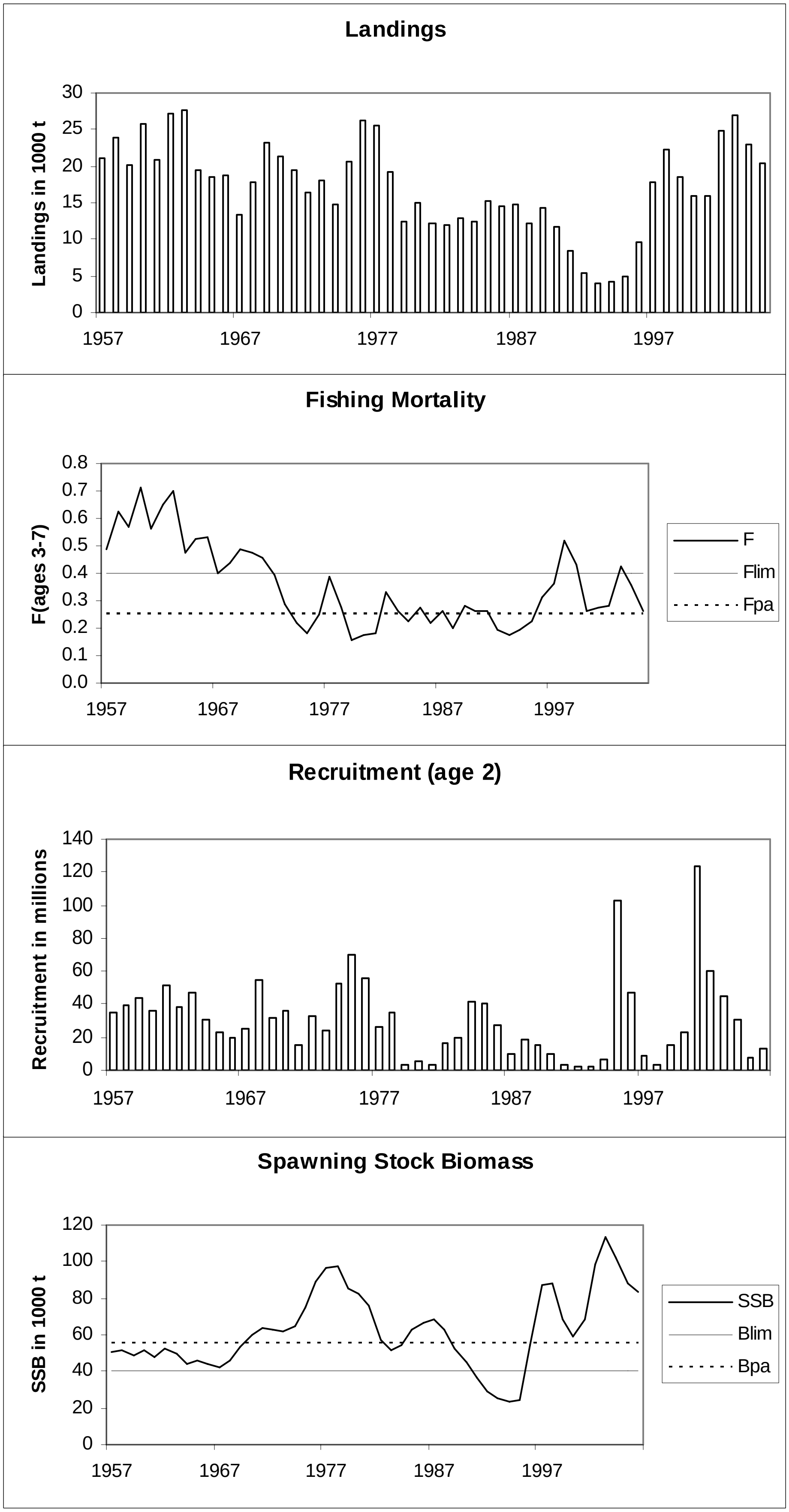
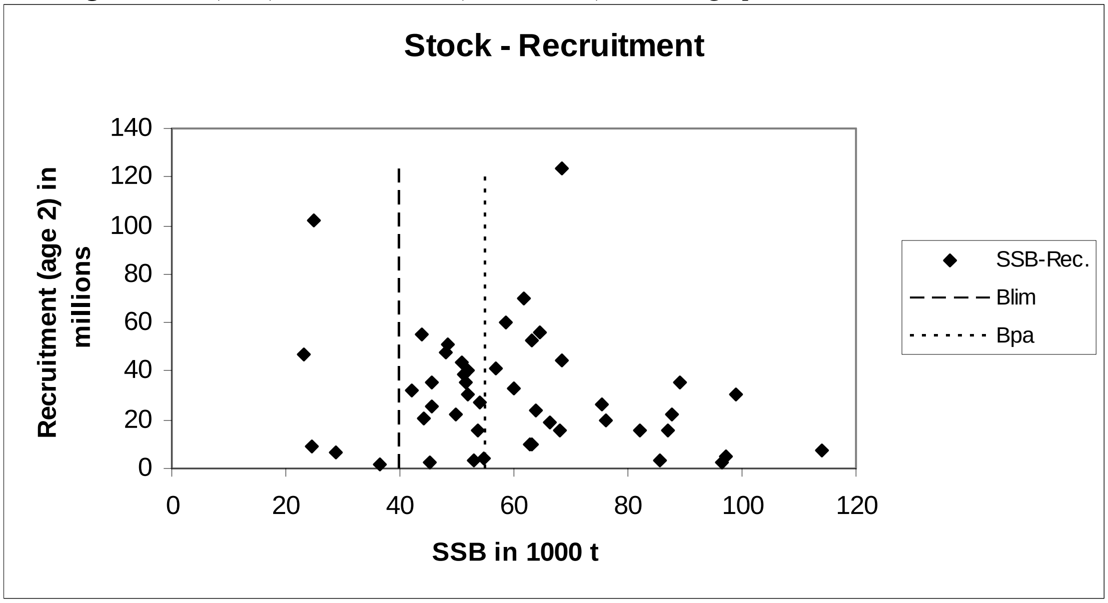
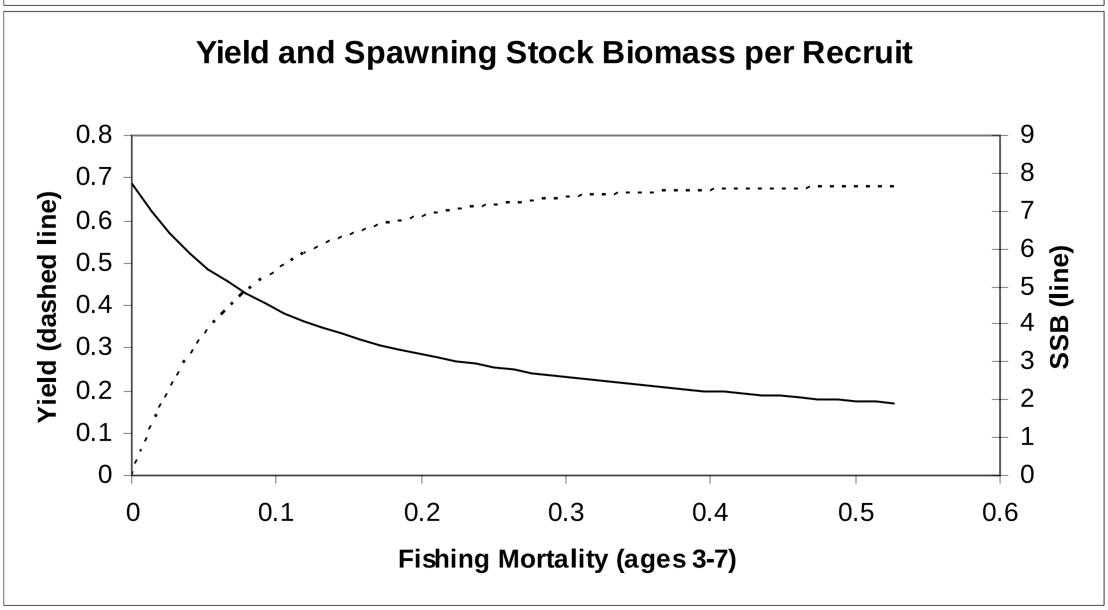
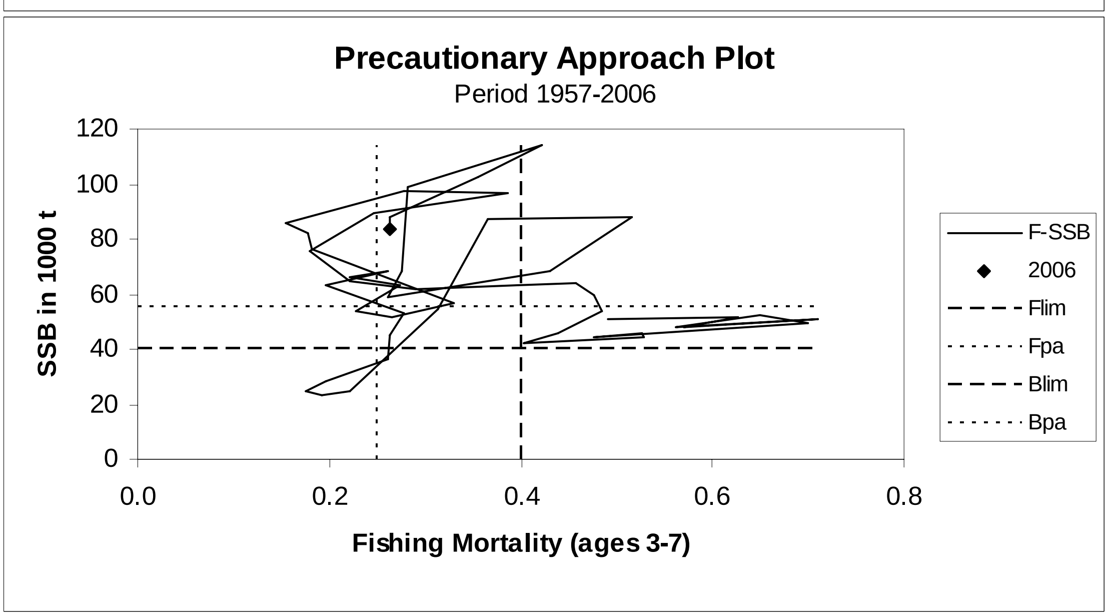


Figure 2.4.16(cont). Faroe haddock (Division Vb) standard graphs from the 2006 assessment







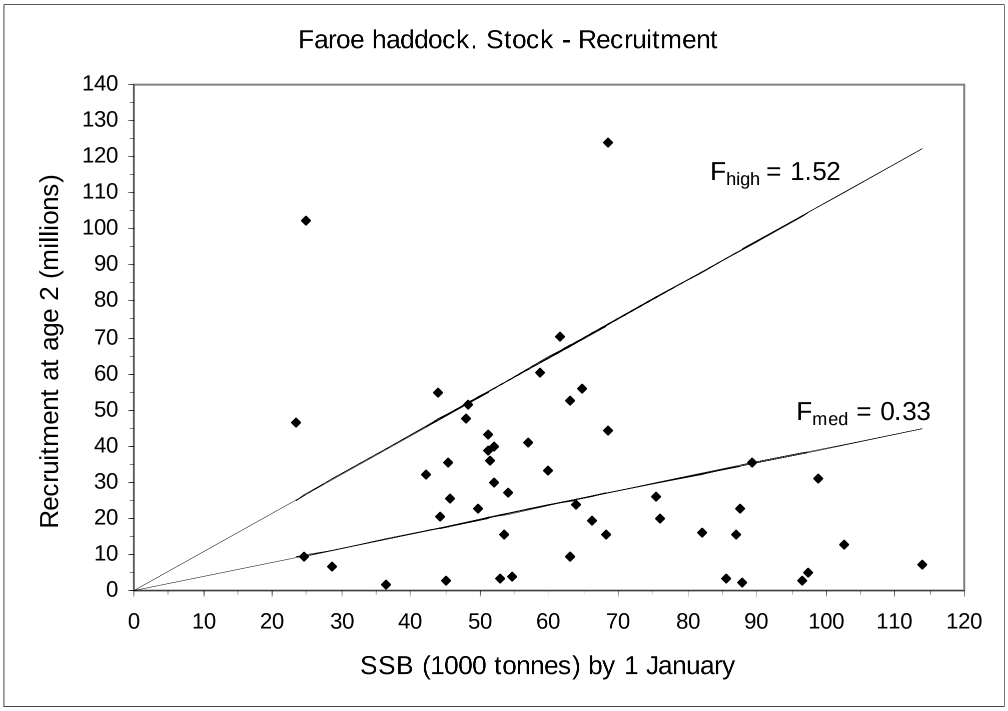
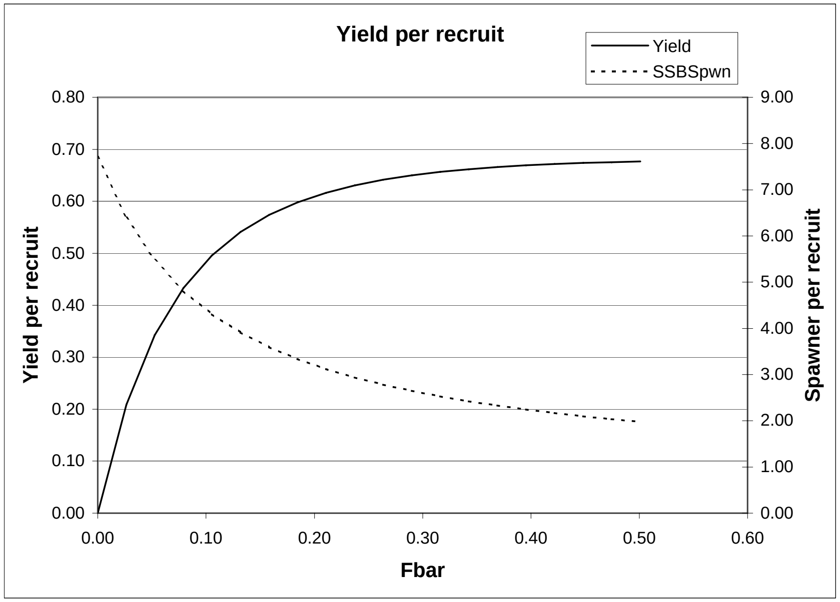
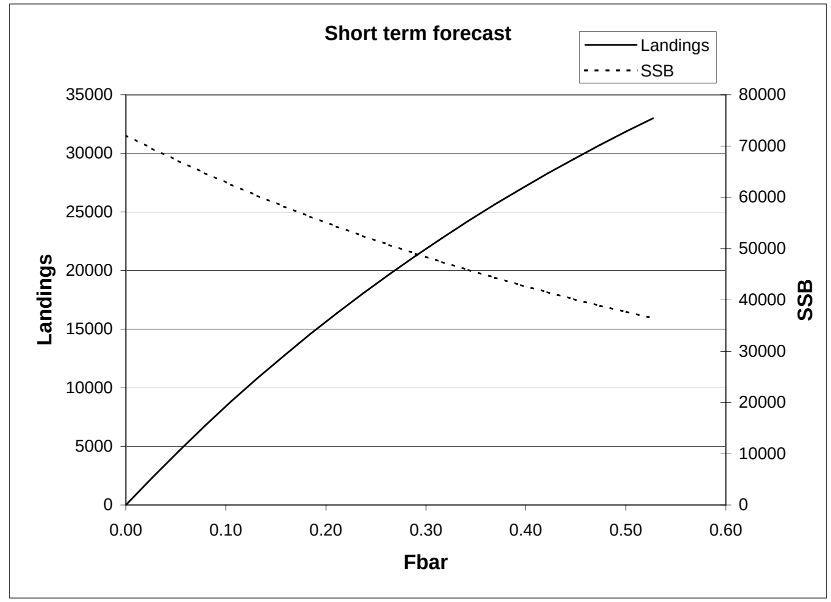


Figure 2.4.17. Faroe haddock. SSB-R plot.





MFYPR version 1
Run: YPR2006
Time and date: 21:42 5/1/2006

Reference point	F multiplier	Absolute F
Fbar(3-7)	1.0000	0.2636
FMax	2.4588	0.6482
F0.1	0.6233	0.1643
F35%SPR	1.0579	0.2789
Flow	5.7608	1.5187
Fmed	1.2567	0.3313
Fhigh	5.7608	1.5187

Weights in kilograms

MFDP version 1
Run: STP2006
Index file 01/05/2006
Time and date: 22:05 5/1/2006
Fbar age range: 3-7

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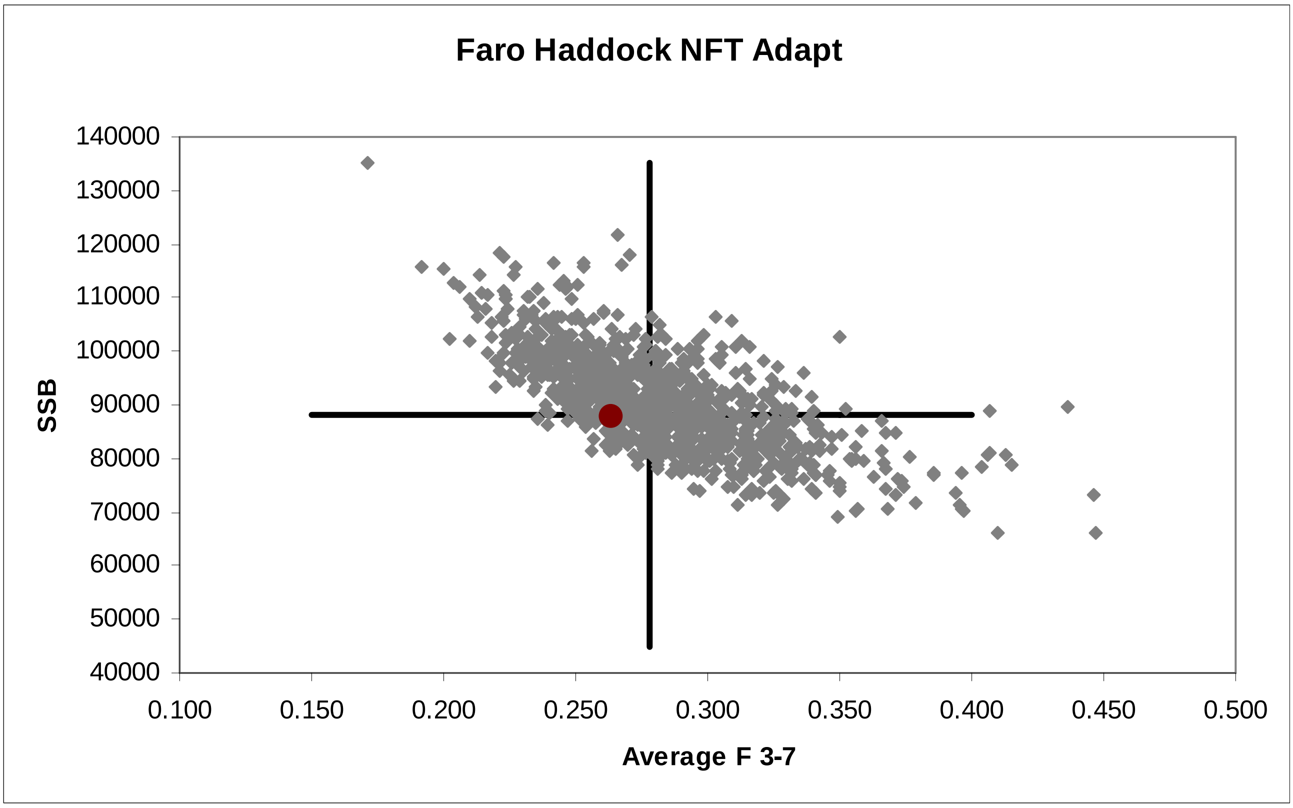


Figure 2.4.19. The F's and SSB's from a 1000 bootstraps of the ADAPT. Inserted are the point values of F and SSB from the accepted XSA.

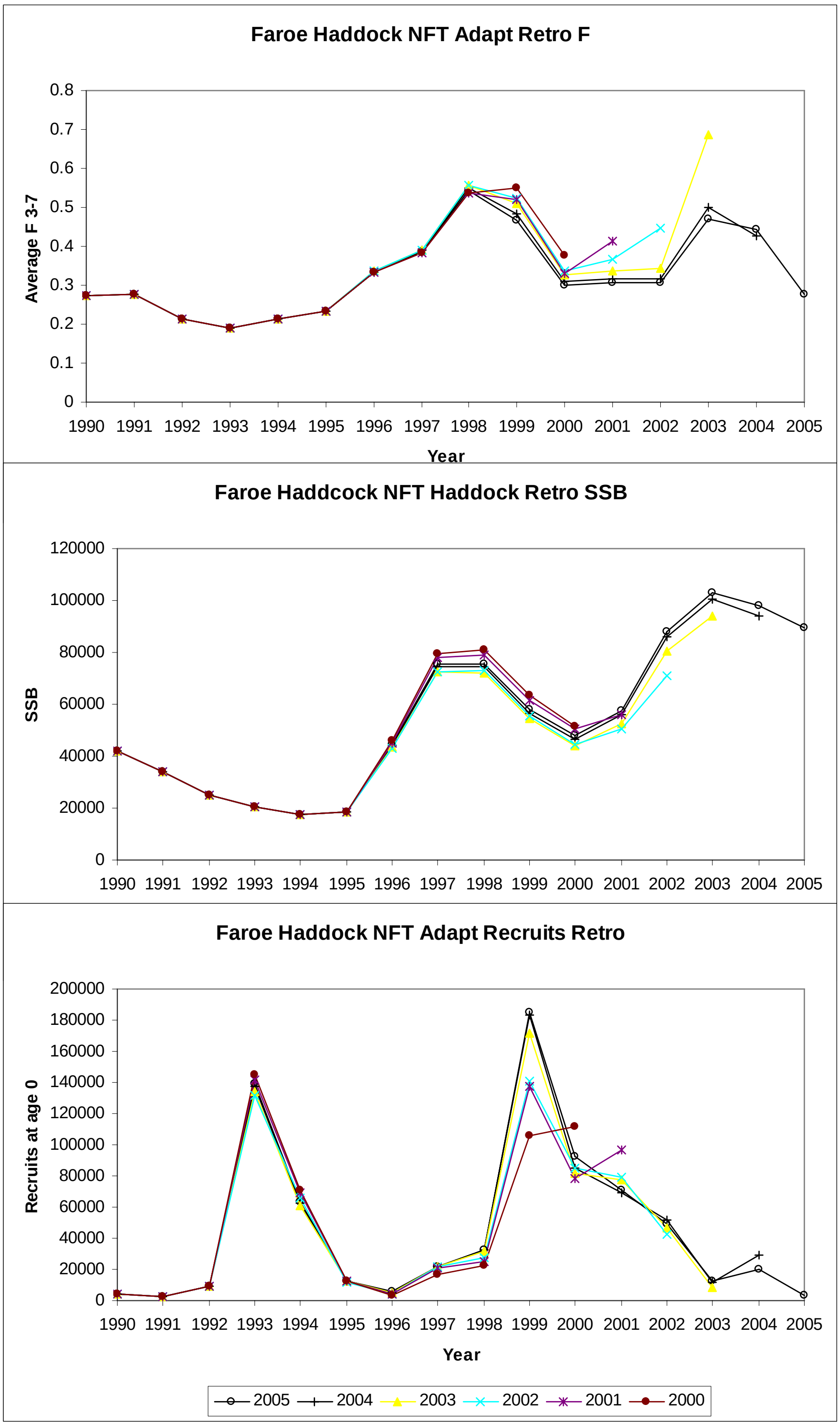
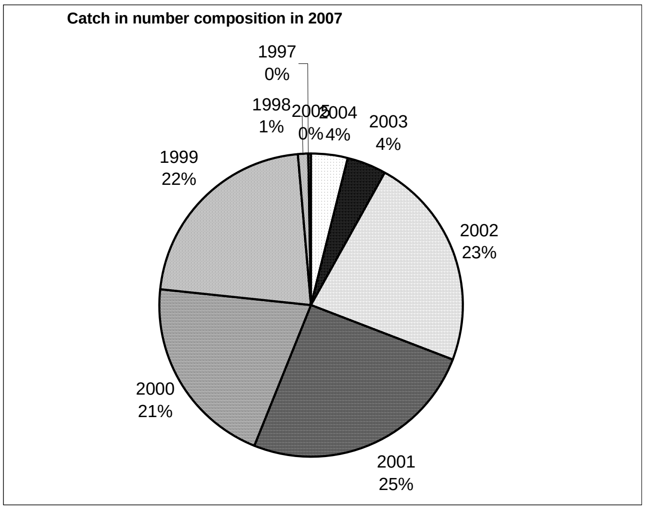


Figure 2.4.20. Faroe haddock. The ADAPT retrospective patterns.



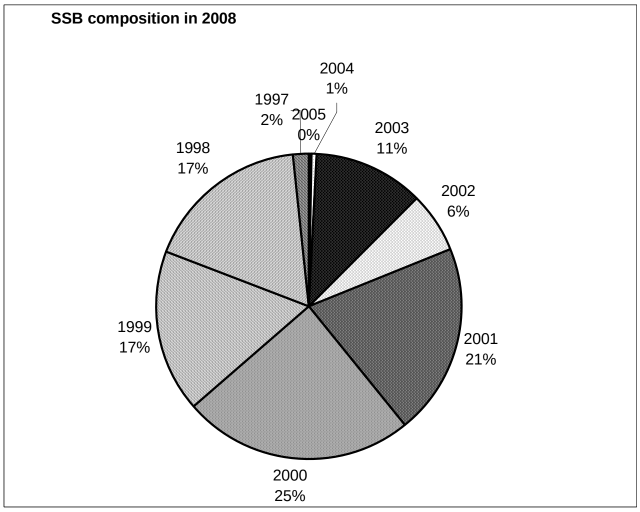


Figure 2.4.21. Faroe haddock. Projected composition of the number by year classes in the catch in 2007 (left figure) and the composition of SSB in 2008 by year classes (right figure).

2.5 Faroe saithe

Summary

The working group estimates of landings in 2005 were 61 000 t compared to 46 000 t in 2004.

Mean weight at age in the catch for all ages displays a downward trend since 1996.

A three year running average smoother has been used to predict maturity at age for 1983-2005 instead of the GLM model in previous assessments.

The XSA model has been tuned with commercial CPUE series derived from a GLM model (WD 37, 2005).

In the present assessment the estimated spawning stock biomassin 2004 is 81 000 tonnes compared to 86 000 tonnes in last year's assessment.

The year classes 2000-2001 were estimated at 46 000 and 28 000 t respectively in the last year assessment compared to 41 000 and 30 000 t in the current assessment.

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 61 400 tonnes, the second highest catch recorded since 1961.

With the introduction of the 200 miles EEZ in 1977, mostly Faroese vessels have prosecuted the saithe fishery. The principal fleet consists of large pair trawlers (>1000 HP), which have a directed fishery for saithe, accounting for about 60% of the reported landings in 1993-2005 (Table 2.5.1.2). The smaller pair trawlers (<1000 HP) have a more mixed fishery and they account for about 10-20% of the total landings of saithe in 1993-2005. During the last decade the proportion of saithe in the catches has generally increased for larger pair trawlers and larger single trawlers (>1000 HP) but decreased for the smaller trawlers and jiggers. In 2003 – 2005 the saithe catches decreased for larger single trawlers and increased for smaller pair trawlers. Other vessel categories report only small catches of saithe as by-catch.

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

2.5.2 Catch at age

Catch at age is based on length and 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 2005 was similar to that in 2004 (Table 2.5.2.2).

2.5.3 Weight at age

Mean weights at age have varied by a factor of about 2 during 1961-2005. 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 2005 are athe lowest since 1991.

The catchability (q) is calculated as the catch number 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 2005 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 1983-2005.. (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 show little variation of SSB (Figure 2.5.4.2).

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). This year's assessment is an update assessment. 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 of cod, haddock and saithe were used. Figure 2.5.5.1 shows a map of the distribution of saithe hauls from the pair trawlers tuning fleet in 2005.

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 was run using data from each haul to standardize the CPUE-data (WD 37, 2005). The fitted CPUE values have been estimated for the period 1995-2005 including year, month, pair, and statistical square as explanatory variables (Figure 2.5.5.2) . The different pairs of trawlers are described in the appendix.

The survey series were updated with the traditional stratification but were not used in 2006 assessment.

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 2006 update 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).

The ADAPT assessments gave results very similar to those of the XSA with a slight tendency to overestimate F and consequently underestimate SSB in the terminal year (Figure 2.5.5.5). The point estimator of the SSB historical time trajectory from the ADAPT and the XSA are almost the same in the final year (Adapt SSB 73495, XSA SSB 77730). The bootstrap probability profile (Figure 2.5.5.4) for the SSB and the reference F in 2005 show the point estimator from the final XSA runand the ADAPT results.

The catchability coefficient for the cuba trawlers shows an increasing trend from 1991 to 1996, but the estimates have been reasonably stable for the period 1997-2002 (ICES C:M: 2003/ACFM:24). The estimates, however, are calculated from an assessment calibrated with a GLM model run on all available data from the pair-trawlers during 1995-2005. The working group accepted the XSA calibrated with the CPUE from the GLM-model

Retrospective analysis of the average fishing mortality from the XSA for age groups 4-8 (Figure 2.5.5.6) shows a tendency to underestimate F in the last three years. This implies that biomass was correspondingly overestimated (Figure 2.5.5.7). With respect to recruitment, the analysis indicated an underestimate (Figure 2.5.5.8). The new stock size index and XSA settings appear to result in an improved retrospective. The fishing mortalities for 1961-2005 are presented in Table 2.5.5.3 and in Figure 2.5.5.9. The average fishing mortality for age groups 4-8 was 0.58 in 2005.

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 2.5.5.10). The 1998 year class is the largest ever (> 83 mill.) and can be seen in the modal length progression in the summer survey from 1999 (Figure 2.5.5.11). 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 2.5.5.12). The SSB has increased since 1996 to 2001 (91 000 tonnes) with the maturation of the 1992, 1994, 1996 and 1998 year-classes but in 2005 the SSB decreased to 78 000 t. The relation between stock and recruitment is given in Figure 2.5.5.13. While the spawning stock biomass graph shows three cycles of decreasing magnitude, that of total biomass (Figure 2.5.5.14) 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

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 2002 year class are from the final VPA run whereas values for the 2003-2005 year classes are the geometric mean of the 1977 to 2002 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 2003-2005 was tried to get a prediction of 2006 mean weight at age. Because the results from this showed an increase in weight in 2006, the 2005 values were used for 2006-2008 weights (Table 2.5.6.1). In the long term prediction (yield per recruit) mean weights for 1961-2005 were used. The value of natural mortality is 0.2.

In the short term prediction the average of 2005-2006 proportion mature values from the spring survey were used for 2006. For 2007 and 2008 the average for 2004-2006 was used. In the long term prediction the average of smoothed values for 1983-2006 was used.

For all three years in the short term prediction the average exploitation pattern in the final VPA for 2003-2005, unscaled to Fbar (ages 4-8) in 2004 in view of a retrospective problem (as suggested by ACFM, 2004), was used. In the long term prediction the exploitation pattern was set equal to the average of exploitation patterns for 2001-2005 (as suggested from ACFM, 2004).

2.5.6.2 Biological reference points

Yield per recruit and spawning stock biomass per recruit curves are presented in Figure 2.5.6.1. Compared to the 2005 average fishing mortality of 0.58 in age groups 4-8, $\mathbf{F}_{max}$ is 0.43, $\mathbf{F}_{0.1}$ is 0.12, $\mathbf{F}_{med}$ is 0.35 and $\mathbf{F}_{high}$ is 1.10 (Table 2.5.6.3, Figure 2.5.6.1 and Figure 2.5.6.2).

	Fish Mort Ages 4-8	Yield/R	SSB/R
Average last 3 years	0.512	1.517	2.763
Fmax	0.432	1.519	3.145
F0.1	0.125	1.319	7.494
Fmed	0.352	1.516	3.672

Yield and spawning biomass per Recruit F-reference points:

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

The history of the stock/fishery in relation to the existing four reference points can be seen in Figure 2.5.6.3.

2.5.6.3 Projection of catch and biomass

Results from predictions with management option are presented in Table 2.5.6.3. Catches at status quo F would be 41 300 t in 2006 and 36 700 t in 2007. The spawning stock biomass would be about 70 000 tonnes in 2006 and about $\mathbf{B}_{lim}$ in 2007.

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 2007 is presented in Figure 2.5.6.4. The catch in 2006 is predicted to rely on the four most recent year classes (84%). In 2007 the 1998 year class (age 9) is expected to contribute about 28% of the SSB, and the 1999-2002 year classes with about 15% each.

2.5.7 Management considerations

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

The spawning stock biomass has decreased below $\mathbf{B}_{pa}$ and is expected to reduce to 70 000 t at status quo fishing mortality, due to poor recruitment in the short term.

2.5.8 Comments on the assessment

The XSA settings have not been changed in the 2006 assessment. The tuning fleets had to be changed due to replacement of vessels in the commercial index tuning fleet. The cpue standardisation with GLM is considered an improvement.

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

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

The 2005 assessment indicates that the point estimator of biomass is lower than in the 2004 assessment (2004 SSB = 81 500t compared to 77 700t) and the fishing mortality has increased to 0.58.

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. Nevertheless, the introduction of the spring survey as an index of stock size in the assessment would be an improvement (Table 2.5.8.1-5, Figure 2.5.8.1-3).

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

The assessment of Faroe saithe is uncertain because:

1) 1. the assessment uses only one index of stock size, a commercial cpue from a subset of the pair trawlers. The effort information is good, but the age composition is the same as is used to derive the pair trawler catch at age, which means that the cpue is not independent of the catch at age.

2) 2. The weights at age have declined substantially over the calibration period (for example the weight of an age 6 fish declined from 3 kg in 1995 to 1.75 kg in 2005, the weight of an age 2 fish in 1995). There are indications that this may affect catchability at age which could currently be lower than those estimated in the XSA assessment. This could be particularly important for the very strong 1999 year class, for which F is estimated to have been high in 2005 (F=1.0 compared with F=0.46 for age 5 and F=0.7 for age 7) with the consequence that the year class appears seriously depleted. The WG believes 1999 year class at age 7 at the beginning of 2006 could in fact be as much as twice the size estimated in the current assessment. This view is supported by the very good saithe catches so far in 2006 (figure 2.5.51b).

<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 sub-area Vb was 468 thousand tonnes in 2003 (ICES, 2004) and only small percentages of by-catch may thus become important in absolute terms. There are indications that the bycatch of saithe is most important in Faroese waters whereas the bycatch of cod is restricted to Icelandic waters (Pálsson 2005). There are also indications that the by-catch may vary by year (was higher in 2004 than in 2003) (Pálsson *et al.* 2005).

Sampling the by-catch of saithe in Faroese and Icelandic waters 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.

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

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

	SCENARIO 1	SCENARIO 2
Total blue whiting catch in Vb (tonnes)	468269	468269
By-catch of saithe (%)	0.69	3.2
By-catch of saithe (tonnes)	3231	14985
Relative change in catch at age in 2004		
Age		
3	1.0	1.0
4	1.0	1.0
5	1.0	1.0
6	1.0	1.1
7	1.1	1.5
8	1.1	1.6
9	1.1	1.4
10	1.1	1.4
11	1.5	3.5
12+	1.7	4.1

2.5.9 Annex

Stock definition

Saithe are widely distributed around the Faroes, from the shallow inshore waters to depths of 500 m. The main spawning areas are found at 150-250 meters depth east and north of the Faroes. Spawning takes place from January to April, with the main spawning in the second-half of February. The pelagic eggs and larvae drift with the anti-clockwise current around the islands until May/June, when the juveniles, at lengths of 2.5-3.5 cm, migrate inshore. The nursery areas during the first two years of life are in very shallow waters in the littoral zone. Young saithe are also distributed in shallow depths, but at increasing depths with increasing age. Saithe enter the adult stock at the age of 3 or 4 years (Jákupsstovu 1999). Tagging experiments of saithe has demonstrated migrations between the Faroes, Iceland, Norway, west of Scotland and the North Sea (Jákupsstovu 1999).

Description of the pair trawlers

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

Four of the pairs were built in East Germany in 1970 as part of a help-programme for Cuba (called Cuba trawlers). In 1973 “Faroe Ship” bought 8 of these trawlers and brought them to Faroe Islands. Today, the Runavik Trawl Company “Beta” keeps them, which is the company that has operated the trawlers during all these years and has registered the catches. During 1977-1978 the trawlers were altered and adjusted for fishing saithe, cod and haddock in Faroese waters. The vessels were equipped with new gear and other equipment. Engine, Winch and equipment for the navigating bridge were replaced principally by Norwegian equipment. Except for the fact that 4 of the trawlers are equipped with bigger winches (to be able to fish at deep waters) the 8 trawlers are identical. The gears used are mainly from the same producers and the vessels are similar with respect to construction. However, improvements have been carried out when needed (*e.g.* winch and engines). Engine power is more than 1 000 HP. Total length is about 37-38m. Loading capacity is approximately. 100 tons catch per vessel. The Cuba-trawlers started as single trawlers. However, since 1983 the trawlers have operated as pair-trawlers to reduce costs (meaning a reduction of *ca.* 45% with respect to fuel and *ca*. 15% with respect to fishing gear).

The new tuning fleet called J&A consists of two identical trawlers, “Jaspis” and “Ametyst”, built at the same shipyard in the Faroe Islands in 1986. They have been operating as pair-trawlers in Faroe waters since the 1986 fishing cod, haddock and saithe, but have in later years been mainly targeting for saithe. The vessels have been stationed at the village of “Saltangará”, the same place as the Cuba trawlers, since origin, but have been in the property and administrated by various companies, the present being “Snaraløkur” Ltd. The engine power is 1350 HP. The engines of both boats were overhauled in 2000. Improvements have been carried out when needed (*e.g.* winch and engines). Both vessels were equipped with new gear and other equipment in 2002 replaced principally by Norwegian equipment. Total length is about 30 m. Loading capacity is approximately 2 500 boxes of fish corresponding to *ca*. 125 tons catch per vessel.

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

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

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

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Table 2.5.1.1. Saithe in the Faroes (Division Vb). Nominal catches (tonnes) by countries, 1989-2005, as officially reported to ICES, and the Working Group estimate.

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

Country	1997	1998	1999	2000	2001	2002	2003	2004	2005 [1]
Estonia	16	-	-	-	-	-	-	-	-
Faroe Islands	21,721	25,995	32,439		49,676	55,165	47,933	48,222	
France	9	17	-	273	934	607	370	147	100
Germany	5	-	100	230	667	422	281	186	1
Greenland	-	-	-	-		442			
Irland	-	-	-	-	5	-	-	-	-
Norway	67	53	160	72	60	77	94	82	82
Portugal	-	-	-	-	-	-	-	5	-
Russia	28	-	-	20	1	10	32	71	210
UK (E/W/NI)	-	19	67	32	80	58	89	85	
UK (Scotland)	460	337	441	534	708	540	610	748	
United Kingdom									940
Total	22,306	26,421	33,207	1,161	52,131	57,321	49,409	49,546	1,333
Working Group estimate [4,5,6,7]	22,306	26,421	33,207	39,020	51,786	53,546	46,555	46,355	61,372

[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 2001-2005 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 1985-2005 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	44547
1990	0.6	0.2	0.2	0.2	7.4	3.9	19.6	24.0	42.8	0.2	0.9	0.0	60740
1991	0.6	0.1	0.1	0.6	9.8	1.3	13.9	26.5	46.2	0.1	0.8	0.0	54290
1992	0.4	0.4	0.0	0.0	10.5	0.5	7.1	24.4	55.6	0.1	1.0	0.0	34934
1993	0.6	0.2	0.1	0.0	9.3	0.6	6.5	21.4	60.6	0.1	0.7	0.0	32313
1994	0.4	0.4	0.1	0.0	12.6	1.1	6.8	18.5	59.1	0.2	0.7	0.0	32405
1995	0.2	0.1	0.4	0.0	9.6	0.9	9.9	17.7	60.9	0.3	0.0	0.0	26915
1996	0.0	0.0	0.1	0.0	9.2	1.2	6.8	23.7	58.6	0.2	0.0	0.0	19262
1997	0.0	0.1	0.1	0.0	8.9	2.5	10.7	17.8	58.9	0.4	0.4	0.0	21713
1998	0.1	0.4	0.1	0.0	8.1	2.8	13.8	16.5	57.6	0.3	0.4	0.0	25993
1999	0.0	0.1	0.1	0.0	5.7	1.2	12.6	18.5	60.0	0.2	1.6	0.0	33057
2000	0.1	0.1	0.2	0.0	3.7	0.3	15.0	17.5	62.3	0.1	0.7	0.0	37450
2001	0.1	0.1	0.1	0.0	2.8	0.3	20.2	16.5	58.8	0.2	0.8	0.1	49395
2002	0.1	0.2	0.1	0.0	1.6	0.1	26.5	10.5	60.8	0.1	0.0	0.0	53698
2003	0.0	0.0	1.9	0.0	0.9	0.4	17.4	14.7	64.7	0.1	0.0	0.0	46555
2004	0.1	0.2	3.7	0.0	1.9	0.4	15.1	14.4	63.8	0.2	0.0	0.0	46355
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	61372
Average	0.3	0.2	0.6	0.1	6.3	2.1	15.9	20.2	53.5	0.2	0.6	0.1	40346

Table 2.5.2.1. Saithe in the Faroes (Division Vb). Catch in 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	20	2	5	0	33	5	38
3	7	40	76	188	14	400	10	409
4	50	211	555	1189	121	2611	52	2663
5	171	631	1617	4039	396	8418	155	8573
6	298	1238	2569	7266	595	14697	304	15001
7	120	723	874	3130	222	6226	177	6404
8	16	130	104	320	20	726	32	758
9	13	149	87	291	22	691	37	727
10	1	10	3	7	1	27	2	29
11	3	16	7	43	3	88	4	92
12	1	2	8	8	1	24	0	25
13	0	1	0	1	0	2	0	3
14	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0
Total No.	681	3171	5901	16488	1395	33943	778	34721
Catch, t.	1249	6491	10120	28533	2408	59938	1434	61372

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 2000-2005.

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	

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

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

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

YEAR	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
AGE										
3	488	595	614	1191	1445	2857	2714	2515	3504	2062
4	1540	796	1689	2086	6577	3316	1774	6253	4126	3361
5	1201	1364	1116	2294	1558	5585	2588	7075	4011	3801
6	1686	792	1095	1414	1478	1005	2742	3478	2784	1939
7	806	1192	548	1118	899	828	1529	1634	1401	1045
8	377	473	655	589	730	469	1305	693	640	714
9	294	217	254	580	316	326	1017	550	368	302
10	205	190	128	239	241	164	743	403	340	192
11	156	97	89	115	86	100	330	215	197	193
+gp	225	140	187	190	132	100	210	186	265	298
TOTALNUM	6978	5856	6375	9816	13462	14750	14952	23002	17636	13907
TONSLAND	25563	21319	20387	27437	29110	32706	42663	57431	47188	41576
SOPCOF %	98	104	102	97	96	109	100	120	113	116

YEAR	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
AGE										
3	3178	1609	611	287	996	411	387	2483	368	1224
4	3217	2937	1743	933	877	1804	4076	1103	11067	3990
5	1720	2034	1736	1341	720	769	994	5052	2359	5583
6	1250	1288	548	1033	673	932	1114	1343	4093	1182
7	877	767	373	584	726	908	380	575	875	1898
8	641	708	479	414	284	734	417	339	273	273
9	468	498	466	247	212	343	296	273	161	103
10	223	338	473	473	171	192	105	98	52	38
11	141	272	407	368	196	92	88	98	65	26
+gp	287	330	535	691	786	1021	902	540	253	275
TOTALNUM	12002	10781	7371	6371	5641	7206	8759	11904	19566	14592
TONSLAND	33065	34835	28138	27246	25230	30103	30964	39176	54665	44605
SOPCOF %	107	104	100	102	99	96	96	100	100	94

YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
AGE										
3	1167	1581	866	451	294	1030	521	1316	690	398
4	1997	5793	2950	5981	3833	5125	4067	2611	3961	1019
5	4473	3827	9555	5300	10120	7452	3667	4689	2663	3468
6	3730	2785	2784	7136	9219	5544	2679	1665	2368	1836
7	953	990	1300	793	5070	3487	1373	858	746	1177
8	1077	532	621	546	477	1630	894	492	500	345
9	245	333	363	185	123	405	613	448	307	241
10	104	81	159	83	61	238	123	245	303	192
11	67	43	27	55	60	128	63	54	150	104
+gp	158	97	60	39	79	118	108	52	49	117
TOTALNUM	13971	16062	18685	20569	29336	25157	14108	12430	11737	8897
TONSLAND	41716	40020	45285	44477	61628	54858	36487	33543	33182	27209
SOPCOF %	94	96	99	97	98	99	105	102	102	102

YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
AGE										
3	297	344	163	322	811	1125	302	330	76	409
4	1087	832	1689	655	2830	2452	8399	2432	2011	2663
5	1146	2440	1934	3096	1484	8437	5962	11152	8544	8573
6	1449	1767	3475	2551	4369	2155	9786	3994	8762	15001
7	1156	1335	1379	4113	2226	3680	862	4287	2125	6404
8	521	624	683	915	2725	1539	1280	417	1807	758
9	132	165	368	380	348	1334	465	419	265	727
10	77	71	77	147	186	293	362	304	293	29
11	64	29	32	24	56	90	33	91	146	92
+gp	82	100	73	69	25	56	45	43	112	28
TOTALNUM	6011	7707	9873	12272	15060	21161	27496	23469	24141	34684
TONSLAND	20029	22306	26421	33207	39020	51786	53546	46555	46355	61372
SOPCOF %	103	100	102	102	102	100	100	100	100	100

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

Table 2 Catch weights at age (kg)

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

YEAR	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
AGE										
3	1.3610	1.2730	1.3020	1.1880	1.2440	1.1010	1.0430	1.0880	1.4300	1.1140
4	2.0260	1.7800	1.7370	1.6670	1.4450	1.3160	1.4850	1.4610	1.5250	1.6580
5	3.0550	2.5340	2.0360	2.3020	2.2490	1.8180	2.0550	1.5820	2.2070	2.2600
6	3.6580	3.5720	3.1200	2.8530	2.8530	2.9780	2.8290	2.2490	2.5000	3.1200
7	4.5850	4.3680	4.0490	3.6730	3.5150	3.7020	3.7910	3.6870	3.1200	3.5570
8	5.5200	5.3130	5.1830	5.0020	4.4180	4.2710	4.1750	4.3850	4.6010	4.0960
9	6.8370	5.8120	6.2380	5.7140	5.4440	5.3880	4.8080	5.1280	5.5590	5.1280
10	7.2650	6.5540	7.5200	6.4050	5.7330	5.9720	5.2940	5.2760	5.7140	6.0940
11	7.6620	7.8060	8.0490	6.5540	6.6620	6.4900	6.9480	6.7270	6.2590	7.1960
+gp	9.2233	8.1494	9.0925	8.0870	8.5844	8.0047	7.5146	8.0307	8.0104	8.5982
SOPCOFAC	.9769	1.0357	1.0194	.9663	.9634	1.0935	1.0043	1.2006	1.1296	1.1607

YEAR	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
AGE										
3	1.0880	1.2230	1.4930	1.2200	1.2300	1.3100	1.3370	1.2080	1.4310	1.4010
4	1.6760	1.6410	2.3240	1.8800	2.1200	2.1300	1.8510	2.0290	1.9530	2.0320
5	2.8780	2.6600	3.0680	2.6200	3.3200	3.0000	2.9510	2.9650	2.4700	2.9650
6	3.0810	3.7900	3.7460	3.4000	4.2800	3.8100	3.5770	4.1430	3.8500	3.5960
7	4.2870	4.2390	4.9130	4.1800	5.1600	4.7500	4.9270	4.7240	5.1770	5.3360
8	4.3520	5.5970	4.3680	4.9500	6.4200	5.2500	6.2430	5.9010	6.3470	7.2020
9	4.7900	5.3500	5.2760	5.6900	6.8700	5.9500	7.2320	6.8110	7.8250	6.9660
10	5.9120	5.9120	5.8320	6.3800	7.0900	6.4300	7.2390	7.0510	6.7460	9.8620
11	6.6190	6.8370	6.0530	7.0200	7.9300	7.0000	8.3460	7.2480	8.6360	10.6700
+gp	7.8941	7.7085	7.5756	8.6262	9.2153	8.9618	10.0411	10.0547	10.0976	11.9501
SOPCOFAC	1.0680	1.0442	1.0049	1.0248	.9937	.9564	.9632	.9997	.9991	.9415

YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
AGE										
3	1.7180	1.6090	1.5000	1.3090	1.2230	1.2400	1.2640	1.4080	1.5030	1.4560
4	1.9860	1.8350	1.9750	1.7350	1.6330	1.5680	1.6020	1.8600	1.9510	2.1770
5	2.6180	2.3950	1.9780	1.9070	1.8300	1.8640	2.0690	2.3230	2.2670	2.4200
6	3.2770	3.1820	2.9370	2.3730	2.0520	2.2110	2.5540	3.1310	2.9360	2.8950
7	4.1860	4.0670	3.7980	3.8100	2.8660	2.6480	3.0570	3.7300	4.2140	3.6510
8	5.5890	5.1490	4.4190	4.6670	4.4740	3.3800	4.0780	4.3940	4.9710	5.0640
9	6.0500	5.5010	5.1150	5.5090	5.4240	4.8160	5.0120	5.2090	5.6570	5.4400
10	6.1500	6.6260	6.7120	5.9720	6.4690	5.5160	6.7680	6.5400	5.9500	6.1670
11	9.5360	6.3430	9.0400	6.9390	6.3430	6.4070	7.7540	8.4030	6.8910	7.0800
+gp	10.2181	10.2439	9.3369	9.9364	8.2869	7.7285	8.2297	8.0501	9.1086	7.5392
SOPCOFAC	.9419	.9620	.9928	.9698	.9811	.9938	1.0506	1.0169	1.0240	1.0205

YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
AGE										
3	**1.4320**	**1.4760**	**1.3880**	**1.3740**	**1.4770**	**1.3300**	**1.1420**	**1.1230**	**1.1430**	**1.1480**
4	1.8750	1.7830	1.7110	1.7120	1.6060	1.5900	1.4600	1.3040	1.3330	1.3250
5	2.4960	2.0320	1.9540	1.9050	2.0770	1.7850	1.6520	1.6140	1.4500	1.5160
6	3.2290	2.7780	2.4050	2.3960	2.3600	2.5860	1.9690	1.9770	1.7890	1.6720
7	3.7440	3.5980	3.3000	2.8450	2.9770	3.0590	3.1300	2.5320	2.5600	2.0870
8	4.9640	4.7660	4.2200	4.1240	3.4800	3.8710	3.5890	3.9700	3.1590	2.9750
9	6.3750	5.9820	4.9990	5.2560	4.8510	4.3740	4.5130	4.8340	4.1540	3.7900
10	6.7450	7.6580	6.3910	5.5260	5.2680	5.5650	5.1380	5.4990	5.1670	6.0870
11	7.4660	7.8820	6.6650	6.9560	6.5230	6.7030	6.4220	6.0990	6.0150	6.1340
+gp	7.9806	9.2453	8.4847	8.5237	5.9024	6.9076	7.5192	6.9154	6.3209	6.7338
SOPCOFAC	1.0319	.9994	1.0221	1.0182	1.0154	1.0017	1.0004	1.0012	1.0038	.9998

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

Table 5 Proportion mature at age

YEAR AGE	1961	1962	1963	1964	1965
3	.0400	.0400	.0400	.0400	.0400
4	.2600	.2600	.2600	.2600	.2600
5	.5700	.5700	.5700	.5700	.5700
6	.8200	.8200	.8200	.8200	.8200
7	.9100	.9100	.9100	.9100	.9100
8	.9800	.9800	.9800	.9800	.9800
9	1.0000	1.0000	1.0000	1.0000	1.0000
10	1.0000	1.0000	1.0000	1.0000	1.0000
11	1.0000	1.0000	1.0000	1.0000	1.0000
+gp	1.0000	1.0000	1.0000	1.0000	1.0000

YEAR AGE	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
3	.0400	.0400	.0400	.0400	.0400	.0400	.0400	.0400	.0400	.0400
4	.2600	.2600	.2600	.2600	.2600	.2600	.2600	.2600	.2600	.2600
5	.5700	.5700	.5700	.5700	.5700	.5700	.5700	.5700	.5700	.5700
6	.8200	.8200	.8200	.8200	.8200	.8200	.8200	.8200	.8200	.8200
7	.9100	.9100	.9100	.9100	.9100	.9100	.9100	.9100	.9100	.9100
8	.9800	.9800	.9800	.9800	.9800	.9800	.9800	.9800	.9800	.9800
9	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
10	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
11	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
+gp	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

YEAR AGE	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
3	.0400	.0400	.0400	.0400	.0400	.0400	.0400	.0000	.0300	.0400
4	.2600	.2600	.2600	.2600	.2600	.2600	.2600	.2800	.2500	.3700
5	.5700	.5700	.5700	.5700	.5700	.5700	.5700	.6300	.5600	.7100
6	.8200	.8200	.8200	.8200	.8200	.8200	.8200	.9900	.9400	.9200
7	.9100	.9100	.9100	.9100	.9100	.9100	.9100	1.0000	.9800	.9800
8	.9800	.9800	.9800	.9800	.9800	.9800	.9800	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 AGE	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
3	.1100	.1100	.1000	.0300	.0000	.0000	.0000	.0100	.0400	.0400
4	.3100	.3200	.2200	.2000	.2000	.1600	.1700	.1500	.1800	.1400
5	.5500	.5900	.5200	.5700	.5500	.4400	.4700	.5100	.6600	.6500
6	.8600	.8300	.7500	.6700	.6800	.7000	.7800	.8300	.8600	.8600
7	.9800	.9700	.9100	.8300	.8000	.8300	.8900	.9400	.9600	.9500
8	1.0000	.9700	.9200	.9200	.9400	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 AGE	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
3	.0200	.0000	.0100	.0300	.0300	.0200	.0000	.0000	.0000	.0000
4	.1300	.1300	.1600	.2000	.2100	.2000	.1800	.1500	.1300	.1700
5	.5900	.4300	.3700	.3500	.3600	.3600	.4100	.3700	.3800	.3500
6	.8000	.6400	.5400	.5200	.6200	.6000	.6000	.5100	.5500	.5600
7	.9400	.8700	.7900	.7400	.7600	.7500	.7300	.6700	.7100	.7100
8	1.0000	.9900	.9700	.9200	.9300	.9100	.9400	.8700	.8700	.8500
9	1.0000	1.0000	.9700	.9700	.9600	.9700	.9700	.9900	.9900	.9700
10	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
11	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
+gp	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

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

```
Faroe Saithe (ICES Div. Vb)    AllpairGLM3-11.dat
101
All pair (GLM) >1000 HP
1995 2005
1 1 0 1
3 11
10498 91    349   1118  457   283   95    46    37    27
6125  99    306   262   358   161   90    43    41    22
7441  76    205   571   389   295   128   28    13    4
8346  46    281   492   637   313   139   73    17    5
12257 89    249   794   1031  1035  418   97    42    6
11234 205   741   432   1278  631   759   91    50    15
13298 315   742   2554  602   958   386   319   66    15
11282 58    1741  1736  3016  228   299   108   77    11
8072  50    528   2321  839   800   70    75    44    13
8616  15    428   1818  1828  370   272   40    42    19
9266  73    463   1573  2829  1219  125   113   3     17
```

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

```
Lowestoft VPA Version 3.1

   28/04/2006   9:54

 Extended Survivors Analysis

 FAROE SAITHE (ICES Division Vb)                 SAI_IND

 CPUE data from file D:\Stovnsmeting\Ices2006\XSA\allpairGLM3-11.DAT

 Catch data for  45 years. 1961 to 2005. Ages  3 to  12.

      Fleet             First  Last  First  Last  Alpha   Beta
                         year  year   age    age
 All pair (GLM) >1000    1995  2005    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   26 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	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
3	.014	.012	.015	.006	.029	.015	.005	.009	.003	.013
4	.039	.048	.072	.075	.068	.114	.148	.051	.069	.125
5	.138	.116	.152	.183	.243	.299	.443	.299	.257	.465
6	.303	.328	.241	.307	.425	.671	.679	.609	.408	.990
7	.490	.508	.462	.501	.483	.788	.629	.734	.788	.597
8	.833	.539	.534	.647	.747	.743	.712	.729	.816	.740
9	.557	.698	.723	.653	.549	1.093	.522	.536	1.791	.967
10	.745	.674	.858	.730	.800	1.394	1.070	.793	.929	1.102
11	.327	.711	.754	.728	.693	1.291	.539	.887	1.239	.886

XSA population numbers (Thousands)

	AGE								
YEAR	3	4	5	6	7	8	9	10	11
1996	2.41E+04	3.12E+04	9.79E+03	6.13E+03	3.30E+03	1.02E+03	3.41E+02	1.62E+02	2.54E+02
1997	3.32E+04	1.94E+04	2.46E+04	6.98E+03	3.70E+03	1.65E+03	3.63E+02	1.60E+02	6.30E+01
1998	1.24E+04	2.68E+04	1.52E+04	1.79E+04	4.12E+03	1.82E+03	7.90E+02	1.48E+02	6.68E+01
1999	5.81E+04	1.00E+04	2.04E+04	1.07E+04	1.15E+04	2.12E+03	8.76E+02	3.14E+02	5.13E+01
2000	3.17E+04	4.73E+04	7.59E+03	1.39E+04	6.42E+03	5.72E+03	9.11E+02	3.73E+02	1.24E+02
2001	8.37E+04	2.52E+04	3.61E+04	4.87E+03	7.46E+03	3.24E+03	2.22E+03	4.31E+02	1.37E+02
2002	6.58E+04	6.75E+04	1.84E+04	2.19E+04	2.04E+03	2.78E+03	1.26E+03	6.09E+02	8.75E+01
2003	4.11E+04	5.36E+04	4.77E+04	9.67E+03	9.11E+03	8.90E+02	1.12E+03	6.13E+02	1.71E+02
2004	3.07E+04	3.33E+04	4.17E+04	2.89E+04	4.31E+03	3.58E+03	3.51E+02	5.35E+02	2.27E+02
2005	3.59E+04	2.51E+04	2.55E+04	2.64E+04	1.58E+04	1.60E+03	1.30E+03	4.80E+01	1.73E+02

Table 2.5.5.2. (Continued)

Estimated population abundance at 1st Jan 2006

0.00E+00 2.90E+04 1.81E+04 1.31E+04 8.03E+03 7.10E+03 6.26E+02 4.03E+02 1.31E+01

Taper weighted geometric mean of the VPA populations:

2.52E+04 1.91E+04 1.28E+04 7.55E+03 4.03E+03 2.10E+03 1.13E+03 5.97E+02 3.31E+02

Standard error of the weighted Log(VPA populations) :

.5357 .5689 .5998 .5904 .5584 .5520 .6563 .8779 .9811

Log catchability residuals.

Fleet : All pair (GLM) >1000

Age	1995
3	.02
4	.40
5	.66
6	-.19
7	.18
8	.05
9	-.05
10	-.52
11	.00

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
3	1.11	.33	.70	-.57	.97	.25	-1.04	-.38	-1.37	-.01
4	-.09	-.21	-.32	.17	-.21	.27	.32	-.35	-.15	.17
5	-.23	-.58	-.34	-.53	-.04	.04	.56	.16	-.03	.34
6	.05	-.18	-.79	-.14	-.05	.18	.46	.30	-.17	.54
7	-.21	.10	-.09	-.29	-.12	.11	.07	.21	.15	-.11
8	.37	-.08	-.22	.40	.13	-.15	-.10	-.07	-.13	-.21
9	.61	-.02	.06	-.17	-.24	.19	-.41	-.31	.64	.00
10	1.38	.02	.33	.05	.17	.36	.21	-.13	-.05	-.28
11	.13	-.21	-.14	-.09	.02	-.01	-.02	-.03	.14	.08

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

Age	3	4	5	6	7	8	9	10	11
Mean Log q	-15.2205	-13.1389	-11.9433	-11.3658	-11.2075	-11.0430	-11.0430	-11.0430	-11.0430
S.E(Log q)	.7912	.2708	.4106	.3696	.1680	.2153	.3420	.5109	.1068

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	3.36	-1.546	26.30	.05	11	2.49	-15.22
4	1.19	-1.080	13.69	.78	11	.32	-13.14
5	1.01	-.040	11.96	.68	11	.44	-11.94
6	.95	.269	11.27	.77	11	.37	-11.37
7	1.09	-1.053	11.46	.93	11	.18	-11.21
8	1.05	-.393	11.21	.88	11	.24	-11.04
9	1.41	-1.897	12.81	.70	11	.43	-11.02
10	1.10	-.460	11.44	.69	11	.56	-10.90
11	.87	4.452	10.23	.99	11	.05	-11.05

Table 2.5.5.2. (Continued)

Terminal year survivor and F summaries :

Age 3 Catchability constant w.r.t. time and dependent on age
Year class = 2002

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
All pair (GLM) >1000	28816.	.826	.000	.00	1	.853	.013
F shrinkage mean	30378.	2.00				.147	.012

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
29041.	.76	.02	2	.027	.013

Age 4 Catchability constant w.r.t. time and dependent on age
Year class = 2001

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
All pair (GLM) >1000	17984.	.282	.492	1.75	2	.978	.126
F shrinkage mean	25461.	2.00				.022	.090

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
18122.	.28	.35	3	1.239	.125

Age 5 Catchability constant w.r.t. time and dependent on age
Year class = 2000

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
All pair (GLM) >1000	12950.	.236	.174	.74	3	.977	.469
F shrinkage mean	21338.	2.00				.023	.310

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
13097.	.23	.15	4	.627	.465

Age 6 Catchability constant w.r.t. time and dependent on age
Year class = 1999

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
All pair (GLM) >1000	7816.	.203	.260	1.28	4	.968	1.007
F shrinkage mean	17952.	2.00				.032	.563

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
8029.	.21	.23	5	1.132	.990

Age 7 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	7129.	.178	.096	.54	5	.981	.595
F shrinkage mean	5821.	2.00				.019	.691

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
7102.	.18	.09	6	.479	.597

Table 2.5.5.2. (Continued)

```
Age  8   Catchability constant w.r.t. time and dependent on age
 Year class = 1997

 Fleet                      Estimated      Int          Ext      Var      N   Scaled
Estimated
                        Survivors     s.e         s.e    Ratio       Weights     F
 All pair (GLM) >1000        627.    .184        .113     .62    6   .975      .739

   F shrinkage mean          606.    2.00                                .025      .757

 Weighted prediction :

 Survivors         Int       Ext     N     Var      F
 at end of year    s.e       s.e          Ratio
       626.        .19       .10     7     .548    .740

 Age  9   Catchability constant w.r.t. time and age (fixed at the value for age)  8
 Year class = 1996

 Fleet                      Estimated      Int          Ext      Var      N   Scaled
Estimated
                        Survivors     s.e         s.e    Ratio       Weights     F
 All pair (GLM) >1000        402.    .190        .063     .33    7   .963      .970

   F shrinkage mean          445.    2.00                                .037      .908

 Weighted prediction :

 Survivors         Int       Ext     N     Var      F
 at end of year    s.e       s.e          Ratio
       403.        .20       .06     8     .293    .967

 Age 10   Catchability constant w.r.t. time and age (fixed at the value for age)  8
 Year class = 1995

 Fleet                      Estimated      Int          Ext      Var      N   Scaled
Estimated
                        Survivors     s.e         s.e    Ratio       Weights     F
 All pair (GLM) >1000         13.    .295        .135     .46    8   .898     1.113

   F shrinkage mean           15.    2.00                                .102     1.009

 Weighted prediction :

 Survivors         Int       Ext     N     Var      F
 at end of year    s.e       s.e          Ratio
        13.        .33       .12     9     .362   1.102

 Age 11   Catchability constant w.r.t. time and age (fixed at the value for age)  8
 Year class = 1994

 Fleet                      Estimated      Int          Ext      Var      N   Scaled
Estimated
                        Survivors     s.e         s.e    Ratio       Weights     F
 All pair (GLM) >1000         59.    .208        .051     .24    9   .965      .884

   F shrinkage mean           53.    2.00                                .035      .947

 Weighted prediction :

 Survivors         Int       Ext     N     Var      F
 at end of year    s.e       s.e          Ratio
        58.        .21       .05    10     .224    .886
```

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
AGE					
3	.0226	.0465	.0307	.0478	.0495
4	.0556	.0863	.0358	.1260	.0772
5	.0994	.1208	.0716	.2198	.1588
6	.1219	.1401	.1115	.1797	.2137
7	.0933	.1192	.1634	.2213	.2216
8	.0852	.0752	.1157	.2566	.2424
9	.0972	.1150	.1355	.1424	.2983
10	.0915	.1295	.2012	.1658	.2355
11	.0916	.1069	.1514	.1891	.2601
+gp	.0916	.1069	.1514	.1891	.2601
FBAR 4- 8	.0911	.1083	.0996	.2007	.1827

YEAR	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
AGE										
3	.0250	.0248	.0320	.0328	.0479	.0885	.0935	.1271	.2293	.1505
4	.1007	.0518	.0910	.1452	.2547	.1480	.0728	.3227	.3170	.3595
5	.1492	.1217	.0954	.1719	.1538	.3579	.1649	.4582	.3543	.5442
6	.2326	.1388	.1357	.1684	.1597	.1404	.2985	.3486	.3276	.2891
7	.2784	.2564	.1345	.2000	.1536	.1262	.3286	.2919	.2297	.1957
8	.2536	.2615	.2183	.2094	.1943	.1118	.2995	.2425	.1770	.1752
9	.2770	.2269	.2182	.3063	.1656	.1244	.3759	.1982	.1960	.1183
10	.3346	.2903	.2027	.3289	.2008	.1213	.4600	.2496	.1809	.1485
11	.2900	.2609	.2141	.2831	.1877	.1196	.3810	.2312	.1854	.1479
+gp	.2900	.2609	.2141	.2831	.1877	.1196	.3810	.2312	.1854	.1479
FBAR 4- 8	.2029	.1660	.1350	.1790	.1832	.1769	.2329	.3328	.2811	.3127

YEAR	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
AGE										
3	.2055	.1478	.0837	.0374	.0926	.0137	.0285	.0693	.0158	.0629
4	.3705	.2977	.2367	.1776	.1536	.2415	.1832	.1061	.4955	.2367
5	.3153	.4251	.2881	.2890	.2024	.1958	.2031	.3629	.3460	.5028
6	.3432	.4140	.1915	.2780	.2299	.4379	.4823	.4648	.5672	.2917
7	.2048	.3665	.2001	.3213	.3217	.5551	.3197	.4954	.6364	.5662
8	.1767	.2537	.4119	.3572	.2550	.6322	.5384	.5284	.4650	.4141
9	.1664	.2026	.2642	.3872	.3127	.5593	.5698	.8446	.5173	.3185
10	.1202	.1740	.3018	.4698	.5105	.5211	.3288	.3718	.3693	.2173
11	.1550	.2111	.3279	.4075	.3617	.5757	.4826	.5866	.4538	.3185
+gp	.1550	.2111	.3279	.4075	.3617	.5757	.4826	.5866	.4538	.3185
FBAR 4- 8	.2821	.3514	.2657	.2846	.2325	.4125	.3453	.3915	.5020	.4023

YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
AGE										
3	.0211	.0367	.0215	.0176	.0159	.0470	.0299	.0634	.0466	.0115
4	.1385	.1386	.0891	.2026	.2042	.4162	.2641	.2058	.2752	.0900
5	.4552	.4274	.3560	.2287	.6239	.7723	.5998	.5545	.3349	.4136
6	.7618	.5769	.6420	.4944	.7893	.8665	.7163	.6083	.6108	.4079
7	.4057	.4624	.5887	.3757	.8095	.8102	.5395	.5267	.6128	.7155
8	.7505	.4173	.5986	.5298	.4081	.6725	.4958	.3755	.6803	.6494
9	.8262	.5485	.5648	.3542	.2135	.7394	.5809	.4990	.4266	.8526
10	.6211	.7314	.5554	.2383	.1877	.8263	.5209	.4853	.7646	.5216
11	.7397	.5705	.5778	.3765	.2712	.7534	.5369	.4566	.6294	.6565
+gp	.7397	.5705	.5778	.3765	.2712	.7534	.5369	.4566	.6294	.6565
FBAR 4- 8	.5023	.4045	.4549	.3662	.5670	.7075	.5231	.4541	.5028	.4553

YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	FBAR **-**
AGE											
3	.0137	.0115	.0146	.0061	.0287	.0150	.0051	.0089	.0027	.0127	.0081
4	.0392	.0485	.0721	.0752	.0685	.1138	.1480	.0515	.0690	.1248	.0818
5	.1385	.1161	.1520	.1831	.2434	.2986	.4432	.2993	.2570	.4652	.3405
6	.3031	.3281	.2411	.3071	.4252	.6708	.6790	.6094	.4077	.9897	.6689
7	.4900	.5081	.4622	.5011	.4830	.7877	.6292	.7340	.7883	.5966	.7063
8	.8327	.5393	.5340	.6467	.7475	.7431	.7116	.7292	.8160	.7396	.7616
9	.5574	.6984	.7235	.6531	.5487	1.0927	.5223	.5356	1.7910	.9672	1.0979
10	.7448	.6737	.8581	.7297	.8005	1.3936	1.0702	.7934	.9291	1.1017	.9414
11	.3268	.7109	.7535	.7282	.6931	1.2908	.5391	.8875	1.2390	.8858	1.0041
+gp	.3268	.7109	.7535	.7282	.6931	1.2908	.5391	.8875	1.2390	.8858	
FBAR 4- 8	.3607	.3080	.2923	.3426	.3935	.5228	.5222	.4847	.4676	.5832	

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
AGE					
3	9047	13663	22431	16192	22803
4	7739	7241	10678	17809	12638
5	5643	5993	5438	8435	12854
6	3881	4183	4349	4145	5543
7	2680	2813	2977	3185	2835
8	1746	1999	2044	2070	2090
9	1384	1313	1518	1491	1311
10	1036	1028	958	1085	1059
11	568	774	740	641	753
+gp	1032	1141	2147	1111	1367
TOTAL	34757	40149	53279	56164	63253

YEAR	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
AGE										
3	21830	26879	21514	40798	34135	37285	33607	23282	18897	16306
4	17769	17432	21468	17059	32325	26640	27941	25059	16786	12301
5	9578	13154	13551	16048	12079	20514	18811	21271	14859	10010
6	8979	6755	9536	10085	11064	8480	11742	13059	11013	8536
7	3665	5826	4814	6816	6978	7721	6033	7132	7545	6498
8	1860	2272	3691	3445	4569	4899	5572	3556	4361	4910
9	1343	1182	1432	2429	2288	3080	3587	3381	2285	2991
10	797	833	771	942	1464	1587	2227	2016	2271	1537
11	685	467	510	515	555	981	1151	1151	1286	1551
+gp	981	670	1067	846	848	977	727	990	1722	2385
TOTAL	67486	75468	78354	98985	106305	112164	111397	100898	81024	67026

YEAR	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
AGE										
3	18910	12940	8414	8632	12450	33326	15215	40976	25962	22192
4	11484	12607	9138	6336	6808	9292	26913	12107	31301	20923
5	7030	6492	7664	5905	4343	4780	5975	18346	8914	15614
6	4756	4199	3475	4704	3621	2905	3218	3993	10449	5164
7	5234	2763	2273	2349	2917	2356	1535	1627	2054	4852
8	4375	3492	1568	1523	1395	1731	1107	913	811	890
9	3374	3002	2218	850	872	885	753	529	441	417
10	2176	2339	2007	1394	473	522	414	349	186	215
11	1085	1580	1609	1215	714	232	254	244	197	105
+gp	2199	1907	2100	2262	2840	2549	2579	1330	759	1106
TOTAL	60623	51319	40466	35171	36433	58578	57963	80413	81075	71477

YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
AGE										
3	61705	48479	44979	28507	20647	24792	19528	23680	16750	38594
4	17061	49464	38261	36042	22932	16638	19366	15517	18197	13089
5	13520	12162	35256	28656	24097	15307	8985	12176	10342	11314
6	7732	7022	6494	20219	18666	10572	5789	4038	5726	6057
7	3158	2955	3229	2798	10097	6941	3639	2316	1799	2545
8	2255	1723	1524	1467	1573	3680	2527	1737	1120	798
9	482	872	930	686	707	857	1538	1260	977	464
10	248	173	412	433	394	468	335	704	627	522
11	142	109	68	194	279	267	168	163	355	239
+gp	329	244	149	136	365	243	284	155	115	265
TOTAL	106632	123203	131302	119138	99757	79763	62159	61746	56006	73889

YEAR	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**GMST 61-****	**AMST 61-****
AGE													
3	24069	33167	12391	58069	31662	83667	65781	41079	30713	35923	0	24871	28726
4	31238	19438	26843	9997	47252	25189	67483	53583	33334	25077	29041	18692	21986
5	9795	24592	15161	20449	7592	36126	18404	47651	41670	25472	18122	12303	14532
6	6125	6982	17927	10663	13941	4873	21943	9673	28922	26385	13097	7103	8192
7	3298	3704	4118	11533	6422	7461	2040	9111	4306	15751	8029	3897	4480
8	1019	1654	1824	2124	5721	3244	2779	890	3580	1603	7102	2091	2431
9	341	363	790	876	911	2218	1263	1117	351	1296	626	1163	1419
10	162	160	148	314	373	431	609	613	535	48	403	635	856
11	254	63	67	51	124	137	88	171	227	173	13	339	523
+gp	323	214	150	145	55	83	118	79	171	52	76		
TOTAL	76624	90337	79419	114221	114052	163429	180507	163968	143810	131781	76509		

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

Run title : FAROE SAITHE (ICES Division Vb)   SAI_IND

At 28/04/2006 9:56

Table 16 Summary (without SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

	RECRUITS Age 3	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 4- 8
1961	9047	121972	83798	9592	.1145	.0911
1962	13663	126462	85635	10454	.1221	.1083
1963	22431	158238	100631	12693	.1261	.0996
1964	16192	160429	98383	21893	.2225	.2007
1965	22803	174777	107215	22181	.2069	.1827
1966	21830	184152	108779	25563	.2350	.2029
1967	26879	181651	104635	21319	.2037	.1660
1968	21514	189804	115962	20387	.1758	.1350
1969	40798	215030	123795	27437	.2216	.1790
1970	34135	224447	129143	29110	.2254	.1832
1971	37285	228425	139500	32706	.2345	.1769
1972	33607	237048	147569	42663	.2891	.2329
1973	23282	210526	136682	57431	.4202	.3328
1974	18897	204072	137611	47188	.3429	.2811
1975	16306	187420	137886	41576	.3015	.3127
1976	18910	169750	122017	33065	.2710	.2821
1977	12940	156334	114098	34835	.3053	.3514
1978	8414	137397	96026	28138	.2930	.2657
1979	8632	113047	83557	27246	.3261	.2846
1980	12450	124847	88942	25230	.2837	.2325
1981	33326	142231	76327	30103	.3944	.4125
1982	15215	150234	83368	30964	.3714	.3453
1983	40976	179273	91795	39176	.4268	.3915
1984	25962	190386	96186	54665	.5683	.5020
1985	22192	190139	118080	44605	.3778	.4023
1986	61705	235606	98138	41716	.4251	.5023
1987	48479	250262	102751	40020	.3895	.4045
1988	44979	260372	100826	45285	.4491	.4549
1989	28507	229044	101129	44477	.4398	.3662
1990	20647	192258	98738	61628	.6242	.5670
1991	24792	149848	71077	54858	.7718	.7075
1992	19528	124126	59363	36487	.6146	.5231
1993	23680	133190	59123	33543	.5673	.4541
1994	16750	126825	62917	33182	.5274	.5028
1995	38594	152377	61422	27209	.4430	.4553
1996	24069	162411	62955	20029	.3181	.3607
1997	33167	180064	63680	22306	.3503	.3080
1998	12391	163767	66461	26421	.3975	.2923
1999	58069	210907	72868	33207	.4557	.3426
2000	31662	217860	83795	39020	.4657	.3935
2001	83667	277388	82858	51786	.6250	.5228
2002	65781	273893	80266	53546	.6671	.5222
2003	41079	249003	77530	46555	.6005	.4847
2004	30713	220706	81516	46355	.5687	.4676
2005	35923	201455	77730	61372	.7896	.5832
Arith. Mean	28930	185988	95395	35316	.3900	.3460
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: FinalFaroeSaitheMFDP
Time and date: 18:10 29/04/2006
Fbar age range: 4-8

2006

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	30518	0.2	0.00	0	0	1.148	0.01	1.148
4	29041	0.2	0.21	0	0	1.325	0.08	1.325
5	18122	0.2	0.45	0	0	1.516	0.34	1.516
6	13097	0.2	0.62	0	0	1.672	0.67	1.672
7	8029	0.2	0.74	0	0	2.087	0.71	2.087
8	7102	0.2	0.89	0	0	2.975	0.76	2.975
9	626	0.2	0.95	0	0	3.790	1.10	3.790
10	403	0.2	1.00	0	0	6.087	0.94	6.087
11	13	0.2	1.00	0	0	6.134	1.00	6.134
12	76	0.2	1.00	0	0	6.734	1.00	6.734

2007

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	30518	0.2	0.00	0	0	1.148	0.01	1.148
4.		0.2	0.17	0	0	1.325	0.08	1.325
5.		0.2	0.40	0	0	1.516	0.34	1.516
6.		0.2	0.58	0	0	1.672	0.67	1.672
7.		0.2	0.72	0	0	2.087	0.71	2.087
8.		0.2	0.87	0	0	2.975	0.76	2.975
9.		0.2	0.97	0	0	3.790	1.10	3.790
10.		0.2	1.00	0	0	6.087	0.94	6.087
11.		0.2	1.00	0	0	6.134	1.00	6.134
12.		0.2	1.00	0	0	6.734	1.00	6.734

2008

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	30518	0.2	0.00	0	0	1.148	0.01	1.148
4.		0.2	0.17	0	0	1.325	0.08	1.325
5.		0.2	0.40	0	0	1.516	0.34	1.516
6.		0.2	0.58	0	0	1.672	0.67	1.672
7.		0.2	0.72	0	0	2.087	0.71	2.087
8.		0.2	0.87	0	0	2.975	0.76	2.975
9.		0.2	0.97	0	0	3.790	1.10	3.790
10.		0.2	1.00	0	0	6.087	0.94	6.087
11.		0.2	1.00	0	0	6.134	1.00	6.134
12.		0.2	1.00	0	0	6.734	1.00	6.734

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: FinalFaroeSaitheMFYPR
Index file 28/4/2006
Time and date: 19:47 29/04/2006
Fbar age range: 4-8

Age	M	Mat	PF	PM	SWt	Sel	CWt
3	0.2	0.027	0	0	1.304	0.01	1.304
4	0.2	0.201	0	0	1.788	0.10	1.788
5	0.2	0.494	0	0	2.382	0.35	2.382
6	0.2	0.718	0	0	3.091	0.67	3.091
7	0.2	0.851	0	0	3.930	0.71	3.930
8	0.2	0.954	0	0	4.850	0.75	4.850
9	0.2	0.989	0	0	5.654	0.98	5.654
10	0.2	1.000	0	0	6.406	1.06	6.406
11	0.2	1.000	0	0	7.244	0.97	7.244
12	0.2	1.000	0	0	8.518	0.97	8.518

Weights in kilograms

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

MFDP version 1a
Run: FinalFaroeSaitheMFDP
Index file 28/4/2006
Time and date: 18:10 29/04/2006
Fbar age range: 4-8

2006				
Biomass	**SSB**	**FMult**	**FBar**	**Landings**
166187	70604	1.0000	0.5118	41313

2007					2008	
Biomass	**SSB**	**FMult**	**FBar**	**Landings**	**Biomass**	**SSB**
152152	57547	0.0000	0.0000	0	185623	84738
.	57547	0.1000	0.0512	4805	179958	80139
.	57547	0.2000	0.1024	9305	174682	75882
.	57547	0.3000	0.1535	13524	169763	71940
.	57547	0.4000	0.2047	17482	165174	68285
.	57547	0.5000	0.2559	21199	160889	64895
.	57547	0.6000	0.3071	24693	156884	61749
.	57547	0.7000	0.3583	27981	153138	58825
.	57547	0.8000	0.4095	31076	149631	56108
.	57547	0.9000	0.4606	33993	146344	53579
.	57547	1.0000	0.5118	36744	143261	51225
.	57547	1.1000	0.5630	39342	140368	49031
.	57547	1.2000	0.6142	41797	137649	46986
.	57547	1.3000	0.6654	44119	135092	45076
.	57547	1.4000	0.7165	46317	132685	43293
.	57547	1.5000	0.7677	48399	130417	41626
.	57547	1.6000	0.8189	50374	128279	40067
.	57547	1.7000	0.8701	52248	126261	38607
.	57547	1.8000	0.9213	54028	124355	37239
.	57547	1.9000	0.9725	55721	122552	35956
.	57547	2.0000	1.0236	57331	120846	34752

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: FinalFaroeSaitheMFYPR
Time and date: 19:47 29/04/2006
Yield per results

FMult	Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNosJan	SSBJan	SpwnNosSpwn	SSBSpwn
0.0000	0.0000	0.0000	0.0000	5.5167	22.1252	3.3084	18.0359	3.3084	18.0359
0.1000	0.0516	0.1818	0.9062	4.6120	15.5000	2.4257	11.4886	2.4257	11.4886
0.2000	0.1032	0.2785	1.2438	4.1319	12.2966	1.9660	8.3556	1.9660	8.3556
0.3000	0.1548	0.3402	1.3902	3.8270	10.4362	1.6799	6.5592	1.6799	6.5592
0.4000	0.2064	0.3838	1.4591	3.6122	9.2277	1.4824	5.4091	1.4824	5.4091
0.5000	0.2580	0.4167	1.4928	3.4503	8.3804	1.3367	4.6154	1.3367	4.6154
0.6000	0.3097	0.4428	1.5093	3.3227	7.7525	1.2241	4.0367	1.2241	4.0367
0.7000	0.3613	0.4641	1.5167	3.2185	7.2674	1.1340	3.5971	1.1340	3.5971
0.8000	0.4129	0.4821	1.5192	3.1313	6.8803	1.0601	3.2521	1.0601	3.2521
0.9000	0.4645	0.4974	1.5190	3.0570	6.5634	0.9982	2.9744	0.9982	2.9744
1.0000	0.5161	0.5107	1.5172	2.9925	6.2986	0.9455	2.7462	0.9455	2.7462
1.1000	0.5677	0.5225	1.5145	2.9359	6.0736	0.9000	2.5554	0.9000	2.5554
1.2000	0.6193	0.5329	1.5113	2.8856	5.8797	0.8603	2.3935	0.8603	2.3935
1.3000	0.6709	0.5423	1.5079	2.8406	5.7105	0.8253	2.2545	0.8253	2.2545
1.4000	0.7225	0.5508	1.5044	2.7999	5.5614	0.7942	2.1338	0.7942	2.1338
1.5000	0.7741	0.5586	1.5009	2.7629	5.4288	0.7663	2.0281	0.7663	2.0281
1.6000	0.8257	0.5657	1.4974	2.7290	5.3099	0.7411	1.9346	0.7411	1.9346
1.7000	0.8774	0.5723	1.4940	2.6977	5.2026	0.7182	1.8515	0.7182	1.8515
1.8000	0.9290	0.5783	1.4908	2.6689	5.1051	0.6974	1.7769	0.6974	1.7769
1.9000	0.9806	0.5840	1.4876	2.6420	5.0160	0.6783	1.7098	0.6783	1.7098
2.0000	1.0322	0.5893	1.4846	2.6170	4.9342	0.6606	1.6488	0.6606	1.6488

Reference point	F multiplier	Absolute F
Fbar(4-8)	1.0000	0.5161
FMax	0.8362	0.4316
F0.1	0.2419	0.1248
F35%SPR	0.3183	0.1643
Flow	0.1783	0.092
Fmed	0.6811	0.3515
Fhigh	2.137	1.1029

Weights in kilograms

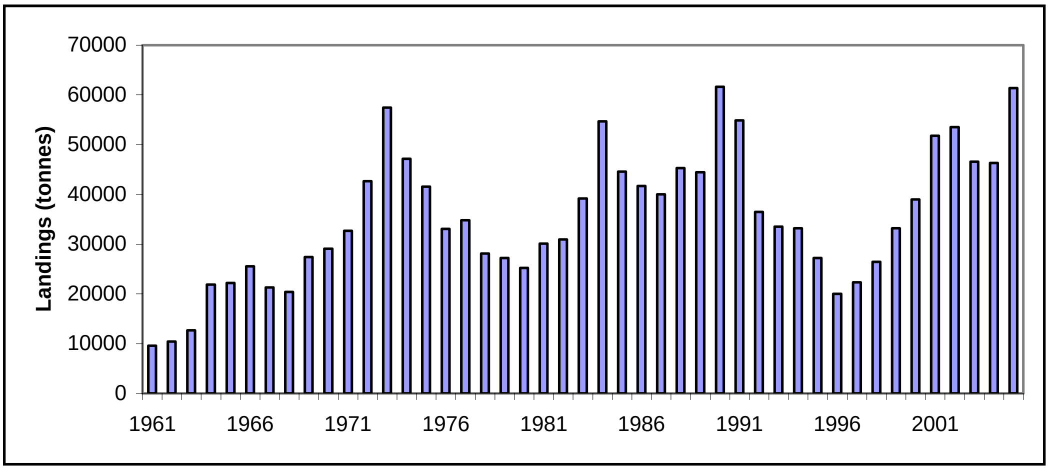


Figure 2.5.1.1. Saithe in the Faroes (Division Vb). Landings in 1000 tonnes.

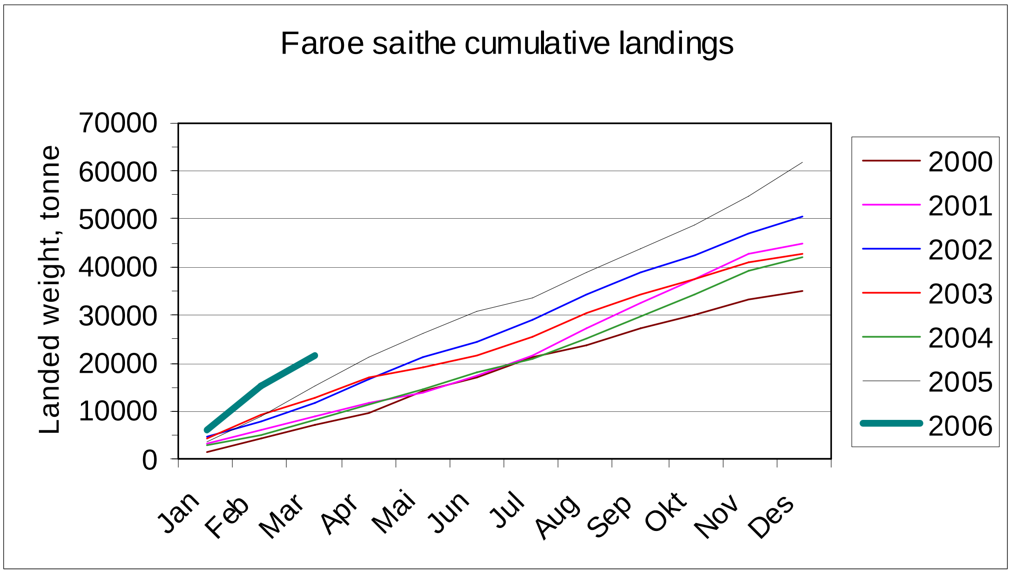


Figure 2.5.1.1b. Saithe in the Faroes (Division Vb). Cumulative landings (tonnes).

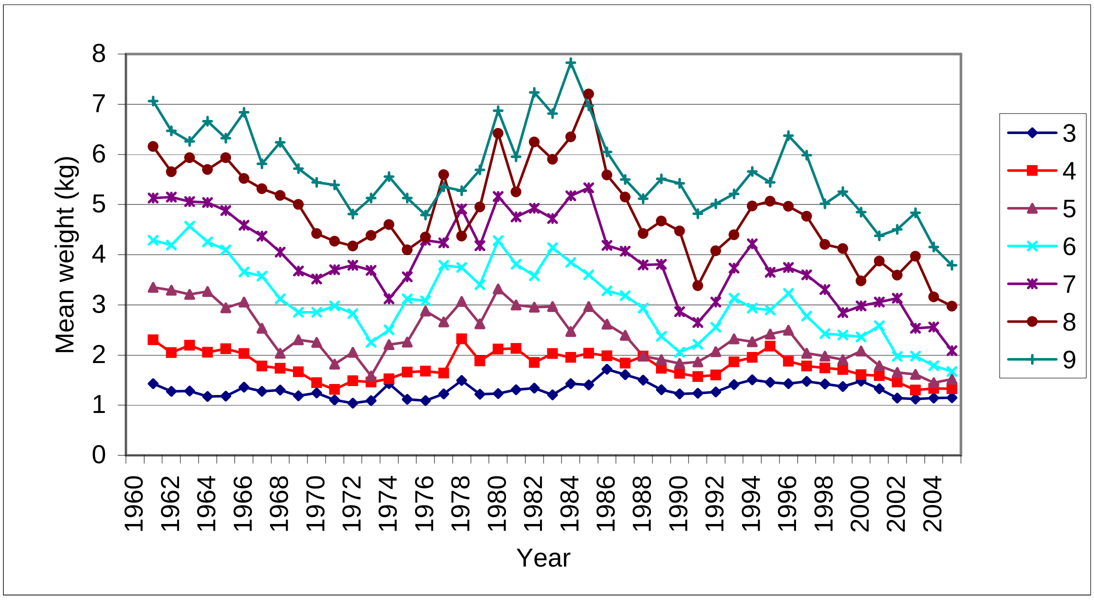


Figure 2.5.3.1. Saithe in the Faroes (Division Vb). Mean weight (kg) at age in the catches in 1961-2005.

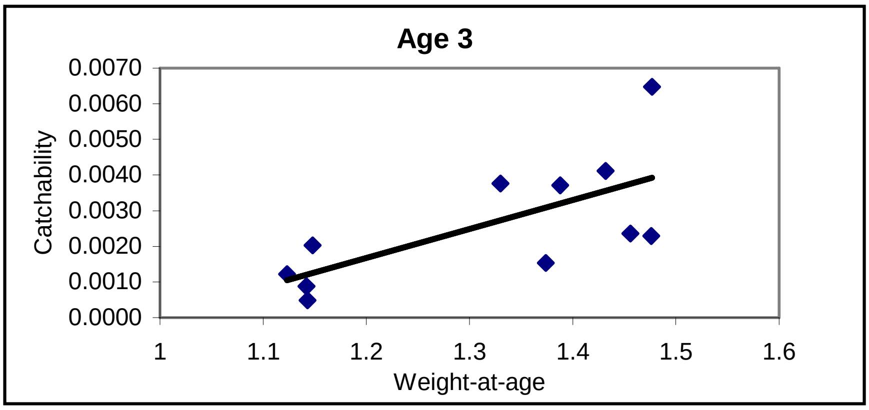
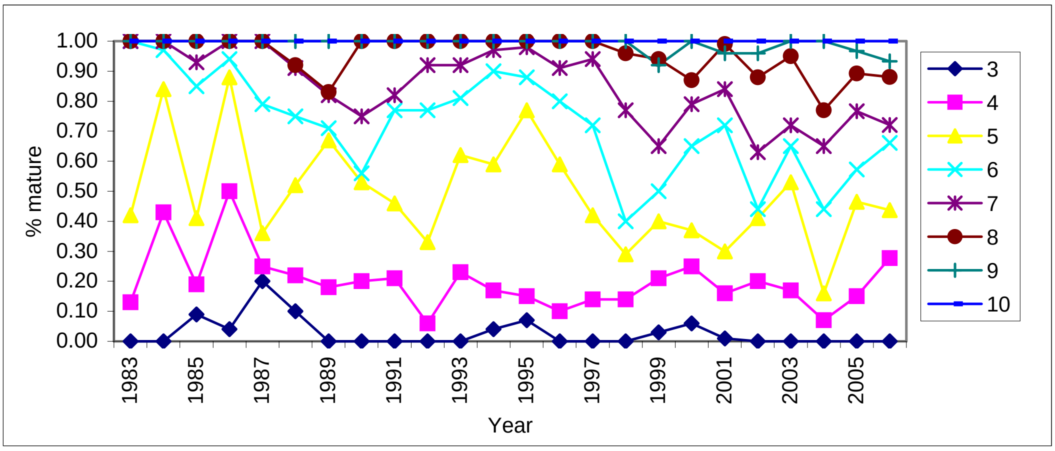


Figure 2.5.3.2. Saithe in the Faroes (Division Vb). Relation between weight at age and catchability for age 3.



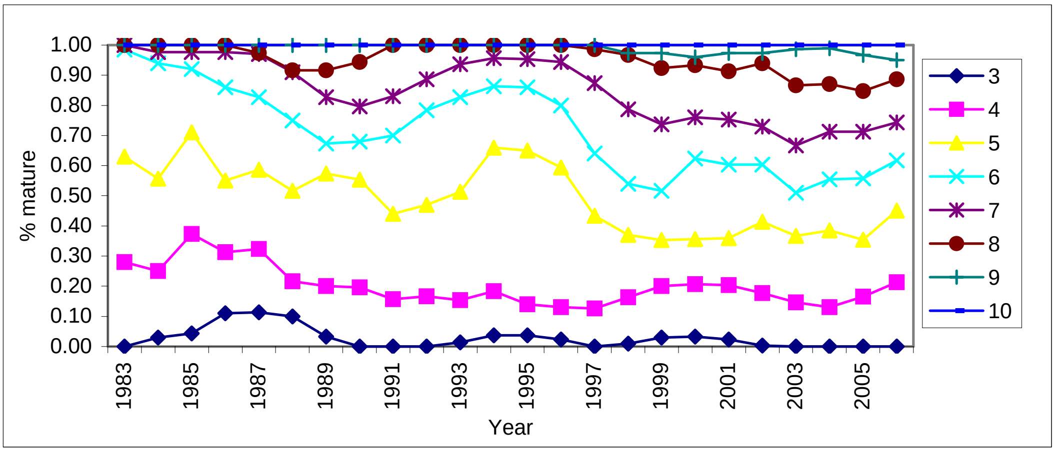


Figure 2.5.4.1. Saithe in the Faroes (Division Vb). Observed (upper figure) and three years running average (lower figure) proportion mature at age for the period 1983-2005. 2006 is the predicted value.

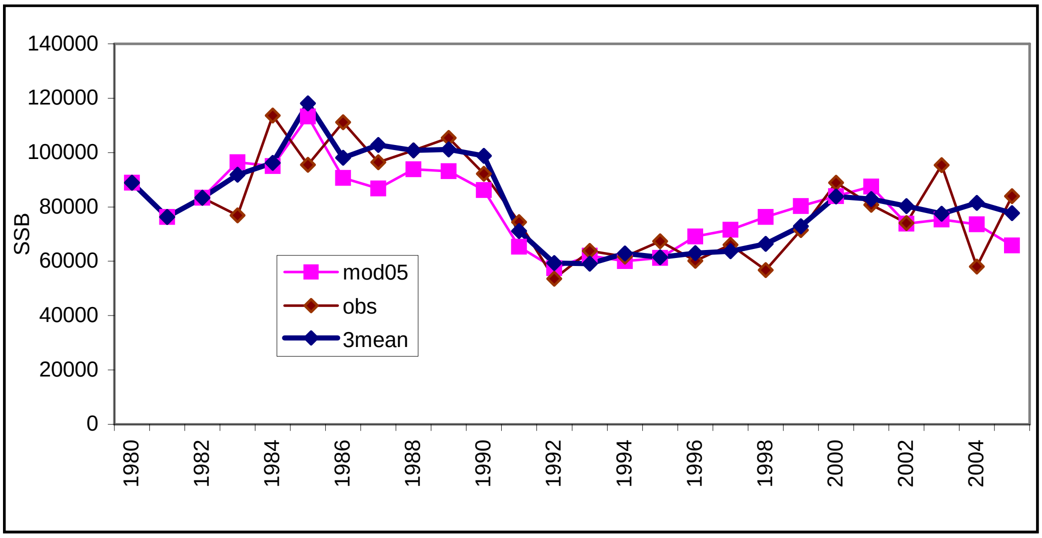


Figure 2.5.4.2. Saithe in the Faroes (Division Vb). Comparison of SSB with different maturity input in XSA. Mod05 is calculated using a GLM model as in the 2005 assessment, obs are the observed values and 3mean are three years running average.

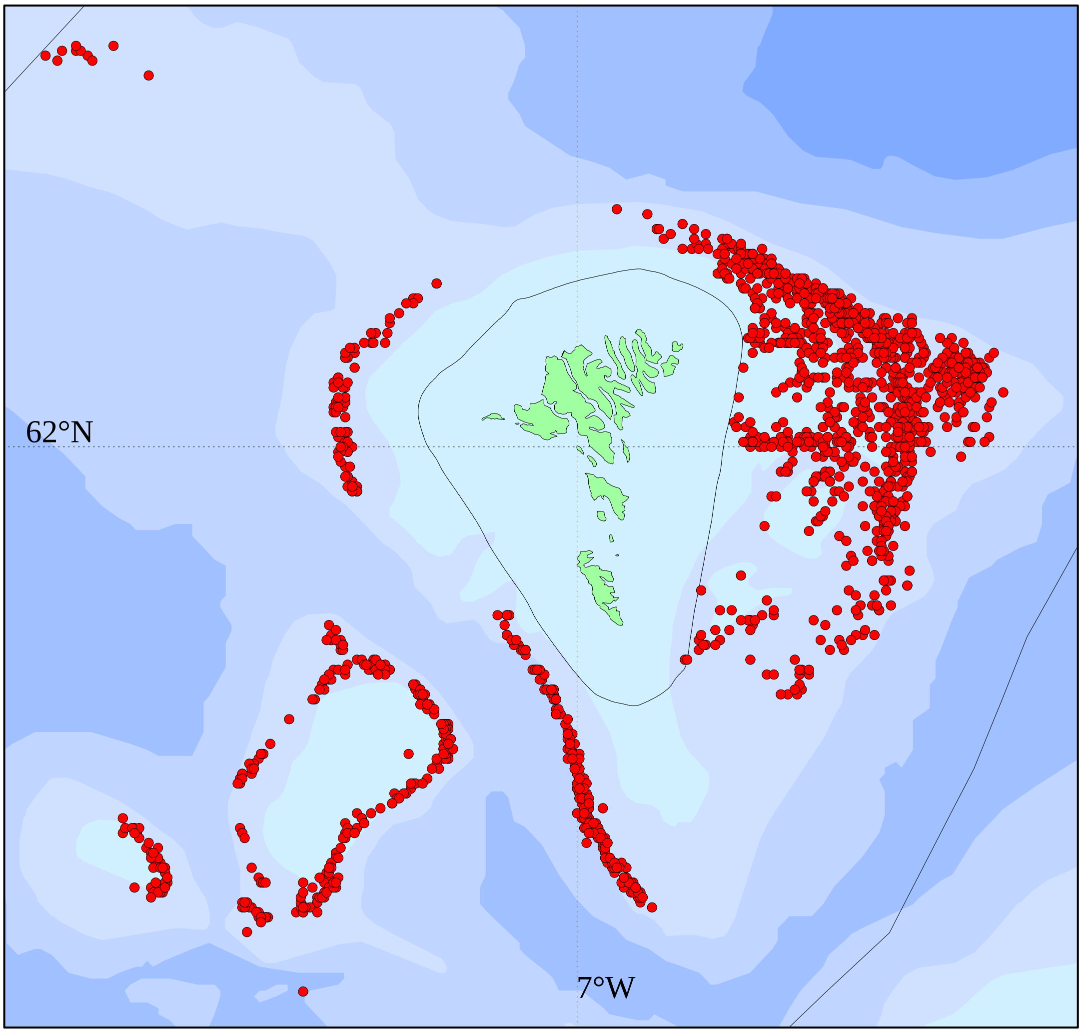


Figure 2.5.5.1. Saithe in the Faroes (Division Vb). Distribution of all saithe hauls from the pair trawlers, which are used in the tuning series.

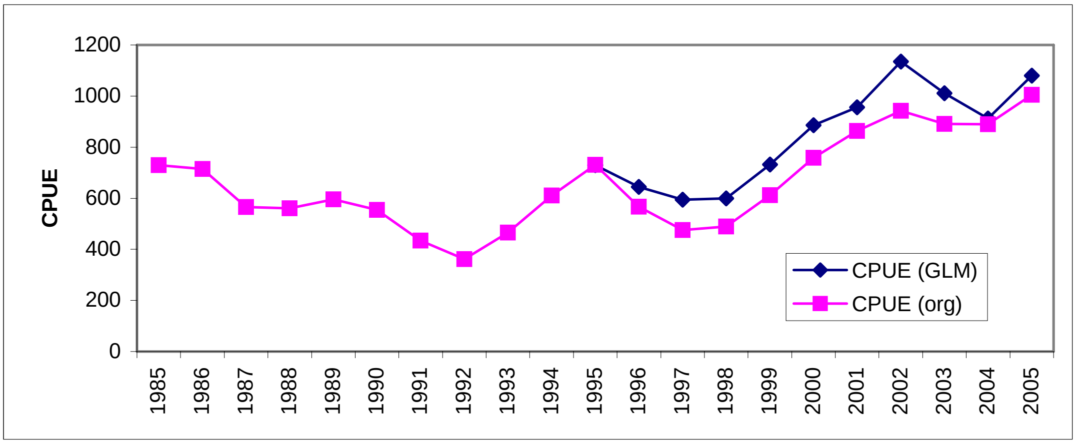


Figure 2.5.5.2. Saithe in the Faroes (Division Vb). Catch per unit effort from pair trawlers (tuning series). CPUE (GLM)- modelled catch per unit effort and CPUE (org)- original cpue for pair trawlers.

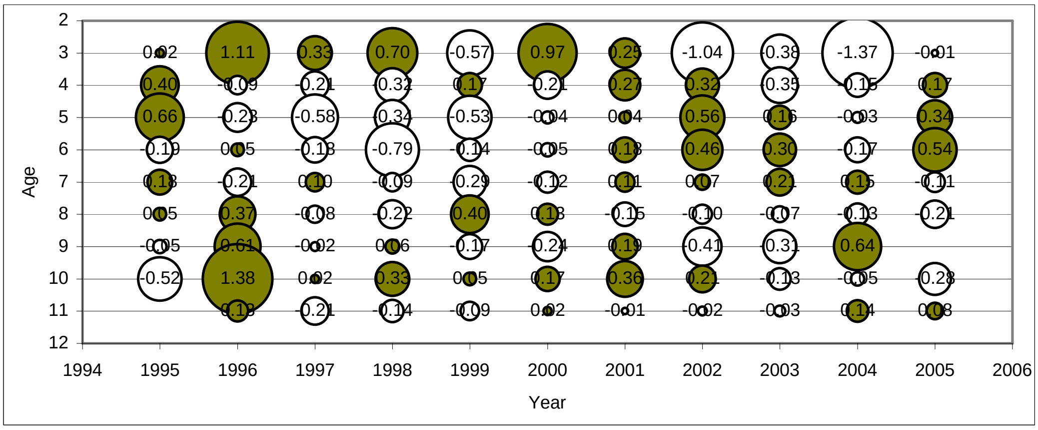


Figure 2.5.5.3. Saithe in the Faroes (Division Vb). Log catchability residuals for age groups 3 -11 from XSA.

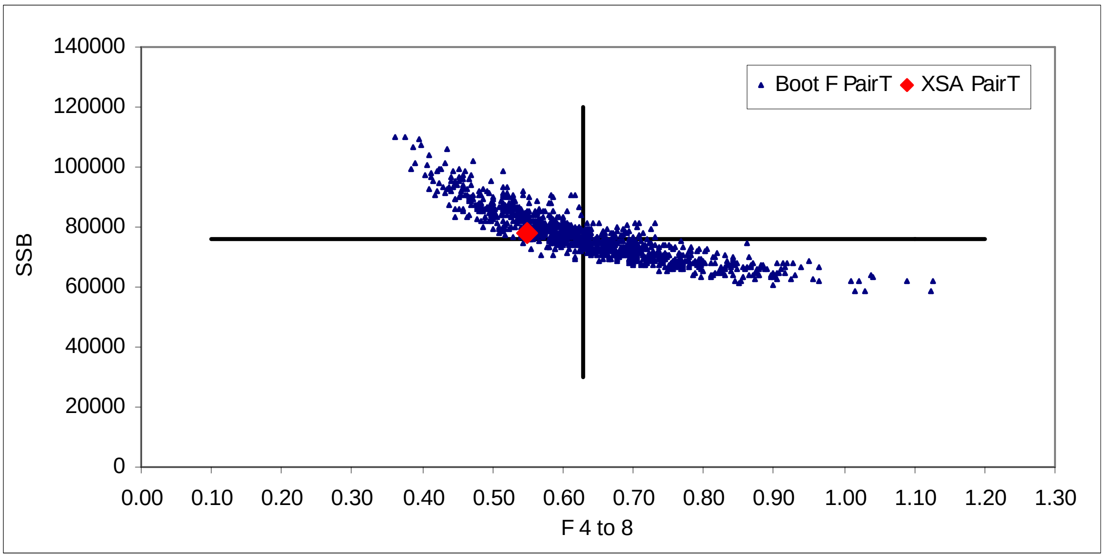
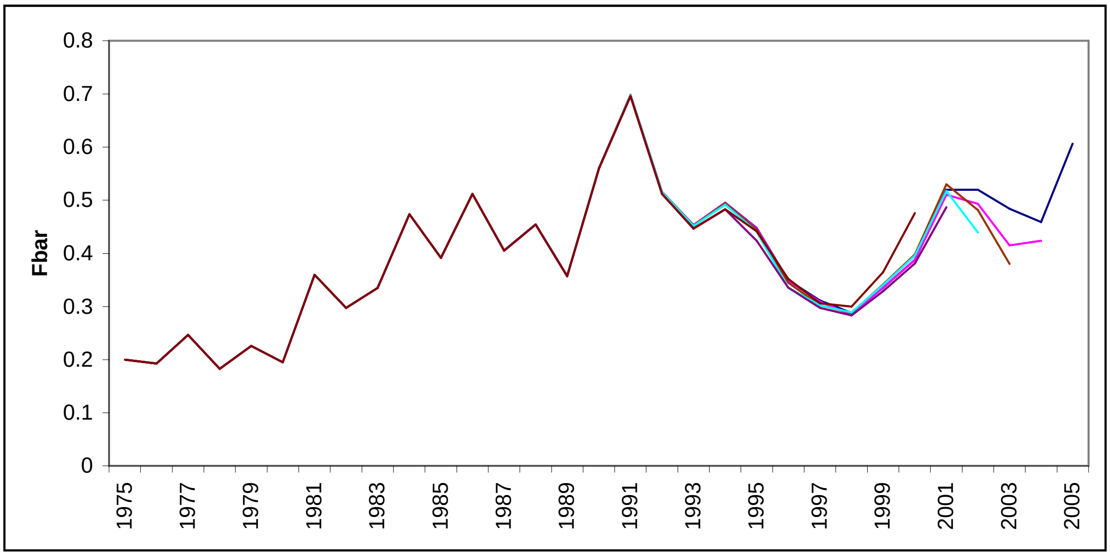


Figure 2.5.5.4. Saithe in the Faroes (Division Vb). Bootstrapped SSB and F on the pair trawler fleet ages 3-11 and the output from XSA on the pair trawlers. Vertical and horizontal lines show the median F and SSB respectively.



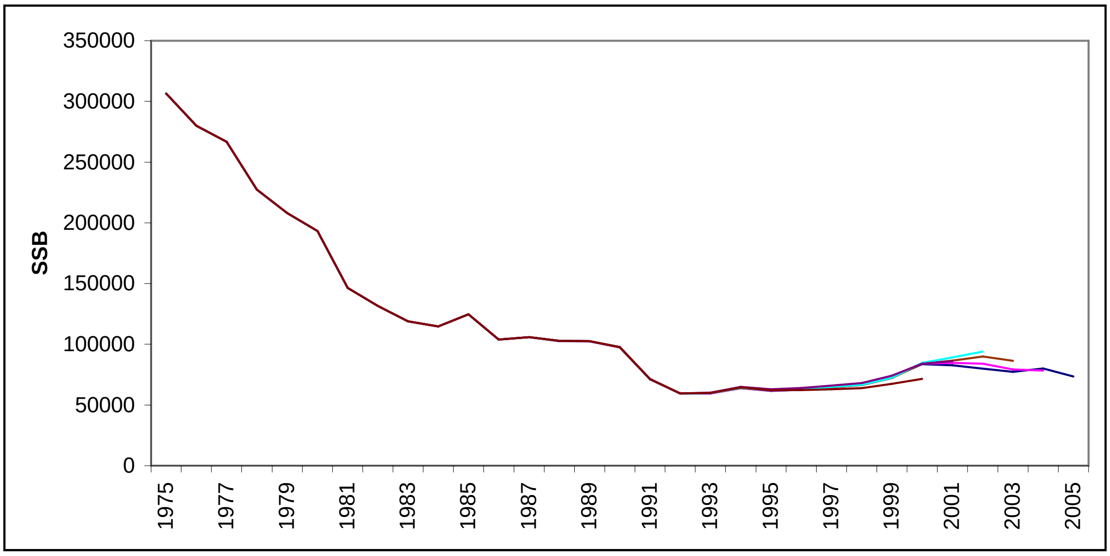


Figure 2.5.5.5. Saithe in the Faroes (Division Vb). Retrospective analysis of spawning stock biomass of age groups 4-8 (lower figure) and retrospective analysis of average fishing mortality of age groups 4-8 from Adapt (upper figure).

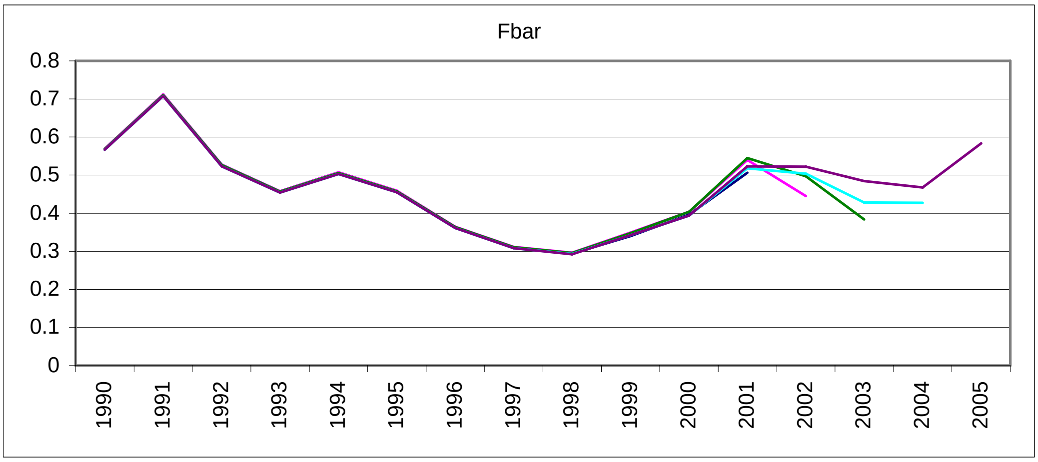


Figure 2.5.5.6. Saithe in the Faroes (Division Vb). Retrospective analysis of average fishingmortality of age groups 4-8 from XSA for the years 2001-2005.

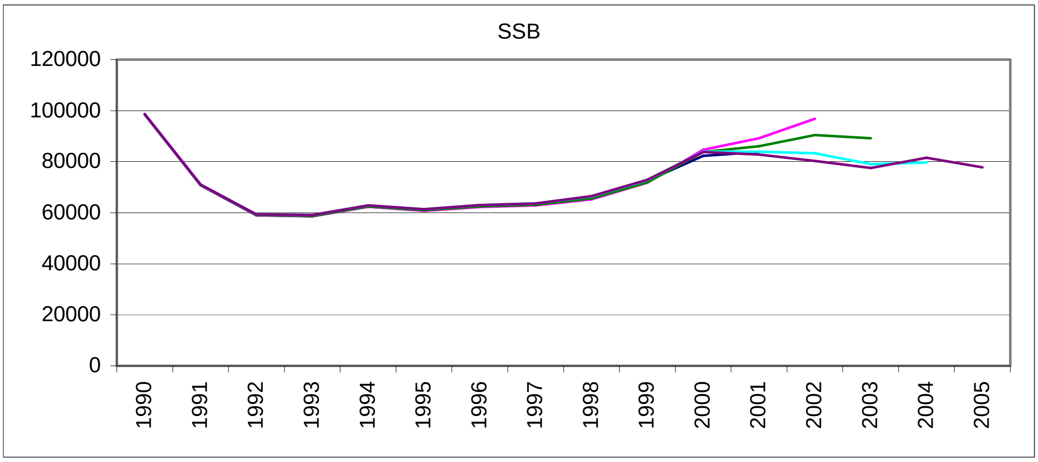


Figure 2.5.5.7. Saithe in the Faroes (Division Vb). Retrospective analysis of spawning stock biomass of age groups 4-8 from XSA for the years 2001-2005.

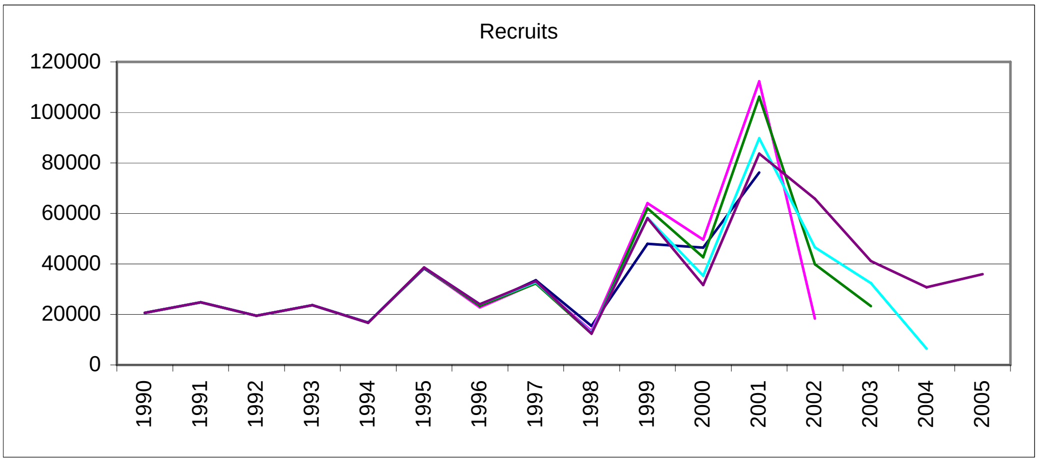


Figure 2.5.5.8. Saithe in the Faroes (Division Vb). Retrospective analysis of average recruitment for age 3 from XSA for the years 2001-2005.

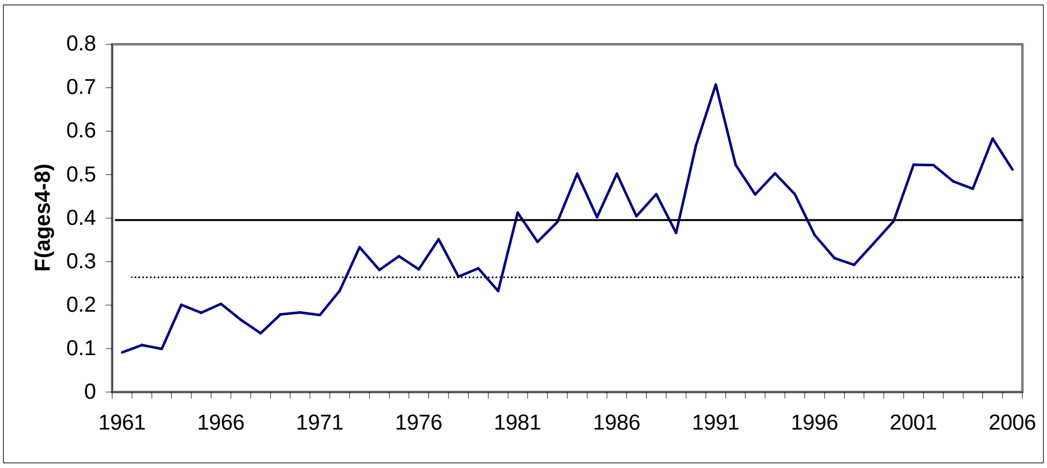


Figure 2.5.5.9. Saithe in the Faroes (Division Vb). Fishing mortality (average F ages 4-8). 2006 is predicted value.

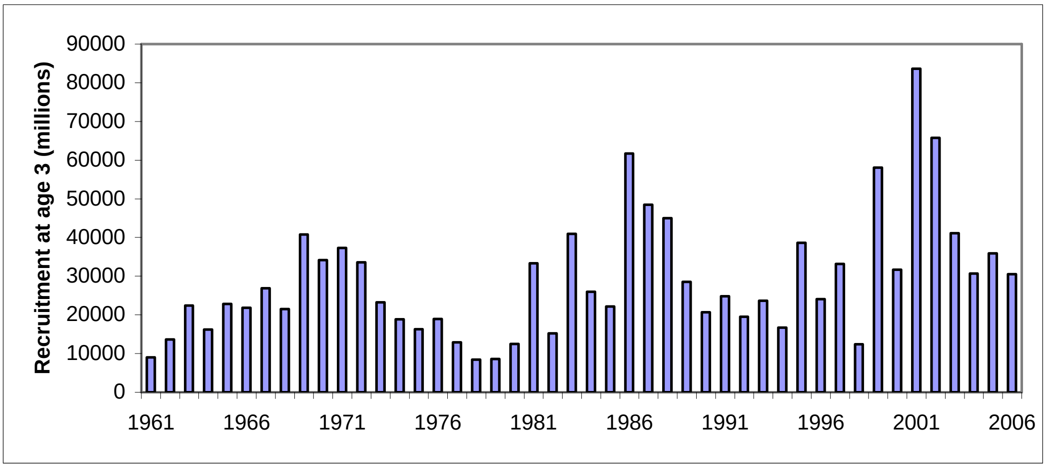


Figure 2.5.5.10. Saithe in the Faroes (Division Vb). Recruitment at age 3 (millions). 2006 is predicted value.

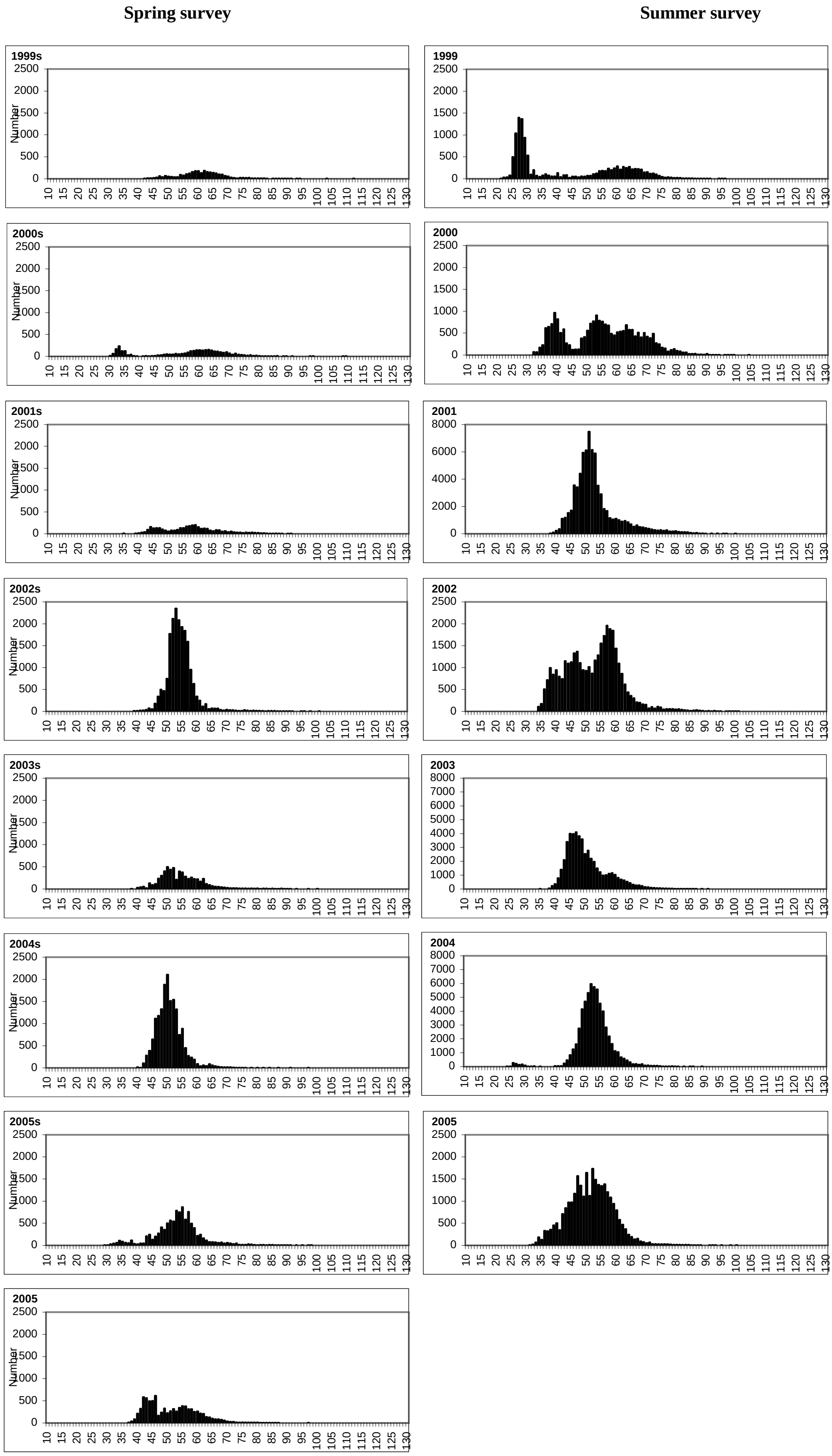


Figure 2.5.5.11. Saithe in the Faroes (Division Vb). Length distribution from spring (s) and summer survey 1999-2006. NB! Different scale for year 2001, 2003 and 2004 summer survey.

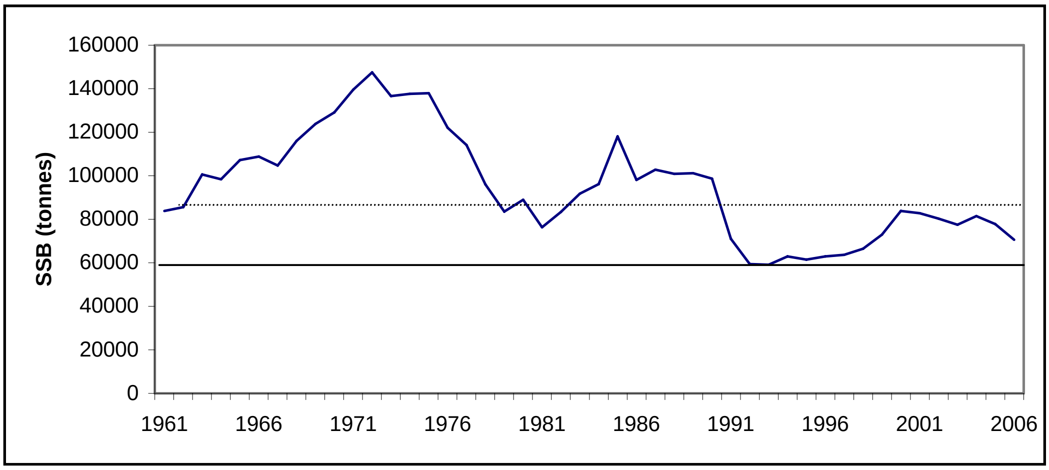


Figure 2.5.5.12 Saithe in the Faroes (Division Vb). Spawning stock biomass (1000 tonnes). 2006 is predicted value.

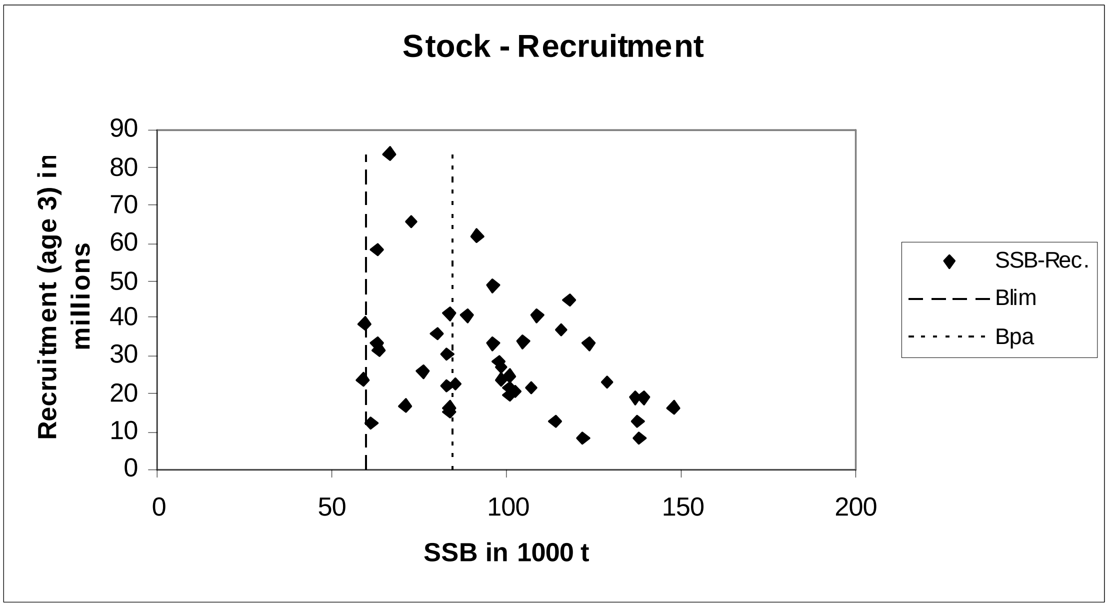


Figure 2.5.5.13 Saithe in the Faroes (Division Vb). Stock-Recruitment plot.

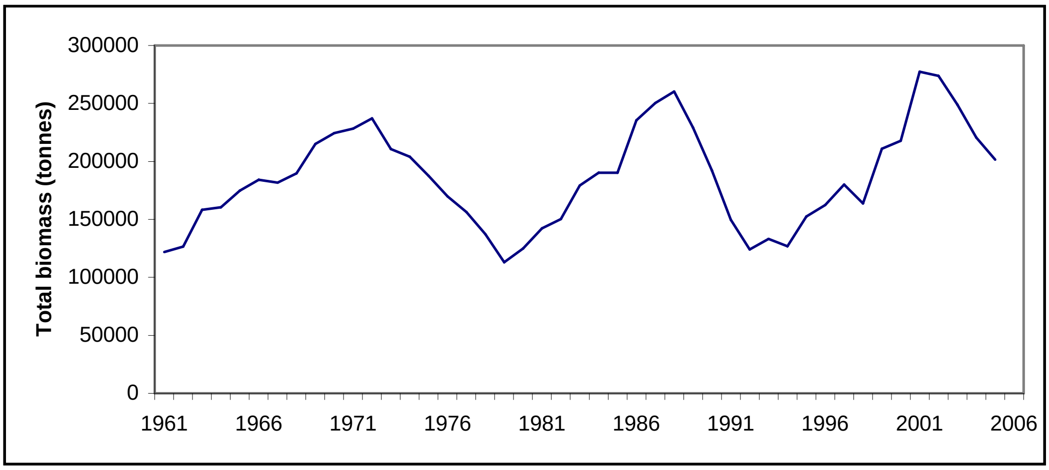


Figure 2.5.5.14. Saithe in the Faroes (Division Vb). Total biomass (1000 tonnes).

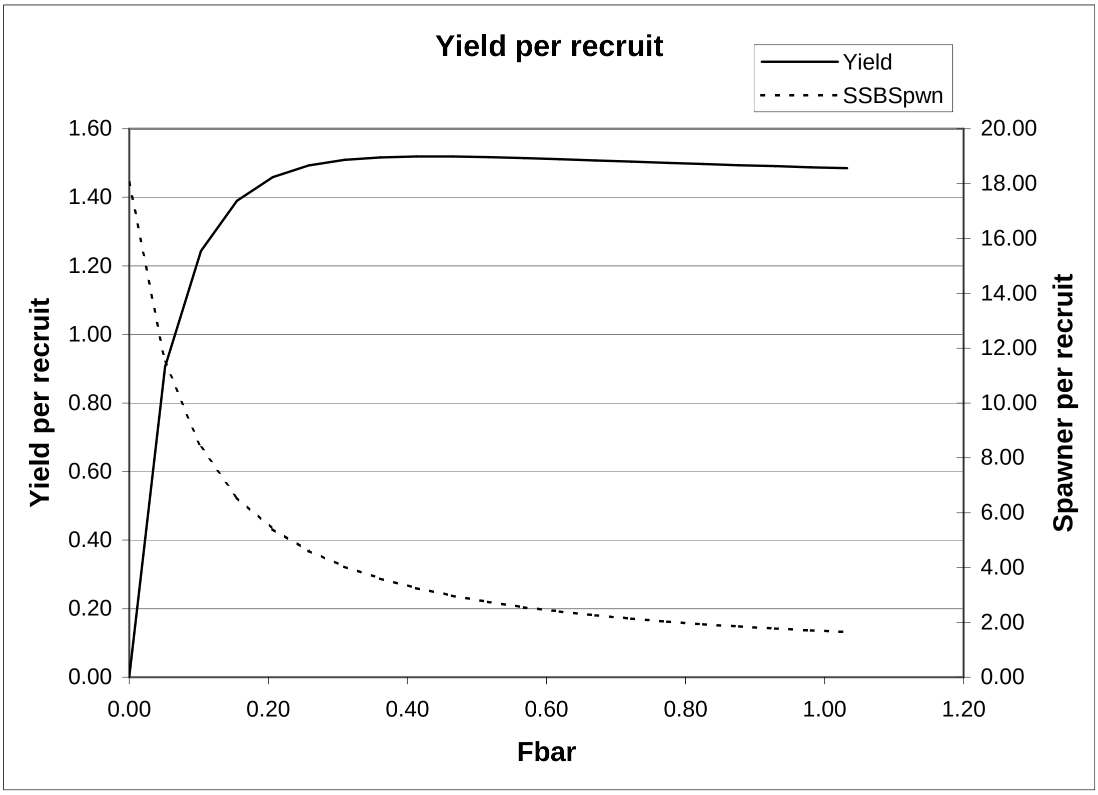


Figure 2.5.6.1 Saithe in the Faroes (Division Vb). Fish stock summary.

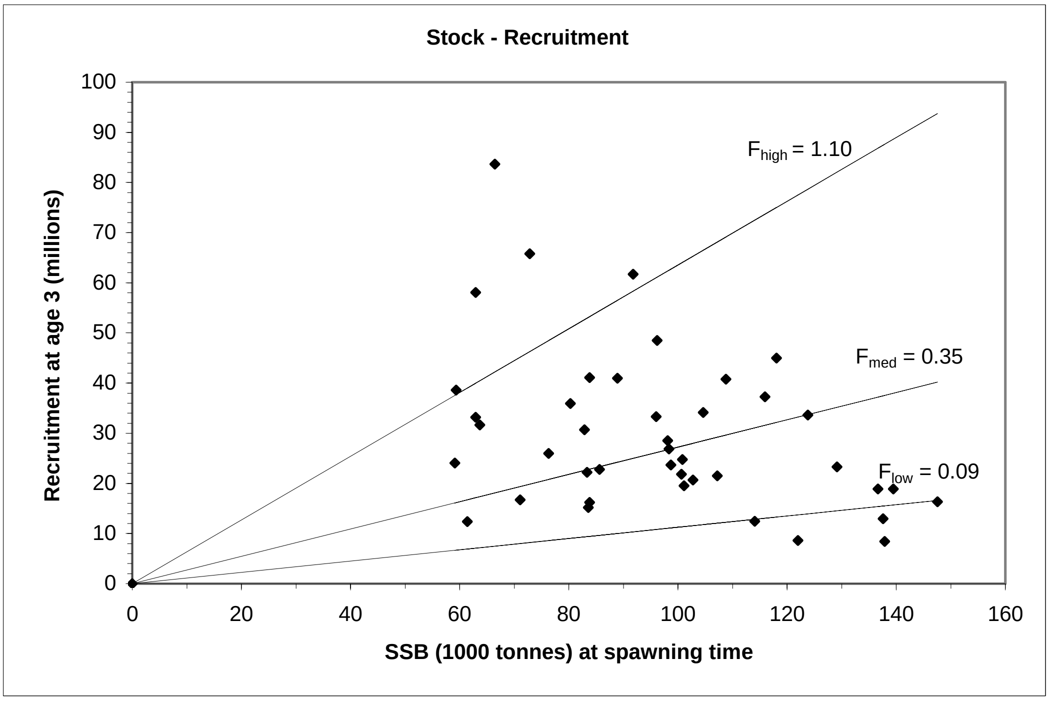


Figure 2.5.6.2 Saithe in the Faroes (Division Vb). Stock- recruitment.

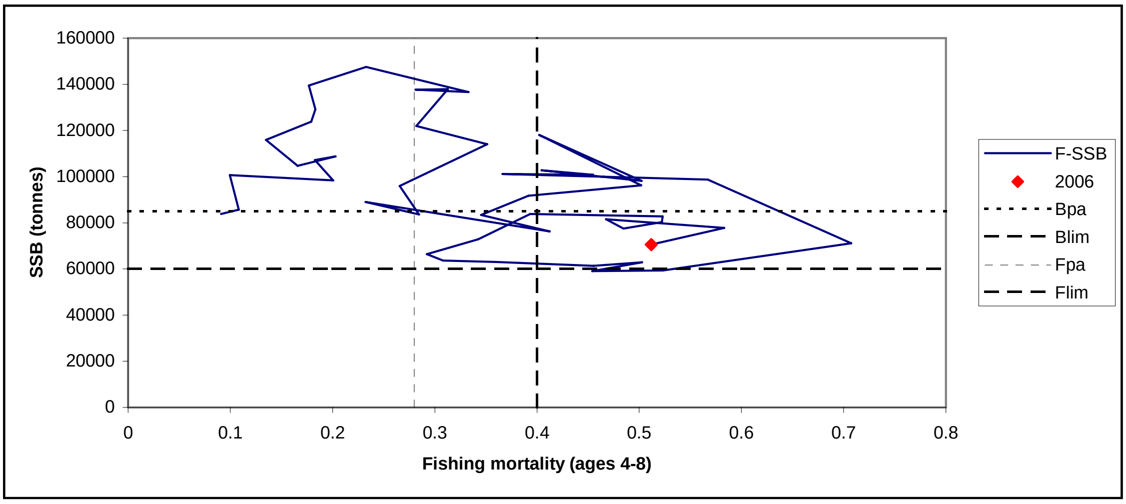
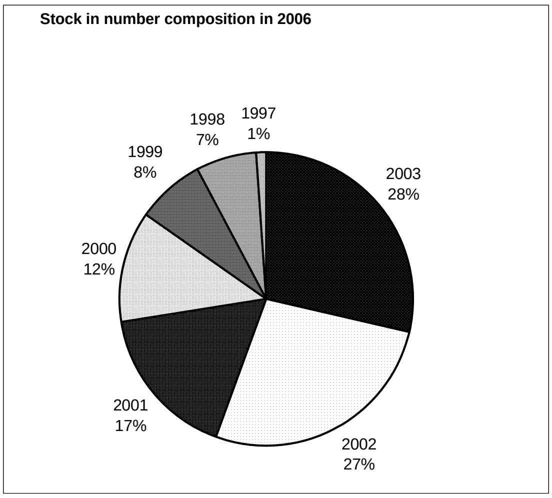


Figure 2.5.6.3. Saithe in the Faroes (Division Vb). Precautionary approach plot, period 1961-2006. The history of the stock/fishery in relation to the four reference points.



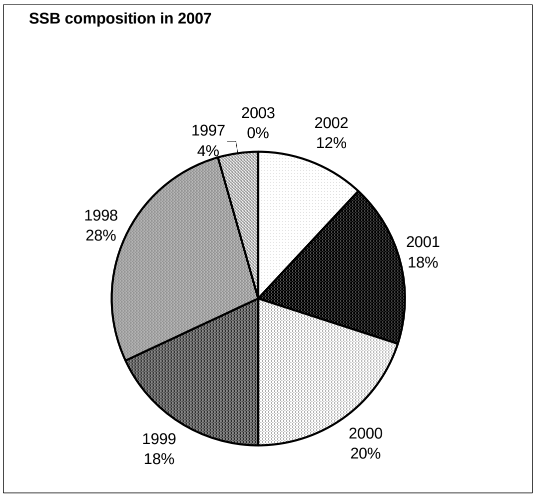


Figure 2.5.6.4. Saithe in the Faroes (Division Vb). Projected composition in number by year classes in the catch in 2006 (left figure) and the composition in SSB in 2007 by year classes (right figure).

3 Stocks in Icelandic waters

3.1 Overview of fisheries and some recent ecosystem observation

This sections 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. Those information are 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 distribution 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 overview 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 are thus limited to the broad categories given below:

TYPE	NO.VESSELS	GEAR TYPE USED
Trawlers	74	(pelagic and bottom trawl)
Other large vessels within the TAC system	259	(Purse seine, longline, gillnet danish seine, pel. Trawl)
Small vessels within the TAC system	825	(Jiggers, longline, gillnet, Purse seine)
Vessels within the effort system	211	(small jiggers)
Total	1 369	NEEDS TO BE CHECKED

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 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 difference 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).

3.1.3 Discards

Discarding measurements have been carried out in Icelandic fisheries since 2001, based on extensive data collection and length based analysis of the data (Pálsson 2003). The data collection is mainly directed towards main fisheries for cod (*Gadus morhua*) and haddock (*Melanogrammus aeglefinus*) and towards saithe (*Pollachius virens*) and golden redfish (*Sebastes marinus*) fisheries in demersal trawl and plaice in Danish seine. Sampling for other species is not sufficient to warrant a satisfactory estimation of discarding. The estimated cod discards is amounted to 1227 metric tons in 2004, 0.60% of landings, slightly more than in 2003 and considerably less than in 2001 and 2002. Haddock discards were estimated 2544 tons in 2004, 3.13%, considerably more than in 2002 and 2003 and similar as in 2001. Discarding of saithe and golden redfish was nil in 2004 and was negligible in previous years. Discards of plaice in the Danish seine fishery was estimated for the first time in 2004 and amounted to 7.11% of landings. Estimates of discards in 2005 are given in table 3.1.2. Since the time series of discards is relatively short it is not included in the assessment.

3.1.4 Management

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

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

In 1990, an individual transferable quota (ITQ) system was established for the fisheries and they were subject to vessel catch quotas. The quotas represent shares in the national total allowable catch (TAC) for each species , and most of the Icelandic fleets operates under this system.

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

Fisheries can with regulations close the area for longer time forcing the fleet to operate in other areas. Inspectors from the Directorate of Fisheries supervise these closures in collaboration with the Marine Research Institute. In 2004, 73 such closures took place.

In addition to allocating quotas on each species, there are other measures in place to protect fish stocks. Based on knowledge on the biology of various stocks, many areas have been closed temporarily or permanently aiming at protect juveniles. Figure 3.3.11 shows map of such legislation that was in force in 2004. Some of them are temporarily, but others have been closed for fishery for decades.

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

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

Amendments adopted in June 2000:

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

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

On the basis of these results the Icelandic government adopted a modification to the HCR by including a 30 thousand tonnes catch-stabiliser and abandoning the minimum catch floor of 155 thousand tonnes. This resulted in a TAC of 220 thousand tonnes for the fishing year 2000/2001 instead of 203 thousand tonnes 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.

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 more scarce. 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 improvement in the SSB biomass has however not resulted in significant increase in production in recent years, despite increased inflow of warmer Atlantic water.

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

3.1.6 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

T

		Landings (t)	Discard (number, thousands)	Discard mass (tonnes)	Discard proportion
Cod	Long line	68633	545	394	0.57
	Gill net	31705	522	1063	3.35
	Danish Sei	12767	47	29	0.23
	Trawl	83415	851	773	0.92
	Total	**196520**	**1965**	**2259**	**1.15**
Haddock	Long line	30535	916	401	1.31
	Danish Sei	10504	414	320	3.05
	Trawl	51917	5772	4150	7.99
	Total	**92956**	**9067**	**7130**	**7.67**

Table 3.1.2.. Estimates of discard of cod and haddock in the Icelandic fisheries in 2005

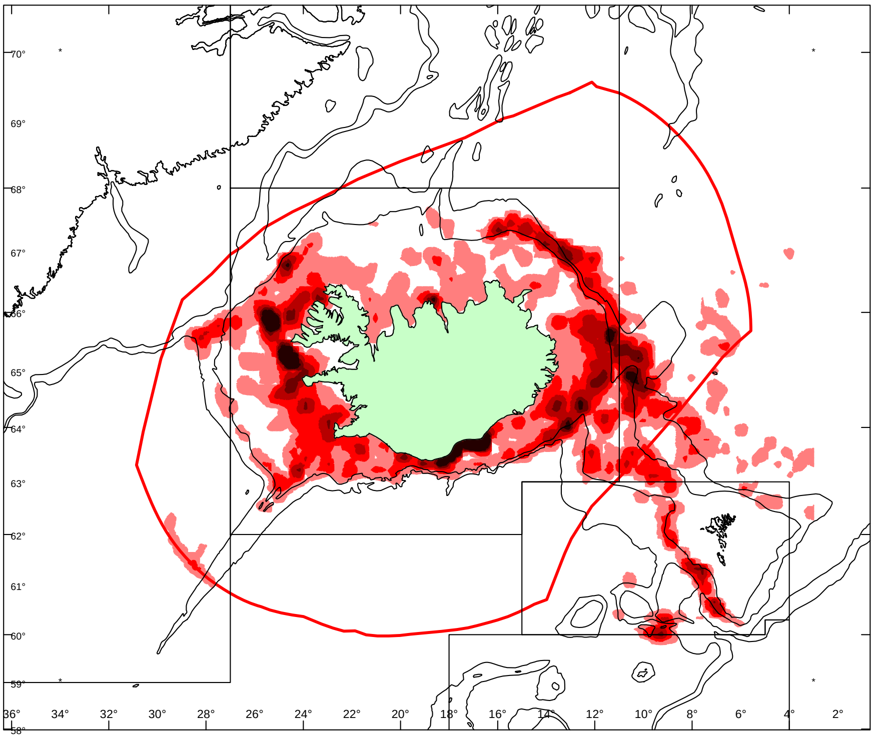

Figure 3.1.1. Distribution of total catch of all species by the Icelandic fishing fleet in Icelandic EEZ and adjacent waters in 2005. The Icelandic EEZ is shown as a red line, regular thin lines show major ICES areas and contour lines indicate 500 and 1000 m depth.

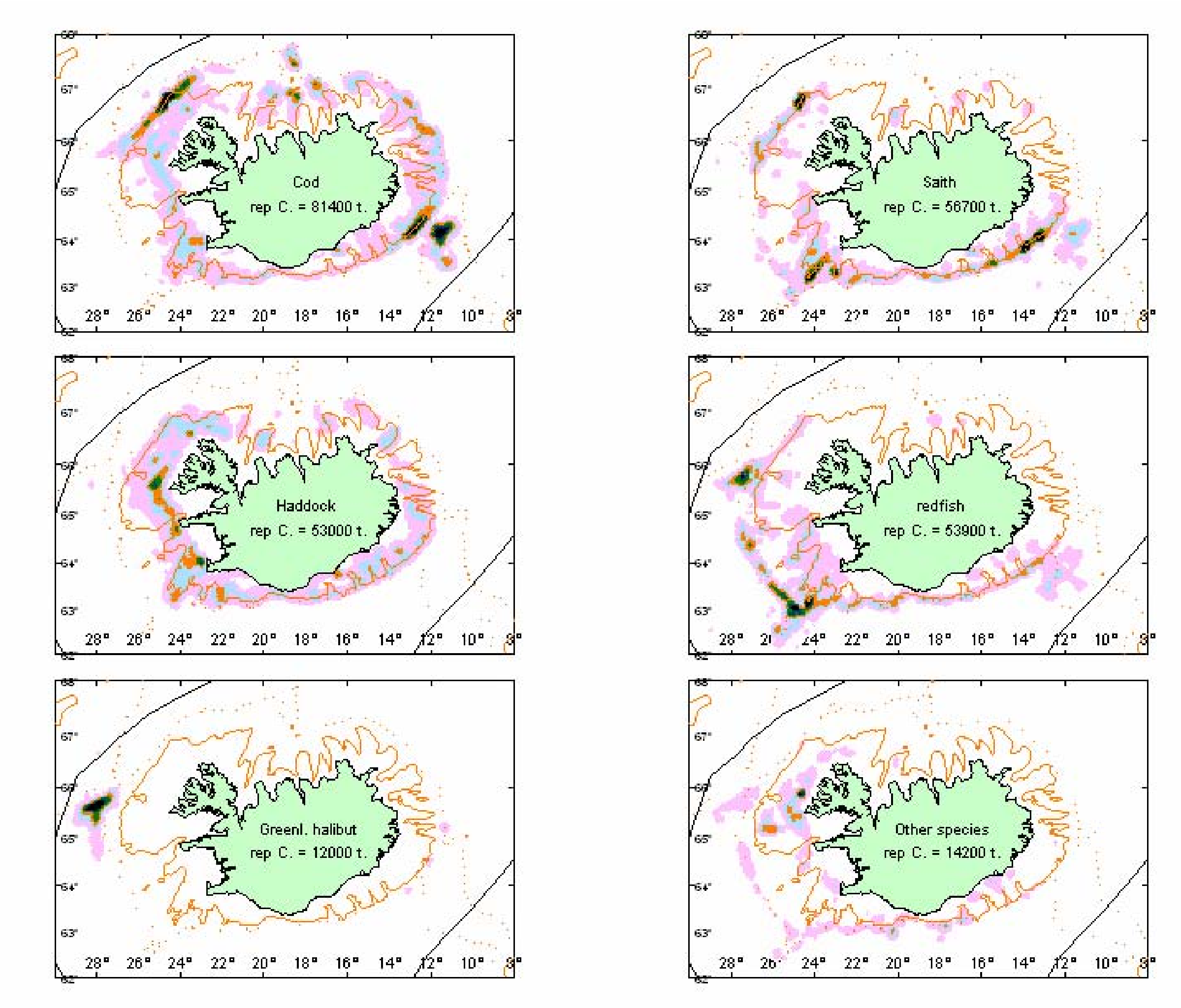

Figure 3.1.2 Location of catches of cod, saithe, haddock, redfish, Greenland halibut and others caught with bottom trawl 2005.

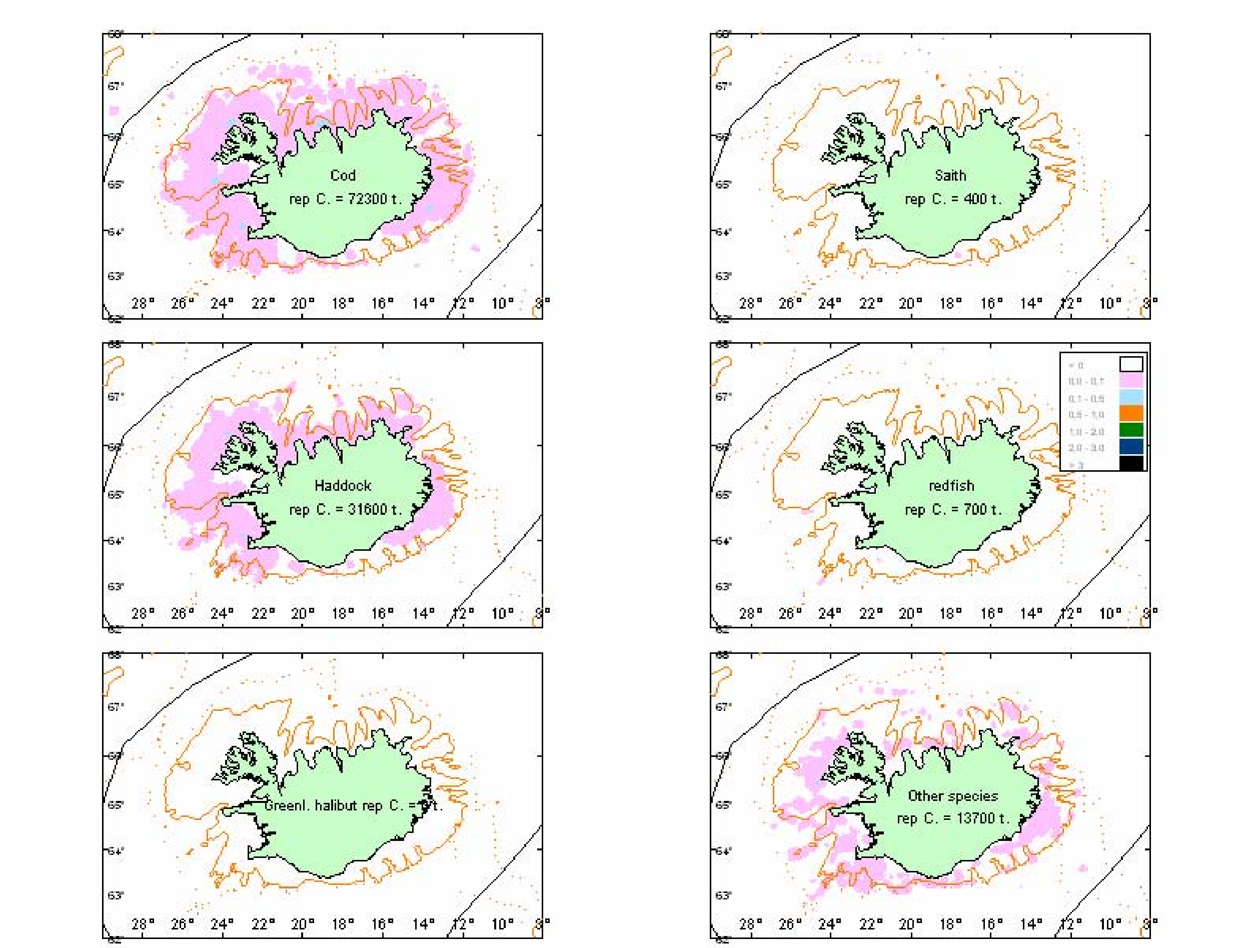

Figure 3.1.3 Location of catches of cod, saithe, haddock, redfish, Greenland halibut and others caught with long-line in 2005.

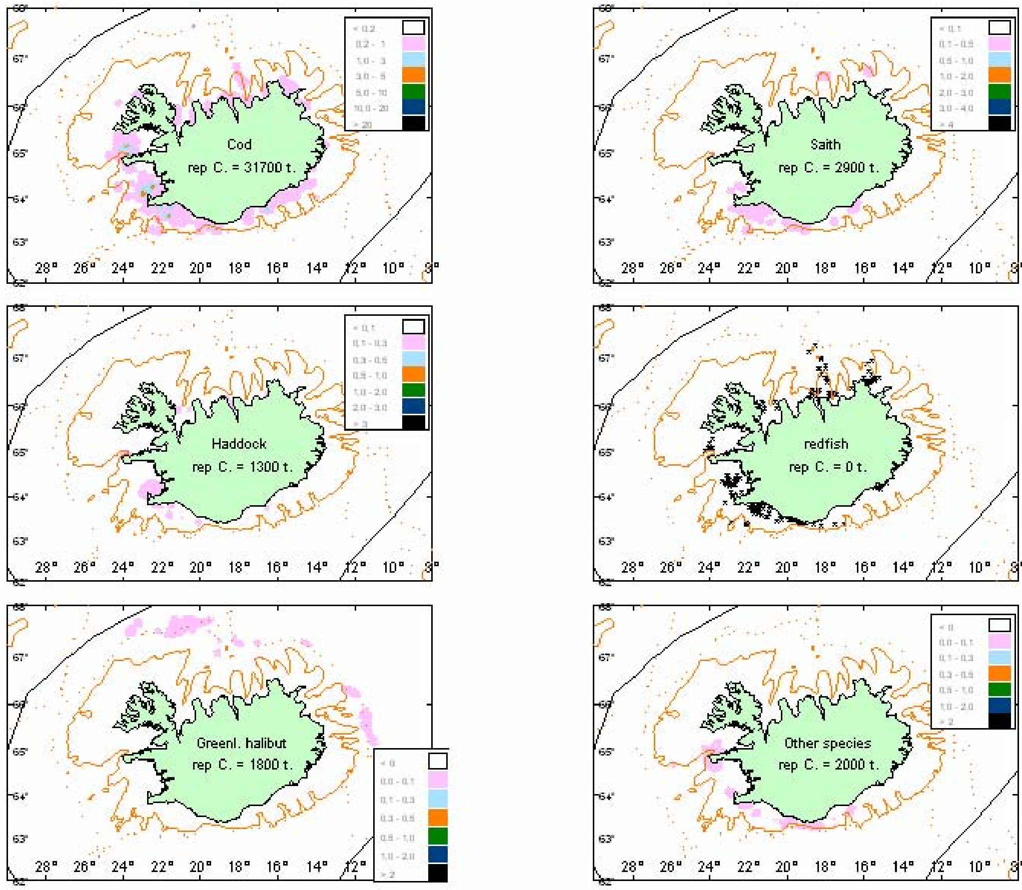

Figure 3.1.4 Location of catches of cod, saithe, haddock, redfish, Greenland halibut and others caught with gillnets in 2005.

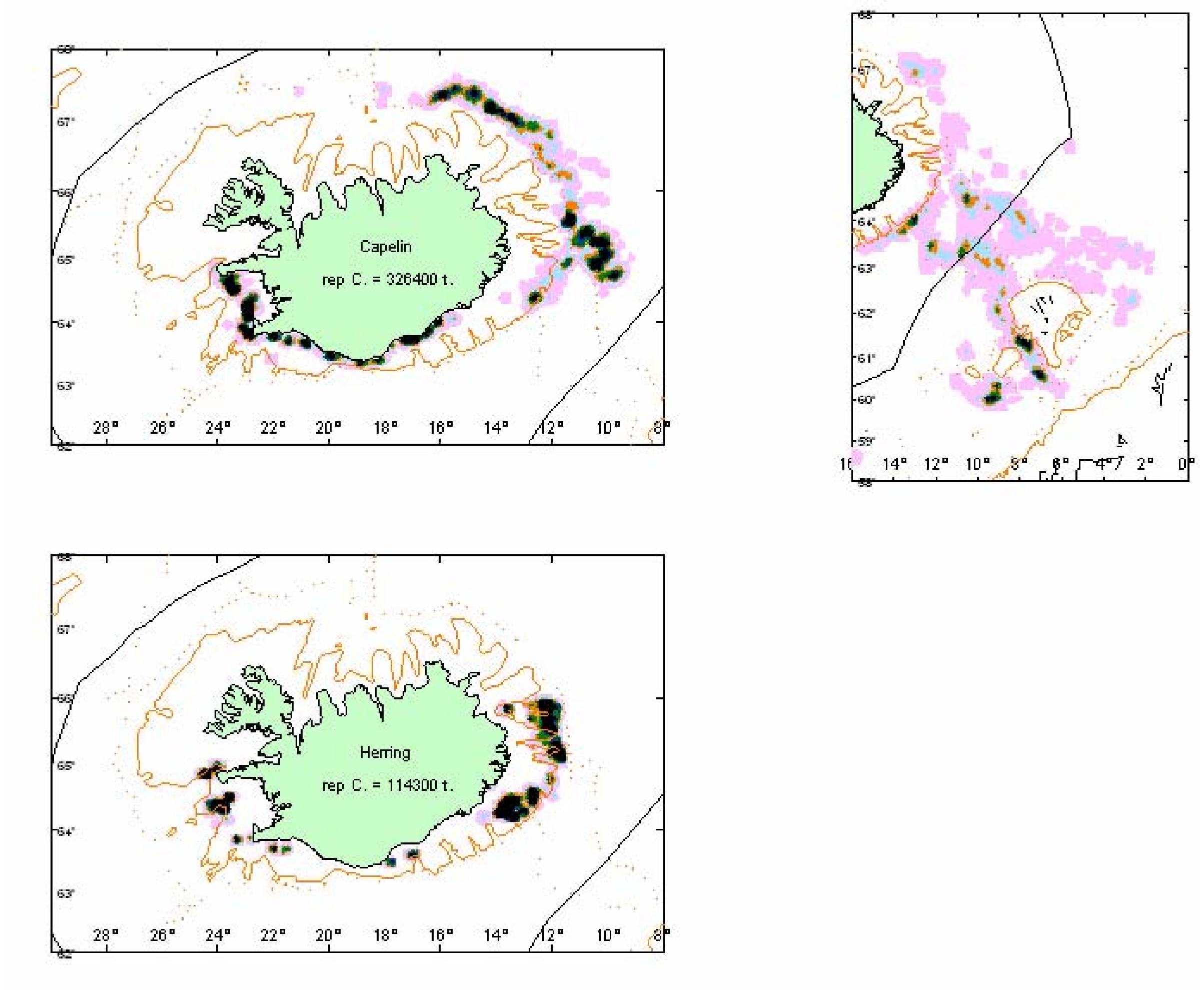

Figure 3.1.5. Location of catches of capelin, Icelandic spring spawning herring and blue whiting with purse seine and pelagic trawls in 2005.

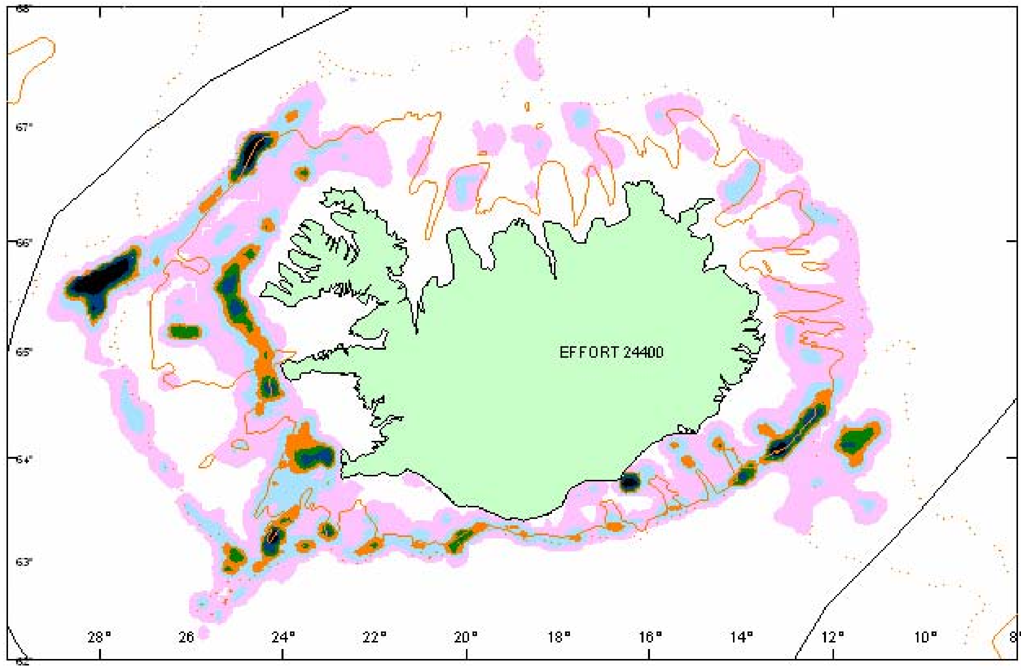

Figure 3.1.6. Effort of the trawler fleet in 2005. The dark colours show the areas of the greatest fishing effort to be off the southeast to the west coast and off Northwest Iceland.

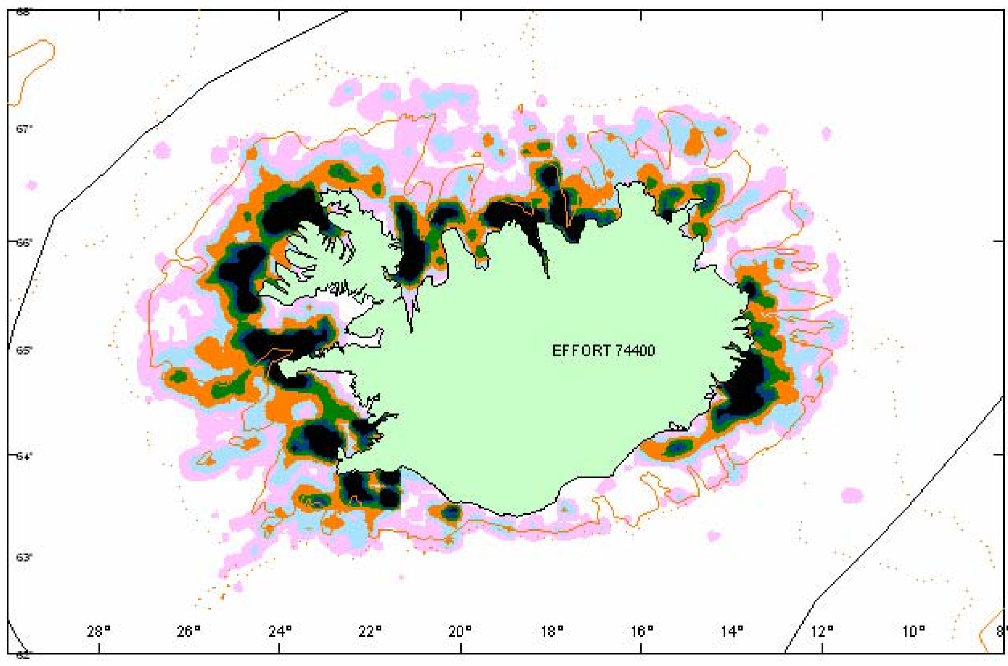

Figure 3.1.7. Effort in the longline fleet in 2005. The dark colours show the areas of the greatest fishing effort to be off the northwest and west coast but fishing is also concentrated along the entire southwest and south coast. The main targeted species for longline fishing are cod, haddock, catfish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

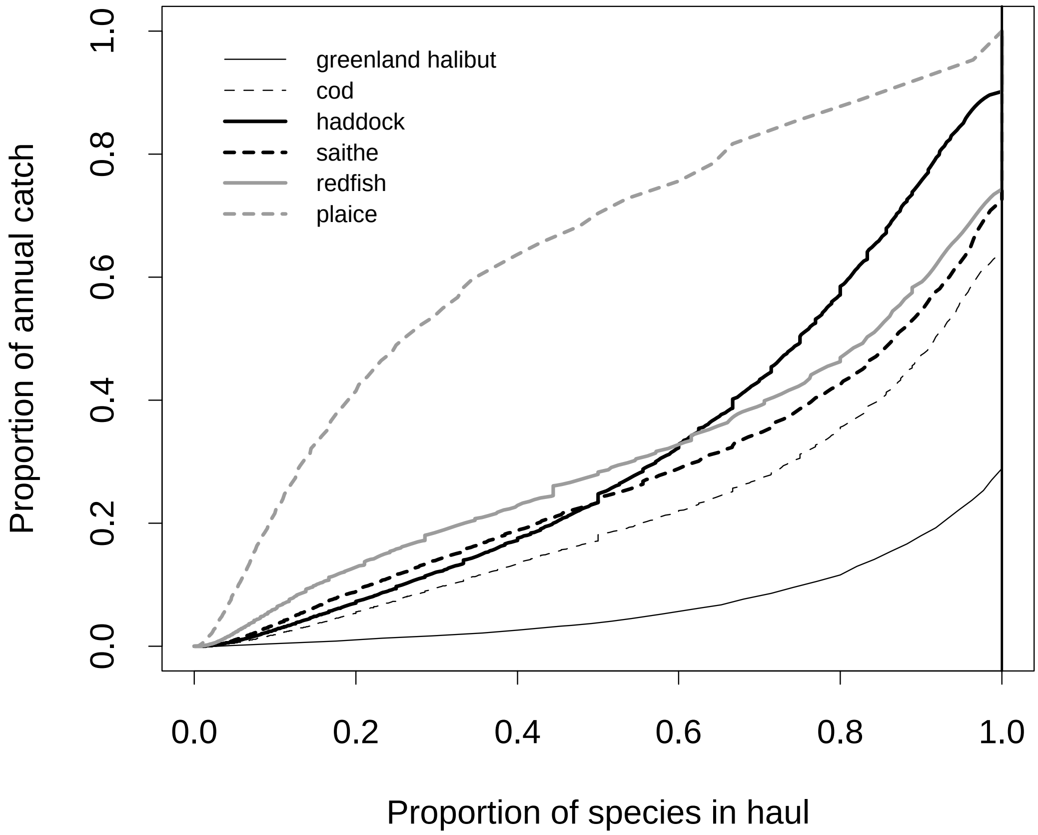

Figure 3.1.8. Cumulative plot for bottom trawl in 2004. An example describes this probably best. Looking at the figure above it can be seen from the dashed lines that 30% of the catch of haddock comes from hauls where haddock is less than 50% of the total catch while only 4% of the catch of greenland 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.

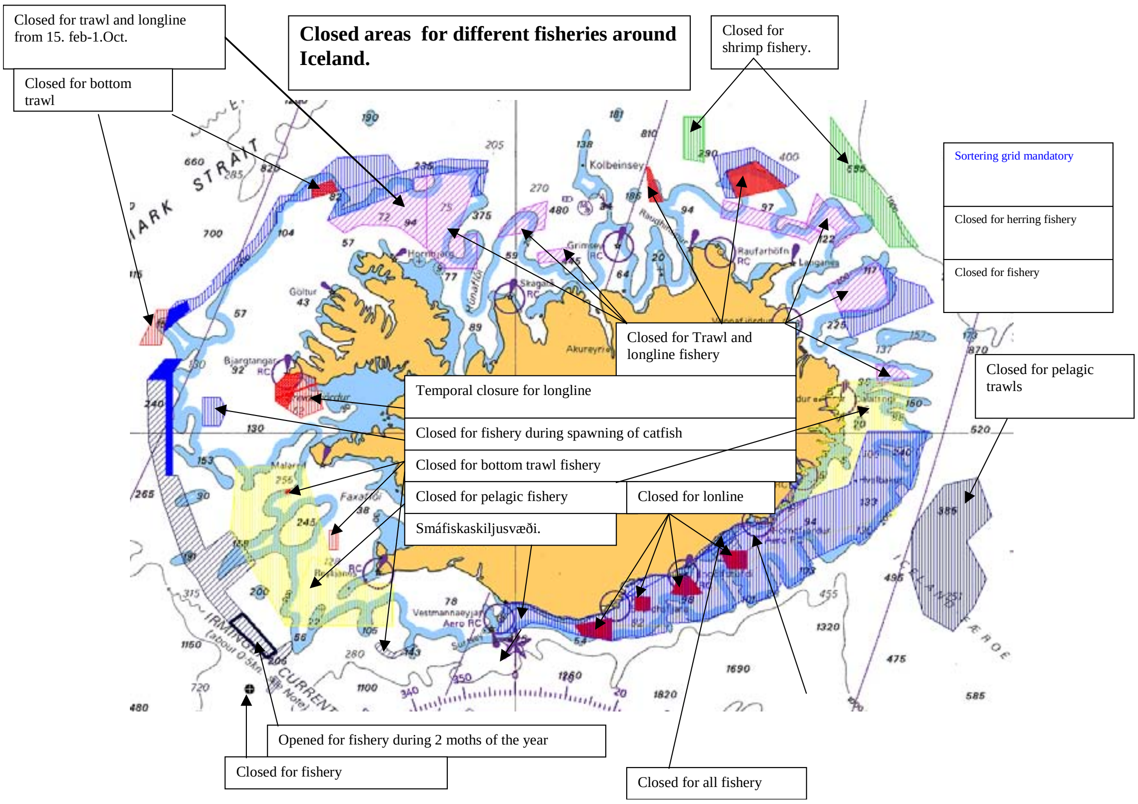

Figure 3.1.9. Overview of closed areas around Iceland. The boxes are of different nature and can be closed for different time period and gear type.

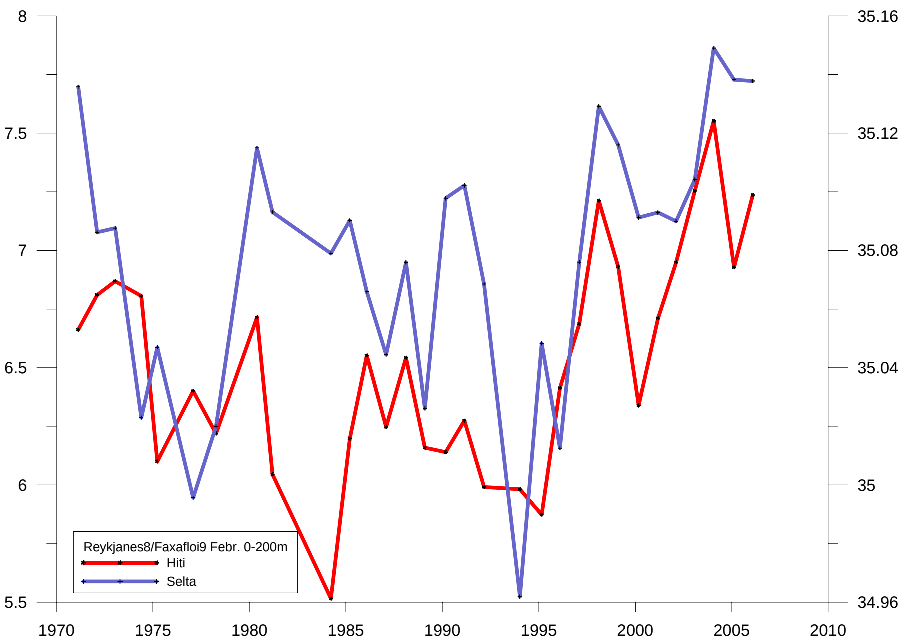

Figure 3.1.10 Changes of temperature and salinity west of Iceland 1970-2006.

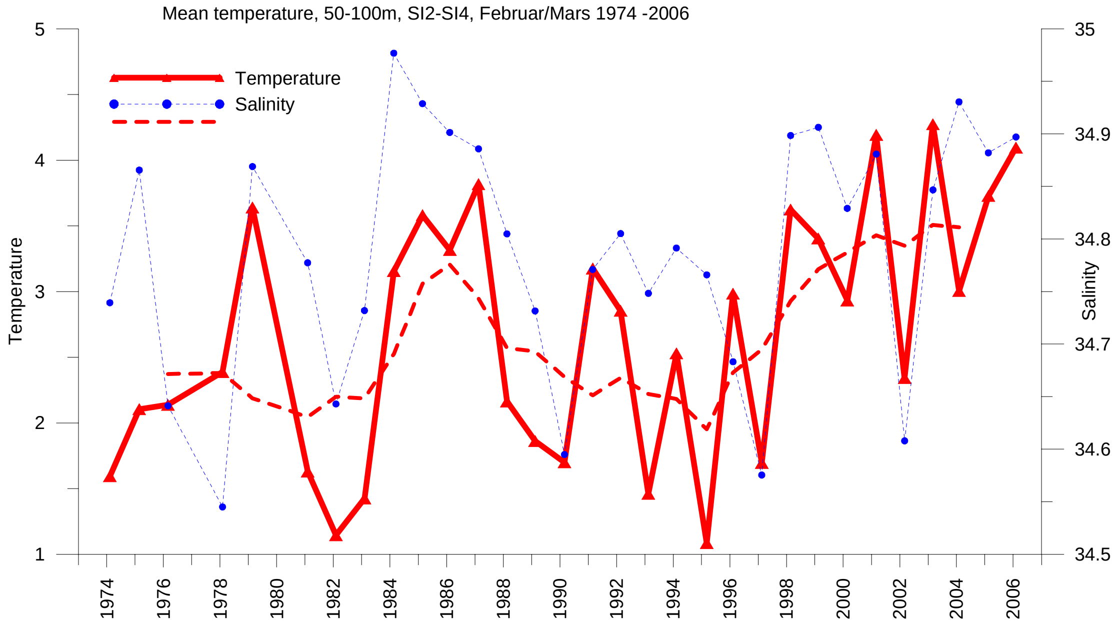

Figure 3.1.11 Changes of temperature and salinity off central North-Iceland 1970-2006.

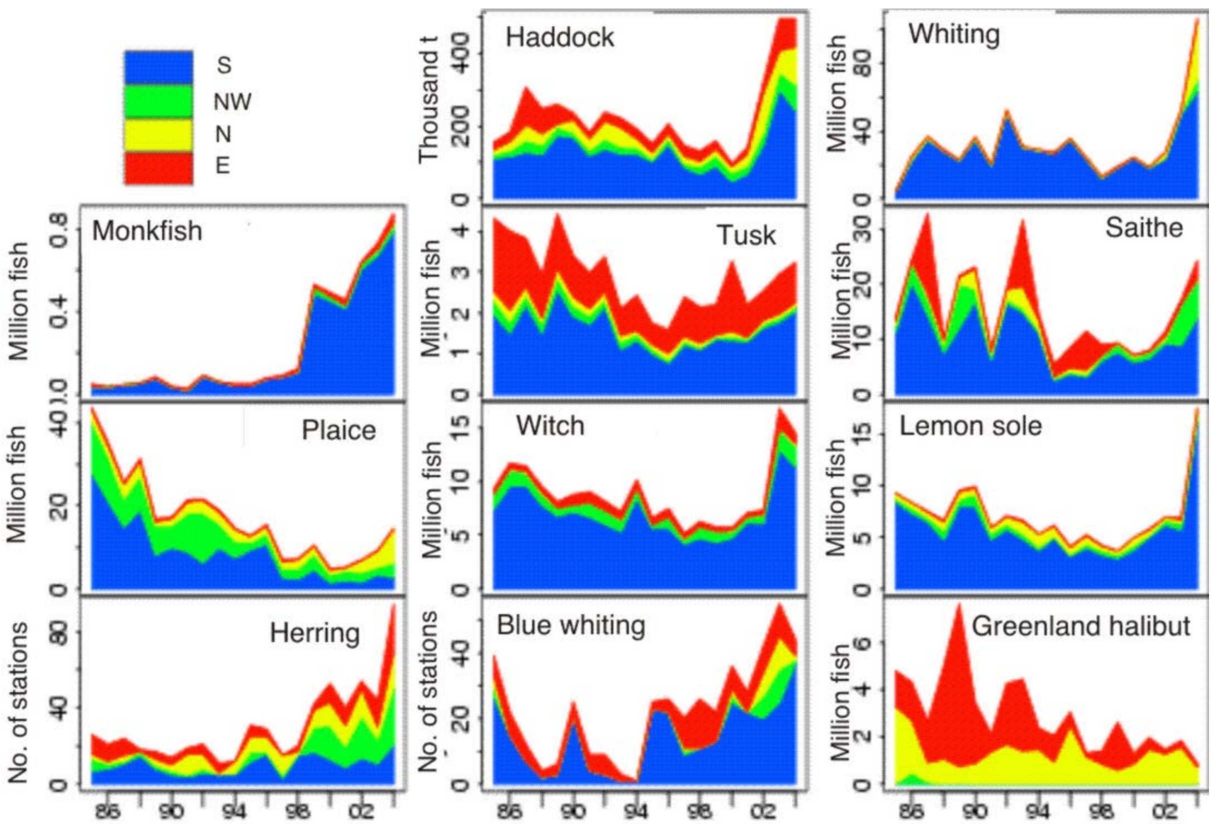

Figure 3.1.12. Changes of indices of abundance and geographical distribution of several fish stocks in Icelandic waters, 1985 – 2005 (based on the spring groundfish survey). The denotations S, NW, N and E beside the color code shown in the top left corner stand for South-, Northwest-, North- and East-Iceland in that order.

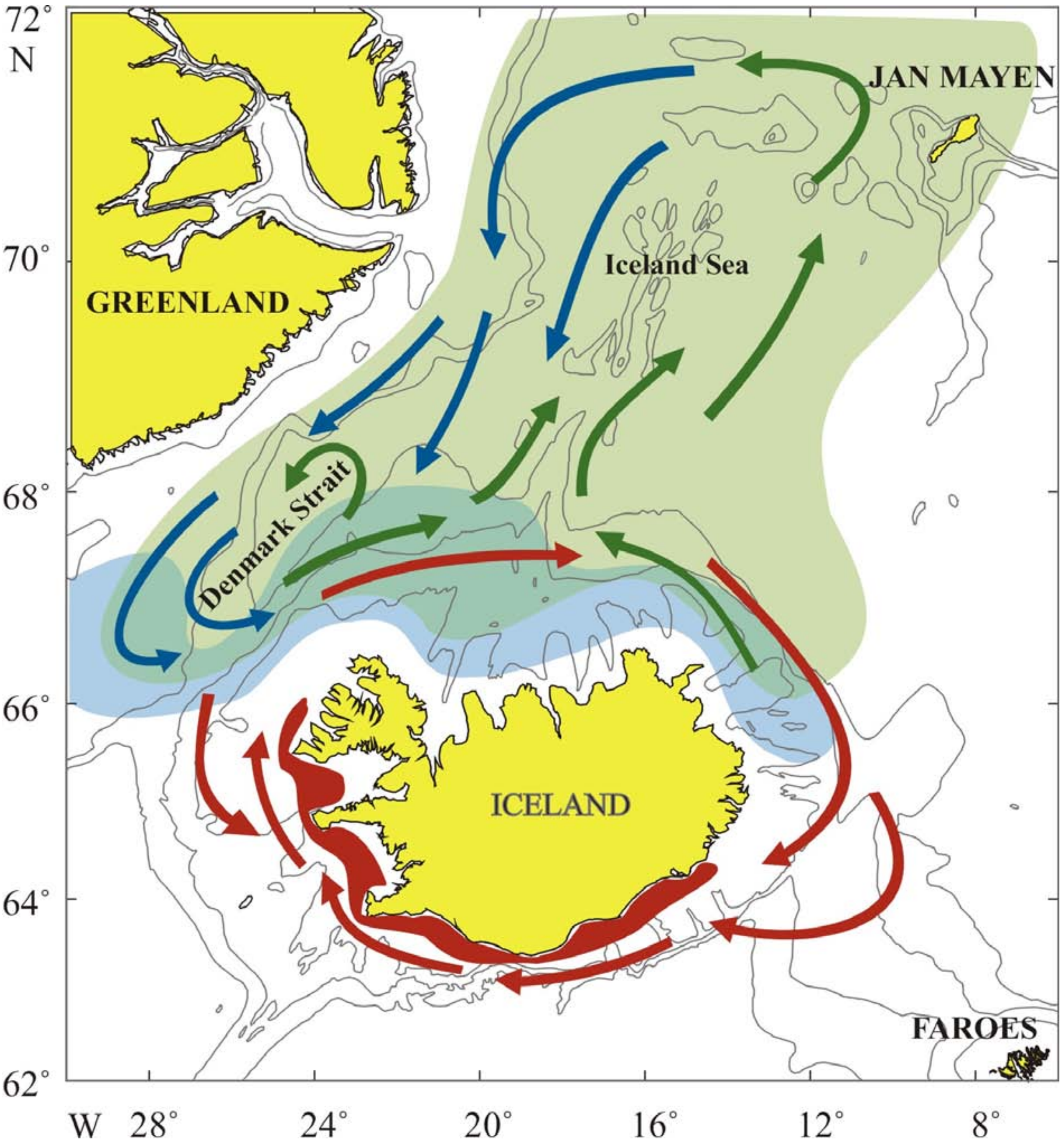

Figure 3.1.13. Distribution and migrations of capelin in the Iceland/East-Greenland/Jan Mayen area before 2001. Red: Spawning grounds; Green: Adult feeding area; Blue: Distribution and feeding area of juveniles; Green arrows: Adult feeding migrations; Blue arrows: Return migrations; Red arrows: Spawning migrations; Depth contours are 200, 500 and 1000 m (Vilhjalmsson 2002)

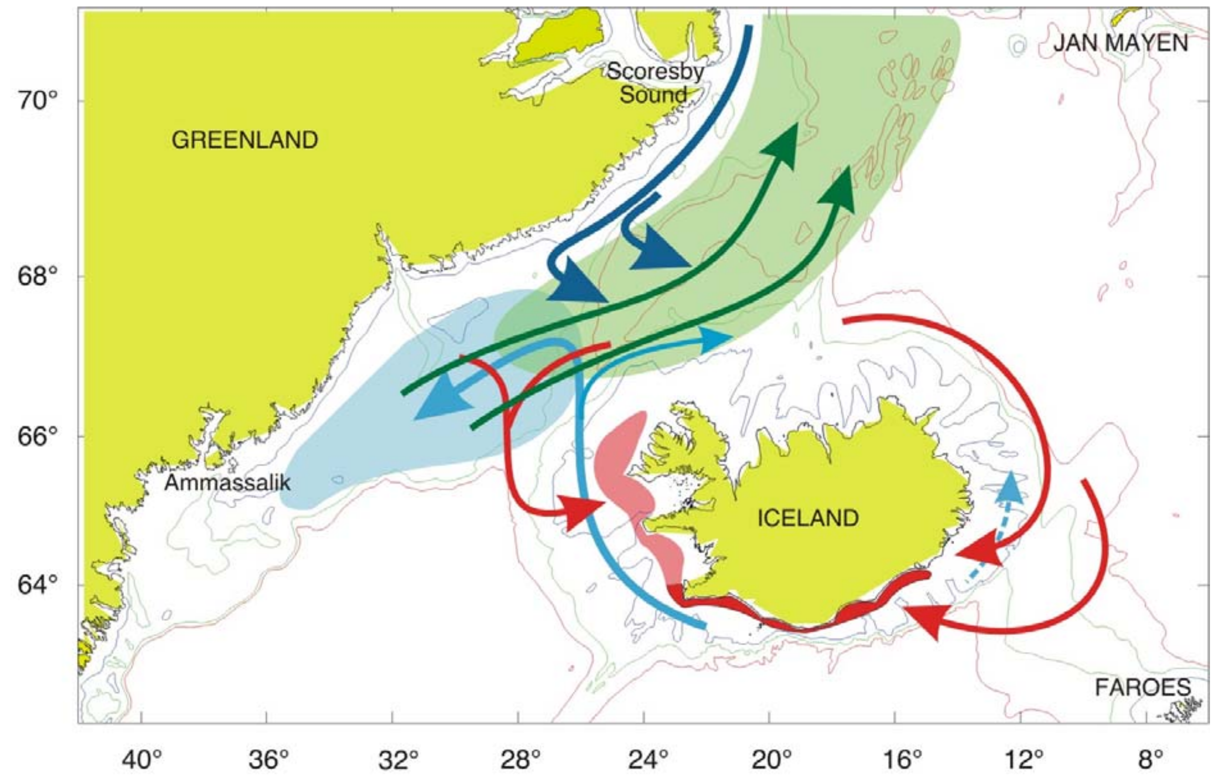

Figure 3.1.14. Likely changes of distribution and migration routes of capelin in the Iceland/Greenland/Jan Mayen area in the last 3-4 years. Green: Feeding area; Light blue: Juvenile area; Red area: Main spawning grounds; Lighter red colour: Lesser importance of W-Iceland spawning areas; Light blue arrows: 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 Saithe in Icelandic waters - An update assessment

Input data

The total reported landings in 2005 were 69 compared to 75 thous. tonnes predicted by the working group.

The landings at age in 2005 were in fairly good accordance with last years projections, total number was ~5% higher than predicted.

Mean weight at age in landings and stock in 2005 and survey weights in 2006 were generally low and were also lower than predicted by the working group last year.

Total biomass survey index in spring survey 2006 was slightly higher than last year but also had higher measurement error (CV) than in 2005.

Assessment models

The assessment modelling approaches applied [1]all show similar recent development of the stock. The results from the 'camera' separable model was, as in previous years, adopted as a point estimate for forward projections.

Changes in assessment results

In present assessment the estimated spawning stock biomass (SSB) in the beginning of 2006 is 218 thous. tonnes compared to 205 thous. tonnes in last years assessment.

The year classes 1999-2002 were estimated 67, 97, 22 and 70 millions respectively in last years assessment compared to 62, 100, 27 and 79 in the current assessment.

No prominent retrospective pattern is apparent in the assessment of this stock but revision of year class strength is to be expected as catches accumulate.

Comments

The empirical retrospective pattern for the stock has clearly improved since the Icelandic GroundFish Survey in March (IGFS) was introduced as a tuning fleet.

3.2.1 Trends in landings, discards and bycatch

Saithe landings from Icelandic waters (ICES division Va) have increased gradually from a low of ~30 Kt in 1998-2001 to 69 Kt in 2005 (Table 3.2.1.1 and Figure 3.2.1.1). Icelandic landings in the quota year September 2004/August 2005 amounted to 70 603 t, close to the national TAC of 70Kt. The saithe TAC has increased from 30 Kt in 1997-2001 to 80 Kt for the fishing year 2005/2006.

Landings of saithe in quota years 2004/2005 and 2005/2006 and in calendar years 2005 and 2006 show how the fishery proceeds at a steady rate, January-April landings in 2006 are close to 20 Kt. Landings in 2005 in the current fishing year (Sep-Dec2005) amounted to 32219 t, which leaves approximately 35 Kt of the quota for 2005/2006 unfished. With foreign catches, estimates of bycatch from the blue whiting fishery and transfers within the ITQ system, likely total landings in 2006 are therefore of the order 75 - 80 Kt, depending on TAC given after the

2006 assessment and inpredictable transfers between species and years in the quota system (Figure 3.2.1.2).

Negligble discards of saithe have been detected in a sampling program conducted by the Directorate of fisheries and the MRI, which samples vessel landings and subseqently from their catches at sea (Ólafur Karvel Pálsson, pers. comm.).

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

A minor discrepancy between offical landings and the total landings in 1991 and 1999-2002 was corrected.

3.2.2 Fleets and fishing grounds

More than 85% of landings in 2005 were taken in bottom trawl, almost 5% both in gillnets and on hooks (jiggers and longline) and 2% in Danish seine. The proportion of the catch taken in gillnets has declined from almost a third of the total in 1994 and 1995, while the bottom trawl share has increased. The gillnet catch, however, increased from 2200t in 2004 to almost 3000t in 2005.

The main fishing grounds of the bottom trawl fishery are southwest of Reykjanes and off the south east coast and in recent years an area NW of Iceland has become increasingly important. The gillnet fishery is concentrated on spawning grounds south and southwest of Iceland. The geographical distribution of reported catch in 2005 from all gears combined is shown in Figure 3.2.2.1, which shows the positions of samples from commercial gear plotted on top of the catch contours.

Simple CPUE indices, i.e. mean and median CPUE in trawl hauls where saithe was recorded, as either more or less than 50% of the reported catch are shown in in Figure 3.2.2.2. The increasing trend in CPUE observed from 2000-2004 has either levelled off or been reversed, depending on the index examined.

3.2.3 Landings at age

Data from samples from catch of most gear types, collected systematically over the year (SÝNÓ-system and Icelandic discards monitoring programme) and representative of the distribution of the fishery (Fig. 3.2.2.1), were used to calculate catch in numbers at age in total landings in 2005, with the sampling level indicated in the text table below, and used as input for the assessment (Table 3.2.3.1).

Gear/nation	Landings (t)	No. of otolith samples	No. of otoliths read	No. of length samples	No of length measurements
Gillnets	2962	3	72	27	1807
Jiggers	2304	3	137	35	2452
Danish seine	1379	1	50	10	217
Bottom trawl	58355	105	5217	356	57440
Other gear	2283	-	-	7	122
Foreign landings	860	-	-	-	-
Bycatch	1700	-	-	-	-
Total	69143	112	5476	435	62038

Gillnet catches were split according to a gear-specific age-length key, the rest of the catches were split according to a key based on all samples from commercial gear except those from gill nets. The length weight relationship used (W = 0.02498 * L^2.75674) was applied to length distributions from both fleets. (Table 3.2.3.1 and Figure 3.2.3.2).

Estimated bycatch of saithe in the blue whiting fishery in the Icelandic EEZ was added to catch in numbers in 2005, as was started in 2005 for years 2003 and 2004. The bycatch was split on age groups according to samples from landings as length distributions of saithe in the bycatch samples were similar to that in landings. The estimates indicate that the bycatch is an insignificant part of the total catch (~1%).

Compared to predicted landings at age in the 2005 assessment, the numbers at age in landings were considerably lower than predicted for age group 5, the large 2000 year class, but higher for age groups 3-4 and 6-7 (Figure 3.2.3.1). The total number of saithe landed was ~5% higher than predicted last year.

Log catch ratios indicate a relatively moderate total mortaility in the stock (Fig. 3.2.3.3).

3.2.4 Mean weight at age

Mean weights at age in landings are computed on the basis of samples of otoliths and lengths along with length distributions and length-weight relationships. Weight at age in 2005 of the 1998-2000 year classes (age groups 5-7) was among the lowest on record (Figure 3.2.4.1 and Table 3.2.4.1). Weight at age in the landings is also used as weight at age in the stock, as done by ACFM in 2005.

Weight at age from the Icelandic ground fish survey (IGFS) show similar trends as catch weight at age (Figures 3.2.4.2 and 3.2.4.3, Tables 3.2.4.1 3.2.4.2). Year classes 1998-200 had low weight at their respective ages in 2006. Weight at age 5 of year class 2001 in the survey was close to the long term average. Persistently lower weight at age for year classses 1976, 1984 and 1992 supported estimating migration for those year classes in the TSA for the stock since 2000.

Prediction of mean weight at age in landings in 2005 made in May 2005 compared to observed weight at age (Fig. 3.2.4.1) shows that weights at age in 2005 were up to ~10% lower than those used in last years assessment. Survey weights at age in 2006 were also generally lower than predicted last year (used in the SPALY weight prediction).

Data on weight at age in landings and survey form the basis for SPALY weight prediction. Weight at age in catches/stock is predicted with weight at age one year younger, with survey weight at age as supporting information, as they are available from the IGFS at the time of assessment (NWWG2005 WD26). Summary of model fit diagnostics are given in Table 3.2.4.3 and for an alternative models where weight was modelled on log-scale and with a factor estimated for each year in Table 3.2.4.4. Negative residuals are apparent in the SPALY model, but as values predicted for weight at age in 2006 from the alternatives were similar the SPALY approach was adopted.

3.2.5 Maturity at age

As has been pointed out in earlier reports of this working group, the maturity at age data for saithe can be misleading due to the nature of the fishery and of the species, as well as inadequate sampling. Migration and density dependent growth or a combination of both have been hypothesized as explanations for drastic fluctuations in both mean weight at age and maturity. A GLM-model has been used to describe maturity at age as a function of age and year class strength based on maturity at age in landings (ICES NWWG 1993). Smoothed values based on maturity at age in samples from landings 1981-2003 were used by ACFM in

2005 and in this assessment (Table 3.2.5.1 and Figure 3.2.5.1). Further work on maturity is required, possibly combining maturity-at-age in samples from landings and surveys.

3.2.6 Migration of saithe

As previously estimated migrations (previous NWWG reports) have little effect on estimation of recent development of the stock, no migration was estimated in the final run (section 3.2.7, compare TSA including migration to 'camera' and XSA, without).

3.2.7 Stock Assessment

3.2.7.1 Tuning input

3.2.7.1.1 Survey

Survey indices for saithe around Iceland are variable but as they add independent information to data on catch-at-age in commerical catches they have been included in assessment of the stock since 2002. Both the IGFS in March and the Icelandic autumn survey show a wider geographical distribution of saithe around Iceland, more frequent occurence and a general increase in survey abundance of saithe from 1997-2005 (Figs. 3.2.7.1-2). A similar development is also apparent in the geographical distribution of the fishery (NWWG2005, Fig. 3.2.2.2). A stratified mean index of survey biomass (Figure 3.2.7.3) shows high fluctuations in 1985-1992 but has in recent years been more stable (Fig. 3.2.7.4). It shows an increase similar to that observed in CPUE indices shown in Figures 3.2.2.2. In the spring survey in recent years, some year classes (notably 2000 and 2002) show modal progression supporting the use of IGFS age disaggregated indices for tuning the asssessment (Fig. 3.2.7.6). Autumn survey length distributions (Fig. 3.2.7.7), do not show an obvious pattern indicating that further work on the treatment of extreme hauls is required. For this reason, and because the autumn time series is relatively short, this survey was not used explored as a tuning fleet.

In this assessment and the 2003-2005 assessments age disaggregated indices of numbers in the IGFS have been used for tuning. Correspondance between index at age for the same year class from one year to the next is noisy (Fig. 3.2.7.8), but residuals from simple linear fits notably show that most of the 2004-2006 observations of age groups 4-8 have positive residuals from a linear fit. This could indicate year effects in the survey but a reduction in effort is also a possible explanation (Fig. 3.2.7.9). A study in NWWG 2004 in showed that when only data from 1992 are studied the correspondance improves.

The stratified IGFS indices for saithe have been modified by setting the most extreme outlier (in 1986, see Fig. 3.2.7.3) equal to the second highest observation, in the same way as previously done. Extreme hauls of saithe on the IGFS are rare and it is disappointing to let that prevent us from using information that could be of help in assessment. Stratified IGFS index-at-age is given in Table 3.2.7.1 and shown in Figure 3.2.3.2 juxtaposed with landings in numbers at age. A general stucture is apparent in both landings at age and index at age which, with some exceptions, is common to the two matrices.

In TSA an index based on indices for age groups 3-5 were used as a recruitment index. In separable model 'camera' (SPALY assessment) and XSA, an age disaggregated index of numbers at age 2-8 from the IGFS was used. (Section 3.2.7.2).

3.2.7.2 Stock assessment

The assessment model 'camera', used by NWWG in 2004 and 2005, was run, with reference to XSA and TSA, all tuned to IGFS indices at age. The separable model 'camera' has been presented to WGMG (see 2002 & 2003 reports of that group).

'camera'

The 'camera' run presented as SPALY is run with identical settings as last year, with the exception of treating a zero observation in index at age 2 with adding a small number (0.01) to both predicted and observed values for age 2. Log residuals from SPALY 'camera' are given in table 3.2.7.4 and shown in Figure 3.2.7.11. The minor discrepancy in landings mentioned in Sections 3.2.1 and 3.2.3 was corrected in the total landings used as input to the model as there was no change in the model results (Fig. 3.2.7.12). The figure also shows results from an alternative run that eliminates the need to project into the assement year was also studied, using 1984-2005 catch at age and shifted IGFS indices. Predicted vs observed landings show a difference that has to be studied further (Fig. 3.2.7.13).

Strict, separable population dynamics (time-invariant commercial selectivity and survey catchability) were modelled with catch-at-age 3-14 in 1985-2005 and tuned to IGFS indices of numbers at age 2-8 in 1985-2006. Survey catchability model was assumed proportional for all ages, common for age groups 6-8, selectivity in catches was estimated for age groups 3-8, set equal to that of age group 8 for age groups 9-14. *Ad hoc* age group case weights in optimization, set *a priori* to the inverse of mean square age group residual from Sheperd-Nicolson models fit to landings at age and index at age were kept the same as in 2005 and 2004. As the 2006 survey index at age 2 was zero a small value was added to both observed and predicted indices at age 2 in the optimization. Estimated parameters from the model with reported AD-ModelBuilder estimates of standard deviations on log-scale are given in Table 3.2.7.5.

Modelled numbers at age *vs.* indices at age are shown in Figure 3.2.7.10 show that after the model has been run, a clearer correspondance than might be expected on the basis of year class index at age *vs.* index at age one year previously (Fig. 3.2.7.8).

Retrospective plots of R3, SSB, and F4-9 from 'camera' are shown in Figures 3.2.7.14. Inclusion of indices-at-age 2-3 in the separable models enables estimation of the incoming year classes

TSA

TSA was run by external expert Guðmundur Guðmundsson of the National Bank of Iceland. His comments on saithe (WD21):

M is fixed at 0.2 and the ratio between measurement errors of catch-at-age (log-scale) and irregular variations of $\log F_{at}$ in the best observed ages is fixed at 1 in the best observed ages.

The relationship between stock values and the March survey is very weak and the survey is only included by using the average index from each cohort at 3-5 years age as a recruitment index at 4 years. (Average of 3 and 4 years only in the last year). The time series analysis estimates no permanent changes of selectivity in catches of this stock.

As has been done in previous assessments, a migration was estimated as described in NWWG2001, 2002 2004 and 2005. A recruitment index for age group 4 based on IGFS indices of numbers at age 3-5 was used in the TSA . Results from the TSA are given in Table 3.2.7.2. Retrospective results SSB from TSA in comparison with that from 'camera' are shown in Figure 3.2.7.15. It should be noted that the TSA starts at age 4 and estimates migration.

XSA

XSA was also run on the Icelandic saithe with default settings and same catchability model as in 'camera'. Diagnostics and summary results are given in Table 3.2.7.3 and the resulting SSB shown in comparison with 'camera' in Figure 3.2.7.16

Comparison of model results and estimation of uncertainty

SSB from SPALY camera is in good agreement with results from 2005 and XSA (Fig.3.2.7.16).

Estimated N2005 and F4-9,2004 shows prediction made in 2004 and results from 'camera' (and a variant tuned with indices at age 1989-2005), XSA and TSA are shown in Figure 3.2.7.17 and terminal estimates in Figure3.2.7.14. Survivor estimates from TSA are slightly lower and terminal F4-9 higher than from the results of the separable model and XSA.

Models, with a range of different assumptions about stock population dynamics, used in the assessment show the same general trends. A bootstrap of the separable model ('camera'), with 1000 replicates was run. Survey residuals from the model fit were chosen at random in *ad hoc* manner: year blocks of survey log residuals were sampled at random, modelled survey indices multiplied by the bootstrap sample in each replicate. Catch residuals were sampled at random for each age group. A scatter the pairs of SSB *vs.* F4-9 is shown in Figure 3.2.7.17. This figure is shown here as an example only since treatment of residual between observed and predicted yield needs further work.

Bootstrap distributions of recruitment estimates, shown in Figure 3.2.7.18, indicate the relative uncertainty of year class estimation from the model.

Adopted assessment

The 'spaly' separable model 'camera' was used as 'final' run as it includes more information on incoming year classes, shows no retrospective pattern and is run by the stock expert. Fishingmortality, stock in numbers and a summary table from the adopted SPALY camera run are given in Tables 3.2.6-3.2.7.8.

3.2.7.3 Spawning stock and recruitment

The spawning stock biomass is shown in Figure 3.2.7.20 and given in Tables 3.2.7.8. Stock estimates prior to 1985 are taken from a long 'camera' run with the whole data series from 1962 tuned to the IGFS, results from the final run used for the recent period, as selectivity can not change in time in 'camera'. After a decline from 1970-1977, the spawning stock biomass averaged between 130-170 Kt in 1978-1989 and increased to about 180 Kt in 1990. Since 1992 the spawning stock biomass has declined to a minimum in 1996-2001 of 90-100Kt , which is the lowest SSB recorded. A gradual increase from 2000 has resulted in apawning stock biomass in the beginning of 2006 of ~220Kt.

The 1983-1985 year classes are all well above the 1962-1998 long-term average of 42 million 3 year old recruits. The 1984 and now the 2000 year classes are the highest on record at 95 and 100 million recruits, respectively. The year classes 1986-1997 are below the long term average. The average size of the 1986-1997 year classes is estimated at only 23 million recruits, close to the lower quartile of the historic series of recruitment. Recruitment has improved recently with the exception of year class 2001, year classes 1997-1999 are all estimated above 30 million 3 year old and the 2000 year class is estimated among the highest on record (Figure 3.2.7.19). The size of of the 2002 year class appears to be established as well above average. The scatter of SSB and recruitment is shown in figure 3.2.7.18.

3.2.8 Prediction of catch and biomass

3.2.8.1 Input data

Predicted catch in 2006 is ~81 KT corresponding to *status quo* F (Section 3.2.1). The input data for the catch projections is given in Table 3.2.8.1 based on SPALY predicted weight at age in stock and the fixed smooth ogive applied by ACFM in 2005 (2006-2008 values same as in 2004-2005).

For predictions of weight-at-age in survey in 2007-2008 a linear model with weight-at-age of the same year class in stock the previous year and year class strength was used for prediction for age groups 4-8. Predicted stock weight-at-age in 2007 was used to predict for 2008 and also as input in the predicton for weight at age in landings. Age group 3 weight were set at average weight at age in the IGFS (WD26 NWWG 2005. For predictions of weight at age in catches and stock in 2006-2008, weight-at-age 4-8 was predicted using survey weight at age (observed in 2006, predicted for 2007 and 2008) and weight at age in landings of the same year class in the previous year (observed in 2005, predicted for 2006 and 2007). Age group 3 and 9-14 weights were set at average weight at age in landings 2003-2005.

For short-term predictions, maturity at age was predicted by applying the old maturity smoother used by ACFM in 2005, using 2004-2005 values for 2006-2008 (Sec. 3.2.5) and weights as described in the previous paragraph. The selection pattern was that estimated in the final separable model run. Size of year classes 2002-2003 is set at point estimates from the adopted run. Size of the 2004 year class (4 year olds in 2008), which was not observed in the IGFS, was set equal to the lowest observed recruitment rounded to 10 million recruits. In the 2002-2005 assessements of the stock, estimates of numbers at age 3 from models tuned with IGFS indices have been used for guidance in decisions regarding the size of poorly determined year classes to use in predictions, with reasonable results (see QCS for saithe). Previously size of incoming year classes were set at *ad hoc* long or short term average recruitment (see QCS for saithe).

Short term prediction based on these inputs is given in Table 3.2.8.2 with SSB based on SPALY predicted weight at age in stock.

3.2.8.2 Biological reference points

The ACFM set B_{pa} at 150 Kt, B_{lim} tentatively at 90 Kt when SSB was calculated with catch-weight-at-age. With survey weights- and maturity-at-age, NWWG 2004 noted this corresponded to SSBs of ~100 and ~50 Kt, respectively. F_{pa} is set at 0.3, F_{lim} has not been set for this stock. The stock in 2004 and 2005 is assessed above the *ad hoc* B_{pa} and is estimated 218Kt in 2005. Some unsolved issues remain, treatment of maturity at age might be improved on, both with scrutiny of maturity data and further analysis of modelling/smoothing, the influence of migration on SSB has to be considered and SSB/R relationsships should be investigated further.

3.2.8.3 Medium term projections

No medium term projections were made for this update assessment.

3.2.9 Management considerations

The stock was overestimated until in the 1997 assessment but has been more stable in more recent assessments. It has recovered from the lowest observed stock size in 1997-2001 and is now assessed as likely to have reached Bpa in 2005 The reference F4-9 values have shown a gradual decrease and are estimated to have been close to Fpa in 2001-5. Recruitment in recent years has shown an increase (1998-2000 and 2002 year classes all above average).

It is advisable not to increase fishing mortality above F_{pa}.

3.2.10 Comments on the assessment

In 2002 the stock was assessmed with TSA, using IGFS survey indices for age groups 3-5 as a recruitment index. ADAPT bootstrap bias corrected numbers at age 3 were used in projections. In 2003 the stock was only assessed domestically, with a separable model 'camera' tuned with IGFS age-disaggregated indices. That procedure was a adopted by NWWG 2004 and the final run that year was an updated 'camera' run. The adopoted 2005 assessment was a SPALY of the one in 2004, with the exception of the use of survey weigth at age in the SSB by the NWWG.

ACFM opted for using weight at age in the landings as weight in stock and smoothed maturity at age based on samples from landings 1980-2003. Due to lack of maturity data the 2004 and later maturity is kept fixed at the values predicted for 2004 by NWWG 2004.

Migration was included in TSA but not estimated in separable models as the contribution of the most recent migrating year class (1992) is now negligible. Low weight at age of year classess 1998-2000 in both the Icelandic and the Faroe saithe might indicate migrations of NEA saithe to the stocks and should be studied in next assessment.

In this update assessment, a spaly ‘camera’ was used in the assessment. Apart from the usual updates with an additional year of data the only change to the pinputs was the correction of landings (Figure 3.2.1.1) which has a small weight in the optimisation in ‘camera’. One minor change had to be made to camera settings in order to allow for a zero observation in index-at-age 2.

In addition to ‘camera’ and TSA, an XSA was run, out of courtesy.

SPALY weight prediction procedure was used although some observed weight at some ages in 2005 landings was around 10% less than predicted in 2005 . An alternative weight predictions approach was studied but gave similar results for 2006 weight-at-age and was therefore not considered further. Results from short term prediction using observed weights at age in 2005 were similar to SPALY prediction (slightly more conservative) and would not have changed the advice.

Table 3.2.1.1. Nominal catch (tonnes) of SAITHE in Division Va by countries, 1997-2005, as officially reported to ICES with working group estimates when data are missing and bycatch estimates are included.

SAITHE Va

COUNTRY	1997	1998	1999	2000	2001	2002	2003*	2004	2005*
Faroe Islands	716	997	700	228**	128**	366**	143	214	322
Germany	-	3	2	1	14	6	56	157	224
Iceland	36,548	30,531	30,583	32,914	31,854	41,687	51,857	62614	
Norway	-	-	6	1	44*	3*	164	1	2
UK (E/W/NI)	-	-	1	2	23	7	...	105	
UK (Scotland)	-	-	1	-	-	2	...		
United Kingdom							35		312
Total	37,264	31,531	31,293				52091	63091	67283
Bycatch							403	1700	1000
WG estimate				33,146	32,063	42,071	52494	64791	69143

*Preliminary.
**WG estimate

Table 3.2.3.1. Saithe in division Va. Catch in numbers (thousands) 1962--2005.

	3	4	5	6	7	8	9	10	11	12	13	14
1962	1534	4999	3861	3744	1019	419	280	245	143	83	28	15
1963	6134	2314	2518	2902	1869	797	329	271	254	193	75	22
1964	3041	11712	3586	2301	1185	559	237	145	107	92	59	33
1965	2003	4825	7589	2158	1324	642	353	164	102	85	81	52
1966	940	2090	3283	4117	1285	739	390	235	133	69	102	73
1967	1116	3400	5591	4326	4931	1200	550	330	169	73	104	65
1968	836	2605	3563	6318	3207	3008	621	343	215	103	79	41
1969	1572	4395	5706	6518	9136	2796	1843	461	100	110	32	44
1970	287	5622	4999	6126	6178	5934	1689	1191	299	171	92	70
1971	476	3031	10221	6736	6694	5045	4272	959	887	349	96	63
1972	565	3786	6524	8646	4178	3320	2098	1421	361	328	79	68
1973	219	1768	5155	7077	7372	2616	1635	871	412	231	80	22
1974	1269	3404	2348	3164	3452	3384	1303	824	351	141	43	13
1975	526	2997	2479	1829	3496	2994	1434	710	325	176	100	36
1976	329	3234	3045	2530	2154	2367	1530	1064	295	191	94	68
1977	59	2099	2858	1801	1036	1068	1528	958	538	166	71	12
1978	548	1145	2435	1556	1275	961	537	575	476	279	139	91
1979	480	3764	1991	3616	1566	718	292	669	589	489	150	72
1980	275	2540	5214	2596	2169	1341	387	262	155	112	64	33
1981	203	1325	3503	5404	1457	1415	578	242	61	154	135	128
1982	508	1092	2804	4845	4293	1215	975	306	59	35	48	46
1983	107	1750	1065	2455	4454	2311	501	251	38	12	2	4
1984	53	657	800	1825	2184	3610	844	376	291	135	185	226
1985	376	4014	3366	1958	1536	1172	747	479	74	23	72	71
1986	3108	1400	4170	2665	1550	1116	628	1549	216	51	30	14
1987	956	5135	4428	5409	2915	1348	661	496	498	58	27	48
1988	1318	5067	6619	3678	2859	1775	845	226	270	107	24	1
1989	315	4313	8471	7309	1794	1928	848	270	191	135	76	10
1990	143	1692	5471	10112	6174	1816	1087	380	151	55	76	37
1991	198	874	3613	6844	10772	3223	858	838	228	40	6	5
1992	242	2928	3844	4355	3884	4046	1290	350	196	56	54	15
1993	657	1083	2841	2252	2247	2314	3671	830	223	188	81	12
1994	702	2955	1770	2603	1377	1243	1263	2009	454	158	188	82
1995	1573	1853	2661	1807	2370	905	574	482	521	106	35	13
1996	1102	2608	1868	1649	835	1233	385	267	210	232	141	74
1997	603	2960	2766	1651	1178	599	454	125	95	114	77	43
1998	183	1289	1767	1545	1114	658	351	265	120	81	85	85
1999	989	732	1564	2176	1934	669	324	140	72	25	28	22
2000	850	2383	896	1511	1612	1806	335	173	57	33	17	7
2001	1223	2619	2184	591	977	943	819	186	94	28	28	13
2002	1187	4190	3147	2970	519	820	570	309	101	27	15	11
2003	2284	4363	6031	2472	1942	285	438	289	196	28	29	15
2004	952	7841	7195	5363	1563	1057	211	224	157	74	39	11
2005	2607	3089	7333	6876	3592	978	642	119	149	89	46	12

* 2003-2005 including esitmated bycach from blue whiting fishery.

Table 3.2.4.1. Saithe in Division Va. Mean weight at age in the catches and in the spawning stock 1962-2005 with predicted weights for 2006-2008.

	3	4	5	6	7	8	9	10	11	12	13	14
1962	1.12	1.96	3.05	4.34	5.38	6.55	7.64	8.63	9.52	10.29	10.97	11.55
1963	1.12	1.96	3.05	4.34	5.38	6.55	7.64	8.63	9.52	10.29	10.97	11.55
1964	1.12	1.96	3.05	4.34	5.38	6.55	7.64	8.63	9.52	10.29	10.97	11.55
1965	1.12	1.96	3.05	4.34	5.38	6.55	7.64	8.63	9.52	10.29	10.97	11.55
1966	1.12	1.96	3.05	4.34	5.38	6.55	7.64	8.63	9.52	10.29	10.97	11.55
1967	1.12	1.96	3.05	4.34	5.38	6.55	7.64	8.63	9.52	10.29	10.97	11.55
1968	1.12	1.96	3.05	4.34	5.38	6.55	7.64	8.63	9.52	10.29	10.97	11.55
1969	1.12	1.96	3.05	4.34	5.38	6.55	7.64	8.63	9.52	10.29	10.97	11.55
1970	1.12	1.96	3.05	4.34	5.38	6.55	7.64	8.63	9.52	10.29	10.97	11.55
1971	1.12	1.96	3.05	4.34	5.38	6.55	7.64	8.63	9.52	10.29	10.97	11.55
1972	1.12	1.96	3.05	4.34	5.38	6.55	7.64	8.63	9.52	10.29	10.97	11.55
1973	1.12	1.96	3.05	4.34	5.38	6.55	7.64	8.63	9.52	10.29	10.97	11.55
1974	1.12	1.76	2.73	4.29	5.54	7.27	8.42	9.41	10	10.56	11.87	13.12
1975	1.12	1.76	2.73	4.29	5.54	7.27	8.42	9.41	10	10.56	11.87	13.12
1976	1.12	1.76	2.73	4.29	5.54	7.27	8.42	9.41	10	10.56	11.87	13.12
1977	1.12	1.76	2.73	4.29	5.54	7.27	8.42	9.41	10	10.56	11.87	13.12
1978	1.12	1.76	2.73	4.29	5.54	7.27	8.42	9.41	10	10.56	11.87	13.12
1979	1.116	1.76	2.731	4.294	5.539	7.268	8.415	9.41	10.001	10.563	11.873	13.115
1980	1.428	1.983	2.667	3.689	5.409	6.321	7.213	8.565	9.147	9.617	10.066	11.041
1981	1.585	2.037	2.696	3.525	4.541	6.247	6.991	8.202	9.537	9.089	9.351	10.225
1982	1.547	2.194	3.015	3.183	5.114	6.202	7.256	7.922	8.924	10.134	9.447	10.535
1983	1.53	2.221	3.171	4.27	4.107	5.984	7.565	8.673	8.801	9.039	11.138	9.818
1984	1.653	2.432	3.33	4.681	5.466	4.973	7.407	8.179	8.77	8.831	11.01	11.127
1985	1.609	2.172	3.169	3.922	4.697	6.411	6.492	8.346	9.401	10.335	11.027	10.644
1986	1.45	2.19	2.959	4.402	5.488	6.406	7.57	6.487	9.616	10.462	11.747	11.902
1987	1.516	1.715	2.67	3.839	5.081	6.185	7.33	8.025	7.974	9.615	12.246	11.656
1988	1.261	2.017	2.513	3.476	4.719	5.932	7.523	8.439	8.748	9.559	10.824	14.099
1989	1.403	2.021	2.194	3.047	4.505	5.889	7.172	8.852	10.17	10.392	12.522	11.923
1990	1.647	1.983	2.566	3.021	4.077	5.744	7.038	7.564	8.854	10.645	11.674	11.431
1991	1.224	1.939	2.432	3.16	3.634	4.967	6.629	7.704	9.061	9.117	10.922	11.342
1992	1.269	1.909	2.578	3.288	4.15	4.865	6.168	7.926	8.349	9.029	11.574	9.466
1993	1.381	2.143	2.742	3.636	4.398	5.421	5.319	7.006	8.07	10.048	9.106	11.591
1994	1.444	1.836	2.649	3.512	4.906	5.539	6.818	6.374	8.341	9.77	10.528	11.257
1995	1.37	1.977	2.769	3.722	4.621	5.854	6.416	7.356	6.815	8.312	9.119	11.91
1996	1.229	1.755	2.67	3.802	4.902	5.681	7.182	7.734	9.256	8.322	10.501	11.894
1997	1.325	1.936	2.409	3.906	5.032	6.171	7.202	7.883	8.856	9.649	9.621	10.877
1998	1.347	1.972	2.943	3.419	4.85	5.962	6.933	7.781	8.695	9.564	10.164	10.379
1999	1.279	2.106	2.752	3.497	3.831	5.819	7.072	8.078	8.865	10.55	10.823	11.3
2000	1.367	1.929	2.751	3.274	4.171	4.447	6.79	8.216	9.369	9.817	10.932	12.204
2001	1.28	1.882	2.599	3.697	4.42	5.538	5.639	7.985	9.059	9.942	10.632	10.988
2002	1.308	1.946	2.569	3.266	4.872	5.365	6.83	7.067	9.24	9.659	10.088	11.632
2003	1.31	1.908	2.545	3.336	4.069	5.792	7.156	8.131	8.051	10.186	10.948	11.78
2004	1.467	1.847	2.181	2.918	4.017	5.135	7.125	7.732	8.42	8.927	10.42	10.622
2005	1.287	1.888	2.307	2.619	3.516	5.08	6.06	8.052	8.292	8.342	8.567	10.256
2006	1.36	1.82	2.56	3.05	3.47	4.47	6.78	7.97	8.25	9.15	9.98	10.89
2007	1.36	1.91	2.39	3.40	3.93	4.58	6.78	7.97	8.25	9.15	9.98	10.89
2008	1.36	1.96	2.59	3.11	4.38	4.89	6.78	7.97	8.25	9.15	9.98	10.89

***Predicted for 2006-2008**

Table 3.2.4.2. Saithe in Division Va. Mean weight at age 3-8 in the IGFS 1985-2006, with prediction for 2007-8.

	AG3	AG4	AG5	AG6	AG7	AG8
1985	0.97	1.69	2.15	3.10	3.99	4.98
1986	0.85	1.42	2.27	3.29	4.66	5.81
1987	0.88	1.17	1.72	3.39	4.20	5.92
1988	0.78	1.44	2.01	2.77	4.26	5.13
1989	0.65	1.41	1.80	2.81	3.66	5.01
1990	0.75	1.27	2.14	2.61	4.37	5.87
1991	0.80	1.37	1.88	2.65	2.92	4.57
1992	0.89	1.40	2.02	2.97	3.77	4.21
1993	0.77	1.48	2.07	2.93	3.73	4.79
1994	0.85	1.61	2.77	3.39	4.72	6.20
1995	0.74	1.22	2.33	3.64	4.27	6.08
1996	0.90	1.33	1.97	2.74	5.25	5.09
1997	0.74	1.30	1.78	2.73	4.23	5.75
1998	0.84	1.16	1.80	2.53	3.93	5.37
1999	0.77	1.47	2.13	2.87	3.55	5.52
2000	0.82	1.35	2.23	2.71	3.61	3.87
2001	0.77	1.52	2.12	3.39	4.22	5.12
2002	0.74	1.27	2.20	3.37	4.59	5.38
2003	0.60	1.18	1.89	2.68	3.67	5.30
2004	0.84	1.26	1.88	2.81	4.24	5.65
2005	0.67	1.41	1.88	2.42	3.60	5.56
2006	0.64	1.17	2.05	2.56	3.14	4.10
2007	0.72	1.25	1.73	2.92	3.23	3.97
2008	0.68	1.44	2.08	2.56	4.13	4.42

*Predicted for 2007-8

Table 3.2.4.3. Saithe in Va. Diagnostics of SPALY weight prediction models for weight at age in stock based weight at age one year younger in landings and the same age in the survey, with year class strength from SPALY camera included in the survey weight model.

SPALY MODEL FOR CATCH/SSB WEIGHTS

```
Call:
lm(formula = way ~ waym1 + age + sw, data = cmodframe)

Residuals:
     Min       1Q   Median       3Q      Max
-0.39963 -0.14685 -0.01242  0.12254  0.54732

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  0.42790    0.17580   2.434   0.0168 *
waym1        0.80452    0.08263   9.737 5.47e-16 ***
age          0.00876    0.05874   0.149   0.8818
sw           0.27796    0.06092   4.563 1.49e-05 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.212 on 96 degrees of freedom
Multiple R-Squared: 0.9765,     Adjusted R-squared: 0.9758
F-statistic:  1332 on 3 and 96 DF,  p-value: < 2.2e-16
```

SPALY MODEL FOR SURVEY WEIGHTS

```
Call:
lm(formula = way ~ waym1 + age + rec, data = smodframe)

Residuals:
      Min        1Q    Median        3Q       Max
-0.991918 -0.207799 -0.002603  0.183408  1.210492

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept) -0.718687   0.299663  -2.398 0.018306 *
waym1        0.680263   0.105434   6.452 3.87e-09 ***
age          0.417552   0.088021   4.744 6.91e-06 ***
rec         -0.005307   0.001549  -3.425 0.000889 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.3425 on 101 degrees of freedom
Multiple R-Squared: 0.9468,     Adjusted R-squared: 0.9453
F-statistic: 599.6 on 3 and 101 DF,  p-value: < 2.2e-16
```

Table 3.2.4.4. Saithe in Va. Diagnostics of alternative weight prediction models for weight at age in stock based on weight at age one year younger in landings and the same age in the survey, with year class strength from SPALY camera included in the survey weight model.

ALTERNATIVE MODEL ON LOG SCALE WITH YEAR FACTOR FOR CATCH/SSB WEIGHTS

```
Call:
lm(formula = log(way) ~ log(waym1) + log(sw) + factor(year),
    data = cmodframe)

Residuals:
      Min        1Q    Median        3Q       Max
-0.140144 -0.029881 -0.001067  0.027484  0.094257

Coefficients:
                  Estimate Std. Error t value Pr(>|t|)
(Intercept)       0.470625   0.026710  17.620  < 2e-16 ***
log(waym1)        0.459521   0.072467   6.341 1.37e-08 ***
log(sw)           0.373352   0.062403   5.983 6.27e-08 ***
factor(year)1987 -0.089634   0.033286  -2.693 0.008669 **
factor(year)1988 -0.067421   0.032297  -2.088 0.040105 *
factor(year)1989 -0.085781   0.032322  -2.654 0.009638 **
factor(year)1990 -0.090544   0.033037  -2.741 0.007599 **
factor(year)1991 -0.114658   0.032651  -3.512 0.000744 ***
factor(year)1992 -0.063453   0.033030  -1.921 0.058378 .
factor(year)1993 -0.011488   0.032758  -0.351 0.726755
factor(year)1994 -0.144510   0.034393  -4.202 6.99e-05 ***
factor(year)1995 -0.066718   0.032979  -2.023 0.046495 *
factor(year)1996 -0.068041   0.032332  -2.104 0.038557 *
factor(year)1997 -0.008849   0.032347  -0.274 0.785154
factor(year)1998  0.007017   0.032611   0.215 0.830199
factor(year)1999 -0.080922   0.032301  -2.505 0.014319 *
factor(year)2000 -0.091876   0.032351  -2.840 0.005751 **
factor(year)2001 -0.082497   0.033272  -2.479 0.015315 *
factor(year)2002 -0.090970   0.033097  -2.749 0.007432 **
factor(year)2003 -0.063704   0.032364  -1.968 0.052584 .
factor(year)2004 -0.160798   0.032718  -4.915 4.81e-06 ***
factor(year)2005 -0.159160   0.032825  -4.849 6.22e-06 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.05104 on 78 degrees of freedom
Multiple R-Squared: 0.9864,     Adjusted R-squared: 0.9827
F-statistic: 269.4 on 21 and 78 DF,  p-value: < 2.2e-16
```

ALTERNATIVE MODEL ON LOG SCALE WITH YEAR FACTOR FOR SURVEY WEIGHTS

```
> summary(sfit3)

Call:
lm(formula = log(way) ~ log(waym1) + rec + factor(year), data = smodframe)

Residuals:
      Min        1Q    Median        3Q       Max
-0.171098 -0.053852  0.004709  0.048334  0.179229

Coefficients:
                   Estimate Std. Error t value Pr(>|t|)
(Intercept)       0.5409574  0.0394588  13.709  < 2e-16 ***
log(waym1)        0.8281848  0.0134257  61.686  < 2e-16 ***
rec              -0.0011502  0.0004448  -2.586  0.01149 *
factor(year)1987 -0.0881191  0.0496750  -1.774  0.07979 .
factor(year)1988  0.0206395  0.0505753   0.408  0.68427
factor(year)1989 -0.0449131  0.0509543  -0.881  0.38066
factor(year)1990  0.0951064  0.0507417   1.874  0.06445 .
factor(year)1991 -0.0980857  0.0504940  -1.943  0.05551 .
factor(year)1992  0.0320995  0.0500071   0.642  0.52273
factor(year)1993 -0.0440721  0.0495150  -0.890  0.37603
factor(year)1994  0.1666929  0.0496166   3.360  0.00119 **
factor(year)1995 -0.0783819  0.0496601  -1.578  0.11833
factor(year)1996 -0.0420226  0.0496086  -0.847  0.39941
```

```
factor(year)1997 -0.0910523  0.0496370  -1.834  0.07023 .
factor(year)1998 -0.0679477  0.0496834  -1.368  0.17517
factor(year)1999  0.0429434  0.0497834   0.863  0.39087
factor(year)2000 -0.0985754  0.0496592  -1.985  0.05048 .
factor(year)2001  0.0489279  0.0496858   0.985  0.32765
factor(year)2002 -0.0129602  0.0495303  -0.262  0.79424
factor(year)2003 -0.1202843  0.0495844  -2.426  0.01747 *
factor(year)2004  0.1084009  0.0506845   2.139  0.03543 *
factor(year)2005 -0.0323918  0.0506756  -0.639  0.52447
factor(year)2006 -0.0481615  0.0517652  -0.930  0.35490
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.07827 on 82 degrees of freedom
Multiple R-Squared: 0.9806,     Adjusted R-squared: 0.9753
F-statistic:   188 on 22 and 82 DF,  p-value: < 2.2e-16
```

Table 3.2.5.1. Saithe in Division Va. Smoohthed sexual maturity at age, based on samples from landings.

	3	4	5	6	7	8	9	10	11	12	13	14
1962	0	0.06	0.27	0.63	0.81	0.97	1	1	1	1	1	1
1963	0	0.06	0.27	0.63	0.81	0.97	1	1	1	1	1	1
1964	0	0.06	0.27	0.63	0.81	0.97	1	1	1	1	1	1
1965	0	0.06	0.27	0.63	0.81	0.97	1	1	1	1	1	1
1966	0	0.06	0.27	0.63	0.81	0.97	1	1	1	1	1	1
1967	0	0.06	0.27	0.63	0.81	0.97	1	1	1	1	1	1
1968	0	0.06	0.27	0.63	0.81	0.97	1	1	1	1	1	1
1969	0	0.06	0.27	0.63	0.81	0.97	1	1	1	1	1	1
1970	0	0.06	0.27	0.63	0.81	0.97	1	1	1	1	1	1
1971	0	0.06	0.27	0.63	0.81	0.97	1	1	1	1	1	1
1972	0	0.06	0.27	0.63	0.81	0.97	1	1	1	1	1	1
1973	0	0.06	0.27	0.63	0.81	0.97	1	1	1	1	1	1
1974	0	0.06	0.27	0.63	0.81	0.97	1	1	1	1	1	1
1975	0	0.06	0.27	0.63	0.81	0.97	1	1	1	1	1	1
1976	0	0.06	0.27	0.63	0.81	0.97	1	1	1	1	1	1
1977	0	0.06	0.27	0.63	0.81	0.97	1	1	1	1	1	1
1978	0	0.06	0.27	0.63	0.81	0.97	1	1	1	1	1	1
1979	0	0.06	0.27	0.63	0.81	0.97	1	1	1	1	1	1
1980	0.15	0.24	0.39	0.65	0.78	0.89	0.95	1	1	1	1	1
1981	0.16	0.27	0.4	0.58	0.8	0.89	0.95	1	1	1	1	1
1982	0.16	0.29	0.45	0.59	0.74	0.9	0.94	1	1	1	1	1
1983	0.14	0.31	0.51	0.64	0.74	0.85	0.96	1	1	1	1	1
1984	0.11	0.26	0.49	0.69	0.8	0.86	0.92	1	1	1	1	1
1985	0.14	0.2	0.43	0.68	0.83	0.9	0.93	1	1	1	1	1
1986	0.08	0.26	0.36	0.63	0.82	0.91	0.95	1	1	1	1	1
1987	0.04	0.15	0.43	0.55	0.78	0.91	0.96	1	1	1	1	1
1988	0.1	0.09	0.28	0.62	0.72	0.89	0.96	1	1	1	1	1
1989	0.14	0.2	0.17	0.46	0.78	0.85	0.94	1	1	1	1	1
1990	0.17	0.27	0.35	0.31	0.65	0.89	0.93	1	1	1	1	1
1991	0.14	0.31	0.44	0.54	0.5	0.8	0.94	1	1	1	1	1
1992	0.19	0.27	0.5	0.63	0.72	0.68	0.9	1	1	1	1	1
1993	0.18	0.34	0.44	0.68	0.79	0.85	0.82	1	1	1	1	1
1994	0.19	0.33	0.53	0.63	0.82	0.89	0.92	1	1	1	1	1
1995	0.14	0.33	0.51	0.71	0.79	0.91	0.95	1	1	1	1	1
1996	0.16	0.27	0.52	0.7	0.84	0.89	0.96	1	1	1	1	1
1997	0.19	0.3	0.44	0.7	0.83	0.92	0.95	1	1	1	1	1
1998	0.22	0.34	0.48	0.63	0.84	0.92	0.96	1	1	1	1	1
1999	0.16	0.38	0.52	0.66	0.79	0.92	0.96	1	1	1	1	1
2000	0.15	0.29	0.57	0.71	0.81	0.89	0.96	1	1	1	1	1
2001	0.13	0.27	0.47	0.74	0.84	0.9	0.95	1	1	1	1	1
2002	0.11	0.24	0.45	0.66	0.86	0.92	0.95	1	1	1	1	1
2003	0.04	0.2	0.41	0.64	0.81	0.93	0.96	1	1	1	1	1
2004	0.075	0.22	0.43	0.65	0.835	0.925	0.955	1	1	1	1	1
2005	0.075	0.22	0.43	0.65	0.835	0.925	0.955	1	1	1	1	1
2006	0.075	0.22	0.43	0.65	0.835	0.925	0.955	1	1	1	1	1
2007	0.075	0.22	0.43	0.65	0.835	0.925	0.955	1	1	1	1	1
2008	0.075	0.22	0.43	0.65	0.835	0.925	0.955	1	1	1	1	1

Table 3.2.7.1. Saithe in Division Va. IGFS indices of numbers at age used for tuning in separable models, TSA and XSA.

	2	3	4	5	6	7	8
1985	0.61	0.58	3.06	5.18	1.73	1.03	0.47
1986	2.33	2.44	2.10	2.10	1.41	0.60	0.26
1987	0.39	11.54	12.94	6.31	3.71	2.89	0.74
1988	0.31	0.48	2.69	2.72	1.62	0.88	0.35
1989	1.43	3.96	4.98	6.46	2.42	1.74	0.89
1990	0.35	1.69	4.83	6.20	11.95	3.17	1.13
1991	0.22	1.40	1.69	2.15	1.08	2.38	0.28
1992	0.14	0.89	5.68	5.45	2.76	2.62	1.86
1993	1.27	11.04	2.00	6.79	2.40	2.24	1.02
1994	0.82	0.73	1.89	1.73	1.94	0.52	0.83
1995	0.48	1.97	1.09	0.50	0.28	0.33	0.09
1996	0.13	0.51	3.71	1.11	0.99	0.57	0.94
1997	0.32	0.90	4.66	3.90	0.94	0.39	0.15
1998	0.11	1.64	2.30	2.50	1.23	0.69	0.29
1999	0.75	3.70	0.92	1.23	1.64	0.56	0.16
2000	0.38	2.01	2.51	0.60	0.84	0.52	0.44
2001	0.89	1.90	2.60	1.58	0.20	0.22	0.38
2002	1.05	2.22	2.93	3.04	2.14	0.41	0.46
2003	0.05	9.60	4.99	2.90	1.34	0.75	0.20
2004	0.91	1.38	8.98	5.80	4.19	1.44	0.80
2005	0.23	4.32	2.32	6.85	4.27	2.17	0.85
2006	0.00	2.18	6.62	1.92	8.58	3.37	1.16

Table 3.2.7.2. Saithe in Division Va. Output from TSA run with average IGFS index for year classes as 3, 4, and 5 year olds (3-4 for year class 2002 in 2006) as a index of recruitment as 4 year olds.

Icelandic saithe

Estimated with catch-at-age 4-11 years
Average survey indices from 3-5 years age are used as a recruitment index for respective cohort.

STOCK

	4	5	6	7	8	9	10	11	BIOM
1985	37280.	20620.	9827.	5637.	3812.	4639.	1436.	290.	264.9
1986	28022.	26939.	13942.	6345.	3307.	2119.	3669.	810.	303.5
1987	57988.	21471.	18345.	8820.	3721.	1775.	1130.	1893.	332.2
1988	58396.	42586.	13368.	10298.	4605.	1850.	853.	552.	371.3
1989	46274.	43257.	28655.	7814.	5594.	2226.	846.	421.	368.6
1990	25506.	33877.	27989.	17122.	4477.	2882.	1088.	418.	353.5
1991	18536.	19103.	22383.	17494.	8448.	2094.	1354.	510.	287.5
1992	22681.	13915.	12304.	11860.	5636.	3759.	917.	550.	231.4
1993	12222.	15865.	7611.	6342.	5872.	9074.	1774.	427.	221.1
1994	15789.	8951.	10200.	4154.	3101.	2736.	4085.	792.	177.4
1995	14521.	10306.	5723.	5906.	2120.	1397.	1153.	1701.	147.3
1996	10286.	9957.	6202.	3087.	2818.	950.	631.	525.	116.0
1997	20077.	6121.	6446.	3633.	1692.	1312.	437.	292.	123.1
1998	13408.	13538.	3040.	3737.	1932.	855.	657.	220.	119.2
1999	6215.	9812.	9126.	4649.	1985.	962.	400.	302.	114.1
2000	21571.	4466.	6575.	5434.	4713.	1015.	492.	204.	131.9
2001	20462.	15496.	2887.	3966.	2982.	2350.	518.	252.	143.2
2002	41569.	14399.	10542.	1797.	2303.	1600.	1194.	266.	195.5
2003	49650.	30125.	9014.	6138.	985.	1191.	815.	622.	252.6
2004	59878.	36635.	19375.	5254.	3326.	524.	604.	411.	297.3
2005	25704.	41967.	23495.	11265.	2839.	1707.	256.	297.	276.0
2006	42385.	18240.	27374.	13484.	5949.	1415.	818.	120.	287.8

STANDARD DEVIATION OF STOCK ESTIMATES

2005	5058.	5904.	2627.	1320.	371.	205.	33.	41.	27.0
2006	9545.	4323.	4681.	2082.	1048.	287.	163.	24.	33.1

Migration
(1000 fish, standard deviation in parentheses)

10 years	1986	2400	(500)
7 years	1991	7600	(2600)
9 years	1993	3300	(1000)
7 years	1999	2500	(1100)
8 years	2000	1100	(700)

Icelandic saithe

Fishing mortality rates

	4	5	6	7	8	9	10	11	FBAR
1985	0.122	0.191	0.236	0.334	0.388	0.047	0.377	0.328	0.220
1986	0.062	0.184	0.256	0.330	0.422	0.428	0.462	0.438	0.281
1987	0.106	0.274	0.372	0.450	0.498	0.533	0.516	0.492	0.372
1988	0.099	0.193	0.336	0.409	0.524	0.578	0.506	0.521	0.356
1989	0.107	0.235	0.312	0.352	0.463	0.516	0.505	0.515	0.331
1990	0.088	0.208	0.414	0.506	0.560	0.555	0.557	0.566	0.389
1991	0.083	0.238	0.437	0.784	0.609	0.625	0.691	0.675	0.463
1992	0.150	0.392	0.459	0.504	0.795	0.550	0.563	0.604	0.475
1993	0.111	0.238	0.389	0.499	0.558	0.593	0.599	0.604	0.398
1994	0.176	0.246	0.344	0.455	0.565	0.634	0.646	0.619	0.403
1995	0.173	0.272	0.406	0.526	0.579	0.571	0.565	0.553	0.421
1996	0.213	0.233	0.331	0.401	0.551	0.564	0.558	0.548	0.382
1997	0.187	0.351	0.345	0.431	0.479	0.491	0.482	0.502	0.381
1998	0.112	0.195	0.407	0.432	0.494	0.554	0.563	0.554	0.366
1999	0.126	0.200	0.319	0.483	0.471	0.471	0.475	0.471	0.345
2000	0.130	0.236	0.303	0.399	0.496	0.472	0.467	0.463	0.339
2001	0.148	0.182	0.271	0.336	0.420	0.477	0.466	0.461	0.306
2002	0.119	0.264	0.341	0.400	0.456	0.473	0.452	0.471	0.342
2003	0.098	0.240	0.340	0.412	0.421	0.472	0.480	0.479	0.330
2004	0.155	0.241	0.342	0.415	0.465	0.511	0.506	0.510	0.355
2005	0.143	0.227	0.355	0.438	0.496	0.535	0.554	0.550	0.366

STANDARD DEVIATIONS OF LOG(F)

2005	0.31	0.15	0.14	0.15	0.16	0.16	0.16	0.16	0.133

Table 3.2.7.3. Saithe in Division Va. Output from XSA run with default setttings tuned to March IGFS 1985-2006 indices for age groups 2-8, shifted by one age group to the end of the year prior to each survey.

```
 Lowestoft VPA Version 3.1

   25/04/2006  10:21

 Extended Survivors Analysis

 Ufsi - Saithe in Va

 CPUE data from file smb.dat

 Catch data for  22 years. 1984 to 2005. Ages  1 to  14.

      Fleet,            First, Last, First, Last, Alpha,  Beta
                    ,    year, year,  age ,  age
 SMB                 ,   1984, 2005,   1,     7,  0.990,  1.000


 Time series weights :

      Tapered time weighting applied
      Power =    3 over  20 years


 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 =   0.500

      Minimum standard error for population
      estimates derived from each fleet =   0.300

      Prior weighting not applied


 Tuning converged after   25 iterations

1


 Regression weights
       , 0.751, 0.820, 0.877, 0.921, 0.954, 0.976, 0.990, 0.997, 1.000, 1.000



 Fishing mortalities
    Age,  1996,  1997,  1998,  1999,  2000,  2001,  2002,  2003,  2004,  2005

      1, 0.000, 0.000, 0.000, 0.000, 0.000, 0.000, 0.000, 0.000, 0.000, 0.000
      2, 0.000, 0.000, 0.000, 0.000, 0.000, 0.000, 0.000, 0.000, 0.000, 0.000
      3, 0.048, 0.038, 0.024, 0.039, 0.032, 0.025, 0.019, 0.026, 0.042, 0.037
      4, 0.133, 0.177, 0.108, 0.128, 0.123, 0.129, 0.112, 0.090, 0.117, 0.186
      5, 0.236, 0.203, 0.152, 0.185, 0.229, 0.159, 0.226, 0.234, 0.211, 0.153
      6, 0.344, 0.339, 0.167, 0.284, 0.274, 0.232, 0.337, 0.279, 0.338, 0.321
      7, 0.358, 0.444, 0.405, 0.325, 0.353, 0.286, 0.328, 0.386, 0.286, 0.398
      8, 0.649, 0.474, 0.480, 0.456, 0.576, 0.360, 0.414, 0.302, 0.376, 0.292
      9, 0.564, 0.529, 0.569, 0.462, 0.437, 0.564, 0.385, 0.408, 0.384, 0.414
     10, 0.584, 0.357, 0.688, 0.467, 0.483, 0.464, 0.429, 0.344, 0.377, 0.390
     11, 0.447, 0.423, 0.699, 0.398, 0.351, 0.532, 0.497, 0.537, 0.318, 0.466
     12, 0.517, 0.468, 0.795, 0.298, 0.320, 0.291, 0.283, 0.246, 0.397, 0.301
     13, 0.657, 0.321, 0.784, 0.718, 0.340, 0.495, 0.250, 0.560, 0.642, 0.463
     14, 0.557, 0.424, 0.714, 0.472, 0.387, 0.475, 0.367, 0.426, 0.428, 0.413



    1
XSA population numbers (Thousands)

                               AGE
YEAR ,           1,         2,         3,         4,         5,         6,         7,         8,         9,        10,

1996 ,    1.26E+04, 2.16E+04, 2.58E+04, 2.32E+04, 9.81E+03, 6.26E+03, 3.07E+03, 2.85E+03, 9.87E+02, 6.67E+02,
1997 ,    4.30E+04, 1.03E+04, 1.77E+04, 2.02E+04, 1.66E+04, 6.34E+03, 3.63E+03, 1.75E+03, 1.22E+03, 4.60E+02,
1998 ,    4.49E+04, 3.52E+04, 8.42E+03, 1.39E+04, 1.38E+04, 1.11E+04, 3.70E+03, 1.91E+03, 8.94E+02, 5.89E+02,
1999 ,    8.15E+04, 3.67E+04, 2.88E+04, 6.73E+03, 1.02E+04, 9.72E+03, 7.71E+03, 2.02E+03, 9.67E+02, 4.14E+02,
2000 ,    1.04E+05, 6.67E+04, 3.01E+04, 2.27E+04, 4.84E+03, 6.98E+03, 5.99E+03, 4.56E+03, 1.05E+03, 4.99E+02,
2001 ,    1.47E+05, 8.48E+04, 5.46E+04, 2.39E+04, 1.64E+04, 3.16E+03, 4.34E+03, 3.45E+03, 2.10E+03, 5.54E+02,
2002 ,    3.83E+04, 1.20E+05, 6.94E+04, 4.36E+04, 1.72E+04, 1.15E+04, 2.05E+03, 2.67E+03, 1.97E+03, 9.78E+02,
2003 ,    1.18E+05, 3.13E+04, 9.83E+04, 5.58E+04, 3.19E+04, 1.12E+04, 6.70E+03, 1.21E+03, 1.45E+03, 1.10E+03,
2004 ,    4.18E+04, 9.62E+04, 2.57E+04, 7.84E+04, 4.17E+04, 2.07E+04, 6.94E+03, 3.73E+03, 7.31E+02, 7.88E+02,
2005 ,    1.39E+03, 3.42E+04, 7.88E+04, 2.02E+04, 5.71E+04, 2.77E+04, 1.21E+04, 4.27E+03, 2.09E+03, 4.08E+02,

Estimated population abundance at 1st Jan 2006

   ,     0.00E+00, 1.14E+03, 2.80E+04, 6.22E+04, 1.37E+04, 4.01E+04, 1.64E+04, 6.64E+03, 2.61E+03, 1.13E+03,
```

Table 3.2.7.3 (cont'd)

Taper weighted geometric mean of the VPA populations:

, 3.76E+04, 4.02E+04, 3.25E+04, 2.34E+04, 1.70E+04, 1.01E+04, 5.67E+03, 3.04E+03, 1.57E+03, 7.93E+02,

Standard error of the weighted Log(VPA populations) :

, 1.2275, 0.6838, 0.7037, 0.6696, 0.7018, 0.6328, 0.5858, 0.5668, 0.5991, 0.6206,

	AGE			
YEAR ,	11,	12,	13,	14,
1996 ,	6.44E+02,	6.35E+02,	3.24E+02,	1.91E+02,
1997 ,	3.04E+02,	3.37E+02,	3.10E+02,	1.37E+02,
1998 ,	2.64E+02,	1.63E+02,	1.73E+02,	1.84E+02,
1999 ,	2.42E+02,	1.07E+02,	6.04E+01,	6.46E+01,
2000 ,	2.13E+02,	1.33E+02,	6.52E+01,	2.41E+01,
2001 ,	2.52E+02,	1.23E+02,	7.93E+01,	3.80E+01,
2002 ,	2.85E+02,	1.21E+02,	7.50E+01,	3.96E+01,
2003 ,	5.21E+02,	1.42E+02,	7.47E+01,	4.78E+01,
2004 ,	6.36E+02,	2.49E+02,	9.10E+01,	3.49E+01,
2005 ,	4.42E+02,	3.79E+02,	1.37E+02,	3.92E+01,

Estimated population abundance at 1st Jan 2006

, 2.26E+02, 2.27E+02, 2.30E+02, 7.07E+01,

Taper weighted geometric mean of the VPA populations:

, 4.36E+02, 2.28E+02, 1.23E+02, 5.57E+01,

Standard error of the weighted Log(VPA populations) :

, 0.5854, 0.6332, 0.6333, 0.7502,

Log catchability residuals.

Fleet : SMB

Age ,	1984,	1985
1 ,	99.99,	99.99
2 ,	99.99,	99.99
3 ,	99.99,	99.99
4 ,	99.99,	99.99
5 ,	99.99,	99.99
6 ,	99.99,	99.99
7 ,	99.99,	99.99

Age ,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995
1 ,	-0.44,	-0.09,	1.82,	0.16,	0.30,	-0.45,	1.89,	0.93,	0.55,	-0.38
2 ,	0.48,	-2.04,	0.66,	0.19,	-0.25,	-0.10,	2.11,	-0.47,	0.01,	-1.19
3 ,	0.62,	-1.37,	-0.07,	0.47,	-0.21,	0.75,	0.33,	-0.02,	-0.42,	0.30
4 ,	0.72,	-0.78,	-0.37,	0.32,	-0.20,	1.08,	1.15,	0.35,	-1.06,	-0.19
5 ,	0.30,	-0.22,	-0.53,	0.57,	-1.05,	0.45,	0.81,	0.29,	-1.06,	0.12
6 ,	0.85,	-0.51,	0.45,	0.33,	-0.52,	0.52,	0.99,	-0.06,	-0.88,	0.35
7 ,	0.41,	-0.65,	0.04,	0.48,	-1.41,	-0.07,	0.22,	0.70,	-1.17,	0.92

Age ,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	2005
1 ,	1.26,	-1.03,	0.84,	-0.43,	0.18,	-0.01,	-1.71,	0.07,	-0.27,	0.00
2 ,	-0.25,	1.10,	0.68,	0.03,	-0.63,	-0.71,	0.41,	-0.19,	-0.17,	0.18
3 ,	0.67,	0.33,	0.14,	-0.07,	-0.09,	-0.57,	-0.28,	-0.04,	-0.03,	-0.11
4 ,	0.54,	0.28,	-0.13,	-0.10,	-0.35,	0.26,	-0.41,	0.02,	-0.13,	0.03
5 ,	0.06,	-0.24,	0.19,	-0.15,	-0.79,	0.29,	-0.16,	0.37,	0.10,	0.42
6 ,	-0.20,	0.35,	-0.59,	-0.41,	-0.95,	0.42,	-0.16,	0.46,	0.32,	0.45
7 ,	-0.43,	0.15,	-0.50,	-0.31,	-0.17,	0.27,	0.23,	0.49,	0.42,	0.29

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
Mean Log q,	-11.6426,	-9.6418,	-9.0395,	-8.9008,	-8.8751,	-8.9433,	-8.9433,
S.E(Log q),	0.8597,	0.7021,	0.3427,	0.4539,	0.4657,	0.5410,	0.5336,

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,	1.08,	-0.337,	11.73,	0.64,	20,	0.97,	-11.64,
2,	1.51,	-1.112,	9.15,	0.32,	20,	1.05,	-9.64,
3,	1.24,	-1.399,	8.71,	0.76,	20,	0.41,	-9.04,
4,	1.04,	-0.182,	8.85,	0.67,	20,	0.49,	-8.90,
5,	0.73,	2.111,	9.11,	0.86,	20,	0.30,	-8.88,
6,	0.92,	0.345,	8.97,	0.62,	20,	0.52,	-8.94,
7,	0.92,	0.313,	8.86,	0.59,	20,	0.51,	-8.88,

Table 3.2.7.3 (cont'd)

```
 Terminal year survivor and F summaries :

 Age  1   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
 SMB                ,       1137.,  0.895,      0.000,   0.00,   1, 1.000,    0.000

   F shrinkage mean  ,         0.,   0.50,,,,                       0.000,    0.000

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      1137.,      0.89,     0.00,    1,   0.000,  0.000


1
 Age  2   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
 SMB                ,      28024.,  0.566,      0.220,   0.39,   2, 1.000,    0.000

   F shrinkage mean  ,         0.,   0.50,,,,                       0.000,    0.000

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
     28024.,      0.57,     0.22,    2,   0.388,  0.000


 Age  3   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
 SMB                ,      56303.,  0.302,      0.046,   0.15,   3, 0.726,    0.041

   F shrinkage mean  ,     80724.,   0.50,,,,                       0.274,    0.029

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
     62152.,      0.26,     0.11,    4,   0.440,  0.037


1
 Age  4   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
 SMB                ,      11612.,  0.254,      0.263,   1.03,   4, 0.757,    0.216

   F shrinkage mean  ,     22960.,   0.50,,,,                       0.243,    0.115

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
     13704.,      0.23,     0.26,    5,   1.142,  0.186


 Age  5   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
 SMB                ,      44134.,  0.226,      0.115,   0.51,   5, 0.792,    0.140

   F shrinkage mean  ,     27961.,   0.50,,,,                       0.208,    0.213

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
     40129.,      0.21,     0.13,    6,   0.632,  0.153

 Age  6   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
 SMB                ,      15893.,  0.211,      0.143,   0.67,   6, 0.763,    0.330
```

Table 3.2.7.3 (cont'd)

```
  F shrinkage mean  ,     18228.,   0.50,,,,                       0.237,    0.294

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
     16418.,      0.20,     0.12,    7,   0.584,  0.321


 Age  7   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
 SMB                 ,      6089.,  0.205,      0.173,   0.84,   7, 0.720,    0.428

  F shrinkage mean  ,      8315.,   0.50,,,,                       0.280,    0.330

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      6643.,      0.20,     0.15,    8,   0.735,  0.398


1
 Age  8   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
 SMB                 ,      3118.,  0.206,      0.114,   0.55,   7, 0.689,    0.250

  F shrinkage mean  ,      1754.,   0.50,,,,                       0.311,    0.408

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      2607.,      0.21,     0.15,    8,   0.710,  0.292


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

 Year class = 1996

 Fleet,                Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SMB                 ,      1205.,  0.208,      0.156,   0.75,   7, 0.543,    0.393

  F shrinkage mean  ,      1055.,   0.50,,,,                       0.457,    0.439

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      1134.,      0.25,     0.11,    8,   0.439,  0.414

1
 Age 10   Catchability constant w.r.t. time and age (fixed at the value for age)  6

 Year class = 1995

 Fleet,                Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SMB                 ,       251.,  0.211,      0.206,   0.98,   7, 0.489,    0.357

  F shrinkage mean  ,       205.,   0.50,,,,                       0.511,    0.423

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
       226.,      0.28,     0.14,    8,   0.524,  0.390


 Age 11   Catchability constant w.r.t. time and age (fixed at the value for age)  6

 Year class = 1994

 Fleet,                Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SMB                 ,       210.,  0.216,      0.177,   0.82,   7, 0.347,    0.496

  F shrinkage mean  ,       237.,   0.50,,,,                       0.653,    0.450

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
       227.,      0.34,     0.10,    8,   0.308,  0.466
```

Table 3.2.7.3 (cont'd)

```
 Age 12   Catchability constant w.r.t. time and age (fixed at the value for age)  6

 Year class = 1993

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SMB                 ,       248.,  0.224,      0.191,   0.85,   7, 0.304,    0.282

   F shrinkage mean  ,       222.,   0.50,,,,                     0.696,    0.309

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
       230.,      0.35,     0.10,    8,   0.291,  0.301


 Age 13   Catchability constant w.r.t. time and age (fixed at the value for age)  6

 Year class = 1992

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SMB                 ,        68.,  0.232,      0.169,   0.73,   7, 0.113,    0.478

   F shrinkage mean  ,        71.,   0.50,,,,                     0.887,    0.461

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
        71.,      0.44,     0.06,    8,   0.124,  0.463


1
 Age 14   Catchability constant w.r.t. time and age (fixed at the value for age)  6

 Year class = 1991

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SMB                 ,        18.,  0.250,      0.177,   0.71,   7, 0.070,    0.467

   F shrinkage mean  ,        21.,   0.50,,,,                     0.930,    0.409

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
        21.,      0.47,     0.07,    8,   0.158,  0.413


    Run title : Ufsi - Saithe in Va

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                   Terminal Fs derived using XSA (With F shrinkage)

       Table  8    Fishing mortality (F) at age
       YEAR,       1984,    1985,

       AGE
         1,       0.0000,  0.0000,
         2,       0.0000,  0.0000,
         3,       0.0012,  0.0116,
         4,       0.0274,  0.1198,
         5,       0.0708,  0.1907,
         6,       0.2582,  0.2477,
         7,       0.3916,  0.3608,
         8,       0.5593,  0.3771,
         9,       0.5600,  0.2100,
        10,       0.9944,  0.7347,
        11,       0.8692,  0.5266,
        12,       0.7095,  0.1435,
        13,       0.6438,  1.1173,
        14,       0.7629,  0.5510,
0  FBAR  4- 9,    0.3112,  0.2510,
```

Table 3.2.7.3 (cont'd)

Table 8 Fishing mortality (F) at age

YEAR,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,
AGE										
1,	0.0000,	0.0000,	0.0000,	0.0000,	0.0000,	0.0000,	0.0000,	0.0000,	0.0000,	0.0000,
2,	0.0000,	0.0000,	0.0000,	0.0000,	0.0000,	0.0000,	0.0000,	0.0000,	0.0000,	0.0000,
3,	0.0469,	0.0096,	0.0261,	0.0111,	0.0073,	0.0079,	0.0179,	0.0360,	0.0443,	0.0595,
4,	0.0547,	0.1020,	0.0648,	0.1116,	0.0763,	0.0566,	0.1554,	0.1037,	0.2252,	0.1578,
5,	0.1761,	0.2451,	0.1852,	0.1470,	0.2021,	0.2317,	0.3752,	0.2222,	0.2461,	0.3254,
6,	0.2271,	0.3639,	0.3310,	0.3209,	0.2626,	0.4189,	0.4844,	0.3942,	0.3263,	0.4275,
7,	0.3172,	0.4164,	0.3332,	0.2663,	0.4948,	0.4954,	0.4473,	0.4988,	0.4477,	0.5604,
8,	0.4870,	0.5050,	0.4847,	0.3941,	0.4735,	0.5245,	0.3484,	0.5285,	0.5745,	0.6039,
9,	0.3563,	0.6050,	0.6993,	0.4524,	0.4044,	0.4300,	0.4112,	0.6196,	0.6240,	0.5759,
10,	0.8961,	0.5327,	0.4264,	0.5026,	0.3756,	0.6336,	0.3116,	0.5104,	0.8524,	0.5172,
11,	0.9102,	0.8427,	0.6307,	0.7959,	0.5908,	0.4066,	0.2912,	0.3347,	0.5886,	0.5553,
12,	0.8759,	0.6674,	0.4263,	0.7694,	0.5583,	0.3019,	0.1631,	0.5042,	0.4217,	0.2595,
13,	0.2822,	2.3636,	0.6533,	0.6183,	1.5925,	0.1049,	0.8701,	0.3755,	1.6139,	0.1531,
14,	0.6703,	1.0137,	0.5720,	0.6334,	0.7111,	0.3779,	0.4123,	0.4724,	0.8288,	0.4151,
0 FBAR 4- 9,	0.2697,	0.3729,	0.3497,	0.2821,	0.3190,	0.3595,	0.3703,	0.3945,	0.4073,	0.4418,

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Run title : Ufsi - Saithe in Va

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Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	2005,	FBAR **-**
AGE											
1,	0.0000,	0.0000,	0.0000,	0.0000,	0.0000,	0.0000,	0.0000,	0.0000,	0.0000,	0.0000,	0.0000,
2,	0.0000,	0.0000,	0.0000,	0.0000,	0.0000,	0.0000,	0.0000,	0.0000,	0.0000,	0.0000,	0.0000,
3,	0.0483,	0.0384,	0.0243,	0.0387,	0.0317,	0.0250,	0.0191,	0.0260,	0.0419,	0.0373,	0.0350,
4,	0.1326,	0.1770,	0.1078,	0.1281,	0.1234,	0.1293,	0.1122,	0.0904,	0.1171,	0.1856,	0.1310,
5,	0.2364,	0.2030,	0.1522,	0.1847,	0.2287,	0.1590,	0.2264,	0.2341,	0.2114,	0.1530,	0.1995,
6,	0.3441,	0.3395,	0.1667,	0.2841,	0.2736,	0.2319,	0.3374,	0.2795,	0.3376,	0.3213,	0.3128,
7,	0.3582,	0.4437,	0.4052,	0.3248,	0.3528,	0.2858,	0.3284,	0.3863,	0.2864,	0.3983,	0.3570,
8,	0.6490,	0.4739,	0.4797,	0.4564,	0.5756,	0.3600,	0.4141,	0.3021,	0.3761,	0.2923,	0.3235,
9,	0.5637,	0.5292,	0.5689,	0.4624,	0.4365,	0.5640,	0.3855,	0.4075,	0.3841,	0.4136,	0.4018,
10,	0.5842,	0.3570,	0.6878,	0.4674,	0.4835,	0.4639,	0.4294,	0.3443,	0.3773,	0.3895,	0.3704,
11,	0.4470,	0.4229,	0.6993,	0.3980,	0.3514,	0.5320,	0.4967,	0.5371,	0.3184,	0.4658,	0.4404,
12,	0.5172,	0.4680,	0.7946,	0.2979,	0.3197,	0.2911,	0.2829,	0.2457,	0.3974,	0.3005,	0.3145,
13,	0.6566,	0.3210,	0.7841,	0.7182,	0.3400,	0.4950,	0.2499,	0.5603,	0.6421,	0.4627,	0.5550,
14,	0.5570,	0.4242,	0.7142,	0.4721,	0.3869,	0.4751,	0.3672,	0.4258,	0.4277,	0.4131,	0.4222,
0 FBAR 4- 9,	0.3807,	0.3610,	0.3134,	0.3067,	0.3318,	0.2883,	0.3007,	0.2833,	0.2855,	0.2940,	

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Run title : Ufsi - Saithe in Va

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Terminal Fs derived using XSA (With F shrinkage)

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

YEAR,	1984,	1985,
AGE		
1,	111745,	164163,
2,	43834,	91489,
3,	48059,	35888,
4,	26900,	39300,
5,	12929,	21429,
6,	8863,	9861,
7,	7450,	5605,
8,	9313,	4123,
9,	2175,	4358,
10,	660,	1017,
11,	554,	200,
12,	294,	190,
13,	431,	118,
14,	468,	185,
0 TOTAL,	273674,	377928,

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

YEAR,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,
AGE										
1,	84391,	46889,	32216,	41300,	22539,	30595,	26713,	44881,	38556,	26399,
2,	134406,	69094,	38389,	26376,	33814,	18453,	25049,	21871,	36745,	31567,
3,	74905,	110042,	56569,	31430,	21595,	27684,	15108,	20508,	17906,	30085,
4,	29043,	58515,	89230,	45122,	25448,	17551,	22487,	12151,	16196,	14025,
5,	28544,	22511,	43261,	68470,	33040,	19304,	13579,	15761,	8968,	10587,
6,	14499,	19597,	14424,	29430,	48394,	22101,	12536,	7639,	10334,	5741,
7,	6302,	9459,	11150,	8482,	17482,	30472,	11902,	6323,	4217,	6105,
8,	3199,	3757,	5107,	6542,	5321,	8727,	15201,	6230,	3143,	2206,
9,	2315,	1609,	1856,	2575,	3612,	2713,	4228,	8785,	3007,	1449,
10,	2892,	1327,	720,	755,	1341,	1973,	1445,	2295,	3871,	1319,
11,	399,	967,	638,	385,	374,	754,	857,	866,	1128,	1351,
12,	97,	132,	341,	278,	142,	170,	411,	525,	508,	513,
13,	135,	33,	55,	182,	105,	67,	103,	286,	259,	273,
14,	32,	83,	3,	24,	80,	18,	49,	35,	161,	42,
0 TOTAL,	381159,	344014,	293959,	261352,	213287,	180581,	149669,	148156,	145000,	131662,

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Table 3.2.7.3 (cont'd)

Run title : Ufsi - Saithe in Va

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Terminal Fs derived using XSA (With F shrinkage)

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

YEAR,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	2005,	2006,	GMST 84-**	AMST 84-**
AGE													
1,	12558,	42961,	44873,	81517,	103606,	146673,	38289,	117547,	41807,	1389,	0,	50351,	62921,
2,	21614,	10281,	35173,	36739,	66741,	84825,	120085,	31349,	96239,	34229,	1137,	39634,	48895,
3,	25845,	17696,	8418,	28797,	30079,	54643,	69449,	98318,	25666,	78794,	28024,	33484,	41151,
4,	23208,	20163,	13942,	6726,	22682,	23858,	43631,	55786,	78429,	20152,	62152,	25305,	30298,
5,	9806,	16641,	13830,	10249,	4845,	16415,	17163,	31931,	41726,	57117,	13704,	17455,	20963,
6,	6260,	6339,	11122,	9724,	6976,	3156,	11463,	11205,	20686,	27652,	40129,	11080,	13483,
7,	3065,	3633,	3696,	7708,	5992,	4344,	2049,	6698,	6937,	12083,	16418,	6637,	8107,
8,	2854,	1754,	1909,	2018,	4561,	3448,	2673,	1208,	3726,	4265,	6643,	3830,	4665,
9,	987,	1221,	894,	967,	1047,	2100,	1969,	1446,	731,	2095,	2607,	2052,	2466,
10,	667,	460,	589,	414,	499,	554,	978,	1097,	788,	408,	1134,	1017,	1244,
11,	644,	304,	264,	242,	213,	252,	285,	521,	636,	442,	226,	474,	560,
12,	635,	337,	163,	107,	133,	123,	121,	142,	249,	379,	227,	223,	268,
13,	324,	310,	173,	60,	65,	79,	75,	75,	91,	137,	230,	126,	160,
14,	191,	137,	184,	65,	24,	38,	40,	48,	35,	39,	71,	57,	95,
0 TOTAL,	108658,	122238,	135229,	185334,	247462,	340505,	308271,	357369,	317747,	239182,	172703,		

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Run title : Ufsi - Saithe in Va ,

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Table 16 Summary (without SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

,	RECRUITS, Age 1	TOTALBIO,	TOTSPBIO,	LANDINGS,	YIELD/SSB,	FBAR 4- 9,
1984,	111745,	355342,	185493,	62719,	0.3381,	0.3112,
1985,	164163,	346352,	168221,	57101,	0.3394,	0.2510,
1986,	84391,	418684,	185077,	66376,	0.3586,	0.2697,
1987,	46889,	506610,	179908,	80531,	0.4476,	0.3729,
1988,	32216,	522587,	178656,	77247,	0.4324,	0.3497,
1989,	41300,	486440,	187160,	82425,	0.4404,	0.2821,
1990,	22539,	461383,	208953,	98127,	0.4696,	0.3190,
1991,	30595,	381278,	205123,	102737,	0.5009,	0.3595,
1992,	26713,	311728,	192005,	79597,	0.4146,	0.3703,
1993,	44881,	265013,	172197,	71648,	0.4161,	0.3945,
1994,	38556,	217821,	145081,	64339,	0.4435,	0.4073,
1995,	26399,	196212,	114076,	48629,	0.4263,	0.4418,
1996,	12558,	182886,	102293,	40101,	0.3920,	0.3807,
1997,	42961,	179282,	98674,	37264,	0.3776,	0.3610,
1998,	44873,	165165,	98914,	31531,	0.3188,	0.3134,
1999,	81517,	169329,	97094,	31290,	0.3223,	0.3067,
2000,	103606,	181827,	96192,	32430,	0.3371,	0.3318,
2001,	146673,	228487,	103642,	31965,	0.3084,	0.2883,
2002,	38289,	306981,	121408,	42069,	0.3465,	0.3007,
2003,	117547,	414417,	138138,	52494,	0.3800,	0.2833,
2004,	41807,	401078,	173995,	64791,	0.3724,	0.2855,
2005,	1389,	432178,	199037,	69143,	0.3474,	0.2940,
Arith. Mean ,	59164,	324140,	152333,	60207,	0.3877,	0.3307,
0 Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),		

1

Table 3.2.7.4A. Saithe in Division Va. Log catch residuals from adopted 'camera' run, SPALY with corrected landings.

	3	4	5	6	7	8	9	10	11	12	13	14
1985	-0.55	0.28	0.01	-0.08	0.15	-0.09	-0.45	0.51	0.15	-0.55	0.31	0.00
1986	0.81	-0.62	-0.07	-0.30	-0.14	0.10	-0.19	0.80	0.24	0.30	0.24	-0.81
1987	-0.94	-0.14	0.09	0.07	-0.06	-0.03	0.09	0.08	0.17	-0.57	0.17	1.22
1988	0.21	-0.33	0.06	0.18	-0.02	0.10	0.43	-0.06	0.40	-0.44	-0.52	-2.20
1989	-0.72	0.16	-0.06	0.23	-0.21	0.01	0.04	-0.03	0.45	0.39	-0.10	-0.72
1990	-1.18	-0.38	0.05	0.10	0.30	0.14	0.03	-0.17	-0.02	-0.20	0.41	-0.23
1991	-1.16	-0.54	0.21	0.42	0.57	0.15	0.15	0.53	0.08	-0.58	-1.65	-1.55
1992	-0.30	0.21	0.62	0.38	0.10	-0.07	-0.17	-0.15	-0.32	-0.72	0.31	-0.14
1993	0.32	-0.24	-0.25	-0.02	-0.11	-0.14	0.36	-0.08	-0.07	0.16	0.17	-0.66
1994	0.20	0.32	-0.22	-0.45	-0.33	-0.40	-0.18	0.32	-0.11	0.15	0.73	0.75
1995	0.57	0.11	0.20	0.15	0.11	0.03	-0.11	-0.08	0.04	-0.50	-0.29	-0.87
1996	0.46	-0.14	-0.07	-0.12	-0.18	0.01	0.00	-0.04	-0.07	0.07	0.62	1.30
1997	0.37	0.29	-0.22	0.01	0.02	0.08	-0.12	-0.26	-0.21	0.18	-0.17	0.29
1998	-0.09	-0.13	-0.47	-0.72	-0.03	-0.10	0.27	0.06	0.42	0.36	0.61	0.65
1999	0.52	0.15	-0.09	-0.08	-0.05	0.01	0.01	0.17	-0.42	-0.33	0.11	0.08
2000	0.26	0.09	0.04	-0.11	-0.11	0.26	-0.04	0.02	-0.09	-0.57	-0.07	-0.64
2001	0.17	0.24	-0.15	-0.20	-0.11	-0.11	0.27	0.16	0.20	-0.01	0.06	0.45
2002	-0.16	0.11	0.12	0.18	-0.06	0.08	0.01	-0.09	0.17	-0.42	-0.02	-0.25
2003	0.16	-0.07	0.26	-0.02	0.11	-0.21	0.16	0.03	0.16	-0.41	0.35	0.69
2004	0.53	0.08	0.12	0.14	-0.23	-0.16	0.09	0.09	0.02	-0.22	0.52	-0.02
2005	0.47	0.43	-0.27	0.10	0.03	-0.32	-0.02	0.15	0.31	0.09	-0.06	-0.02

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Table 3.2.7.4B. Saithe in Division Va. Log survey residuals from adopted 'camera' run.

	3	4	5	6	7	8	9	10	11	12	13	14
1985	-0.55	0.28	0.01	-0.08	0.15	-0.09	-0.45	0.51	0.15	-0.55	0.31	0.00
1986	0.81	-0.62	-0.07	-0.30	-0.14	0.10	-0.19	0.80	0.24	0.30	0.24	-0.81
1987	-0.94	-0.14	0.09	0.07	-0.06	-0.03	0.09	0.08	0.17	-0.57	0.17	1.22
1988	0.21	-0.33	0.06	0.18	-0.02	0.10	0.43	-0.06	0.40	-0.44	-0.52	-2.20
1989	-0.72	0.16	-0.06	0.23	-0.21	0.01	0.04	-0.03	0.45	0.39	-0.10	-0.72
1990	-1.18	-0.38	0.05	0.10	0.30	0.14	0.03	-0.17	-0.02	-0.20	0.41	-0.23
1991	-1.16	-0.54	0.21	0.42	0.57	0.15	0.15	0.53	0.08	-0.58	-1.65	-1.55
1992	-0.30	0.21	0.62	0.38	0.10	-0.07	-0.17	-0.15	-0.32	-0.72	0.31	-0.14
1993	0.32	-0.24	-0.25	-0.02	-0.11	-0.14	0.36	-0.08	-0.07	0.16	0.17	-0.66
1994	0.20	0.32	-0.22	-0.45	-0.33	-0.40	-0.18	0.32	-0.11	0.15	0.73	0.75
1995	0.57	0.11	0.20	0.15	0.11	0.03	-0.11	-0.08	0.04	-0.50	-0.29	-0.87
1996	0.46	-0.14	-0.07	-0.12	-0.18	0.01	0.00	-0.04	-0.07	0.07	0.62	1.30
1997	0.37	0.29	-0.22	0.01	0.02	0.08	-0.12	-0.26	-0.21	0.18	-0.17	0.29
1998	-0.09	-0.13	-0.47	-0.72	-0.03	-0.10	0.27	0.06	0.42	0.36	0.61	0.65
1999	0.52	0.15	-0.09	-0.08	-0.05	0.01	0.01	0.17	-0.42	-0.33	0.11	0.08
2000	0.26	0.09	0.04	-0.11	-0.11	0.26	-0.04	0.02	-0.09	-0.57	-0.07	-0.64
2001	0.17	0.24	-0.15	-0.20	-0.11	-0.11	0.27	0.16	0.20	-0.01	0.06	0.45
2002	-0.16	0.11	0.12	0.18	-0.06	0.08	0.01	-0.09	0.17	-0.42	-0.02	-0.25
2003	0.16	-0.07	0.26	-0.02	0.11	-0.21	0.16	0.03	0.16	-0.41	0.35	0.69
2004	0.53	0.08	0.12	0.14	-0.23	-0.16	0.09	0.09	0.02	-0.22	0.52	-0.02
2005	0.47	0.43	-0.27	0.10	0.03	-0.32	-0.02	0.15	0.31	0.09	-0.06	-0.02

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Table 3.2.7.5. Saithe in Division Va. Estimated parameters and their standard errrors from FINAL 'camera' run on 1985-2005 landings in numbers, 1985-2006 IGFS used as input. For parameters estimated on log scale, standard deviations can be interpreted as CVs.

year/agegroup	index	name	value	std
Estimated log selectivity				
3	1	logsel	-2.98E+00	1.57E-01
4	2	logsel	-1.45E+00	9.31E-02
5	3	logsel	-8.30E-01	9.86E-02
6	4	logsel	-4.33E-01	9.51E-02
7	5	logsel	-2.09E-01	8.01E-02
notused	6	Sfull	8.50E+00	1.29E+04
notused	7	logvarL	0.00E+00	5.81E+04
notused	8	logvarR	0.00E+00	5.81E+04
notused	9	a50	8.50E+00	1.29E+04
notused	10	deltaA	7.00E+00	1.85E+04
Estimated log N2				
1985	11	logPopAgeOne	1.13E+01	1.06E-01
1986	12	logPopAgeOne	1.17E+01	1.06E-01
1987	13	logPopAgeOne	1.10E+01	1.06E-01
1988	14	logPopAgeOne	1.06E+01	1.07E-01
1989	15	logPopAgeOne	1.01E+01	1.09E-01
1990	16	logPopAgeOne	1.06E+01	1.10E-01
1991	17	logPopAgeOne	9.84E+00	1.09E-01
1992	18	logPopAgeOne	1.00E+01	1.08E-01
1993	19	logPopAgeOne	9.96E+00	1.08E-01
1994	20	logPopAgeOne	1.06E+01	1.08E-01
1995	21	logPopAgeOne	1.04E+01	1.09E-01
1996	22	logPopAgeOne	9.96E+00	1.11E-01
1997	23	logPopAgeOne	9.22E+00	1.15E-01
1998	24	logPopAgeOne	1.04E+01	1.20E-01
1999	25	logPopAgeOne	1.05E+01	1.27E-01
2000	26	logPopAgeOne	1.10E+01	1.42E-01
2001	27	logPopAgeOne	1.13E+01	1.61E-01
2002	28	logPopAgeOne	1.17E+01	1.85E-01
2003	29	logPopAgeOne	1.04E+01	2.24E-01
2004	30	logPopAgeOne	1.15E+01	3.12E-01
2005	31	logPopAgeOne	1.04E+01	6.38E-01
2006	32	logPopAgeOne	6.84E+00	1.79E+00
Estimated log N1985				
3	33	logPopYearOne	1.05E+01	1.07E-01
4	34	logPopYearOne	1.05E+01	1.10E-01
5	35	logPopYearOne	1.00E+01	1.19E-01
6	36	logPopYearOne	9.20E+00	1.27E-01
7	37	logPopYearOne	8.53E+00	1.35E-01
8	38	logPopYearOne	8.33E+00	1.51E-01
9	39	logPopYearOne	8.24E+00	1.99E-01
10	40	logPopYearOne	6.83E+00	2.37E-01
11	41	logPopYearOne	5.33E+00	2.85E-01
12	42	logPopYearOne	4.86E+00	3.75E-01
13	43	logPopYearOne	5.15E+00	5.22E-01
14	44	logPopYearOne	5.44E+00	9.96E-01

Table 3.2.7.5 (cont'd)

Estimated log fully selected fishing mortality				
1985	45	logFullF	-8.83E-01	1.23E-01
1986	46	logFullF	-7.68E-01	1.20E-01
1987	47	logFullF	-5.68E-01	1.16E-01
1988	48	logFullF	-7.72E-01	1.20E-01
1989	49	logFullF	-7.96E-01	1.19E-01
1990	50	logFullF	-7.21E-01	1.19E-01
1991	51	logFullF	-8.17E-01	1.20E-01
1992	52	logFullF	-7.58E-01	1.19E-01
1993	53	logFullF	-5.77E-01	1.18E-01
1994	54	logFullF	-3.11E-01	1.11E-01
1995	55	logFullF	-5.00E-01	1.13E-01
1996	56	logFullF	-5.36E-01	1.15E-01
1997	57	logFullF	-6.38E-01	1.17E-01
1998	58	logFullF	-6.32E-01	1.19E-01
1999	59	logFullF	-7.44E-01	1.22E-01
2000	60	logFullF	-6.95E-01	1.21E-01
2001	61	logFullF	-8.14E-01	1.27E-01
2002	62	logFullF	-7.86E-01	1.34E-01
2003	63	logFullF	-8.47E-01	1.47E-01
2004	64	logFullF	-8.06E-01	1.68E-01
2005	65	logFullF	-7.91E-01	2.01E-01
2006	66	logFullF	-8.93E-01	7.54E-01
Estimated log survey selectivity				
2	67	logqjus	-1.14E+01	2.08E-01
3	68	logqjus	-9.67E+00	1.88E-01
4	69	logqjus	-8.98E+00	9.54E-02
5	70	logqjus	-8.75E+00	1.03E-01
6+	71	logqjus	-8.75E+00	7.42E-02
Estimated F4-9				
1985	72	Fbar	2.85E-01	3.43E-02
1986	73	Fbar	3.19E-01	3.71E-02
1987	74	Fbar	3.90E-01	4.38E-02
1988	75	Fbar	3.18E-01	3.67E-02
1989	76	Fbar	3.11E-01	3.56E-02
1990	77	Fbar	3.35E-01	3.84E-02
1991	78	Fbar	3.04E-01	3.53E-02
1992	79	Fbar	3.23E-01	3.73E-02
1993	80	Fbar	3.86E-01	4.46E-02
1994	81	Fbar	5.04E-01	5.45E-02
1995	82	Fbar	4.18E-01	4.55E-02
1996	83	Fbar	4.03E-01	4.44E-02
1997	84	Fbar	3.64E-01	4.10E-02
1998	85	Fbar	3.66E-01	4.18E-02
1999	86	Fbar	3.27E-01	3.83E-02
2000	87	Fbar	3.44E-01	4.01E-02
2001	88	Fbar	3.05E-01	3.72E-02
2002	89	Fbar	3.14E-01	4.04E-02
2003	90	Fbar	2.95E-01	4.22E-02
2004	91	Fbar	3.08E-01	5.06E-02
2005	92	Fbar	3.12E-01	6.19E-02
2006	93	Fbar	2.82E-01	2.12E-01

Table 3.2.7.5 (cont'd)

Estimated B4+				
1985	94	FSB	2.78E+05	1.59E+04
1986	95	FSB	2.98E+05	1.67E+04
1987	96	FSB	3.14E+05	1.73E+04
1988	97	FSB	3.97E+05	2.27E+04
1989	98	FSB	3.85E+05	2.13E+04
1990	99	FSB	3.67E+05	2.04E+04
1991	100	FSB	2.99E+05	1.64E+04
1992	101	FSB	2.81E+05	1.56E+04
1993	102	FSB	2.38E+05	1.39E+04
1994	103	FSB	1.92E+05	1.16E+04
1995	104	FSB	1.48E+05	8.33E+03
1996	105	FSB	1.51E+05	8.45E+03
1997	106	FSB	1.58E+05	8.93E+03
1998	107	FSB	1.57E+05	9.10E+03
1999	108	FSB	1.28E+05	7.44E+03
2000	109	FSB	1.33E+05	8.16E+03
2001	110	FSB	1.50E+05	1.01E+04
2002	111	FSB	2.03E+05	1.60E+04
2003	112	FSB	2.72E+05	2.49E+04
2004	113	FSB	3.59E+05	3.93E+04
2005	114	FSB	3.65E+05	4.57E+04
2006	115	FSB	3.79E+05	6.02E+04
2007	116	FSB	3.63E+05	8.46E+04
Estimated SSB				
1985	117	SSB	1.62E+05	9.16E+03
1986	118	SSB	1.77E+05	9.65E+03
1987	119	SSB	1.69E+05	9.28E+03
1988	120	SSB	1.63E+05	8.55E+03
1989	121	SSB	1.69E+05	8.90E+03
1990	122	SSB	1.83E+05	9.78E+03
1991	123	SSB	1.78E+05	9.81E+03
1992	124	SSB	1.82E+05	1.05E+04
1993	125	SSB	1.69E+05	1.01E+04
1994	126	SSB	1.44E+05	9.11E+03
1995	127	SSB	1.09E+05	6.25E+03
1996	128	SSB	9.92E+04	5.41E+03
1997	129	SSB	9.76E+04	5.24E+03
1998	130	SSB	9.97E+04	5.57E+03
1999	131	SSB	9.34E+04	5.28E+03
2000	132	SSB	9.08E+04	5.22E+03
2001	133	SSB	9.72E+04	5.98E+03
2002	134	SSB	1.13E+05	7.82E+03
2003	135	SSB	1.31E+05	1.06E+04
2004	136	SSB	1.69E+05	1.64E+04
2005	137	SSB	2.16E+05	2.60E+04
2006	138	SSB	2.19E+05	3.32E+04
2007	139	SSB	2.35E+05	5.89E+04

Table 3.2.7.6. Saithe in Division Va. Fishing mortality from adopted 'camera' run, a separable model calibrated with IGFS survey 1985-2006.

	3	4	5	6	7	8	9	10	11	12	13	14
1985	0.021	0.097	0.180	0.268	0.336	0.414	0.414	0.414	0.414	0.414	0.414	0.414
1986	0.024	0.109	0.202	0.301	0.377	0.464	0.464	0.464	0.464	0.464	0.464	0.464
1987	0.029	0.133	0.247	0.368	0.460	0.567	0.567	0.567	0.567	0.567	0.567	0.567
1988	0.023	0.108	0.202	0.300	0.375	0.462	0.462	0.462	0.462	0.462	0.462	0.462
1989	0.023	0.106	0.197	0.292	0.366	0.451	0.451	0.451	0.451	0.451	0.451	0.451
1990	0.025	0.114	0.212	0.315	0.395	0.486	0.486	0.486	0.486	0.486	0.486	0.486
1991	0.022	0.104	0.193	0.286	0.359	0.442	0.442	0.442	0.442	0.442	0.442	0.442
1992	0.024	0.110	0.204	0.304	0.380	0.469	0.469	0.469	0.469	0.469	0.469	0.469
1993	0.029	0.132	0.245	0.364	0.456	0.561	0.561	0.561	0.561	0.561	0.561	0.561
1994	0.037	0.172	0.320	0.475	0.595	0.733	0.733	0.733	0.733	0.733	0.733	0.733
1995	0.031	0.142	0.265	0.393	0.492	0.606	0.606	0.606	0.606	0.606	0.606	0.606
1996	0.030	0.137	0.255	0.379	0.475	0.585	0.585	0.585	0.585	0.585	0.585	0.585
1997	0.027	0.124	0.230	0.342	0.429	0.528	0.528	0.528	0.528	0.528	0.528	0.528
1998	0.027	0.125	0.232	0.345	0.431	0.532	0.532	0.532	0.532	0.532	0.532	0.532
1999	0.024	0.111	0.207	0.308	0.386	0.475	0.475	0.475	0.475	0.475	0.475	0.475
2000	0.025	0.117	0.218	0.324	0.405	0.499	0.499	0.499	0.499	0.499	0.499	0.499
2001	0.023	0.104	0.193	0.287	0.360	0.443	0.443	0.443	0.443	0.443	0.443	0.443
2002	0.023	0.107	0.199	0.295	0.370	0.456	0.456	0.456	0.456	0.456	0.456	0.456
2003	0.022	0.101	0.187	0.278	0.348	0.429	0.429	0.429	0.429	0.429	0.429	0.429
2004	0.023	0.105	0.195	0.290	0.363	0.447	0.447	0.447	0.447	0.447	0.447	0.447
2005	0.023	0.106	0.198	0.294	0.368	0.453	0.453	0.453	0.453	0.453	0.453	0.453

Table 3.2.7.7. Saithe in Division Va. Stock in numbers (in thousands) from adopted 'camera' run, a separable model calibrated with IGFS survey 1985-2006.

	2	3	4	5	6	7	8	9	10	11	12	13	14
1985	80094	34564	36193	22166	9940	5082	4133	3795	926	207	129	172	230
1986	115888	65575	27710	26893	15151	6224	2974	2237	2054	501	112	70	93
1987	61797	94881	52438	20349	17984	9182	3497	1531	1152	1058	258	58	36
1988	38423	50595	75476	37588	13010	10196	4746	1624	711	535	491	120	27
1989	25576	31458	40462	55448	25156	7894	5737	2447	838	367	276	253	62
1990	38216	20940	25172	29803	37289	15374	4482	2992	1276	437	191	144	132
1991	18760	31289	16726	18389	19737	22275	8483	2256	1506	643	220	96	72
1992	22862	15360	25048	12346	12417	12135	12743	4465	1188	793	338	116	51
1993	21254	18718	12279	18373	8239	7502	6792	6529	2288	609	406	173	59
1994	39664	17402	14894	8814	11776	4688	3895	3172	3049	1068	284	190	81
1995	32057	32474	13726	10269	5242	5996	2118	1532	1248	1200	420	112	75
1996	21231	26246	25781	9749	6453	2897	3001	945	684	557	536	188	50
1997	10090	17382	20859	18402	6184	3616	1475	1369	431	312	254	244	86
1998	33202	8261	13855	15089	11966	3595	1929	712	661	208	151	123	118
1999	35315	27183	6583	10014	9797	6942	1912	928	343	318	100	72	59
2000	62134	28914	21725	4822	6664	5895	3865	973	472	174	162	51	37
2001	81988	50871	23080	15823	3175	3948	3219	1921	484	235	87	80	25
2002	122223	67126	40723	17032	10678	1951	2256	1692	1010	254	123	46	42
2003	33548	100067	53701	29963	11431	6507	1104	1171	879	524	132	64	24
2004	95963	27467	80163	39762	20347	7088	3762	588	625	468	280	70	34
2005	31652	78568	21983	59105	26790	12470	4039	1970	308	327	245	146	37
2006	930	25914	62861	16183	39706	16348	7066	2101	1025	160	170	128	76

Table 3.2.7.8. Saithe in Division Va. Summary table from adopted 'camera' run for 1985-2006, 1962-1984 estimates from a long 'camera' run (same selectivity in 1962-2005). Pre-1985 values and the final run concatenated.

	Recruits Age 3	Totalbio	TotalSpbio	Landings	Yield/SSB	Fbar 4-9
1962	29576	314117	101277	50514	0.499	0.287
1963	76779	357635	106978	48011	0.449	0.350
1964	54222	452286	114542	60257	0.526	0.268
1965	84110	537247	150227	60177	0.401	0.248
1966	68172	628980	211962	52003	0.245	0.198
1967	66811	710840	279863	75712	0.271	0.257
1968	63023	781436	335129	77549	0.231	0.229
1969	88050	807770	373045	115853	0.311	0.267
1970	63573	801527	383875	116601	0.304	0.318
1971	51833	732368	370028	136764	0.370	0.427
1972	27076	605893	327251	111301	0.340	0.377
1973	18501	506718	295897	110888	0.375	0.335
1974	20617	437802	278006	97568	0.351	0.309
1975	26133	382433	235977	87954	0.373	0.320
1976	29758	326600	190302	82003	0.431	0.357
1977	19585	313200	149398	62026	0.415	0.301
1978	44204	336251	137016	49672	0.363	0.322
1979	54260	333901	132038	63504	0.481	0.368
1980	27388	329798	145844	58347	0.400	0.330
1981	18614	318500	148610	58986	0.397	0.332
1982	23057	318270	156289	68615	0.439	0.368
1983	31304	325123	153404	58266	0.380	0.228
1984	41705	368526	170053	62719	0.369	0.318
1985	34565	413892	162135	57102	0.352	0.285
1986	65575	509316	176727	64868	0.367	0.319
1987	94881	519725	168704	80531	0.477	0.390
1988	50595	499673	163042	77247	0.474	0.318
1989	31458	454608	169347	82425	0.487	0.311
1990	20940	439970	183010	98127	0.536	0.335
1991	31289	355925	178319	102316	0.574	0.304
1992	15360	323628	182358	79597	0.436	0.323
1993	18718	285575	169256	71648	0.423	0.386
1994	17402	257069	144212	64339	0.446	0.504
1995	32474	224324	108807	48629	0.447	0.418
1996	26246	204803	99174	40101	0.404	0.403
1997	17382	191039	97640	37264	0.382	0.364
1998	8261	201707	99657	31531	0.316	0.366
1999	27183	198144	93414	31293	0.335	0.327
2000	28914	235150	90807	33146	0.365	0.344
2001	50871	297501	97189	32063	0.330	0.305
2002	67127	412698	113306	42071	0.371	0.314
2003	100067	436427	130533	52494	0.402	0.295
2004	27467	494758	169490	64791	0.382	0.308
2005	78568	503368	215802	69143	0.320	0.312
2006	25914		218495			
Arith. Mean	42213	420148	181743	68773	0.394	0.326
Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

Table 3.2.8.1. Saithe in Va. Prediction with management option/short term prediction - input data. SPALY weight prediction

Icelandic SAITHE. Division Va.
Prognosis - input parameters

Recruitment=	**10**
Fpa	**0.3**
Starting year =	**2006**

Desired TAC:

	2006	*2007*	*2008*
Opt1	81	0	0
Opt2	81	84	79
Opt3	81	9	12
Opt4	81	23	28
Opt5	81	44	49
Opt6	81	63	65
Opt7	81	74	73
Opt8	81	81	78
Opt9	81	88	82
Opt10	81	98	87

Fpa 0.3

F-factor:

	2006	*2007*	*2008*
Opt1	1	0	0
Opt2	1	1	1
Opt3	1	0.096	0.096
Opt4	1	0.240	0.240
Opt5	1	0.481	0.481
Opt6	1	0.721	0.721
Opt7	1	0.865	0.865
Opt8	1	0.962	0.962
Opt9	1	1.058	1.058
Opt10	1	1.202	1.202

Mean weight in the catches:

age/year	*2006*	*2007*	*2008*
3	1.355	1.355	1.355
4	1.822	1.912	1.964
5	2.561	2.389	2.588
6	3.047	3.403	3.114
7	3.468	3.927	4.375
8	4.467	4.575	4.885
9	6.780	6.780	6.780
10	7.972	7.972	7.972
11	8.254	8.254	8.254
12	9.152	9.152	9.152
13	9.978	9.978	9.978
14	10.886	10.886	10.886

Table 3.2.8.1 (cont'd)

Mean weight at spawning time:

age/year	*2006*	*2007*	*2008*
3	1.355	1.355	1.355
4	1.822	1.912	1.964
5	2.561	2.389	2.588
6	3.047	3.403	3.114
7	3.468	3.927	4.375
8	4.467	4.575	4.885
9	6.780	6.780	6.780
10	7.972	7.972	7.972
11	8.254	8.254	8.254
12	9.152	9.152	9.152
13	9.978	9.978	9.978
14	10.886	10.886	10.886

Sexual maturity:

age/year	*2006*	*2007*	*2008*
3	**0.075**	**0.075**	**0.075**
4	**0.220**	**0.220**	**0.220**
5	**0.430**	**0.430**	**0.430**
6	**0.650**	**0.650**	**0.650**
7	**0.835**	**0.835**	**0.835**
8	**0.925**	**0.925**	**0.925**
9	**0.955**	**0.955**	**0.955**
10	**1**	**1**	**1**
11	**1**	**1**	**1**
12	**1**	**1**	**1**
13	**1**	**1**	**1**
14	**1**	**1**	**1**

Natural mortality (M):

age/year	*2006*	*2007*	*2008*
3	0.2	0.2	0.2
4	0.2	0.2	0.2
5	0.2	0.2	0.2
6	0.2	0.2	0.2
7	0.2	0.2	0.2
8	0.2	0.2	0.2
9	0.2	0.2	0.2
10	0.2	0.2	0.2
11	0.2	0.2	0.2
12	0.2	0.2	0.2
13	0.2	0.2	0.2
14	0.2	0.2	0.2

Table 3.2.8.1 (cont'd)

Selection pattern:

age/year	*2006*	*2007*	*2008*
3	0.023	0.023	0.023
4	0.106	0.106	0.106
5	0.198	0.198	0.198
6	0.294	0.294	0.294
7	0.368	0.368	0.368
8	0.453	0.453	0.453
9	0.453	0.453	0.453
10	0.453	0.453	0.453
11	0.453	0.453	0.453
12	0.453	0.453	0.453
13	0.453	0.453	0.453
14	0.453	0.453	0.453
F4-9	**0.31**	**0.31**	**0.31**

Stock in numbers in starting year (millions):

age/year	**2006**
3	25.514
4	62.861
5	16.183
6	39.706
7	16.248
8	7.066
9	2.101
10	1.025
11	0.16
12	0.17
13	0.128
14	0.076
Total=	**170.537**

Table 3.2.8.2. Saithe in Va. Prediction with management/short term prediction. Based on SPALY predicted weights. With some ACFM calculations added

SPALY prediction

in 2005-2007 for different management strategies.

2006				**2007**				**2008**							
Stofn 4+	Hrygn-stofn				Stofn 4+	Hrygn-stofn			Stofn 4+	Hrygn-stofn				Current TAC qy05/06	
Stock 4+	*Spawning stock*	F	Afli *Catch*	Afli *Catch*	*Stock 4+*	*Spawn. stock*	F	Afli *Catch*	*Stock 4+*	*Spawn. stock*	F			80	
												Basis	Fmul	%deltaTAC	%deltaSSB
393	228	0.312	82	0	365	239	0.00	0	402	308	0.00	Zero catch	0	-100	29
				85	365	239	0.31	80	304	225	0.31	Fsq	1	6	-6
				9	365	239	0.03	12	391	299	0.03	Fpa*0.1	0.096	-88	25
				23	365	239	0.08	28	375	286	0.08	Fpa*0.25	0.240	-71	19
				44	365	239	0.15	49	351	265	0.15	Fpa*0.5	0.481	-45	11
				64	365	239	0.23	66	328	246	0.23	Fpa*0.75	0.721	-20	3
				75	365	239	0.27	74	316	235	0.27	Fpa*0.9	0.865	-6	-2
			Fpa	82	365	239	0.30	78	307	228	0.30	Fpa	0.962	3	-5
				89	365	239	0.33	82	300	221	0.33	Fpa*1.1	1.058	11	-7
				99	365	239	0.38	87	288	212	0.38	Fpa*1.25	1.202	24	-11

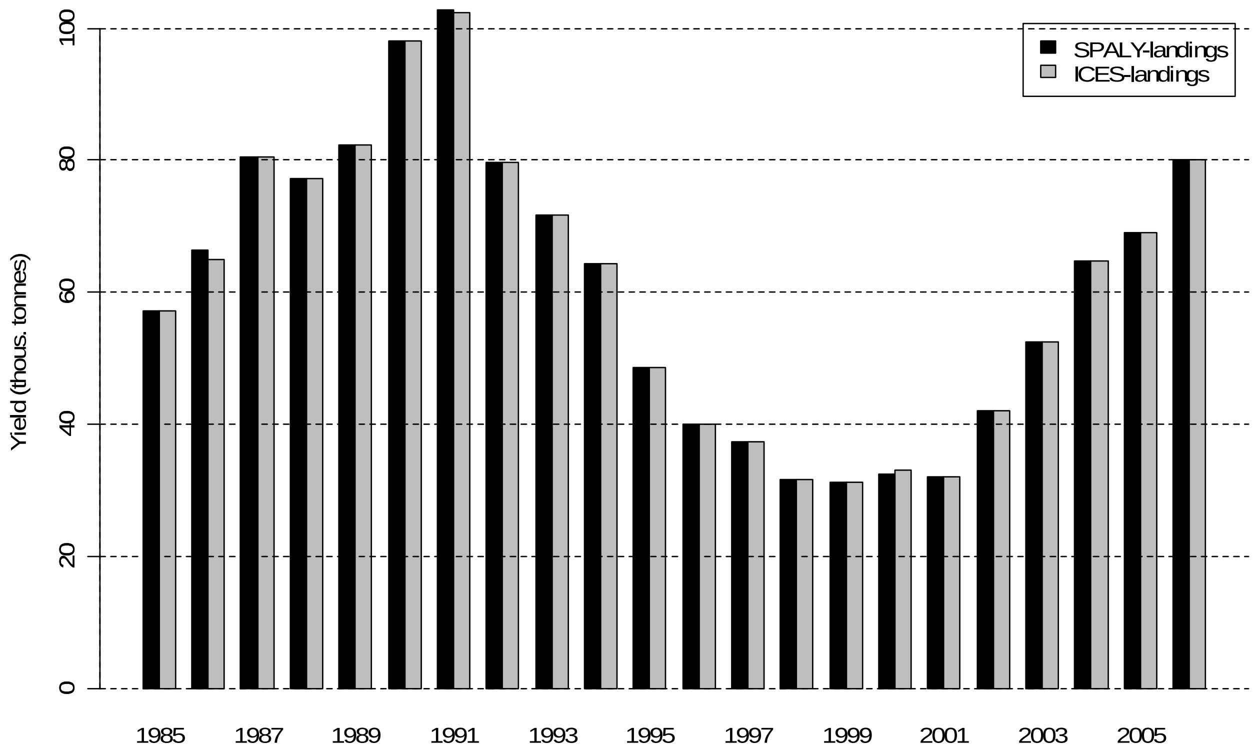


Figure 3.2.1.1. Saithe in Va. Nominal landings 1985-2005, and assumed catch of 80kt in 2006 in SPALY 'camera'. The slight difference between landings used in the 2005 'camera' assessment and ICES offical stats for a few years is shown.

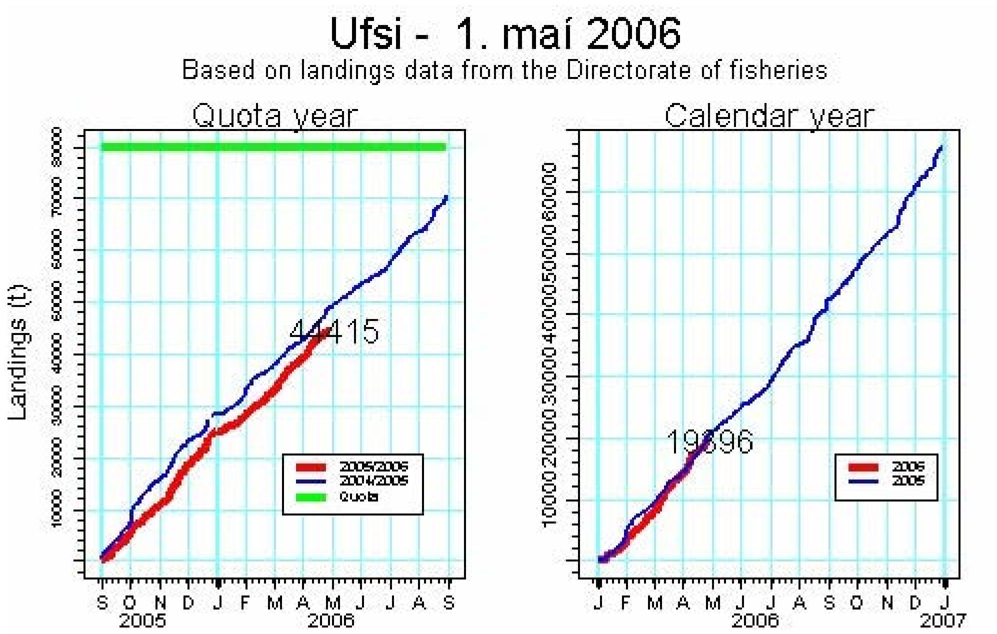


Figure 3.2.1.2. Saithe in Va. Landings in qouta years 2004/2005 (blue) and 2005/2006 and calendar years 2005 and 2006 (www.hafro.is/~sigurdur/Landings).

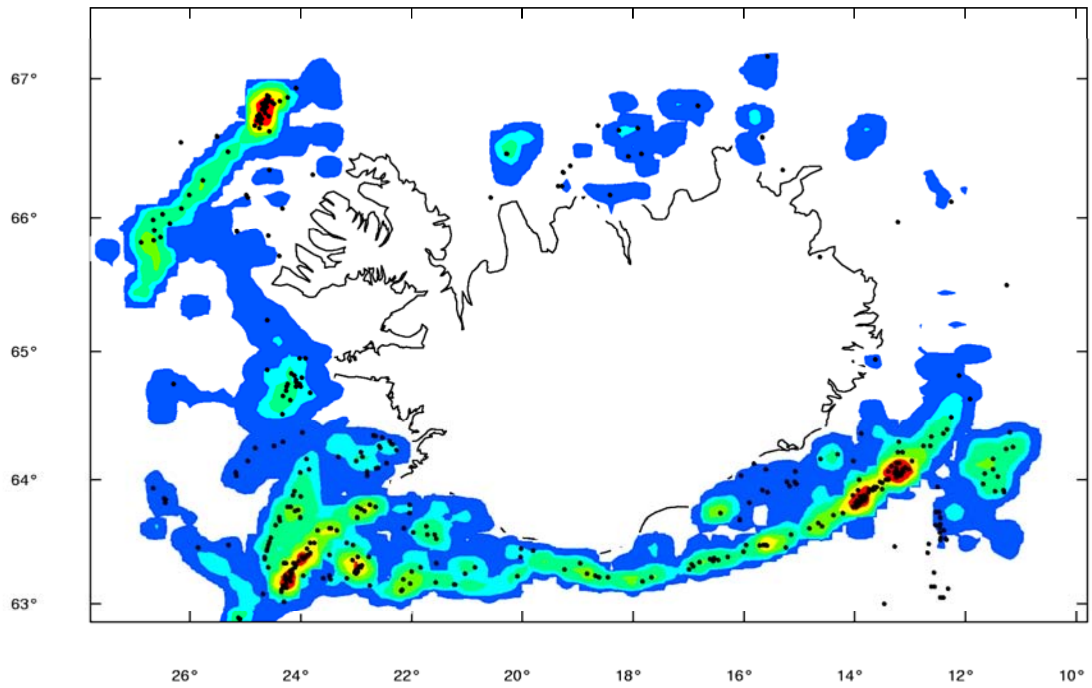


Figure 3.2.2.1. Saithe in Va. Geographical distribution of the 2005 saithe fishery with (all gear, from logbooks) with sample position superimposed.

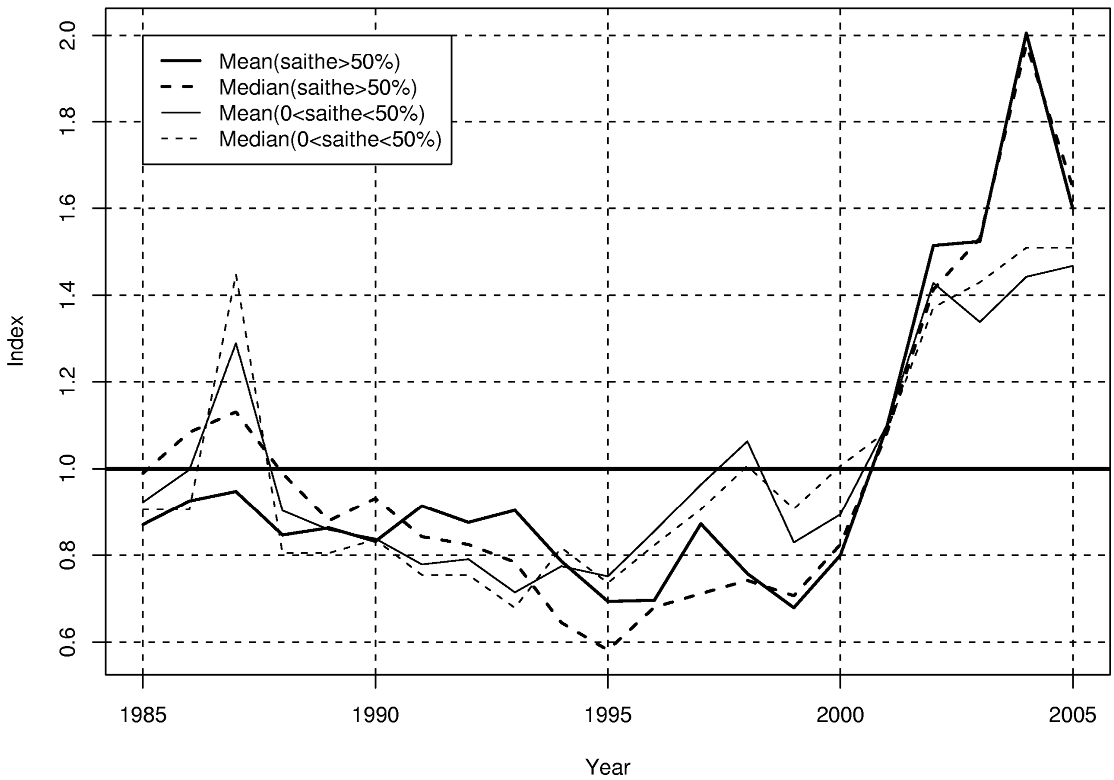


Figure 3.2.2.2. Saithe in Va. Simple CPUE indices from the trawler fleet for 1985-2005. Mean and median CPUE in trawl hauls where saithe was recorded, as either more or less than 50% of the reported catch.

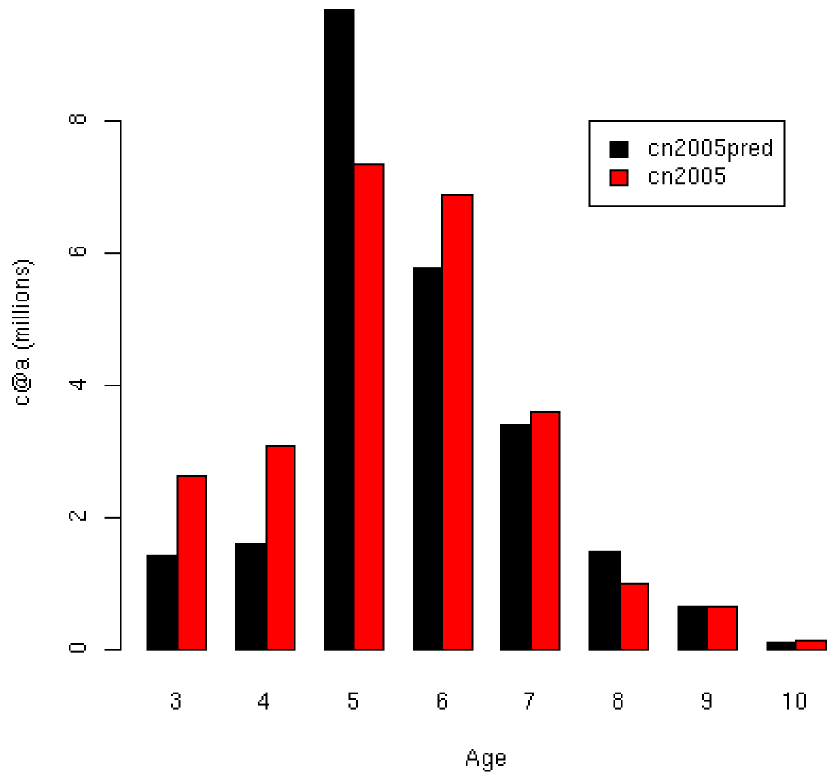


Figure 3.2.3.1. Saithe in Va. Prognosis in May 2005 and estimate in April 2006 of proportional distribution of landings in numbers at age in 2005.

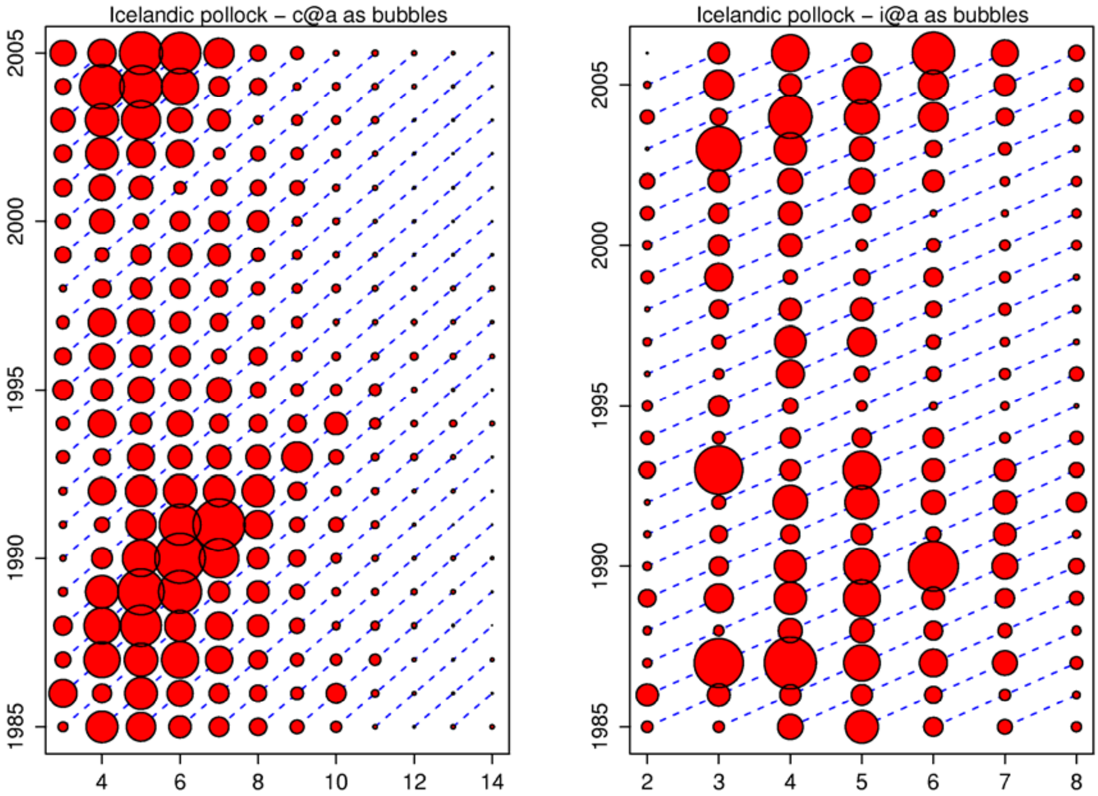


Figure 3.2.3.2. Saithe in Va. Circles representing landings at age 3-14 in1985-2005 (right) and of index at age 2-8 in 1985-2006 juxtaposed.

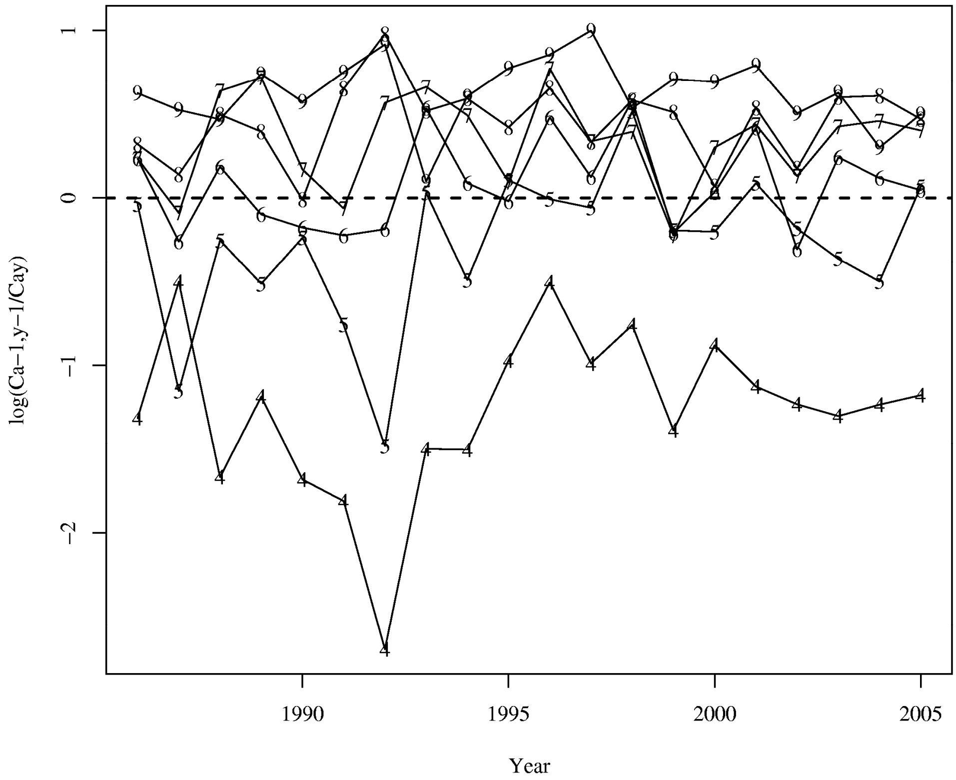


Figure 3.2.3.3. Saithe in Va. Log ratios of catch-at-age for age groups 3-14 in1985-2005.

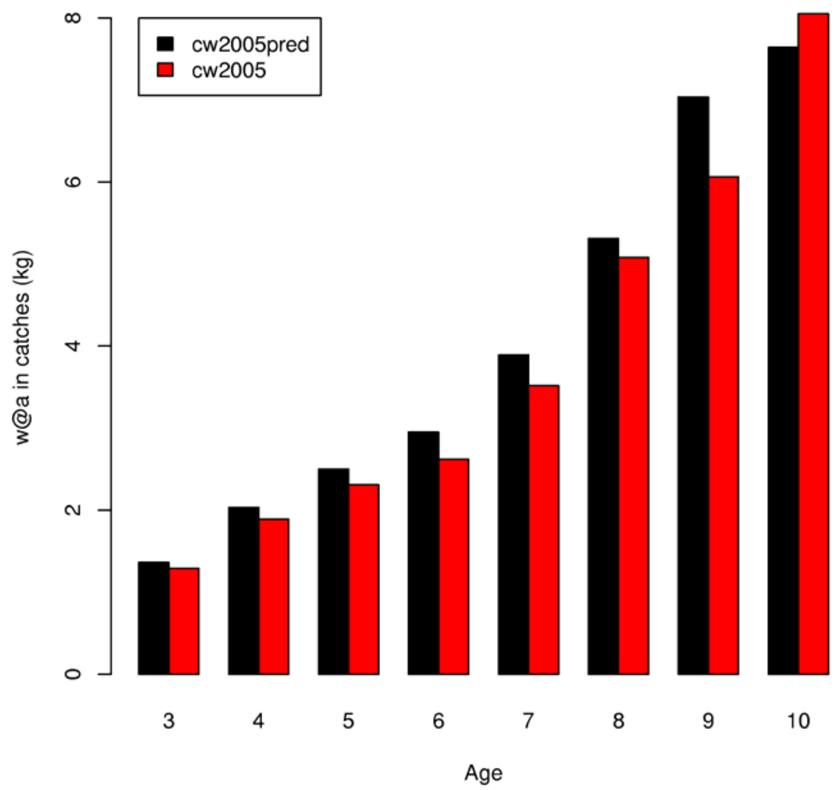


Figure 3.2.4.1. Saithe in Va. Mean weight at age 3-10 in the landings/SSB predicted in 2005 (black) and estimated in 2006 based on samples from landings in 2005 (red/gray).

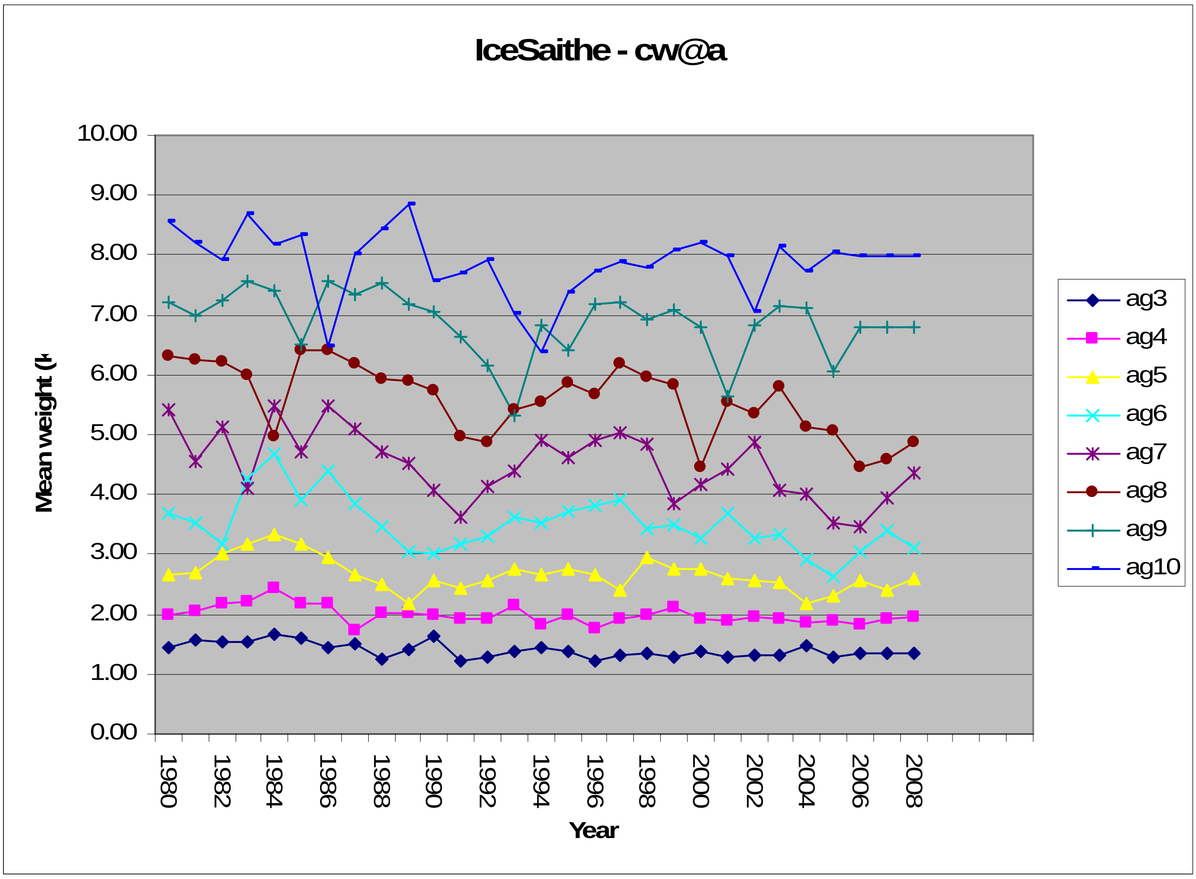


Figure 3.2.4.2. Saithe in Va. Mean weight at age in the landings and spawning stock in 1980-2005, 2006-2008 predicted with SPALY weight prediction model.

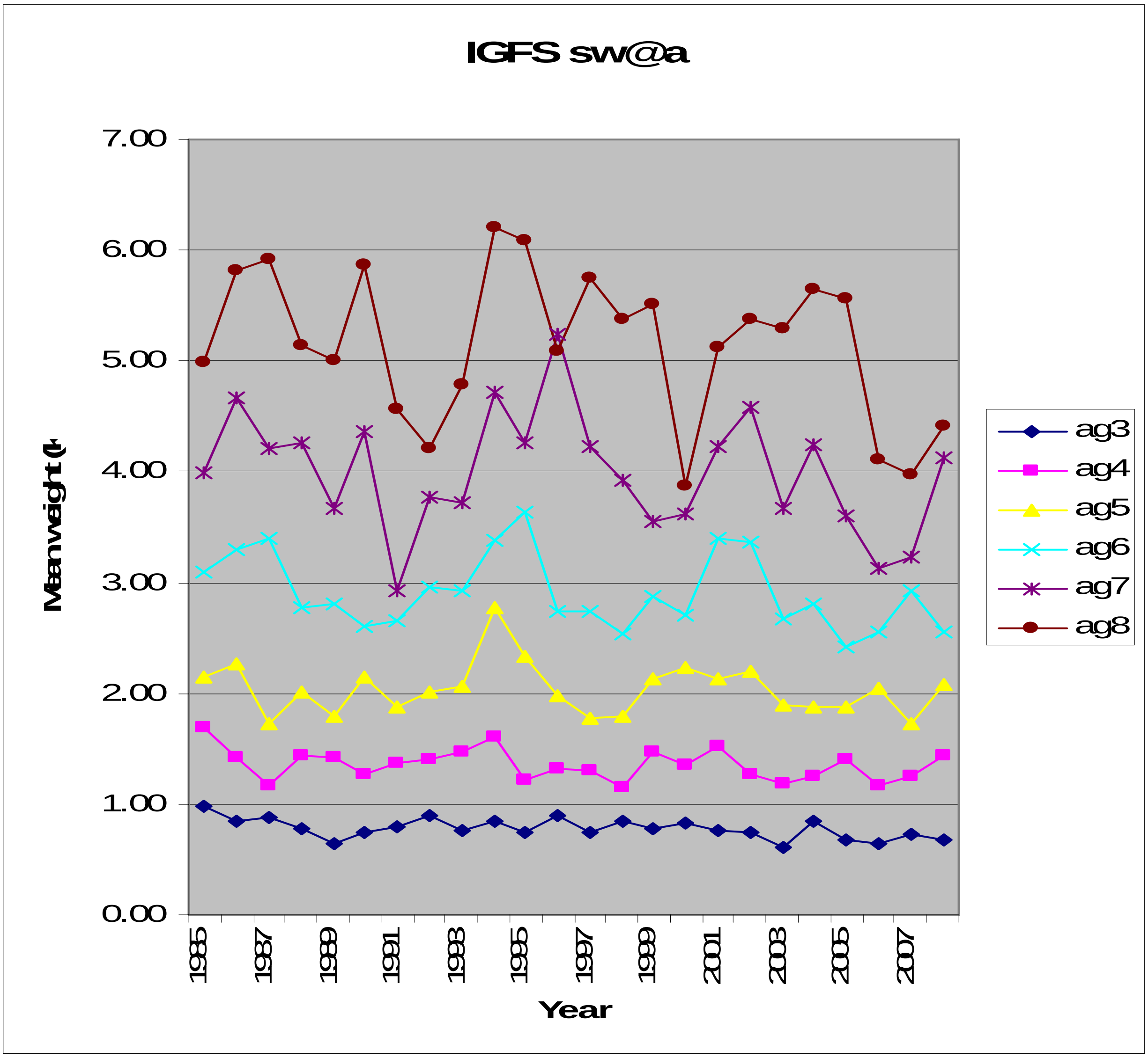


Figure 3.2.4.3. Saithe in Va. Mean weight at age in the IGFS survey in 1980-2006, 2007-2008 predicted with SPALY weight prediction model.

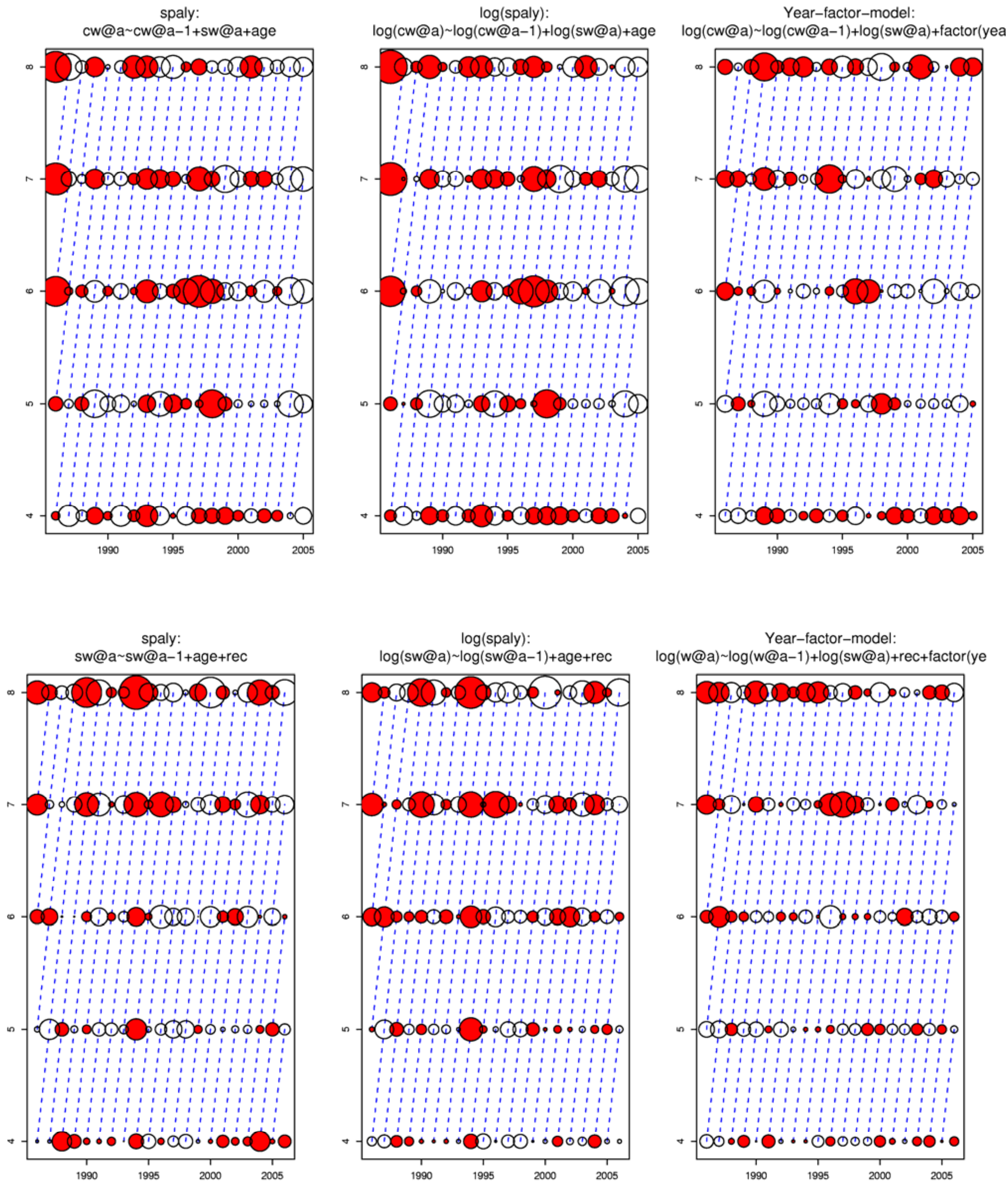


Figure 3.2.4.4. Saithe in Va.Residuals from SPALY-weight prediction (left), an intermediate model with same structure except on log-scale (middle) and a model on log-scale with a year factor modelled. Catch/SSB weight model upper panels, survey weight model lower panels. Based on 1985-2005 mean weight at age in landings and 1985-2006 weight at age in IGFS survey in March.

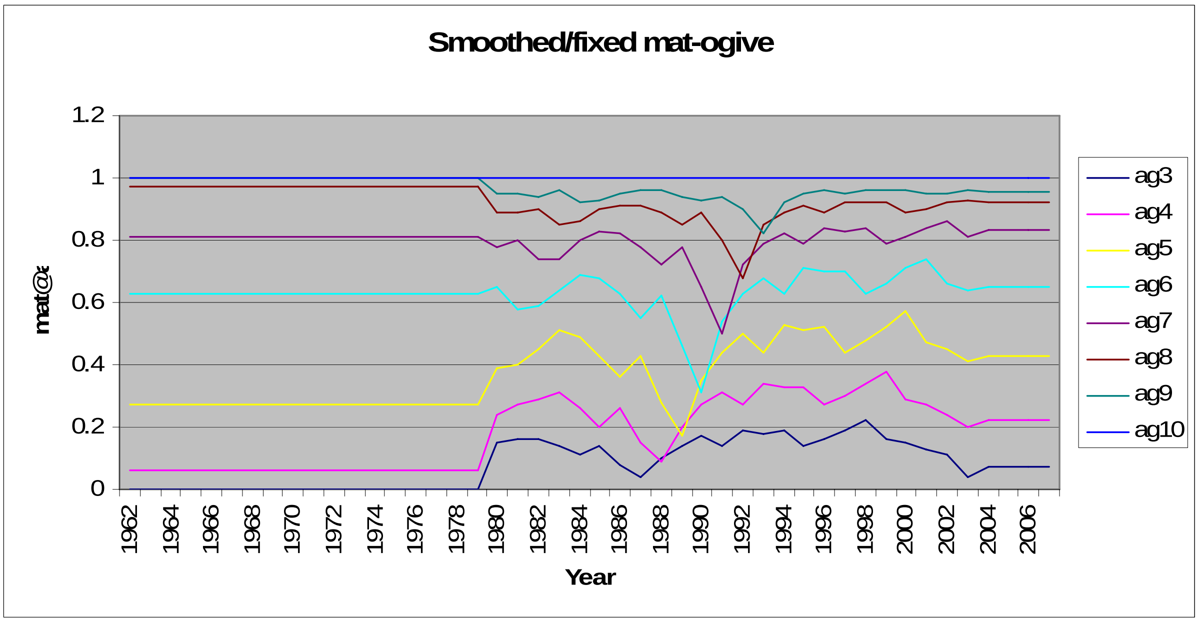


Figure 3.2.5.1. Saithe in Va.. Smoothed maturity for age in the stock based on samples from landings as used in spring 2005, taken from NWWG2004.

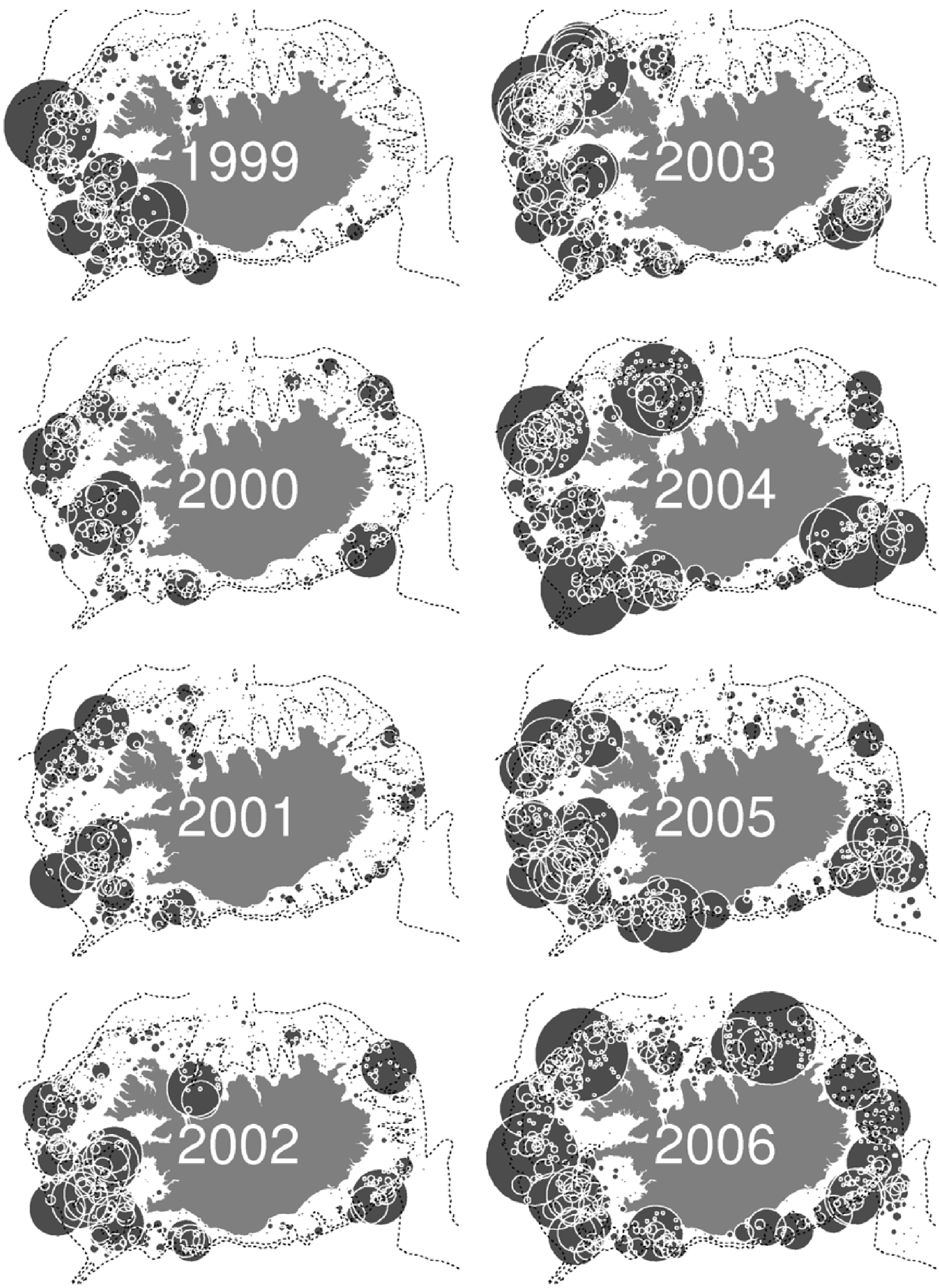


Figure 3.2.7.1. Saithe in Va. Geographic distribution of abundance in IGFS 1999-2009. Circle area changes for cutpoints 1, 5, 10, 50, 100, 500, 1000, largest circles denote hauls where more than 1000 saithe were caught.

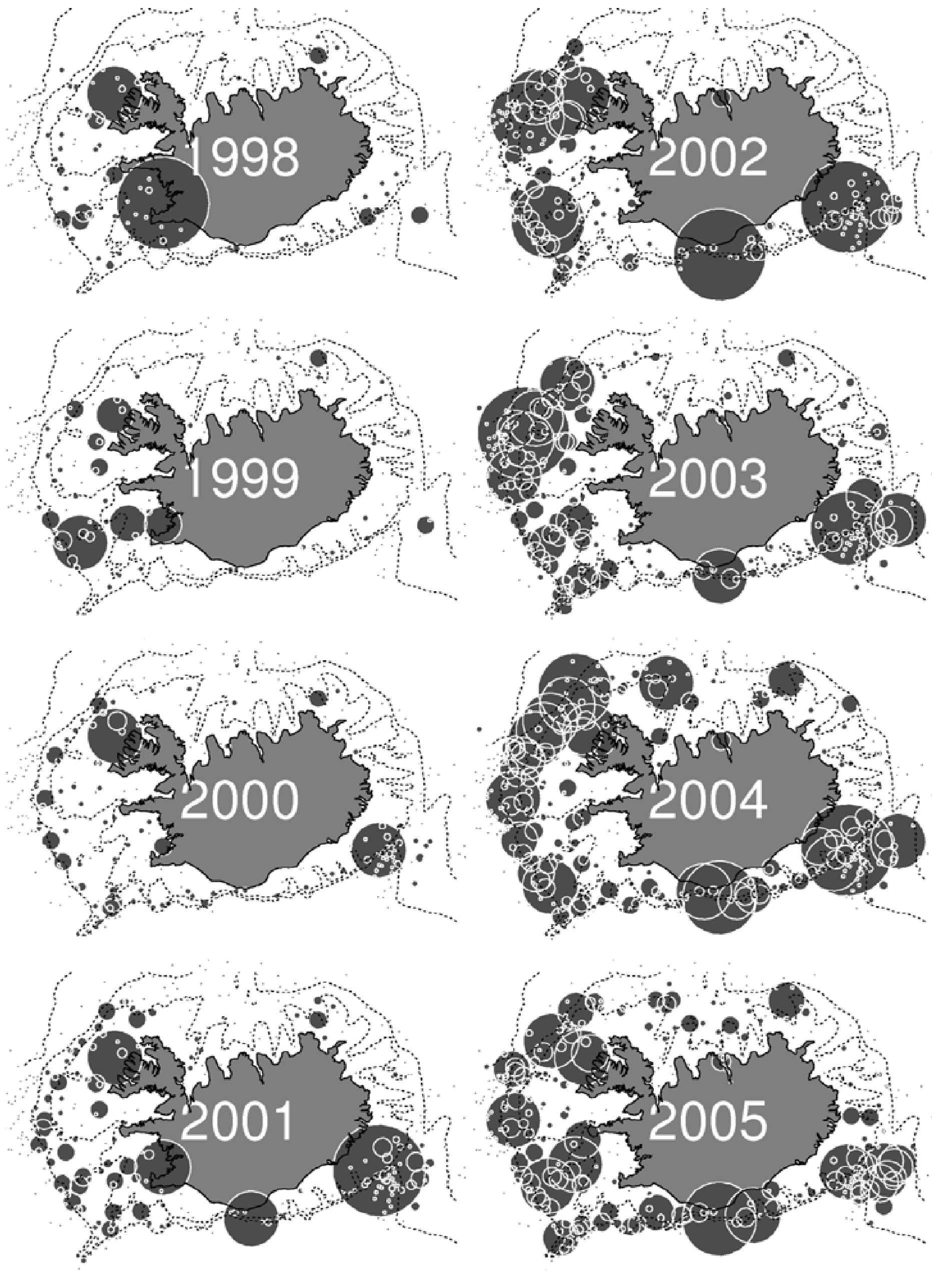


Figure 3.2.7.2. Saithe in Va. Geographic distribution of abundance in Icelandic autumn survey 1997-2004. Circle area changes for cutpoints 1, 5, 10, 50, 100, 500, 1000, largest circles denote hauls where more than 1000 saithe were caught.

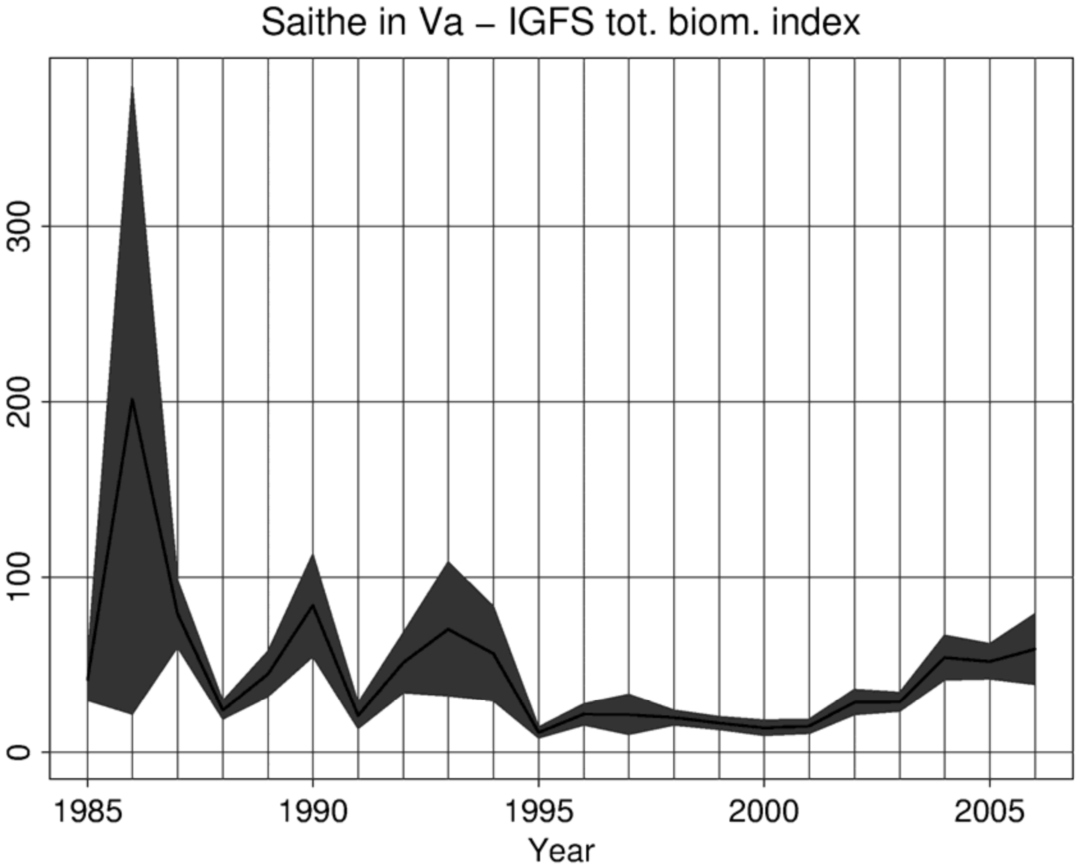


Figure 3.2.7.3. Saithe in Va. Stratified mean survey biomass index from IGFS 1985-2006.

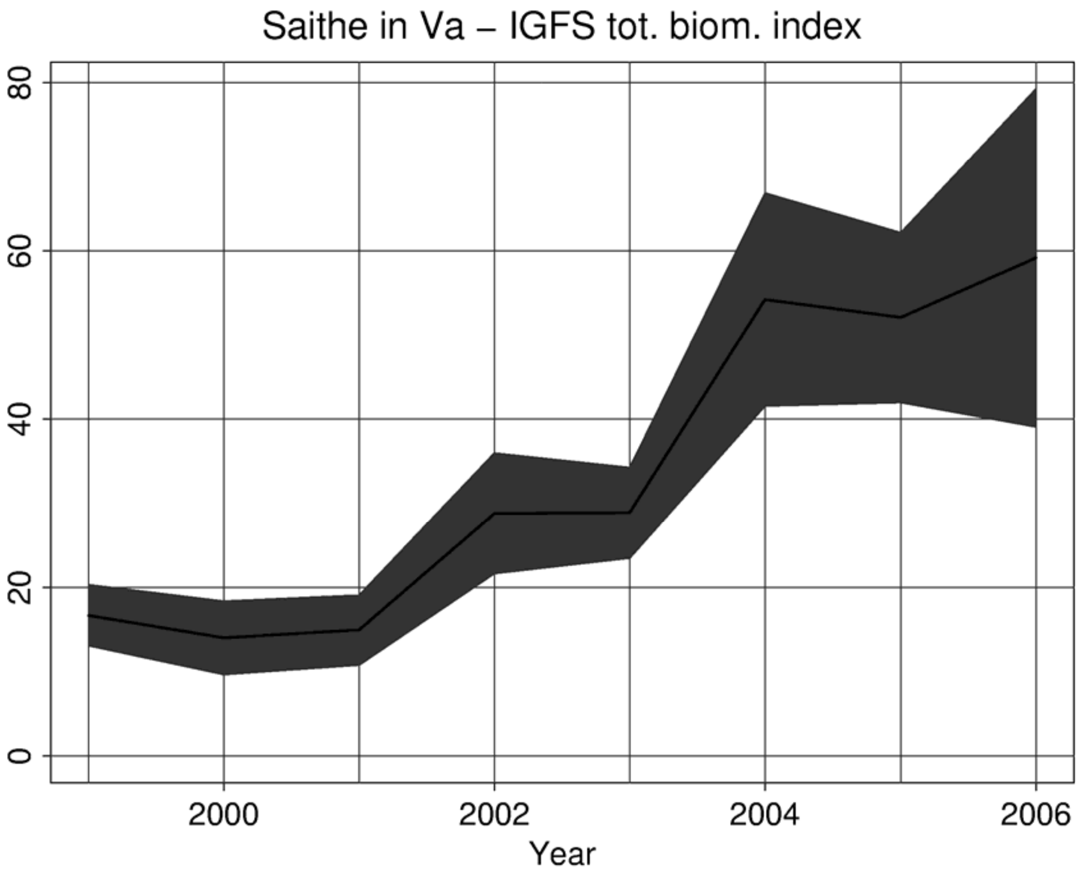


Figure 3.2.7.4. Saithe in Va. Stratified mean survey biomass index from IGFS 1999-2006.

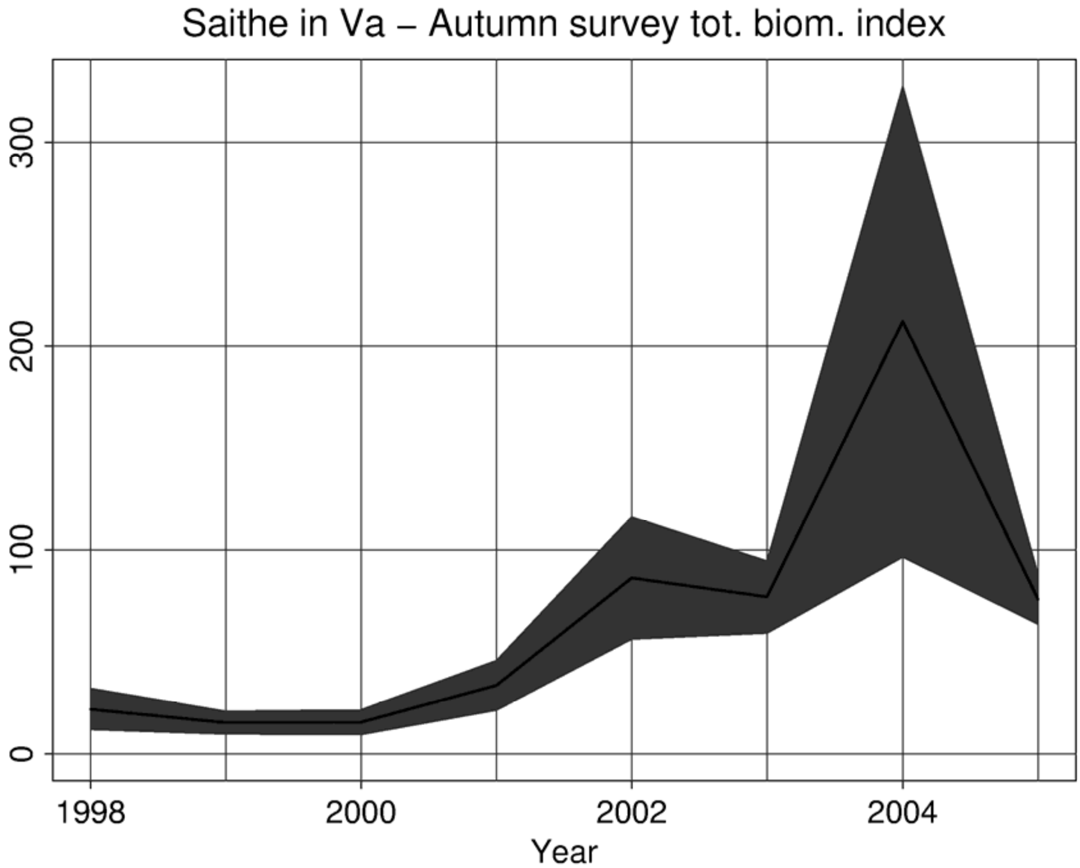


Figure 3.2.7.5. Saithe in Va. Stratified mean survey biomass index from autumn survey 1999-2005.

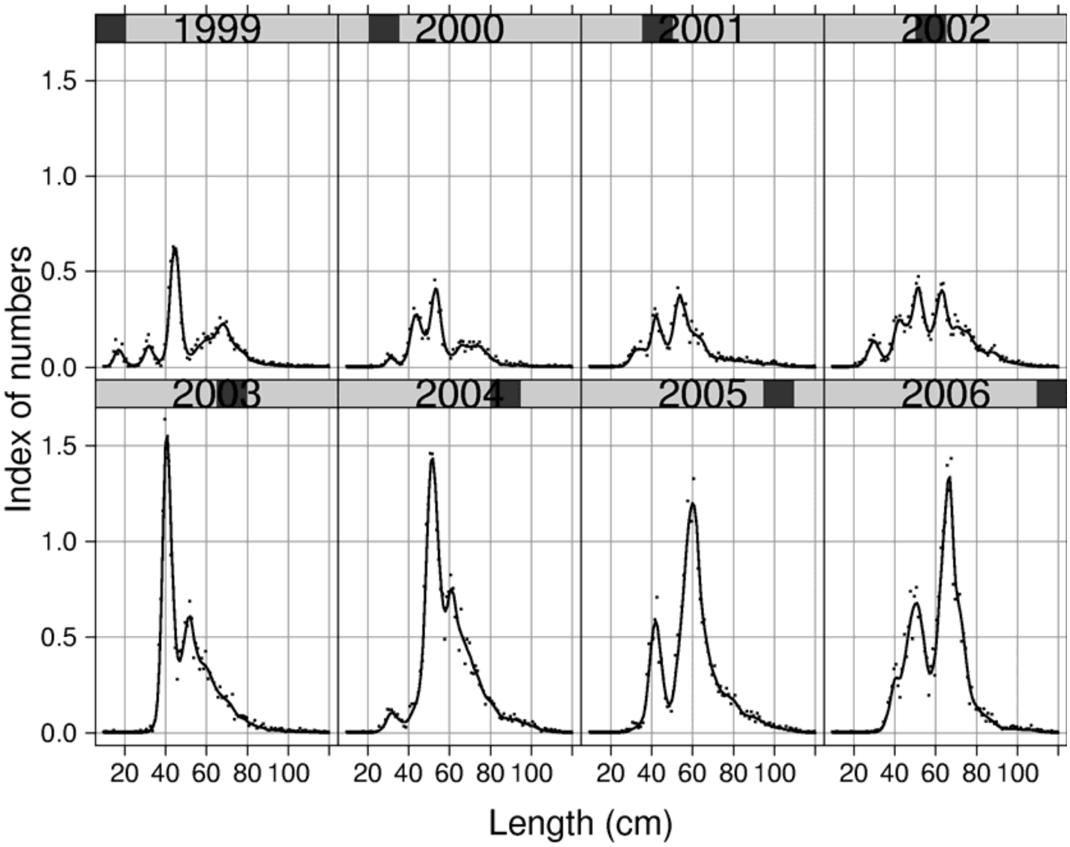


Figure 3.2.7.6. Saithe in Va. Length distributions in IGFS 1999-2006

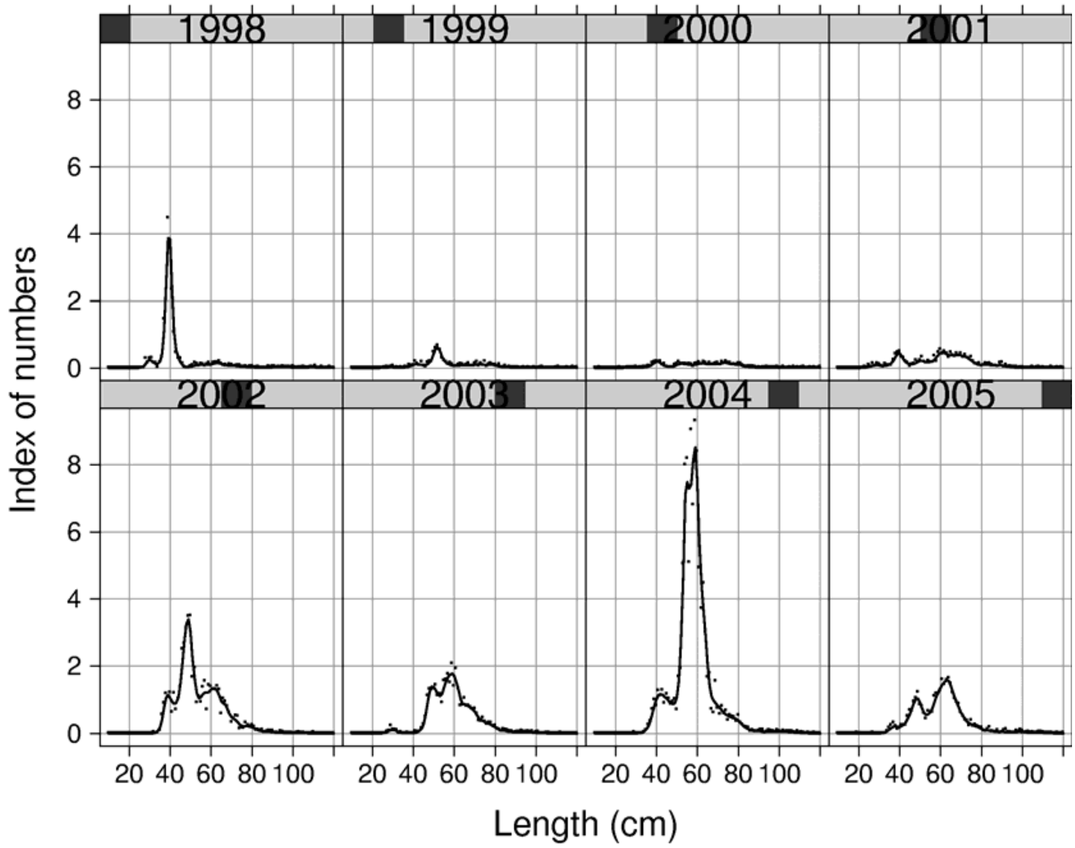


Figure 3.2.7.7. Saithe in Va. Length distributions from autumn survey 1998-2005.

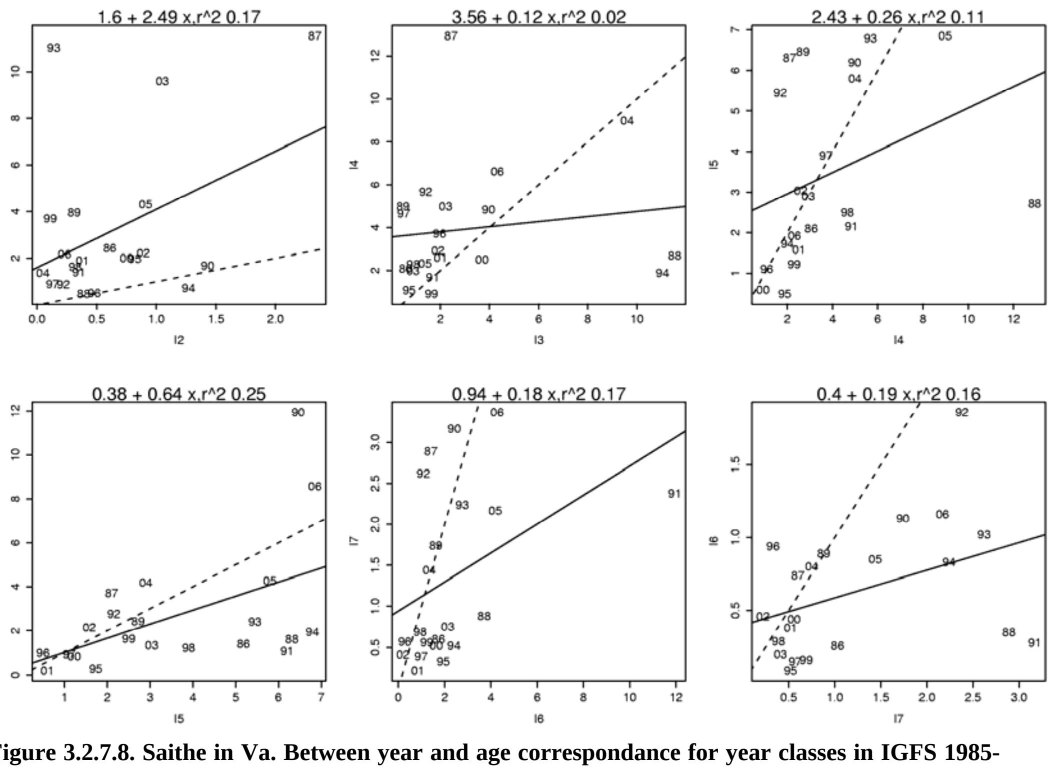


Figure 3.2.7.8. Saithe in Va. Between year and age correspondance for year classes in IGFS 1985-2004 with R^2 from linear fit. Year at older age is shown

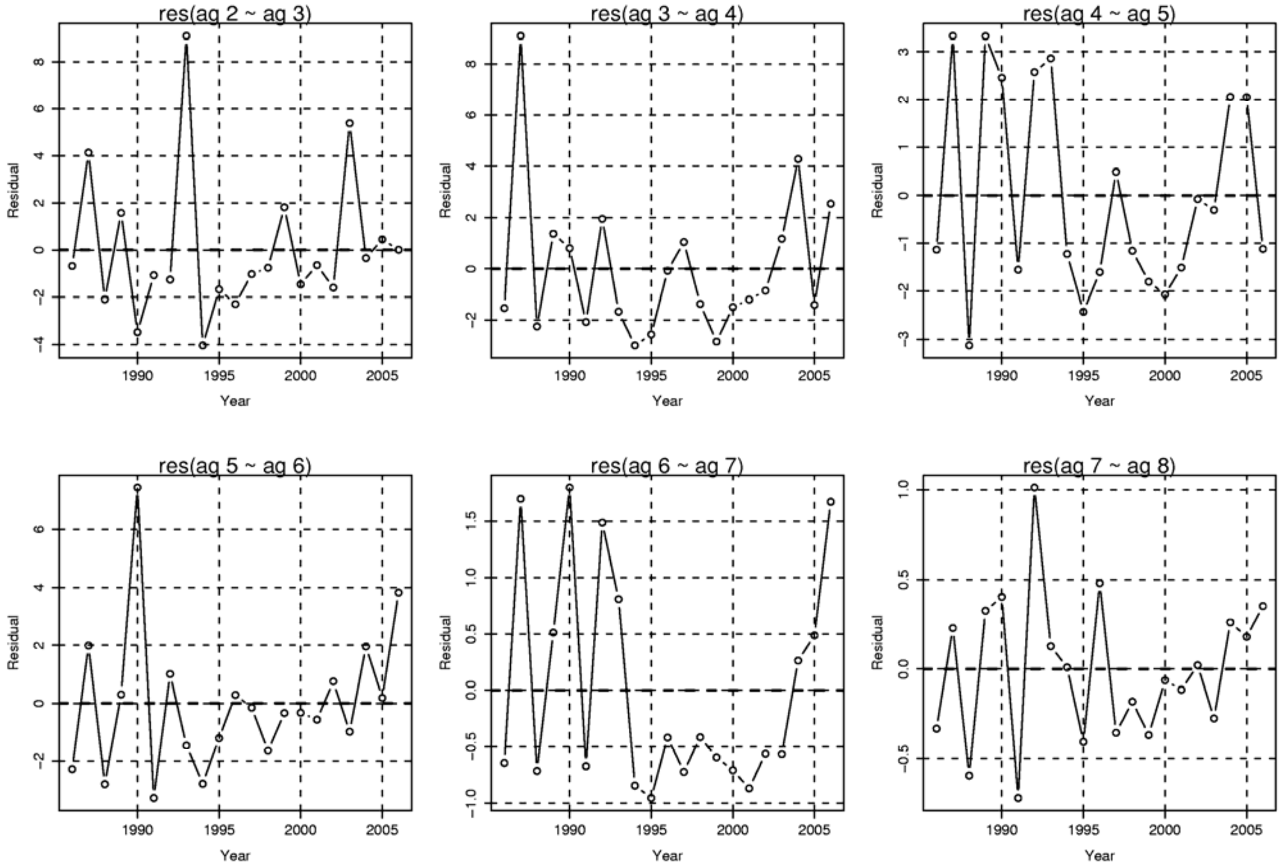


Figure 3.2.7.9. Saithe in Va. Residuals from linear fit between corresponding IGFS survey indices. Year at older age is shown.

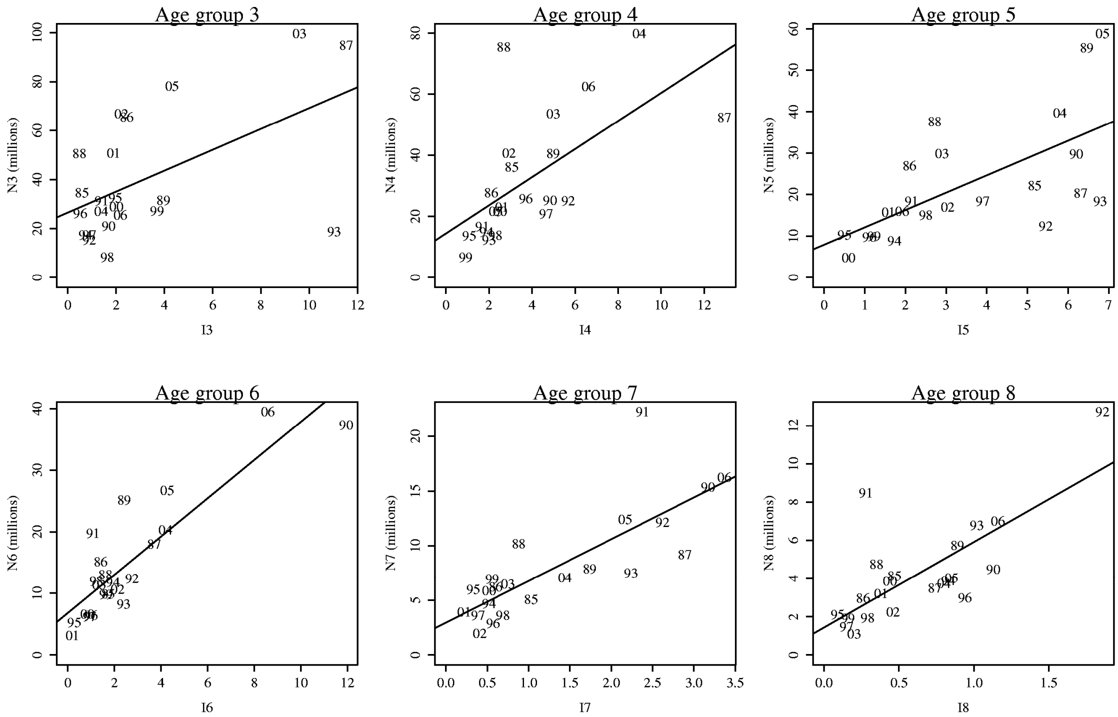


Figure 3.2.7.10. Saithe in Va. Numbers at age from 'SPALY-camera' vs. index at age for age groups 3-8 in 1985:2006

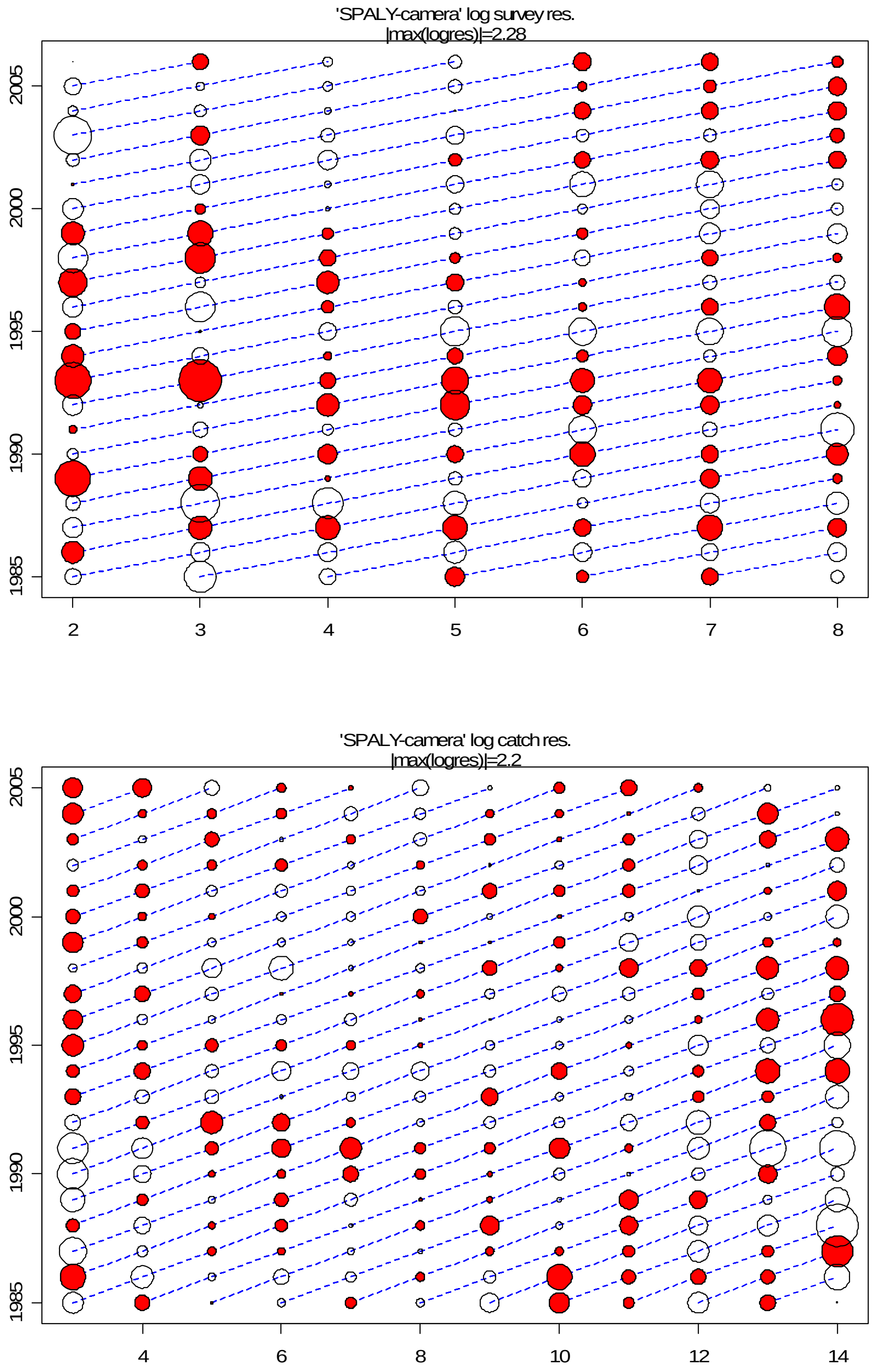


Figure 3.2.7.11. Saithe in Va. 'SPALY-camera' catch (lower) and survey (lower)-log-residuals.

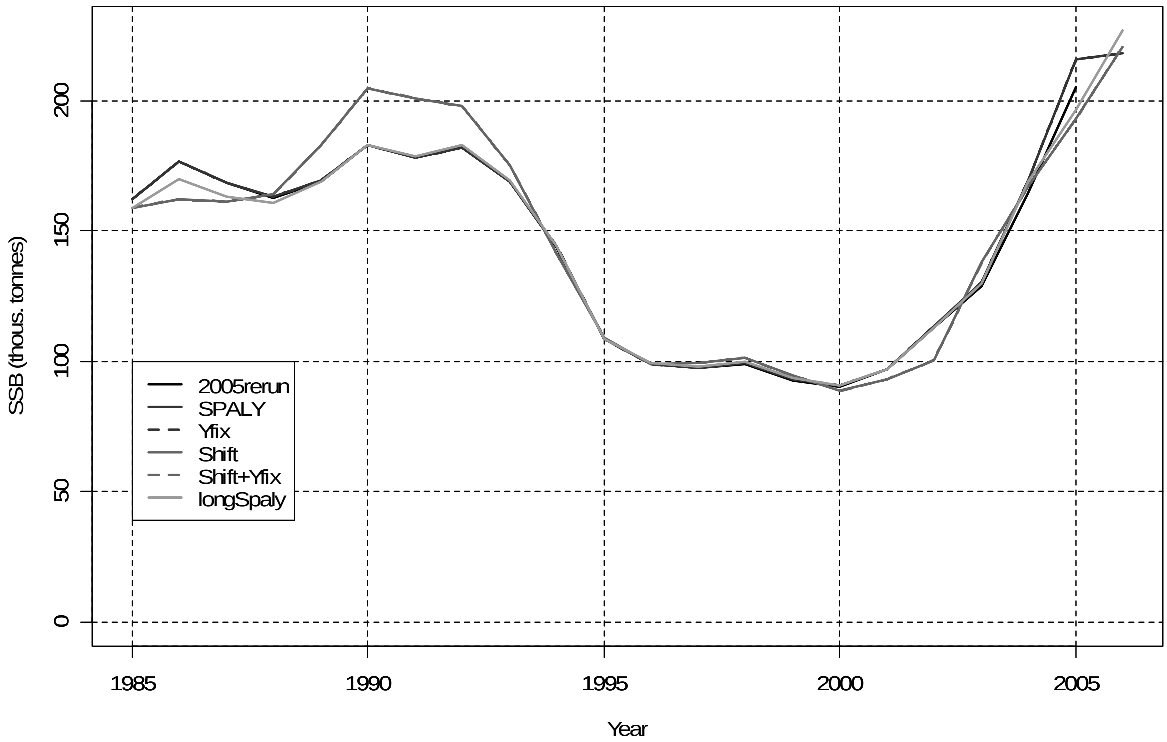


Figure 3.2.7.12. Saithe in Va. SSB from a rerun of 2005 'camera', a SPALY 'camera', a 'SPALY' with total landings input to the model corrected, a run with indices at age shifted to cover the period 1984-2005, a run with shifted indices and corrected landins and from a long SPALY run with inputs from the period 1962-2006.

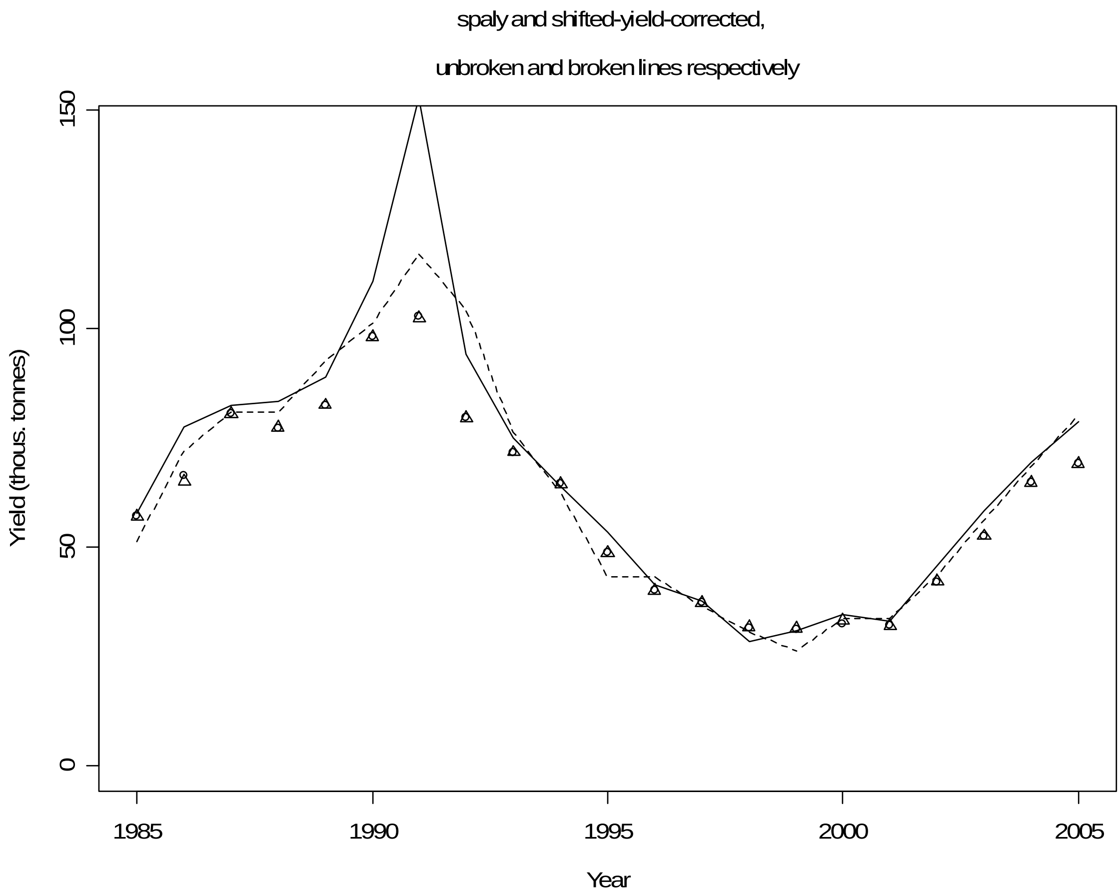


Figure 3.2.7.13. Saithe in Va. Reported landings and predicted yield from SPALY 'camera' and an alternative using shifted 1985-2006 IGFS survey indices at age for tuning over the period 1984-2005.

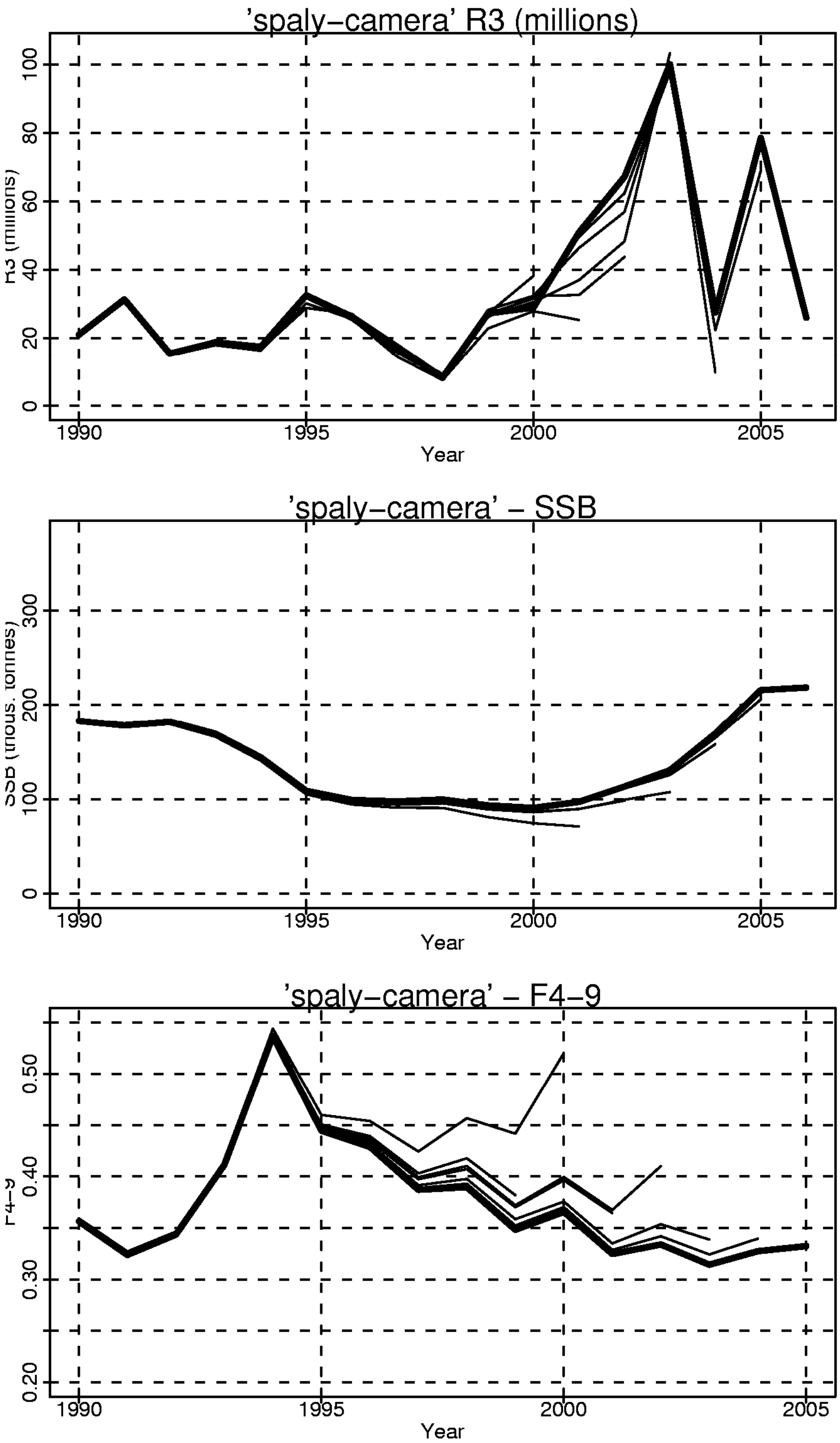
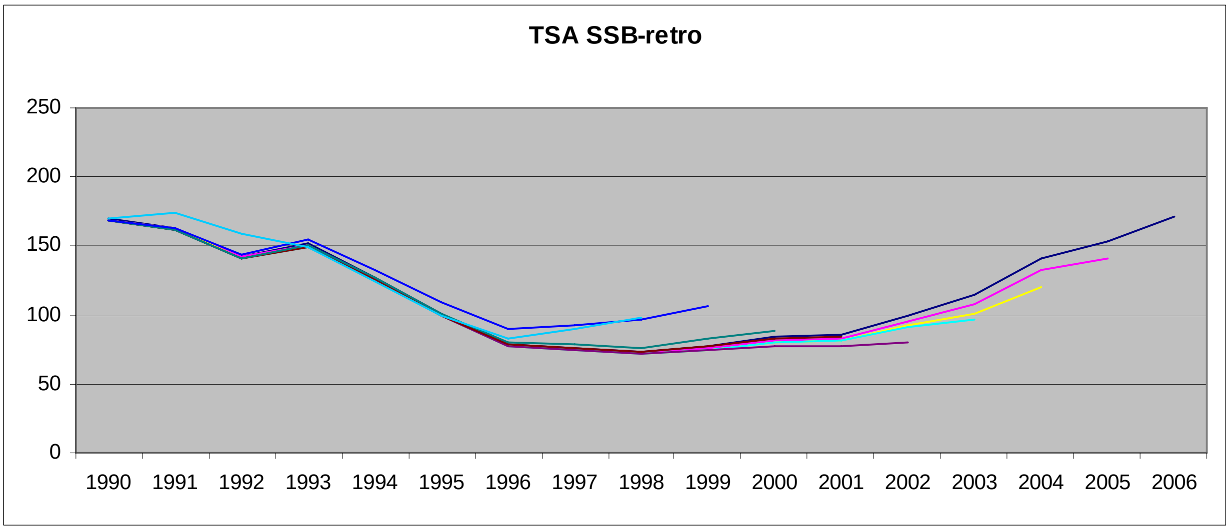


Figure 3.2.7.14. Saithe in Va. Retrospective analysis of 'camera' and R3, SSB and F4-9.



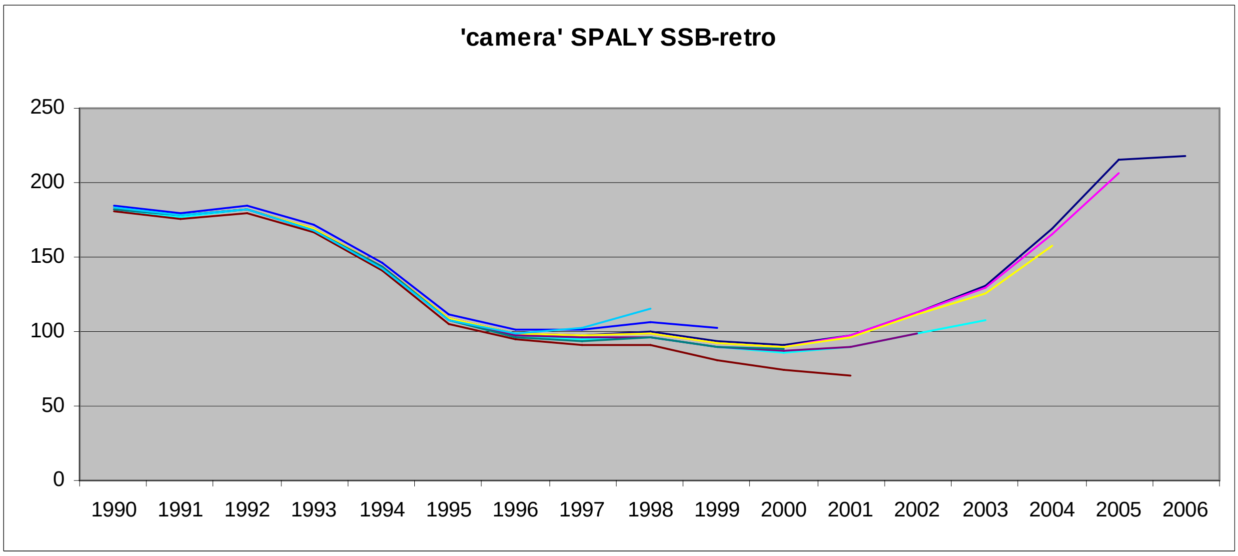


Figure 3.2.7.15. Retrospective analysis of 'camera' and TSA SSB. Note that in TSA, migration is estimated and only indices for numbers at age 3-5 in the IGFS are used.

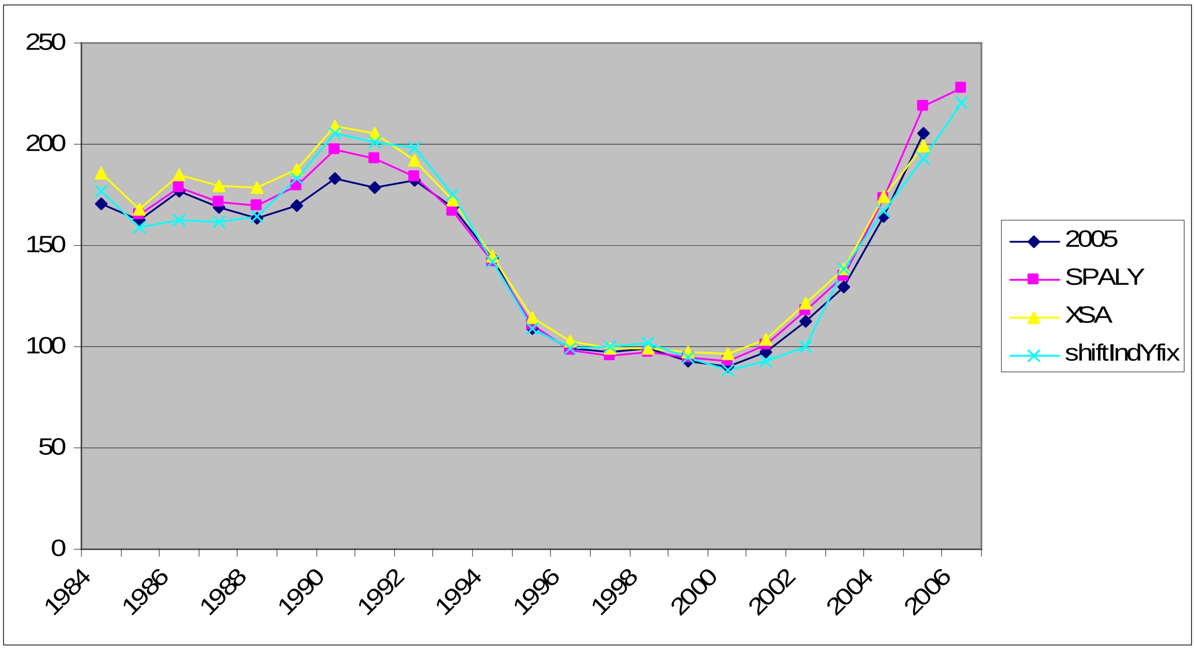
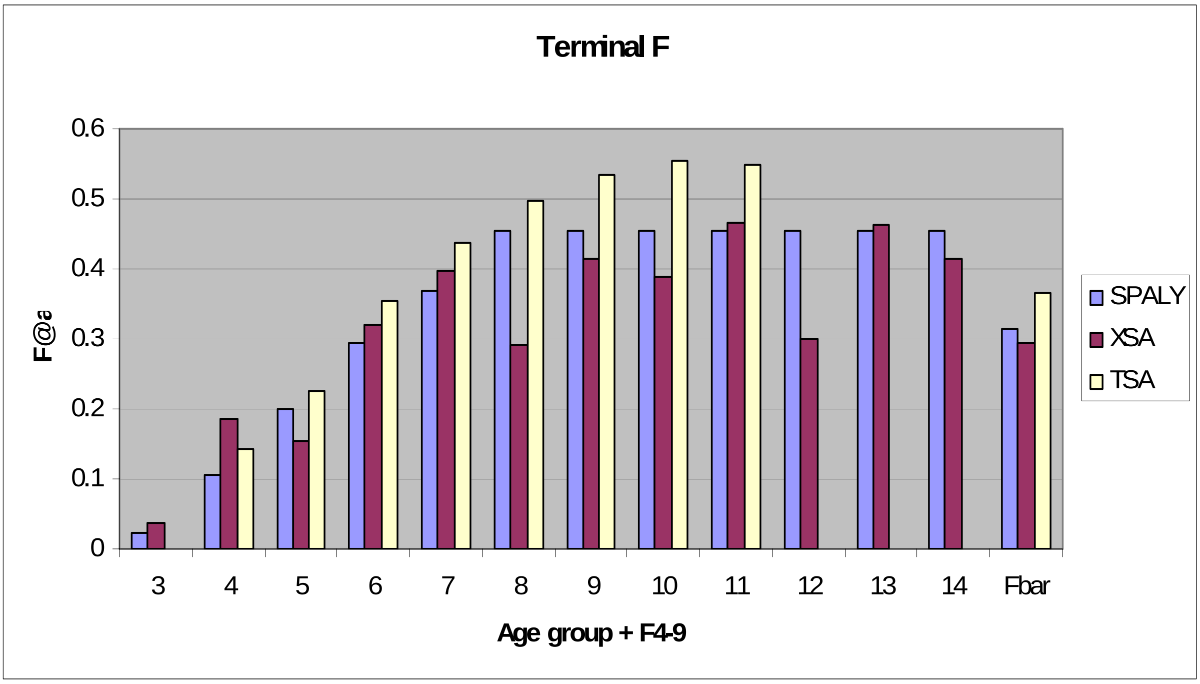


Figure 3.2.7.16. Saithe in Va. Spawning stock biomass from ACFM 2005, SPALY separable model 'camera', XSA, and an alternative with shifted indices.



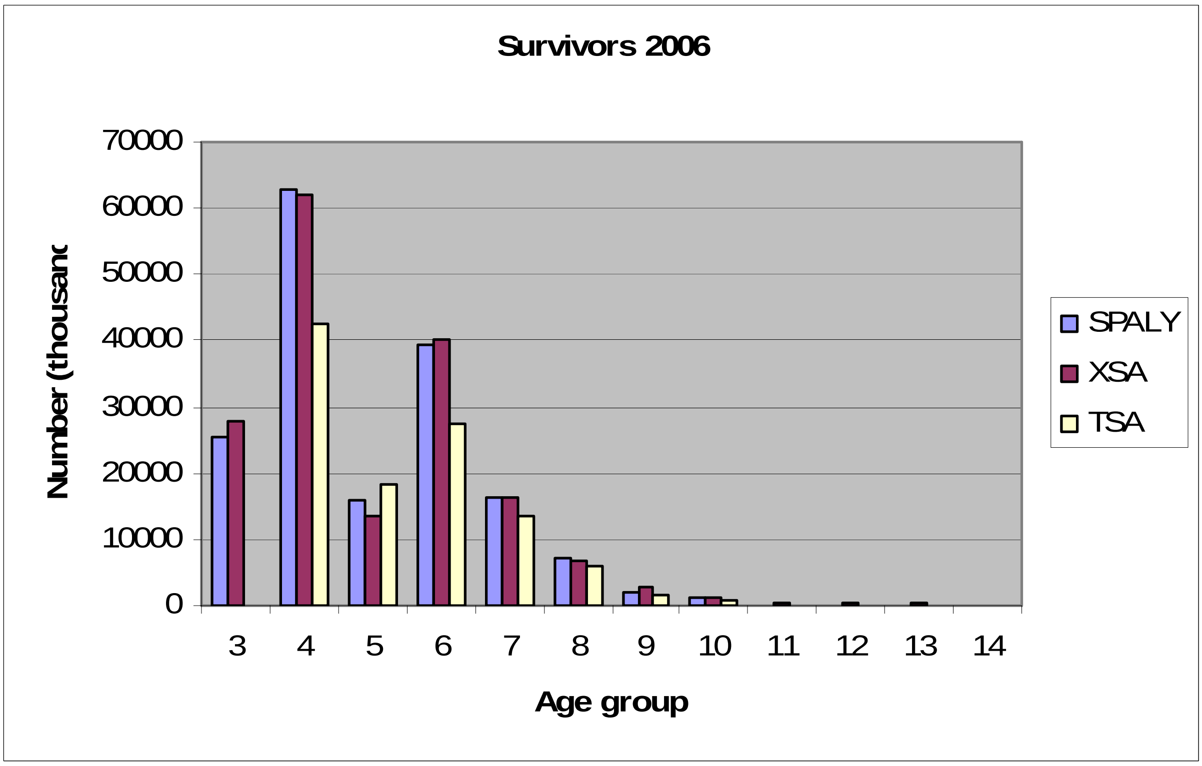


Figure 3.2.7.17. Saithe in Va. Terminal F-at-age and survivors-at-age from 'camera', TSA and XSA. Note TSA starts estimation at age 4.

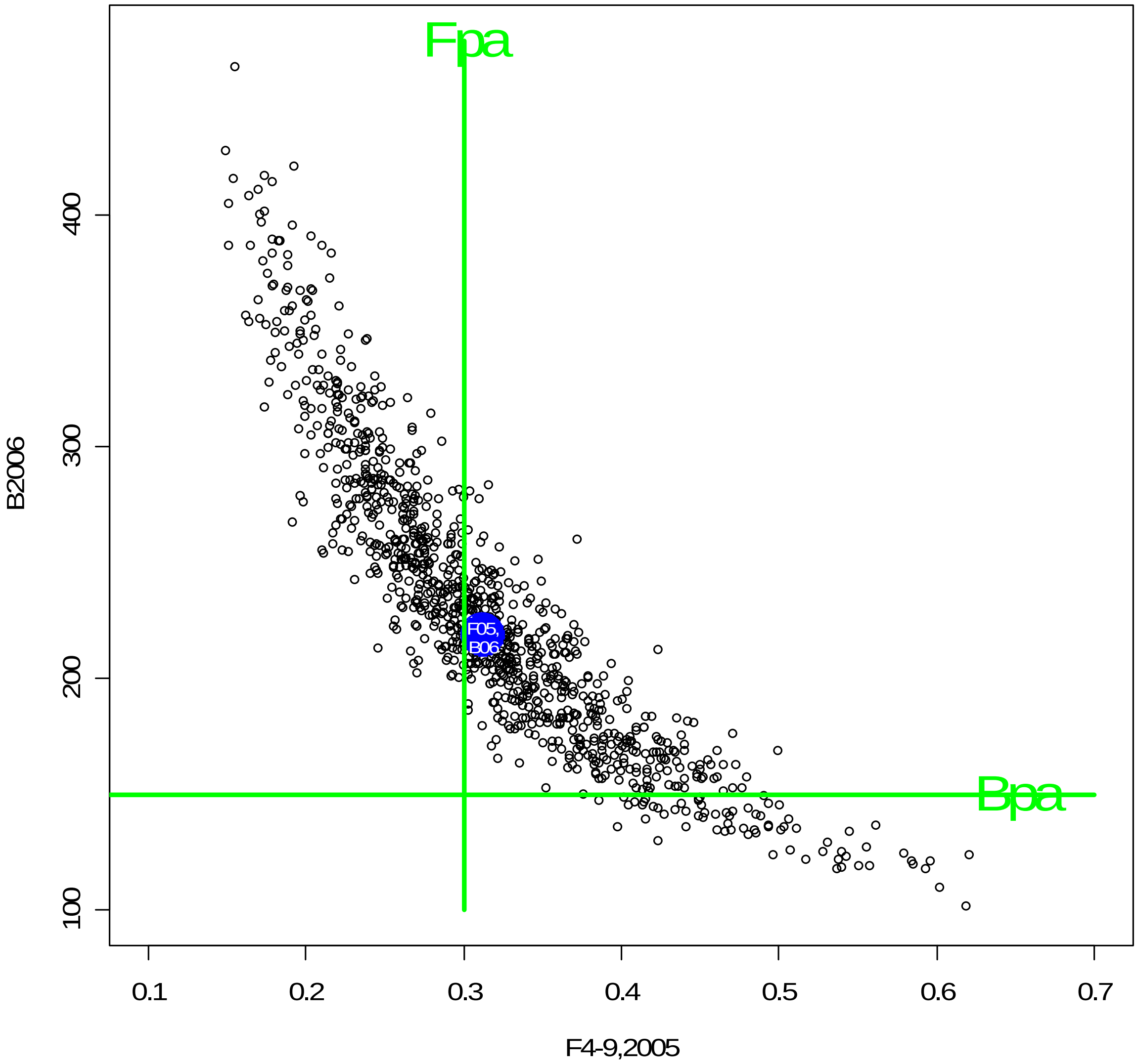


Figure 3.2.7.18. Saithe in Va bootstrap banana. SPALY 'camera' boostrap distribution of SSB2006 vs F2005,4-9 from 1000 bootstrap runs of 'camera' with point estimate from final run. Lines corresponding to Fpa=0.3 and Bpa=150kt. Less than 10% of the bootstrapped biomasses are below 150Kt, ~46% of Fs are below Fpa

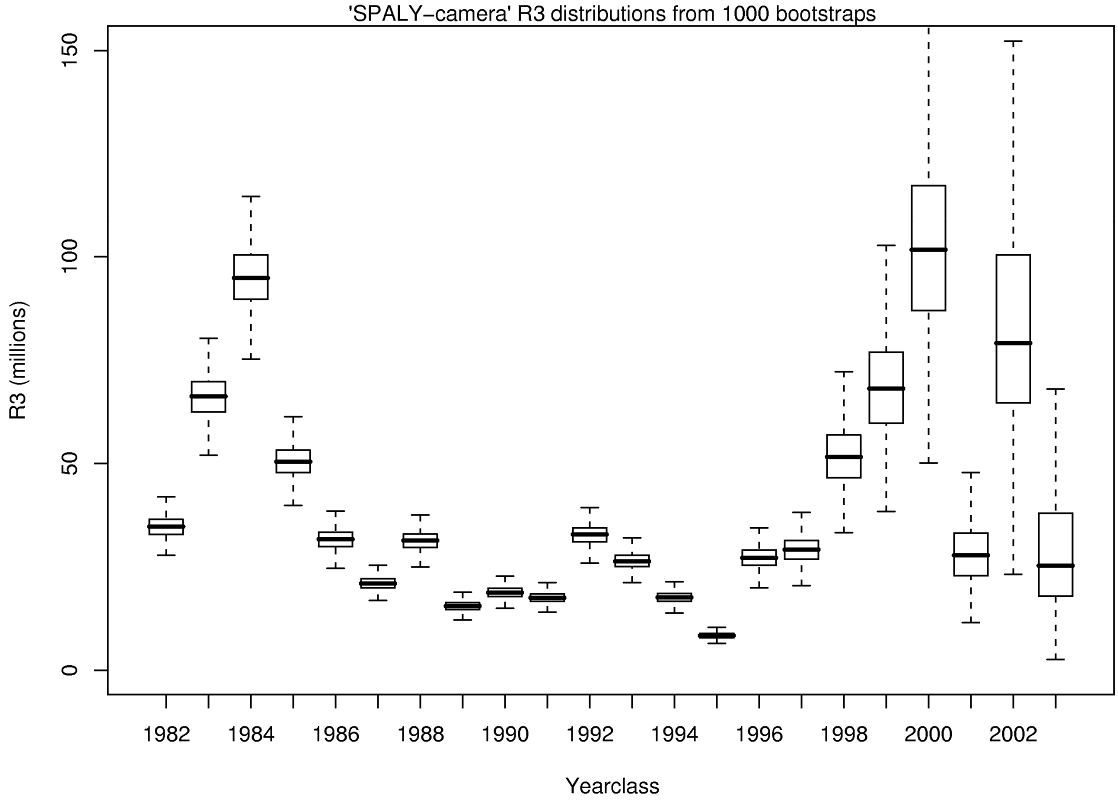


Figure 3.2.7.19. Distributions of recruits at age 3 from 1000 bootstraps of the SPALY 'camera' separable model. Less than 10% of the bootstrapped biomasses are below 150Kt, ~46% of Fs are below Fpa.

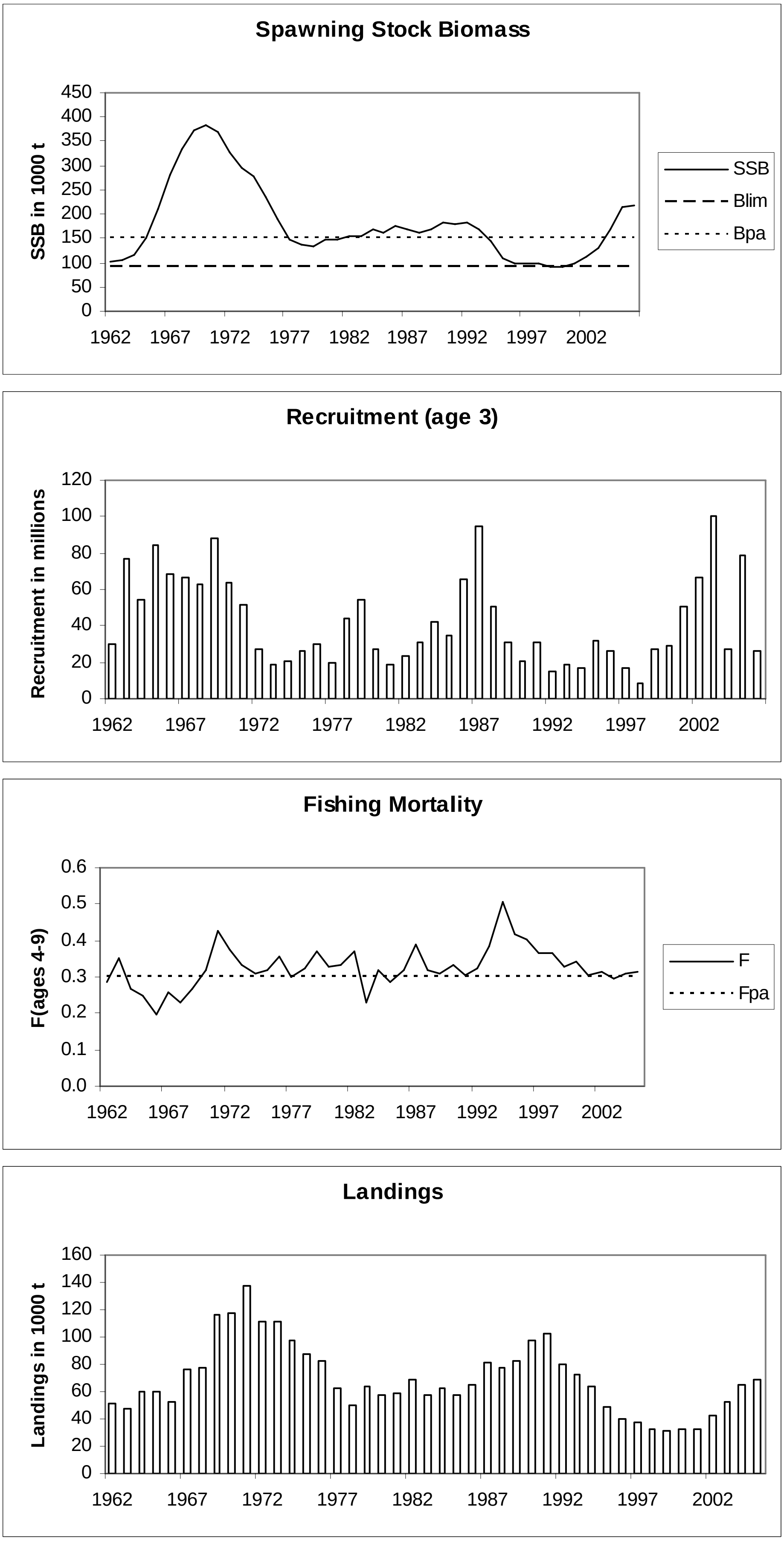


Figure 3.2.7.20. Saithe in Va. Standard plots.

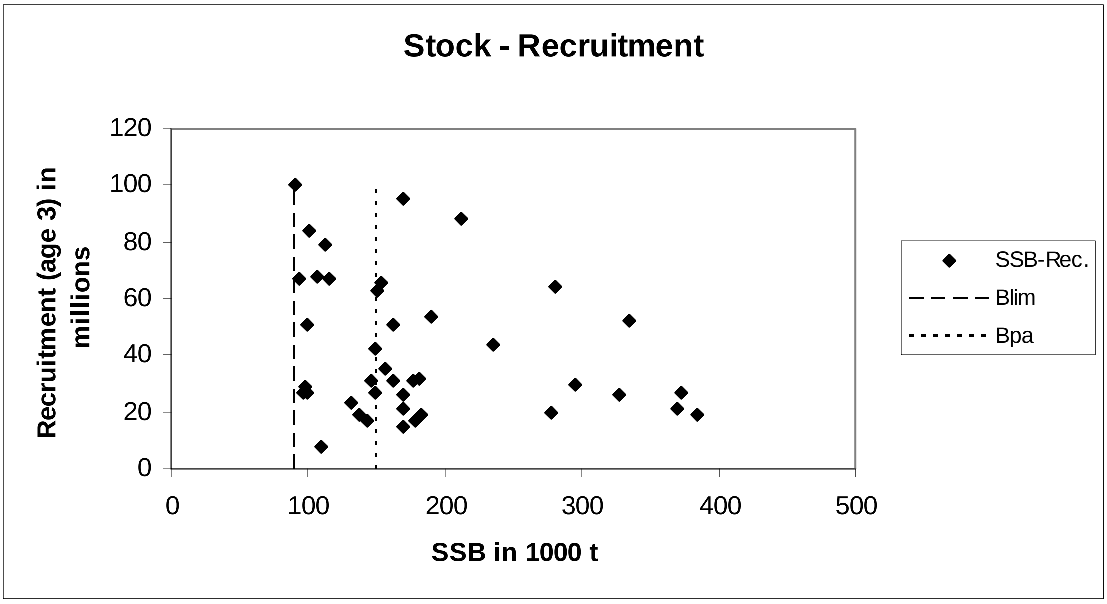


Figure 3.2.7.21. Saithe in Va. Stock recruitment scatter.

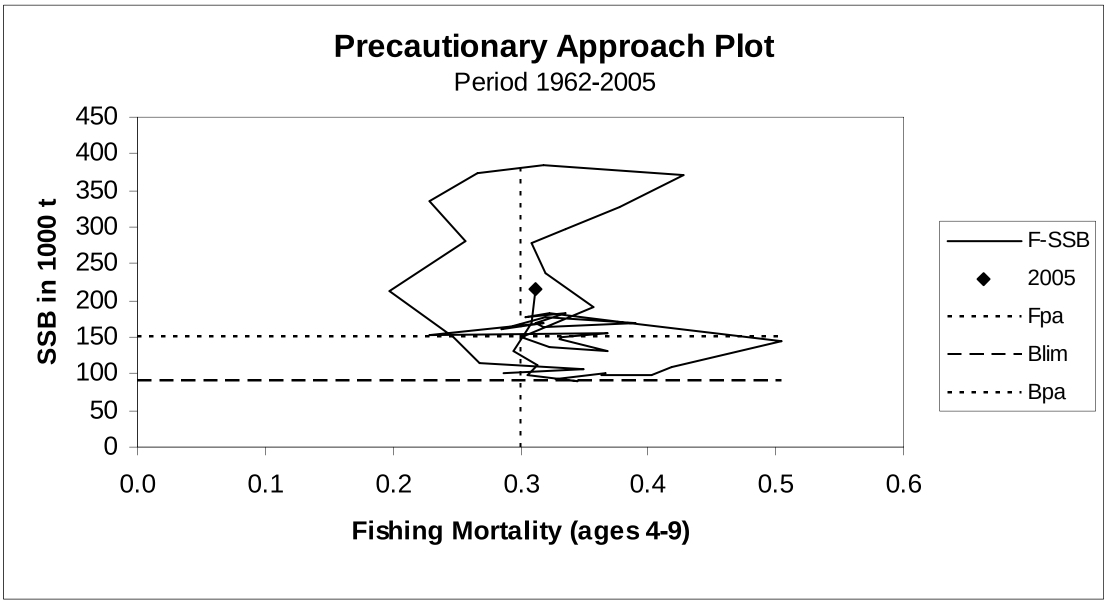


Figure 3.2.8.1. Saithe in Va. Precautionary approach plot.

3.3 Icelandic cod

3.3.1 Summary

3.3.1.1 Input data

The total reported landings in 2005 were 212 thos. tonnes compared to 206 estimated by the working group (now including Faroese landings from the Faroe-Icelandic-ridge of 4 thous. tonnes).

The landings at age in 2005 were in good accordance with last years projections.

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

Total biomass survey index in spring survey 2006 was observed about 15% lower compared to last year but with similiar measurment error (CV) as in 2005.

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 2006 is 756 thous. tonnes compared to 823 thous. tonnes in last years assessment. The reference biomass in 2005 was estimated at 760 thous. tonnes in last year's assessment but in the current assessment at 715 thous. tonnes.

The year classes 2001-2004 were estimated 69, 168, 133 and 110 millions respectively in last years assessment compared to 61, 164, 127 and 87 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 refernce biomass (B4+) will most likely stay around the same level in coming years but a moderate increase in SSB is seen.

The situation now with 3 of the 5 recent year classes estimated poor (2001, 2003 and 2004) and 2002 and 2005 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

In the period 1978–1981 landings of cod increased from 320 000 t to 469 000 t due to immigration of the strong 1973 year class from Greenland waters combined with an increase in fishing effort. Catches declined rapidly to only 280 000 t in 1983. Although cod catches have been regulated by quotas since 1984, catches increased to 392 000 t in 1987 due to the recruitment of the 1983 and 1984 year classes to the fishable stock in those years (Table 3.3.1 and Fig. 3.3.1). During the period 1990-2000 all year classes entering the fishable stock were below average, or even poor, resulting in a continuous decline in the landings. The 1995 catch of only 170 000 t was the lowest since 1942. With increasing effort from 1995 catches increased continuously to 1999 when the estimated landings were 260 000 tonnes but decreased to 235 000 tonnes in the years 2000 and 2001, declined to 202 000 tonnes in 2003 and the recorded landings in 2004 and 2005 were 223 000 and 212 000 tonnes respectively.

According to data presented to the working group this year around 4 thous. tonnes of Faroes annual landings in 2003-2005 were caught at the Faroe-Icelandic-ridge. 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, see Figure 3.3.32 and 3.3.33. On the basis of preliminary sensitivity analysis conducted during the working group metting (WD-31) it was decided not to take these landings into account in this year assessment. See section “3.1.5. Assessment deficiences, data gaps and research priorities”.

A large project which aim is to estimate discards for some of the main species in the Icelandicfishery 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. An analysis of by-catch in the Icelandic blue whiting fishery. Fisheries Research 73:135-146 and draft of 2004 results "bycatchBlueWhiting2004draft.doc" in Relevants reorts). This by-catch is included in the estimated annual landings for 2004.

At the meeting no information was available about by-catch in the blue whiting fishery in 2005.

Misreporting is not regarded as a major problem in this fishery but no analytical assessment is available to support that general perspective. Production figures from Processing plants seem to be in "good" coherence with landings figures according verbal statements from the Fisheries Directorate.

3.3.2.1.2 Sampling intensity

The data samples comprising the age-length keys for 2005 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	347	29005	38	1834	20693
Gillnet	South	Jan.-May	421	24309	678	3482	24900
Handlines*	South	Jan.-May	307	1162	0	0	1100
Danish seine	South	Jan.-May	136	7008	2	100	6000
Bottom trawl	South	Jan.-May	173	11571	47	1054	12400
Longline	North	Jan.-May	109	23309	11	550	12693
Gillnet	North	Jan.-May	57	8761	687	736	3900
Handlines*	North	Jan.-May	15	2739	0	0	1200
Danish seine**	North	Jan.-May	122	1879	0	0	700
Bottom trawl	North	Jan.-May	239	21682	129	1444	23600
Longline	South	June-Dec.	189	14816	10	485	5393
Gillnet	South	June-Dec.	30	3140	1	50	2800
Handlines*	South	June-Dec.	403	2690	0	0	1800
Danish seine	South	June-Dec.	114	4420	3	146	2500
Bottom trawl	South	June-Dec.	42	4377	21	522	3200
Longline	North	June-Dec.	219	43394	21	1047	32093
Gillnet	North	June-Dec.	16	1878	2	99	500
Handlines	North	June-Dec.	38	4081	6	158	3800
Danish seine	North	June-Dec.	115	5160	3	150	3700
Bottom trawl	North	June-Dec.	488	70242	173	2659	45000

*In handlines where there are no age-samples age-length keys from long lines from the same area and season are used. **For Danish seine where there are no length-age keys the keys from bottom trawls are 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. In 2004 and 2005 age 7 and younger accounted for around 95% of the landings in numbers. Predicions last year of catches for 2005 were in most cases an underestimate of catch in numbers.

3.3.2.1.4 Mean weight at age in the landings

In 2005 there is a decrease in mean weight at age in age groups 3 to 7 by 10% compared to 2002 and mean weights at age are near historical low, inspite of this there is a small increase in mean weight at age in age groups 4 to 6 compared to last year. Mean weight at age for age groups 8 to 10 are at a historical low, 20-40% lower than in 2002. The mean weights at age in the landings are shown in table 3.3.5 and figure 3.3.7. The weights at age in the landings are used to calculate the "reference biomass" B4+ used in the Harvest Control Rule.

3.3.2.1.5 Logbooks

The 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. An increase has been observed in bottom trawl in 2001- 2004 but the CPUE in 2005 is observed about the same level in 2004. In longliners a slight decrease in CPUE was observed in 2003 compared to 2002 but increased again in 2004 and this increase continued in 2005.

The increase in effort in 1998-2001 can be explained by overestimation of the stock and the amendment of the HCR in the year 2000. Substantial linear trend in catchability in cpue from commercial fleets has been observed (WD-31, NWWG 2002) and they are therefore not used for calibration of assessment models.

3.3.2.2 Fisheries independent data

3.3.2.2.1 Survey abundance indices

A conventional stratified random type method was used for calculating survey indices. The strata used follow depth contours. The stratified indices were calculated separately for two areas: Northern and Southern area and combined. 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). The total biomass index from the survey is presented in figure 3.3.10.

3.3.2.2.2 Mean weight at age in survey

The calculated annual mean weight at age in the IGS show similar pattern as the weights in landings although survey weights for age 3 to 5 are always considerably lower than weights from the catches from in the same period.

The mean weights at age used to calculate the spawning stock biomass are taken from mature fish in the spring survey for age groups 4-7 and for age 8 and older the weights in the catches are used. The justification is that as a consequence of the random otolith sampling scheme used in the survey and a relatively low abundance of age group 8 and older the mean weight at age for the older fish are poorly estimated from survey data.

The mean weight at age used for calculation of spawning stock biomass are shown in table 3.3.6. and figure 3.3.8.

As the survey data are only available back to 1985 mean weights in the spawning stock prior 1985 were estimated using the relationship between the mean weight at age in the catches to the weights of mature fish in the survey in 1985-2005.

Mean weights at age in the 2006 IGS are at a historical low for ages 2 to 5 which is part of a continous decreasing trend since 2001 for age groups 2 to 6. In age groups 7 and 8 there is a slight increase compared to 2005.

3.3.2.2.3 Maturity at age in survey

In assessments prior to 2004 maturity data from the commercial catch period January-May were used for estimation of maturity at age in the spawning stock. In recent years the quality of maturity data from commercial catches has decreased for various resons as explained in the report last year and in NWWG-2005-WD23.

The observed maturity at age from the spring survey for age groups 3-9 are used for estimation of the spawning stock biomass while for age 10 and older, values from catches are used. The resulting numbers are shown in table 3.3.7. figure 3.3.6.

As the survey data are only available back to 1985 maturity at age weights in the spawning stock prior 1985 were estimated using the relationship between the maturity at age in the catches to the weights of mature fish in the survey in 1985-2005.

3.3.2.3 Analysis of input data

The Shepherd Nicholson model, using landings at age data, gives a CV of approximately 0.2 for age groups 4-10. Catch curves for year classes 1976-2000 are presented in figure 3.3.5.

It should be noted that much higher proportions of the older age groups are taken during the first part of the year and this fishing mortality affects estimation of the spawning stock at spawning time. Since the catch-at-age data have historically only been available for January to May, and not by shorter periods, it is assumed that 60% of those catches were taken during January to March, i.e., before spawning time (Table 3.3.4). Natural mortality before spawning is assumed to be one fourth of the annual natural mortality.

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

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

In figure 3.3.14 the relationships between the survey indices and estimated stock in numbers for age groups 1-9 using 1985-2005 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) as was introduced last year. Correlation of residuals in the survey are modelled as multivariate normal with correlation between ages i and j calculated by $\rho^{|(i-j\,|}$. Investigation of residuals indicated that the residuals of age 1 and 2 should not be correlated with the other age groups and that change was implemented. The correlation coefficient ρ was estimated to by 0.38 for the March survey.

The five different assessment models were run all using the same datasets, catch in number at age, Table 3.3.3, and survey indices, Table 3.3.8, expect for TSA using weighted geometric mean of North and South areas indices, Table 3.3.9. All models assume that catchability in the survey is dependent on stock size for the youngest age groups.

XSA tuning

XSA was run using the same settings as in last years assessment using age groups 1-9 from survey for tuning. To use the latest information available for tuning, the 2006 spring survey indices were moved three months back in time i.e. to end of December 2004. The resulting tuning diagnostic and terminal F's are presented in Table 3.3.10, resulting retrospective analysis in Figure 3.3.16 and Figure 3.3.17 and the log catchability residuals in Figure 3.3.18. The estimated terminal reference F (average of age groups 5-10) is **0.57.**

TSA

The results of the TSA run are presented in Table. 3.3.11. The test statistics from standardised residuals of prediction errors of catches and survey indices seem satisfactory. (Table 3.3.11 and Figure 3.3.18) (see also WD#33). The results from corresponding retrospective analysis are presented in Figures 3.3.16-17. The terminal reference fishing mortality based on this run is **0.56**.

ADAPT

The ADAPT type model model estimates the survivors in the beginning of the assessment years an backcalculates from there using Popes equation. On the right side the fishing mortality of the oldest age is the weighted mean of the fishing mortality of the two agegroups next to it. The recruitment model, the survey tuning model and the prognosis module are the same as in the ADCAM model and the model does stock estimation, recruitment estimates and prognosis in the same run.

The estimated fishing mortality rates in the final year and stock in numbers in 2006 are presented in Table 3.3.13. The terminal reference fishing mortality is estimated **0.56**.

X-CAM

A fixed separable CAEGIAN type of model using c@age for the years 1985-2005, ages 3-11 (age 11 as a plus group) and indices@age from spring survey for ages 1-9. Same lamda weight applied to each source of information and a yield penality added.

The estimated fishing mortality rates in 2005 and stock in numbers in 2006 are presented in Table 3.3.13 and Figures 3.3.19-3.3.20. The terminal reference fishing mortality is estimated **0.45**.

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 **0.56**.

3.3.3.2 Final assessment

Comparison of the retrospective results from three 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 AD-CAM 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 expect for TSA show positive blocks in survey residuals in 1998 when catchabilty in survey is assumed to have been exceptionally high. In the TSA model catchabilty is estimated and partly corrected for and also different weightings are used for combining North and South indices.

In Table 3.3.13 and Figures 3.3.19-21 a summary of the resulting terminal fishing mortalities and estimated, biomass and stock in numbers in 2006 from the different models are presented. The estimated stock in weight (4+) in the beginning of 2006 from the three models used are similar or in the range of 706-811 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 0.56-0.57 expect from the X-CAM, 045, which is reflecting the difference in the older ages. The estimated stock in numbers in the beginning of 2006 from all models are well within one standard error of the AD-AM model results (Figure 3.3.24).

For the last three years the NWWG has concluded that the ADCAM modelling approach is the most appropriate since it provides stock and recruitment estimates within the same statistical and operational framework including probability profiles. Medium term projection 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 2006 from the AD-CAM model is 756 thous. tonnes with standard error of 39. The resulting fishing mortalities are given in Table 3.3.14 and in Figure 3.3.22B. The fishing mortality increased to a peak in 1988, dropped markedly in 1995-1997 due to restriction of the cod quota but then rose to another peak in 1999-2001. In recent years the reference fishing mortalities are estimated to have been around 0.60.

3.3.3.3 Short term projections

3.3.3.3.1 Input data to the short-term prediction

Prior to 2004 the catch weights at age had been predicted from the weight at age of the same yerarclass in the previous year and predicted size of the capelin stock. This regression had given reasonable results for some years but had led to overestimation of the weights in some recent years, due to reduced availability of capelin and/or overestimation of the capelin stock. 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 assesment 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 ltwo previous years but the linear model assumed an average growth. Last year a result from 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 in gain in predicting power or resulting advice compared to the simple approach of using last years observation for the mean weight at age in the catches in the assessment year and the following year. On the basis of this analysis and that no informations 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 mean weight 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.

Survey weights are not used in the assessment as the weights at age in landings are used to calculate the "reference biomass" used in the HCR.

The analysis conducted in last year on comparison of different methods of predicting mean weight at age was upddated this year giving similar results (WD-32). On the basis of that analysis, and still no informations are available about the capelin stock size, the the working group decide to use same procedure as last year for mean weight at age predictions. The mean weight at age in the catches in 2005 were used for 2006 and onwards and for SSB weights in 2006 for weights in 2007 and onwards.

The exploitation pattern used for the short-term predictions was taken as the average of the years 2003–2005.

Based on the reported landings in the first month of the 2005/2006 fishing year and an assumption of the use of harvest control rule for the coming fishing year the expected catch in 2006 will be a around 204 000t corresponding to F=0.52. A yield constraint is used for this stock since the yield forecasts based on TAC have historically been relatively good.

The size of the year classes 2001–2004 as estimated by the various models give all similar results expect for TSA giving 2-10% 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 erros (WD-31 (tittlingaskítur)) 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 2009 with different management options are presented in Table 3.3.19.

The resulting TAC according to the harvest control rule in the 2006/2007 fishing year will be 188 000t. The SSB will increase to about 250 000 t in 2007 and the resulting reference fishing mortality is about 0.48. The estimated age distribution of the catches and SSB in 2007 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 1985–2005 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 curvewith no trend in Rmax. The point of maximum recruitment in the Ricker curve is probably close to Bmsy and is put in Figure 3.3.30 for reference. 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} (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.

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 Harvest Control law was followed.
- Assessment error was assumed to be lognormal with CV of 15% and autocorrelation 0.2.
- The SSB-recruitment relationship used are described in Table 3.3.12
- Deviations in weights at age were assumed to be lognormal with CV 0.1 and autocorrelation 0.35. The same deviations were applied to all age groups in the same year. The values are based on examination of weight at age in the catches 1980-2003. Errors in weights at age and assessment errors were not correlated but it is likely that sudden reduction in weight at age will not be predicted and lead to too high catches.

The results of the simulations are shown in figures 3.3.27-30. The results indicate that SSB and the catchable biomass 4+ will most likely stay around the same level in coming years.

3.3.3.7 Harvest control rule scenarios

Medium term simulations were performed looking at 3 different HCR. All of the HCR are implemented as proportion of reference biomass which is the estimated number at age 4 and older in the beginning of the year multiplied by the weights at age in the catches the same year. The scenarios investigated are.

The currently implemented HCR where the TAC the next fishing year is 25% of the mean of the reference biomass in the beginning of the current year and the beginning of next calendar year. In addition interannual changes in TAC are limited to 30 kT.

The proposed HCR by the "long term committee" where the TAC for next fishing year is the mean of last fishing years TAC and 22% of the reference biomass in the beginning of the current year.

In their work the long term commitee used as criterion to maximize the current value of the revenue from the fisheries. The results indicated that ratios from 19 to 23% of the reference biomass gave optimal results. Therfore 20% of the reference biomass was one of the scenarios investigated.

Figure 3.3.28 and Figure 3.3.30 shows the development of the spawning stock according to the 3 HCR. They indicate that the currently adopted HCR will most likely not lead to any noteworthy increase in the SSB in the period but the rules taking lower proportion of the stock will lead to some increase. Figure 3.3.29 show the TAC from the three scenarios and show that most likely the TAC will not change much in the period. The difference in spawning stock between the scenarios is close to the difference in catches at the yield per recruit curve is relatively flat and the simultion is not for long enough period for improved recruitment at larger spawning stock to affect the results. Medium term projections are similar to last years except for the projected median values for SSB and yield are approximately 10% lower.

3.3.4 Management considerations

3.3.4.1 Management measures

Catch quotas for the Icelandic cod stock have since 1994 been based on the 25% catch rule. This catch rule was based on extensive simulations and has been considered precautionary. Until year 2000 the Icelandic government followed the catch rule with minimal deviations although it has turned out that the TAC has exceeded the 25% rule due to overestimation of the stock. In 2000 the Icelandic government, after some limited studies by the MRI, changed the adopted 25% catch rule by limiting the allowed changes in TAC between consecutive years to 30 thousand tonnes. The catch control rule was in a reviewing process in 2001-2004 by a group of scientists appointed by the Ministry of Fisheries. This group delivered a final report to the Minister in May 2004. The report has not been published and is only available in icelandic. Based on simulation work the group recommended a new HCR using the average of last years TAC and 22% of the estimated reference biomass (B4+) in the assessment year. This HCR has still not been adopted.

3.3.4.2 Technical management measures

- A quick area closure system is in force allowing inspectors to close fishing areas for maximum two weeks if the proportion of 55 cm cod or smaller exceeds 25% in numbers. If the same area has been closed two times or more consequently, the Ministry of Fisheries, on the basis of an advice from the MRI, can close the area more permanently by specific directive. Numerious areas are closed temporarily or permanently for all fisheries or specific gears for protecting juveniles, or for social-political reasons.

- The minimum allowed mesh size in codend of bottom trawl and Danish seine is 135 mm.
- For the gillnet fishery both minimum and maximum mesh-sizes are restricted. Since autumn 2004 the maximum allowed mesh-size in the gillnet fishery is 8 inches. The objective of this measure is to decrease the effort directed towards bigger spawners.
- Since 1995 the main cod spawning areas are closed for all fisheries for 2-3 weeks during the spawning season with the objective to decrease the disturbance on the spawning grounds during spawning and thereby increase the probability of successful spawning.

3.3.4.3 Evaluation of management measures

Since the implementation of the catch rule in 1995 realised reference fishing mortalities have been in the range of 0.51-0.76, in last three years 0.56-0.59. The expected long-term fishing mortality by the application of catch rule was 0.4. At present fishing mortality is high (F5-10 in the year 2005 about 0.6) and age 9 and younger fish account for 99% of the fishable biomass(4+) in 2006. Spawners at age 10 and older will constitute only to about 5% of the spawning stock biomass in 2007. 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).

3.3.4.4 Comments on the assessment

The current assessment compared to last years assessment indicates a slight overestimation in 2005. Recent years assessments are more consistent with previous years assessments compared to the assessments in 1998-2000 were substantial overestimation was observed. As in four 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 2005 was estimated at 760 thous. tonnes in last year's assessment, the current assessment estimate of biomass 4+ in 2005 is 715 thous. tonnes. The observed mean weight at age in the catches in 2005 were slightly higher than predicted hence the estimated decrease in biomass 4+ in 2005 is mainly do to lower estimates of stock in numbers.

The year classes 2001-2004 were estimated 69, 168, 133 and 110 millions respectively in last years assessment compared to 61, 164, 127 and 87 in the current assessment. Retrospective pattern of recruitment estimates in recent years, both historical and analytical, indicate constant downward revision.

The situation now with 3 of the 5 recent year classes estimated poor (2001, 2003 and 2004) and 2002 and 2005 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.

3.3.5 Assessment deficiencies, data gaps and research priorities

No serious assessment deficiencies or data gaps have been revealed for stock in recent years expect for observed downward revision of recent year classes. The relatively high positive residuals in 1998 survey data and overestimation of the stock in 1998-2000 still remain unexplained although the retrospective pattern of the models used for assessing the stock in recent years are not showing serious deviations in these years.

As stated in section 3.1.2.1.1 data was presented to the working group this year which indicates that for the last three years around 4000 tonnes of cod were caught by Faroese fishermen on the Icelandic-Faroe Ridge.. All available information indicate that these catches are more likely to be Icelandic cod than Faroe Plateau cod. These catches represent an average of 2% of the total landings of Icelandic cod in the years in question. A sensitivity analysis run during the meeting indicated that the raising of the catches by 2% had minor influence on the stock assessment, both in terms of the status of the stock and the status of the fishing (WD-31). WD-31 also addressed other issues, such as incomplete survey coverage in the south eastern area as well as changes in gutting conversion factors by the Icelandic management authorities (resulting in different scaling of the landed catches in the time series) in the sensitivity analysis. Some ad hoc assumption were made regarding these latter factors as input measures. All the analysis showed final point values of modeled stock numbers are not very sensitive to these different assumption on the input values. The assessment of the Icelandic cod is for all practical purposes done and reviewed nationally prior to the WG meeting. It was thus concluded that it would be more appropriate to do a more thorough analysis of all these factors next year rather than just include one factor and exclude others.

Several research projects are conducted at the MRI dealing with cod reflecting the research priorities. Among others, projects are ongoing dealing with following: population structure with respect to management, the effect of fisheries on life history traites, the potential effects of capelin catches on yield of cod.

3.3.6 Ecosystem considerations

3.3.6.1 Ecosystem effect on the stock

Several important biological interactions in the ecosystem around Iceland are connected to the cod stock. The single most important interaction is the cod-capelin connection (Pálsson, 1981) 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). This year, as was also the case last year, no estimates are available for capelin stock size.

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

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

3.3.6.2 Fishery effect on the ecosystem

Iceland is currently 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 shows 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.

3.3.6.3 Technical interactions

A number of fleets operate in Division Va. The primary gears are described in Section 3.3.2. Earlier work by this group included the separation of catches into finer seasonal and areal splits, but this has not been taken further in recent meeting.

A numerical description of interactions between fisheries and species requires data on landings as well as catches in numbers at age of each species by gear type, region and season.

3.3.7 Icelandic cod (Quality handbook)

3.3.7.1 Stock definition

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

3.3.7.2 Fisheries dependent data

3.3.7.2.1 Sampling protocol

In recent years emphasis has been put on relating the sampling scheme to the landings database automatically, calling for samples when certain amount has been landed 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 long lines, bottom trawl, gillnets, hand lines and Danish seine, seasons January-May (spawning season) and June-December and regions North and South. Historically, there have been some changes in fleet definitions and thus there does not currently exist a fully consistent set of catch-at-age data on a per-fleet basis. In some cases samples are not available for a cell or 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 is calculated 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 3.3.7.

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.

3.3.7.2.2 Catch rate and effort data (log books)

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

The unstandardised CPUE indices and effort from the commercial fleets since 1991 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 2002-2003 a decrease in effort was observed for trawlers and gillnetters but an increase in 2003 by longliners. CPUE for gillnets has been decreasing since 1997 but an increase has been observed in bottom trawl since 2001 and a slight decrease in 2003 by longliners. The increase in effort in 1998-2001 can be explained by overestimation of the stock and the amendment of the HCR in the year 2000.

3.3.7.3 Fisheries independent data

3.3.7.3.1 Survey description

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

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

3.3.7.4 Assessment input data

3.3.7.4.1 Survey abundance indices

Survey abundance indices are age disaggregated and represent

3.3.7.4.2 Mean weight at age

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

3.3.7.5 Stock assessment model

3.3.7.5.1 Present input data

Weights at age in the landings are used to calculate stock biomasses. with the exception of the spawning stock biomass (see section 3.3.3.2.2).

In previous assessments data from the commercial catch period January-May were used for estimation of mean weights at age in the spawning stock and maturity at age. Because of the selectivity of the commercial fishing gears only the largest individuals of the youngest age groups are represented in samples from landings leading to overestimation of both mean weight at age and proportion mature at age for the youngest fish. Using data collected in the

Icelandic groundfish survey (IGS) is considered to provide a better estimates of mean weights at age in the spawning stock as well as maturity at age, at least for the youngest fish. The survey takes place near spawning time, sampling is performed with small meshes in the trawl codend and it covers the distribution of cod. As a consequence of the random otolith sampling scheme used in the survey and a relatively low abundance of age group 8 and older the mean weight and maturity at age for the older fish are poorly estimated from survey data. For these reasons the mean weights at age used to calculate the spawning stock biomass are taken from mature fish in the spring survey for age groups 4-7 and for age 8 and older the weights in the catches are used. The observed maturity at age from the spring survey for age groups 3-9 are now used for estimation of the spawning stock biomass while for age 10 and older, values from catches are used. The mean weight at age used for calculation of spawning stock biomass are shown in table 3.3.6. and figure 3.3.8. and the maturities in table 3.3.7. figure 3.3.6.

As the survey data are only available back to 1985 mean weights in the spawning stock prior 1985 were estimated using the relationship between the mean weight at age in the catches to the weights of mature fish in the survey in 1985-2004. The same procedure was used for maturity at age using the relationship between proportion mature in the survey and in samples taken from the catches January-May 1985-2004.

3.3.7.5.2 Predictions

For long-term predictions, fluctuating environmental conditions can be ignored, but it is essential to take into account potential changes due to density-dependent growth. These have been investigated for this stock (Steinarsson and Stefánsson, 1991 and ICES 1991/Assess:7) where no signs of density-dependent growth were found. However, the results in Schopka (1994) contain indications of some density dependence of growth and this will affect the long-term results at low fishing mortalities. This is not taken into account in typical yield-per-recruit calculations. Effect of catch on mean weight at age by selection of the largest individuals of incoming year classes is also an important effect not taken into account.

Naturally, any stock-recruitment relationship will affect yield-potential calculations and this is not taken into account in the yield-per-recruit calculations.

Average exploitation pattern for the last three years and mean weight at age and maturity at age over the years 1982−2003 has been used as input (Table 3.3.25).

3.3.7.5.3 Present model setup

ADCAM

Input data and estimated parameters:

- The model used catchdata from 1955 to 2003 and survey data from 1985 – 2004. Age groups included are 1-10 in the survey and 3 – 14 in the catches.

Parameter settings and assumptions used:

- Fishing mortality was estimated for every year and age.
- Recruitment was assumed to be lognormally distributed around a Ricker curve with the CV of the lognormal distribution estimated. Timetrend in Rmax of the Ricker curve was allowed and CV of the residuals in the SSB recruitment relationship depend on stock size. The SSB – recruitment relationship was based on spawning stock based on maturity at age from the survey, predicting the survey maturity at age backwards in time from the observations from the catches.
- Migrations for specified years in specified ages are estimated (specify which year and which ages).

- Catchability in the survey was dependent on stocksize for ages 1-5.
- CV of commercial catch data and of survey indices as function of age are estimated. The CV of the commercial catch is a parabola but estimated separately for each age in the survey (change from last year when it was also a 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.

Table 3.3.1 Icelandic cod division Va. Nominal catches (tonnes) by contries 1997-2005 as officially reported to ICES.

Country	1997	1998	1999	2000	2001	2002	2003*
Faroe Islands	408	1,078	1,247				
Germany	-	9	21	15	11	15	88
Greenland	-	-*	25*	-*	-*	-*	
Iceland	202,745	241,545	258,658	234,362	233,875	206,987	199,965
Norway	-	-	85	60	129*	76*	278
UK (E/W/NI)	-	-	12	10	15	19	...
UK (Scotland)	-	-	4	+	5	13	...
United Kingdom							142
Total	203,153	242,632	260,052	234,647	234,035	207,110	200,473
WG estimate				235,623	235,164	208,298	205,570

*Preliminary.

Country	2004*	2005*
Faroe Islands	1,133	1,962
Germany	88	177
Greenland	-	
Iceland	221,084	
Norway	104	77
UK (E/W/NI)	405	-
UK (Scotland)	-	535
United Kingdom		
Total	222,814	2,751
WG estimate	226,814	212,192

*Preliminary.

Table 3.3.2 Icelandic cod division Va. Landings (tonnes), effort, CPUE and precentage changes in effort and CPUE in 1991-2004 (with 1991 as 100%). Data is based on logbooks which have been mandatory in the fisheries since 1991.

Bottom trawl			**Effort**		**Cpue**
year	**Catch**	**Effort**	**% changes**	**Cpue**	**% changes**
1991	175142	234946	100	745	100
1992	131504	228196	97	576	77
1993	110757	176646	75	627	84
1994	65213	82758	35	788	106
1995	55656	65401	28	851	114
1996	63749	63749	27	1000	134
1997	81202	74841	32	1085	146
1998	108424	84905	36	1277	171
1999	123140	119206	51	1033	139
2000	102094	124809	53	818	110
2001	96624	108323	46	892	120
2002	85741	82127	35	1044	140
2003	86992	75645	32	1150	154
2004	94041	76456	33	1230	165
2005	84959	72615	31	1170	157

Gillnet			**Effort**		**Cpue**
year	**Catch**	**Effort**	**% changes**	**Cpue**	**% changes**
1991	58948	11101	100	5	100
1992	59712	10720	97	6	105
1993	56350	11270	102	5	94
1994	39821	8028	72	5	93
1995	31182	5423	49	6	108
1996	40807	6447	58	6	119
1997	45919	6458	58	7	134
1998	51004	8543	77	6	112
1999	47137	9446	85	5	94
2000	48018	9921	89	5	91
2001	53600	13333	120	4	76
2002	44162	11096	100	4	75
2003	37498	10474	94	4	67
2004	37296	11166	101	3	63
2005	32185	8006	72	4	76

Long line			**Effort**		**Cpue**
year	**Catch**	**Effort**	**% changes**	**Cpue**	**% changes**
1991	44711	2009	100	22	100
1992	42301	2017	100	21	94
1993	45938	2162	108	21	96
1994	35990	1633	81	22	99
1995	44584	1724	86	26	116
1996	39770	1476	73	27	121
1997	31276	830	41	38	169
1998	37244	979	49	38	171
1999	52658	1536	76	34	154
2000	49869	1706	85	29	131
2001	47120	1794	89	26	118
2002	42153	1401	70	30	135
2003	44662	1598	80	28	126
2004	57480	1835	91	31	141
2005	68632	2154	107	32	143

Table 3.3.3 Icelandic cod division Va. Observed catch in numbers by year and age in millions in the 1955-2005 period and predicted catches for 2006-2008.

Year/age	3	4	5	6	7	8	9	10	11	12	13	14
1955	4.790	25.164	46.566	28.287	10.541	5.224	2.467	25.182	2.101	1.202	1.668	0.665
1956	6.709	17.265	31.030	27.793	14.389	4.261	3.429	2.128	16.820	1.552	1.522	1.545
1957	13.240	21.278	17.515	24.569	17.634	12.296	3.568	2.169	1.171	6.822	0.512	1.089
1958	25.237	30.742	14.298	10.859	15.997	15.822	12.021	2.003	2.125	0.771	3.508	0.723
1959	18.394	37.650	23.901	7.682	5.883	8.791	13.003	7.683	0.914	0.990	0.218	1.287
1960	14.830	28.642	27.968	14.120	8.387	6.089	6.393	11.600	3.526	0.692	0.183	0.510
1961	16.507	21.808	19.488	15.034	7.900	6.925	3.969	3.211	6.756	1.202	0.089	0.425
1962	13.514	28.526	18.924	14.650	12.045	4.276	8.809	2.664	1.883	2.988	0.405	0.324
1963	18.507	28.466	19.664	11.314	15.682	7.704	2.724	6.508	1.657	1.030	1.372	0.246
1964	19.287	28.845	18.712	11.620	7.936	18.032	5.040	1.437	2.670	0.655	0.370	1.025
1965	21.658	29.586	24.783	11.706	9.334	6.394	11.122	1.477	0.823	0.489	0.118	0.489
1966	17.910	30.649	20.006	13.872	5.942	7.586	2.320	5.583	0.407	0.363	0.299	0.311
1967	25.945	27.941	24.322	11.320	8.751	2.595	5.490	1.392	1.998	0.109	0.030	0.106
1968	11.933	47.311	22.344	16.277	15.590	7.059	1.571	2.506	0.512	0.659	0.047	0.098
1969	11.149	23.925	45.445	17.397	12.559	14.811	1.590	0.475	0.340	0.064	0.024	0.021
1970	9.876	47.210	23.607	25.451	15.196	12.261	14.469	0.567	0.207	0.147	0.035	0.050
1971	13.060	35.856	45.577	21.135	17.340	10.924	6.001	4.210	0.237	0.069	0.038	0.020
1972	8.973	29.574	30.918	22.855	11.097	9.784	10.538	3.938	1.242	0.119	0.031	0.001
1973	36.538	25.542	27.391	17.045	12.721	3.685	4.718	5.809	1.134	0.282	0.007	0.001
1974	14.846	61.826	21.824	14.413	8.974	6.216	1.647	2.530	1.765	0.334	0.062	0.028
1975	29.301	29.489	44.138	12.088	9.628	3.691	2.051	0.752	0.891	0.416	0.060	0.046
1976	23.578	39.790	21.092	24.395	5.803	5.343	1.297	0.633	0.205	0.155	0.065	0.029
1977	2.614	42.659	32.465	12.162	13.017	2.809	1.773	0.421	0.086	0.024	0.006	0.002
1978	5.999	16.287	43.931	17.626	8.729	4.119	0.978	0.348	0.119	0.048	0.015	0.027
1979	7.186	28.427	13.772	34.443	14.130	4.426	1.432	0.350	0.168	0.043	0.024	0.004
1980	4.348	28.530	32.500	15.119	27.090	7.847	2.228	0.646	0.246	0.099	0.025	0.004
1981	2.118	13.297	39.195	23.247	12.710	26.455	4.804	1.677	0.582	0.228	0.053	0.068
1982	3.285	20.812	24.462	28.351	14.012	7.666	11.517	1.912	0.327	0.094	0.043	0.011
1983	3.554	10.910	24.305	18.944	17.382	8.381	2.054	2.733	0.514	0.215	0.064	0.037
1984	6.750	31.553	19.420	15.326	8.082	7.336	2.680	0.512	0.538	0.195	0.090	0.036
1985	6.457	24.552	35.392	18.267	8.711	4.201	2.264	1.063	0.217	0.233	0.102	0.038
1986	20.642	20.330	26.644	30.839	11.413	4.441	1.771	0.805	0.392	0.103	0.076	0.044
1987	11.002	62.130	27.192	15.127	15.695	4.159	1.463	0.592	0.253	0.142	0.046	0.058
1988	6.713	39.323	55.895	18.663	6.399	5.877	1.345	0.455	0.305	0.157	0.114	0.025
1989	2.605	27.983	50.059	31.455	6.010	1.915	0.881	0.225	0.107	0.086	0.038	0.005
1990	5.785	12.313	27.179	44.534	17.037	2.573	0.609	0.322	0.118	0.050	0.015	0.020
1991	8.554	25.131	15.491	21.514	25.038	6.364	0.903	0.243	0.125	0.063	0.011	0.012
1992	12.217	21.708	26.524	11.413	10.073	8.304	2.006	0.257	0.046	0.032	0.009	0.008
1993	20.500	33.078	15.195	13.281	3.583	2.785	2.707	1.181	0.180	0.034	0.011	0.013
1994	6.160	24.142	19.666	6.968	4.393	1.257	0.599	0.508	0.283	0.049	0.018	0.006
1995	10.770	9.103	16.829	13.066	4.115	1.596	0.313	0.184	0.156	0.141	0.029	0.008
1996	5.356	14.886	7.372	12.307	9.429	2.157	0.837	0.208	0.076	0.065	0.055	0.005
1997	1.722	16.442	17.298	6.711	7.379	5.958	1.147	0.493	0.126	0.028	0.037	0.021
1998	3.458	7.707	25.394	20.167	5.893	3.856	2.951	0.500	0.196	0.055	0.033	0.013
1999	2.525	19.554	15.226	24.622	12.966	2.795	1.489	0.748	0.140	0.046	0.010	0.005
2000	10.493	6.581	29.080	11.227	11.390	5.714	1.104	0.567	0.314	0.074	0.022	0.006
2001	11.338	25.040	9.311	19.471	5.620	3.929	2.017	0.452	0.202	0.118	0.013	0.009
2002	5.934	18.482	24.297	6.874	8.943	2.227	1.353	0.689	0.123	0.040	0.041	0.002
2003	3.839	15.710	21.281	17.598	4.902	4.325	1.093	0.394	0.169	0.033	0.019	0.015
2004	1.743	18.960	24.540	16.974	9.728	2.682	2.006	0.477	0.125	0.062	0.014	0.005
2005	4.970	4.999	25.890	16.458	8.112	4.601	1.269	0.903	0.201	0.088	0.025	0.002
2006	3.083	14.385	7.698	19.724	9.870	4.787	2.434	0.361	0.268	0.047	0.026	0.009
2007	2.001	10.555	19.969	6.191	11.971	5.221	2.355	1.050	0.134	0.109	0.018	0.011
2008	3.895	7.469	15.997	17.591	4.128	6.972	2.833	1.123	0.432	0.061	0.046	0.008

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 1955-2005 and predictions for 2006-2008.

Year/age	3	4	5	6	7	8	9	10	11	12	13	14
1955	827	1307	2157	3617	4638	5657	6635	6168	8746	8829	10086	14584
1956	1080	1600	2190	3280	4650	5630	6180	6970	6830	9290	10965	12954
1957	1140	1710	2520	3200	4560	5960	7170	7260	8300	8290	10350	13174
1958	1210	1810	3120	4510	5000	5940	6640	8290	8510	8840	9360	13097
1959	1110	1950	2930	4520	5520	6170	6610	7130	8510	8670	9980	11276
1960	1060	1720	2920	4640	5660	6550	6910	7140	7970	10240	10100	12871
1961	1020	1670	2700	4330	5530	6310	6930	7310	7500	8510	9840	14550
1962	990	1610	2610	3900	5720	6660	6750	7060	7540	8280	10900	12826
1963	1250	1650	2640	3800	5110	6920	7840	7610	8230	9100	9920	11553
1964	1210	1750	2640	4020	5450	6460	8000	9940	9210	10940	12670	15900
1965	1020	1530	2570	4090	5410	6400	7120	8600	12310	10460	10190	17220
1966	1170	1680	2590	4180	5730	6900	7830	8580	9090	14230	14090	17924
1967	1120	1820	2660	4067	5560	7790	7840	8430	9090	10090	14240	16412
1968	1170	1590	2680	3930	5040	5910	7510	8480	10750	11580	14640	16011
1969	1100	1810	2480	3770	5040	5860	7000	8350	8720	10080	11430	13144
1970	990	1450	2440	3770	4860	5590	6260	8370	10490	12310	14590	21777
1971	1090	1570	2310	2980	4930	5150	5580	6300	8530	11240	14740	17130
1972	980	1460	2210	3250	4330	5610	6040	6100	6870	8950	11720	16000
1973	1030	1420	2470	3600	4900	6110	6670	6750	7430	7950	10170	17000
1974	1050	1710	2430	3820	5240	6660	7150	7760	8190	9780	12380	14700
1975	1100	1770	2780	3760	5450	6690	7570	8580	8810	9780	10090	11000
1976	1350	1780	2650	4100	5070	6730	8250	9610	11540	11430	14060	16180
1977	1259	1911	2856	4069	5777	6636	7685	9730	11703	14394	17456	24116
1978	1289	1833	2929	3955	5726	6806	9041	10865	13068	11982	19062	21284
1979	1408	1956	2642	3999	5548	6754	8299	9312	13130	13418	13540	20072
1980	1392	1862	2733	3768	5259	6981	8037	10731	12301	17281	14893	19069
1981	1180	1651	2260	3293	4483	5821	7739	9422	11374	12784	12514	19069
1982	1006	1550	2246	3104	4258	5386	6682	9141	11963	14226	17287	16590
1983	1095	1599	2275	3021	4096	5481	7049	8128	11009	13972	15882	18498
1984	1288	1725	2596	3581	4371	5798	7456	9851	11052	14338	15273	16660
1985	1407	1971	2576	3650	4976	6372	8207	10320	12197	14683	16175	19050
1986	1459	1961	2844	3593	4635	6155	7503	9084	10356	15283	14540	15017
1987	1316	1956	2686	3894	4716	6257	7368	9243	10697	10622	15894	12592
1988	1438	1805	2576	3519	4930	6001	7144	8822	9977	11732	14156	13042
1989	1186	1813	2590	3915	5210	6892	8035	9831	11986	10003	12611	16045
1990	1290	1704	2383	3034	4624	6521	8888	10592	10993	14570	15732	17290
1991	1309	1899	2475	3159	3792	5680	7242	9804	9754	14344	14172	20200
1992	1289	1768	2469	3292	4394	5582	6830	8127	12679	13410	15715	11267
1993	1392	1887	2772	3762	4930	6054	7450	8641	10901	12517	14742	16874
1994	1443	2063	2562	3659	5117	6262	7719	8896	10847	12874	14742	17470
1995	1348	1959	2920	3625	5176	6416	7916	10273	11022	11407	13098	15182
1996	1457	1930	3132	4141	4922	6009	7406	9772	10539	13503	13689	16194
1997	1484	1877	2878	4028	5402	6386	7344	8537	10797	11533	10428	12788
1998	1230	1750	2458	3559	5213	7737	7837	9304	10759	14903	16651	18666
1999	1241	1716	2426	3443	4720	6352	8730	9946	11088	12535	14995	15151
2000	1308	1782	2330	3252	4690	5894	7809	9203	10240	11172	13172	17442
2001	1499	2050	2649	3413	4766	6508	7520	9055	8769	9526	11210	13874
2002	1294	1926	2656	3680	4720	6369	7808	9002	10422	13402	9008	16893
2003	1256	1786	2418	3503	4459	5038	5986	7852	8819	10834	12152	13804
2004	1254	1769	2317	3302	4262	5389	5874	7394	10780	11563	13814	12954
2005	1193	1709	2377	3440	4399	5211	6211	5496	7213	9946	12947	18147
2006	1193	1709	2377	3440	4399	5211	6211	5496	7213	9946	12947	18147
2007	1193	1709	2377	3440	4399	5211	6211	5496	7213	9946	12947	18147
2008	1193	1709	2377	3440	4399	5211	6211	5496	7213	9946	12947	18147

Table 3.3.6 Icelandic cod division Va. Mean weight at age in the spawning stock in 1955-2005 and predictions for 2007-2008.

Year/age	3	4	5	6	7	8	9	10	11	12	13	14
1955	645	1019	1833	3183	4128	5657	6635	6168	8746	8829	10086	14584
1956	645	1248	1862	2886	4138	5630	6180	6970	6830	9290	10965	12954
1957	645	1334	2142	2816	4058	5960	7170	7260	8300	8290	10350	13174
1958	645	1412	2652	3969	4450	5940	6640	8290	8510	8840	9360	13097
1959	645	1521	2490	3978	4913	6170	6610	7130	8510	8670	9980	11276
1960	645	1342	2482	4083	5037	6550	6910	7140	7970	10240	10100	12871
1961	645	1303	2295	3810	4922	6310	6930	7310	750	8510	9840	14550
1962	645	1256	2218	3432	5091	6660	6750	7060	7540	8280	10900	12826
1963	645	1287	2244	3344	4548	6920	7840	7610	8230	9100	9920	11553
1964	645	1365	2244	3538	4850	6460	8000	9940	9210	10940	12670	15900
1965	645	1193	2184	3599	4815	6400	7120	8600	12310	10460	10190	17220
1966	645	1310	2202	3678	5100	6900	7830	8580	9090	14230	14090	17924
1967	645	1420	2261	3579	4948	7790	7840	8430	9090	10090	14240	16412
1968	645	1240	2278	3458	4486	5910	7510	8480	10750	11580	14640	16011
1969	645	1412	2108	3318	4486	5860	7000	8350	8720	10080	11430	13144
1970	645	1131	2074	3318	4325	5590	6260	8370	10490	12310	14590	21777
1971	645	1225	1964	2622	4388	5150	5580	6300	8530	11240	14740	17130
1972	645	1139	1878	2860	3854	5610	6040	6100	6870	8950	11720	16000
1973	645	1108	2100	3168	4361	6110	6670	6750	7430	7950	10170	17000
1974	645	1334	2066	3362	4664	6660	7150	7760	8190	9780	12380	14700
1975	645	1381	2363	3309	4850	6690	7570	8580	8810	9780	10090	11000
1976	645	1388	2252	3608	4512	6730	8250	9610	11540	11430	14060	16180
1977	645	1491	2428	3581	5142	6636	7685	9730	11703	14394	17456	24116
1978	645	1430	2490	3480	5096	6806	9041	10865	13068	11982	19062	21284
1979	645	1526	2246	3519	4938	6754	8299	9312	13130	13418	13540	20072
1980	645	1452	2323	3316	4681	6981	8037	10731	12301	17281	14893	19069
1981	645	1288	1921	2898	3990	5821	7739	9422	11374	12784	12514	19069
1982	645	1209	1909	2732	3790	5386	6682	9141	11963	14226	17287	16590
1983	645	1247	1934	2658	3645	5481	7049	8128	11009	13972	15882	18498
1984	645	1346	2207	3151	3890	5798	7456	9851	11052	14338	15273	16660
1985	485	1375	1750	2709	3454	6372	8207	10320	12197	14683	16175	19050
1986	758	1597	2882	3246	4581	6155	7503	9084	10356	15283	14540	15017
1987	576	1584	2423	3522	4905	6257	7368	9243	10697	10622	15894	12592
1988	610	1475	2261	3277	4398	6001	7144	8822	9977	11732	14156	13042
1989	673	1494	2338	3429	4686	6892	8035	9831	11986	10003	12611	16045
1990	563	1035	2170	2798	4422	6521	8888	10592	10993	14570	15732	17290
1991	686	1283	2039	2747	3397	5680	7242	9804	9754	14344	14172	20200
1992	619	1336	2094	3029	3753	5582	6830	8127	12679	13410	15715	11267
1993	708	1363	2309	3235	4109	6054	7450	8641	10901	12517	14742	16874
1994	847	1728	2254	3340	4514	6262	7719	8896	10847	12874	14742	17470
1995	745	1635	2345	3186	4489	6416	7916	10273	11022	11407	13098	15182
1996	678	1753	2490	3531	4273	6009	7406	9772	10539	13503	13689	16194
1997	670	1347	2267	3746	5245	6386	7344	8537	10797	11533	10428	12788
1998	599	1516	2261	3263	4474	7737	7837	9304	10759	14903	16651	18666
1999	711	1467	1932	2996	3961	6352	8730	9946	11088	12535	14995	15151
2000	600	1355	1915	2881	4319	5894	7809	9203	10240	11172	13172	17442
2001	661	1550	2071	2694	4131	6508	7520	9055	8769	9526	11210	13874
2002	630	1590	2259	3120	3984	6369	7808	9002	10422	13402	9008	16893
2003	579	1338	2215	2988	4169	5038	5986	7852	8819	10834	12152	13804
2004	590	1453	2099	3057	3757	5389	5874	7394	10780	11563	13814	12954
2005	557	1119	1897	2963	3874	5211	6211	5496	7213	9946	12947	18147
2006	557	1383	1998	2905	4385	5211	6211	5496	7213	9946	12947	18147
2007	557	1383	1998	2905	4385	5211	6211	5496	7213	9946	12947	18147
2008	557	1383	1998	2905	4385	5211	6211	5496	7213	9946	12947	18147

Table 3.3.7 Icelandic cod division Va. Maturity at age in 1955-2005 and predictions for 2007-2008.

Year/age	3	4	5	6	7	8	9	10	11	12	13	14
1955	0.02	0.02	0.03	0.18	0.58	0.78	0.83	0.96	1.00	1.00	1.00	1.00
1956	0.02	0.03	0.03	0.11	0.58	0.78	0.82	0.98	0.98	1.00	1.00	1.00
1957	0.02	0.03	0.04	0.10	0.55	0.80	0.84	0.99	1.00	1.00	1.00	1.00
1958	0.02	0.03	0.09	0.52	0.68	0.80	0.83	1.00	1.00	1.00	1.00	1.00
1959	0.02	0.03	0.07	0.54	0.77	0.82	0.83	0.99	1.00	1.00	1.00	1.00
1960	0.02	0.03	0.07	0.58	0.78	0.83	0.83	0.99	1.00	1.00	1.00	1.00
1961	0.02	0.03	0.05	0.45	0.77	0.82	0.83	0.99	0.99	1.00	1.00	1.00
1962	0.02	0.03	0.05	0.28	0.79	0.83	0.83	0.99	0.99	1.00	1.00	1.00
1963	0.02	0.03	0.05	0.24	0.71	0.83	0.85	1.00	1.00	1.00	1.00	1.00
1964	0.02	0.03	0.05	0.33	0.76	0.83	0.85	1.00	1.00	1.00	1.00	1.00
1965	0.02	0.03	0.05	0.35	0.75	0.83	0.84	1.00	1.00	1.00	1.00	1.00
1966	0.02	0.03	0.05	0.39	0.79	0.85	0.85	1.00	1.00	1.00	1.00	1.00
1967	0.02	0.03	0.05	0.34	0.77	0.84	0.85	1.00	1.00	1.00	1.00	1.00
1968	0.02	0.03	0.05	0.29	0.68	0.80	0.84	1.00	1.00	1.00	1.00	1.00
1969	0.02	0.03	0.04	0.23	0.68	0.80	0.84	1.00	1.00	1.00	1.00	1.00
1970	0.02	0.02	0.04	0.23	0.64	0.77	0.82	1.00	1.00	1.00	1.00	1.00
1971	0.02	0.03	0.04	0.07	0.66	0.71	0.77	0.98	0.99	0.98	0.99	1.00
1972	0.02	0.02	0.04	0.11	0.45	0.77	0.81	0.98	0.99	0.98	0.99	1.00
1973	0.02	0.03	0.16	0.38	0.70	0.80	0.83	1.00	1.00	1.00	1.00	1.00
1974	0.02	0.03	0.09	0.35	0.64	0.79	0.82	0.99	1.00	1.00	1.00	1.00
1975	0.02	0.04	0.12	0.29	0.72	0.81	0.84	1.00	1.00	1.00	1.00	1.00
1976	0.03	0.03	0.09	0.25	0.41	0.80	0.84	1.00	1.00	1.00	1.00	1.00
1977	0.02	0.02	0.06	0.38	0.74	0.82	0.84	1.00	1.00	1.00	1.00	1.00
1978	0.03	0.03	0.05	0.19	0.74	0.82	0.84	1.00	1.00	1.00	1.00	1.00
1979	0.02	0.02	0.05	0.28	0.64	0.79	0.84	0.92	1.00	1.00	1.00	1.00
1980	0.03	0.02	0.05	0.23	0.65	0.78	0.83	0.98	1.00	0.96	1.00	1.00
1981	0.02	0.02	0.03	0.09	0.45	0.75	0.81	0.96	0.99	1.00	1.00	1.00
1982	0.02	0.03	0.04	0.07	0.30	0.71	0.82	0.97	1.00	1.00	1.00	1.00
1983	0.02	0.03	0.05	0.12	0.26	0.53	0.72	0.98	0.99	1.00	1.00	1.00
1984	0.02	0.02	0.05	0.17	0.44	0.62	0.72	0.95	0.97	0.95	1.00	1.00
1985	0.00	0.02	0.19	0.41	0.50	0.74	0.57	1.00	1.00	1.00	1.00	1.00
1986	0.00	0.02	0.15	0.40	0.68	0.73	0.94	0.96	0.99	1.00	1.00	1.00
1987	0.00	0.03	0.09	0.36	0.49	0.89	0.78	1.00	0.98	1.00	1.00	1.00
1988	0.01	0.03	0.23	0.51	0.45	0.68	0.94	0.95	0.97	0.82	1.00	1.00
1989	0.01	0.03	0.14	0.37	0.65	0.65	0.63	0.99	1.00	0.90	0.86	1.00
1990	0.01	0.01	0.16	0.44	0.58	0.80	0.81	0.99	1.00	1.00	1.00	1.00
1991	0.00	0.06	0.15	0.37	0.64	0.79	0.68	0.84	1.00	1.00	1.00	1.00
1992	0.00	0.06	0.27	0.40	0.81	0.92	0.89	1.00	1.00	1.00	1.00	1.00
1993	0.01	0.09	0.27	0.46	0.69	0.80	0.84	0.97	1.00	1.00	1.00	1.00
1994	0.01	0.11	0.34	0.59	0.70	0.92	0.70	0.85	0.99	1.00	1.00	1.00
1995	0.01	0.11	0.38	0.53	0.75	0.79	0.86	1.00	1.00	1.00	1.00	1.00
1996	0.00	0.03	0.19	0.50	0.65	0.73	0.81	1.00	1.00	0.99	0.97	1.00
1997	0.01	0.04	0.25	0.42	0.69	0.79	0.80	0.93	1.00	0.91	1.00	1.00
1998	0.00	0.06	0.21	0.49	0.78	0.81	0.81	0.93	1.00	1.00	1.00	1.00
1999	0.01	0.04	0.24	0.52	0.65	0.84	0.69	0.99	1.00	1.00	1.00	1.00
2000	0.00	0.07	0.25	0.51	0.61	0.87	1.00	0.98	1.00	1.00	1.00	1.00
2001	0.00	0.04	0.26	0.59	0.75	0.74	0.86	0.99	1.00	1.00	1.00	1.00
2002	0.01	0.09	0.32	0.66	0.76	0.92	0.55	0.98	1.00	1.00	1.00	1.00
2003	0.01	0.05	0.22	0.52	0.87	0.80	0.86	1.00	1.00	1.00	1.00	1.00
2004	0.00	0.04	0.25	0.55	0.63	0.84	0.82	0.99	1.00	1.00	1.00	1.00
2005	0.01	0.11	0.28	0.50	0.79	0.81	0.95	0.99	1.00	1.00	1.00	1.00
2006	0.00	0.02	0.29	0.45	0.75	0.87	0.74	1.00	1.00	1.00	1.00	1.00
2007	0.00	0.06	0.27	0.50	0.72	0.84	0.84	1.00	1.00	1.00	1.00	1.00
2008	0.00	0.06	0.27	0.50	0.72	0.84	0.84	1.00	1.00	1.00	1.00	1.00

Table 3.3.8. Icelandic cod division Va. CPUE from bottom trawl surveys in 1985-2006 as used in XSA and AD-CAM tuning. Sum of north and south (stratified mean) area indices.

Year/age	1	2	3	4	5	6	7	8	9	10
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

Table 3.3.9 Icelandic cod division Va. CPUE from bottom trawl surveys in 1985-2006 as used for TSA suns. Weighted geometric mean of the north and south (stratified mean) area indices.

Year/age	3	4	5	6	7	8	9
1985	9806	16548	16377	9531	4681	2040	1340
1986	24978	8294	7986	10400	3069	866	388
1987	27642	28116	5981	5205	4407	1189	341
1988	17530	35198	22473	3685	2176	1797	282
1989	4945	27209	24733	16381	2033	649	377
1990	7738	3448	10952	16163	6420	738	270
1991	4644	10453	5597	8820	10347	2069	393
1992	10805	7727	5829	2855	2845	2704	687
1993	12702	15728	5772	4592	953	877	554
1994	4297	12500	8530	2752	1417	309	246
1995	8615	4210	9930	8211	1766	750	165
1996	15732	13239	5198	7078	6371	1575	507
1997	4988	18852	9663	4044	3780	2523	259
1998	8929	5403	15086	10347	2593	1767	1186
1999	2143	13484	4673	11136	5152	1183	471
2000	13633	2835	10908	3821	3585	2073	256
2001	12746	14820	1963	6408	1395	774	397
2002	12265	17182	15660	3596	3325	724	315
2003	13010	13249	11616	8596	2050	1222	342
2004	2292	22507	14115	11562	6024	1310	652
2005	8001	3256	14061	10838	4704	2153	438
2006	3860	10141	2989	11288	4475	1522	520

Table 3.3.10. Icelandic cod division Va. XSA tuning diagostics

Lowestoft VPA Version 3.1

8/04/2006 11:26

Extended Survivors Analysis

"ICELANDIC COD (Div. Va); data from 1971-2005"

CPUE data from file codvarnt.dat

Catch data for 34 years. 1972 to 2005. Ages 0 to 14.

Fleet,		First, year,	Last, year,	First, age ,	Last, age	Alpha,	Beta
SMB. Tot	,	1984,	2005,	0,	8,	.990,	1.000

Time series weights :

Tapered time weighting not applied

Catchability analysis :

Catchability dependent on stock size for ages < 5

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

Catchability independent of age for ages >= 11

Terminal population estimation :

Survivor estimates shrunk towards the mean F
of the final 3 years or the 4 oldest ages.

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

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

Prior weighting not applied

Tuning converged after 16 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,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	2005
0,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000
1,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000
2,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000
3,	.036,	.022,	.023,	.041,	.068,	.083,	.040,	.021,	.027,	.032
4,	.143,	.147,	.128,	.176,	.143,	.230,	.188,	.141,	.140,	.102
5,	.246,	.247,	.356,	.399,	.431,	.310,	.366,	.344,	.340,	.288
6,	.488,	.372,	.509,	.707,	.582,	.581,	.397,	.497,	.512,	.402
7,	.506,	.618,	.660,	.737,	.869,	.660,	.584,	.553,	.570,	.494
8,	.602,	.711,	.791,	.779,	.882,	.875,	.602,	.632,	.680,	.586
9,	.581,	.768,	.985,	.840,	.842,	.942,	.888,	.683,	.691,	.828
10,	.564,	.836,	.956,	.733,	.946,	1.080,	1.059,	.711,	.739,	.794
11,	.560,	.821,	1.006,	.793,	.809,	1.159,	1.040,	.831,	.513,	.829
12,	.631,	.412,	1.136,	.687,	1.517,	.849,	.752,	.914,	.868,	.860
13,	.763,	.944,	1.327,	.634,	.861,	1.442,	.839,	1.051,	1.491,	1.143
14,	.636,	.763,	1.120,	.718,	1.047,	1.145,	.933,	.884,	.912,	.917

Table 3.3.10 Cont'd

XSA population numbers (Thousands)

YEAR	AGE 0	1	2	3	4	5	6	7	8	9
1996	1.26E+05	2.49E+05	1.08E+05	1.68E+05	1.23E+05	3.73E+04	3.52E+04	2.62E+04	5.27E+03	2.10E+03
1997	3.21E+05	1.03E+05	2.04E+05	8.86E+04	1.33E+05	8.74E+04	2.39E+04	1.77E+04	1.29E+04	2.36E+03
1998	2.88E+05	2.63E+05	8.46E+04	1.67E+05	7.10E+04	9.36E+04	5.59E+04	1.35E+04	7.80E+03	5.20E+03
1999	3.07E+05	2.36E+05	2.15E+05	6.92E+04	1.34E+05	5.12E+04	5.37E+04	2.75E+04	5.71E+03	2.90E+03
2000	3.65E+05	2.51E+05	1.93E+05	1.76E+05	5.44E+04	9.18E+04	2.81E+04	2.17E+04	1.08E+04	2.14E+03
2001	1.30E+05	2.99E+05	2.06E+05	1.58E+05	1.35E+05	3.86E+04	4.88E+04	1.29E+04	7.45E+03	3.65E+03
2002	3.16E+05	1.07E+05	2.45E+05	1.68E+05	1.19E+05	8.75E+04	2.32E+04	2.23E+04	5.44E+03	2.54E+03
2003	2.52E+05	2.59E+05	8.75E+04	2.00E+05	1.32E+05	8.07E+04	4.97E+04	1.28E+04	1.02E+04	2.44E+03
2004	1.90E+05	2.07E+05	2.12E+05	7.16E+04	1.60E+05	9.42E+04	4.68E+04	2.48E+04	6.01E+03	4.44E+03
2005	3.10E+05	1.55E+05	1.69E+05	1.74E+05	5.70E+04	1.14E+05	5.49E+04	2.30E+04	1.15E+04	2.49E+03

Estimated population abundance at 1st Jan 2006

, 0.00E+00, 2.54E+05, 1.27E+05, 1.38E+05, 1.38E+05, 4.22E+04, 7.01E+04, 3.01E+04, 1.15E+04, 5.22E+03,

Taper weighted geometric mean of the VPA populations:

, 2.84E+05, 2.32E+05, 1.96E+05, 1.61E+05, 1.24E+05, 8.33E+04, 4.59E+04, 2.15E+04, 8.98E+03, 3.46E+03,

Standard error of the weighted Log(VPA populations) :

, .4212, .4212, .4300, .4302, .4255, .4047, .4413, .4984, .5757, .6916,

YEAR	AGE 10	11	12	13	14
1996	5.34E+02	1.96E+02	1.54E+02	1.14E+02	1.17E+01
1997	9.62E+02	2.49E+02	9.16E+01	6.69E+01	4.35E+01
1998	8.98E+02	3.42E+02	8.95E+01	4.96E+01	2.13E+01
1999	1.59E+03	2.83E+02	1.02E+02	2.35E+01	1.08E+01
2000	1.02E+03	6.25E+02	1.05E+02	4.21E+01	1.02E+01
2001	7.56E+02	3.25E+02	2.28E+02	1.88E+01	1.46E+01
2002	1.17E+03	2.10E+02	8.36E+01	7.98E+01	3.64E+00
2003	8.56E+02	3.31E+02	6.09E+01	3.23E+01	2.82E+01
2004	1.01E+03	3.44E+02	1.18E+02	2.00E+01	9.24E+00
2005	1.82E+03	3.94E+02	1.69E+02	4.06E+01	3.68E+00

Estimated population abundance at 1st Jan 2006

, 8.91E+02, 6.74E+02, 1.41E+02, 5.84E+01, 1.06E+01,

Taper weighted geometric mean of the VPA populations:

, 1.34E+03, 4.99E+02, 1.86E+02, 6.74E+01, 2.15E+01,

Standard error of the weighted Log(VPA populations) :

, .7452, .7339, .7006, .7285, 1.1576,

1

Log catchability residuals.

Fleet : SMB. Tot

Age	1984	1985
0	-.18	.29
1	.09	-.04
2	.08	-.14
3	.29	-.22
4	.14	-.04
5	.27	.04
6	.63	-.27
7	.29	-.28
8	.66	-.44

Age	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
0	.36	-.13	.20	-.19	-.17	-.26	-.31	.28	-.21	-.32
1	.08	.09	.04	.13	-.24	-.04	-.01	-.20	.10	-.12
2	.08	.37	.35	.00	.03	-.13	.00	-.08	-.23	.06
3	-.26	.04	.38	.04	.05	.06	-.09	-.05	-.08	-.14
4	-.13	-.11	-.01	-.09	.20	-.15	.07	-.19	.12	.24
5	.06	-.55	.17	-.18	.09	-.20	-.02	-.31	.02	.11
6	.06	.23	-.22	.02	.14	-.17	-.31	-.13	-.16	.28
7	-.14	.56	-.01	-.31	-.21	-.13	-.05	-.41	.01	.58
8	-.06	-.33	.58	.16	.17	-.31	-.28	.08	-.04	.31

Table 3.3.10 Cont'd

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
0	.05	-.03	.04	.40	.03	-.11	.13	.12	-.02	.04
1	-.03	.14	.12	.14	-.05	.07	-.01	-.02	-.06	-.19
2	.00	-.15	-.16	.17	.04	.04	-.06	-.11	-.02	-.13
3	.19	.06	.02	-.20	-.08	.08	-.04	.06	-.03	-.07
4	-.04	.40	-.05	-.08	-.43	.08	.08	.01	-.04	.03
5	.06	.31	.17	-.24	-.18	-.20	.03	.35	.11	.06
6	.20	.18	.00	-.07	-.45	-.08	-.23	.37	.16	-.19
7	.23	.50	.02	-.05	-.42	-.39	.13	.15	.20	-.28
8	-.43	.47	.22	-.43	-.53	-.26	.19	.57	.02	-.32

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

Age	5	6	7	8
Mean Log q	-7.8979	-7.8170	-7.8177	-7.9177
S.E(Log q)	.2175	.2552	.3056	.3698

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
0	.45	4.310	11.62	.75	22	.22	-10.65
1	.52	8.030	10.69	.93	22	.12	-9.23
2	.61	4.726	9.88	.88	22	.16	-8.49
3	.61	4.711	9.62	.88	22	.16	-8.19
4	.68	3.641	9.16	.87	22	.17	-7.99

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
5	.85	1.595	8.41	.84	22	.18	-7.90
6	.86	1.316	8.22	.81	22	.21	-7.82
7	.94	.400	7.93	.71	22	.29	-7.82
8	1.00	.024	7.92	.61	22	.38	-7.92

1

Terminal year survivor and F summaries :

Age 0 Catchability dependent on age and year class strength

Year class = 2005

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SMB. Tot	265305.	.300	.000	.00	1	.663	.000
P shrinkage mean	232487.	.42				.337	.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
253773.	.24	.08	2	.314	.000

Age 1 Catchability dependent on age and year class strength

Year class = 2004

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SMB. Tot	114559.	.212	.085	.40	2	.804	.000
P shrinkage mean	196421.	.43				.196	.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
127308.	.19	.18	3	.931	.000

Table 3.3.10 Cont'd

```
Age  2   Catchability dependent on age and year class strength

Year class = 2003

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
SMB. Tot            ,    135190.,   .173,       .075,    .43,   3,  .861,     .000

  P shrinkage mean  ,    160747.,    .43,,,,                        .139,     .000

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

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
   138495.,       .16,      .07,    4,    .422,   .000


Age  3   Catchability dependent on age and year class strength

Year class = 2002

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
SMB. Tot            ,    138275.,   .150,       .044,    .30,   4,  .819,     .032

  P shrinkage mean  ,    124207.,    .43,,,,                        .105,     .036

  F shrinkage mean  ,    150017.,    .50,,,,                        .076,     .030

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
   137576.,       .14,      .04,    6,    .266,   .032


1
Age  4   Catchability dependent on age and year class strength

Year class = 2001

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
SMB. Tot            ,     40240.,   .134,       .028,    .21,   5,  .829,     .107

  P shrinkage mean  ,     83281.,    .40,,,,                        .103,     .053

  F shrinkage mean  ,     26635.,    .50,,,,                        .068,     .157

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
    42183.,       .12,      .11,    7,    .866,   .102


Age  5   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
SMB. Tot            ,     71613.,   .123,       .023,    .19,   6,  .917,     .283

  F shrinkage mean  ,     55464.,    .50,,,,                        .083,     .352

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
    70102.,       .12,      .04,    7,    .301,   .288


1
```

Table 3.3.10 Cont'd

```
Age  6   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
SMB. Tot            ,     30758.,   .116,       .070,    .61,   7,  .897,     .395

  F shrinkage mean  ,     24682.,    .50,,,,                         .103,     .472

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
    30071.,       .12,      .07,    8,    .579,   .402


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

Year class = 1998

Fleet,                  Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
    ,                   Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
SMB. Tot            ,     11842.,   .118,       .076,    .64,   8,  .859,     .482

  F shrinkage mean  ,      9474.,    .50,,,,                         .141,     .574

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
    11475.,       .12,      .07,    9,    .584,   .494

1
Age  8   Catchability constant w.r.t. time and dependent on age

Year class = 1997

Fleet,                  Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
    ,                   Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
SMB. Tot            ,      5384.,   .128,       .082,    .64,   9,  .803,     .573

  F shrinkage mean  ,      4607.,    .50,,,,                         .197,     .644

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
     5221.,       .14,      .07,   10,    .512,   .586


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

Year class = 1996

Fleet,                  Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
    ,                   Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
SMB. Tot            ,       835.,   .120,       .063,    .53,   9,  .650,     .865

  F shrinkage mean  ,      1005.,    .50,,,,                         .350,     .762

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
      891.,       .19,      .06,   10,    .315,   .828

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

Year class = 1995

Fleet,                  Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
    ,                   Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
SMB. Tot            ,       752.,   .132,       .104,    .79,   9,  .454,     .735

  F shrinkage mean  ,       615.,    .50,,,,                         .546,     .845

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
      674.,       .28,      .08,   10,    .296,   .794
```

Table 3.3.10 Cont'd

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

Year class = 1994

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
SMB. Tot ,	125.,	.132,	.084,	.64,	9,	.280,	.898
F shrinkage mean ,	148.,	.50,,,,				.720,	.803

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
141.,	.36,	.06,	10,	.175,	.829

1

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

Year class = 1993

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
SMB. Tot ,	53.,	.146,	.092,	.63,	9,	.105,	.916
F shrinkage mean ,	59.,	.50,,,,				.895,	.854

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
58.,	.45,	.04,	10,	.098,	.860

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

Year class = 1992

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
SMB. Tot ,	9.,	.128,	.088,	.68,	9,	.022,	1.271
F shrinkage mean ,	11.,	.50,,,,				.978,	1.140

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
11.,	.49,	.06,	10,	.128,	1.143

1

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

Year class = 1991

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
SMB. Tot ,	1.,	.122,	.080,	.65,	9,	.007,	.964
F shrinkage mean ,	1.,	.50,,,,				.993,	.916

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
1.,	.50,	.03,	10,	.054,	.917

1

Table 3.3.11 Icelandic cod division Va. TSA-results

Input data and estimated parameters:

Estimated with catch-at-age 4-11 years 1984-2005. Bottom trawl survey, spring, 3-9 years, 1985-2006

Estimated stock in numbers and total biomass									
Year/Age	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**BIOM**
1984	182409	75922	40265	18341	14013	5113	1003	1027	876.7
1985	110363	121178	44436	19421	7740	4826	1807	359	900.5
1986	107301	67932	66828	20735	7857	2881	1723	631	832.0
1987	238455	69409	31443	26953	7054	2443	872	527	978.2
1988	219219	141989	32904	11740	8400	2034	692	247	1008.6
1989	137938	142144	69929	11798	3484	1864	474	168	999.1
1990	64238	85702	102580	31252	4422	1137	607	151	816.4
1991	102079	41439	43906	44381	11627	1525	380	201	686.2
1992	78400	60538	19969	16162	14400	3656	455	109	535.3
1993	131807	43086	26081	6655	4674	4357	1154	139	571.3
1994	103222	78670	20788	9902	2196	1282	1126	301	578.2
1995	56253	62837	46102	10544	4279	849	496	441	559.5
1996	119099	37812	35488	25413	5134	2007	394	225	672.3
1997	132256	84503	23704	17802	12241	2240	871	169	787.0
1998	68725	92999	53706	13077	7784	4893	839	327	718.0
1999	127118	49041	52930	26647	5503	2813	1551	269	723.0
2000	52688	85866	26723	21678	10679	2081	1060	581	577.4
2001	136646	36948	46082	11995	7765	3696	718	361	680.4
2002	122736	89577	21574	21230	4794	2700	1231	240	719.1
2003	129249	82968	51046	11750	9700	2000	1025	467	737.4
2004	148740	91065	48215	25522	5645	4243	828	426	808.2
2005	47605	104461	53124	23869	11543	2438	1754	342	704.8
2006	105209	34382	63335	28616	11521	4960	946	691	706.3
Standard deviation of stock estimates:									
2005	3995	4798	3544	1880	942	187	181	41	34.0
2006	9017	3289	3976	2787	1417	726	152	127	44.4

Fishing mortality rates									
Year/age	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**F_5-10**
1984	0.209	0.330	0.528	0.660	0.865	0.840	0.827	0.830	0.675
1985	0.284	0.395	0.560	0.705	0.788	0.827	0.851	0.854	0.688
1986	0.236	0.560	0.708	0.878	0.967	0.993	0.985	0.995	0.849
1987	0.314	0.544	0.776	0.963	1.043	1.062	1.062	1.072	0.908
1988	0.233	0.498	0.819	1.012	1.277	1.248	1.210	1.206	1.011
1989	0.271	0.480	0.589	0.756	0.903	0.890	0.902	0.922	0.754
1990	0.237	0.461	0.638	0.789	0.862	0.895	0.905	0.914	0.758
1991	0.322	0.529	0.774	0.914	0.953	1.005	1.035	1.022	0.868
1992	0.397	0.642	0.896	1.018	0.994	0.951	0.986	1.017	0.914
1993	0.316	0.524	0.767	0.909	1.075	1.141	1.138	1.130	0.926
1994	0.286	0.334	0.478	0.638	0.748	0.741	0.733	0.732	0.612
1995	0.196	0.357	0.395	0.520	0.557	0.568	0.590	0.598	0.498
1996	0.143	0.265	0.463	0.527	0.612	0.623	0.632	0.630	0.520
1997	0.150	0.253	0.392	0.585	0.697	0.745	0.743	0.739	0.569
1998	0.137	0.357	0.501	0.654	0.753	0.869	0.845	0.824	0.663
1999	0.191	0.406	0.679	0.714	0.771	0.772	0.776	0.799	0.686
2000	0.150	0.422	0.600	0.817	0.861	0.863	0.876	0.886	0.740
2001	0.222	0.319	0.571	0.698	0.851	0.885	0.879	0.868	0.700
2002	0.191	0.361	0.389	0.571	0.643	0.757	0.754	0.733	0.579
2003	0.150	0.340	0.491	0.520	0.614	0.667	0.667	0.657	0.550
2004	0.153	0.339	0.496	0.589	0.637	0.682	0.683	0.672	0.571
2005	0.125	0.300	0.417	0.522	0.634	0.738	0.721	0.708	0.556
Standard deviations of log(F)									
2005	0.120	0.080	0.090	0.080	0.090	0.110	0.120	0.120	0.073

Table 3.3.11 (continued).

Standardized catch prediction errors								
Year/age	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
1985	0.86	-0.01	1.50	0.18	1.20	-1.28	0.53	0.52
1986	-0.07	0.67	1.36	1.82	0.75	1.44	-0.84	0.35
1987	1.91	0.99	-0.93	0.66	0.24	0.40	0.87	-0.49
1988	-0.84	1.57	1.86	-1.15	0.47	0.25	0.30	1.88
1989	-1.15	-0.42	0.94	0.30	-1.04	-2.36	-1.37	-0.25
1990	-0.48	-1.63	-0.43	1.65	1.64	0.47	0.50	1.23
1991	1.03	1.29	-0.55	0.75	0.19	0.84	0.68	0.41
1992	1.35	1.34	1.32	-0.78	-1.00	-0.70	-0.44	-1.13
1993	0.31	-0.97	0.46	-0.63	-1.32	-0.11	2.38	2.01
1994	0.38	-0.22	-0.74	0.31	1.65	-0.79	-0.51	1.33
1995	-0.49	-1.45	-0.95	-0.62	-1.30	-1.54	-1.24	-0.96
1996	-0.07	-1.26	-1.28	0.40	0.14	0.26	1.09	-0.51
1997	-0.54	0.15	-0.53	-0.99	1.02	0.17	0.80	1.33
1998	-0.23	0.30	1.90	0.78	-1.32	0.65	-0.06	-0.03
1999	1.21	1.67	1.07	1.44	-0.32	-1.81	-2.03	-1.46
2000	0.22	1.71	1.23	-0.49	0.50	-0.05	-0.19	-0.22
2001	0.06	0.30	0.63	0.33	-1.35	0.06	0.83	0.16
2002	-0.93	-1.04	0.28	-0.26	0.49	-0.01	0.73	0.36
2003	-0.74	-0.95	-1.33	1.26	0.47	2.31	-0.44	-0.42
2004	0.16	0.46	-0.91	-1.54	1.69	1.25	1.75	-0.88
2005	-0.09	0.11	-0.54	-2.12	-1.56	1.63	0.88	1.06

Standardized cpue prediction errors						
Year/age	**4**	**5**	**6**	**7**	**8**	**9**
1985	1.33	-0.03	1.59	1.57	1.44	0.72
1986	-1.04	-0.46	-0.42	-0.11	-1.17	-0.35
1987	-0.06	-0.77	-0.82	0.04	0.25	-0.12
1988	0.58	1.75	-0.65	-0.22	0.62	-0.36
1989	1.34	1.08	2.35	0.97	0.26	-0.08
1990	-0.86	-0.89	-0.60	2.18	1.21	1.28
1991	0.41	2.32	-0.33	1.58	0.45	1.39
1992	1.05	-0.36	-0.33	-1.00	-0.25	0.06
1993	0.89	0.79	0.70	-0.73	-0.33	-0.55
1994	-0.53	-0.34	-1.02	-0.89	-0.59	-0.32
1995	-0.31	-0.31	0.14	-0.35	-0.15	0.03
1996	0.93	0.97	-0.91	1.82	2.09	1.13
1997	0.03	0.01	-0.35	-0.99	-0.08	-1.92
1998	-0.02	-0.23	0.33	-0.16	-0.78	-0.01
1999	0.79	-0.12	-0.62	0.19	-0.15	-1.47
2000	0.59	0.73	-0.04	-1.10	0.37	-0.94
2001	-0.29	-0.41	-0.47	-0.94	-1.74	-0.89
2002	0.43	1.22	2.15	0.52	0.77	-0.26
2003	-0.36	-0.02	-0.61	1.71	0.11	1.15
2004	1.78	0.93	0.50	0.91	2.36	0.55
2005	0.59	-0.29	0.22	-0.38	-0.18	0.52
2006	0.22	0.02	-0.57	-0.87	-1.44	-1.85

Table 3.3.12 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. Timetrend in R_{max} of the Ricker curve was allowed and CV of the residuals in the SSB-recruitment relationship depend on stock size. The SSB – recruitment relationship was based on spawning stock based on maturity at age from the survey, predicting the survey maturitity at age backwards in time from the observations from the catches.
- Migrations for specified years in specified ages are estimated.
- Catchability in the survey was dependent on stocksize for ages 1-5.
- CV of commercial catch data and of survey indices as function of age are estimated. The CV of the commercial catch is a parabola but estimated seperately for each age in the survey (change from last year when it was also a 2nd order polynomial) Correlation of residuals of different agegroups in the survey was estimated as a 1st order AR model.
- Fishing mortality of each age group was random walk with standard deviation specified as proportion of the estimated CV in the catch at age data. In the input file the process error (variablility in F) is specified to be larger than the measurement error for the younger ages but the measurement error is specified to be larger for the older age groups.
- The model estimates standard deviation on survey and age disaggregated catches. The division of the standard deviation in catches between process (random walk of F) and measurement error must be specified.

Some non-traditional of the assemssment model are.

- Rmax decrease by 0.9% per year from 1955 to 1995 so precdicted recruitment in 1995 is expected to be 67% of what it was in 1995 for the same spawing size of the spawing stock. At lesat part of this trend is considered to be due to different composition of the spawning stock with higher percentage of young fish in the spawing stock in recent years. Using catch maturity at age gives 1.5% trend per year.
- CV in recruitment. increases with reduced spawning stock as expected.

Age	M	Survey sigma	Survey lnQ	Survey Power	Meansel	Progsel	Sigma
1	0.2	0.402	-23.873	2.133	-1.000	-1.000	-1.000
2	0.2	0.155	-20.428	1.974	-1.000	-1.000	-1.000
3	0.2	0.207	-17.228	1.749	0.151	0.044	0.172
4	0.2	0.211	-14.539	1.563	0.496	0.210	0.099
5	0.2	0.181	-11.821	1.360	0.778	0.459	0.113
6	0.2	0.142	-7.694	1.000	0.965	0.665	0.123
7	0.2	0.169	-7.584	1.000	1.199	0.807	0.083
8	0.2	0.204	-7.568	1.000	1.403	0.924	0.106
9	0.2	0.229	-7.668	1.000	1.460	1.061	0.160
10	0.2	0.232	-7.613	1.000	1.516	1.144	0.156
11	0.2	-1.000	-1.000	-1.000	1.468	1.076	0.197
12	0.2	-1.000	-1.000	-1.000	1.312	1.083	0.197
13	0.2	-1.000	-1.000	-1.000	1.000	1.000	0.251
14	0.2	-1.000	-1.000	-1.000	1.000	1.000	0.251

Table 3.3.12 (continued)

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

log(C_ay,ob/C_ay,pre)												
Year/age	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1985	0.051	0.183	-0.103	0.119	-0.105	-0.025	-0.150	0.140	0.038	-0.345	0.471	0.477
1986	0.128	-0.102	0.019	-0.018	0.172	-0.056	0.108	-0.215	0.091	0.056	-0.594	0.192
1987	-0.164	0.106	0.038	-0.156	0.060	0.031	-0.039	0.114	-0.373	-0.106	0.128	-0.284
1988	-0.083	-0.079	-0.065	0.162	-0.088	0.065	0.148	0.029	0.492	0.019	0.557	0.142
1989	-0.194	0.044	0.132	-0.083	0.011	-0.158	-0.335	-0.093	-0.013	0.521	-0.016	-1.385
1990	-0.004	-0.113	-0.098	0.002	0.025	0.108	-0.094	-0.230	0.302	0.116	-0.204	0.103
1991	0.090	0.042	-0.096	-0.060	0.085	-0.089	0.122	-0.081	-0.306	0.402	-0.561	0.146
1992	-0.230	0.103	0.056	0.057	0.098	-0.013	-0.066	-0.052	-0.739	-0.772	-0.560	-0.128
1993	0.249	0.049	-0.168	-0.052	-0.063	-0.129	0.052	0.483	0.539	-0.204	-0.964	0.467
1994	0.052	0.234	-0.123	-0.167	-0.055	0.076	-0.210	-0.132	0.452	0.558	0.552	-0.339
1995	0.266	-0.014	0.081	-0.028	-0.025	-0.130	-0.131	-0.298	-0.183	0.748	1.173	0.674
1996	0.000	-0.062	-0.142	0.078	0.046	0.041	0.100	0.176	-0.361	-0.383	0.642	0.021
1997	-0.135	0.013	-0.028	-0.091	-0.107	0.220	0.178	0.226	0.430	-0.734	-0.201	0.214
1998	-0.192	-0.144	0.071	0.076	0.038	-0.173	0.224	0.050	0.079	0.277	0.164	-0.691
1999	-0.072	0.014	0.078	0.036	0.081	-0.012	-0.275	-0.170	-0.201	-0.399	-0.428	-0.848
2000	0.132	-0.210	0.103	0.005	-0.005	0.100	0.027	-0.121	0.073	0.216	-0.076	0.018
2001	0.194	0.144	-0.119	-0.008	0.042	-0.206	0.037	0.283	0.005	0.213	-0.406	0.067
2002	-0.029	0.071	-0.003	-0.019	-0.043	0.006	-0.238	0.224	0.302	-0.318	0.463	-1.027
2003	-0.276	-0.019	-0.009	-0.040	0.197	-0.012	0.184	-0.373	0.039	0.143	0.141	0.574
2004	-0.017	-0.012	0.070	-0.034	-0.117	0.268	-0.029	0.235	-0.501	-0.041	0.269	-0.328
2005	0.129	-0.120	0.035	-0.010	-0.160	-0.137	0.324	0.107	0.442	0.117	0.085	-0.753

log(U_ay,ob/U_ay,pre)									
Year/age	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
1985	-0.297	0.108	0.173	0.414	0.189	0.357	0.529	0.331	0.448
1986	0.495	-0.039	-0.368	-0.308	-0.123	0.033	-0.151	-0.315	-0.291
1987	0.570	0.038	0.112	-0.379	-0.049	-0.055	0.089	-0.043	-0.064
1988	-0.354	0.054	0.472	0.184	-0.084	-0.418	0.136	0.547	-0.166
1989	0.284	0.058	0.511	0.546	0.201	0.134	-0.158	-0.165	0.207
1990	-0.485	0.167	-0.020	-0.075	-0.185	-0.175	0.027	-0.190	-0.005
1991	-0.316	-0.518	0.006	0.085	0.224	0.077	0.182	-0.180	0.331
1992	-0.763	0.006	-0.262	0.028	-0.171	-0.137	-0.159	-0.134	-0.128
1993	-0.649	-0.101	0.091	-0.089	-0.009	-0.045	-0.303	-0.210	-0.296
1994	0.552	-0.341	-0.130	0.006	-0.232	-0.403	-0.193	-0.369	-0.234
1995	-0.522	0.140	-0.342	-0.253	0.113	0.028	-0.199	-0.063	-0.038
1996	-0.744	-0.206	0.033	-0.209	0.153	-0.028	0.333	0.575	0.334
1997	0.007	-0.067	0.055	0.251	-0.066	-0.004	-0.012	0.346	-0.413
1998	-0.149	0.274	-0.275	0.031	0.525	0.344	0.177	0.278	0.575
1999	-0.022	0.155	-0.186	0.007	-0.106	0.111	0.059	0.045	0.015
2000	0.900	0.185	0.192	-0.399	-0.107	-0.210	-0.201	0.021	-0.306
2001	0.106	-0.075	-0.028	-0.189	-0.694	-0.220	-0.396	-0.676	-0.444
2002	-0.049	0.154	0.066	0.037	0.011	-0.110	-0.148	-0.311	-0.540
2003	0.329	0.251	-0.113	-0.054	-0.018	-0.107	-0.063	0.084	0.387
2004	0.347	0.002	0.110	0.132	0.025	0.224	0.196	0.338	0.567
2005	0.203	-0.010	-0.032	0.061	-0.015	0.095	-0.017	0.029	0.201
2006	0.076	-0.077	-0.132	-0.120	0.129	0.065	-0.194	-0.418	-0.460

Table 3.3.13 Icelandic cod division Va. Comparison of results from various assessment methods.

Estimated fishing mortality rate in 2005:

Age	XSA	TSA	AD-CAM	ADAPT	X-CAM
3	0.03		0.03	0.03	0.04
4	0.10	0.13	0.14	0.11	0.15
5	0.29	0.30	0.30	0.29	0.28
6	0.41	0.42	0.43	0.43	0.40
7	0.50	0.52	0.53	0.46	0.49
8	0.59	0.63	0.62	0.53	0.54
9	0.83	0.74	0.72	1.04	0.54
10	0.80	0.72	0.79	0.62	0.49
11	0.83	0.71	0.74	1.41	0.42
12	0.86		0.75	4.29	
13	1.14		0.69	3.07	
14	0.92		0.69	0.73	
F(5-10)	**0.57**	**0.56**	**0.56**	**0.56**	**0.45**

Estimated stock in numbers (millions) in 2006:

Age	XSA	TSA	AD-CAM	ADAPT	X-CAM
3	138.714	118.000	126.959	130.016	124.585
4	137.817	105.209	130.435	132.205	131.550
5	42.258	34.382	34.359	39.213	36.395
6	69.998	63.335	64.408	70.073	66.843
7	29.871	28.616	27.590	27.796	29.875
8	11.319	11.521	12.061	12.461	13.679
9	5.179	4.960	5.539	6.020	6.442
10	0.889	0.946	0.780	0.629	0.990
11	0.67	0.691	0.604	0.960	1.503
12	0.141		0.104	0.059	
13	0.058		0.062	0.001	
14	0.011		0.020	0.001	

Recruitment:

Yearcl.	XSA	TSA	AD-CAM	ADAPT	X-CAM
2001	72	58	61	67	65
2002	174	147	164	167	166
2003	138	116	127	130	125
2004	104	85	87	92	86
2005	170	150	165	175	174

Estimated stock in weight (4+, Thous. tonnes) in 1990-2006

Year	XSA	TSA	AD-CAM	ADAPT	X-CAM
1992	554	535	546	554	570
1993	588	571	590	588	602
1994	585	578	574	585	590
1995	563	560	553	563	569
1996	688	672	668	688	675
1997	805	787	784	804	801
1998	739	718	718	738	737
1999	751	723	730	751	745
2000	602	577	586	601	599
2001	697	680	691	697	700
2002	726	719	727	729	737
2003	744	737	735	740	754
2004	838	808	815	834	846
2005	750	705	714	742	777
2006	**811**	**706**	**756**	**796**	**800**

Table 3.3.14 Icelandic cod division Va. Estimates of fishing mortality 1955-2005 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	F_{5-10}
1955	0.04	0.17	0.25	0.27	0.30	0.30	0.28	0.32	0.32	0.31	0.32	0.32	**0.29**
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	**0.29**
1957	0.08	0.21	0.27	0.27	0.30	0.33	0.33	0.36	0.36	0.33	0.30	0.30	**0.31**
1958	0.11	0.25	0.30	0.29	0.32	0.37	0.40	0.44	0.44	0.39	0.33	0.33	**0.35**
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	**0.32**
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	**0.37**
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	**0.36**
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	**0.38**
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	**0.46**
1964	0.13	0.29	0.37	0.36	0.43	0.57	0.74	0.81	0.83	0.61	0.39	0.39	**0.55**
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	**0.58**
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	**0.59**
1967	0.08	0.23	0.30	0.34	0.48	0.61	0.75	0.88	0.93	0.72	0.46	0.46	**0.56**
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	**0.72**
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	**0.56**
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	**0.61**
1971	0.09	0.31	0.48	0.53	0.62	0.72	0.80	0.96	1.04	0.88	0.58	0.58	**0.68**
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	**0.69**
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	**0.70**
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	**0.76**
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	**0.81**
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	**0.75**
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	**0.59**
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	**0.48**
1979	0.03	0.17	0.27	0.34	0.50	0.57	0.50	0.49	0.42	0.39	0.25	0.25	**0.45**
1980	0.03	0.17	0.31	0.39	0.54	0.62	0.56	0.55	0.47	0.44	0.29	0.29	**0.49**
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	**0.66**
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	**0.73**
1983	0.02	0.18	0.38	0.55	0.71	0.88	0.92	0.86	0.74	0.68	0.53	0.53	**0.72**
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	**0.64**
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	**0.67**
1986	0.06	0.26	0.52	0.71	0.82	0.96	0.88	0.78	0.66	0.63	0.50	0.50	**0.78**
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	**0.87**
1988	0.05	0.26	0.52	0.79	0.92	1.10	1.09	0.95	0.88	0.84	0.74	0.74	**0.90**
1989	0.04	0.24	0.46	0.65	0.79	0.90	0.81	0.73	0.65	0.64	0.52	0.52	**0.72**
1990	0.05	0.25	0.47	0.66	0.79	0.86	0.75	0.69	0.62	0.61	0.50	0.50	**0.70**
1991	0.09	0.30	0.56	0.81	0.88	0.95	0.85	0.78	0.71	0.70	0.59	0.59	**0.80**
1992	0.10	0.32	0.59	0.86	0.92	1.01	0.91	0.81	0.74	0.73	0.62	0.62	**0.85**
1993	0.14	0.31	0.55	0.79	0.89	1.03	1.04	0.95	0.90	0.88	0.79	0.79	**0.87**
1994	0.09	0.24	0.38	0.53	0.68	0.76	0.73	0.71	0.65	0.65	0.56	0.56	**0.63**
1995	0.06	0.20	0.32	0.42	0.57	0.62	0.56	0.58	0.52	0.53	0.45	0.45	**0.51**
1996	0.04	0.16	0.28	0.41	0.56	0.62	0.58	0.60	0.54	0.55	0.47	0.47	**0.51**
1997	0.03	0.15	0.27	0.42	0.58	0.67	0.67	0.69	0.64	0.64	0.56	0.56	**0.55**
1998	0.03	0.16	0.33	0.51	0.66	0.78	0.84	0.85	0.81	0.80	0.74	0.74	**0.66**
1999	0.05	0.18	0.39	0.64	0.74	0.85	0.94	0.92	0.89	0.87	0.81	0.81	**0.75**
2000	0.06	0.19	0.39	0.62	0.74	0.87	0.97	0.97	0.94	0.93	0.88	0.88	**0.76**
2001	0.07	0.19	0.39	0.58	0.70	0.84	1.00	1.02	1.00	0.98	0.95	0.95	**0.75**
2002	0.04	0.17	0.34	0.49	0.61	0.71	0.85	0.90	0.86	0.86	0.81	0.81	**0.65**
2003	0.03	0.15	0.33	0.47	0.58	0.65	0.74	0.79	0.74	0.75	0.69	0.69	**0.59**
2004	0.03	0.15	0.33	0.49	0.58	0.66	0.76	0.81	0.76	0.77	0.71	0.71	**0.60**
2005	0.03	0.14	0.30	0.43	0.53	0.62	0.72	0.79	0.74	0.75	0.69	0.69	**0.56**
2006	0.03	0.13	0.28	0.41	0.50	0.57	0.65	0.70	0.66	0.67	0.61	0.61	**0.52**
2007	0.03	0.12	0.27	0.39	0.47	0.54	0.62	0.66	0.62	0.63	0.58	0.58	**0.49**
2008	0.03	0.13	0.27	0.40	0.48	0.55	0.63	0.68	0.64	0.65	0.60	0.60	**0.50**

Table 3.3.15 Icelandic cod, division Va. Estimates of numbers at age in stock in 1955-2005 using final F from AD-CAM using catch at age and spring trawl survey indices and predictions for 2007-2008.

Year/age	3	4	5	6	7	8	9	10	11	12	13	14
1955	151.999	217.646	211.978	115.438	36.023	24.550	12.934	87.468	9.183	7.791	8.111	2.635
1956	152.825	119.562	150.298	134.773	71.819	21.797	14.829	7.977	51.754	5.433	4.682	4.799
1957	170.656	118.905	81.586	95.881	85.187	44.001	13.171	9.039	4.634	29.679	3.179	2.745
1958	220.729	128.830	78.534	50.804	59.824	51.636	35.166	7.773	5.143	2.635	17.427	1.930
1959	289.145	161.188	82.274	47.543	31.100	35.434	51.525	19.340	4.100	2.701	1.466	10.307
1960	154.362	216.183	104.524	50.791	30.117	18.886	20.617	37.477	10.619	2.289	1.603	0.953
1961	192.921	114.280	140.200	63.732	31.064	17.587	10.389	10.997	19.044	5.403	1.273	1.001
1962	128.941	143.804	74.712	88.569	40.168	18.220	23.600	5.597	5.687	10.038	3.117	0.830
1963	177.568	94.427	91.876	46.157	55.714	23.259	9.764	12.113	2.743	2.858	5.626	2.008
1964	204.143	127.711	58.262	54.192	27.749	31.104	11.644	4.447	5.198	1.202	1.473	3.460
1965	216.455	147.395	78.218	32.884	30.942	14.712	14.400	4.548	1.619	1.846	0.535	0.817
1966	229.182	157.044	90.832	43.585	17.988	15.814	6.597	5.599	1.593	0.550	0.785	0.286
1967	320.272	170.779	99.787	52.867	24.362	9.014	6.951	2.474	1.834	0.476	0.205	0.377
1968	171.875	242.862	111.203	60.328	30.868	12.296	4.011	2.689	0.842	0.593	0.189	0.106
1969	247.574	130.325	155.382	64.692	32.934	41.229	4.684	1.166	0.663	0.177	0.164	0.074
1970	180.453	191.692	84.587	92.162	37.177	32.925	18.374	1.869	0.413	0.227	0.071	0.086
1971	188.615	137.935	119.850	46.918	49.280	17.539	14.069	7.031	0.627	0.131	0.083	0.034
1972	139.178	141.359	82.909	60.798	22.550	21.694	23.275	5.174	2.209	0.182	0.044	0.038
1973	273.155	104.395	85.591	42.027	28.625	9.643	8.565	8.636	1.623	0.626	0.060	0.020
1974	178.941	198.601	62.027	42.997	19.567	12.019	3.713	3.153	2.723	0.468	0.207	0.027
1975	260.873	130.799	117.521	30.831	19.803	7.958	4.282	1.210	0.897	0.684	0.137	0.084
1976	367.954	191.678	78.573	58.236	13.842	7.873	2.690	1.261	0.320	0.209	0.185	0.051
1977	143.269	281.919	121.209	41.939	27.456	5.653	2.747	0.852	0.376	0.090	0.066	0.078
1978	226.854	113.779	189.859	71.374	22.373	12.216	2.249	1.084	0.333	0.153	0.039	0.036
1979	244.160	180.738	78.283	117.352	41.007	10.833	5.474	1.065	0.512	0.168	0.080	0.024
1980	139.822	194.338	124.741	48.713	71.822	20.304	5.029	2.726	0.533	0.276	0.092	0.051
1981	140.792	111.301	133.573	75.200	27.105	47.157	8.937	2.355	1.291	0.273	0.145	0.056
1982	131.965	112.683	76.419	76.847	37.766	11.599	17.005	3.115	0.848	0.498	0.111	0.070
1983	233.280	105.105	76.130	42.185	36.029	15.354	3.862	5.306	1.064	0.328	0.206	0.054
1984	138.551	186.568	71.997	42.802	19.853	14.562	5.197	1.256	1.840	0.416	0.136	0.099
1985	137.449	109.141	125.040	40.482	20.672	8.288	5.328	1.990	0.507	0.827	0.193	0.071
1986	334.159	106.996	70.955	67.175	18.631	8.286	2.950	2.015	0.805	0.228	0.382	0.101
1987	264.793	257.195	67.355	34.680	26.977	6.686	2.608	0.999	0.759	0.339	0.100	0.190
1988	174.879	205.094	160.318	31.710	12.626	8.928	1.895	0.783	0.347	0.294	0.137	0.045
1989	86.859	136.595	129.652	77.831	11.806	4.120	2.424	0.522	0.248	0.118	0.104	0.054
1990	130.263	68.258	87.738	100.528	33.169	4.365	1.378	0.886	0.207	0.106	0.051	0.050
1991	104.130	101.407	43.479	44.970	42.598	12.334	1.516	0.531	0.363	0.091	0.047	0.025
1992	173.441	78.203	61.369	20.341	16.453	14.400	3.910	0.530	0.200	0.146	0.037	0.021
1993	136.521	128.137	46.438	27.803	7.051	5.345	4.311	1.295	0.192	0.078	0.058	0.016
1994	75.810	97.371	76.605	21.933	10.291	2.375	1.560	1.248	0.412	0.064	0.026	0.022
1995	152.182	56.791	62.525	42.759	10.582	4.279	0.906	0.618	0.505	0.176	0.027	0.012
1996	166.561	117.148	38.184	37.246	22.959	4.889	1.879	0.422	0.284	0.246	0.085	0.014
1997	85.324	131.535	81.643	23.621	20.282	10.736	2.152	0.861	0.190	0.135	0.116	0.043
1998	162.203	68.079	93.065	50.852	12.746	9.261	4.518	0.904	0.354	0.082	0.058	0.054
1999	67.390	129.018	47.716	54.948	24.888	5.368	3.493	1.598	0.317	0.128	0.030	0.023
2000	176.352	52.724	88.273	26.421	23.755	9.707	1.874	1.117	0.519	0.107	0.044	0.011
2001	159.567	136.090	35.858	48.734	11.646	9.235	3.345	0.579	0.345	0.166	0.035	0.015
2002	160.375	122.215	91.889	19.942	22.339	4.726	3.259	1.012	0.171	0.104	0.051	0.011
2003	189.769	125.788	84.559	53.339	10.049	9.943	1.893	1.139	0.338	0.059	0.036	0.019
2004	60.824	150.801	88.552	49.937	27.257	4.626	4.230	0.738	0.422	0.132	0.023	0.015
2005	164.227	48.198	106.169	51.936	25.151	12.532	1.954	1.622	0.268	0.161	0.050	0.009
2006	127.013	130.513	34.381	64.449	27.610	12.070	5.543	0.780	0.605	0.104	0.062	0.020
2007	87.346	101.205	93.888	21.228	35.070	13.762	5.598	2.363	0.316	0.256	0.044	0.028
2008	165.256	69.706	73.344	58.910	11.823	17.982	6.593	2.477	0.997	0.139	0.112	0.020

Table 3.3.16 Icelandic cod, division Va. Estimates of spawning stock biomass (SSB) by age in 1955-2005 using final F from AD-CAM using catch at age and spring trawl survey indices and predictions for 2007-2008.

Year/age	3	4	5	6	7	8	9	10	11	12	13	14	Total
1955	1.766	4.501	11.456	58.325	72.713	90.451	59.476	421.959	65.432	56.459	66.647	31.306	**940.490**
1956	1.774	3.434	8.258	38.040	146.013	79.937	61.948	44.005	278.045	40.906	41.646	50.429	**794.435**
1957	1.976	3.774	6.679	23.699	160.942	173.123	64.701	51.952	30.745	199.724	27.138	29.827	**774.280**
1958	2.548	4.633	15.809	91.514	152.615	198.660	153.219	49.695	33.685	18.424	132.868	20.588	**874.258**
1959	3.345	6.485	12.719	89.209	100.101	146.529	228.448	107.324	27.645	19.107	12.467	99.061	**852.440**
1960	1.784	6.880	15.139	104.407	99.176	81.691	92.128	200.712	64.164	18.538	13.534	10.255	**708.410**
1961	2.231	3.401	15.211	96.195	98.848	72.545	46.781	60.802	10.902	37.012	10.690	12.427	**467.045**
1962	1.489	4.108	7.056	75.152	134.797	79.991	101.141	29.133	31.994	65.987	28.825	9.033	**568.706**
1963	2.047	2.747	8.678	31.756	147.012	102.987	46.720	64.429	15.935	19.841	46.316	19.249	**507.718**
1964	2.354	4.092	5.443	53.932	82.629	123.057	52.853	28.567	30.576	9.348	14.747	43.459	**451.058**
1965	2.497	3.973	6.647	35.368	88.900	56.866	57.568	24.818	12.463	13.440	4.229	10.922	**317.691**
1966	2.650	4.861	7.867	53.662	57.222	67.147	28.745	29.520	8.521	5.119	8.157	3.778	**277.249**
1967	3.709	6.198	10.152	55.530	73.586	43.087	30.779	13.048	10.182	3.236	2.231	4.723	**256.460**
1968	1.991	6.851	11.291	51.394	72.102	39.633	14.720	12.235	4.497	3.896	1.848	1.133	**221.590**
1969	2.872	4.701	12.368	41.739	79.046	141.120	18.637	6.209	3.629	1.204	1.444	0.745	**313.714**
1970	2.091	4.519	6.212	58.207	79.795	101.726	62.267	9.721	2.619	1.813	0.767	1.393	**331.129**
1971	2.182	3.801	7.357	7.396	106.623	44.337	39.358	26.123	3.085	0.900	0.878	0.426	**242.466**
1972	1.610	3.336	4.603	14.884	29.027	64.981	74.168	18.598	8.654	0.985	0.367	0.434	**221.646**
1973	3.650	2.908	24.689	40.936	64.130	32.286	30.954	35.036	6.946	3.076	0.435	0.240	**245.286**
1974	2.175	7.369	9.155	40.127	42.263	41.817	13.311	13.903	12.078	2.662	1.748	0.270	**186.877**
1975	3.172	5.688	27.521	23.314	49.569	27.834	15.883	5.762	4.131	3.753	0.904	0.608	**168.138**
1976	5.612	6.281	13.018	42.945	18.493	27.670	11.285	7.115	2.115	1.446	1.805	0.576	**138.362**
1977	1.666	9.265	15.478	48.073	78.936	21.269	11.940	5.538	2.994	0.915	0.904	1.474	**198.453**
1978	3.472	3.750	21.809	40.848	65.396	49.835	12.455	8.622	3.280	1.404	0.623	0.636	**212.130**
1979	2.839	5.343	8.281	100.048	100.932	42.908	28.498	6.857	5.237	1.772	0.911	0.411	**304.038**
1980	2.225	5.462	12.008	30.837	169.980	79.876	24.563	20.937	4.984	3.535	1.138	0.801	**356.347**
1981	1.638	2.906	6.709	16.144	35.971	137.040	35.505	13.723	9.633	2.377	1.341	0.795	**263.782**
1982	1.696	3.130	4.782	11.006	30.949	28.276	55.600	17.265	6.748	4.868	1.426	0.863	**166.610**
1983	2.714	3.622	5.997	10.502	25.184	28.840	11.922	26.660	7.719	3.148	2.417	0.738	**129.463**
1984	1.610	5.530	7.298	18.545	25.218	35.018	18.367	7.970	14.078	4.102	1.598	1.272	**140.606**
1985	0.000	2.876	34.687	36.241	25.591	25.657	16.459	13.954	4.418	8.792	2.396	1.046	**172.115**
1986	0.240	3.566	25.503	66.354	40.405	23.450	13.002	11.569	5.704	2.457	4.164	1.134	**197.548**
1987	0.289	12.176	12.586	32.907	43.636	22.152	8.860	5.837	5.293	2.442	1.139	1.717	**149.033**
1988	0.606	7.965	68.149	40.001	16.653	21.487	7.176	3.954	2.112	1.801	1.294	0.396	**171.596**
1989	0.443	4.646	36.507	77.842	25.053	11.908	7.996	3.422	2.078	0.749	0.831	0.636	**172.110**
1990	0.417	0.771	24.993	96.213	59.963	14.818	6.619	6.331	1.611	1.101	0.603	0.650	**214.089**
1991	0.000	6.446	10.937	34.162	62.539	34.779	4.744	2.879	2.401	0.892	0.480	0.368	**160.628**
1992	0.202	5.816	27.972	18.268	33.546	45.173	14.748	2.778	1.690	1.316	0.412	0.170	**152.092**
1993	0.545	13.344	23.760	31.385	13.604	15.710	15.689	6.563	1.298	0.609	0.556	0.180	**123.244**
1994	0.485	16.852	50.633	35.215	23.947	9.292	5.656	6.429	3.073	0.574	0.285	0.274	**152.715**
1995	0.536	9.292	49.495	60.389	27.309	15.656	4.479	4.587	4.128	1.483	0.275	0.145	**177.774**
1996	0.214	5.883	15.693	55.327	48.973	15.619	8.151	2.948	2.199	2.388	0.855	0.176	**158.426**
1997	0.326	6.074	40.471	31.545	55.456	38.372	8.794	4.692	1.437	0.998	0.879	0.404	**189.447**
1998	0.000	5.823	38.575	66.550	32.906	39.540	18.278	4.939	2.452	0.793	0.651	0.676	**211.183**
1999	0.545	7.670	19.021	66.886	45.846	18.660	12.724	9.611	2.191	1.011	0.291	0.224	**184.679**
2000	0.100	4.272	36.165	30.864	44.865	32.325	8.726	6.020	3.225	0.730	0.362	0.119	**167.775**
2001	0.399	8.334	16.751	61.953	26.250	29.367	12.825	3.028	1.788	0.939	0.235	0.125	**161.994**
2002	0.766	15.422	58.382	33.630	50.909	19.271	8.868	5.528	1.126	0.882	0.296	0.120	**195.201**
2003	0.521	7.167	35.817	69.095	27.824	28.565	6.507	5.816	1.988	0.428	0.302	0.175	**184.206**
2004	0.000	7.708	40.041	69.043	48.916	14.971	13.432	3.489	3.011	1.004	0.215	0.131	**201.962**
2005	0.521	5.455	50.163	63.765	59.780	38.636	7.797	5.768	1.291	1.067	0.443	0.115	**234.801**
2006	0.134	3.858	17.912	70.698	71.554	40.558	17.824	2.917	3.026	0.719	0.573	0.264	**230.037**
2007	0.000	7.815	45.102	26.168	88.081	45.338	20.716	9.004	1.611	1.792	0.410	0.361	**246.399**
2008	0.000	5.379	35.165	72.381	29.541	58.838	24.191	9.352	5.035	0.965	1.034	0.261	**242.142**

Table 3.3.17 Icelandic cod, division Va. Stock weight at age in stock in 1955-2005 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	125.703	284.463	457.237	417.539	167.075	138.878	85.819	539.502	80.312	68.788	81.804	38.425	2359.8
1956	165.051	191.299	329.153	442.055	333.960	122.717	91.646	55.599	353.478	50.476	51.339	62.166	2083.9
1957	194.548	203.328	205.596	306.819	388.453	262.244	94.437	65.623	38.463	246.041	32.906	36.167	1880.1
1958	267.082	233.182	245.027	229.127	299.118	306.720	233.501	64.434	43.770	23.289	163.120	25.275	1866.6
1959	320.951	314.317	241.063	214.893	171.669	218.629	340.580	137.893	34.888	23.415	14.627	116.222	1828.2
1960	163.624	371.835	305.210	235.670	170.460	123.705	142.465	267.588	84.633	23.435	16.194	12.270	1753.5
1961	196.779	190.848	378.540	275.961	171.782	110.973	71.996	80.387	142.829	45.982	12.526	14.562	1496.4
1962	127.652	231.524	194.997	345.419	229.760	121.347	159.297	39.517	42.877	83.112	33.975	10.647	1492.5
1963	221.960	155.804	242.552	175.395	284.700	160.952	76.549	92.181	22.576	26.009	55.813	23.196	1315.7
1964	247.013	223.494	153.812	217.852	151.233	200.931	93.148	44.201	47.870	13.144	18.667	55.012	1219.4
1965	220.784	225.514	201.020	134.494	167.397	94.154	102.524	39.116	19.932	19.314	5.449	14.072	1023.0
1966	268.143	263.834	235.256	182.184	103.070	109.119	51.657	48.040	14.483	7.828	11.060	5.122	1031.7
1967	358.705	310.818	265.433	215.009	135.455	70.218	54.492	20.856	16.672	4.807	2.923	6.187	1102.9
1968	201.094	386.151	298.024	237.088	155.577	72.668	30.125	22.805	9.046	6.868	2.766	1.696	1222.8
1969	272.331	235.888	385.347	243.889	165.987	241.600	32.789	9.732	5.780	1.782	1.878	0.969	1325.6
1970	178.648	277.953	206.393	347.452	180.679	184.051	115.023	15.640	4.332	2.796	1.032	1.875	1337.2
1971	205.590	216.558	276.854	139.815	242.949	90.325	78.506	44.296	5.347	1.469	1.228	0.591	1097.9
1972	136.394	206.384	183.229	197.594	97.640	121.705	140.580	31.564	15.177	1.631	0.518	0.609	996.6
1973	281.350	148.241	211.410	151.296	140.264	58.920	57.128	58.296	12.056	4.980	0.608	0.336	843.5
1974	187.888	339.608	150.726	164.247	102.533	80.045	26.550	24.467	22.303	4.579	2.568	0.397	918.0
1975	286.960	231.514	326.708	115.923	107.925	53.241	32.418	10.381	7.903	6.693	1.378	0.926	895.0
1976	496.738	341.187	208.219	238.768	70.181	52.982	22.192	12.115	3.695	2.393	2.602	0.831	955.2
1977	180.376	538.747	346.173	170.651	158.612	37.513	21.110	8.288	4.395	1.300	1.157	1.886	1289.8
1978	292.415	208.557	556.097	282.285	128.105	83.139	20.337	11.783	4.346	1.830	0.750	0.765	1298.0
1979	343.777	353.524	206.823	469.291	227.505	73.163	45.431	9.918	6.727	2.249	1.079	0.487	1396.2
1980	194.632	361.857	340.917	183.551	377.714	141.739	40.420	29.250	6.558	4.763	1.377	0.970	1489.1
1981	166.135	183.758	301.875	247.634	121.510	274.503	69.164	22.186	14.683	3.486	1.812	1.075	1241.7
1982	132.757	174.659	171.637	238.534	160.808	62.474	113.625	28.475	10.146	7.078	1.920	1.162	970.5
1983	255.442	168.063	173.197	127.442	147.576	84.157	27.225	43.125	11.718	4.582	3.278	1.002	791.4
1984	178.454	321.830	186.903	153.274	86.779	84.428	38.745	12.377	20.337	5.969	2.073	1.650	914.4
1985	193.391	215.117	322.103	147.758	102.862	52.814	43.724	20.540	6.179	12.136	3.119	1.361	927.7
1986	487.538	209.819	201.796	241.359	86.356	50.998	22.132	18.303	8.332	3.485	5.559	1.514	849.7
1987	348.468	503.073	180.915	135.045	127.223	41.835	19.219	9.234	8.124	3.601	1.584	2.388	1032.2
1988	251.476	370.195	412.979	111.588	62.247	53.578	13.535	6.910	3.465	3.450	1.933	0.592	1040.5
1989	103.014	247.647	335.799	304.708	61.507	28.396	19.474	5.131	2.975	1.183	1.306	0.859	1009.0
1990	168.039	116.311	209.079	305.002	153.374	28.467	12.245	9.387	2.274	1.549	0.805	0.867	839.4
1991	136.306	192.572	107.611	142.061	161.531	70.059	10.980	5.207	3.545	1.310	0.669	0.513	696.1
1992	223.565	138.264	151.521	66.963	72.294	80.378	26.709	4.303	2.534	1.957	0.583	0.241	545.7
1993	190.037	241.795	128.727	104.596	34.759	32.358	32.121	11.188	2.097	0.973	0.851	0.275	589.7
1994	109.393	200.876	196.262	80.251	52.661	14.874	12.044	11.106	4.469	0.824	0.391	0.376	574.1
1995	205.141	111.254	182.574	155.000	54.773	27.456	7.171	6.349	5.563	2.011	0.358	0.188	552.7
1996	242.679	226.096	119.593	154.234	113.003	29.379	13.918	4.127	2.996	3.315	1.158	0.232	668.1
1997	126.621	246.891	234.968	95.146	109.562	68.559	15.804	7.353	2.048	1.558	1.206	0.554	783.7
1998	199.510	119.137	228.753	180.982	66.446	71.651	35.406	8.414	3.808	1.223	0.973	1.011	717.8
1999	83.630	221.395	115.758	189.185	117.473	34.095	30.493	15.889	3.514	1.609	0.451	0.346	730.2
2000	230.668	93.955	205.675	85.922	111.409	57.211	14.634	10.276	5.317	1.196	0.580	0.191	586.4
2001	239.191	278.985	94.987	166.327	55.507	60.103	25.152	5.241	3.027	1.577	0.388	0.207	691.5
2002	207.525	235.386	244.058	73.388	105.439	30.097	25.446	9.106	1.785	1.394	0.457	0.185	726.7
2003	238.350	224.657	204.463	186.847	44.808	50.094	11.330	8.940	2.979	0.642	0.440	0.256	735.5
2004	76.273	266.767	205.175	164.893	116.169	24.928	24.850	5.458	4.550	1.521	0.318	0.193	814.8
2005	195.923	82.370	252.364	178.661	110.641	65.306	12.139	8.915	1.935	1.606	0.648	0.168	714.8
2006	151.527	223.047	81.723	221.706	121.457	62.896	34.427	4.289	4.362	1.038	0.807	0.372	756.1
2007	104.204	172.959	223.173	73.023	154.271	71.714	34.769	12.988	2.281	2.542	0.568	0.501	748.8
2008	197.150	119.128	174.339	202.650	52.010	93.704	40.950	13.615	7.190	1.380	1.445	0.365	706.8

Table 3.3.18 Icelandic cod, division Va. Landings ('000 tonnes), average fishing m ortality 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	F_{5-10}	SSB	Recruitment	Bio_{4+}	Harvest Ratio
1955	538	0.29	940	151999	2360	0.36
1956	481	0.29	794	152825	2084	0.37
1957	452	0.31	774	170656	1880	0.38
1958	509	0.35	874	220729	1867	0.43
1959	453	0.32	852	289145	1828	0.40
1960	465	0.37	708	154362	1753	0.48
1961	375	0.36	467	192921	1496	0.44
1962	387	0.38	569	128941	1492	0.45
1963	410	0.46	508	177568	1316	0.53
1964	434	0.55	451	204143	1219	0.63
1965	394	0.58	318	216455	1023	0.68
1966	357	0.59	277	229182	1032	0.66
1967	345	0.56	256	320272	1103	0.60
1968	381	0.72	222	171875	1223	0.69
1969	406	0.56	314	247574	1326	0.59
1970	471	0.61	331	180453	1337	0.68
1971	453	0.68	242	188615	1098	0.80
1972	399	0.69	222	139178	997	0.81
1973	383	0.70	245	273155	844	0.86
1974	375	0.76	187	178941	918	0.90
1975	371	0.81	168	260873	895	0.91
1976	348	0.75	138	367954	955	0.78
1977	340	0.59	198	143269	1290	0.61
1978	330	0.48	212	226854	1298	0.52
1979	368	0.45	304	244160	1396	0.51
1980	434	0.49	356	139822	1489	0.57
1981	469	0.66	264	140792	1242	0.72
1982	388	0.73	167	131965	971	0.79
1983	300	0.72	129	233280	791	0.73
1984	284	0.64	141	138551	914	0.69
1985	325	0.67	172	137449	928	0.76
1986	369	0.78	198	334159	850	0.88
1987	392	0.87	149	264793	1032	0.91
1988	378	0.90	172	174879	1040	0.91
1989	356	0.72	172	86859	1009	0.85
1990	335	0.70	214	130263	839	0.88
1991	309	0.80	161	104130	696	1.00
1992	268	0.85	152	173441	546	1.03
1993	252	0.87	123	136521	590	1.02
1994	179	0.63	153	75810	574	0.73
1995	169	0.51	178	152182	553	0.60
1996	182	0.51	158	166561	668	0.55
1997	203	0.55	189	85324	784	0.55
1998	243	0.66	211	162203	718	0.67
1999	260	0.75	185	67390	730	0.79
2000	236	0.76	168	176352	586	0.78
2001	235	0.75	162	159567	692	0.74
2002	209	0.65	195	160375	727	0.63
2003	202	0.59	184	189769	735	0.59
2004	222	0.60	202	60824	815	0.61
2005	208	0.56	235	164227	715	0.58

Table 3.3.19. Icelandic cod division Va. Short term predictions (Management options table).

Calculations were performed with the spreadsheet: codpr2006.xls.

Input data:

Sexual maturity at spawning time:				
age\year	**2005**	**2006**	**2007**	**2008**
3	0.01	0.00	0.00	0.00
4	0.11	0.02	0.06	0.06
5	0.28	0.29	0.27	0.27
6	0.50	0.45	0.50	0.50
7	0.79	0.75	0.72	0.72
8	0.81	0.87	0.84	0.84
9	0.95	0.74	0.84	0.84
10	1.00	1.00	1.00	1.00
11	1.00	1.00	1.00	1.00
12	1.00	1.00	1.00	1.00
13	1.00	1.00	1.00	1.00
14	1.00	1.00	1.00	1.00

Mean weights in the SSB (in March survey)				
age\year	**2005**	**2006**	**2007**	**2008**
3	0.590	0.515	0.515	0.515
4	1.119	1.383	1.383	1.383
5	1.897	1.998	1.998	1.998
6	2.963	2.905	2.905	2.905
7	3.874	4.385	4.385	4.385
8	5.211	5.211	5.211	5.211
9	6.211	6.211	6.211	6.211
10	5.496	5.496	5.496	5.496
11	7.213	7.213	7.213	7.213
12	9.946	9.946	9.946	9.946
13	12.947	12.947	12.947	12.947
14	18.147	18.147	18.147	18.147

Mean weights in the catch				
age\year	**2005**	**2006**	**2007**	**2008**
3	1.193	1.193	1.193	1.193
4	1.709	1.709	1.709	1.709
5	2.377	2.377	2.377	2.377
6	3.440	3.440	3.440	3.440
7	4.399	4.399	4.399	4.399
8	5.211	5.211	5.211	5.211
9	6.211	6.211	6.211	6.211
10	5.496	5.496	5.496	5.496
11	7.213	7.213	7.213	7.213
12	9.946	9.946	9.946	9.946
13	12.947	12.947	12.947	12.947
14	18.147	18.147	18.147	18.147

Table 3.3.19. (Continued)

Selection pattern from a AD-CAM:

age\year	2000	2001	2002	2003	2004	2005	03-05	Used
3	0.078	0.088	0.066	0.050	0.054	0.053	0.052	0.052
4	0.243	0.256	0.259	0.254	0.250	0.244	0.249	0.249
5	0.517	0.513	0.529	0.550	0.552	0.530	0.544	0.544
6	0.813	0.769	0.746	0.794	0.803	0.765	0.788	0.788
7	0.977	0.931	0.937	0.970	0.954	0.947	0.957	0.957
8	1.136	1.116	1.099	1.102	1.094	1.091	1.096	1.096
9	1.279	1.321	1.309	1.249	1.254	1.272	1.258	1.258
10	1.278	1.350	1.379	1.335	1.343	1.394	1.357	1.357
11	1.238	1.326	1.325	1.252	1.258	1.319	1.276	1.233
12	1.219	1.303	1.315	1.259	1.266	1.333	1.285	1.233
13	1.158	1.258	1.241	1.159	1.173	1.230	1.186	1.233
14	1.158	1.258	1.241	1.159	1.173	1.230	1.186	1.233

Natural Mortality

age\year	2005	2006	2007	2008	2009
3	0.2	0.2	0.2	0.2	0.2
4	0.2	0.2	0.2	0.2	0.2
5	0.2	0.2	0.2	0.2	0.2
6	0.2	0.2	0.2	0.2	0.2
7	0.2	0.2	0.2	0.2	0.2
8	0.2	0.2	0.2	0.2	0.2
9	0.2	0.2	0.2	0.2	0.2
10	0.2	0.2	0.2	0.2	0.2
11	0.2	0.2	0.2	0.2	0.2
12	0.2	0.2	0.2	0.2	0.2
13	0.2	0.2	0.2	0.2	0.2
14	0.2	0.2	0.2	0.2	0.2

Given stock numbers					Mortality proportions before spawning	
age\year	2006	2007	2008	2009	F	M
3	126.959	87	165	160	0.085	0.25
4	130.435				0.18	0.25
5	34.359				0.248	0.25
6	64.408				0.296	0.25
7	27.590				0.382	0.25
8	12.061				0.437	0.25
9	5.539				0.477	0.25
10	0.780				0.477	0.25
11	0.604				0.477	0.25
12	0.104				0.477	0.25
13	0.062				0.477	0.25
14	0.020				0.477	0.25

Table 3.3.19 (Continued)

Prognosis - Summary

Catch, '000 tonnes	2002	2003	2004	2005	2006	2007	2008	2009
Opt1	208	202	222	208	204	170	170	170
Opt2	208	202	222	208	204	188	182	186
Opt3	208	202	222	208	204	180	180	180
Opt4	208	202	222	208	204	200	200	200
Opt5	208	202	222	208	204	220	220	220

Average fishing mortality of 5-10 years old	2002	2003	2004	2005	2006	2007	2008	2009
Opt1	0.650	0.594	0.605	0.564	0.523	0.424	0.399	0.373
Opt2	0.650	0.594	0.605	0.564	0.523	0.478	0.450	0.443
Opt3	0.650	0.594	0.605	0.564	0.523	0.454	0.436	0.417
Opt4	0.650	0.594	0.605	0.564	0.523	0.516	0.520	0.522
Opt5	0.650	0.594	0.605	0.564	0.523	0.581	0.617	0.655

Fishable stock, 4+ in '000 tonnes at the beginnig of the year	2002	2003	2004	2005	2006	2007	2008	2009
Opt1	727	735	815	715	756	747	729	813
Opt2	727	735	815	715	756	747	709	778
Opt3	727	735	815	715	756	747	718	790
Opt4	727	735	815	715	756	747	695	744
Opt5	727	735	815	715	756	747	672	698

Spawning stock in '000 at the time of spawning	2002	2003	2004	2005	2006	2007	2008	2009
Opt1	195	184	202	235	230	252	263	284
Opt2	195	184	202	235	230	247	248	259
Opt3	195	184	202	235	230	249	254	267
Opt4	195	184	202	235	230	244	236	234
Opt5	195	184	202	235	230	238	217	201

Prognosis - Summary table (nwwg2006)

2006				2007				2008				2009			
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)
204	756	230	0.523	170	747	252	0.424	170	729	263	0.399	170	813	284	0.373
				188	747	247	0.478	182	709	248	0.450	186	778	259	0.443
				180	747	249	0.454	180	718	254	0.436	180	790	267	0.417
				200	747	244	0.516	200	695	236	0.520	200	744	234	0.522
				220	747	238	0.581	220	672	217	0.617	220	698	201	0.655

Table 3.3.20 Icelandic cod, divisionVa. Input fot long-term predictions.

Age	M	Mat	PF	PM	SWt	Sel	CW
3	0.2	0.00	0.085	0.25	0.645	0.052	1.338
4	0.2	0.05	0.18	0.25	1.447	0.249	1.861
5	0.2	0.23	0.248	0.25	2.203	0.544	2.595
6	0.2	0.48	0.296	0.25	3.131	0.788	3.565
7	0.2	0.67	0.382	0.25	4.233	0.957	4.764
8	0.2	0.80	0.437	0.25	6.155	1.096	6.147
9	0.2	0.80	0.477	0.25	7.452	1.258	7.468
10	0.2	0.97	0.477	0.25	9.100	1.357	9.009
11	0.2	1.00	0.477	0.25	10.686	1.276	10.516
12	0.2	0.98	0.477	0.25	12.475	1.285	12.398
13	0.2	0.99	0.477	0.25	13.834	1.186	13.793
14	0.2	1.00	0.477	0.25	15.464	1.186	15.712

Table 3.3.21. Icelandic cod, division Va. Biological reference points.

	Fish Mort Ages 5-10	Yield/R	SSB/R
Average last 3 years	0.583	1.755	1.673
Fmax	0.336	1.804	3.336
F0.1	0.148	1.632	7.651
Fmed	0.662	1.734	1.414

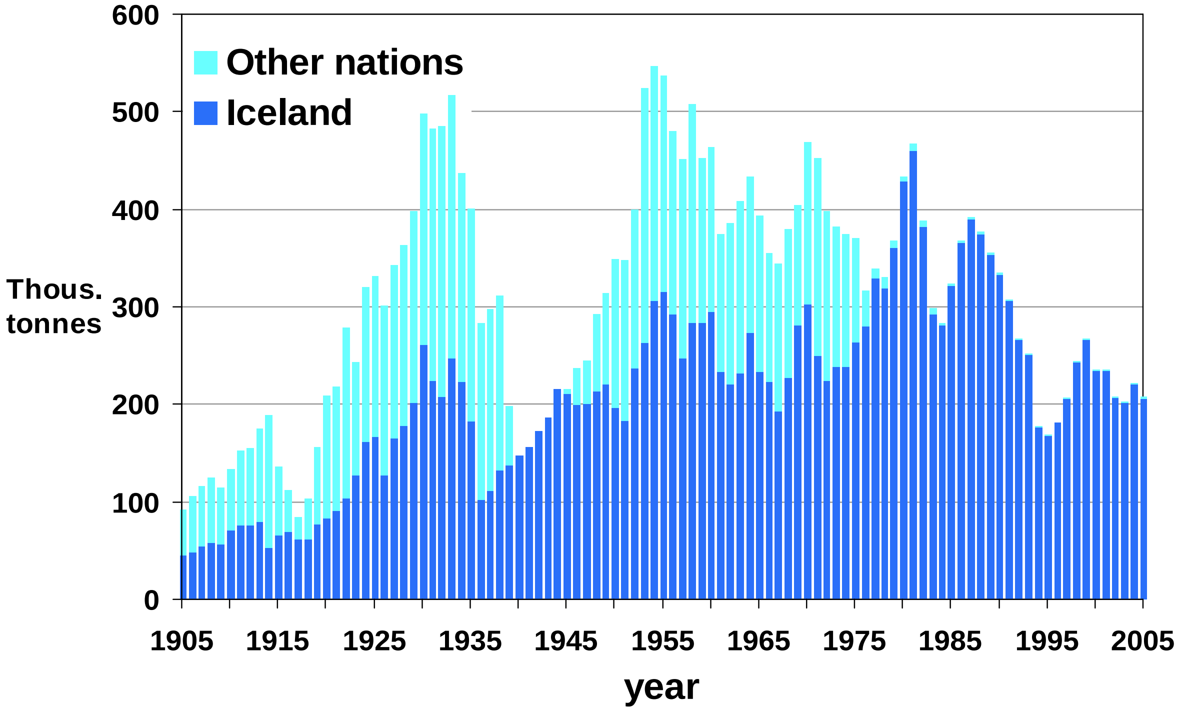


Figure 3.3.1 Cod at Iceland Division Va. Landings since 1905.

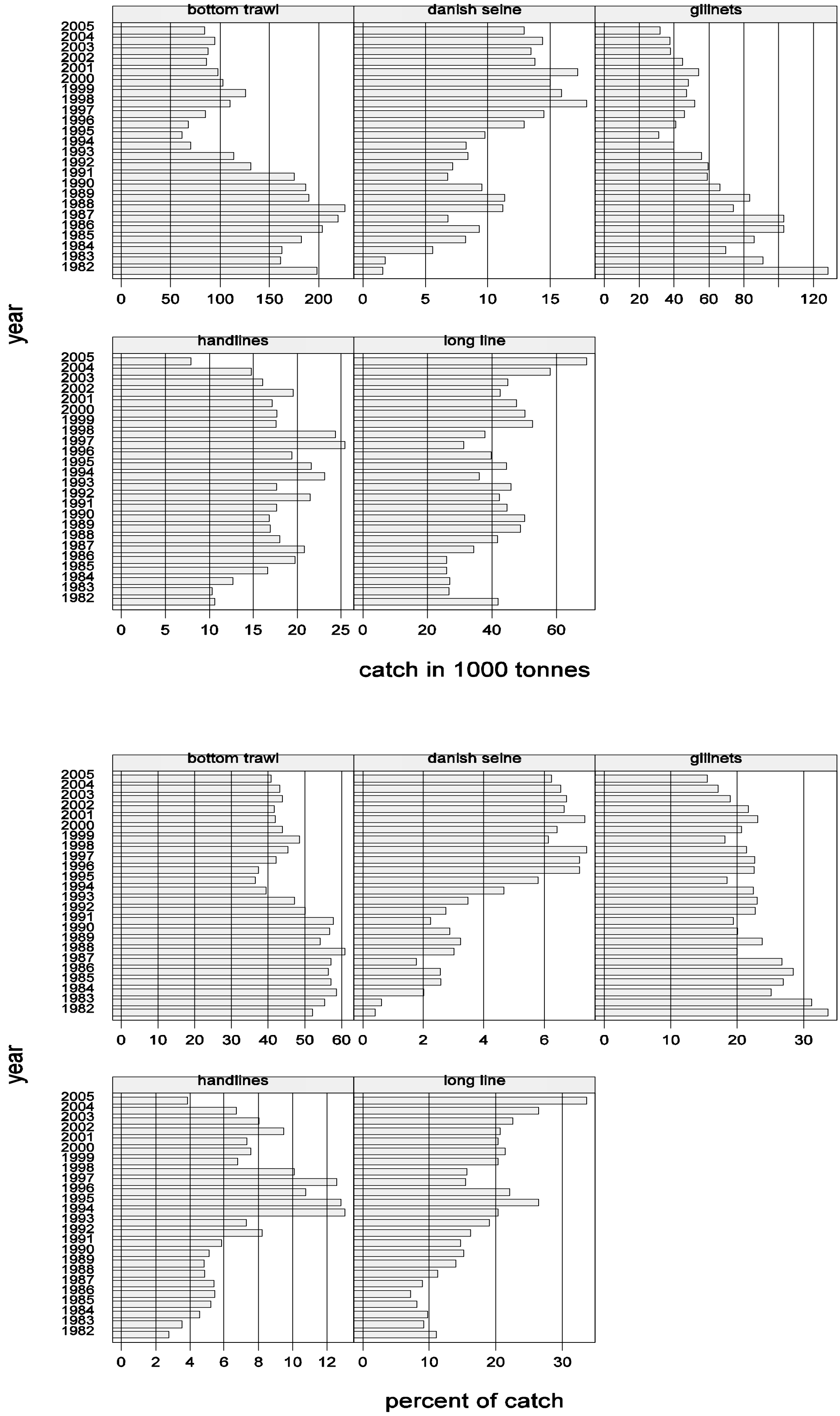


Figure 3.3.2 Landings by gear and year. Upper pictures in tonnes and lower in percentages.

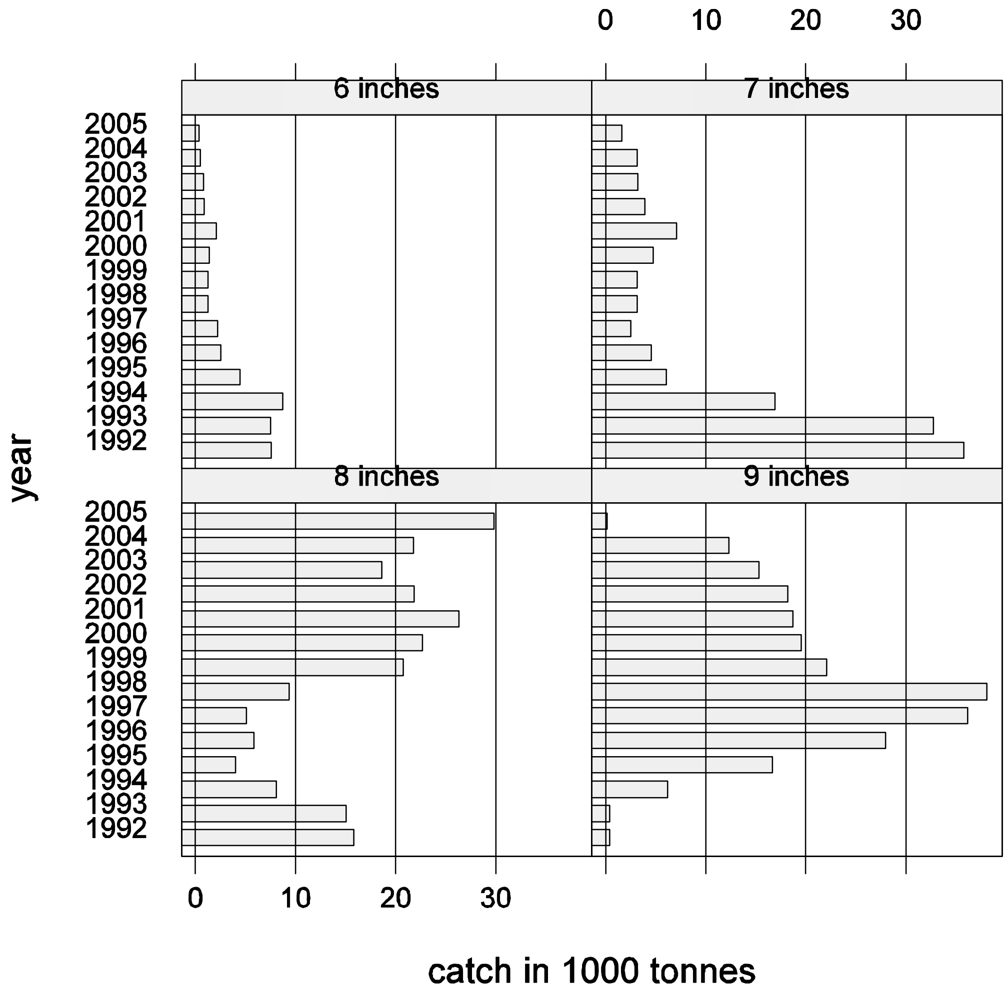


Figure 3.3.3.. Cod in division Va. Gillnet landings by mesh size and year.

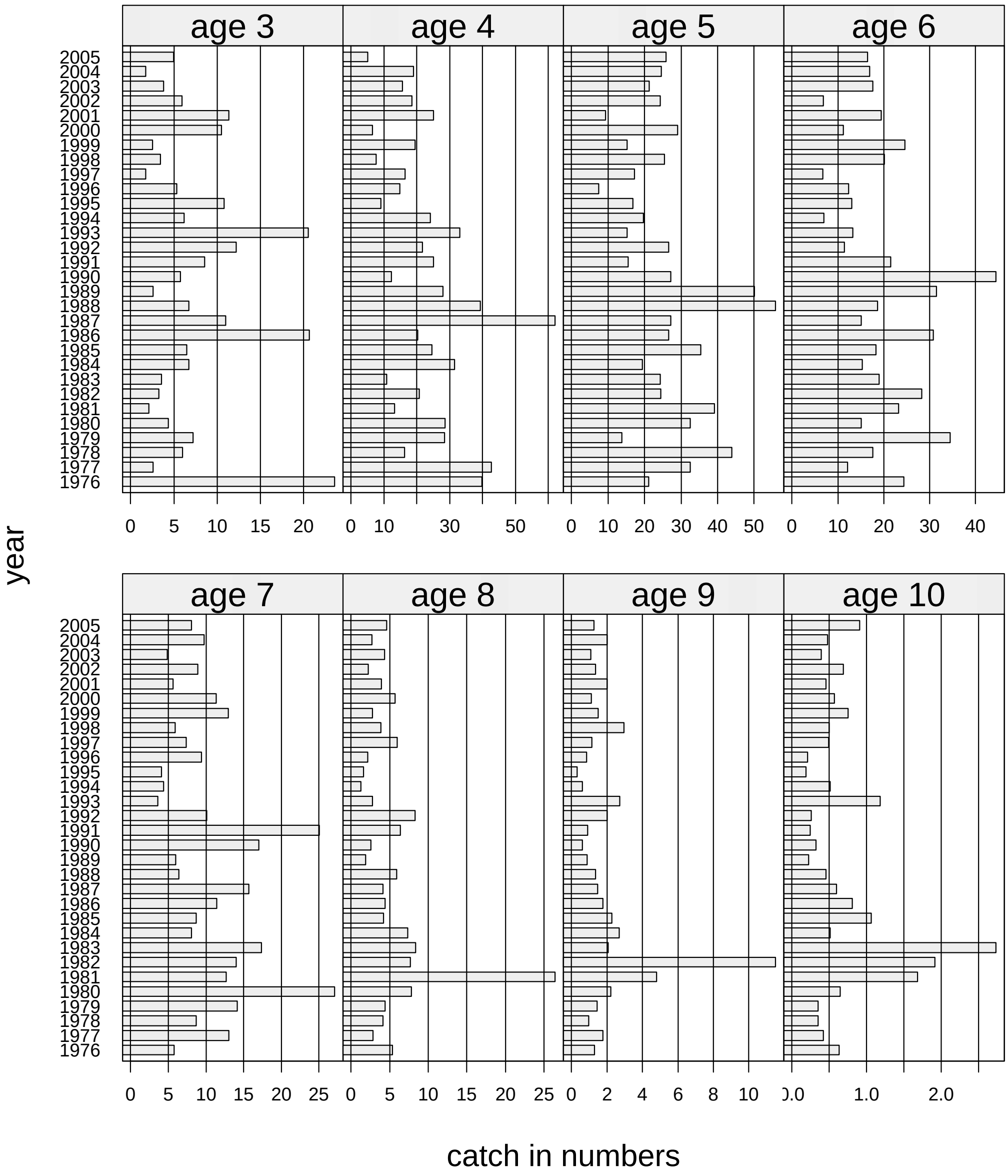


Figure 3.3.4 . Cod in division Va. Catch in numbers by year and age.

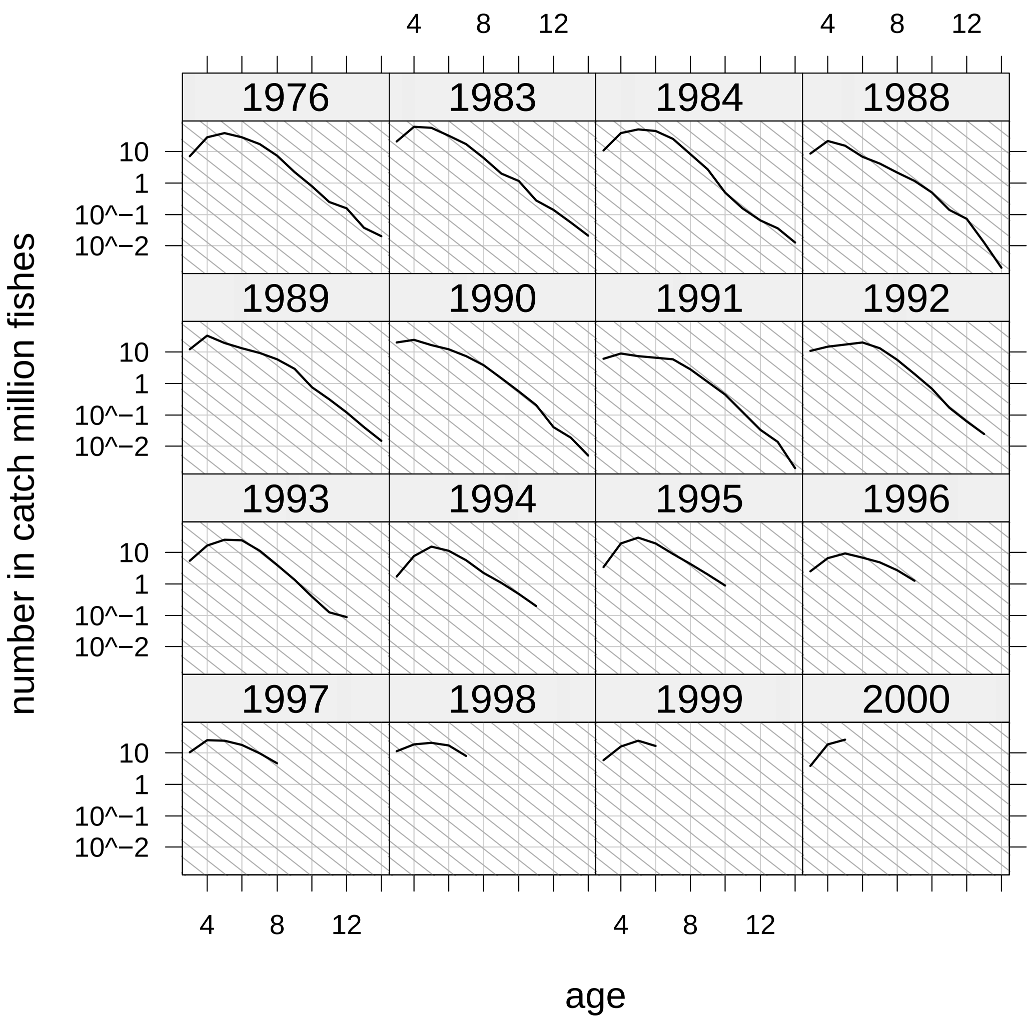


Figure 3.3.5. Icelandic cod. Catch curves. Grey lines show Z = 1.

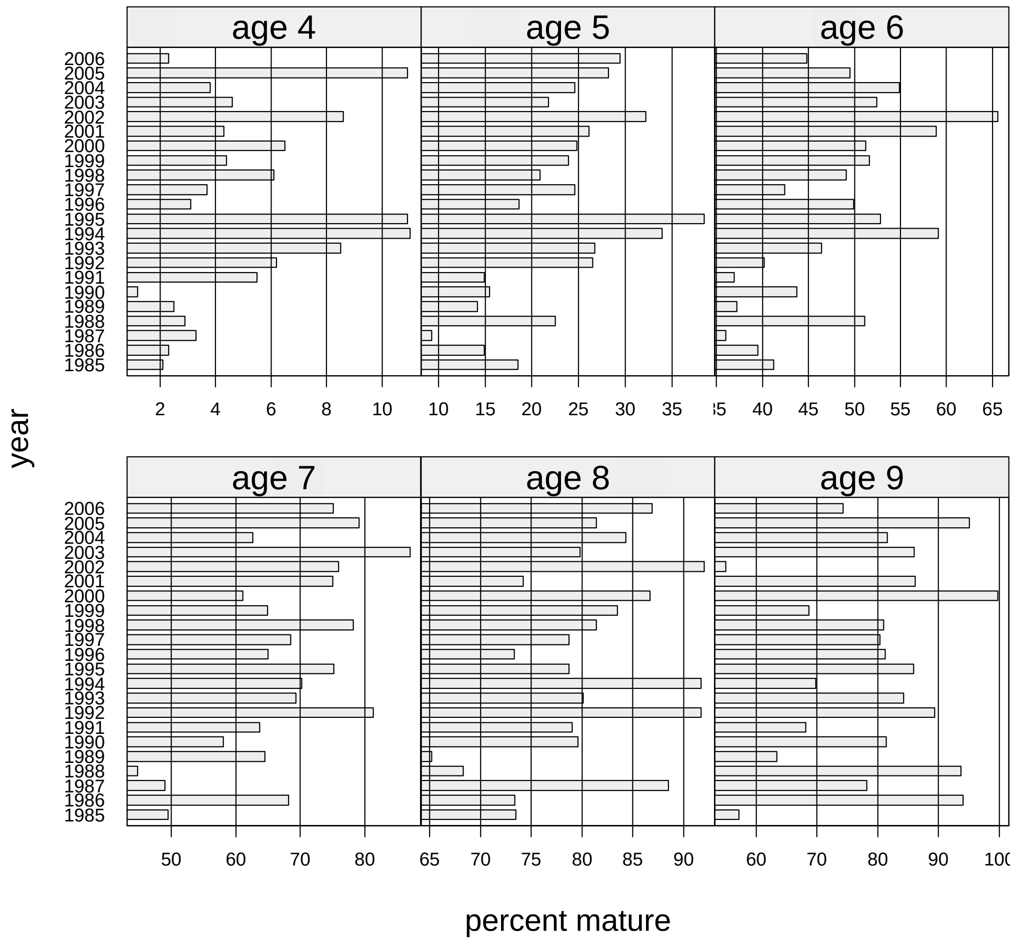


Figure 3.3.6. Cod. Sexual maturity at age in the spring survey.

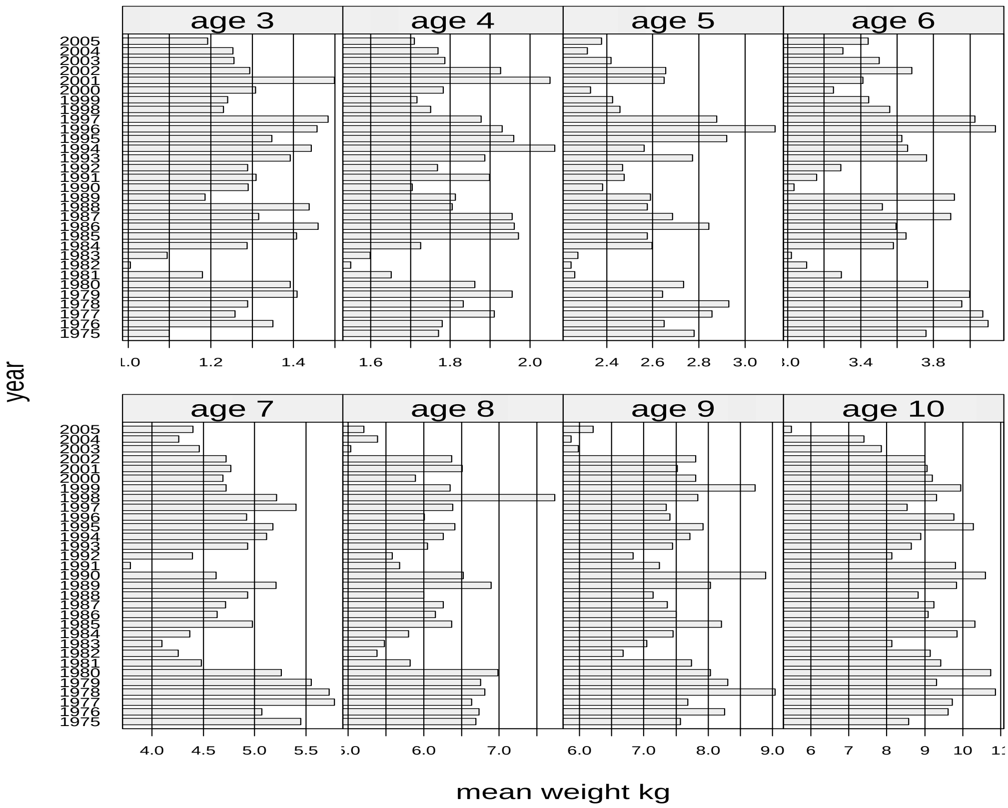


Figure 3.3.7 Cod in division Va. Mean weight at age in the catches.

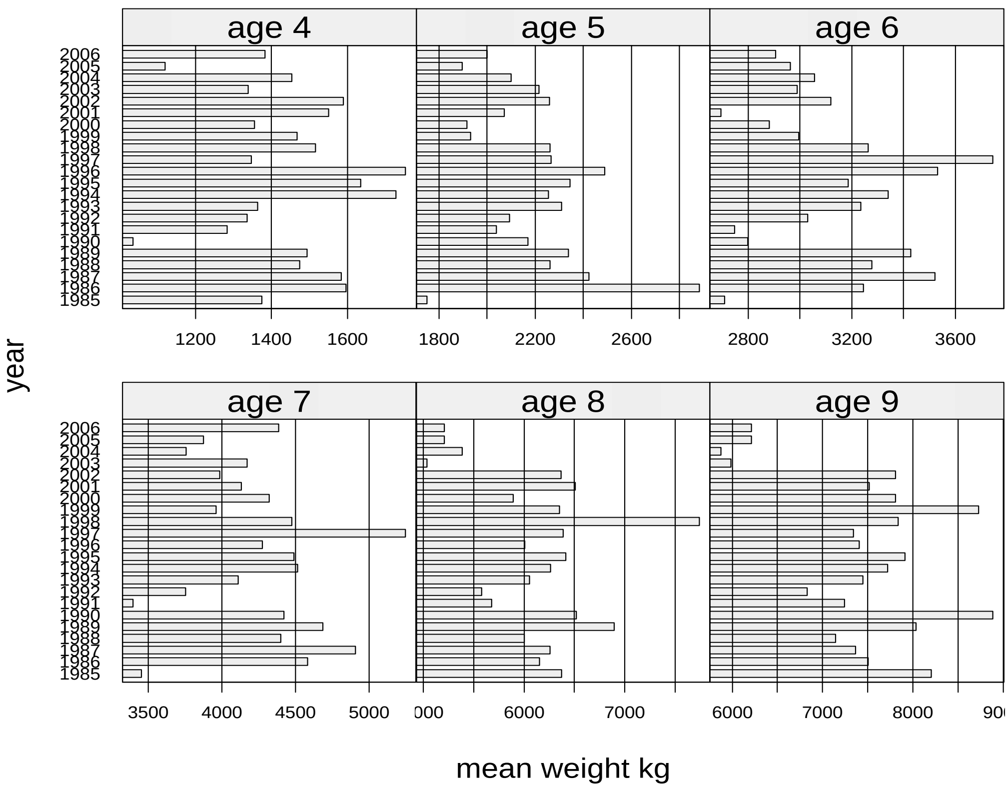


Figure 3.3.8 Cod in division Va. Mean weight at age in the SSB.

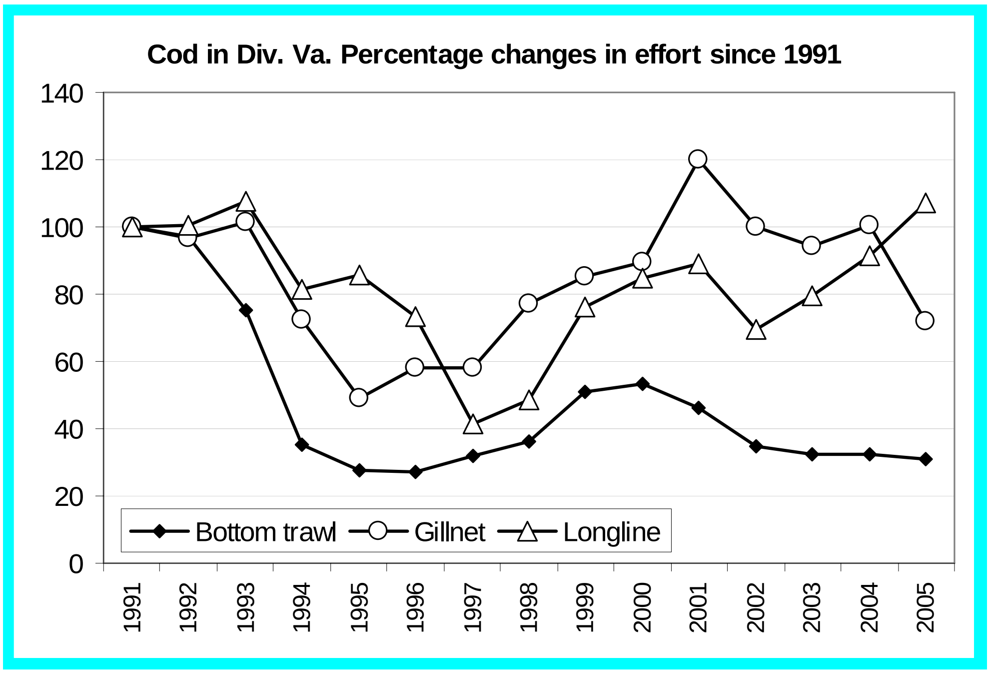


Figure 3.3.9.A. Cod at Iceland Division Va. Percentages changes in effort for the main geras since 1991.

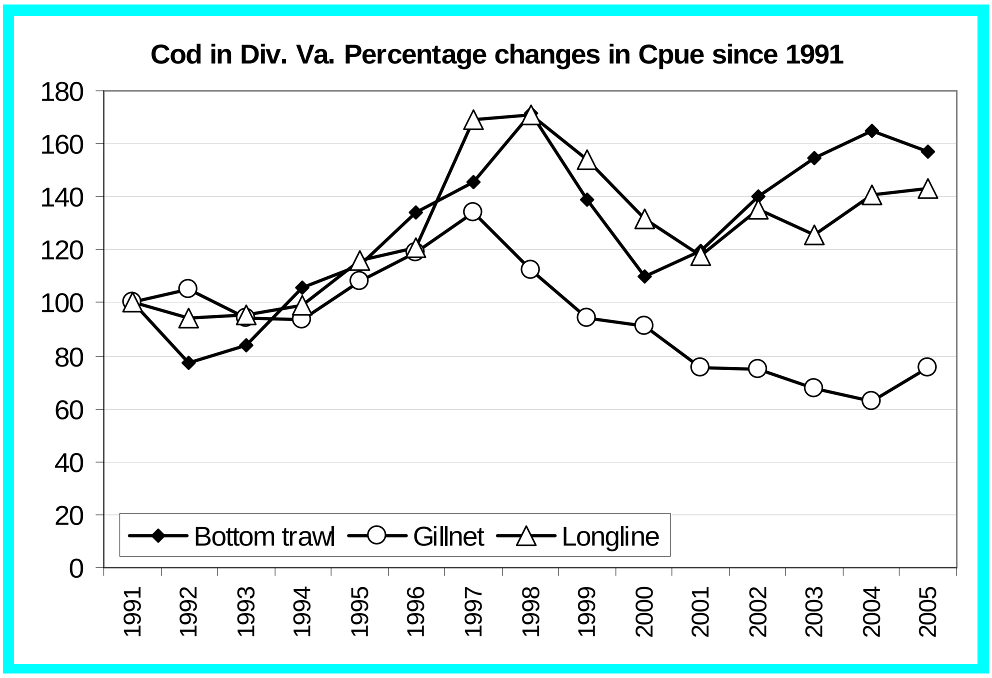


Figure 3.3.9.B. Cod at Iceland Division Va. Percentages changes in cpue for the main gears since 1991.

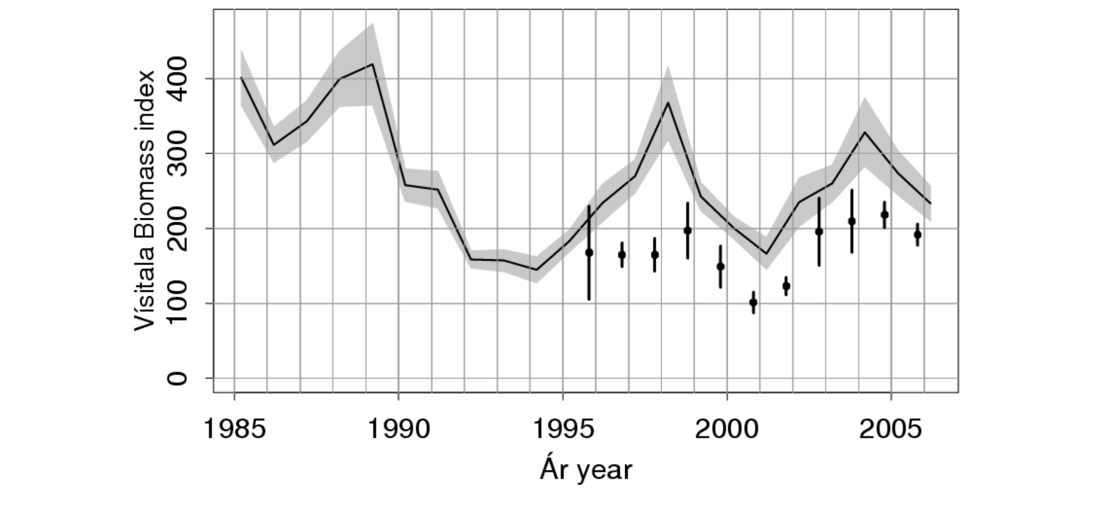


Figure 3.3.10. Cod in division Va. Total biomass index from the spring groundfish survey 1985-2006 and from the autumn survey 1996-2005.

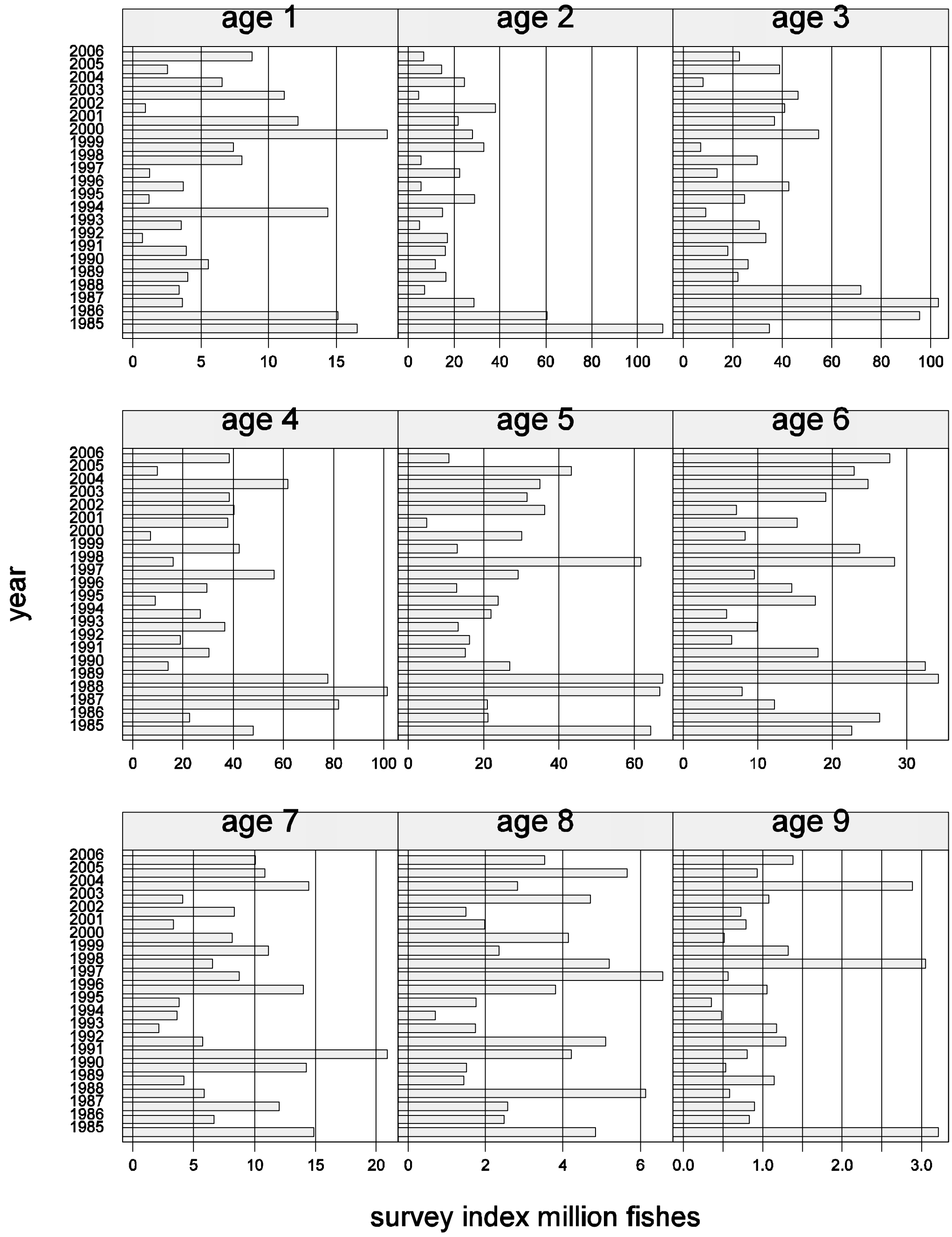


Figure 3.3.11. Cod in division Va. Survey indices from the March survey. Numbers by year and age.

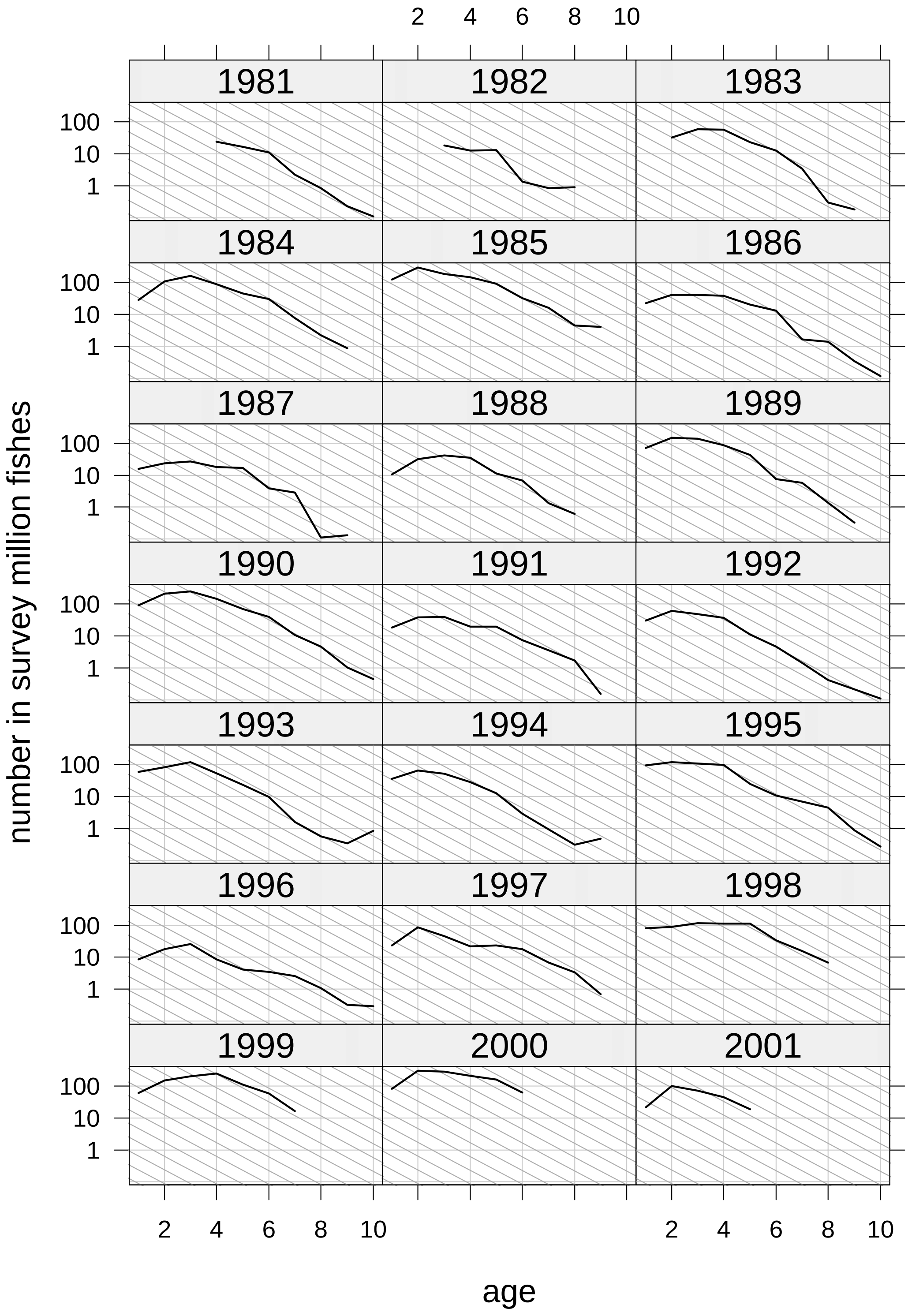


Figure 3.3.12. Cod in division Va. Catchcurves from the survey. The grey lines show Z=1

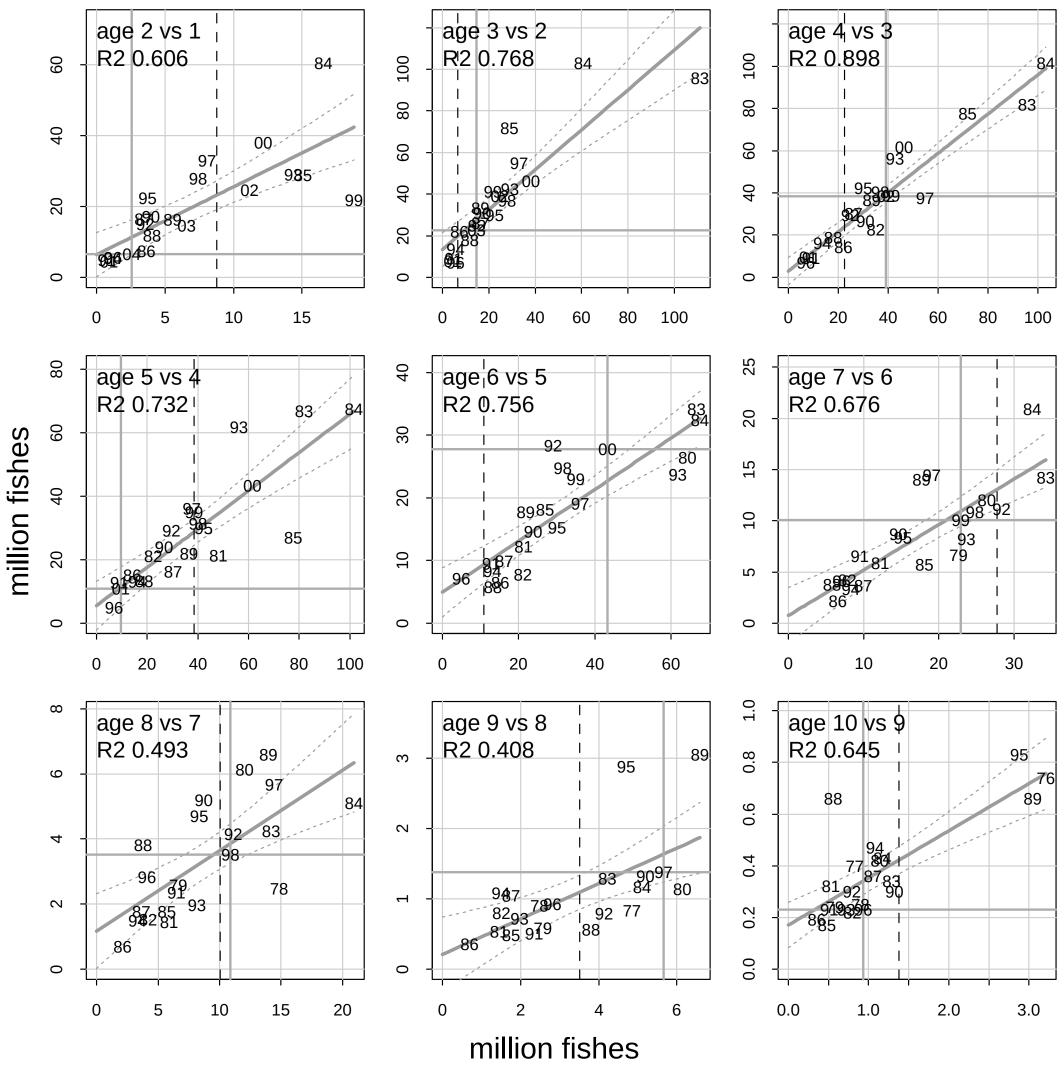


Figure 3.3.13. Cod in division Va. Indices from the groundfish survey vs. index of the same year class in survey a year later.

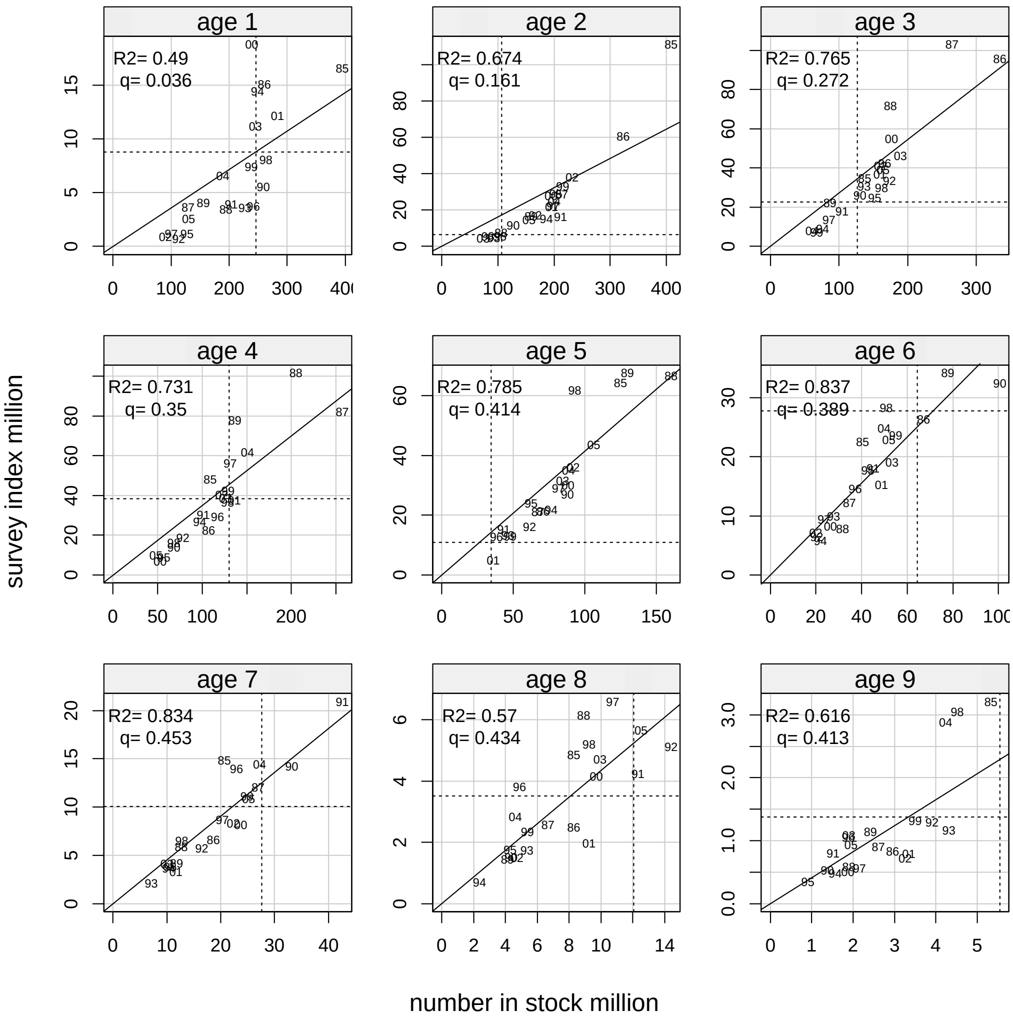


Figure 3.3.14. Cod in division Va. Survey indices vs. number in stock. Line fitted on original scale using 1985-2002 data.

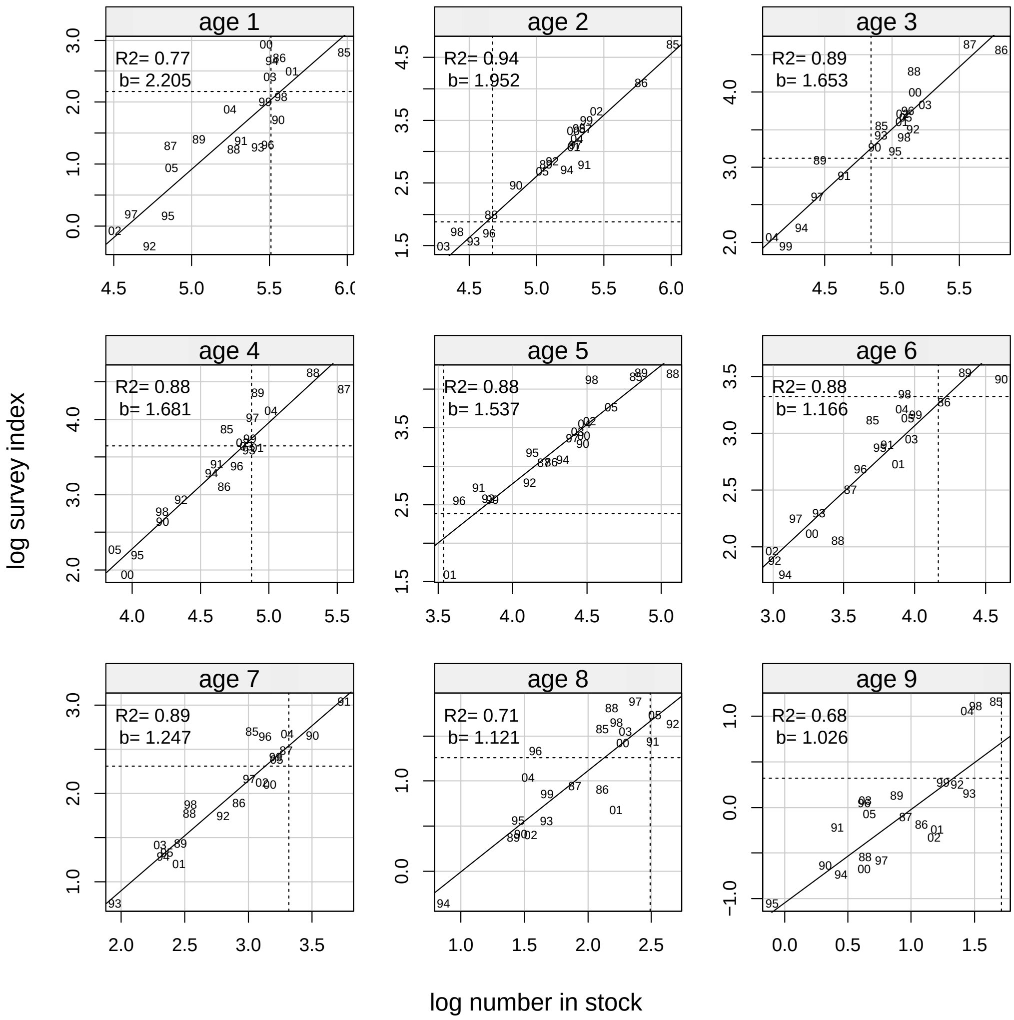


Figure 3.3.15. Cod in division Va. Survey indices vs. number in stock. Line fitted on logscale (power curve) using 1985-2002 data.

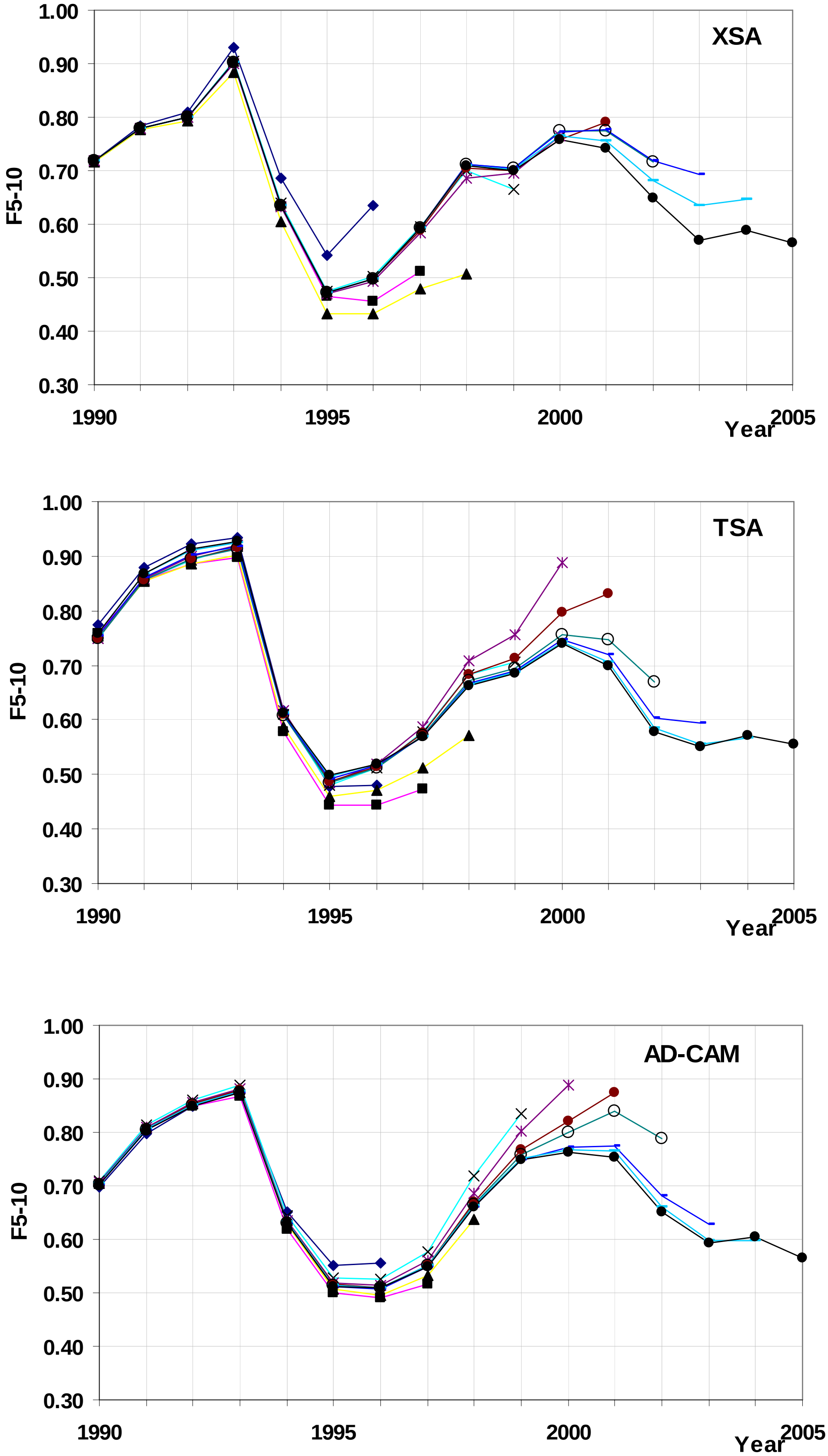


Figure 3.3.16. Retrospective pattern from three assessment runs. The figures show mean fishing mortality of ages 5 to 10.

Figure 3.3.17. Retrospective patterns from three assessment runs. The figures show number of age 4 and older multiplied by the weight in the catches.

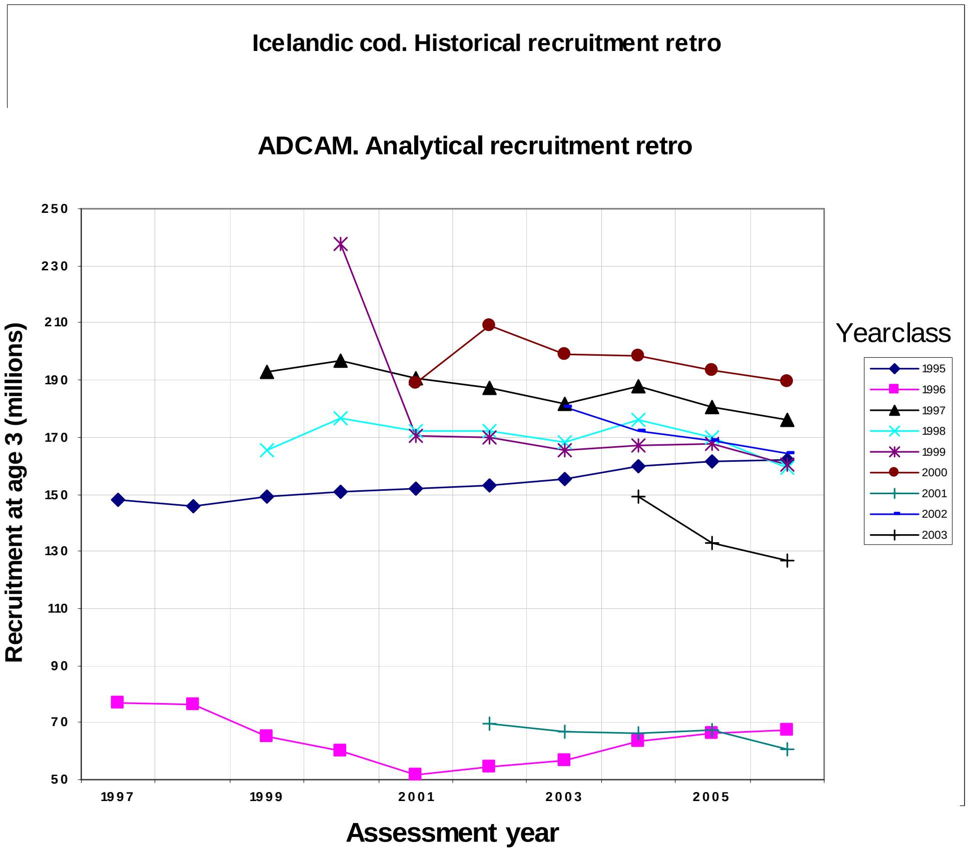
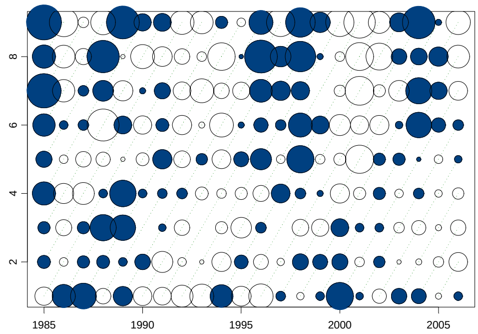
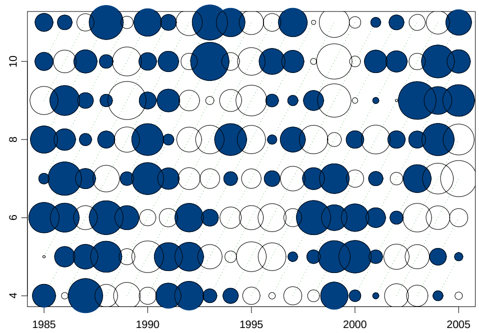


Figure 3.3.17B. Historical and analytical (ADCAM) recruitment retrospective pattern.

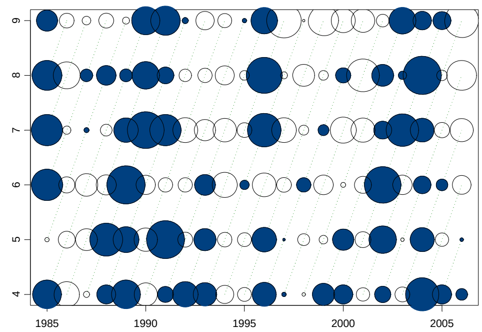
XSA -Log catchability residuals



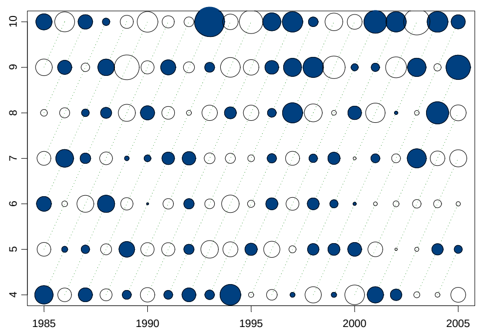
TSA - Standarsized catch prediction errors



TSA - Standardsized prediction errors of survey cpue



ADCAM ln(CNayOserved/CNayPredicted)



ADCAM - ln(UayOserved/UayPredicted)

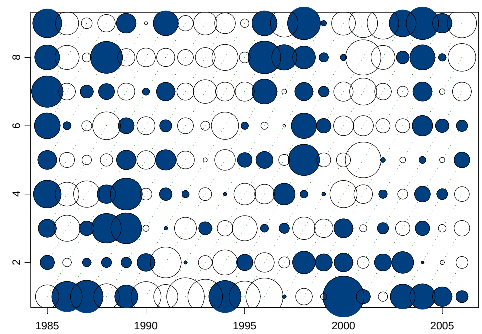


Figure 3.3.18. Residuals by year and age group from the various models. Solid symbols indicate positive values, open symbols indicate negative values. Bubble area is proportional to magnitude.

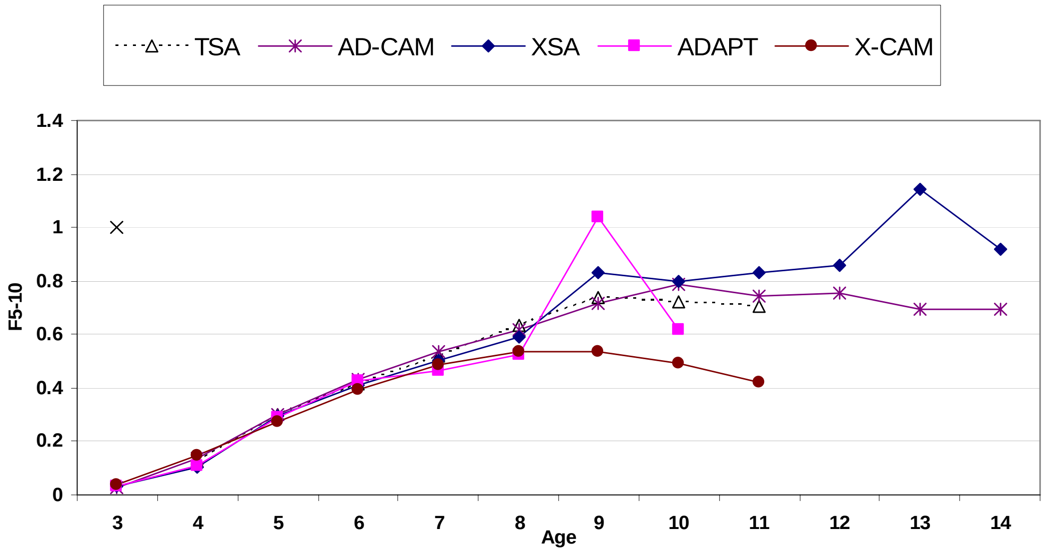


Figure 3.3.19. Comparison of estimated fishing mortalities in 2004 from different assessment runs.

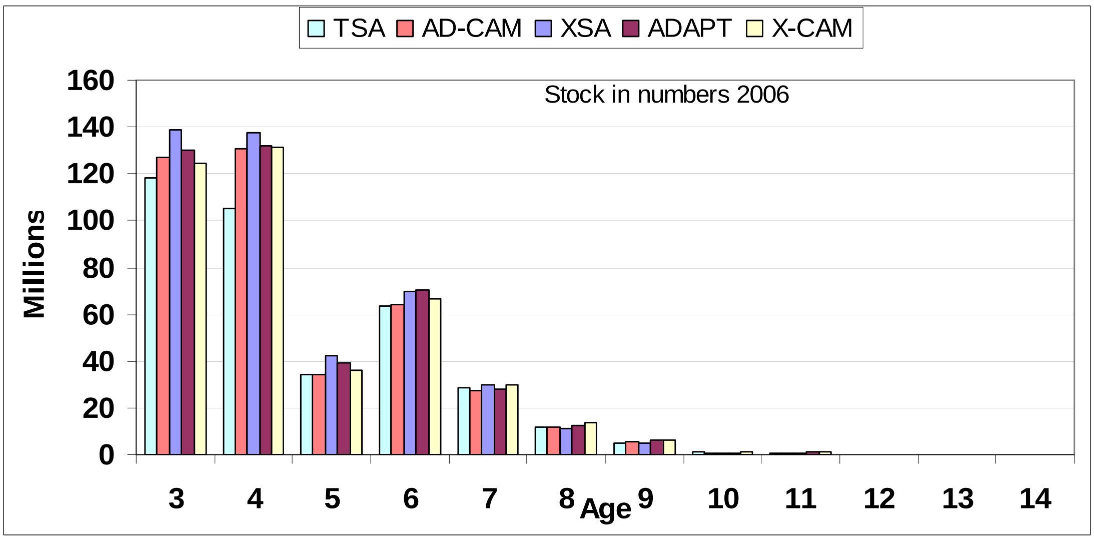


Figure 3.3.20. Comparison of estimated stock in numbers in 2005 from different assessment runs.

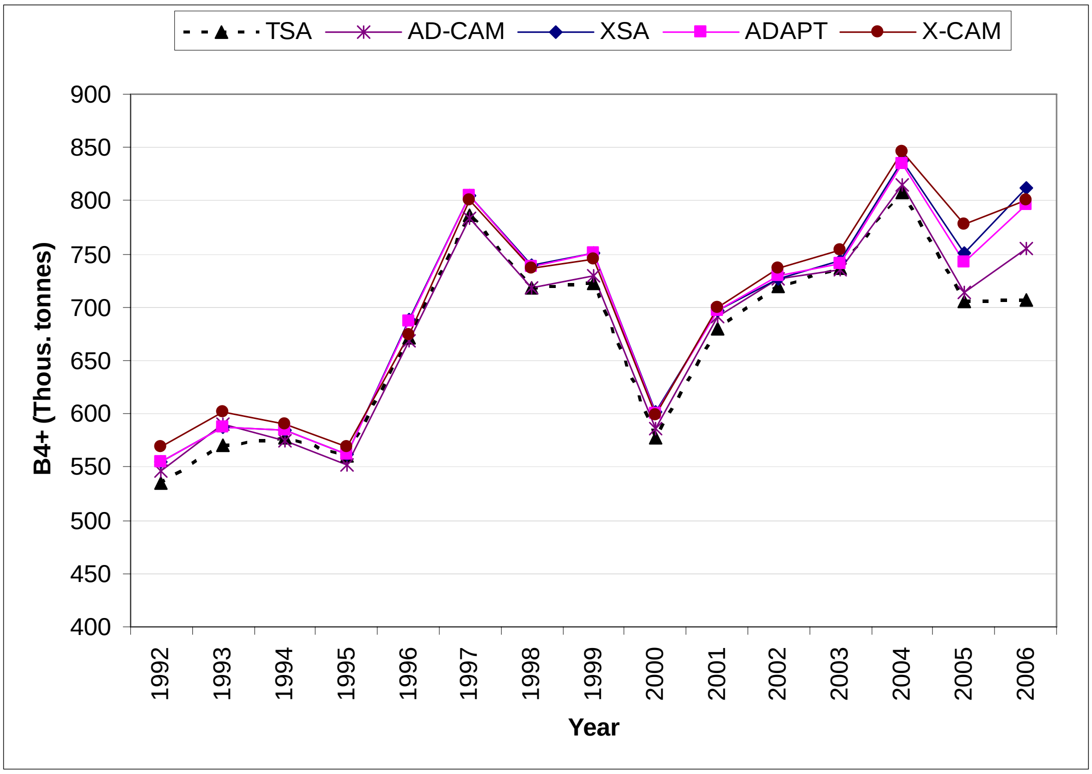


Figure 3.3.21. Estimated 4+ biomass from the various assessment models.

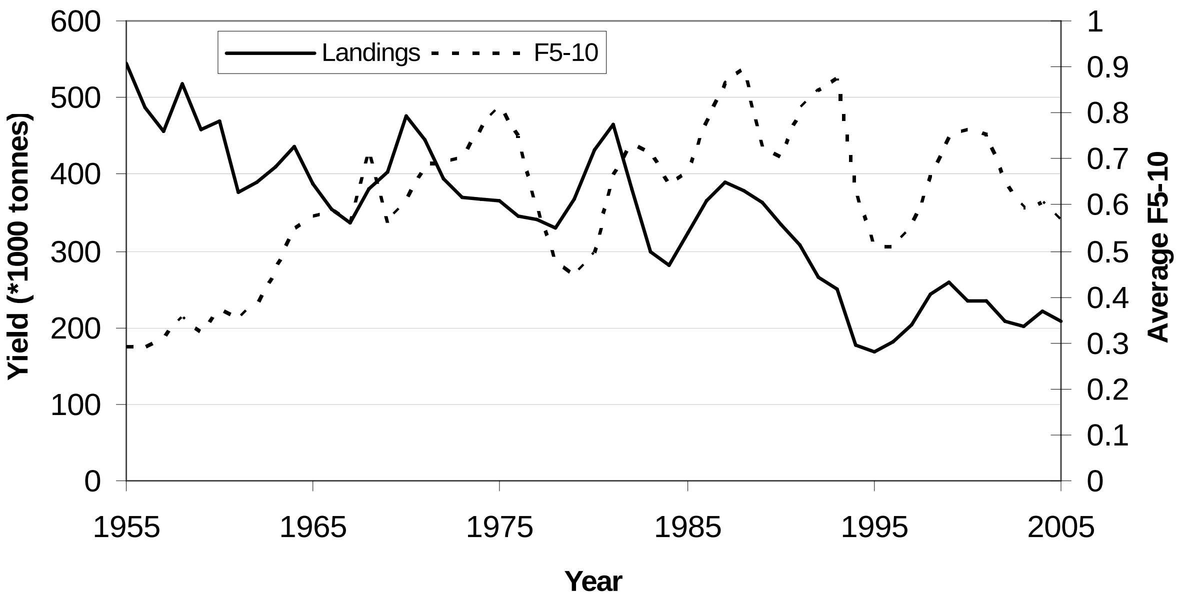


Figure 3.3.22A. Yield and fishing mortality

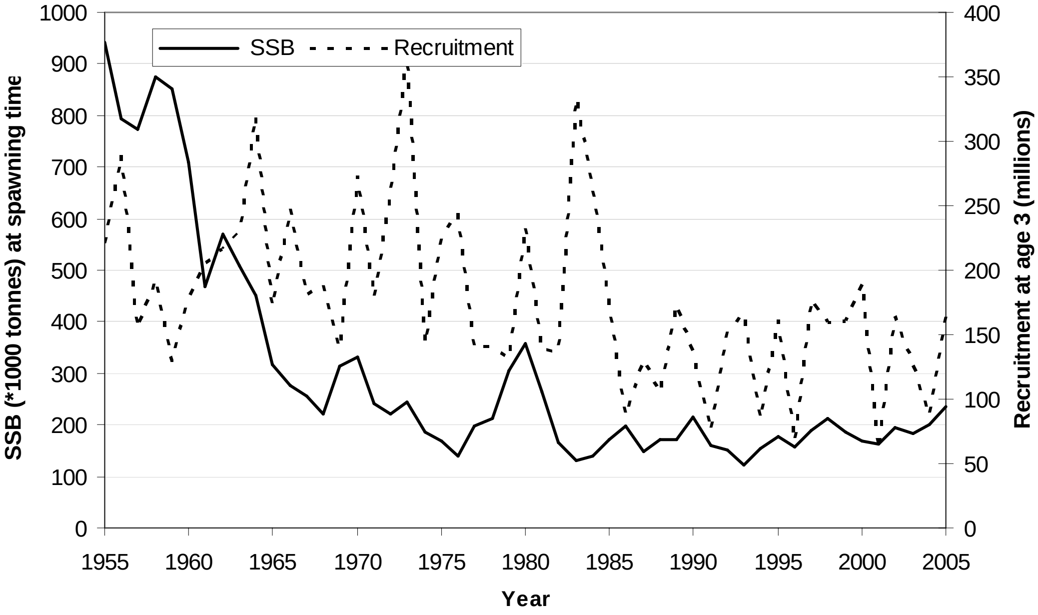
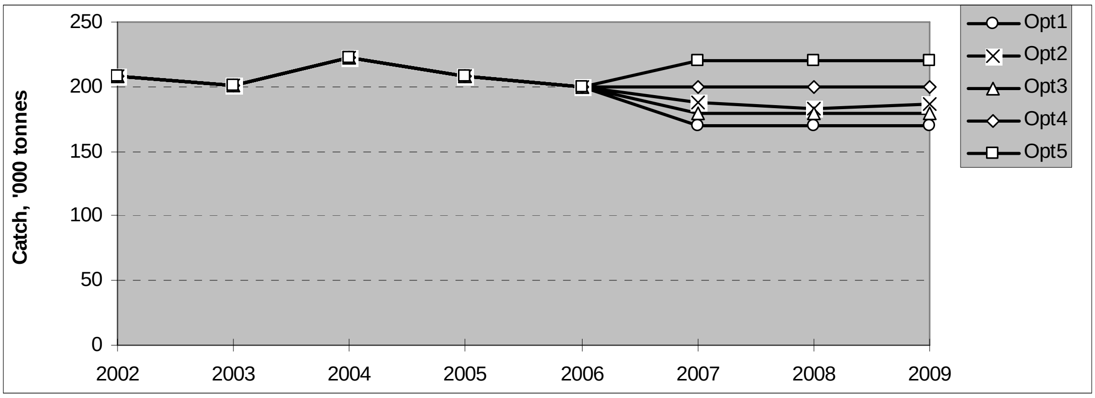
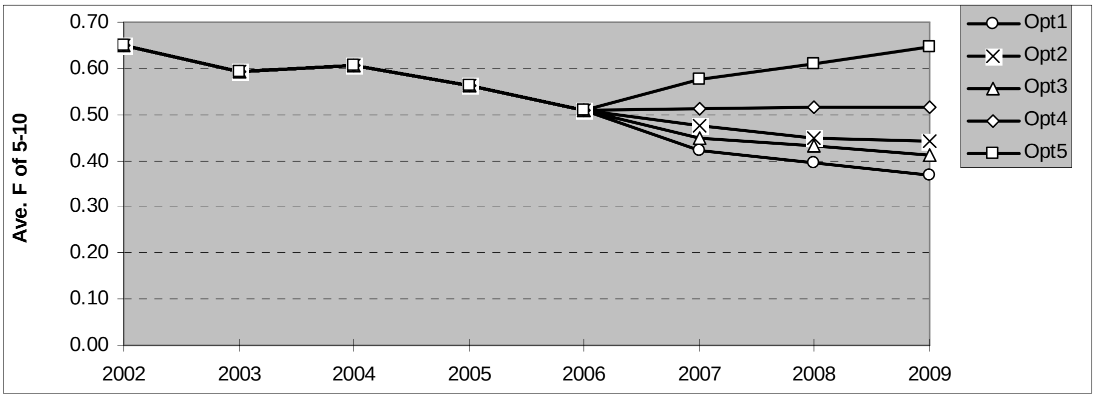
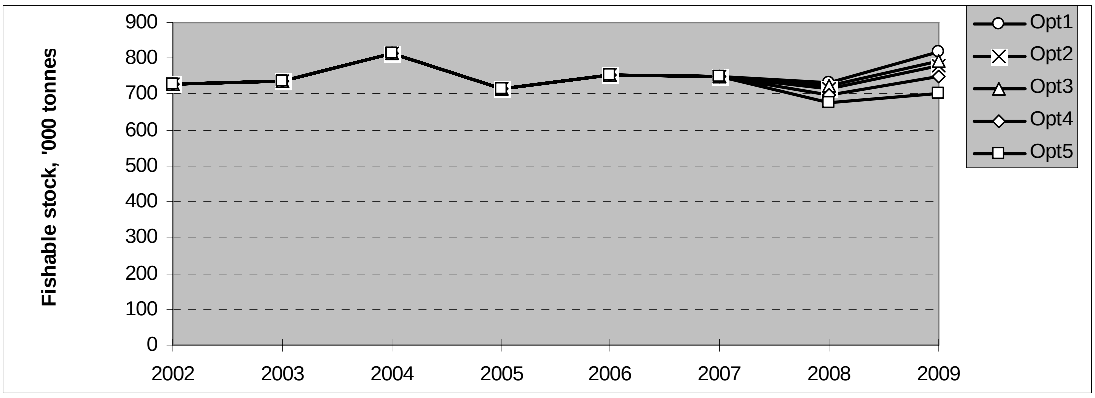


Figure 3.3.22B. Spawning stock and recruitment.







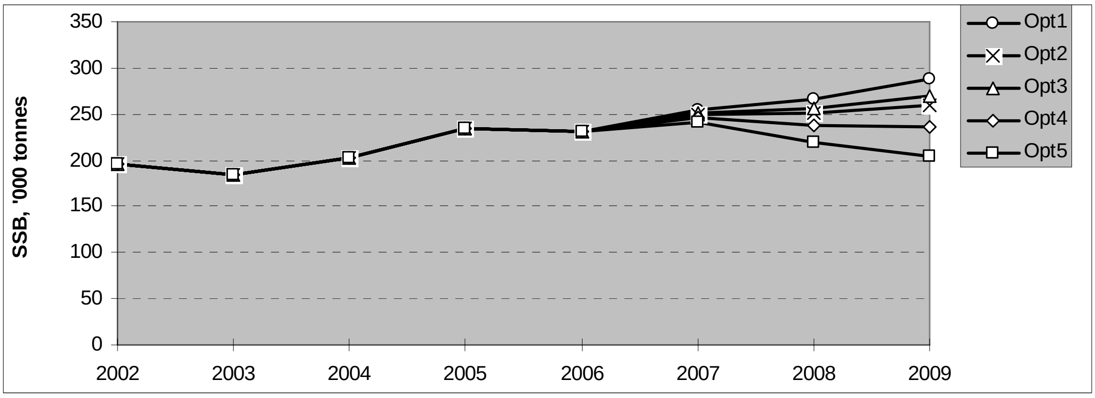
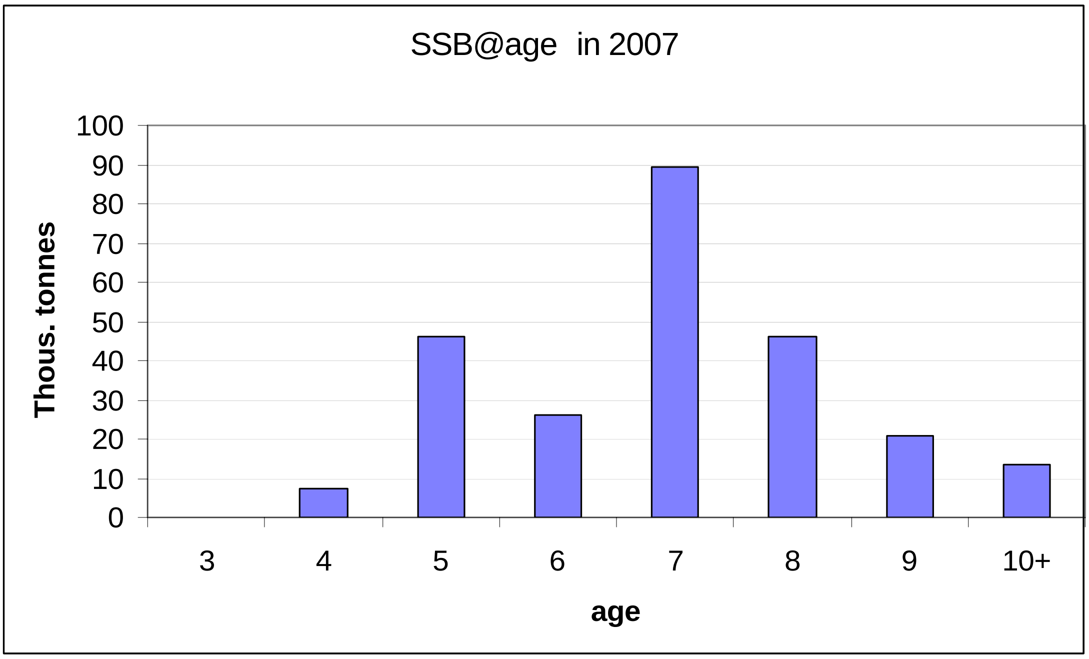


Figure 3.3.23A. Results of different management options.Opt2 corresponds to harvest control rule.



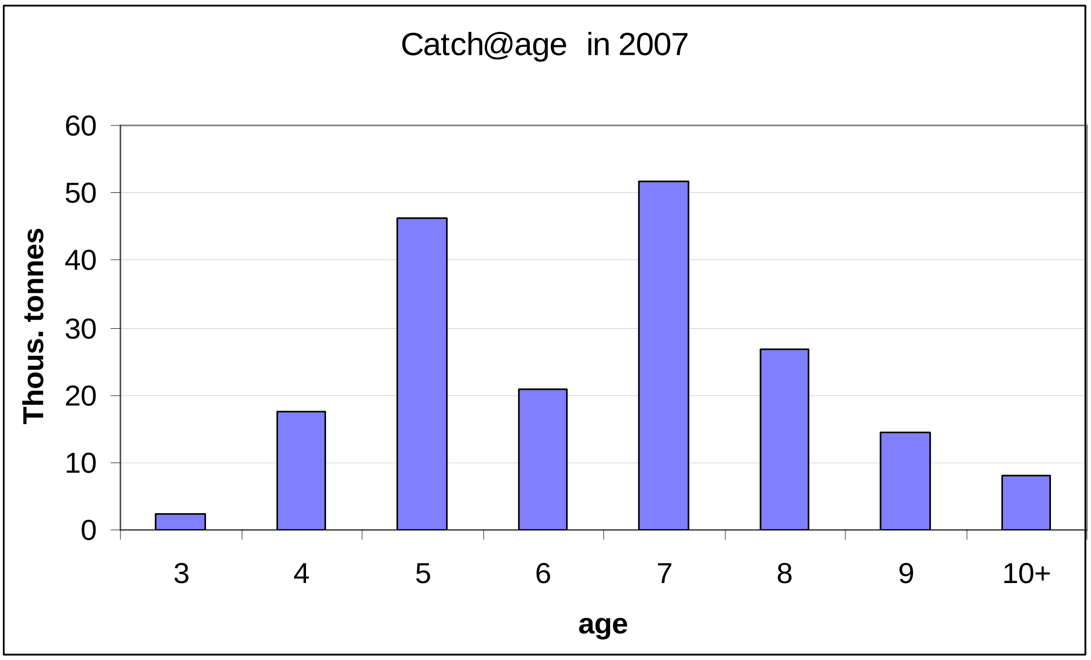


Figure 3.3.23B. Estimed age composition of the SSB and the catches in 2007.

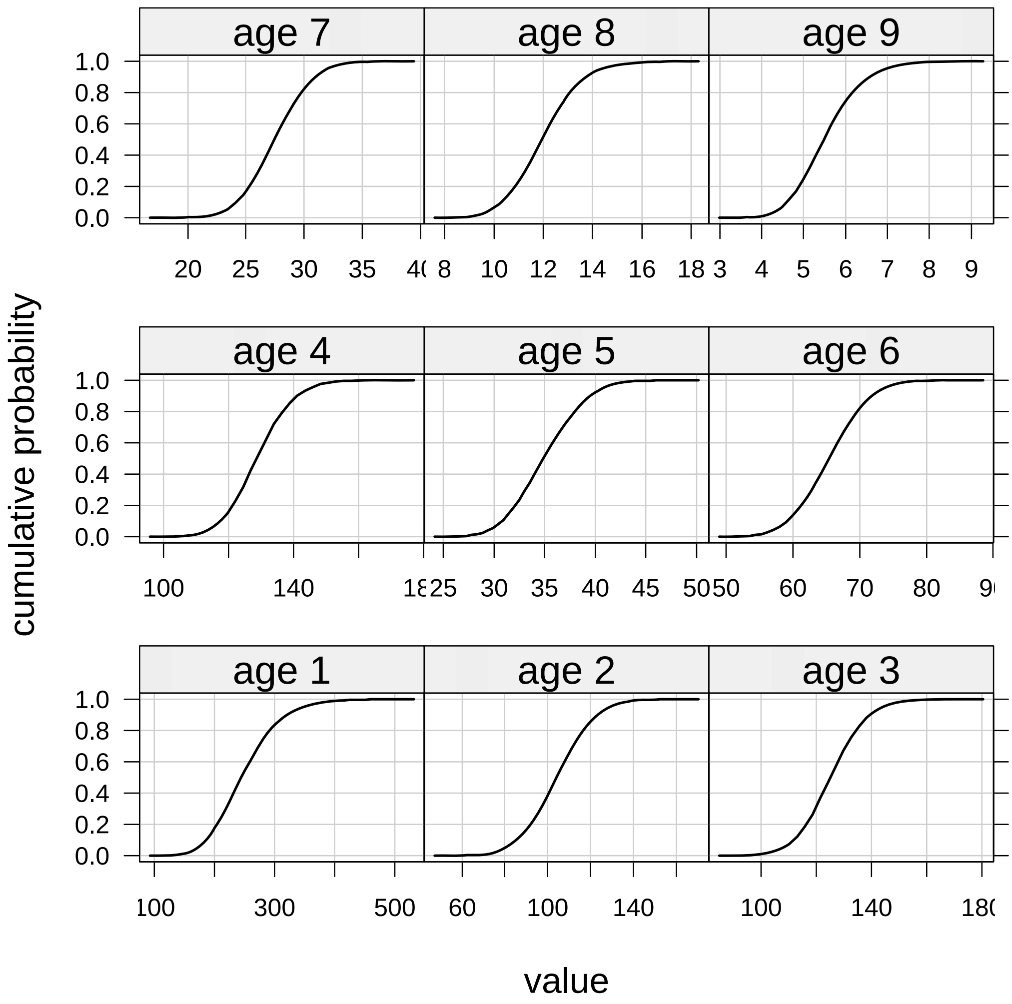


Figure 3.3.24.. Cod in division Va. Cumulative probability distribution of number in stock at the start of 2006.

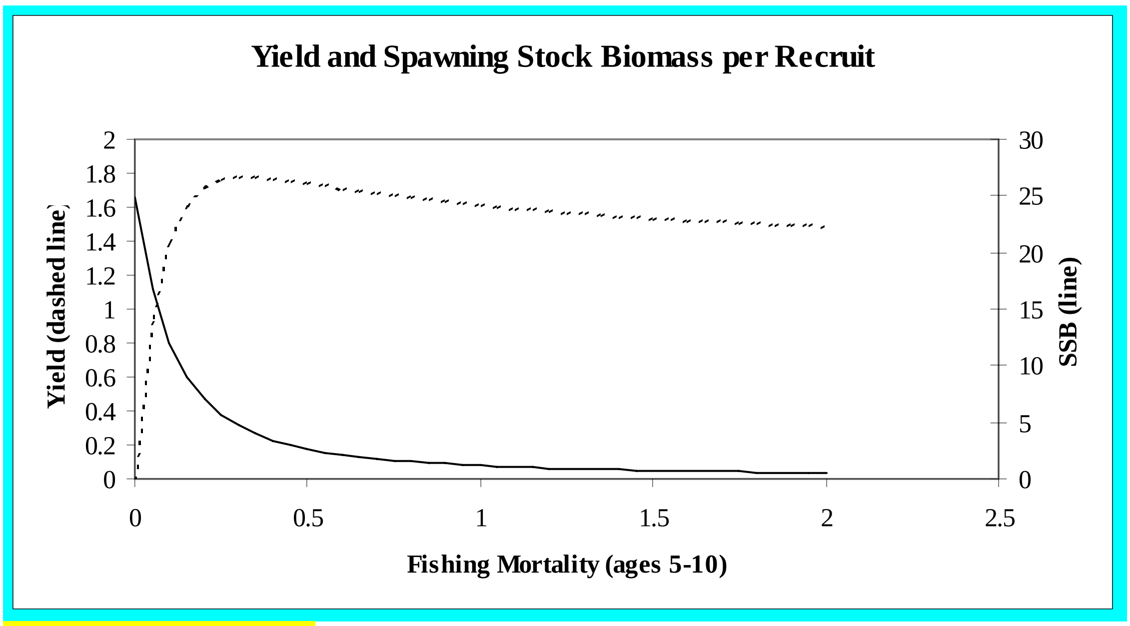


Figure 3.3.25 Yield per recruit

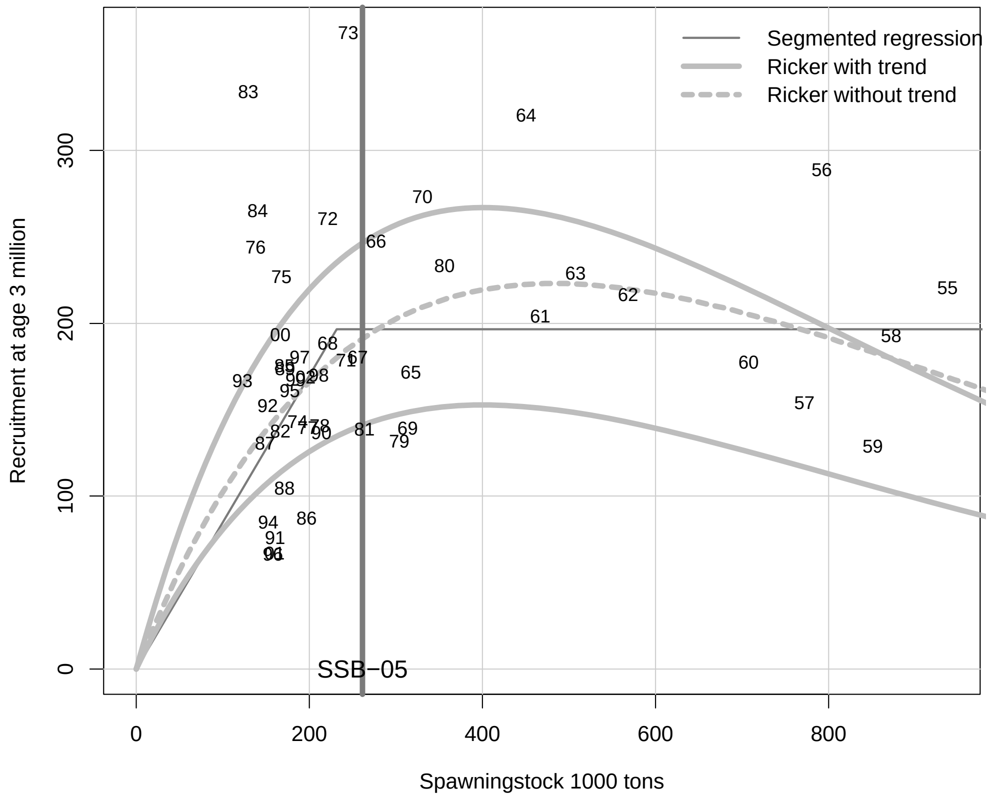


Figure 3.3.26 Spawning stock biomass and recruitment at age 3

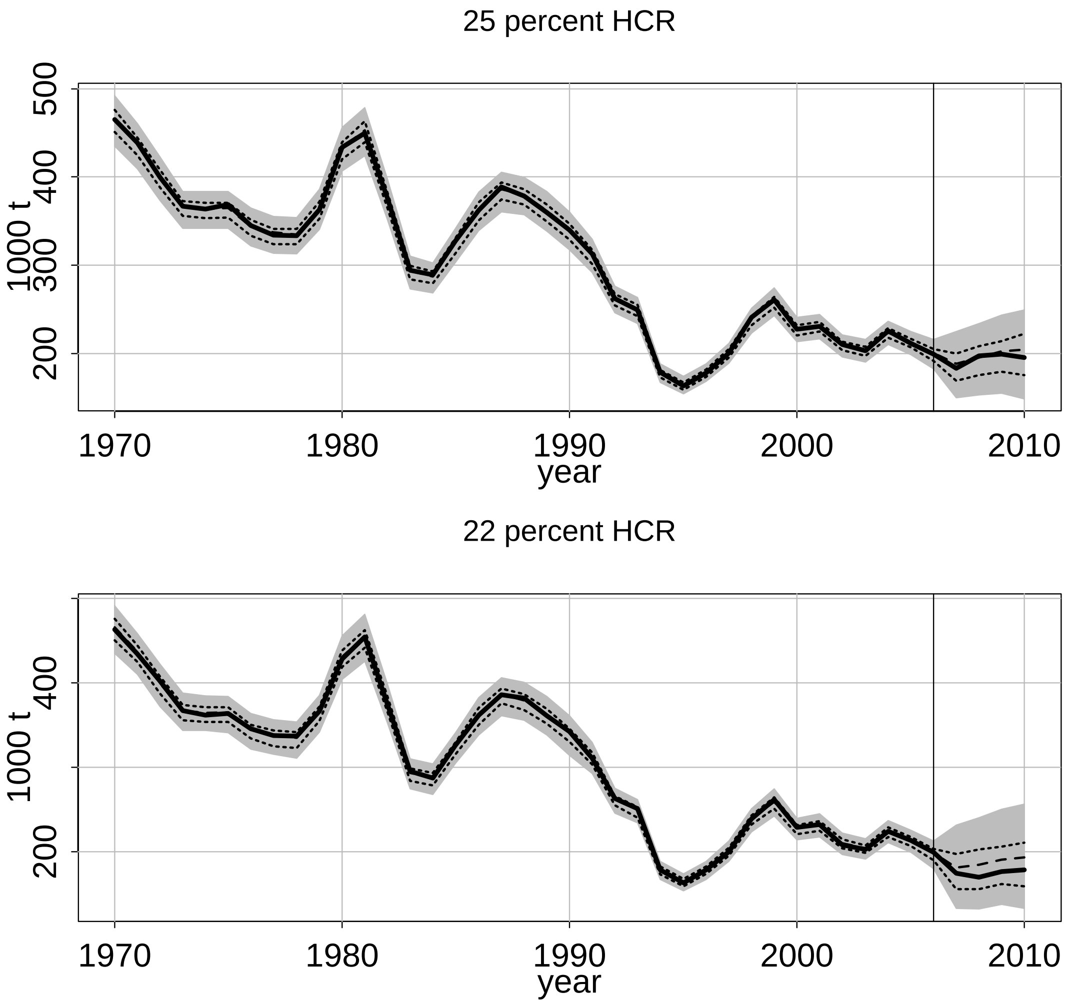


Figure 3.3.27. Cod in division Va. Yield estimate and medium term prognosis according to the ammended catchrule and a 22 persent HCR. Shaded are shows 90% percentile distribution and the dotted line represent the 50% percentile.

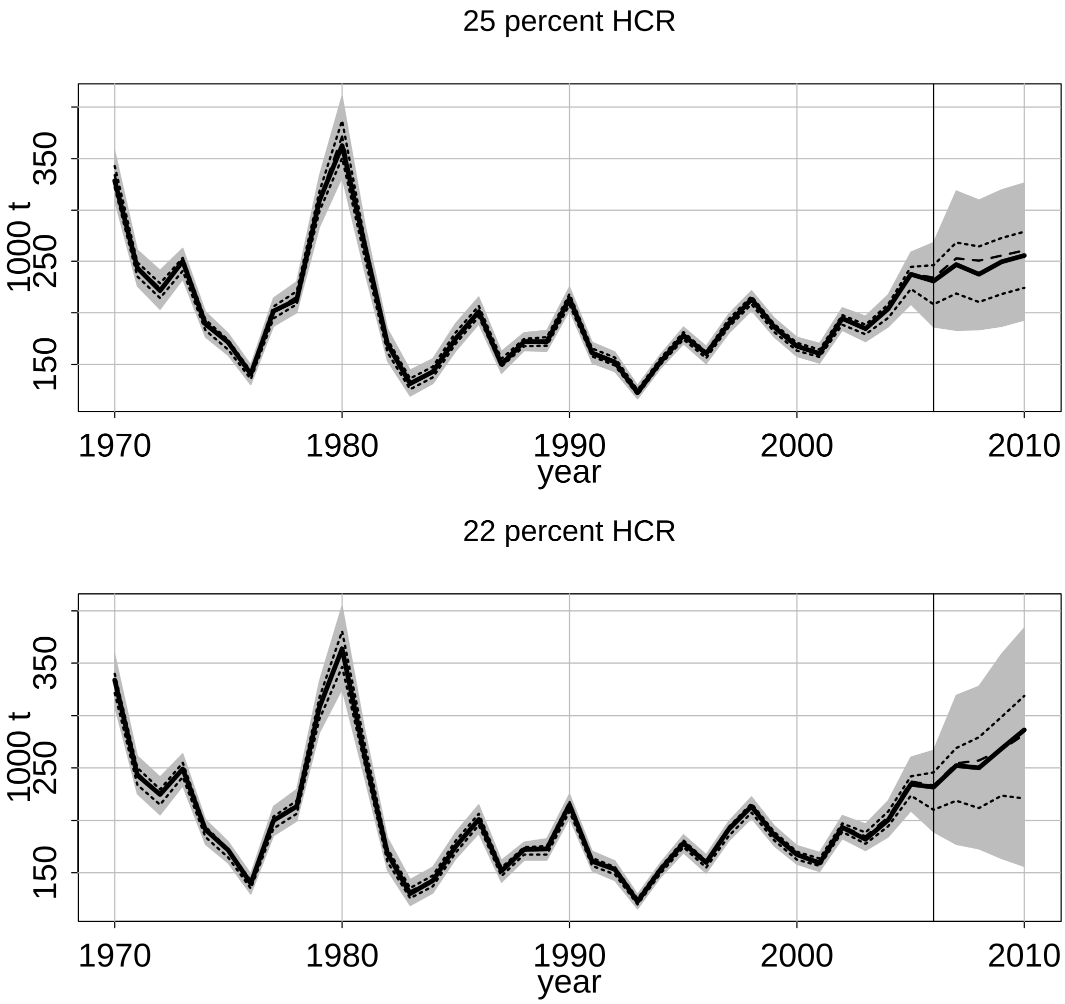


Figure 3.3.28. Cod in division Va. SSB estimate and medium term prognosis according to the ammended catchrule and 22 percent HCR. Shaded are shows 90% percentile distribution and the dotted line represent the 50% percentile.

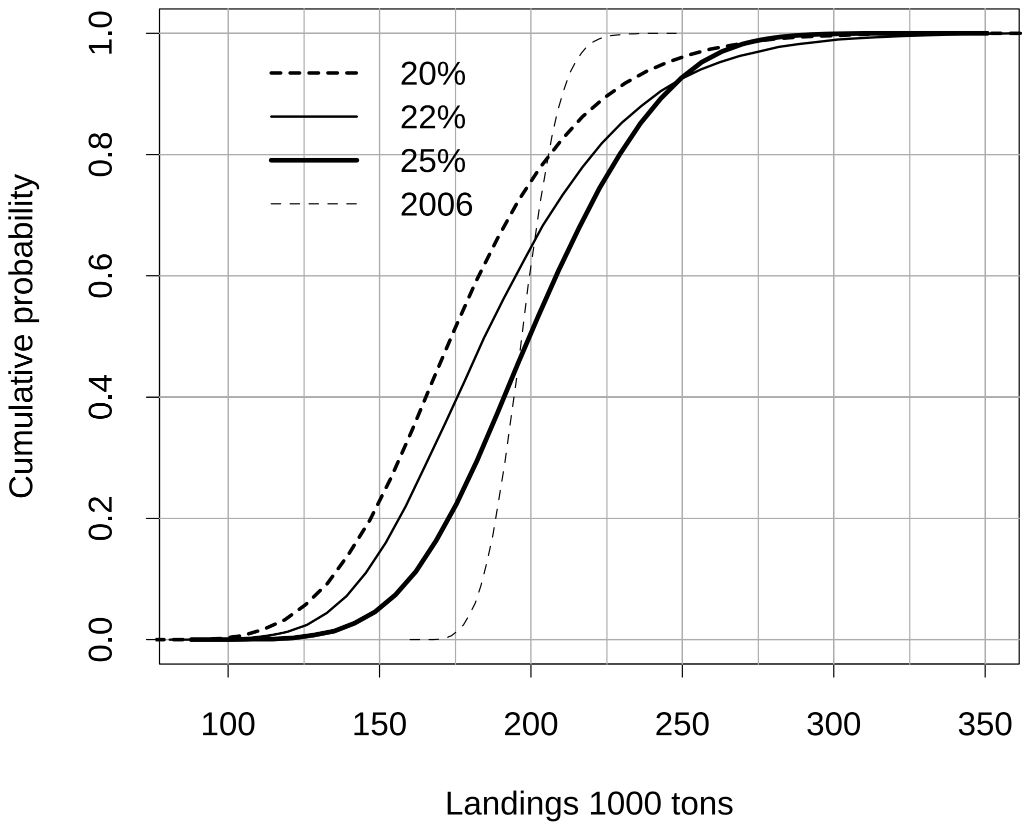


Figure 3.3.29. Cod in division Va.. Cod in division Va. Cumulative probability distribution of the expected landings in the year 2010 according to three different harvestitng ratios (HCR).

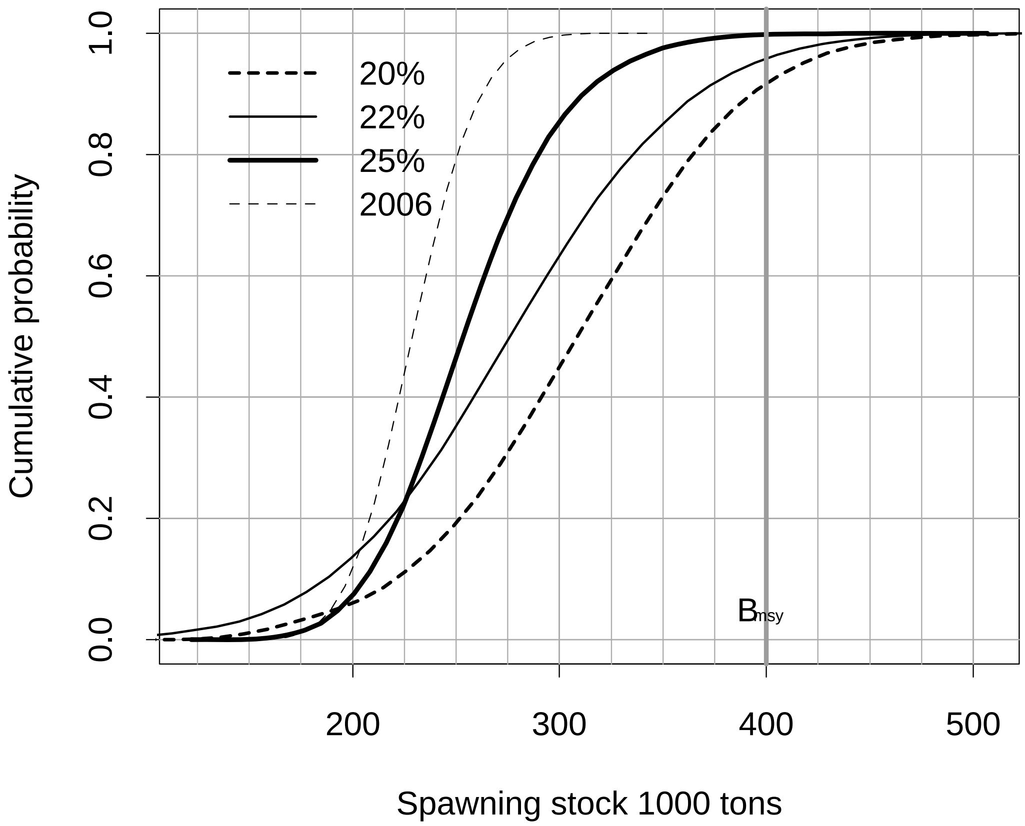


Figure 3.3.30. Cod in division Va. Cumulative probability distribution of the estimated size of the spawning stock in 2010 according to three different harvestitng ratios (HCR).

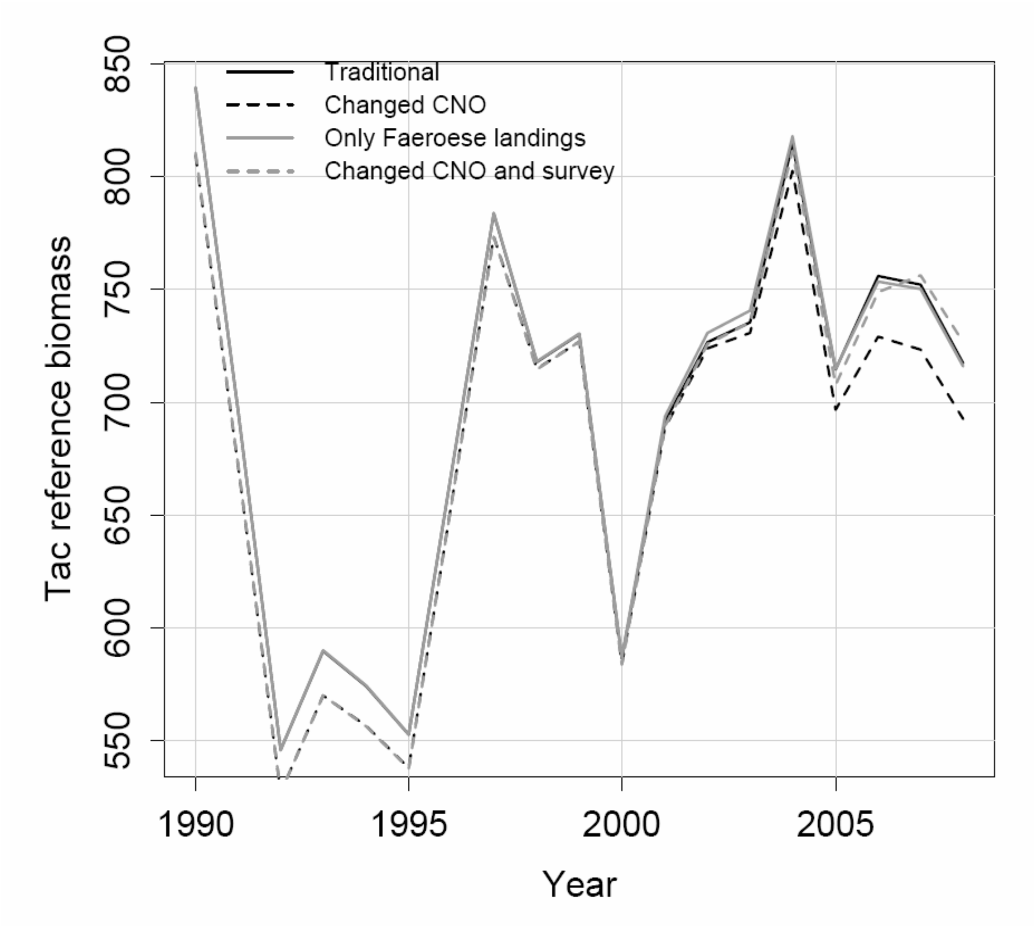


Figure 3.3.31. Estimated reference biomass (4+) from four diffrenent scenarios.

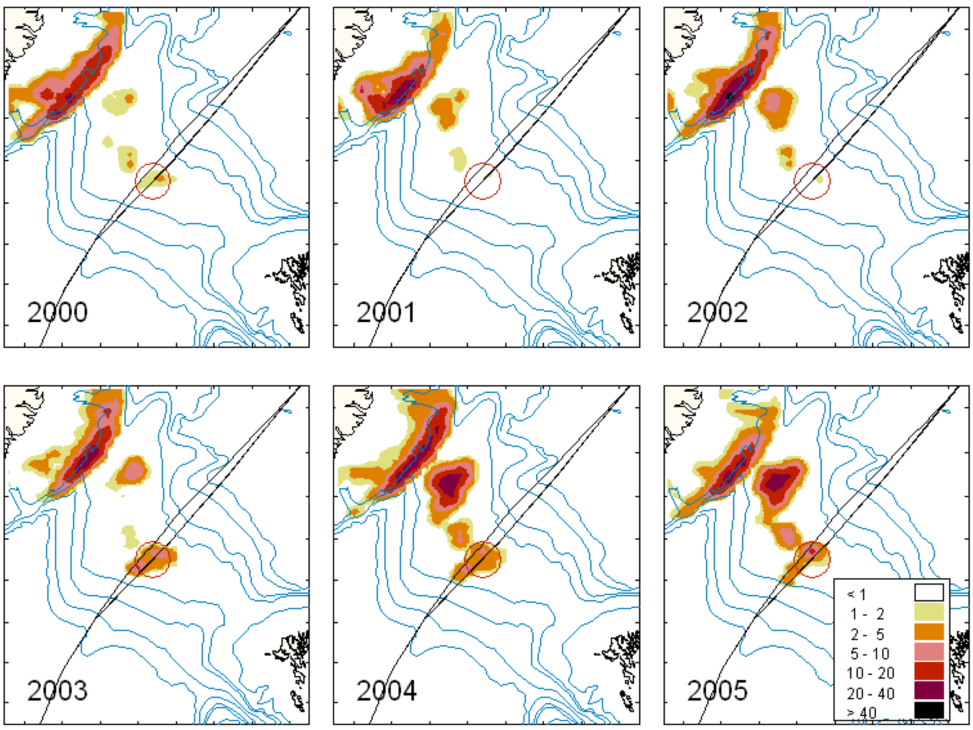


Figure 3.3.32 . Observed trawler catches from Icelandic and Faroese logbooks.

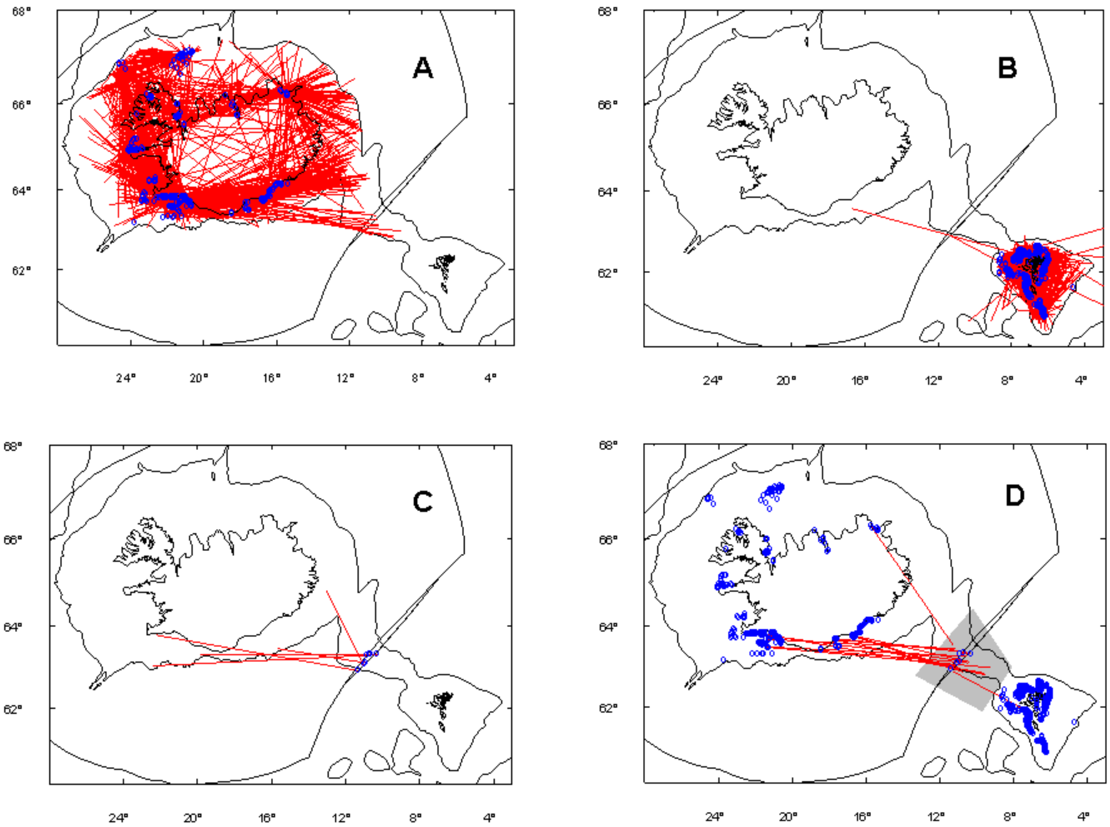


Figure 3.3.33. Tagging location (blue circle) and shortest recapture route (red line) of cod from the Iceland and Faroe. A) Recaptures of cod tagged on the Icelandic shelf, B) Recaptures of cod tagged on the Faroe Plateau, C) Recapture of cod tagged on the Faroe-Icelandic Ridge, D) Tagging location of cod recaptured on the Faroe-Icelandic Ridge.

3.4 Icelandic haddock

3.4.1 Introductory comment

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 Greenand 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 year classes 1998-2000 and 2002 are all estimated to be strong, The 2003 year class is estimated to be very strong. These year classes 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 is probably due to favourable environmental conditions for haddock north of Iceland.

Icelandic haddock was assessed at the North-Western Working Group in 1970 and 1976 but otherwise assessments were conducted by the Marine Research Institute in Iceland until in 1999 when it was again assessed by the North-Western Working Group.

This years assessment is based on the same data as last year with one additional year. The most important change in the data from last year is reduction in mean weight at age of most age groups, indicating slow growth in 2005. Results of the assessment are in line with last years assessment indicating very good recruitment in recent years and increasing stock size.

The main difference from last years report is less emphasis on the difference between results based on the groundfish survey in March and October (this difference still exists) and more focus on prediction of mean weight at age and selection pattern of the fisheries that depends on mean weight at age. Working paper 19 describes problems with prediction of weight at age in the stock and the catches, maturity and selection which is a major factor in formulating the advice this year.

3.4.2 Trends in landings and fisheries

During the early sixties haddock landings were around 100 000 tonnes for six years (Figure 3.4.2.1) After that, landings have been between 40 and 97 thousand tonnes highest in 2005 . 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 2005 were 97 thousand tonnes, increasing from 84 thousand tonnes in 2004. In last year the forecasted landings for the year 2005 were 96 thousand tonnes.

In 2005, 56% of landings were caught in demersal trawl, 11% in Danish seine, 32% on long line and 2% in gillnets. The share of bottom trawl has decreased from 2004 but the share of longline and Danish seine increased (figures 3.4.2.1 and 3.4.2.2). The share of longlines have increased in the last 4 years from 15 to over 30%.

In recent years increasing percentage of the catches have been taken north of Iceland. (figures 3.4..2.3 and 3.4.5.12).

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 2004 the discards were estimated to be 3.1% of landings and 7% by number (Anon 2005). Discard estimates for 2005 were not available when this report was written. .Discards estimates are not used in calculations of catch in numbers by age. The effect on the current assessment based on the groundfish survey in March is not big 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.

3.4.3 Catch at age

Catch at age for 2005 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 2005 are given in the table below.

Region	Season	Gear	Number length measured	Number. Aged	No of length samples	Number of age samples	Number weighed	Landings
South	Jan-May	Long line	15229	1471	102	30	800	8183
South	Jan-May	Gillnets	623	49	5	1	50	712
South	Jan-May	Danish seine	5448	171	36	4	173	5620
South	Jan-May	Bottom trawl	30331	2425	163	48	1250	21237
South	June-Dec	Long line	8121	521	60	11	401	4207
South	June-Dec	Gillnets	784	0	9	0	0	467
South	June-Dec	Hand lines	3	0	1	0	0	30
South	June-Dec	Danish seine	3402	196	21	4	100	1958
South	June-Dec	Bottom trawl	16445	1267	96	26	949	9180
North	Jan-May	Long line	5769	398	47	8	300	3230
North	Jan-May	Danish seine	660	0	9	0	0	370
North	Jan-May	Bottom trawl	14277	889	81	18	549	9319
North	June-Dec	Long line	24273	1086	165	22	898	14920
North	June-Dec	Gillnets	789	148	7	3	150	269
North	June-	Danish	3281	247	24	5	250	2552

	Dec	seine						
North	June-Dec	Bottom trawl	31478	1782	165	36	999	12206

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 (Working document #34). 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.

The table below shows catch at age in 2005 in percent of number compared to last year's prediction. For age 2 the prediction from last year using mean selection of last 5 years was 6.4% but much less landings were expected due to slow growth of this year class. Less than predicted of age 3 is also caused by slow growth causing low proportion of this year class to enter the size sought by the fisheries. Contribution of other age groups is close to the prediction.

Age	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Forecast %	0	23.7	8.7	36.9.5	20.1	8.6	1.8	0.2
Catch %	2.5	14.9	11.1	40.4	21.9	7.5	1.3	0.4

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 (3.4.4.2).. 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 1985–2006 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 until 2006 above what is was for the 1990 and 1995 year classes. An exception was the big year class 2003, where the weight at age was similar to what it was for the 1990 year class. In 2006 things have changed considerably and mean weight at age of nearly all age groups is low and the 2003 year class has now the lowest mean weight at age on record. The data do therefore indicate that growth of nearly all agegroups of haddock was slow in 2005. 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 2 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 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 indices from the autumn survey in table 3.4.5.2.

The index of total biomass from the groundfish surveys in March and October is shown in figure 3.4.5.2. Both surveys show much increase in recent years, but the change occurred earlier and more rapidly in the March survey than in the October survey and the indices from the October survey were not as low in 2000 and 2001 as in March 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) suggests 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 show large increase in recent year.

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 and 2005 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.

In figures 3.4.5.9 and 3.4.5.10 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 survey 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) and that the most recent estimate (shown as intersection of dashed lines) is close to prediction from the SPALY assessment calibrated with the March survey. Figure

3.4.5.10 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.

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 3.4.5.11, 3.4.5.12 and 3.4.5.13) 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 recent years can explain why discards have decreased and recent year classes have progressively become stronger in every new survey (Björnsson and Jónsson 2004).

CPUE from the commercial fleet is shown in figure 3.4.5.15. The CPUE indices are calculated from records where more than 50% of the catch is haddock and also from all records where haddock were caught. They show an increase in recent years for bottom trawl and longlines which are the most important fishing gear. (It must be noted that the longline data are only comparable from 2000 onwards). The change in CPUE is though much smaller than observed in the surveys and Danish seine and gillnets do not show any increase in recent years. Figure 3.4.5.16 shows then the effort calculated by dividing the total catch for each gear by the CPUE indices, both based on records where more than 50% of the catch was haddock and all records where some haddock was found. The figure shows increase in effort in recent year which is not in line with decreasing fishing mortality that the assessment predicts.

The discrepancy between CPUE from commercial fleets and survey indices from 2003 to 2005 is of interest and needs some clarification.

- Large part of the increase in the haddock abundance indices in recent years is in the area north of Iceland where fishing effort is small
- The method used here before to calculate effort for figure 3.4.5.15 is conceptually wrong.

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 3.4.5.12). 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 3.4.5.17 and 3.4.5.18. Figure 3.4.5.17 indicates that number caught, calculated in this way are not very far from official catch in numbers and Figure 3.4.5.18 that fishing mortality (by bottom trawl) might have been decreasing in recent years until 2005when it increases again.

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 11 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 2007 assuming F4-7 =0.47 in 2007 and 110 000 TAC constraint in 2006 is shown for some of the models.

Summary of results from different assessment models.

	F4-7 2005	Biomass 3+ 2006	Std. Err in 3+ bio	N7-2006	N6-2006	N5-2006	F 2006 110 kt	Tac 2007
XSA March survey 2-9	0.403	387		20.0	59.8	.22.4		
TSA March survey*	0.477	330	22	15.9	40.0	18.7		
TSA autumn survey	0.628	249	19	15.4	29.3	17.3		
Adapt March survey	0.538	333		10.2	42.0	15,3		
Last years spaly	0.597	331	30	13.2	40.4	15.3	0.557	112
Adapt Autumn survey 1-9	0.624	237	32	11.6	34.6	13.2	0.789	69
Adcam Autumn surve 1-9	0.61	228	25.2	11.6	30.3	13,1	0.84	65
Last years assessment	0.42	411		17.3	45.3	18.9		

In addition to the stock assessment models two models estimating only recruitment were used, i.e a timeseries model from Gudmundur Gudmundsson (WD#34) and RCT3 based were used. The results of the recruitment models are shown in the table below.

Recruitment age 2 (million)

YEAR CLASS	LAST YEARS ASSESSMENT	RTC3 MARCH SURVEY	ADAPT AUTUMN SURVEY	XSA MARCH SURVEY AGE 1+	ADCAM SPALY	ADAPT	ADCAM AUTUMN SURVEY	TSA MARCH SURVEY	TSA OCT SURVEY
2001	48	59	41	64	46	46	41		
2002	207	225	139	236	202	204	137	184	145
2003	481	473	282	536	454	466	272	405	251
2004	112	85	34	90	81	83	55	66	43
2005		74			76	65		54	

***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.

Recruitment of haddock has been well above average since 1998 andfishing mortality decreased until 2004 but increased again in 2005. Last year the use of inertia factors was questioned as fishing mortality had been decreasing for a number of years. This year that issue is not important as fishing mortality seems to have increased again. Linking certain age group with the same agegroup few years ago might though be questionable as the mean size at age had decreased.

Last year there were indications from the TSA model that catchability in the March survey might have increased in recent years. In this years assessment this increased catchability is not as clear and assessment based on the March survey seems more reliable than last year (working paper #34)

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 still a concern. It is also a puzzle if figure 3.4.5.10 is investigated as most of the points (except the 2002 year class) seem to be on or above the line relating the assessment and. survey indices. A problem with the autumn survey is that it started in 1995 and the big year class from 1990 first appeared in the survey at age 5 and the 1985 year class is not seen in the survey at all. Therefore estimate of the most recent year classes is much more of an extrapolation in assessement based on the autumn survey than the March survey. Plotting figure 3.4.5.10 on log scale might help in understanding the problem but the assessment model “sees” the data on log scale. To reduce possible effect of inertia terms the ADAPT model tuned with the autumn survey was run with very little effect of the initial guess (or P shrinkage) but that does not seem to change much. As mentioned earlier, relatively high discards in the period 1996-1999 could have more effect on the autumn survey assessment than the March survey assessment as the timeseries for the autumn survey is shorter.

The conclusion from these considerations is that the March survey is more suitable series for calibration, due to longer time series that captures “converged” year classes of similar size as most recent year classes (except 2003 that is much larger).

The ADCAM used as SPALY model last year is a statistical catch at age model written in AD-model builder (described in working paper 33 in 2002) was used. (Other models using the same data gave similar results) The settings used in the final run are described in last years report but repeated here below:

- Fishing mortality was estimated for every year and age.
- Recruitment was assumed to be lognormally distributed around a fixed mean with the CV of the lognormal distribution estimated. This term can be looked at as the P-shrinkage in the model. The estimate of the CV was 0.82 to be compared with estimated CV of the survey indices shown in figure 3.4.6.2.
- CV of commercial catch data and of survey indices as function of age are estimated. The CV of the commercial catch is a parabola but estimated separately for each age in the survey (change from last year when it was also a 2nd order polynomial (figure 3.4.6.2). Correlation of the residuals of different age groups in the survey is estimated and the residuals assumed to follow a multivariate normal distribution. The correlation between different ages i and j is $\rho^{|i-j|}$. where ρ is the estimated correlation coefficient
- Catchability in survey was independent of stock size for all ages. (See figures 3.4.5.7 and 3.4.5.8 for justification)
- Fishing mortality of each age group was random walk with standard deviation specified as proportion of the estimated CV in the catch at age data. In the input file the process error (variability in log(F)) is specified to be larger than the measurement error for the younger ages but the measurement error is specified to be larger for the older age groups
- The model estimates standard deviation on survey and age disaggregated catches. The division of the standard deviation in catches between process (random walk of F) and measurement error can not be estimated.

The results from the SPALY ADCAM run are shown in Figures 3.4.6.1 to 3.4.6.5 and results from the same run based on the autumn survey are shown in figures 3.4.5.6 to 3.4.5.8. Figure 3.4.6.4 shows large blocks in the survey. There are some possible explanations for those year blocks, among them

- Large abundance of haddock in a survey leads to subsampling for the length measurement in number of stations. Getting representative length sample is difficult and a common belief is that larger haddock tend rather to be selected for length sample.
- Abundance dependent catchability at each station.

In TSA a common year factor is estimated for all age groups in the survey but in ADCAM the correlation between residuals of different agegroups in the March survey is estimated. The estimate is high, or 0.6 between adjacent age groups . This high correlation works in a way like a year factor and the model does not follow the most recent surveys as well as it would do if the correlation was 0 (in the autumn survey the estimate is 0.28 so the effect is less). Modelling of the correlation of survey residuals explains most of the differences between results from ADCAM and TSA compared to XSA (see table above).

Fishing mortality from the selected run is shown in table 3.4.6.4. The fishing mortality for ages 8 and 9 (forced to be the same) seems to be rather stable, probably due to too strong effect of the random walk term relative to the measurement error in the catch in numbers and the survey. At the moment these settings do not have much effect on the advice but in 2006 the first of the large year classes since 1998 reaches age 8 and then these settings might start to have effect. At the same time inclusion of ages older than 9 in the catch in numbers need to be considered.

Figure 3.4.6.5 shows the residuals in catch at age from the SPALY. The residuals are small as the selection pattern of the model is quite flexible and the catch at age for this stock does usually not contain major surprises.

The standard error of the Biomass (3+) by some of the models is given in the table above. It is smaller than the largest difference between different models and it is probably an underestimate of the real uncertainty in the assessment.

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 2006 and the predicted weights in coming years are even lower.

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. To summarize the findings of working paper #19 the stock weights are predicted forward in time starting with the weights from the March survey 2006 and a model where growth was predicted as a function of weight at age and a year effect. .The value of the year effect in 2005 was then used in prediction for next years but the growth in 2005 is the slowest in the time period that dates back to 1985.

Mean weight at age in the stock was used to predict weight at age in the catches, selection pattern and maturity at age. For maturity, data from 2001-2006 were used but data from 1985-2006 to predict the selection by age and mean weight at age in the catches. Figure 3.4.7.4 shows the relationship between mean weight at age in the stock and selection at age of the fisheries.

At the end of working paper #19 the effect of different methods of prediction on the TAC for the year 2007 are compared using the target F_{4-7} of 0.47

Stock numbers in the year 2006 and recruitment in 2006 – 2008 were obtained from the ADCAM model based on the March survey and the same model was used for prediction.

A TAC constraint of 110 000 tonnes was used for the year 2006. The estimate was the sum of the TAC for the fishing year starting September 1st 2005 that was remaining in the beginning of 2005 and 36% of the estimated TAC for the fishing year 2006-2007 but 36% of the TAC for the fishing year 2005-2006 was taken in the year 2005 In the prognosis last year a TAC constraint of 96 000 t was used for the year 2005 while the landings are now estimated to be 97 000 tonnes

Stochastic short term prognosis were done using the ADCAM model. Recruitment after the 2005 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 proposed Fpa of 0.47 was used for the years 2007 and later. 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 3.4.7.1. 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=0.54 for 2005, 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- 2005 is shown in Figure 3.4.6.1 and a plot of recruitment vs. spawning stock in figure 3.4.7.3.

In the year 2000 the working group proposed provisional Fpa set to the Fmed value of 0.47 and this value has been used as Ftarget since then. Since 1986 F4–7 has exceeded Fmax and for only 4 years since 1960 has F4–7 been lower than Fpa.

The SGPRP proposed Bloss as candidate for Bpa at its meeting in February 2003. The working group did not discuss this matter further.

TAC for Icelandic fish stock is given for fishery years which are from September 1st. each year to August 3rd the following year. 1/3rd of the fishing year 2004/2005 falls withing the calendar year 2005 and 2/3rd within the calendar year 2006. The TAC for the next fishing year will therefore be 1/3rd of the landings in 2006 plus 2/3rd of the advice for 2007.

3.4.7.3 Projection of catch and biomass

Results from short term prediction are shown in tables 3.4.7.4.

At the beginning of 2006, the biomass of age 3+ is predicted to be 278 000 t with a spawning stock of 182 000 t according to the SPALY run.

With a catch of 110 000 t in 2006, fishing mortality is estimated to be 0.56 and at the start of 2007 the biomass of age 3+ is predicted to be 323 000 t and the spawning stock 174 000 tonnes. Landings in 2007 will be 113 000 tonnes if F4-7=0.47.

The table below shows the effect of different assumptions regarding growth and selection on the TAC in 2007 using F=0.47 as the target F.

2005 growth. Selection based on stock weights.	112
2004 growth. Selection based on stock weights.	122
2003 growth. Selection based on stock weights.	130
2005 growth. Selection based on age (mean of last 5 years)	128

Figure 3.4.7.5 shows the output of the short term prognosis including errors in mean weight at age and assessment errors, assuming F4-7=0.47 after 2006. 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 2008 but the landings in 2010 and later will in the end depend on the size of year class 2006 and later.

3.4.8 Management considerations

For more than a decade fishing mortality on haddock was high with F4–7 between 0.6 and 0.8 since 1986. The advice last years has been based on the provisionally proposed F_{med} that is 0.47.

The short term predictions do not show much advantage in terms of total yield in reducing fishing mortality as may also be seen by the yield per recruit plot (figure 3.4.7.1). It must though be born in mind that a number of factors, like discard, hidden mortality due to mesh penetration and reduction of mean weight at age by removal of the largest individuals of each age group are not included in these predictions.

Prediction using the SPALY run indicate that F=0.47 will lead to a catch of 113 000 tonnes for the calendar year 2007 which is more than has been caught since the early sixties (figure 3.4.1.1). Of this 43 thousand tonnes are expected to come from year class 2003 even though the selection on it is expected to be very low at age 4. Discard of year class 2003 could become a problem in 2006 and 2007 but the fleet might as well be able to avoid the year class and transfer the fishing effort to the older year classes.

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 problem has been relatively small in recent years due to relatively little overlap between the fishing effort and the recruits.

Predictions indicate that landings will start to decrease after 2008 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.

The hidden mortality by mesh penetration is predicted to be highest for ages 1 and 2. As year classes 2004 and 2005 are estimated to be small compared to most recent year classes this part of hidden mortality will most likely not be important in 2006 but what happens in 2007 will depend on the size and spatial distribution of the 2006 year class.

The current slow growth of the Icelandic haddock has raised voices that the fishing effort should be inceased to “reduce the stock size and improve growth”. One problem with this approach is that the fisheries target the largest haddock but not the most abundant part of the stock i.e year class 2003 as the price for it will be very low. It might as well be argued that when growth is slow the age used in the reference F should be increased from 4-7 to 5-8 so the reference F includes similar size fish.

3.4.9 Comments on the assessment

The current assessment was done using only groundfish surveys for tuning.

Fishing mortality on haddock increased after 1985 (Figure 3.4.6.2.) The high fishing mortality was at least partly due to an overestimation of the stock biomass through the use of catch weights that are 20–25% higher than survey weights which have been used in the assessment since 1999.

The assessment presented here gives $F_{4–7}$=0.538 in 2005 which is an increase from 2004 when $F_{4–7}$ is now estimated to have been 0.477 (last years estimate for 2004 was 0.44)

This year assessment gives a somewhat different view of the stock than last year assessment . This assessment strengthens earlier findings that many of the recent year classes are large or very large and rejects the suspicion from last year that catchability in the March survey might have changed permanently in 2003. Growth has on the other hand decreased more than expected but growth was expected to be slow especially for the 2003 year class. Mean weight at age are now near historic low and below it for the 2003 year class. This slow growth caused little contribution of the 2002 year class in 2005 increasing the fishing mortality on the older age groups.

Biomass of age 3+ is now estimated to be 332 thousand tonnes but was estimated to be 411 tonnes last year, the difference is nearly all caused by reduced mean weight at age.

Although weights at age in the stock were overestimated last year the possibility of much slower growth of the 2003 year class was considered and the estimated contribution that year class which was 30 000 tonnes was subtracted from the adviced TAC for 2006.

This year more work is put in predicting mean weight at age, maturity and selection. As the stock is expected to continue to be very large in coming years growth was assumed to be similar as in 2005 and year classes predicted to recruit slowly to the fisheries. The prediction gives a Tac of 113 thousand tonnes in 2007 using $F_{4\text{–}7}$ =0.47. Predicting mean weight at age and selection in the same way as last year would have given a Tac of more than 140 thousand tonnes.

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 class 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
Belgium			
Faroe Islands	833	1035	1372
Iceland	59970	83791	95859
Norway	30	9	
UK	51		
Total	60884	84835	97231

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	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

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	33	145	316	586	1018	1405	1721	2062	2275
2008	33	145	343	565	865	1289	1631	1890	2151

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	369	702	1192	1602	1928	2281	2501	3229
2007	403	677	1024	1481	1836	2102	2372	2533
2008	403	715	999	1328	1733	2029	2238	2440

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	2.7	11.7	46.2	62.1	73.9	91.8	100	100	2.7
2007	2.2	12.9	39.6	71.1	84.2	89.7	93.1	94.4	2.2
2008	2.2	15.3	37.5	62.5	81.3	88.4	91.6	93.7	2.2

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		97.74	108.47	450.44	115.78	10.67	23.41	6.69	2.34	
2008			101.72	80.56	296.62	58.49	4.68	9.64	2.61	

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

Table 3.4.6.1 Haddock in division Va. Summary table from the SPALY run using the March survey for tuning.

year	Recruitment million atage 2	Biomass 3+ 1000 tons	SSB 1000 tons	Landings 1000 tons	F_{4-7}	Yield/SSB
1979	78860	163132	95972	59190	0.535	0.617
1980	37233	191830	116115	50902	0.44	0.438
1981	9681	204403	139242	63491	0.486	0.456
1982	42434	179359	136047	68533	0.455	0.504
1983	30323	144723	109603	64698	0.489	0.59
1984	18710	111440	81320	48121	0.505	0.592
1985	42537	99147	63683	50261	0.563	0.789
1986	87712	92230	55606	47272	0.707	0.85
1987	166421	104719	44206	40132	0.658	0.908
1988	43870	153581	67077	53871	0.661	0.803
1989	24815	169165	100386	62712	0.63	0.625
1990	23619	142931	109918	67038	0.612	0.61
1991	81062	118160	87168	54694	0.624	0.627
1992	167599	103289	65099	47026	0.696	0.722
1993	35976	128682	69597	48737	0.691	0.7
1994	39423	124310	80486	59007	0.685	0.733
1995	70868	118368	80717	60111	0.673	0.745
1996	36177	105185	67731	56716	0.696	0.837
1997	99417	86266	57689	44006	0.652	0.763
1998	16619	95290	62731	41374	0.676	0.66
1999	49472	87154	61552	45231	0.721	0.735
2000	120243	85728	59376	41870	0.671	0.705
2001	152226	112186	67058	39530	0.547	0.589
2002	180653	164525	95907	50294	0.492	0.524
2003	45438	213893	143423	60598	0.445	0.423
2004	202007	242680	174848	84405	0.477	0.483
2005	454769	266887	173381	96655	0.538	0.557
2006	80921	331714	148503	110062	0.558	0.741
2007	76235	322898	174470	112129	0.47	0.643
2008	60498	297814	185704	128442	0.47	0.692
Mean 79-05	87339	141084	91331	55795	0.594	0.651

Table 3.4.6.2 Haddock in division Va. Number in stock from the SPALY run using the March survey. The shaded numbers are input for prediction.

YEAR/AGE	1	2	3	4	5	6	7	8	9
1979	45.5	78.9	120.3	26.8	20.1	21.2	3.2	0.8	0.1
1980	11.8	37.2	64.3	96.3	18.4	10.8	8.7	1.1	0.3
1981	51.8	9.7	30.1	51.4	69	11	5	3.4	0.4
1982	37	42.4	7.9	24.1	37.4	40.8	4.5	1.8	1.2
1983	22.9	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	107.1	42.5	15.3	19.5	17.9	2.1	3.9	3.9	2.7
1986	203.3	87.7	34.5	11.1	11.5	9	0.8	1.6	1.3
1987	53.6	166.4	71.6	24.8	5.8	5	2.8	0.3	0.5
1988	30.3	43.9	134.6	52.2	13.6	2.4	1.9	1.1	0.1
1989	28.8	24.8	35.8	100.7	29.1	5.9	0.9	0.7	0.3
1990	99	23.6	20.2	26.9	60.9	14.8	2	0.3	0.2
1991	204.7	81.1	19	14.5	15.6	29	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	48.2	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	121.4	36.2	56.1	21.3	12.3	26.4	4	0.4	0.1
1997	20.3	99.4	28.6	37.5	11	6	9.5	1.2	0.1
1998	60.4	16.6	80.1	19.9	20.3	4.7	2.6	3.2	0.4
1999	146.9	49.5	13.4	58.1	10.6	8.8	1.8	0.9	0.9
2000	185.9	120.2	39.6	9.6	32.5	4.1	3	0.6	0.3
2001	220.6	152.2	96.3	26.8	5.7	14.6	1.5	1	0.2
2002	55.5	180.7	122.7	68.9	15.7	3.2	6.4	0.5	0.3
2003	246.7	45.4	146.9	91.2	42.1	8.3	1.6	2.5	0.2
2004	555.5	202	36.9	114.1	59.7	22.9	4.2	0.7	0.8
2005	98.8	454.8	164.2	26.6	77.1	31.5	10.7	1.7	0.2
2006	93.1	80.9	370.9	125.6	15.4	40.4	13.2	4.4	0.5
2007	73.9	76.2	65.8	288.3	77.7	7.6	17.2	4.9	1.6
2008	73.9	60.5	61.9	51.6	197.3	41.8	3.5	7	1.8

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	0.691	0.851	0.851	0.851
1980	0.014	0.023	0.133	0.311	0.573	0.743	0.86	0.86
1981	0.004	0.021	0.12	0.325	0.7	0.8	0.875	0.875
1982	0.002	0.034	0.146	0.346	0.54	0.79	0.902	0.902
1983	0.001	0.025	0.259	0.364	0.661	0.673	0.907	0.907
1984	0.004	0.038	0.236	0.428	0.715	0.642	0.904	0.904
1985	0.009	0.12	0.33	0.489	0.743	0.689	0.94	0.94
1986	0.003	0.129	0.441	0.643	0.959	0.787	0.961	0.961
1987	0.013	0.115	0.402	0.685	0.772	0.771	0.967	0.967
1988	0.004	0.089	0.384	0.638	0.816	0.806	0.983	0.983
1989	0.005	0.086	0.303	0.477	0.903	0.839	0.995	0.995
1990	0.019	0.134	0.346	0.541	0.73	0.83	0.991	0.991
1991	0.032	0.088	0.347	0.592	0.735	0.821	0.996	0.996
1992	0.018	0.131	0.404	0.68	0.838	0.864	1.001	1.001
1993	0.008	0.102	0.374	0.651	0.8	0.94	1.002	1.002
1994	0.009	0.123	0.341	0.647	0.792	0.96	1.013	1.013
1995	0.034	0.205	0.341	0.589	0.82	0.943	1.044	1.044
1996	0.035	0.201	0.463	0.52	0.825	0.974	1.052	1.052
1997	0.016	0.16	0.416	0.643	0.654	0.896	1.041	1.041
1998	0.015	0.121	0.437	0.631	0.791	0.844	1.031	1.031
1999	0.023	0.132	0.382	0.744	0.876	0.88	1.016	1.016
2000	0.022	0.19	0.326	0.599	0.832	0.927	1.004	1.004
2001	0.016	0.136	0.333	0.378	0.623	0.855	0.986	0.986
2002	0.007	0.097	0.293	0.434	0.487	0.753	0.976	0.976
2003	0.007	0.053	0.223	0.407	0.489	0.659	0.97	0.97
2004	0.007	0.128	0.192	0.439	0.562	0.715	0.989	0.989
2005	0.004	0.068	0.35	0.446	0.673	0.683	1.000	1.000
2006	0.007	0.052	0.28	0.502	0.651	0.798	0.816	0.816
2007	0.008	0.043	0.179	0.421	0.586	0.694	0.782	0.782
2008	0.009	0.059	0.183	0.375	0.593	0.729	0.82	0.858

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.

		2006		
B3+	SSB	Fmult	F4-7	Landings
332	149	1.036	0.558	110

		2007			2008	
B3+	SSB	Fmult	F4-7	Landings	B3+	SSB
323	174	0.2	0.108	30	361	233
323	174	0.3	0.161	43	350	225
323	174	0.4	0.215	57	340	217
323	174	0.5	0.269	69	330	210
323	174	0.6	0.323	81	321	203
323	174	0.7	0.377	93	312	197
323	174	0.8	0.43	104	304	190
323	174	0.9	0.484	115	296	184
323	174	1	0.538	125	288	178
323	174	1.1	0.592	135	280	173
323	174	1.2	0.646	145	273	168
323	174	1.3	0.699	154	266	162
323	174	1.4	0.753	163	260	158
323	174	1.5	0.807	171	253	153
323	174	1.6	0.861	179	247	149
323	174	1.7	0.915	187	241	144
323	174	1.8	0.968	195	236	140
323	174	1.9	1.022	202	230	136
323	174	2	1.076	209	225	133

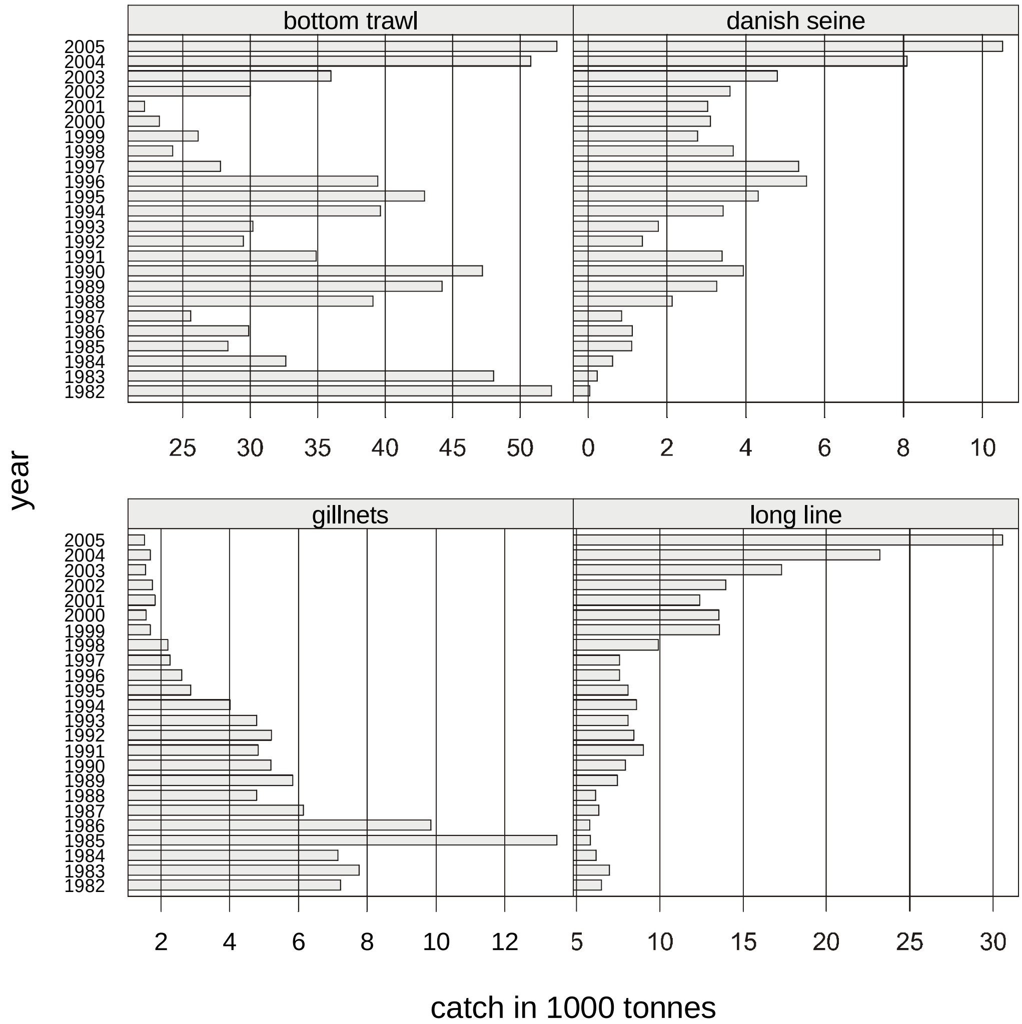


Figure 3.4.2.1 Haddock Division VA. Landings by fishing gear 1982 -2005.

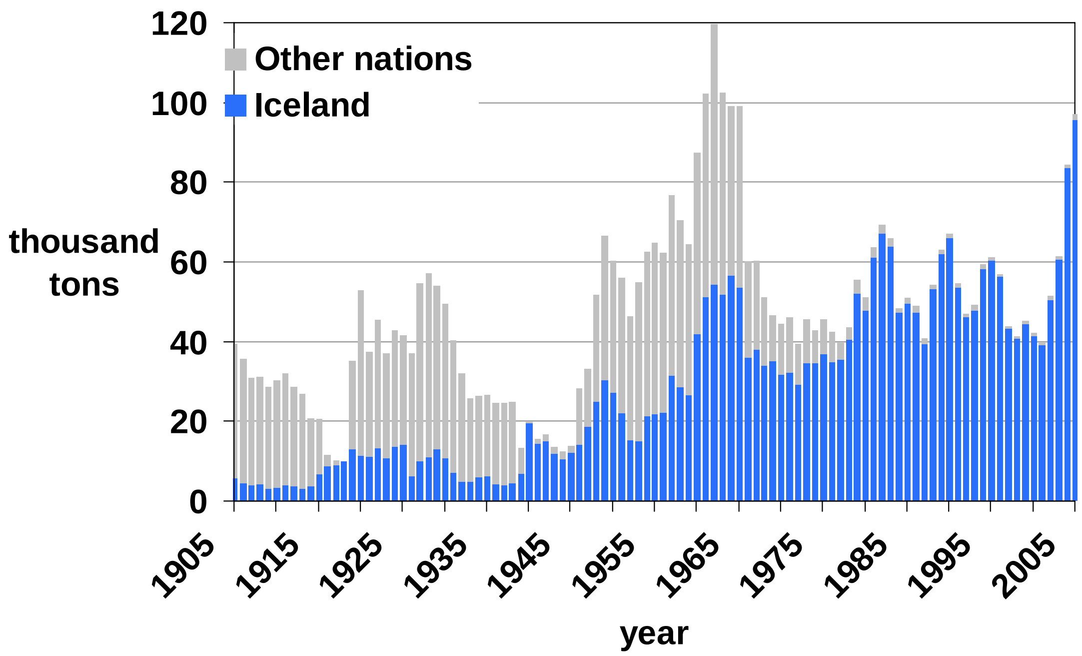


Figure 3.4.2.2 Haddock in division Va. Landings 1905 – 2005.

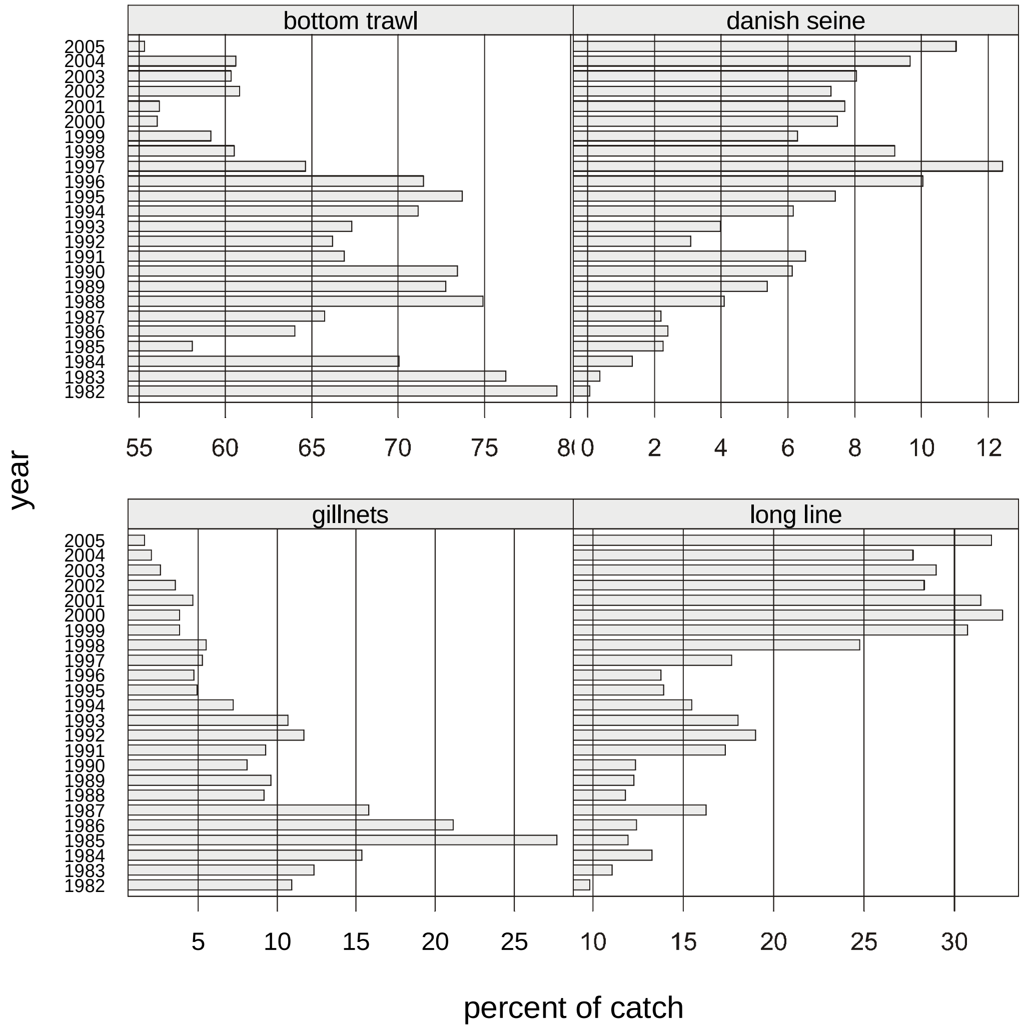


Figure 3.4.2.3 Haddock Division VA. Landings in percent of total by gear and year. The upper picture shows landings in tons and the lower percent of total.

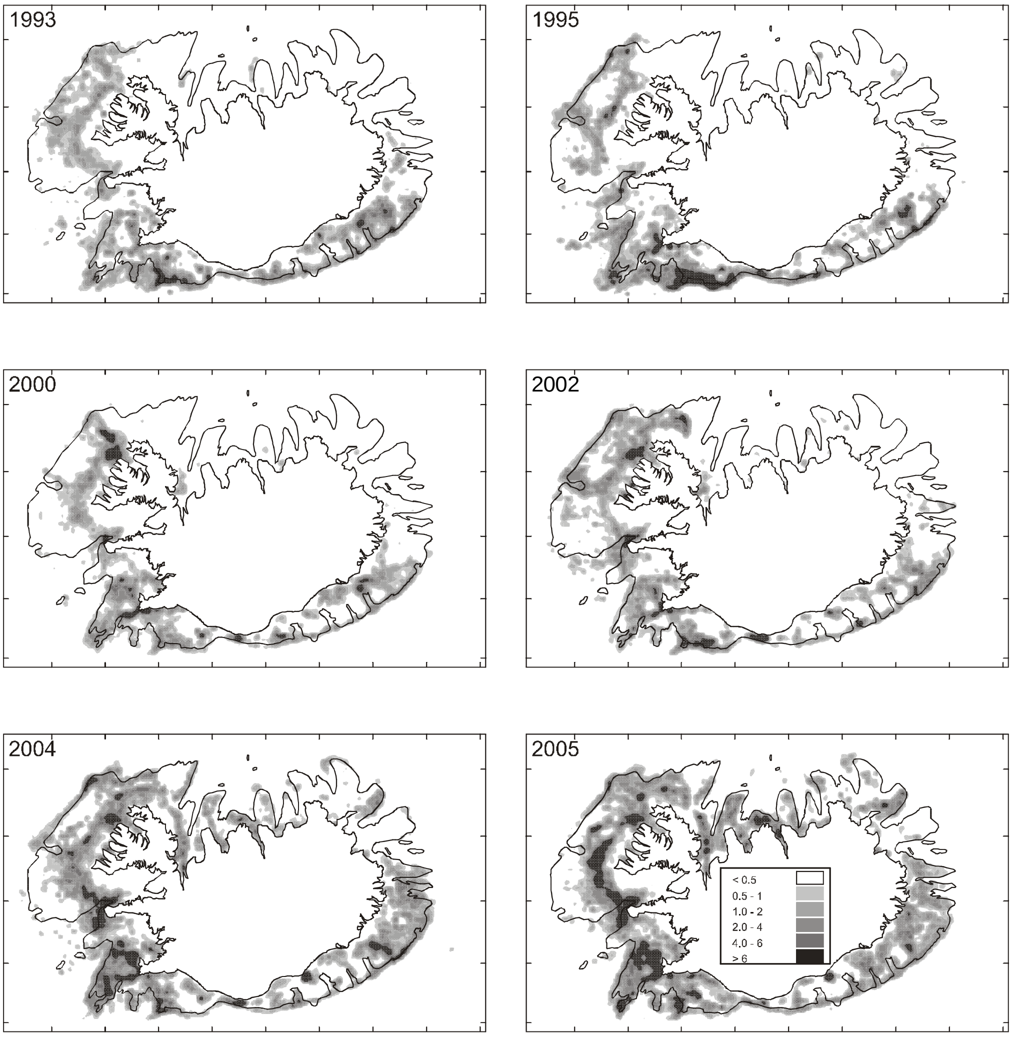


Figure 3.4.2.3 Haddock Division VA. Spatial distribution af landings. The legend show tonnes per square mile. .

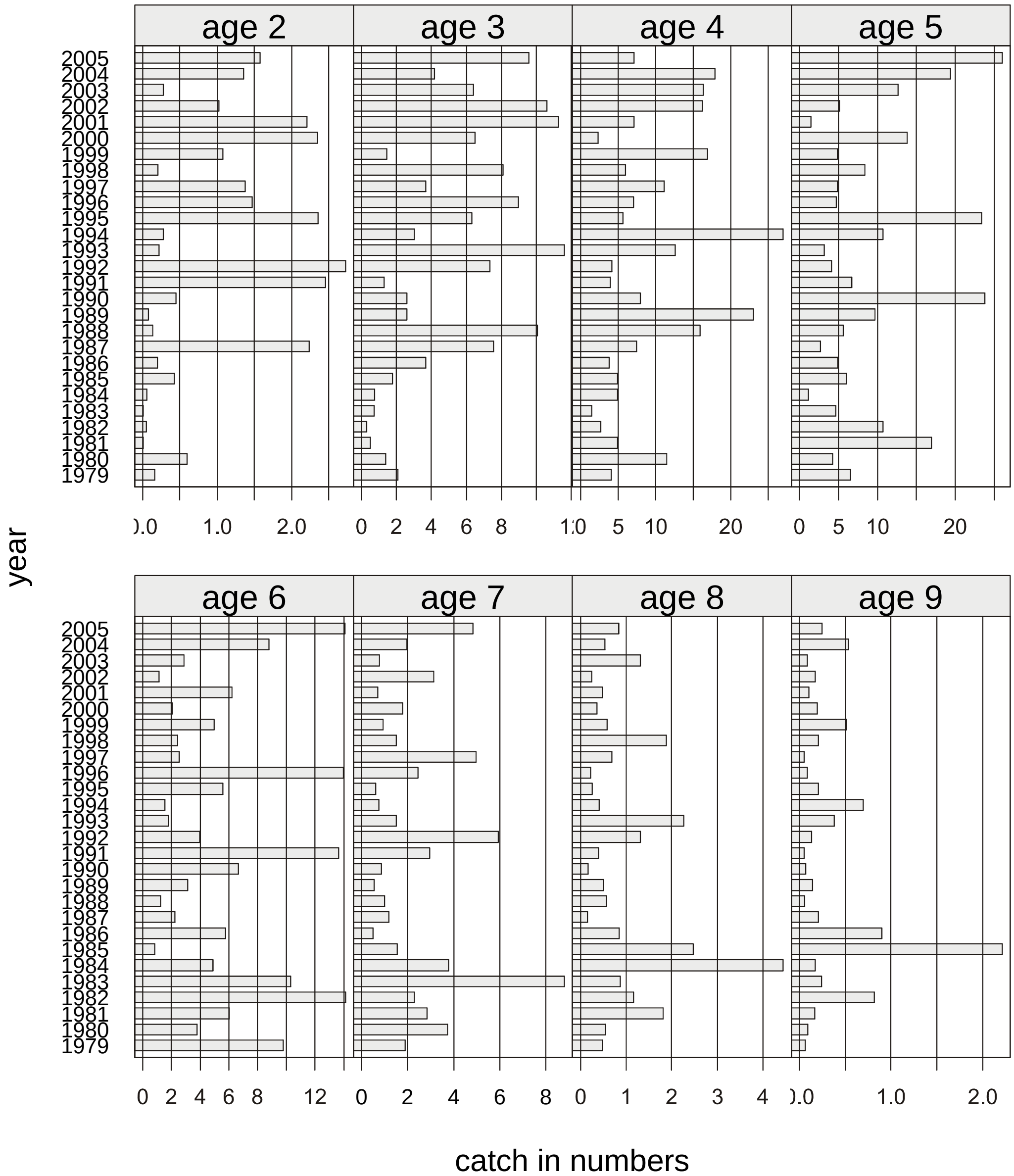


Figure 3.4.3.1 Haddock in division Va. Age disaggregated catch in numbers.

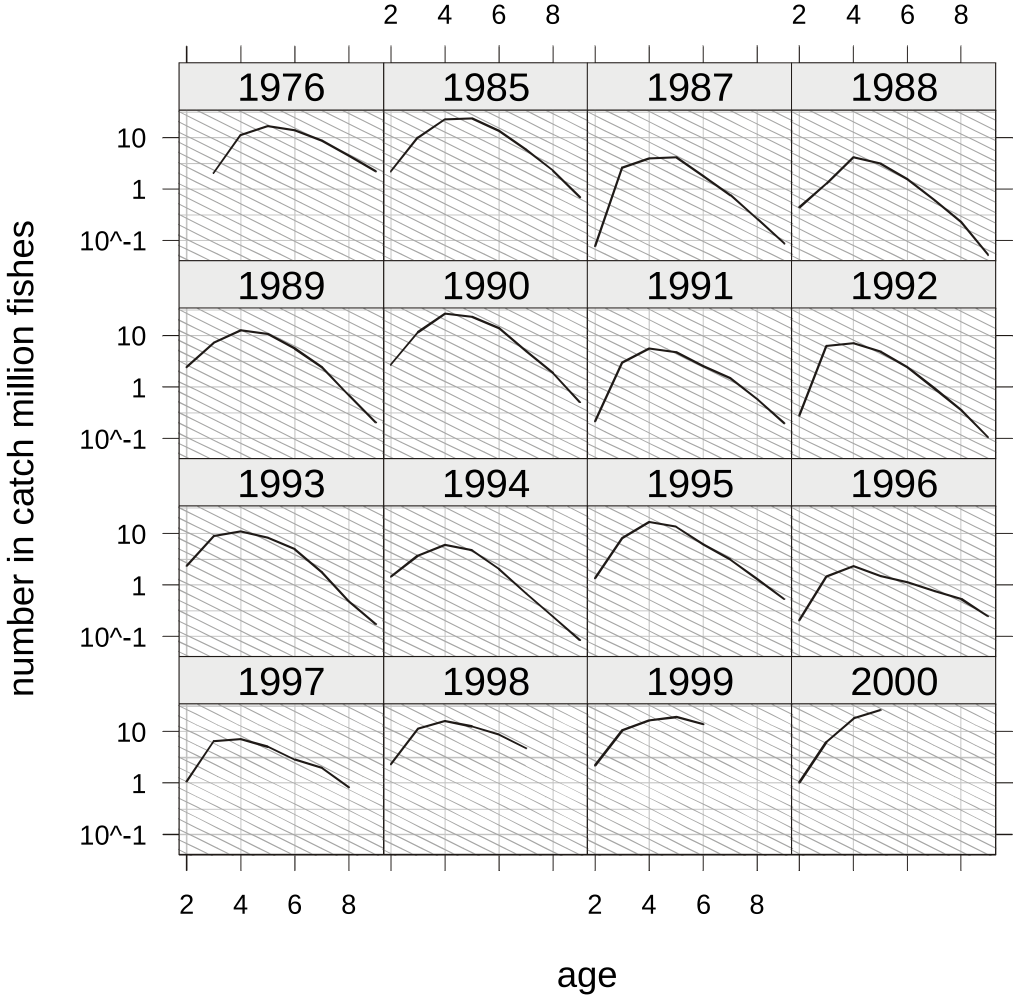


Figure 3.4.3.2. Haddock in division Va. Age disaggregated catch in numbers plotted on log scale. The grey lines show Z = 0.6.

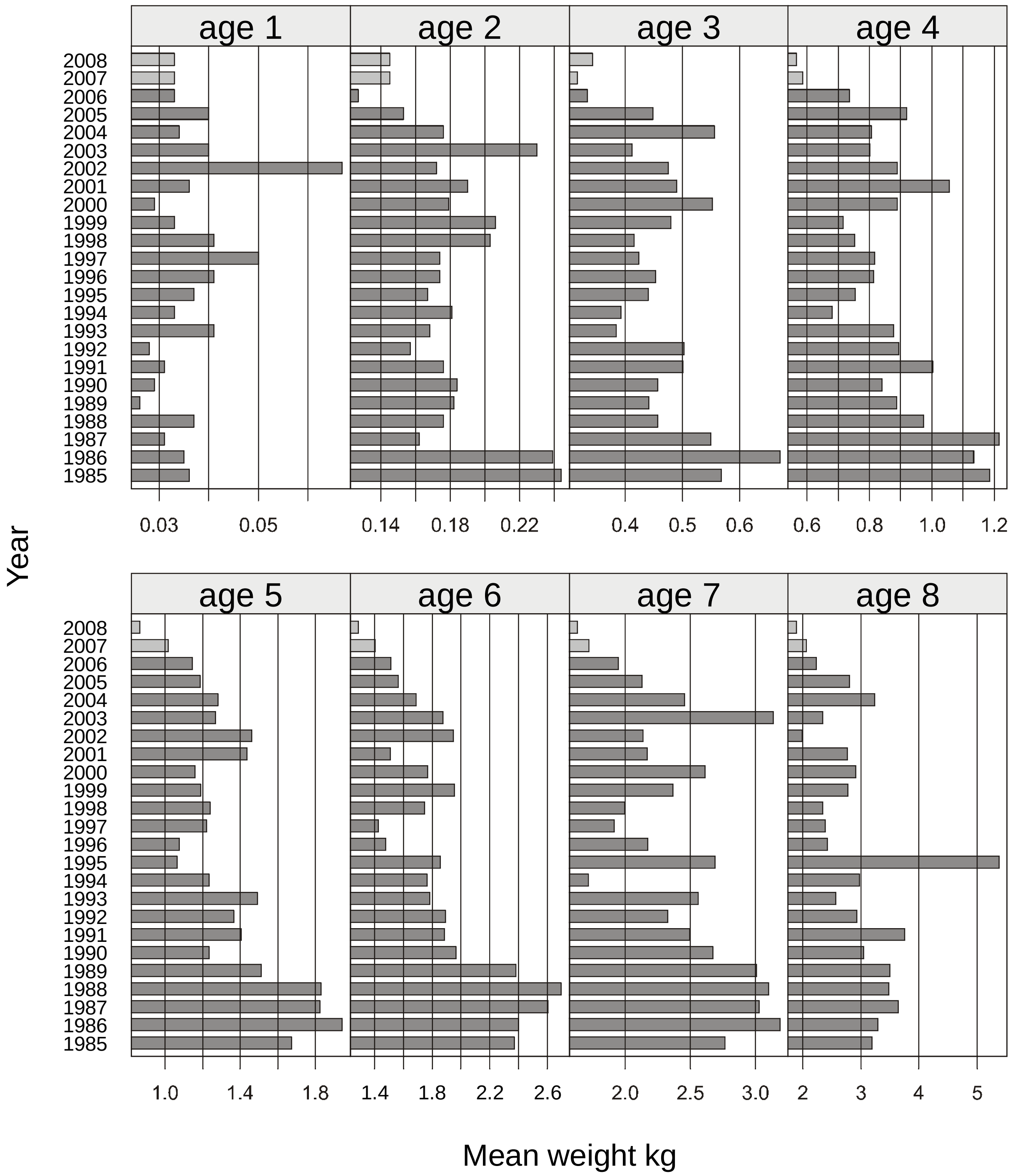


Figure 3.4.4.1 Haddock in division Va. Mean weight at age in the survey. Perdictions are shown as light grey. The values shown are used as weight at age in the stock.

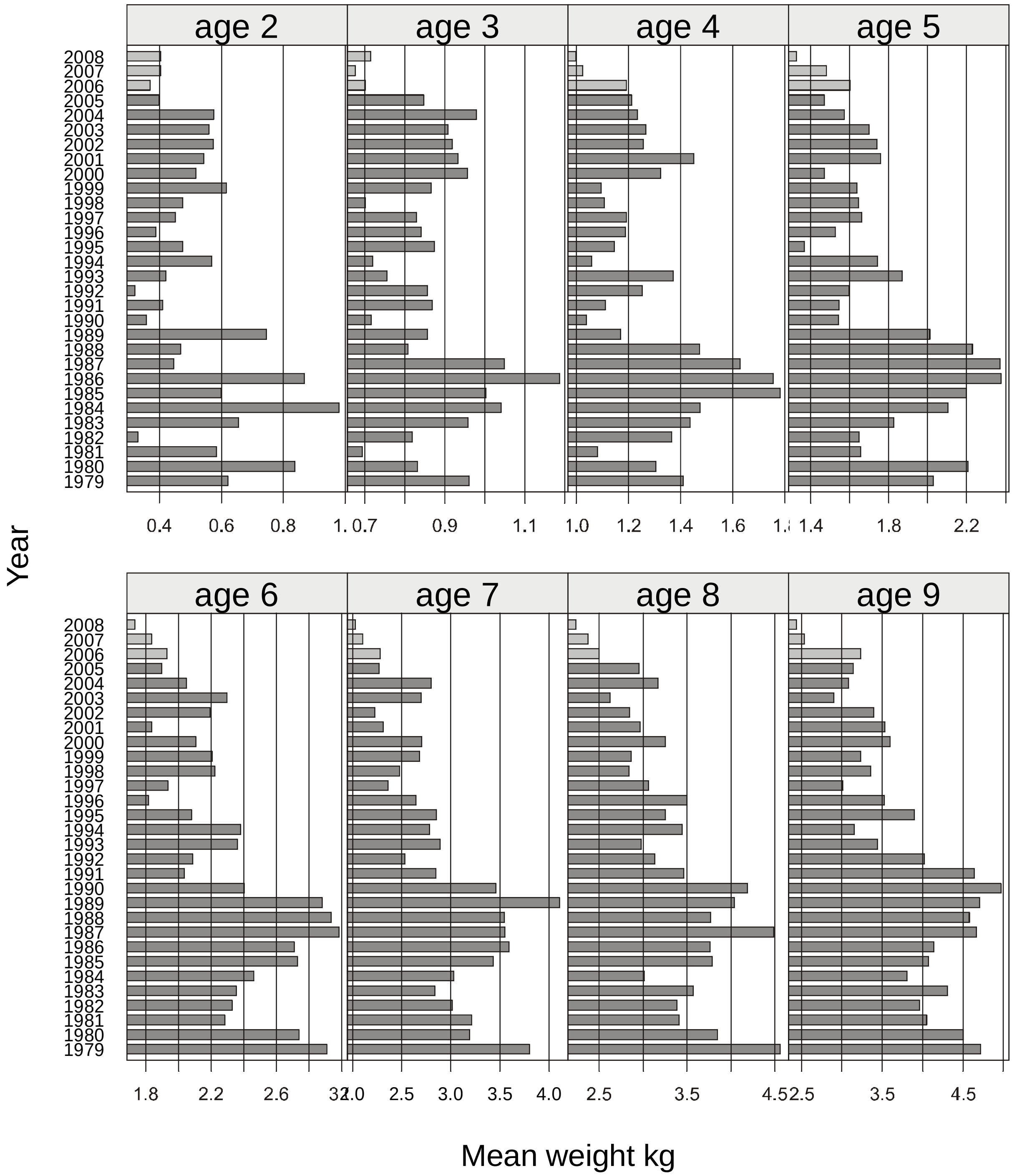


Figure 3.4.4.2 Haddock in division Va. Mean weight at age in the catches. Perdictions are shown as light grey.

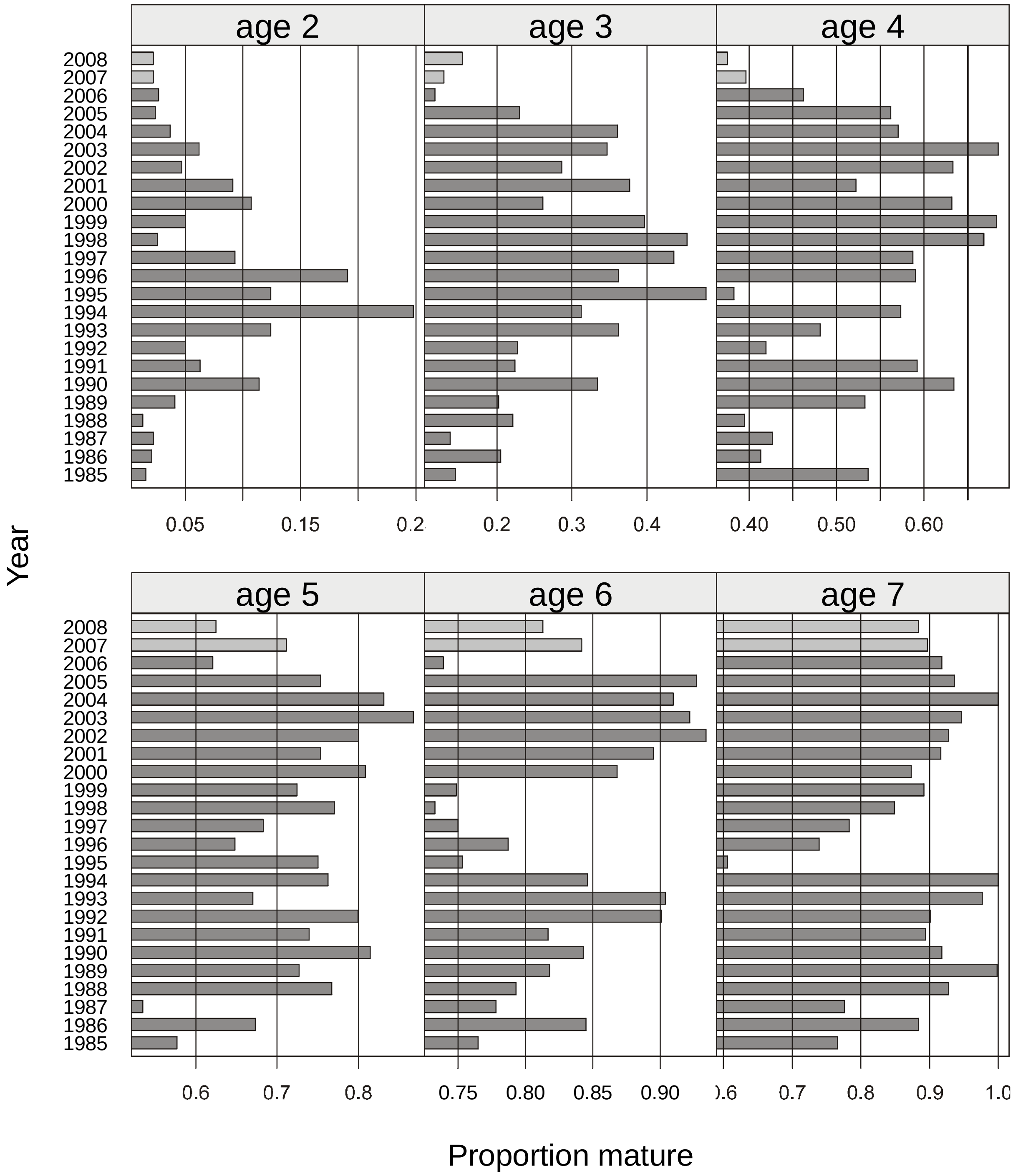


Figure 3.4.4.3 Haddock in division Va. Maturity at age in the survey. The light grey bars indicate prediction. The values are used to calculate the spawning stock.

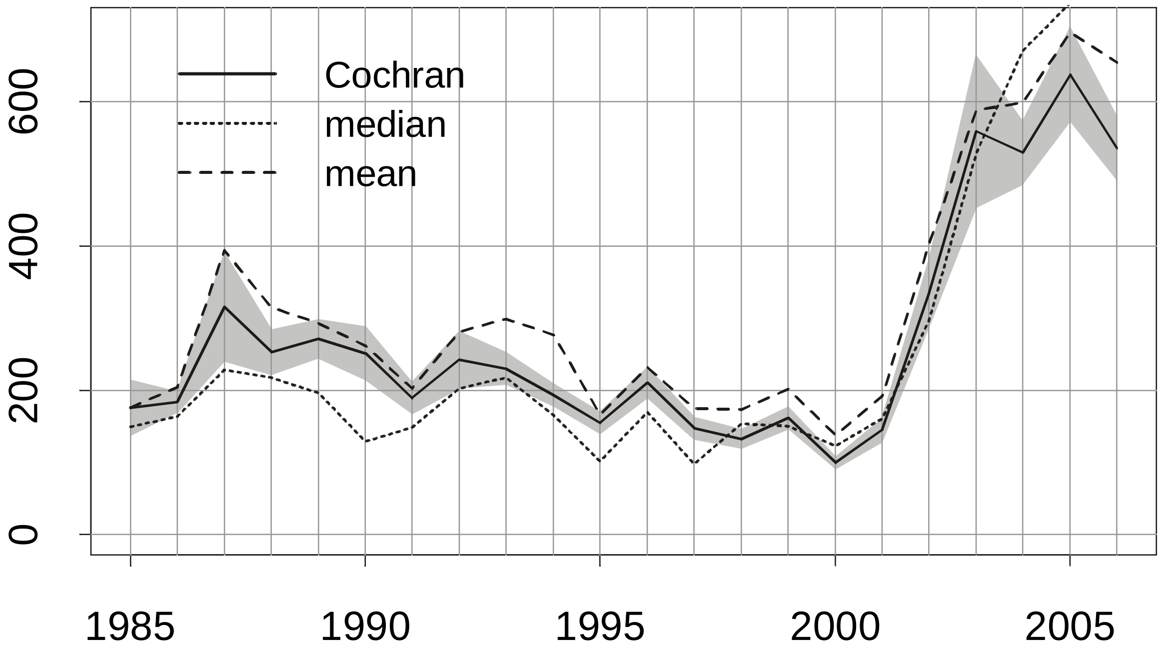


Figure 3.4.5.1. Haddock in division va. Total biomass index from the groundfish survey. 1000 tonnes. The shaded area shows show the standard error in the estimate of the indices. Indices based on unweighed mean of all stations and number of stations with haddock times median of the haddock catch at those stations are shown for comparison.

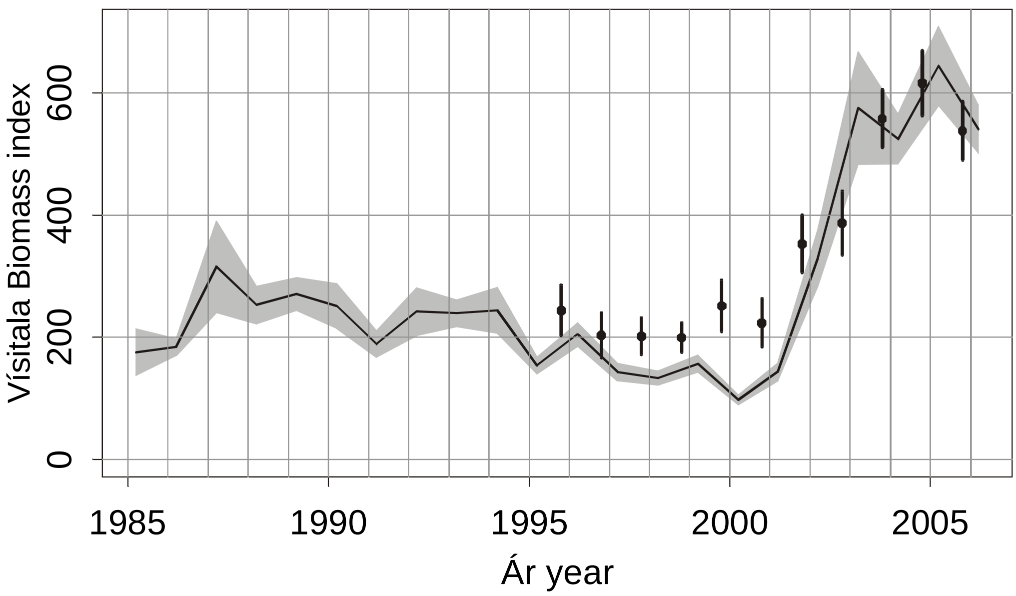


Figure 3.4.5.2 Icelandic haddock. Total biomass indices from the groundfish surveys in March (lines and shading) and the groundfish survey in October vertical segments. The standard error in the estimate of the indices is shown in the figure.

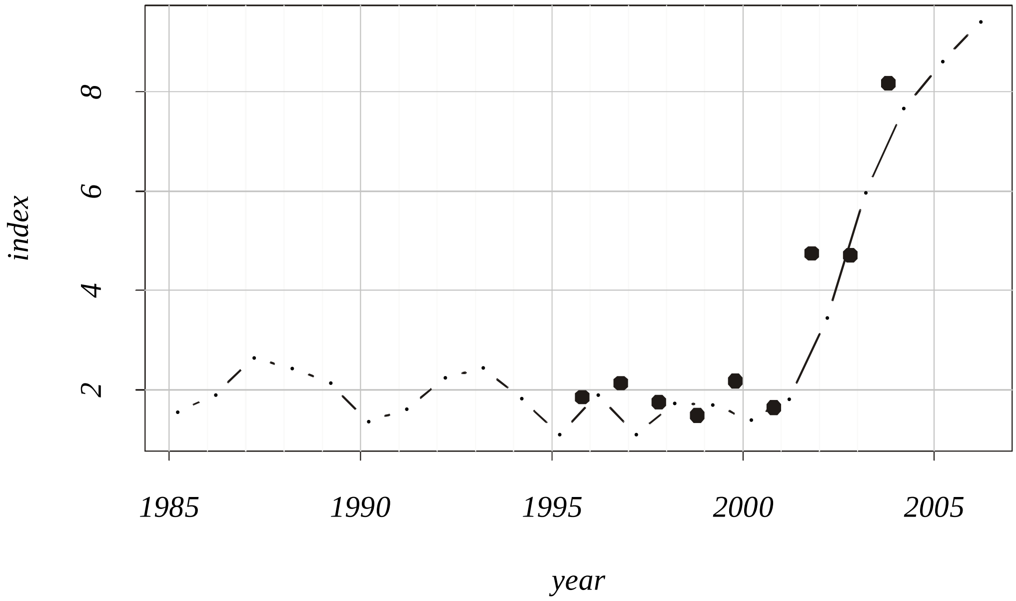


Figure 3.4.5.3 Icelandic haddock. Median indices from the groundfish survey in March and the autumn survey. The index is calculated as the number of stations where haddock is caught times median of the haddock catch at those stations are shown for comparison. The line show the March survey and the dots the autumn survey.

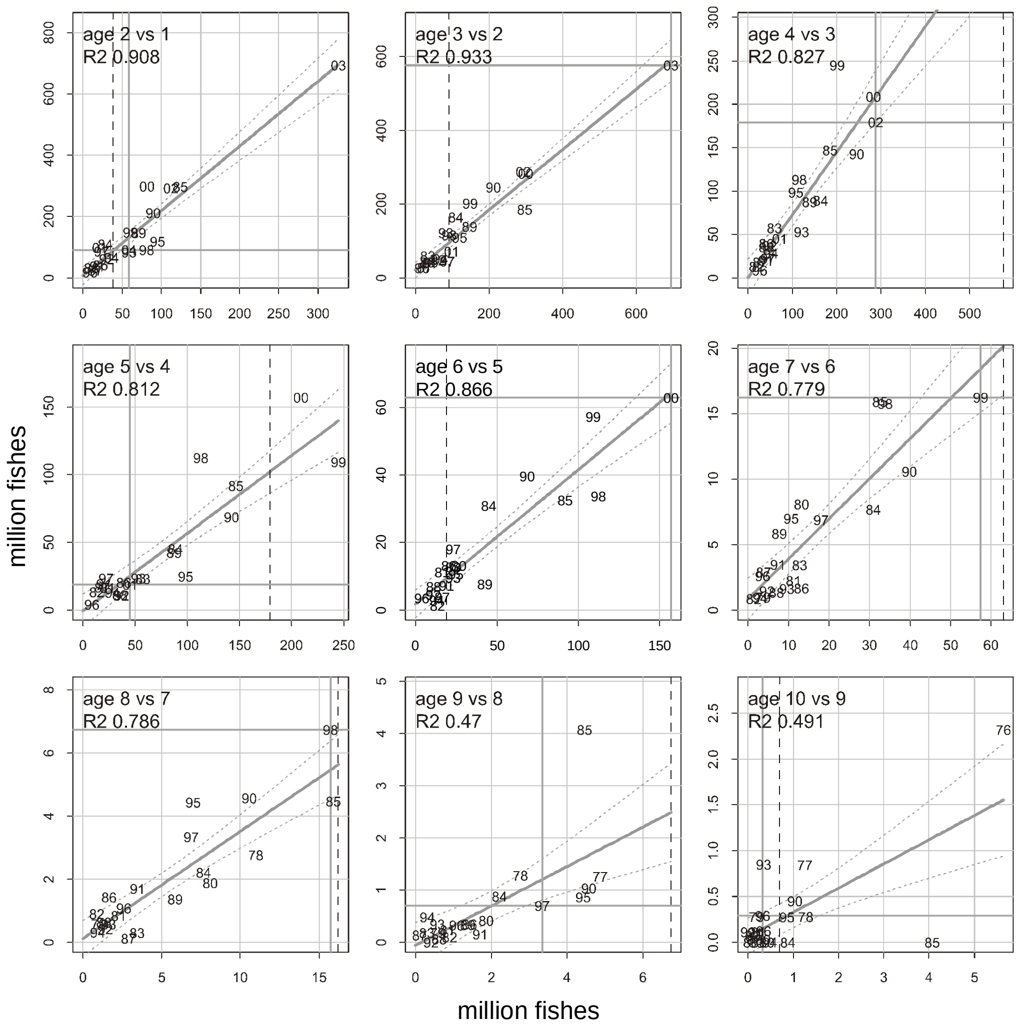


Figure 3.4.5.4 Haddock in division Va. Indices from March survey plotted against indices of the same year class one year earlier. The letters in the figure are year classes. The dashed vertical lines show the most recent values and the intersection of the gray lines the most recent pair. .

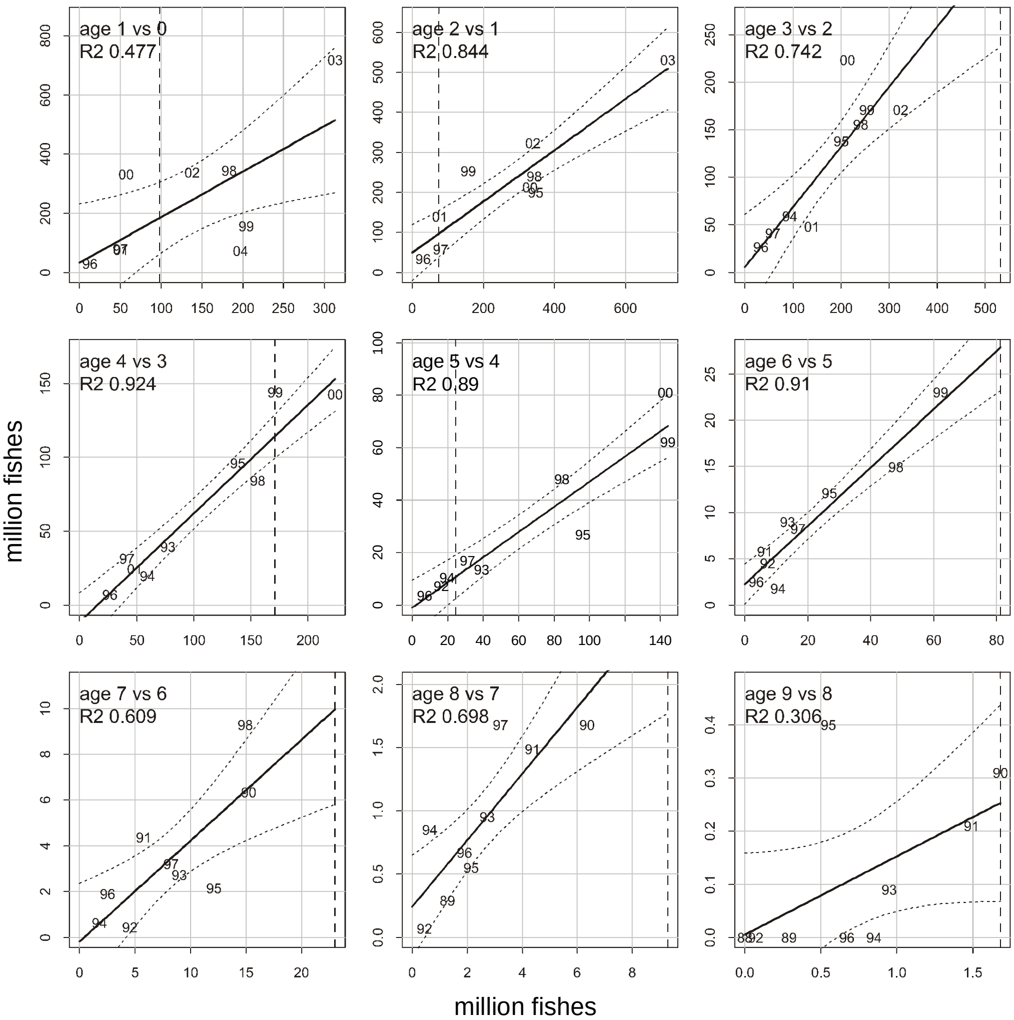


Figure 3.4.5.5 Haddock in division Va. Indices from October survey plotted against indices of the same year class one year earlier. The letters in the figure are year classes. The dashed vertical lines show the most recent values. .

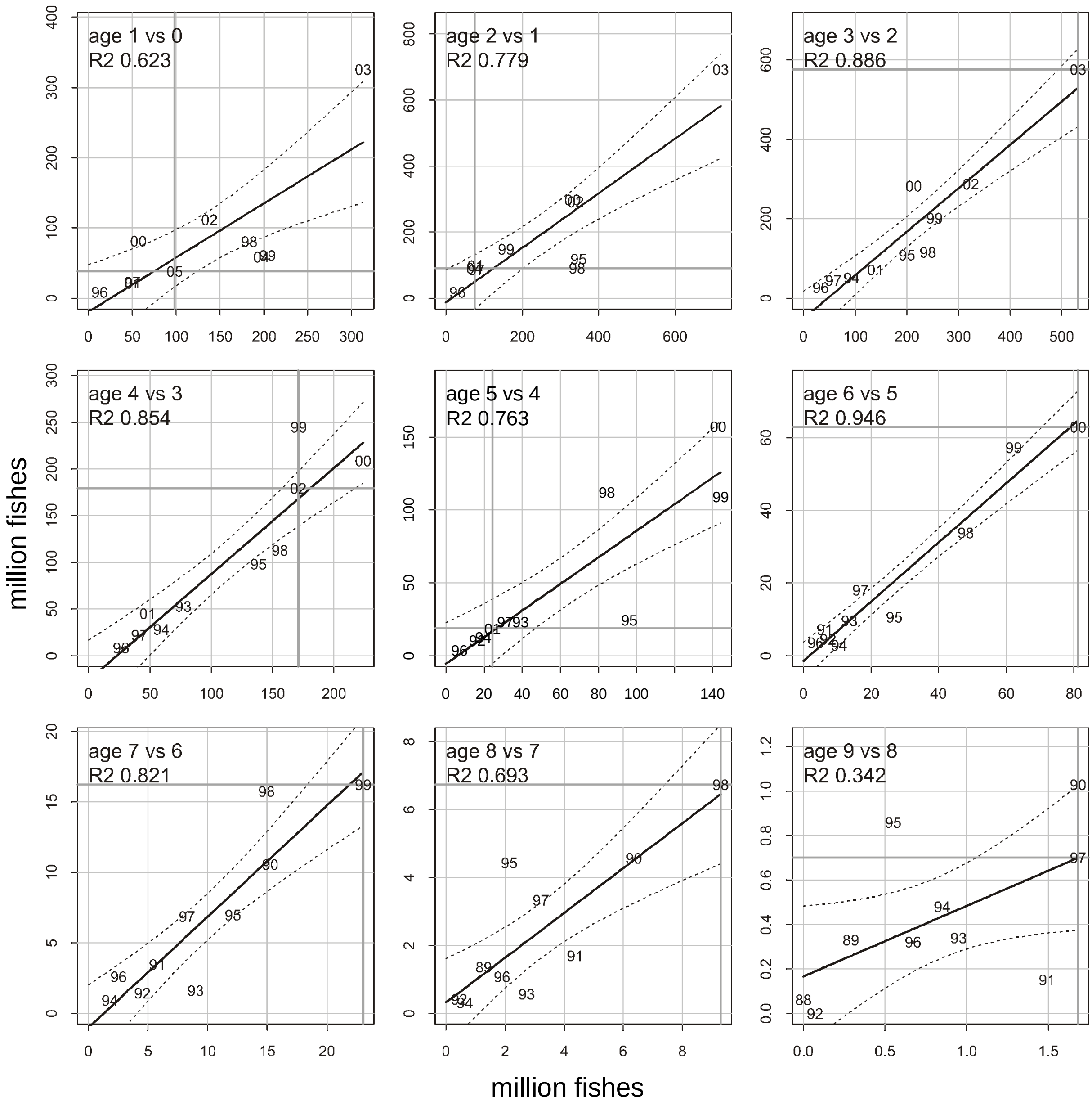


Figure 3.4.5.6 Haddock in division Va. Indices from the March survey plotted against indices of the same year class in the Autumn survey one year earlier. The letters in the figure are year classes. The dashed vertical lines show the most recent values. .

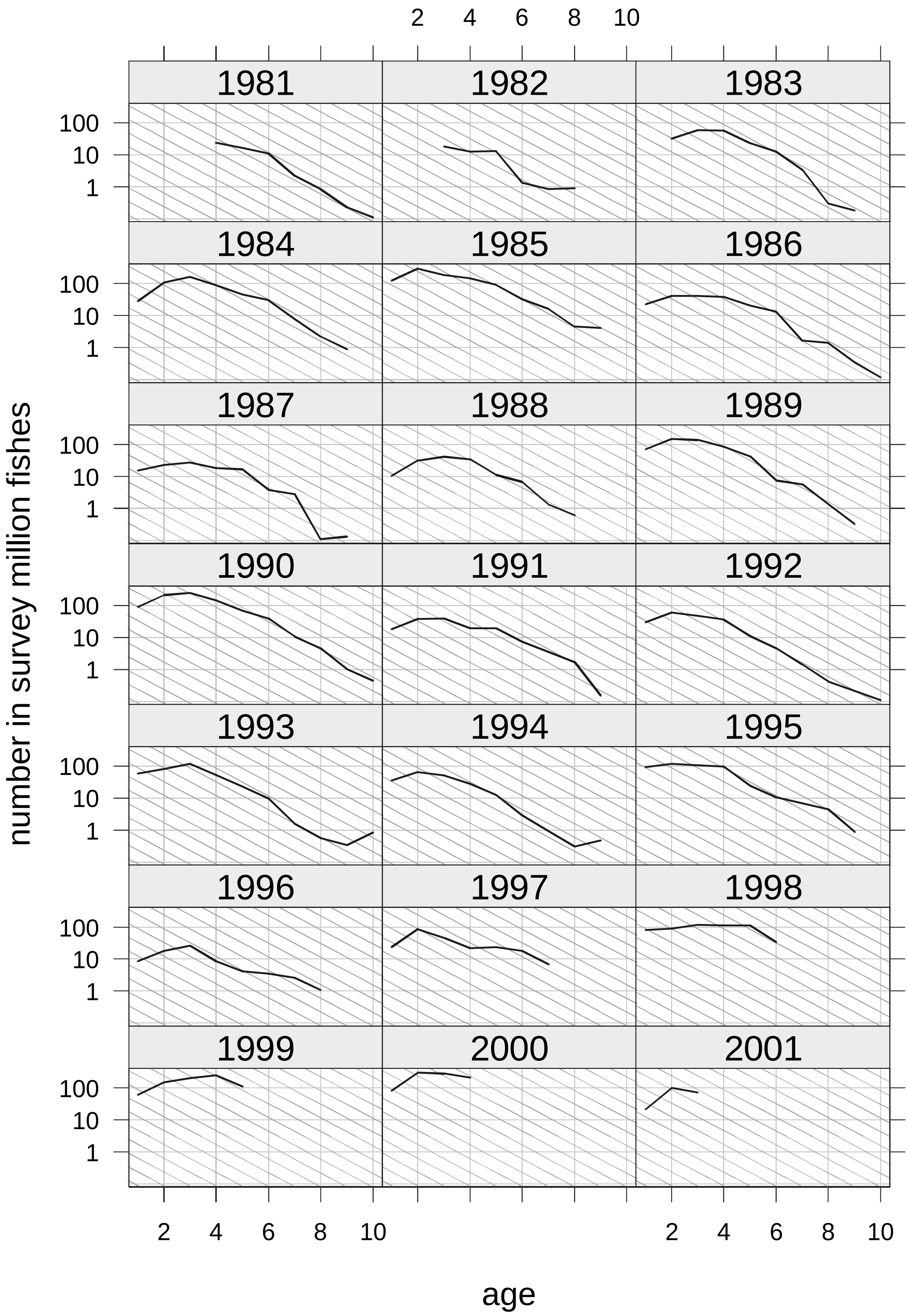


Figure 3.4.5.7. Catchcurves from the groundfish survey in March. Grey lines show Z=1.

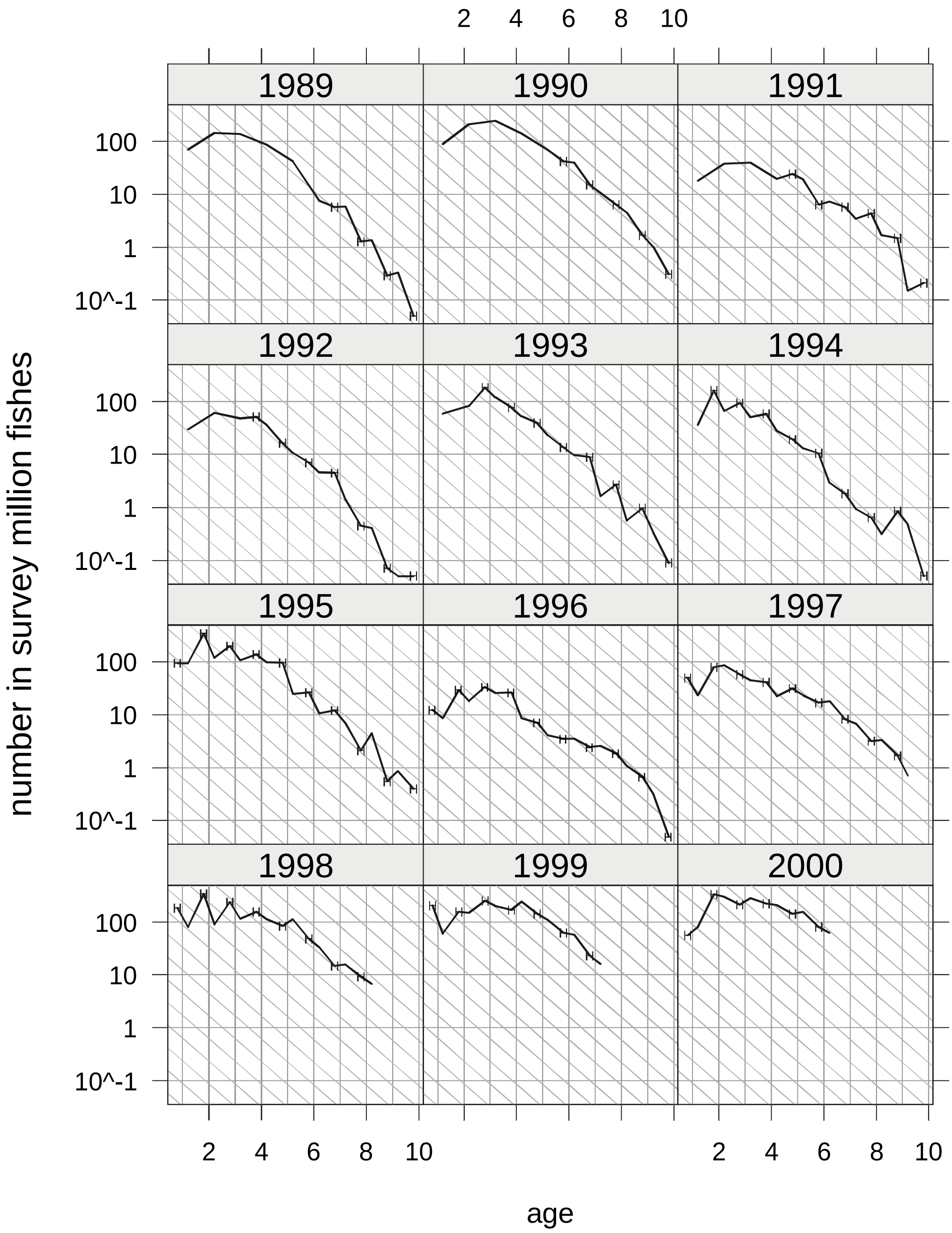


Figure 3.4.5.8. Catchcurves from the groundfish surveys in March and October. Grey lines show Z=1. Points from the autumn survey are labelled "H".

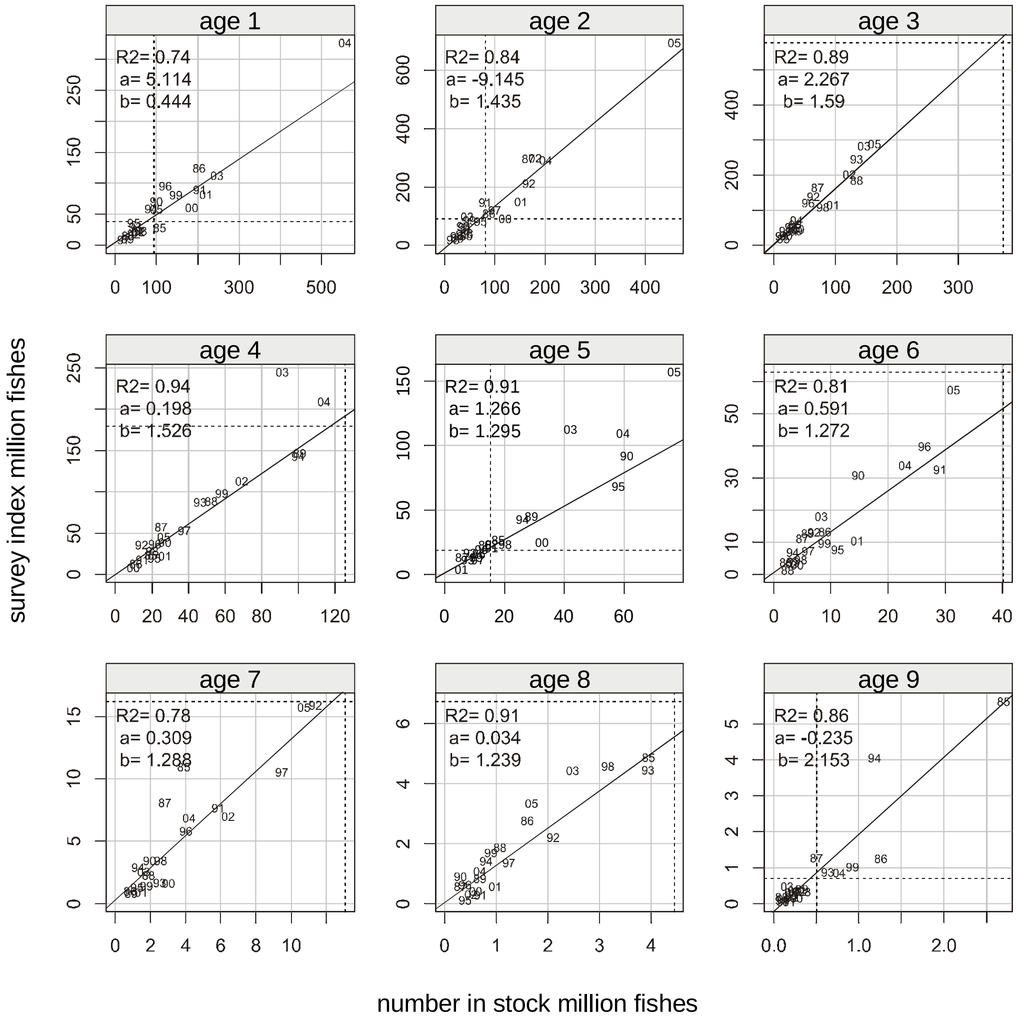


Figure 3.4.5.9 Icelandic haddock. Abundance indices from the March survey vs. number in stock according to the SPALY run from last year. Line fitted through origin on original scale. . The fitted line uses the data until 2002. Dashed lines show most recent estimates..

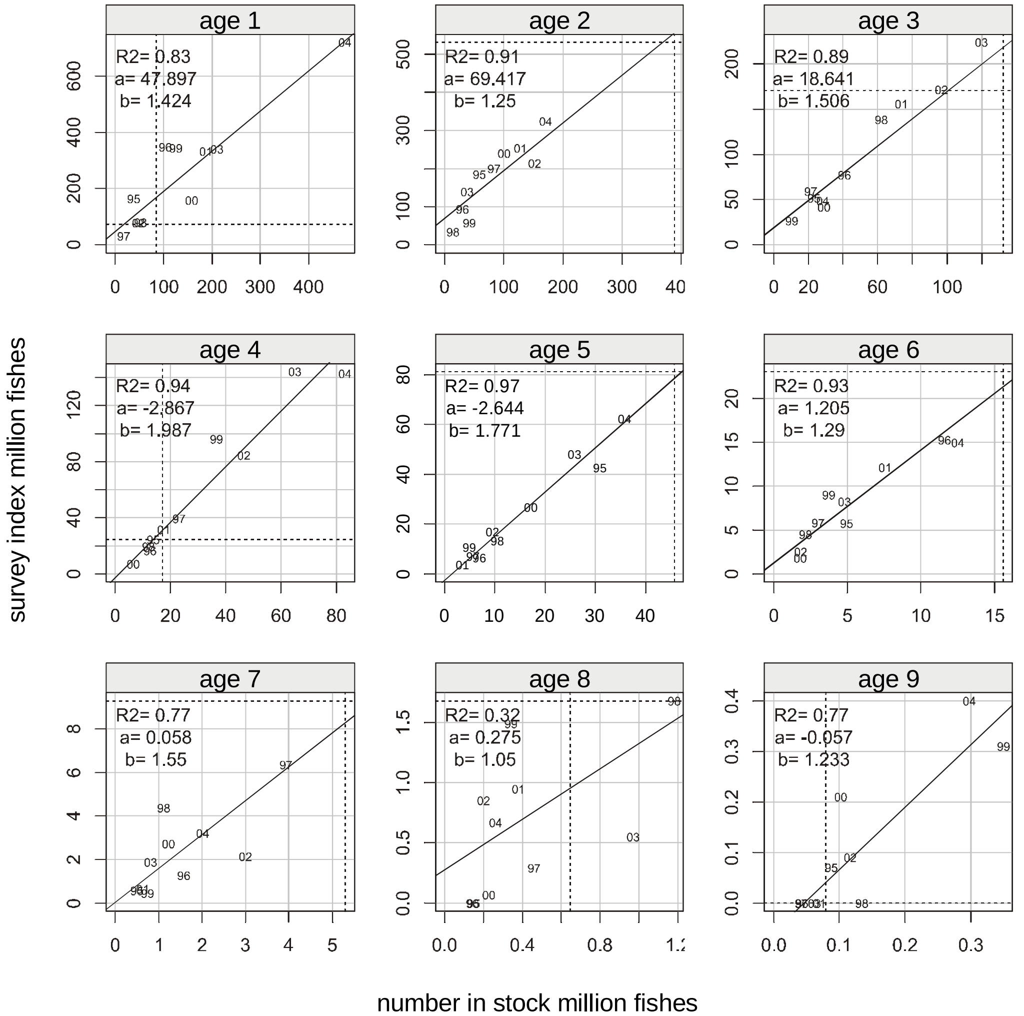


Figure 3.4.5.10 Icelandic haddock. Abundance indices from the October survey vs. number in stock according to the SPALY run from last year. Line fitted through origin on original scale. . The fitted line uses all the data as the assessment is not using the autumn survey.

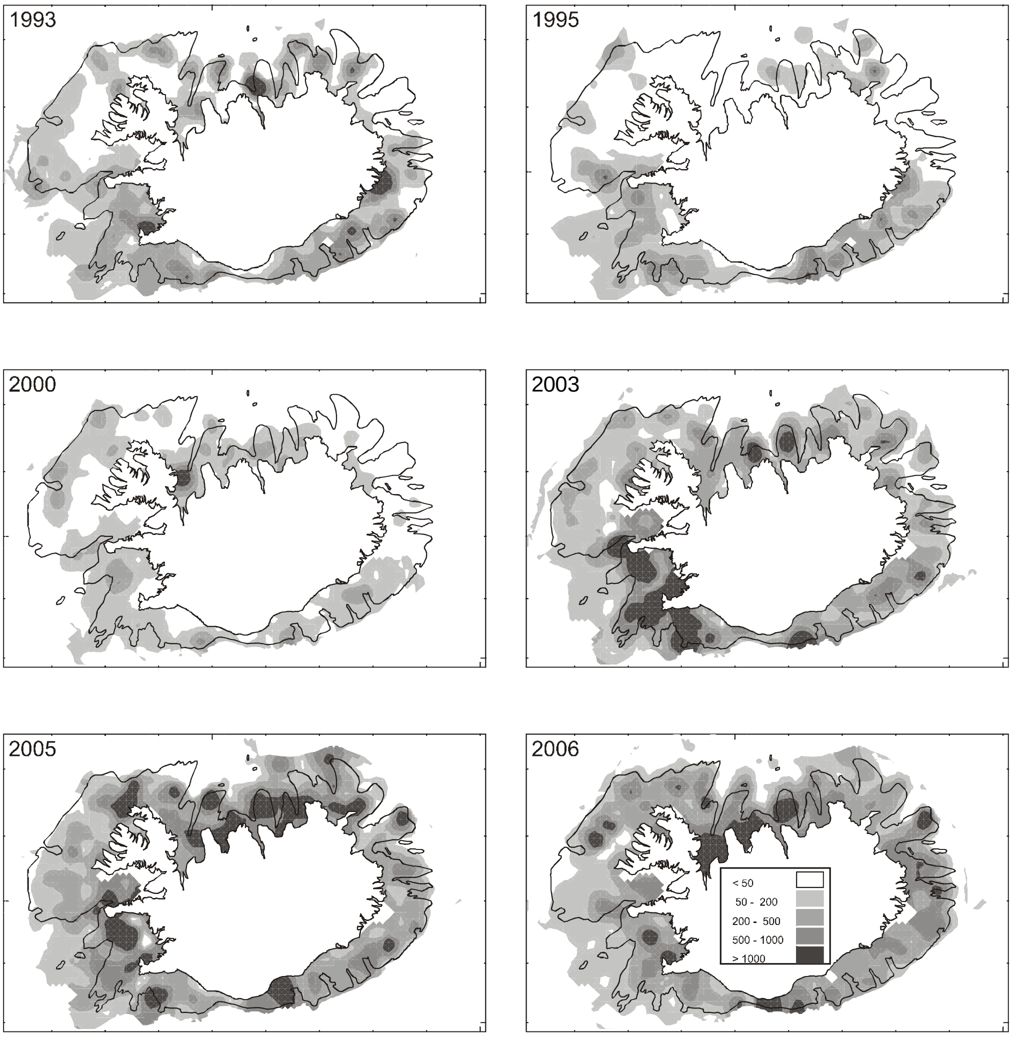


Figure 3.4.5.11. Spatial distribution of haddock in the groundfish survey in March. The legend show kg per hour towed.

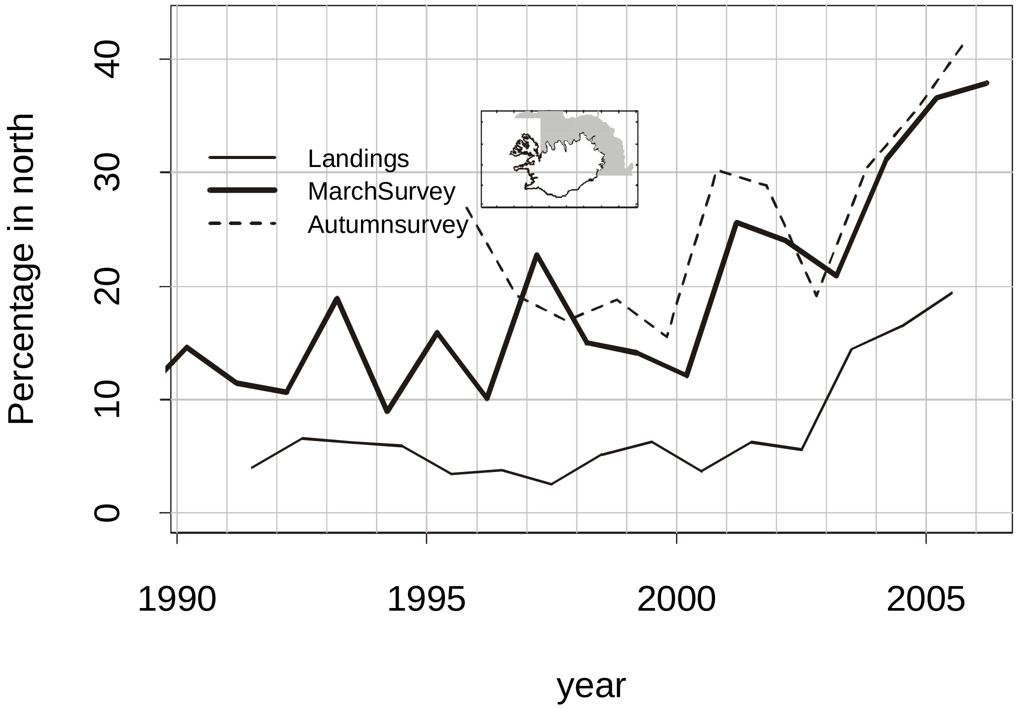


Figure 3.4.5.12. Proportion of the landings and the biomass of 42cm and older haddock that is in the north area. The small figure shows the northern area.

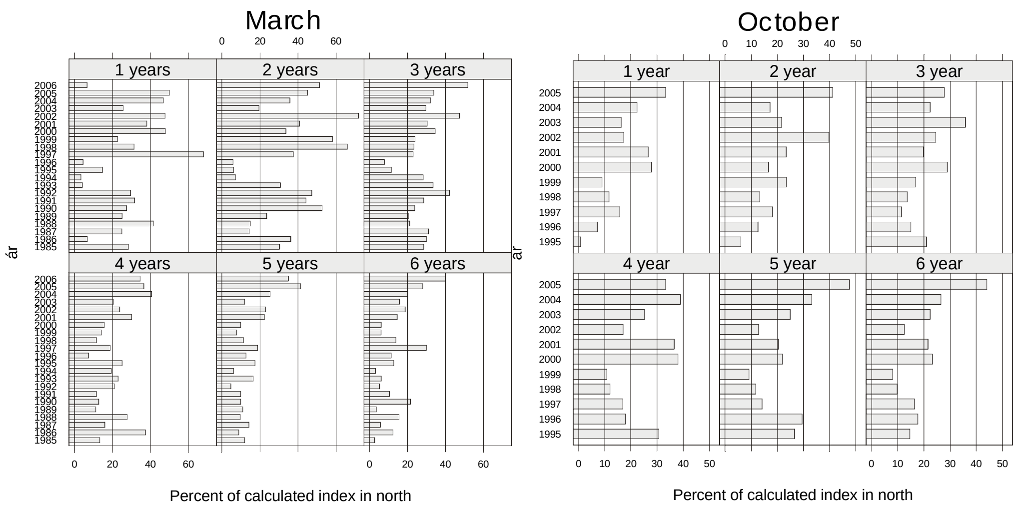


Figure 3.4.5.13. Proportion of each age group in the northern area in March and October. .

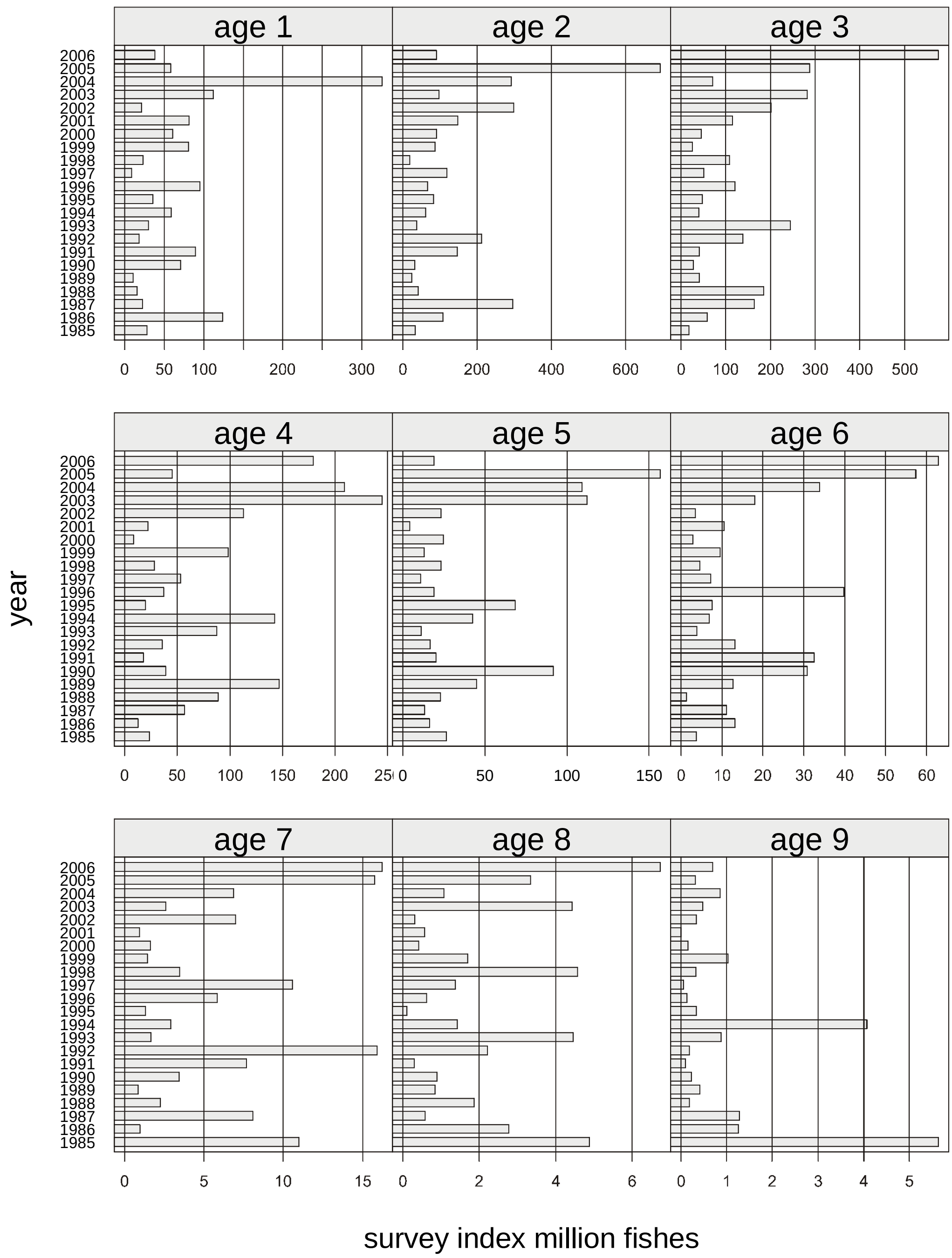


Figure 3.4.5.14. Haddock in division Va. Age disaggregated survey from the groundfish survey in March.

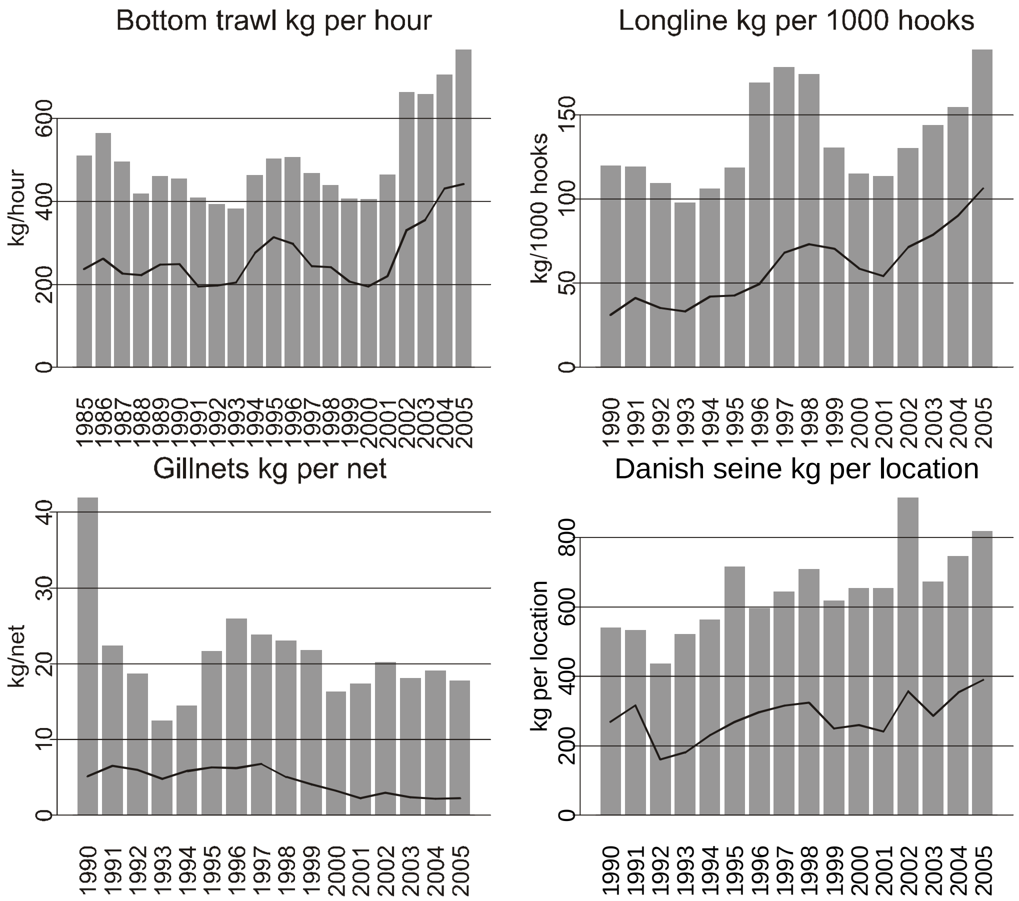


Figure 3.4.5.15. Catch per unit effort in the most important gear types. The bars are based on locations where more than 50% of the catch is haddock and the lines on all records where haddock is caught. A change occurred in the longline fleet starting September 1999. Earlier only vessels larger than 10 BRT were required to return logbooks but later all vessels were required to return logbooks.

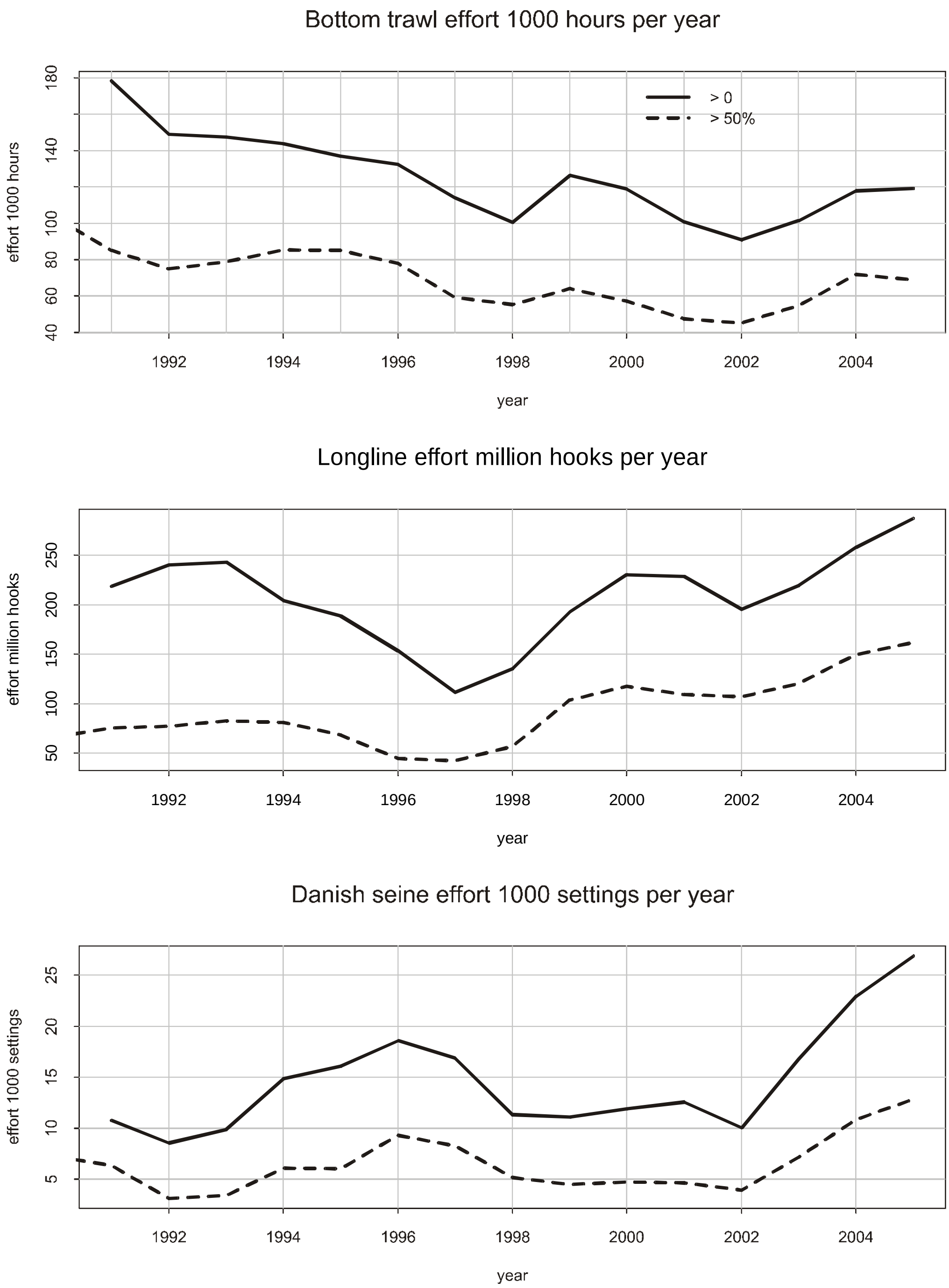


Figure 3.4.5.16. Effort towards haddock. The effort is calculated as the ratio of the total landings for the gear and the CPUE based on records where haddock was more than 50% of the registered catch.

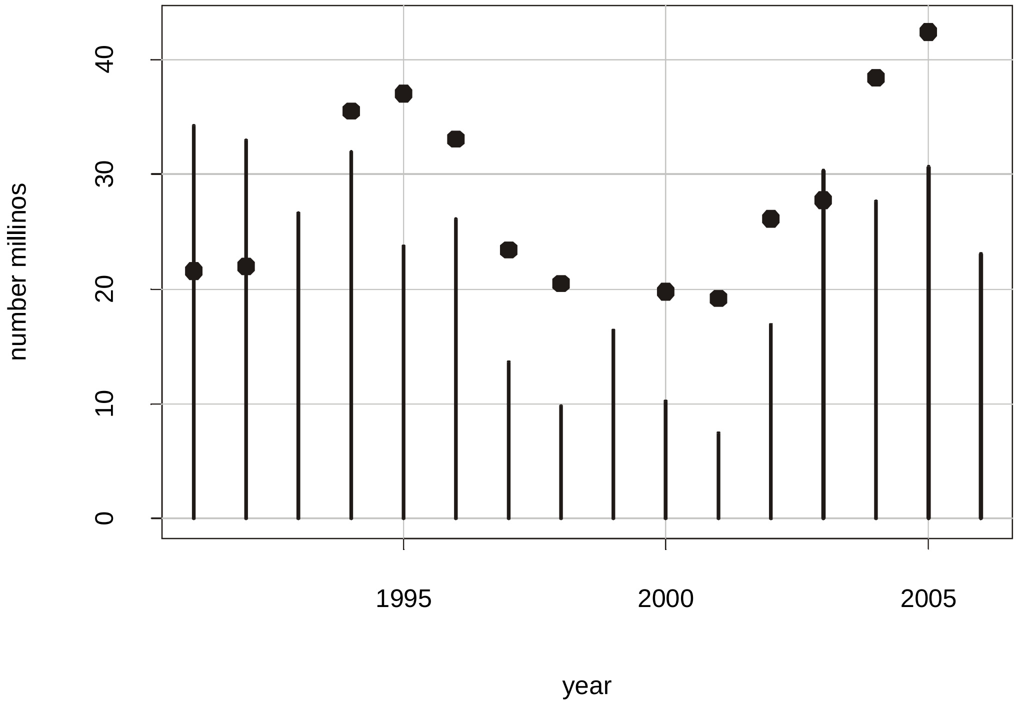


Figure 3.4.5.17. Number of haddock caught. The number is calculated by multiplying the mean number of 42cm and larger haddock per hour in the groundfish survey in March in each statistical square (1/2x1degree) by the trawling effort in that square. Catch in number for bottom trawl is shown for comparison (the dots).

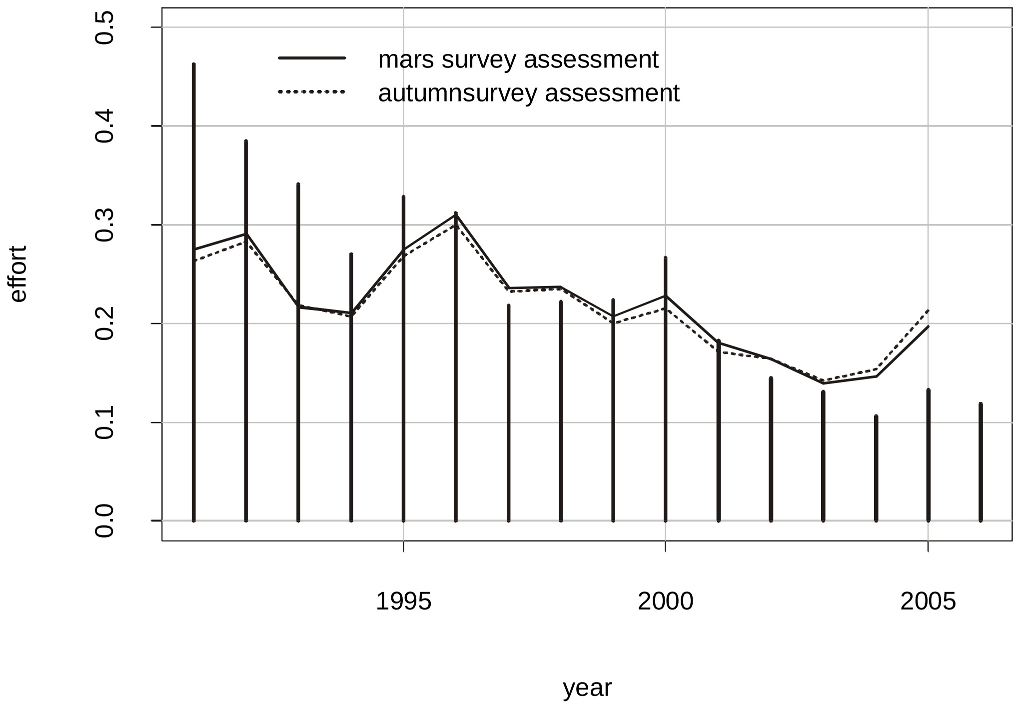


Figure 3.4.5.18. Index of proportion of haddock larger than 42cm caught by bottom trawl each in each year. The index is calculated by dividing the total number caught as shown in figure 3.4.15 by the abundance index from the survey. Proportion of age 4 and older caught according to assessment is shown for comparison

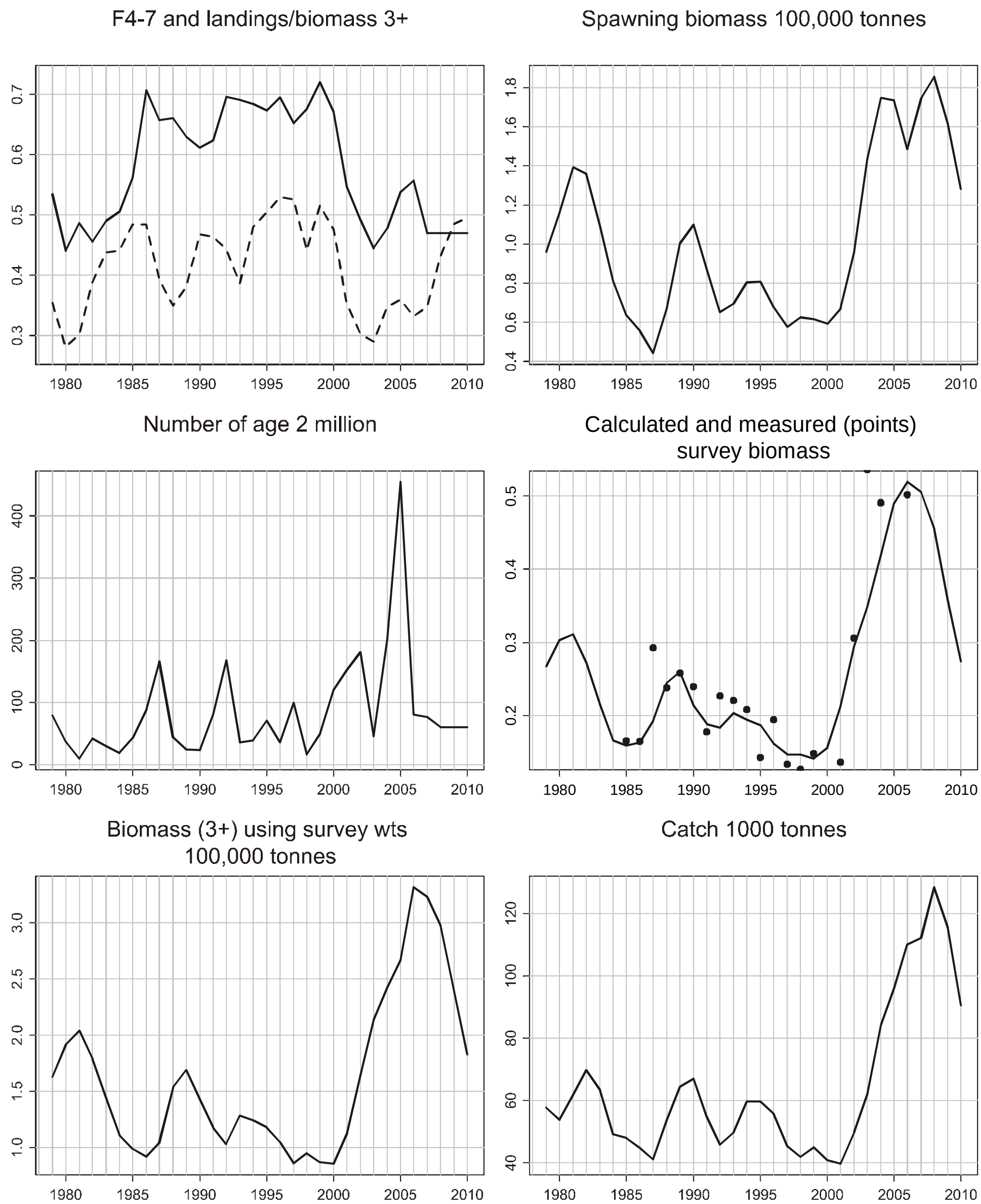


Figure 3.4.6.1. Haddock in division Va. Summary plots from the SPALY run using the March survey

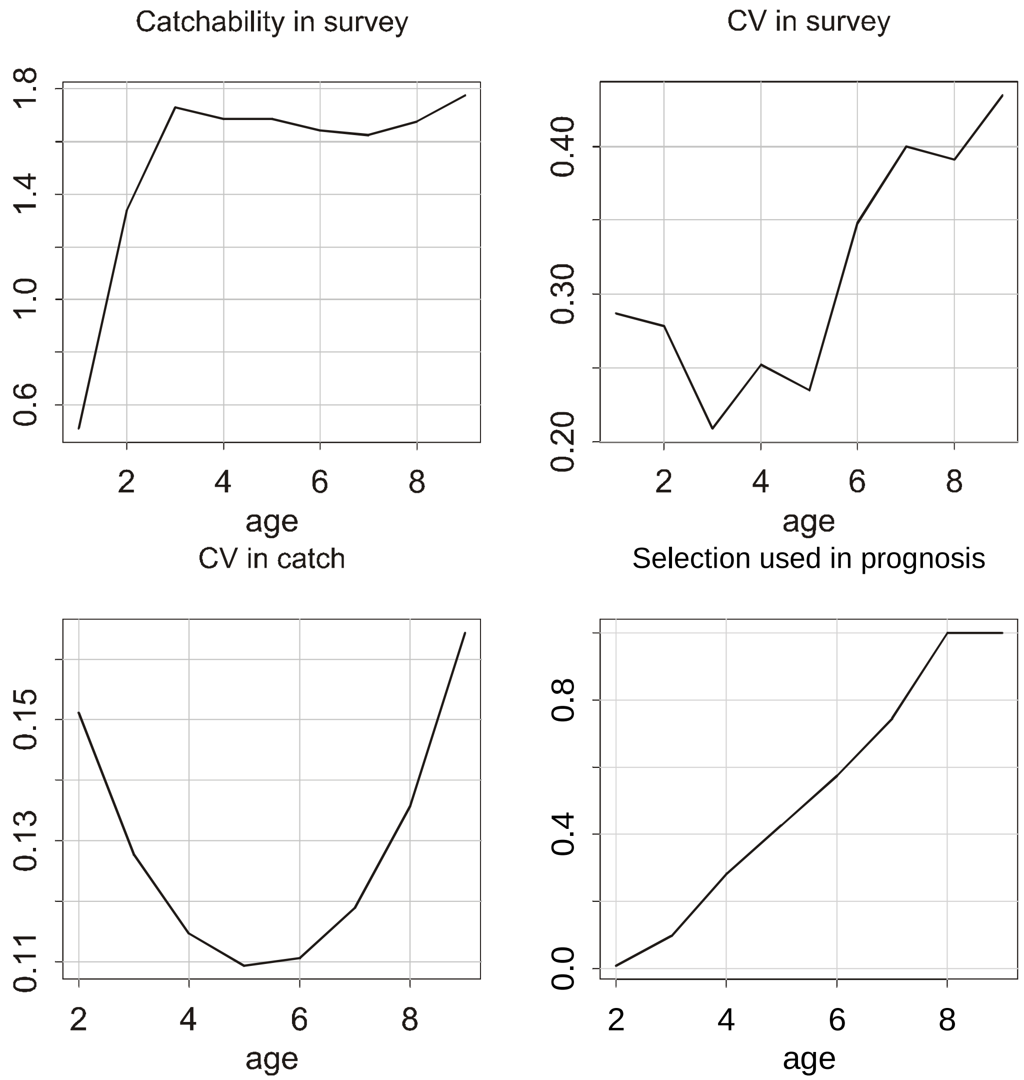


Figure 3.4.6.2. Haddock in division Va. SPALY model based on the March survey. Model estimate of selection pattern and variance in survey and in the catch. Selection used in prognosis is the mean of last 5 years.

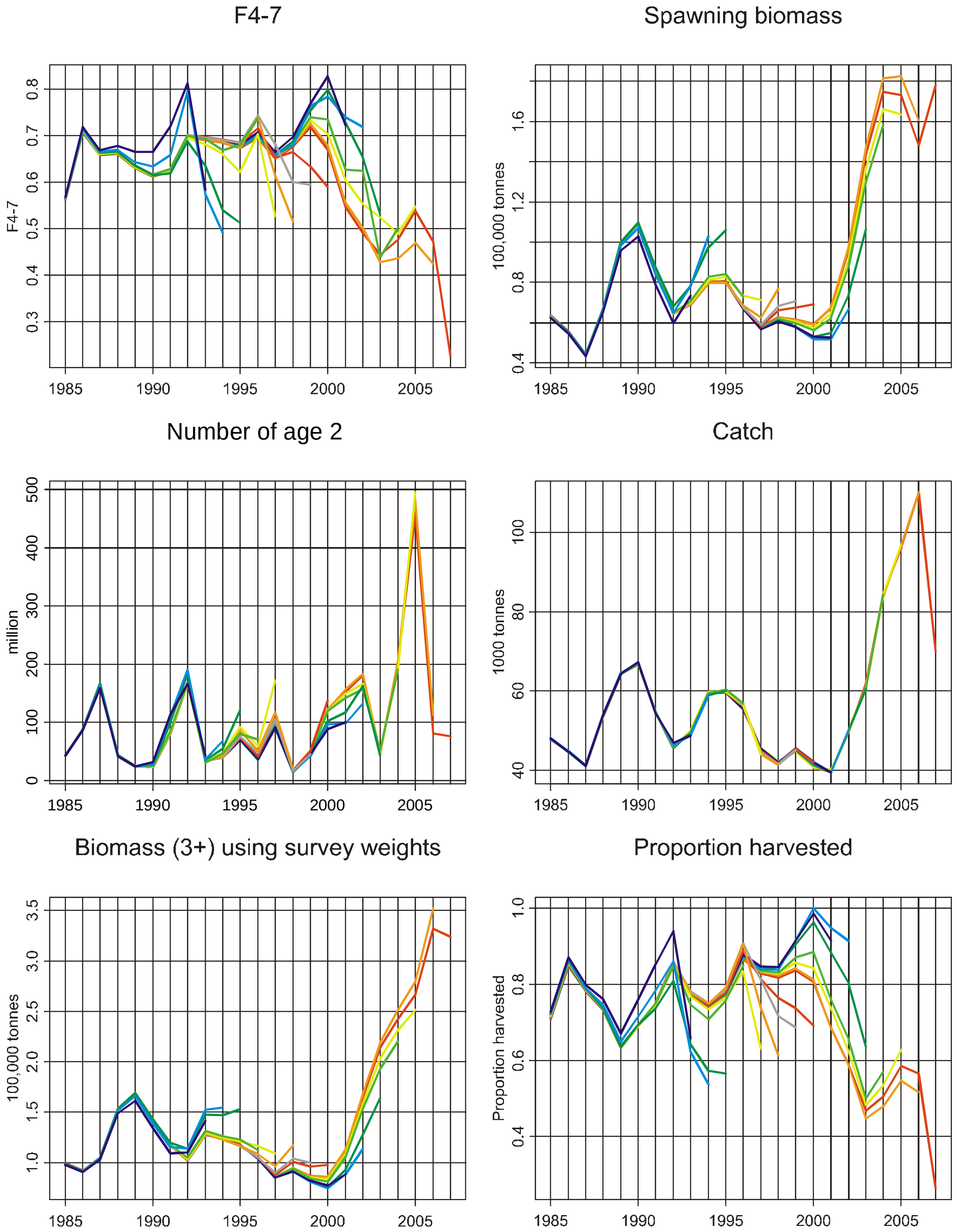


Figure 3.4.6.3 Haddock in division Va. Retrospective pattern from the ADCAM run using indices from age 1 to 9.

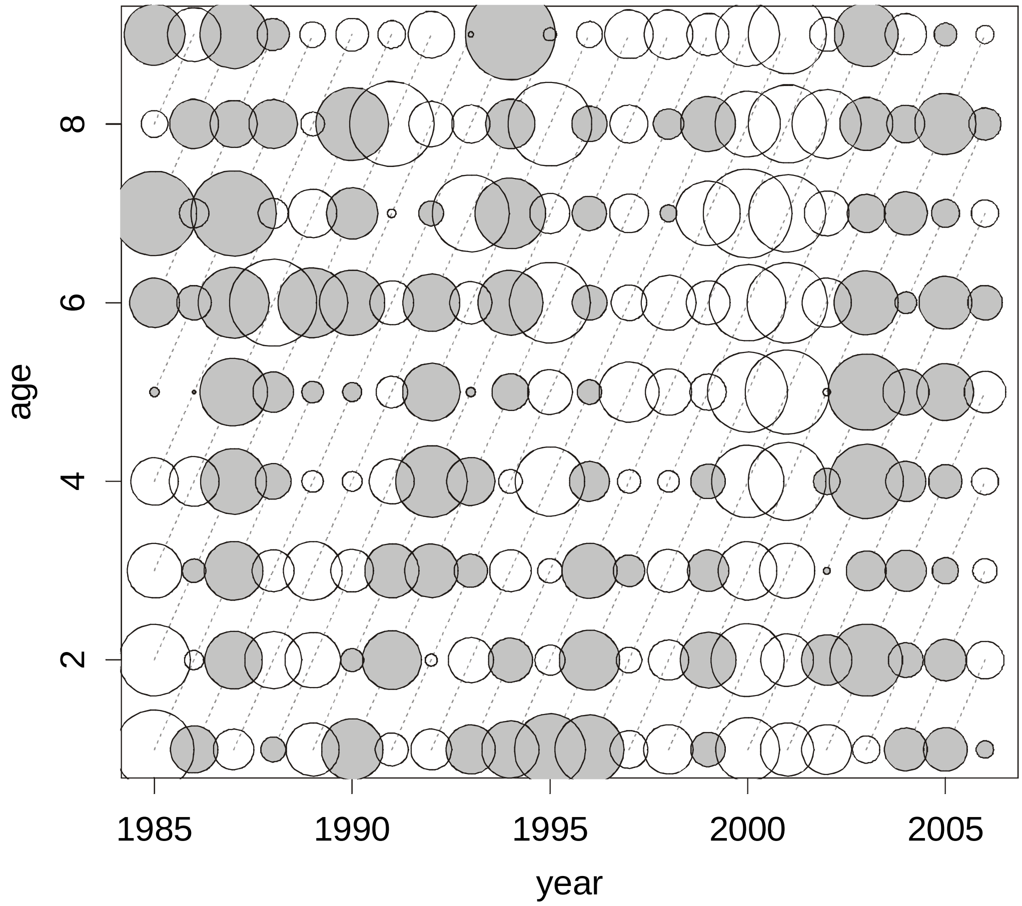


Figure 3.4.6.4 Residuals from the fit to survey data . $\frac{\log(I_{ay} + \varepsilon_{age})}{\log(I_{ay} + \varepsilon_{age})}$ **Coloured circles indicate positive residuals (observed > modelled). The largest circle corresponds to a value of 0.78 and residuals are proportional to the area of the circles**

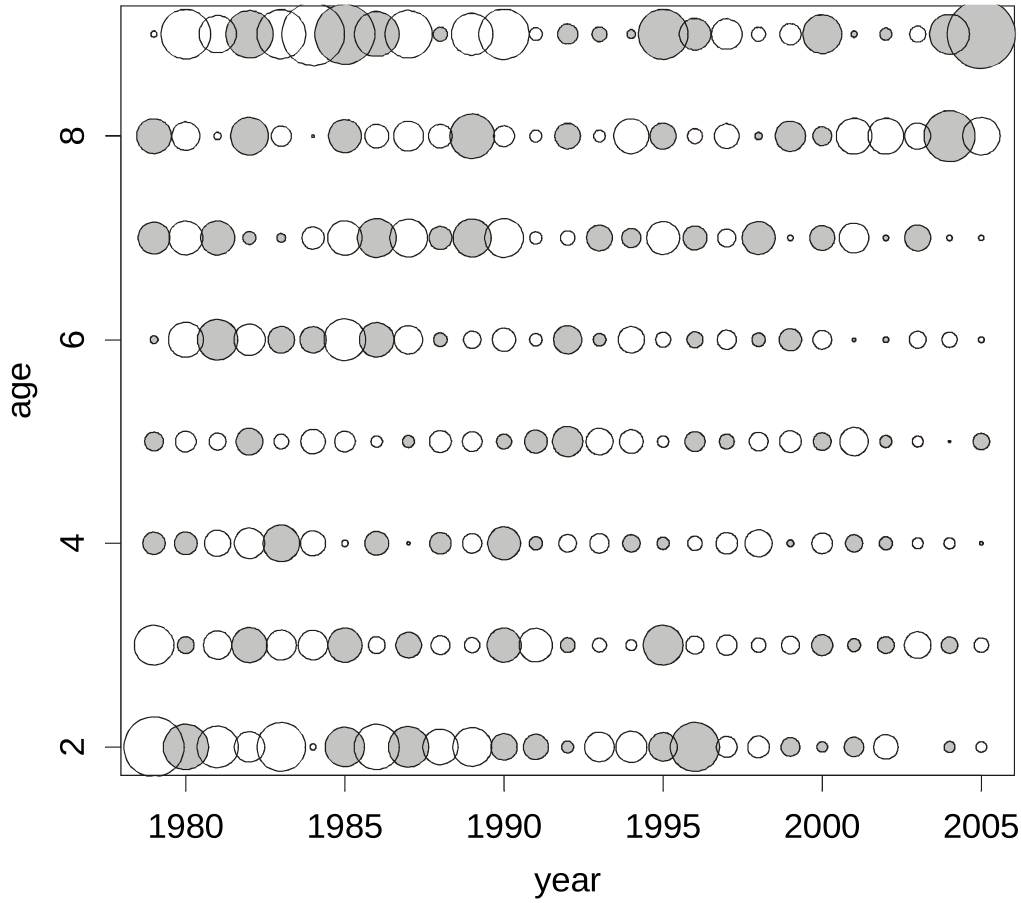


Figure 3.4.6.5 Haddock in division Va. Residuals from the model fit to catch at age data using the selected AD-cam model. .

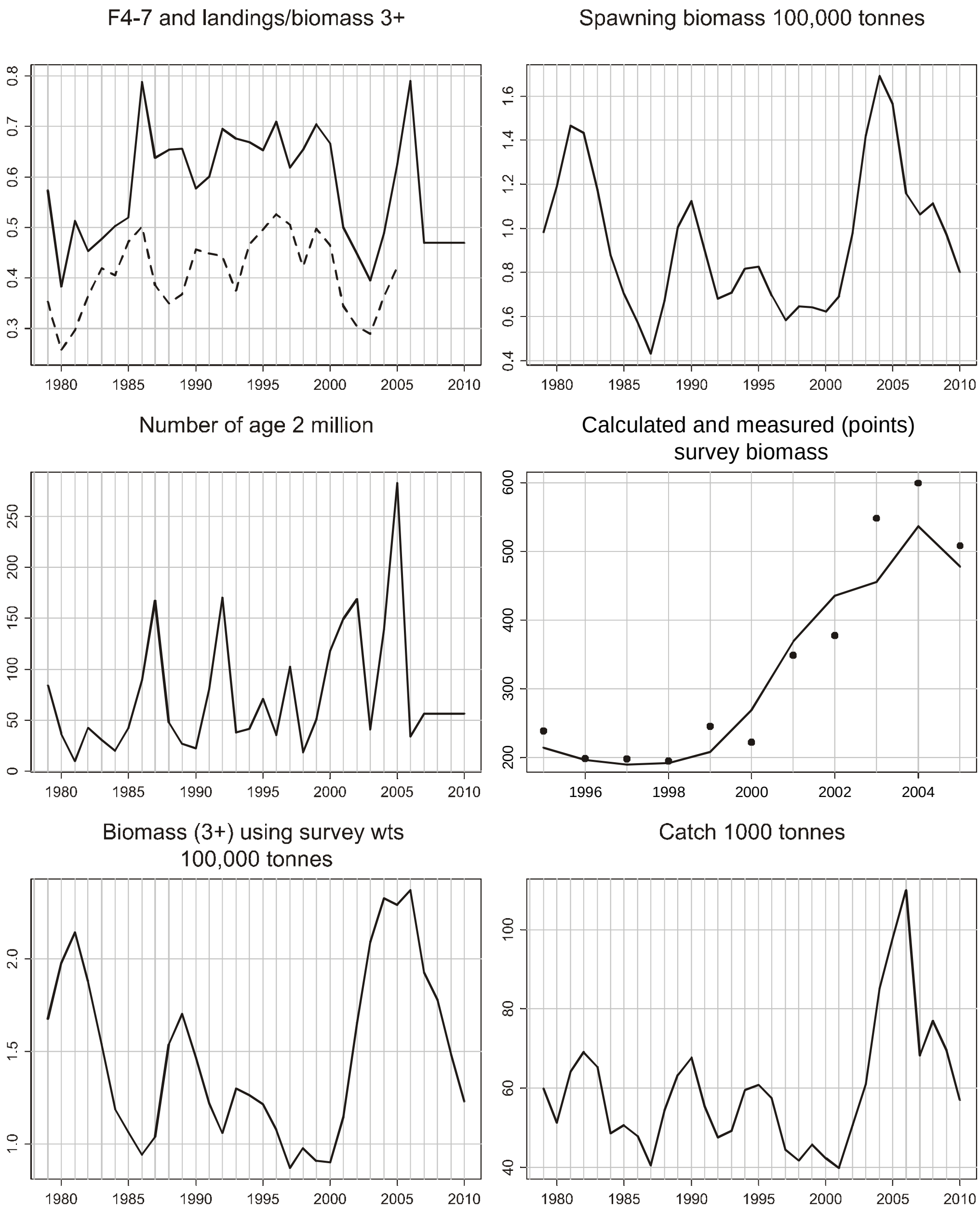


Figure 3.4.6.6. Haddock in division Va. Summary plots from an Adapt run using the Autumn survey

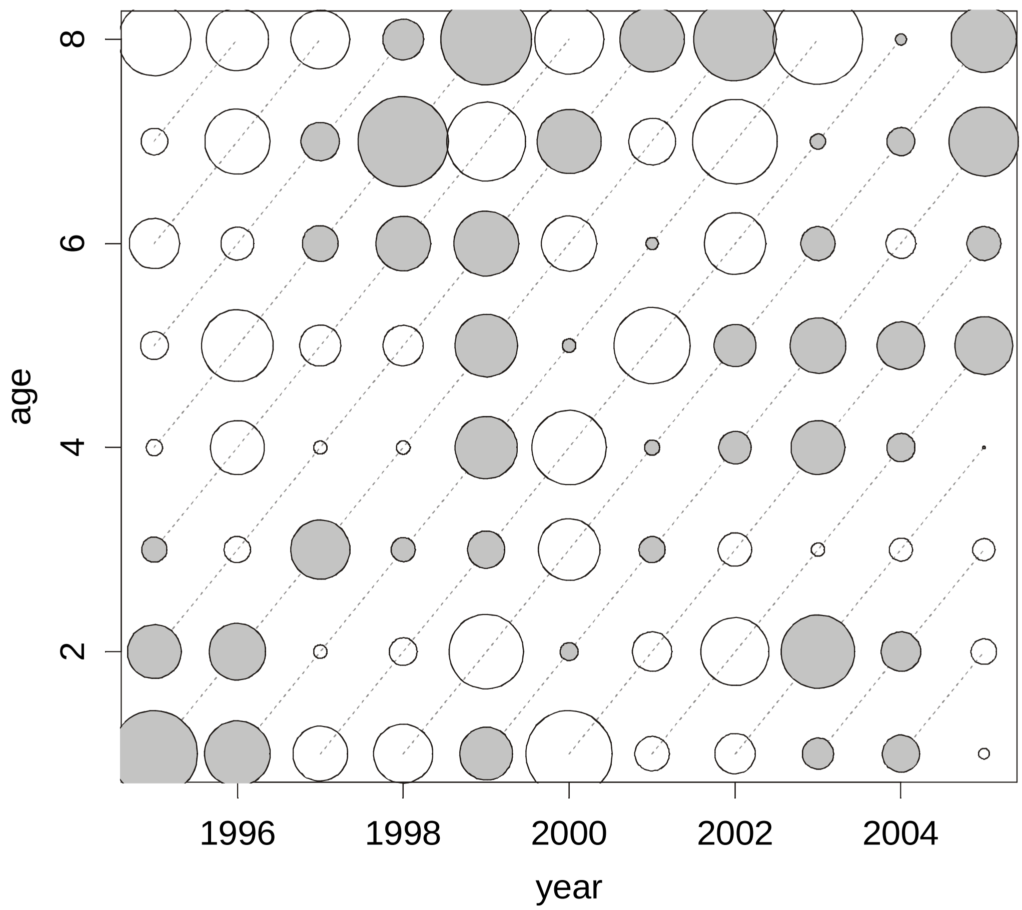


Figure 3.4.6.7 Residuals from the fit to survey data . $\frac{\log(I_{ay} + \epsilon_{age})}{\log(I_{ay} + \epsilon_{age})}$ from ADCAM run based on the autumn survey. Coloured circles indicate positive residuals (observed > modelled). The largest circle corresponds to a value of 0.78 and residuals are proportional to the area of the circles

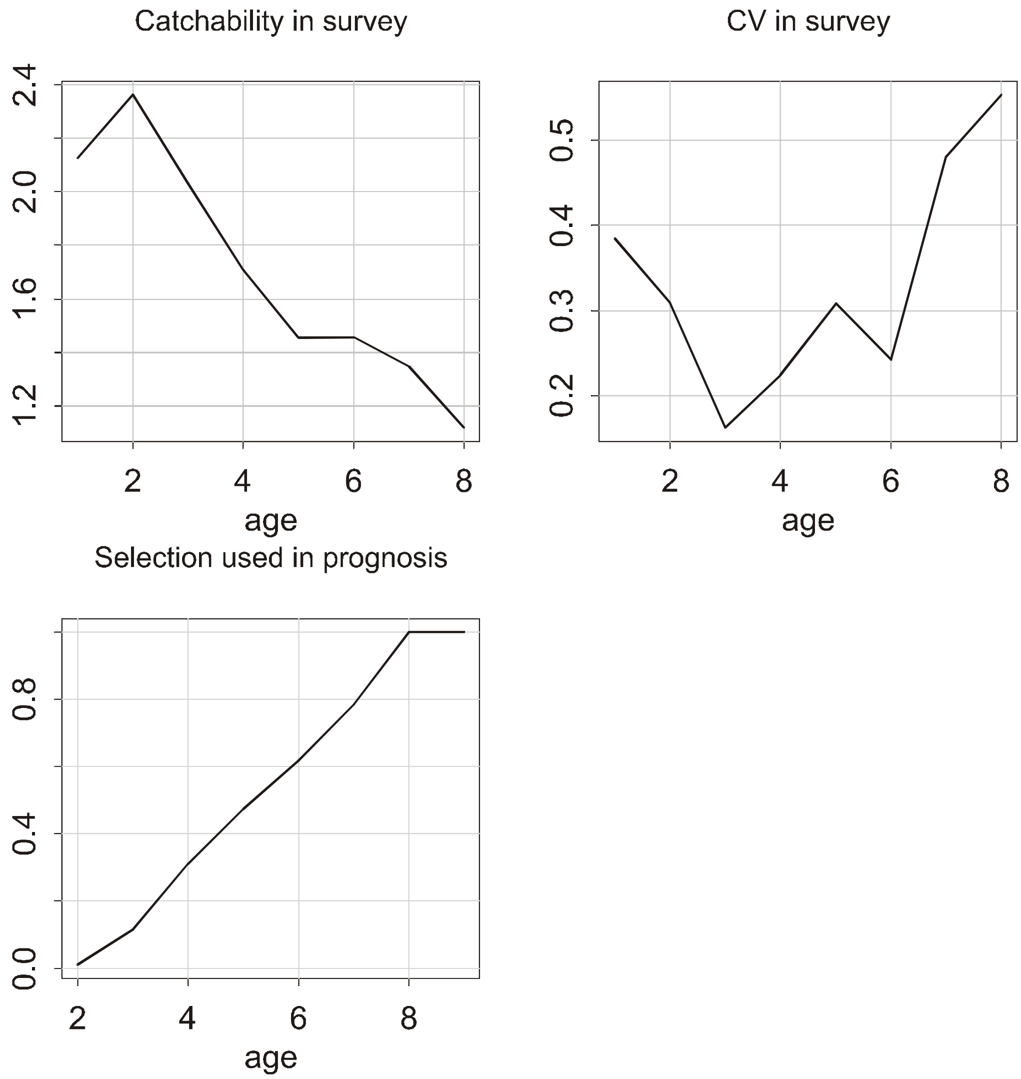


Figure 3.4.6.8. Haddock in division Va. ADCAM model based on the autumn survey. Model estimate of selection pattern and variance in survey and in the catch. Selection used in prognosis is the mean of last 5 years.

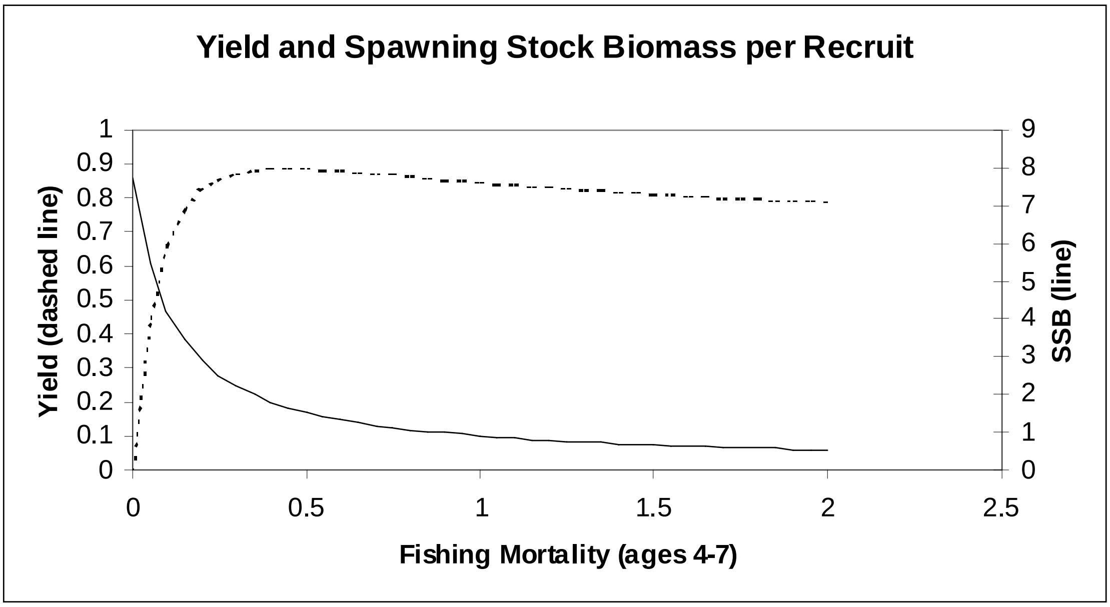


Figure 3.4.7.1 Haddock in division Va. Yield per recruit.

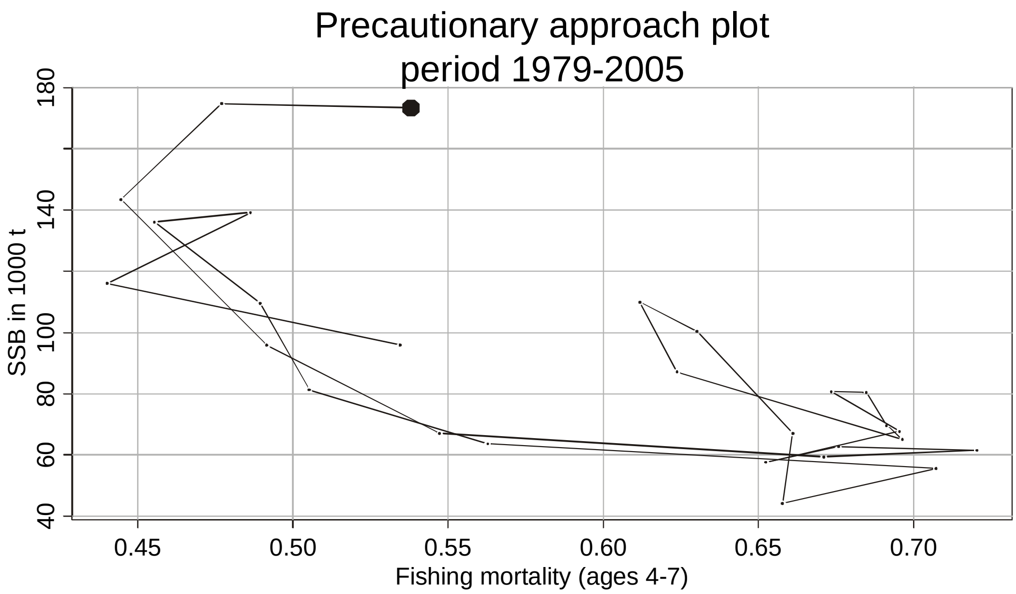


Figure 3.4.7.2 Haddock in division Va. Spawning stock vs. fishing mortality.

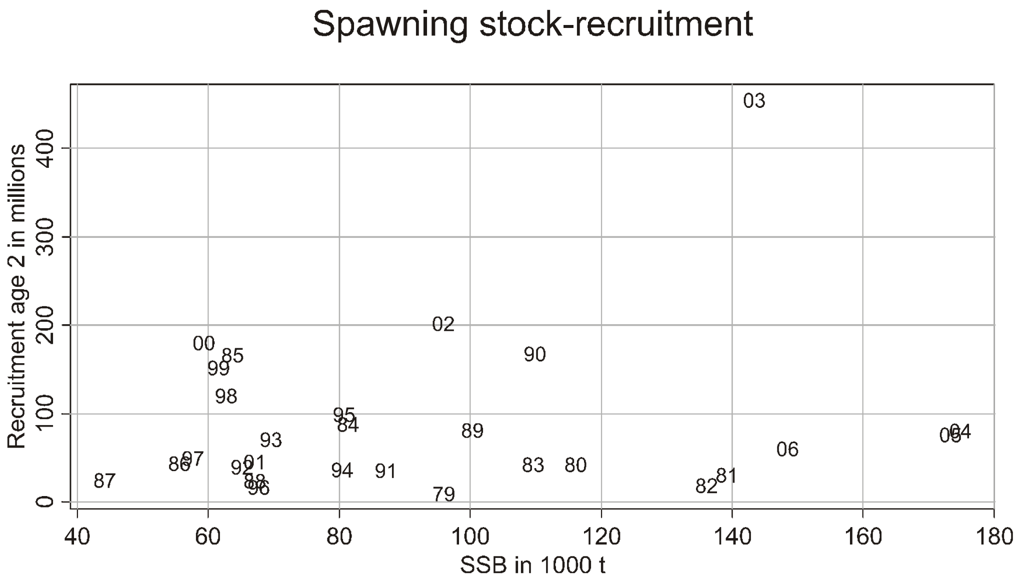


Figure 3.4.7.3 Haddock in division Va. Spawning stock vs. recruitment. . The labels in the figure show year classes.

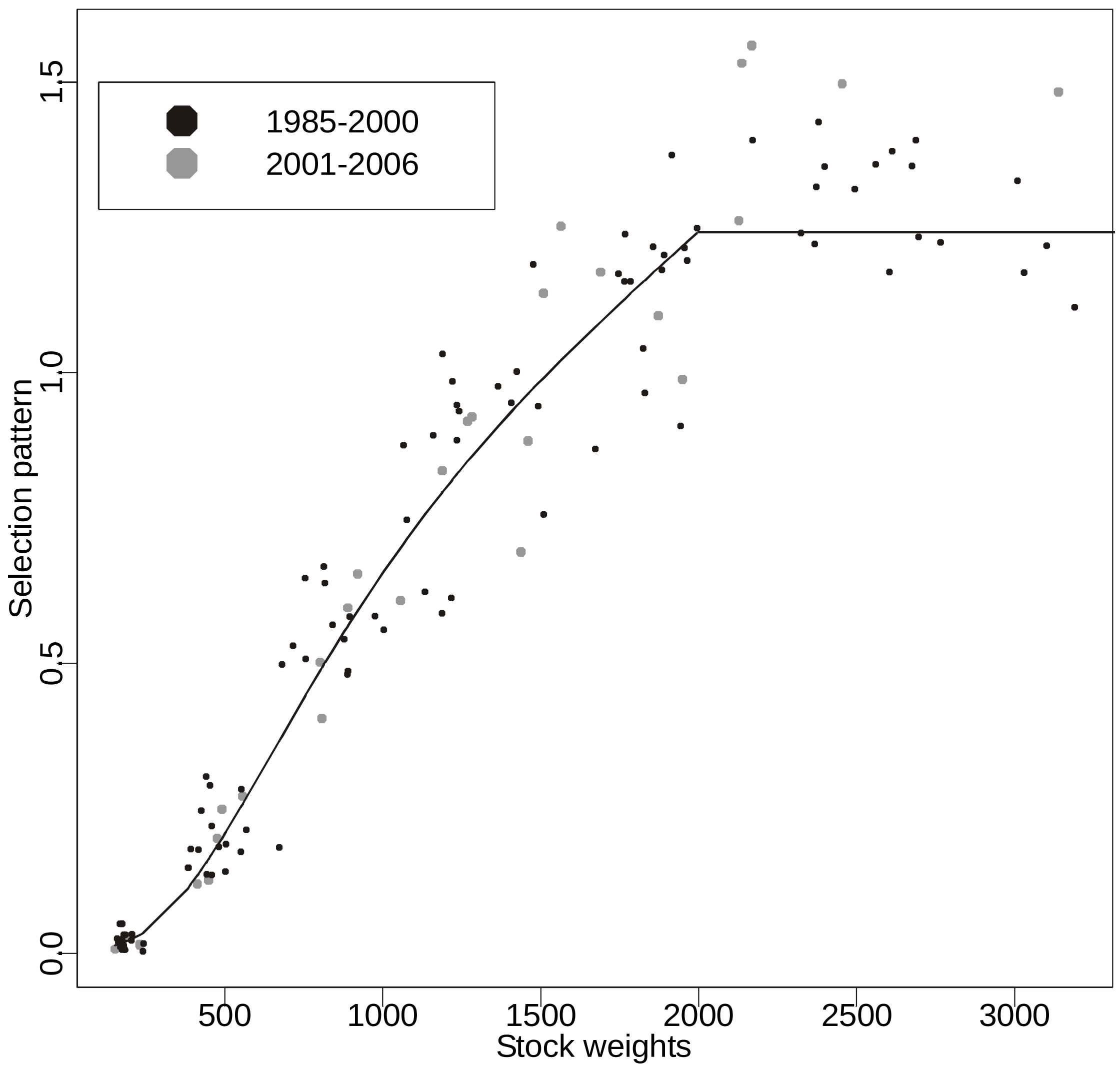


Figure 3.4.7.4 Haddock in division Va. Relationship between selection pattern and mean weight at age in the stock with fitted relationship shown.

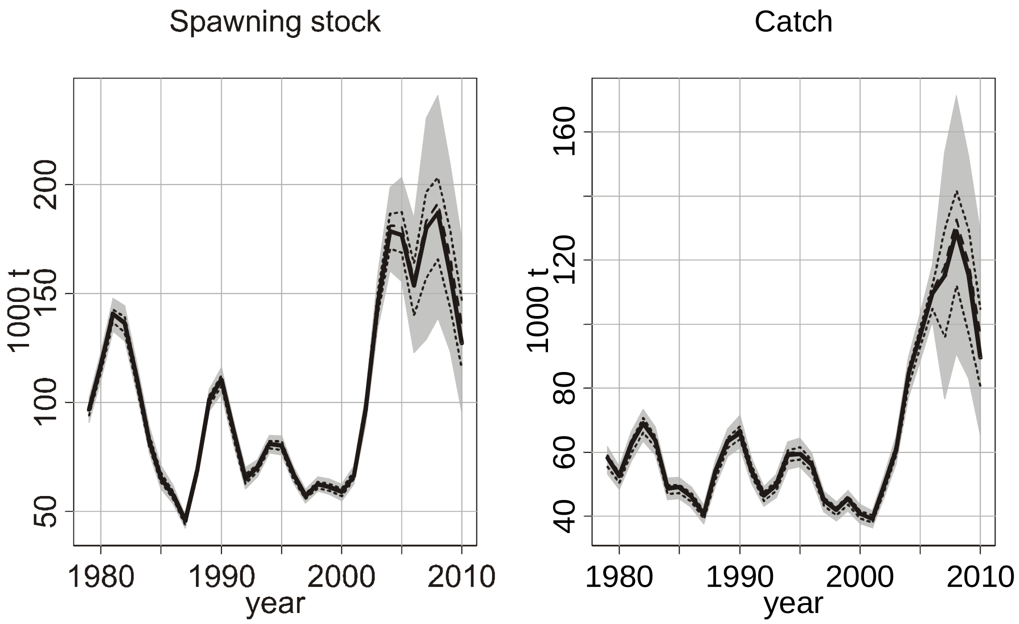


Figure 3.4.7.5 Haddock in division Va. Cumulative probability profiles of landings, and SSB according to the SPALY run based on the March survey. F=0.47 and 15%CV in assessment after

3.5 Icelandic summer spawning herring

Summary

Input data

- The total reported landings in 2005 were 103 thous. tons while the TAC was 110 thous. tons.
- Since the last year assessment (2005), the catch at age has been recalculated for the fishing seasons 2000/01 to 2004/05 and those results are used in present assessment, as well as unchanged catch data for earlier seasons and the most recent fishery data (2005/06).
- A fixed maturity ogive was applied to all years where proportion mature at age 3 was set 20%, 85% for fish at age 4, while all older fish is considered mature.
- The total estimate of the adult stock in the herring acoustic surveys was 668 thous. tons, which is the highest measurements in the 29 years old history of the survey.

Assessment

- Several assessment models were applied as in recent years, all giving similar results. The results from the NFT-Adapt model was adopted as a point estimate for forward projections.

Predictions

- Fishing at $\mathbf{F}_{0.1}$= 0.22 in the fishing season 2006/07 will give at catch of 134 thous. tones.

Comments

- There was a large uncertainty regarding the assessment of the stock last year. Using the recalculations improved the models running very much. 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 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.

3.5.1 Fishery

The landings of Icelandic summer-spawning herring by fishing season from 1983 - 2005 are given in Table 3.5.1.1 and in Figure 3.5.1.1. The total landings in 2005/2006 season were about 103 thousands tonnes with no discards reported. The fishery took place in September through January both east and west off Iceland, as has been since the fishing season 1997/98. Overview of geographical distribution of the catches is given in Figure 3.5.1.2.

Like in the fishing season 2004/05 a small part of the Norwegian spring spawning herring stock was mixed with the Icelandic summer spawning herring stock east of Iceland in the 2005/06 season. Based on port inspections, it was estimated to be about 2691 t of NSSH mixed with the summer spawning herring during October through December. 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.

3.5.2 Fleets and fishing grounds

Until 1990, the herring fishery took place during the last three months of the calendar year. During 1990-2005 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 60% of the catch in 2005/06 was taken with purse-seines and about 40% with pelagic trawls, which is similar to the mean fishing pattern 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 2005/06, around 35% of the catch was taken west off Iceland.

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 while only one closure was inforced 2005/06.

3.5.3 Catch in numbers, weight at age and maturity

Data from samples taken from purse seine and pelagic trawl were used to calculate catch in numbers at age for total landings in the fishing season 2005/06 (Table 3.5.3.1). The calculations were accomplished by divide the total catch into 10 cells confined by area (five areas) and months (in the area off the east fjords). As in previous assessments, two different weight at length relationships were used, of the east coast and the west coast, which were based on length and weight measurements. The catches of the Icelandic summer spawners in numbers at age for the period 1981- 2004 are given in Table 3.5.3.2. It must be noted that the numbers at catch for the fishing seasons 2000/01 through 2004/05 have been recalculated since the last years assessment (2006). The reasons for the revisions are several and includes (i) inappropriate length at weight relationships (2003/04 and 2004/05), (ii) incorrect total catch (2004/05), (iii) re-aging of the fish (2000/01 to 2002/03), (iv) different official total catch (2002/03), (v) ignorance of different catchability of fishing gears applied (2000/01 to 2002/03), (vi) inclusion of the off-season summer fisheries (in the summers 2002 and 2003), and (vii) not having used all available catch samples in former estimation (fisheries inspectors samples were excluded in 2000/01 to 2002/03). Further work on re-ageing of herring from the catch samples during the fishing seasons 1992/93 to 1999/00 is ongoing at the Marine Research Institute.

The mean weight at age is derived from the same samples and are given in Tables 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 2005/06 was 5872 and 5545 of them were aged from their fish scales. The geographical location of the sampling is shown on Figure 3.5.3.1.

The strong year classes from 1999 and 2000 dominated in the total catch weight (40% and 26%, respectively) and total catch number (37% and 28%, respectively) in the fishing season 2005/06 just like in the season before (by weight, 35% and 30%; by number 34% and 30%).

The proportion mature at age has traditionally been estimated annually from the catch data alone for the stock. Those results are probably imprecise for several reasons, including that the commercial fishery is mainly targeting the mature component of the stock. In a NWWG Working document 2006 (No. 18), estimations of the maturation of the stock from research survey data were introduced. The proportion mature at age 3 ranged from 2 (1991) to 83%

(2005) and for age 4 it ranged from 67 (1991) to 99% (2001), with overall means at 21 and 86%. However, because of the large variation of the maturity values over the years, which was considered to be more related to imprecision of the estimations than variation in the stock, it was suggested that weighed mean values representing the whole period should be used in stock assessment. Thus, unless more reliable survey indices are achieved (through the survey design), proportion mature at age 3 should be set 20% and 85% for fish at age 4, while all older fish is considered mature.

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. Three acoustic surveys were conducted in the fishing season 2005/2006, in January off the east coast and off the west coast and then again in the beginning of March off the west coast. The fishery had ceased when the surveys took place. On the main fishing grounds off the east coast (constituted to 65% of the total catch in 2005/06) the survey recorded about 75 thous. t of adult herring (≥27 cm). A total of 679 thous. t were estimated on the grounds off the west coast of which 593 thous. t were adult herring. The total estimate of the adult stock was therefore 668 thous. t. Figure 3.5.4.1 shows the total estimated biomass of 4 year and older herring in the acoustic survey since 1987.

The 1999 and 2000 year classes were most numerous in the survey or 39% and 26%, respectively, of the total number of herring at age 4 and older. The number of fish at age 2 indicate that the 2003 year class is moderate in size. However, the 2002 year class could be above average in size, even if this year survey show it not as strong as did the survey in 2004 at age 2 where it had the highest index in the whole series (Table 3.5.4.1).

The stock composition in terms of age in the acoustic estimation in 2005/06 is based on total 22 samples where 8 samples were taken in the eastern area and 14 in the western (Table 3.5.4.2). The total number of aged scales from these samples was 1894.

The vessels used in the acoustic surveys this year, as well as previous years, were equated with EK500/BI500 which 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.

3.5.5 Assessment

In last year (2005) there was a large uncertainty regarding the assessment of the stock and no assessment was considered reliable. Assessments have been consistently biased in overestimating the spawning stock for some years. Discrepancies in the catch and survey datasets were discovered last year and it was suggested that they could be part of the overestimation problem. Another option causing the overestimation is a possible higher mortality related to much more widespread spatial distribution of the stock since 1997, which means more accessibility for predators. Then higher mortality could be related to the fishery with the pelagic trawl, but since 1997 around 40-60% of the catch is taken by the pelagic trawl. Then still another worry is the reductive part of the stock that is acoustically measured east of Iceland.

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 1986-2005 (Figure 3.5.5.1.1). From them it can be seen that the total mortality sign is around 0.4 provided that effort has been the same the whole time. 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 one sees a drop in the curve at age 9 but the curve keeps on with the same slope as before. This fits to the fact 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.

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. A comparison between ages in the survey was made by fitting a line through the origin (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 these speculations is that both the catch- and the surveydata are showing similar trend in Z.

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 TSA (Gudmundsson, G. 1994). All models used catchdata from 1986-2005 and surveydata from 1987-2005. Natural mortality is M=0.1 for all agegroups, proportion of M before spawning is set to 0.5 and proportion of F before spawning is set to 0.

Though all models behaved much better now than they did last year they still showed the same retrospective pattern in consistently overestimating the spawning stock in 1997-2002. This seems though have stopped now for the first time. All models were run with higher mortality from 1997 onwards to explore the possibly affect of it on the retrospective pattern. All models behaved better retrospective seen, TSA seemingly best, but the results did not have any impact on the upcoming advice (less than 8 thous. tonnes). Therefore it was decided to stick to runs with fixed natural mortality of 0.1 as until now. As all models showed similar results (Figure 3.5.5.2.1) and one model had to be chosen as a basis for the predictions, the WG chose NFT Adapt the one to go for. One reasoning was the ease of its use and good documentation.

Adapt was run with different ageranges in the tuning series, to see if it had an impact of the assessment retrospective seen. The pattern was less using only ages 5-9 than 3-9, but still out there. But as the consistency between the youngest ages, that is 3 to 4 and 4 to 5 is good (see Figure 3.5.5.1.4) it was decided to use ages 3-9 from the survey (Table 3.5.4.1). (Ages are shifted to the beginning of the next year in Adapt, also being 4-10).

In 1997 the results from the acoustic measurements were not considered reliable and even speculated if part of the stock might have migrated to other fishing grounds. The year after, it was found west of Iceland, confirming the speculation. The weather conditions in 2001 were so bad that acoustic measurements could not be finished. Therefore this index has not been considered representative for that year. The Adapt was run with and without these years. It didn't have any impact on the assessment and was excluded from the survey series.

3.5.6 Final assessment

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). In this year's assessment the estimated parameters are stock numbers for ages 4 to 10 in 2006, but stock numbers at age 3 are set to the geometric mean from 1986-2003. The catchability at age in the survey and the CV is shown in Figure 3.5.6.1. Further results and model settings are shown in Table 3.5.6.1. Stock numbers and fishing mortalities derived from the run are shown in Tables 3.5.6.2 and 3.5.6.3 respectively and summarized in Table 3.5.6.4 and Figure 3.5.6.2. Residuals of the model fit are shown in Figure 3.5.6.3. From the figure it can be seen that the observed values are higher for older ages in the last year and for all ages in 2003, which means that the survey is overestimating those ages. The year class 2000 seems though to be fairly well estimated in 2006.

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 $F_{\mathbf{pa}}$. Flim 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 at the highest level ever. Year class 1999 (at age 3 in 2002) is the biggest one in the whole series and the year class 2000 is next to it. The 2002 year class is due to this assessment below the geometric mean, but it has the highest value ever in the acoustic surveys as 2 years old.

Retrospective analysis (Figure 3.5.6.4) 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 result from the bootstrap run are shown in Figure 3.5.6.5. Temporal patterns are reproduced, but the uncertainty can been seen. In Figure 3.5.6.6 the probability and the cumulative distribution in 2005 are shown. From it one can derive that there is about 50% probability that the spawning stock is below 700 thousand tonnes and about 70% likely that it is below 750 thousand tonnes.

3.5.7 Short term prediction

The weight at age in the prognosis was set equal to the average weight at age in the catch data in the fishing season 2005/2006 (Figure 3.5.7.1). That decision was based on a comparison of prognoses with different scenarios in estimations of the weights. All of the scenarios gave similar results regarding the TAC for 2006 when keeping F0.22 (TAC ranging from 134 to 142 thousand tons, respectively), the other scenarios being; (a) the weights obtained from the catch at age analysis for 2005/06, (b) mean weight at age over the most recent three years. The selection pattern used in the prognosis was determined from the fishing mortality at age ($F_{\text{age } i}/F_{\text{age5 to 10}}$) in 2005 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 2006, 2007, and 2008 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 F0.22-0.23) would correspond to a catch of 134 thousand tons in 2006/07 season. Keeping the TAC of 2006/07 equal to the last years TAC (110 thousand tons) corresponds to F=0.177.

Regarding the fishing season 2007/08, fishing at F0.22 will give lower TAC (127 thousands tons) than in the previous season (Table 3.5.7.2). The decrease in TAC is related to that the relative contribution of the two big year classes from 1999 and 2000 to the catch will become gradually smaller (total 55% of the catch in 2006/07 and 44% in 2007/08; Table 3.5.7.2).

It must be noted that strength of the year classes that are recruiting to the spawning stock from 2006 and on, is very poorly determined as there are no recruitment indices available for the stock and the acoustic survey cover them poorly. There are indications from the acoustic surveys in January 2004 and 2005 (Table 3.5.4.1) that the 2002 year class might be above average (see 3.5.4 above). However, from the final FTP-Adapt run and the prognosis the 2002 year class is set somewhat below average in size.

3.5.8 Medium term predictions

No medium term predictions were performed.

3.5.9 Management consideration

Since the late 1970s, fishing mortality on the Icelandic summer-spawning herring has been close to the management target of F0.1. During some periods, however, F has been above the management target, due to biases in the stock assessment, but fortunately this has not had negative consequences. F is estimated to have been below F0.1 for the last three years and the stock is at an historical maximum.

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 0.322 or approximately 40% higher than the intended target of F0.1=0.23. This is despite the fact that the managers have followed the scientific advice and restricted quotas with the aim of fishing at the intended target. During this time period the SSB has remained above Blim. As there is an aggreed management strategy that have been applied since the fishery was reopend after it collapsed in late 1960's, it is proposed to use $F_{0.1} = \mathbf{F}_{pa}$ as F_{target}.

3.5.11 Comments to the assessment

As has been pointed out, there was a large uncertainty regarding the assessment of the stock last year. However, using the recalculations of the catch at age matrices back to 2000/01 in this year assessment (2006) has caused that the models have behaved better and converged in the running. Considering the general agreement of the different assessment models, conclusion of the assessment models, the acoustic assessment survey, and the prognosis in this year assessment, the state of the stock is considered good.

The assessment models showed retrospective patterns in the time series in the period of 1997 and 2003 that could be diminished by changing M over the period (see NWWG working document No. 21), even if the same pattern existed anyway. The WG suggested that it could be related for the need for re-aging of catch samples for the 1992/03 to 1999/00 fishing seasons. That work will hopefully be finished before the assessment in 2007 so further speculations concerning the patterns should be postponed until then.

No assessment was provided last year due to data and model problems, different from now. This conversion of models performance and the observed retrospective pattern from the models used this year, gives the WG a reason to be reasonable carefully in the advices for the fishing season 2006/07.

There are concerns regarding the fact that 65% of the catch is taken off the east coast where 10% of the adult stock was measured in the acoustic survey that took place after the fishery had ceased. It is not known whether it is because the stock migrates between the areas during the period between the cessation of the fishery and the acoustic survey. However, if there is not a migration it would mean that main fishery off E Iceland was prosecuted on different component than the main stock measured off W Iceland. That could have consequences on the assessment results that can only be speculated at this point. A biological comparison between the herring caught off the E and W Iceland during 1997 to 2003 showed a difference between the mean lengths at age of all year-classes from 1993 to 2000 was consistently higher for all age groups (Oskarsson 2006). In other words, there exist indications that the mixing between the areas was under some limitations at least during that period. The weight at length was also found to be generally higher off the E than the W coast over the study period.

3.5.12 References

Oskarsson, G. 2006. A comparison of the Icelandic summer-spawning herring off the east- and west coast during 1997 to 2003. Marine Research Institute Report, Reykjavik, Iceland. *In print.*

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*	101.4	101.4	125
2002/2003*	96.1	96.1	105
2003/2004	125.7	125.7	110
2004/2005	114.2	114.2	110
2005/2006**	103	103	110

***Summer fishery in 2001 and 2002 included**

****Preliminary**

Table 3.5.3.1. Overview of the catch data for Icelandic summer-spawning herring 2005/06.

	EAST OF 18°W	WEST OF 18°W	TOTAL
Total catch (thousands tonnes)	66.3	36.7	103.0
Number of samplings for ageing	70	30	100
Number of aged fish	3803	1694	5497
Number of weighed fish	4045	1779	5824
Number of samplings for length determinations	151	54	205
Number of fish length measured	21085	7589	28674

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	11.009	14.345	57.024	34.347	77.819	152.236	32.265	8.713	4.432	4.287	2.517	1.226	1.019	0.610	105.097
1991	35.869	92.758	51.047	87.606	33.436	54.840	109.418	9.251	3.796	2.634	1.826	0.516	0.262	0.298	109.489
1992	12.006	79.782	131.543	43.787	56.083	41.932	36.224	44.765	9.244	2.259	0.582	0.305	0.203	0.102	108.504
1993	0.869	35.560	170.106	87.363	25.146	28.802	18.306	24.268	14.318	3.639	0.878	0.300	0.200	0.100	102.741
1994	6.225	110.079	99.377	150.310	90.824	23.926	20.809	19.164	17.973	16.222	2.955	1.433	0.345	0.345	134.003
1995	7.411	26.221	159.170	86.940	105.542	74.326	20.076	13.797	8.873	9.140	7.079	2.376	0.927	0.124	125.851
1996	1.100	18.723	45.304	92.948	69.878	86.261	37.447	13.207	6.854	4.012	1.672	4.179	1.672	0.100	95.882
1997	9.323	27.072	28.397	29.451	42.267	35.285	28.506	21.828	8.160	3.815	1.696	6.570	1.378	1.802	64.682
1998	16.161	37.787	151.853	42.833	19.872	30.280	22.572	32.779	14.366	4.802	2.199	1.084	5.081	3.036	86.998
1999	0.629	43.537	65.871	145.127	24.653	20.614	25.853	21.163	14.436	6.973	2.164	2.426	0.473	0.961	92.896
2000	14.806	53.551	135.567	49.189	77.418	11.376	8.234	16.740	10.596	11.780	6.795	3.056	1.555	1.168	100.332
2001	24.016	42.885	84.677	93.600	30.683	53.651	10.484	9.131	12.329	9.776	7.816	5.956	1.992	1.688	101.390
2002	12.379	87.004	73.305	46.911	55.072	21.029	40.909	9.541	4.801	6.156	8.698	8.614	3.941	5.841	96.128
2003	27.306	221.999	282.822	55.670	26.542	23.808	14.075	10.388	1.815	3.245	3.169	2.380	0.892	1.166	125.719
2004	24.232	63.309	139.550	182.309	42.021	14.660	10.145	6.269	7.463	3.268	1.861	3.736	1.111	1.868	114.237
2005	7.057	25.647	41.351	118.174	132.750	28.925	12.453	10.358	5.385	5.829	1.014	1.858	2.068	0.886	103.043

Table 3.5.3.3. The mean weight (g) at age of Icelandic summer-spawning herring from the commercial catch (the years refer to the autumn).

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	75	119	198	244	273	286	309	329	351	369	387	422	408	436
1991	74	139	188	228	267	292	303	325	343	348	369	388	404	396
1992	63	144	190	232	276	317	334	346	364	392	444	399	419	428
1993	74	150	212	245	288	330	358	373	387	401	425	387	414	420
1994	67	135	204	249	269	302	336	368	379	398	387	421	402	390
1995	69	129	178	236	276	292	314	349	374	381	400	409	438	469
1996	78	140	166	208	258	294	312	324	360	349	388	403	385	420
1997	62	137	197	234	270	299	323	342	358	363	373	412	394	429
1998	78	147	184	213	246	286	314	341	351	354	350	372	400	437
1999	64	143	211	236	268	300	318	349	347	377	359	403	408	445
2000	61	159	217	268	287	327	345	366	387	397	412	431	440	447
2001	73	134	214	246	289	301	327	349	359	380	400	417	452	466
2002	81	154	206	253	278	315	329	354	387	395	406	423	459	482
2003	70	155	190	235	268	294	329	364	347	390	412	401	407	447
2004	80	144	209	246	279	314	331	350	351	379	387	410	432	433
2005	99	163	222	260	273	294	320	331	327	350	365	386	399	398

Table 3.5.4.1 Recalculated acoustic estimates (in millions) of the Icelandic summer spawning herring, 1987-2005 (the years refer to the autumn). No survey was conducted in 1994.

YEAR\AGE	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1987	116	401	858	308	57	33	70	37	24	18	24	10	4	5
1988	636	201	233	381	188	46	26	33	17	10	9	5	3	5
1989	139	655	179	279	593	180	22	22	13	10	2	-1	-1	-1
1990	404	132	259	94	191	514	79	38	9	13	-1	-1	-1	-1
1991	598	1050	355	320	90	138	257	21	10	-1	9	-1	-1	1
1992	268	831	730	159	131	54	96	97	25	1	1	3	-1	-1
1993	302	505	883	496	67	58	106	49	36	-1	4	18	-1	-1
1994	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
1995	217	134	762	278	385	177	98	49	16	29	48	4	-1	-1
1996	33	271	134	469	270	326	217	93	55	39	30	53	19	13
1997*	292	602	81	57	287	156	203	106	35	27	14	36	14	12
1998	100	256	1082	103	52	135	71	102	54	17	14	3	4	9
1999	516	839	239	606	88	43	166	90	121	78	22	4	11	-1
2000	190	967	1316	191	482	34	16	38	14	15	15	2	3	-1
2001*	1048	287	217	260	161	346	62	57	38	46	38	21	4	-1
2002	1732	1919	553	206	262	153	276	99	48	55	19	24	24	1
2003	1115	1435	2058	331	109	101	39	46	7	6	8	11	-1	2
2004	2417	714	1022	1047	171	62	44	11	24	13	-1	2	11	-1
2005	470	444	345	819	1221	281	122	130	73	65	10	9	4	12

*** The estimates from the fishing season 1997/98 and 2001/02 were omitted from the tuning procedure in the assessment 2006 because of incomplete covearge of the surveys due to weather contition 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 1987/1988-2005/2006 (the years refer to the autumn). 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	11	59	246	156	37	28	58	33	22	16	23	10	5	8	712	8	1	7
1988	229	78	181	424	178	69	50	77	42	29	23	13	7	12	1412	18	5	10
1989	38	245	96	132	225	35	2	2	3	3	2				783	8		8
1990	418	229	303	90	131	257	28	6	3	8					1473	15		15
1991	414	439	127	127	33	48	84	5	3	0	2	0	0	1	1283	15		15
1992	122	513	289	68	73	28	38	34	6	2	2	6	0	0	1181	12		12
1993	63	285	343	129	13	15	7	14	11	0	1	3	0	0	884	9		9
1994															0			
1995	183	90	471	162	209	107	38	18	8	14	18	2	0	0	1320	14	9	5
1996	24	150	88	351	141	137	87	32	15	10	7	14	4	2	1062	11	4	7
1997	101	249	50	36	159	95	122	62	21	13	8	15	8	5	944	14	7	7
1998	130	216	777	72	31	65	59	86	37	22	17	5	6	11	1534	17	10	7
1999	116	227	72	144	17	13	26	26	27	10	8	2	1		689	7	3	4
2000	116	249	332	87	166	10	7	21	8	14	11	3	1	0	1025	14	10	4
2001	61	56	130	114	62	136	25	24	17	21	17	10	3	0	676	9	4	5
2002	520	705	258	104	130	74	128	46	26	25	13	15	10	1	2055	22	12	10
2003	126	301	415	88	35	32	15	17	3	4	4	6	1	1	1048	13	8	5
2004	304	159	284	326	70	29	17	5	8	4	0	3	3		1212	13	4	9
2005	217	312	190	420	501	110	40	38	26	18	5	5	5	7	1894	22	14	8

Table 3.5.6.1. Icelandic summer spawning herring. Model settings and results of model parameters from final run.

```
VPA Version 2.3.2
 Model ID: Run 9 in 2006  ages 3-12+ in catchdata  ages 4-10 in tuning
 Input File: C:\NFT\VPA\RUN9\SUMMERSP_RUN9.DAT
 Date of Run: 29-APR-2006                         Time of Run: 08:29

 Levenburg-Marquardt Algorithm Completed     5 Iterations
 Residual Sum of Squares =     26.8198

 Number of Residuals     =    112
 Number of Parameters    =      7
 Degrees of Freedom      =    105
 Mean Squared Residual   =     0.255427
 Standard Deviation      =     0.505398

 Number of Years =    20
 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 (2006)
 Age    Stock Predicted     Std. Error      CV

   4         394194.372   0.206325E+06   0.523408E+00
   5         357010.064   0.139257E+06   0.390065E+00
   6         671721.907   0.233477E+06   0.347580E+00
   7         732578.228   0.235530E+06   0.321509E+00
   8         142637.518   0.464882E+05   0.325918E+00
   9          61114.124   0.191850E+05   0.313921E+00
  10          62080.958   0.189551E+05   0.305329E+00

 Catchability Values for Each Survey Used in Estimate
 INDEX     Catchability    Std. Error      CV

   1       0.112604E+01   0.129541E+00   0.115042E+00
   2       0.134490E+01   0.165907E+00   0.123360E+00
   3       0.121219E+01   0.122273E+00   0.100869E+00
   4       0.117916E+01   0.117159E+00   0.993576E-01
   5       0.122174E+01   0.142573E+00   0.116697E+00
   6       0.144994E+01   0.234224E+00   0.161541E+00
   7       0.142802E+01   0.219084E+00   0.153418E+00


 -- Non-Linear Least Squares Fit --

 Default Tolerances Used

 Scaled Gradient Tolerance      =    6.055454E-06
 Scaled Step Tolerance          =    3.666853E-11
 Relative Function Tolerance    =    3.666853E-11
 Absolute Function Tolerance    =    4.930381E-32

 VPA Method Options

 - Catchability Values Estimated as an Analytic Function of N
 - Pope Approximation Used in Cohort Solution
 - Plus Group Backward 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 2006
  =  Geometric Mean of First Age Populations
     Year Range Applied =  1986 to  2003


Stock Estimates

Age   4
Age   5
Age   6
Age   7
Age   8
Age   9
Age  10

Full F in Terminal Year               =   0.1582

F in Oldest True Age in Terminal Year =   0.1541

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	0.700	0.355	0.0611	NO	Stock Estimate in T+1
4	0.800	0.618	0.1064	NO	Stock Estimate in T+1
5	0.900	0.897	0.1544	NO	Stock Estimate in T+1
6	1.000	0.928	0.1598	YES	Stock Estimate in T+1
7	1.000	0.980	0.1688	YES	Stock Estimate in T+1
8	1.000	1.000	0.1722	YES	Stock Estimate in T+1
9	1.000	0.766	0.1319	YES	Stock Estimate in T+1
10	1.000	0.918	0.1582	NO	Input PR * Full F
11	1.000	0.895	0.1541		F-Oldest

Table 3.5.6.2. Icelandic summer spawners. Stock in numbers (thousands) 1986-2006.

AGE	1986	1987	1988	1989	1990
3	1100174.	557315.	311167.	438545.	323273.
4	368339.	987705.	501289.	277031.	375288.
5	121737.	301004.	851297.	414270.	225319.
6	98251.	87844.	215015.	675766.	300818.
7	203236.	69229.	59869.	128604.	432005.
8	73824.	110053.	43853.	32336.	75354.
9	53265.	49437.	55595.	20531.	21538.
10	39480.	37746.	30243.	19674.	12968.
11	43091.	27548.	20872.	15619.	10865.
12	69351.	71564.	43629.	19771.	13615.
Total	2170749.	2299445.	2132829.	2042146.	1791044.

AGE	1991	1992	1993	1994	1995
3	811798.	1031469.	616136.	686846.	269549.
4	278864.	646311.	857420.	523677.	516774.
5	285332.	203769.	459679.	614016.	379312.
6	171205.	174845.	142726.	332833.	412605.
7	198168.	123107.	104859.	105225.	214765.
8	246083.	127144.	71505.	67483.	72452.
9	37492.	118583.	80587.	47287.	41267.
10	11201.	25124.	64717.	49834.	24558.
11	7518.	6524.	13940.	44939.	27995.
12	8283.	3443.	5662.	14067.	32179.
Total	2055943.	2460320.	2417232.	2486207.	1991457.

AGE	1996	1997	1998	1999	2000
3	259894.	778054.	366240.	600172.	412704.
4	218956.	217352.	678261.	295444.	501644.
5	316189.	155025.	169656.	469269.	204670.
6	260516.	197685.	112258.	112767.	286563.
7	272946.	169254.	138667.	82672.	78585.
8	123626.	164918.	119584.	96668.	55196.
9	46460.	76241.	122108.	86733.	62877.
10	24216.	29476.	48222.	79308.	58348.
11	13781.	15392.	18909.	29968.	58029.
12	26184.	46179.	44891.	25889.	63303.
Total	1562768.	1849576.	1818796.	1878890.	1781920.

AGE	2001	2002	2003	2004	2005	2006
3	537216.	1933818.	1442594.	551588.	463081.	588197.
4	318942.	445853.	1672872.	1104132.	438832.	394194.
5	324275.	206383.	336076.	1241609.	866323.	357010.
6	138308.	204384.	143361.	248809.	949903.	671722.
7	186415.	96290.	133375.	103104.	186617.	732578.
8	60124.	116842.	66950.	96339.	80235.	142638.
9	42054.	44534.	65582.	47069.	78285.	61114.
10	41324.	29717.	30890.	48931.	37102.	62081.
11	43403.	25745.	22412.	25829.	37596.	28660.
12	74903.	111170.	63701.	70676.	41285.	62081.
Total	1766965.	3214735.	3977813.	3538086.	3179259.	3100275.

Table 3.5.6.3 Icelandic summer spawning herring. Fishing mortality calculated at age 1986-2005.

AGE	1986	1987	1988	1989	1990
3	0.0078	0.0059	0.0162	0.0558	0.0478
4	0.1019	0.0486	0.0907	0.1066	0.1740
5	0.2263	0.2364	0.1309	0.2200	0.1747
6	0.2501	0.2834	0.4140	0.3474	0.3174
7	0.5134	0.3566	0.5160	0.4345	0.4628
8	0.3010	0.5829	0.6589	0.3063	0.5981
9	0.2444	0.3914	0.9388	0.3595	0.5539
10	0.2599	0.4925	0.5608	0.4937	0.4452
11	0.2684	0.4889	0.7195	0.3865	0.5324
12	0.2684	0.4889	0.7195	0.3865	0.5324
F 5-10	0.2992	0.3905	0.5366	0.3602	0.4253
WF 5-10	0.3424	0.3400	0.2623	0.3166	0.3722

AGE	1991	1992	1993	1994	1995
3	0.1280	0.0848	0.0626	0.1845	0.1079
4	0.2137	0.2408	0.2339	0.2225	0.3913
5	0.3898	0.2561	0.2229	0.2975	0.2757
6	0.2298	0.4113	0.2048	0.3381	0.3132
7	0.3438	0.4433	0.3407	0.2732	0.4523
8	0.6301	0.3560	0.3135	0.3918	0.3443
9	0.3003	0.5056	0.3806	0.5552	0.4331
10	0.4405	0.4891	0.2647	0.4767	0.4778
11	0.4569	0.4502	0.3196	0.4746	0.4184
12	0.4569	0.4502	0.3196	0.4746	0.4184
F 5-10	0.3890	0.4102	0.2879	0.3887	0.3827
WF 5-10	0.4107	0.3833	0.2572	0.3291	0.3367

AGE	1996	1997	1998	1999	2000
3	0.0788	0.0373	0.1148	0.0793	0.1577
4	0.2453	0.1477	0.2684	0.2671	0.3363
5	0.3697	0.2228	0.3084	0.3932	0.2919
6	0.3313	0.2546	0.2059	0.2611	0.3300
7	0.4038	0.2474	0.2608	0.3040	0.1678
8	0.3834	0.2005	0.2212	0.3301	0.1719
9	0.3550	0.3581	0.3316	0.2964	0.3197
10	0.3532	0.3439	0.3757	0.2124	0.1959
11	0.3639	0.3009	0.3095	0.2796	0.2292
12	0.3639	0.3009	0.3095	0.2796	0.2292
F 5-10	0.3661	0.2712	0.2839	0.2995	0.2462
WF 5-10	0.3696	0.2489	0.2768	0.3381	0.2794

AGE	2001	2002	2003	2004	2005
3	0.0864	0.0450	0.1674	0.1287	0.0611
4	0.3353	0.1827	0.1981	0.1426	0.1064
5	0.3616	0.2644	0.2007	0.1678	0.1544
6	0.2621	0.3268	0.2296	0.1876	0.1598
7	0.3672	0.2634	0.2253	0.1508	0.1688
8	0.2002	0.4775	0.2523	0.1075	0.1722
9	0.2472	0.2658	0.1929	0.1379	0.1319
10	0.3732	0.1821	0.0789	0.1635	0.1582
11	0.2735	0.3085	0.1747	0.1363	0.1541
12	0.2735	0.3085	0.1747	0.1363	0.1541
F 5-10	0.3019	0.2967	0.1966	0.1525	0.1575
WF 5-10	0.3278	0.3148	0.2092	0.1654	0.1579

Table 3.5.6.4. Icelandic summer spawning herring. Summary table from final run.

Year	Recruits, (millions) Age - 3	Totalbio, (thous.t)	TotalSpbio, (thous. t)	Landings (thous. t)	Yield/SSB	WF 5-10
1986	1100	447	298	66	0.220	0.342
1987	557	514	390	75	0.194	0.340
1988	311	507	429	93	0.216	0.262
1989	439	468	393	101	0.256	0.317
1990	323	418	358	104	0.292	0.372
1991	812	430	316	107	0.338	0.411
1992	1031	503	347	108	0.310	0.383
1993	616	551	428	103	0.240	0.257
1994	687	556	443	134	0.301	0.329
1995	270	463	401	125	0.313	0.337
1996	260	363	313	96	0.306	0.370
1997	778	404	297	64	0.215	0.249
1998	366	403	324	86	0.264	0.277
1999	600	424	329	93	0.282	0.338
2000	413	451	363	100	0.275	0.279
2001	537	413	326	94	0.287	0.328
2002	1934	672	389	96	0.247	0.315
2003	1443	780	525	129	0.245	0.209
2004	552	832	695	112	0.162	0.165
2005	463	815	702	102	0.146	0.158

Table 3.5.7.1. Prognosis input data. The geometric mean of number at age 3 on Jan. 1st was used as the recruits for the following years.

AGE	MEAN WEIGHTS (KG)	M	MATURITY OGIVE	SELECTION PATTERN	MORTALITY PROP. BEFORE SPAWN. F	M	NUMBER AT AGE JAN. 1ST 2006
3	0.166	0.1	0.20	0.39	0	0.5	588.197
4	0.221	0.1	0.85	0.67	0	0.5	394.194
5	0.257	0.1	1.00	1.00	0	0.5	357.010
6	0.272	0.1	1.00	1.00	0	0.5	671.722
7	0.297	0.1	1.00	1.00	0	0.5	732.578
8	0.323	0.1	1.00	1.00	0	0.5	142.638
9	0.334	0.1	1.00	1.00	0	0.5	61.114
10	0.335	0.1	1.00	1.00	0	0.5	62.081
11	0.352	0.1	1.00	1.00	0	0.5	28.660
12+	0.381	0.1	1.00	1.00	0	0.5	62.081

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.

2006/2007				2007/2008			
TAC	*3+ stock*	*Sp. stock*	*F (5-10)*	*TAC*	*3+ Stock*	*Sp. stock*	*F (5-10)*
100	798	672	0.159	100	798	669	0.161
110	798	672	0.177	110	788	659	0.181
120	798	672	0.194	120	777	650	0.203
134 *	798	672	0.220	127	762	635	0.220
150	798	672	0.249	150	746	620	0.273

*** fishing at $F_{0.1}$**

Table 3.5.7.3. The expected contribution in weight and percentages of the different age classes to the catch in two fishing seasons according to option 1 in Table 3.5.7.2 (F0.22) of the Icelandic summer spawning herring.

	Catch in weight (10^3 t)		Catch in weight (%)	
Age \ season	**2006/07**	**2007/08**	**2006/07**	**2007/08**
3	7.631	7.629	6	6
4	11.367	14.085	8	11
5	17.308	14.922	13	12
6	34.429	13.287	26	10
7	40.924	27.249	30	22
8	8.677	32.362	6	26
9	3.840	6.507	3	5
10	3.918	2.801	3	2
11	1.901	2.990	1	2
12+	4.454	4.728	3	4
Total	134.450	126.560	100	100

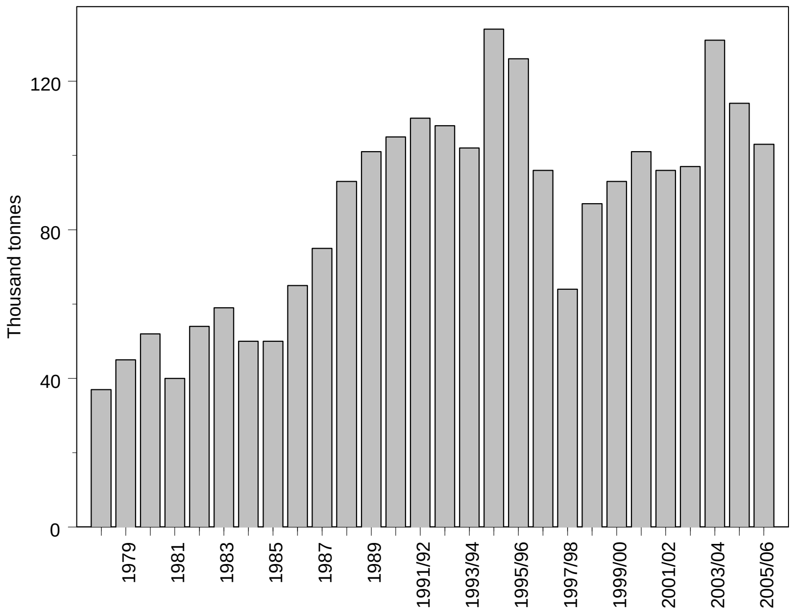


Figure 3.5.1.1. Total catch (in thousand tonnes) of the Icelandic summer-spawning herring in 1978/79-2005/06.

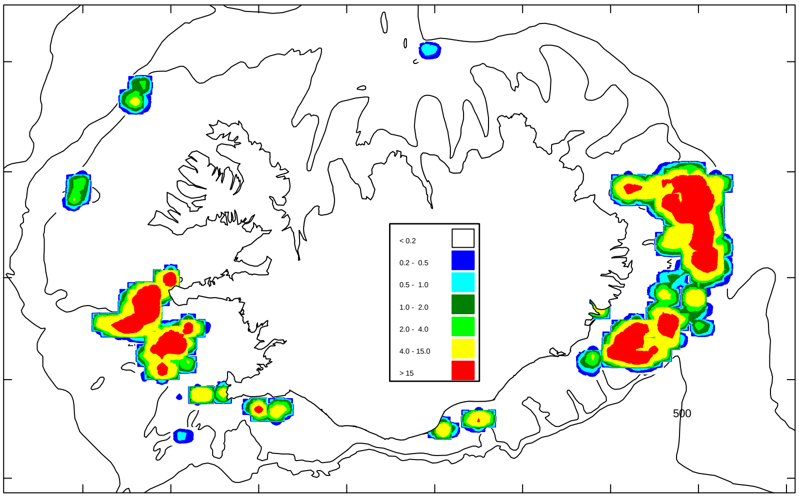


Figure. 3.5.1.2 Distribution of the catches of the Icelandic summer spawning herring in the fishing season 2005/06 based on data from logbooks.

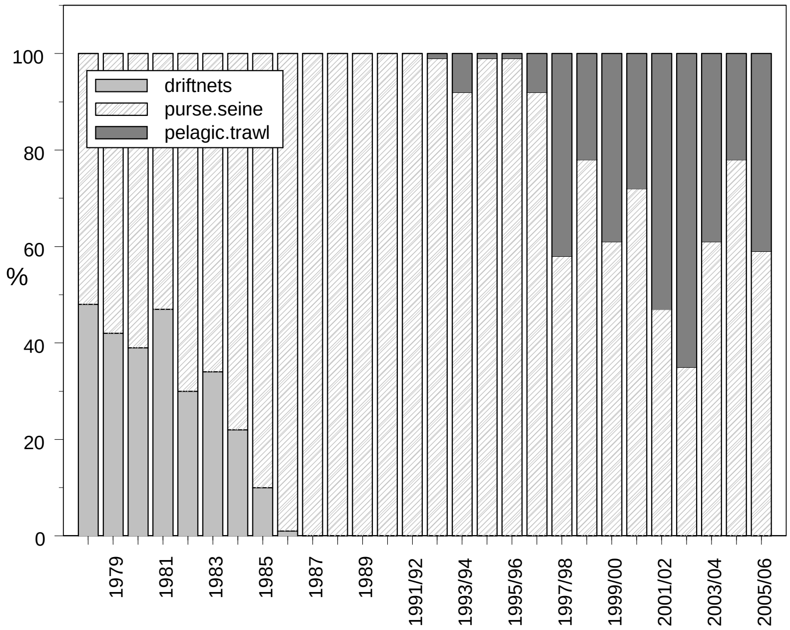


Figure 3.5.2.1. Proportion of the catches of the Icelandic summer-spawning herring in 1978/79-2005/06 taken by different gears.

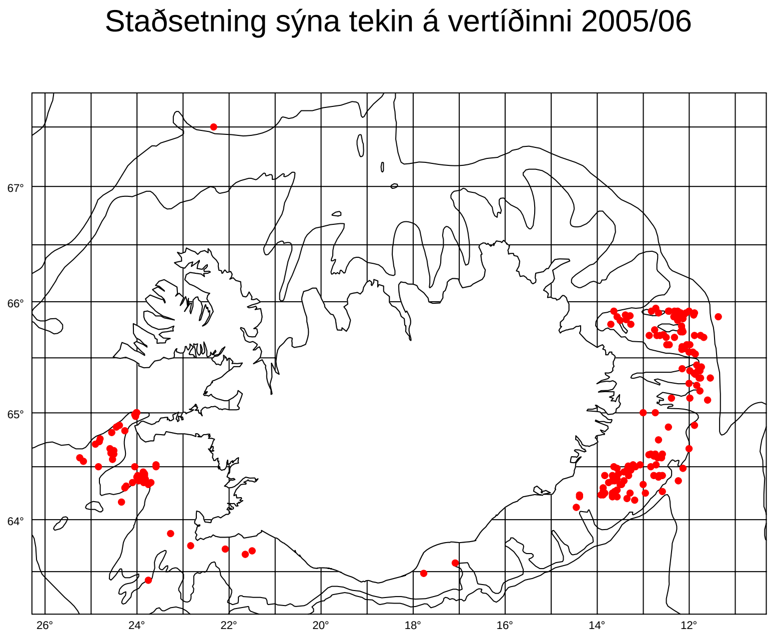


Figure 3.5.3.2. The locations of the Icelandic summer-spawning herring catch samples in 2005/06.

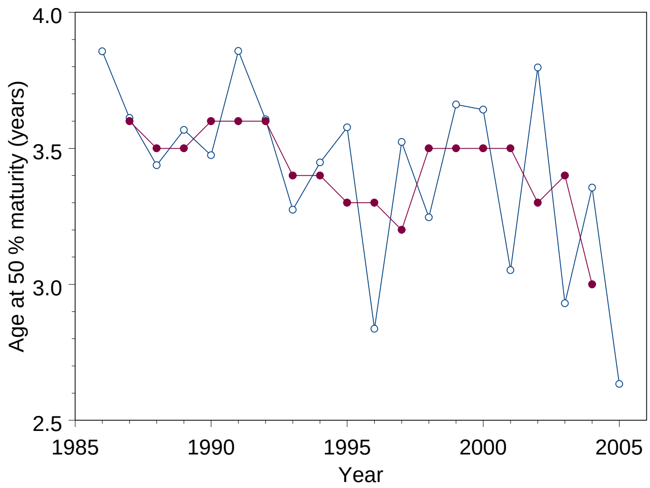


Figure 3.5.3.2. The annual estimation of age at 50% maturity of the Icelandic summer spawning herring from research surveys data during 1986 through 2005 (open dots) and a 3 years running mean (solid dots).

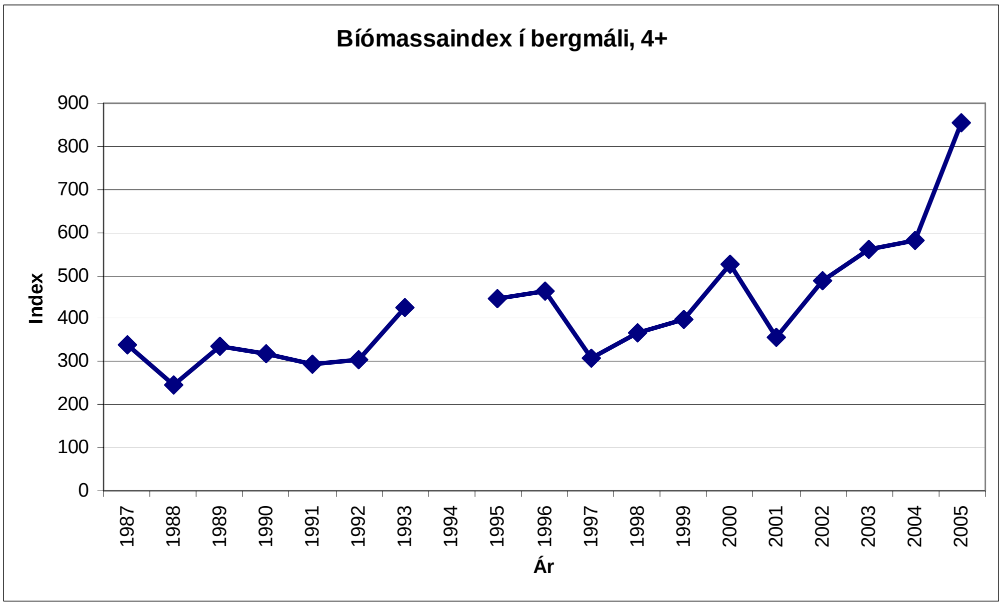


Figure 3.5.4.1 Total biomass from the acoustic surveys for ages 4 and older in the fishing seasons 1986/07 to 2005/06.

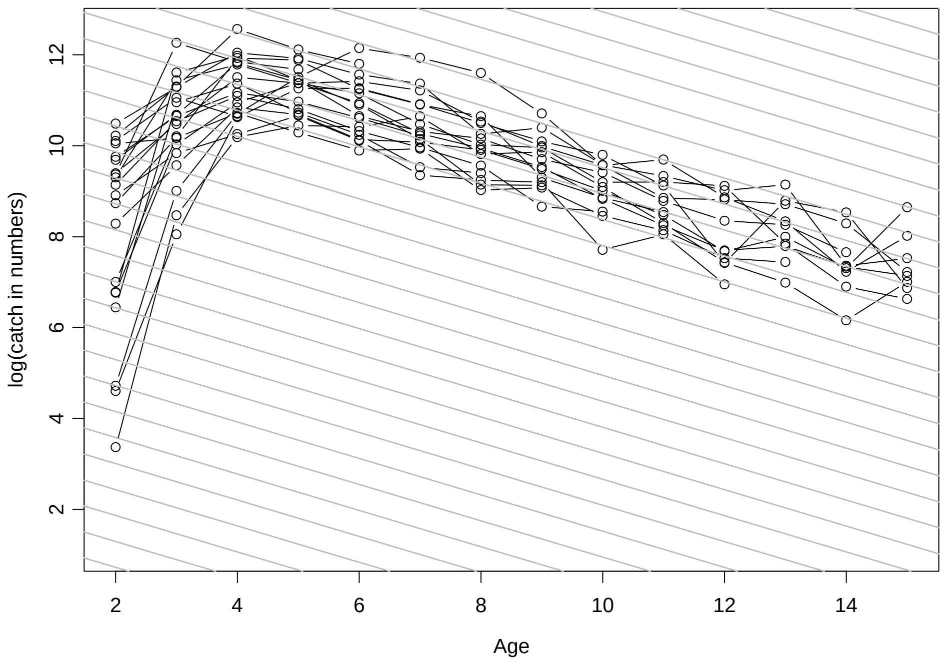


Figure 3.5.5.1.1 Catch curves by yearclasses and years. Grey lines correspond to Z=0.4.

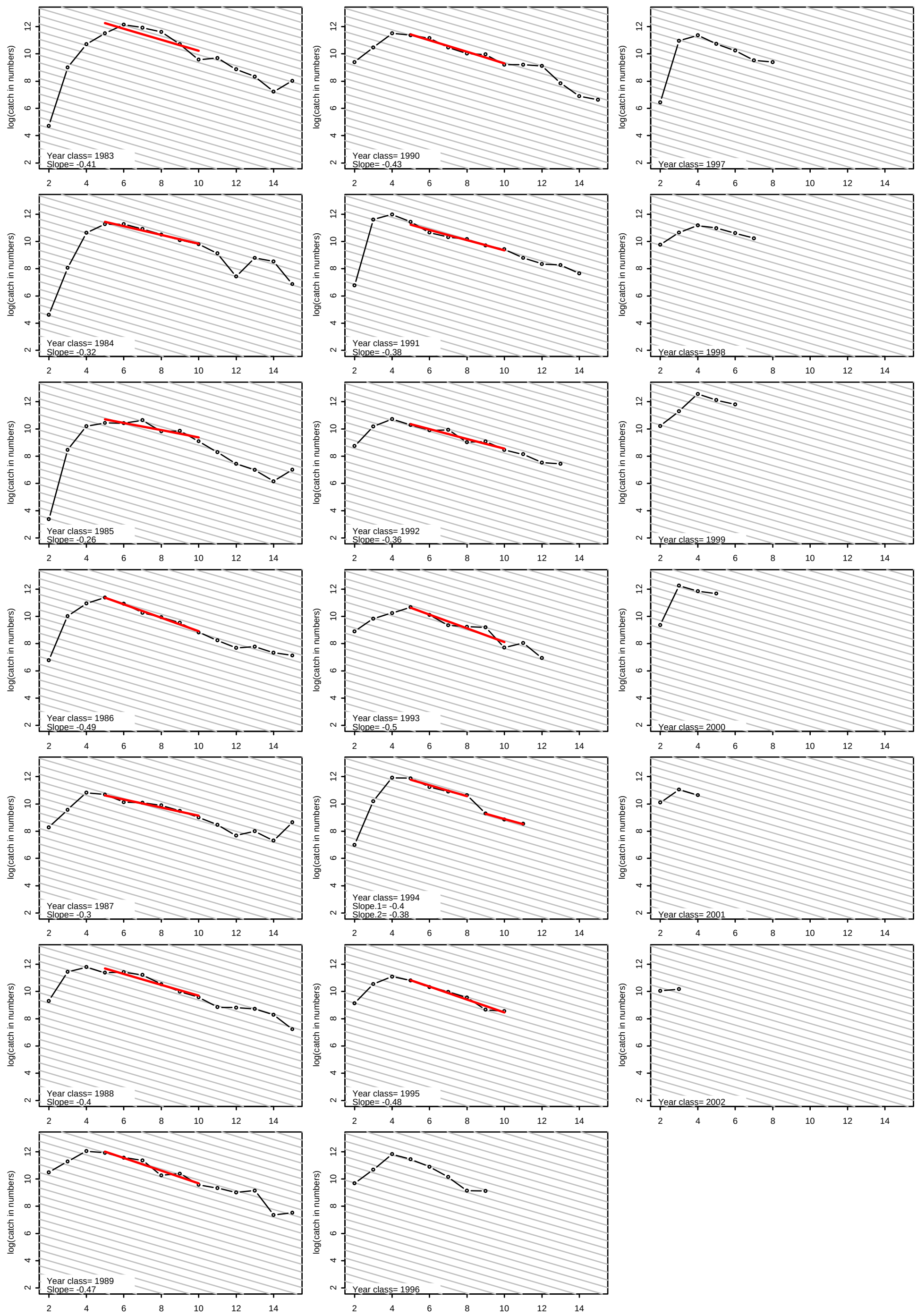


Figure 3.5.5.1.1. Catch curves by yearclasses and years. Grey lines correspond to Z=0.4.

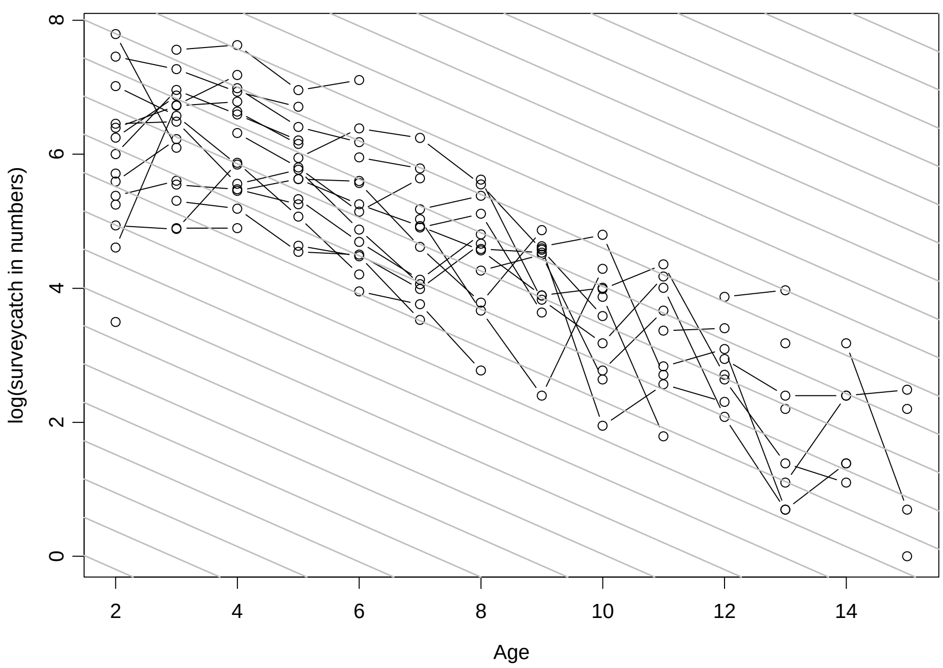


Figure 3.5.5.1.2 Catch curves for the icelandic summer spawning herring made from survey data in the seasons 1985/86-2005/06. Grey lines correspond to Z=0.4.

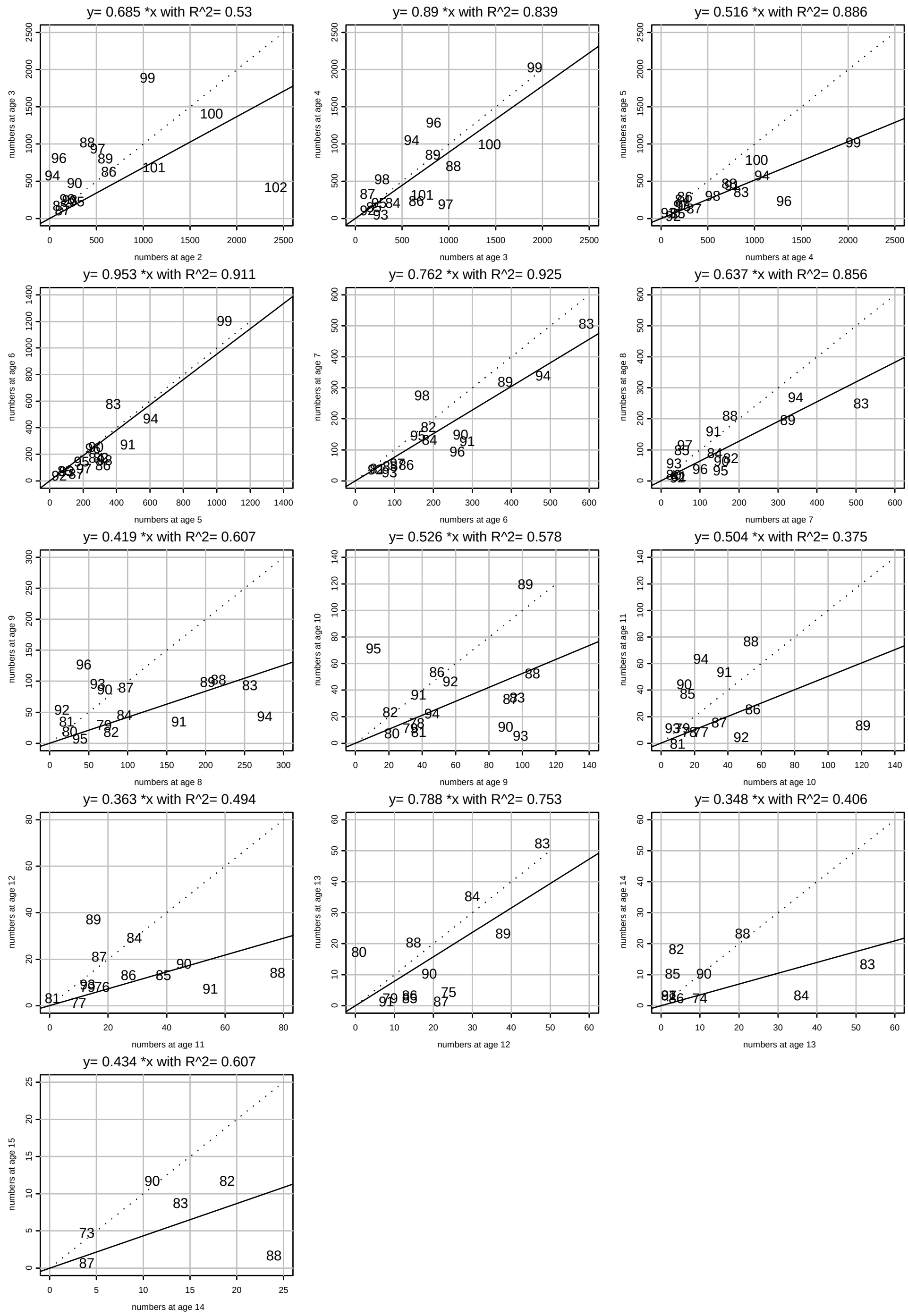


Figure 3.5.5.1.4. Comparison between ages in the survey. Yearclasses are denoted in the graphs. Solid line is the fitted line through origin and dotted line is line with slope 1.

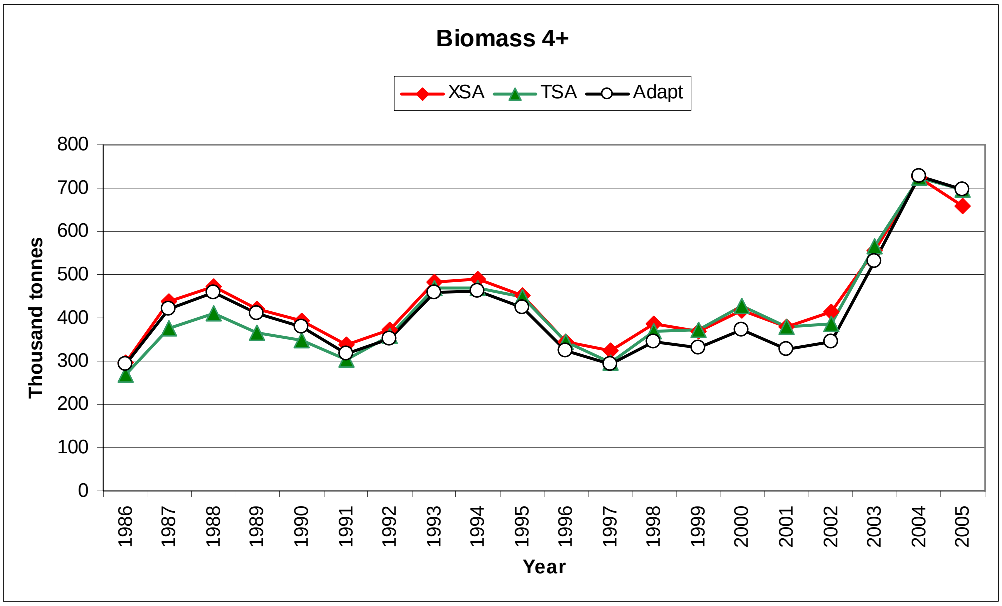


Figure 3.5.5.2.1. Icelandic summerspawning herring. Comparisons of different models.

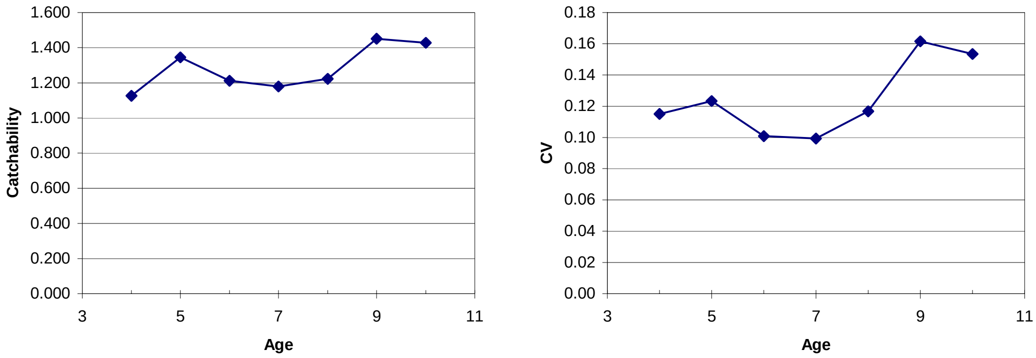


Figure 3.5.6.1 Icelandic summerspawning herring. The catchablity and its CV for the acoustic survey used in the Adapt run.

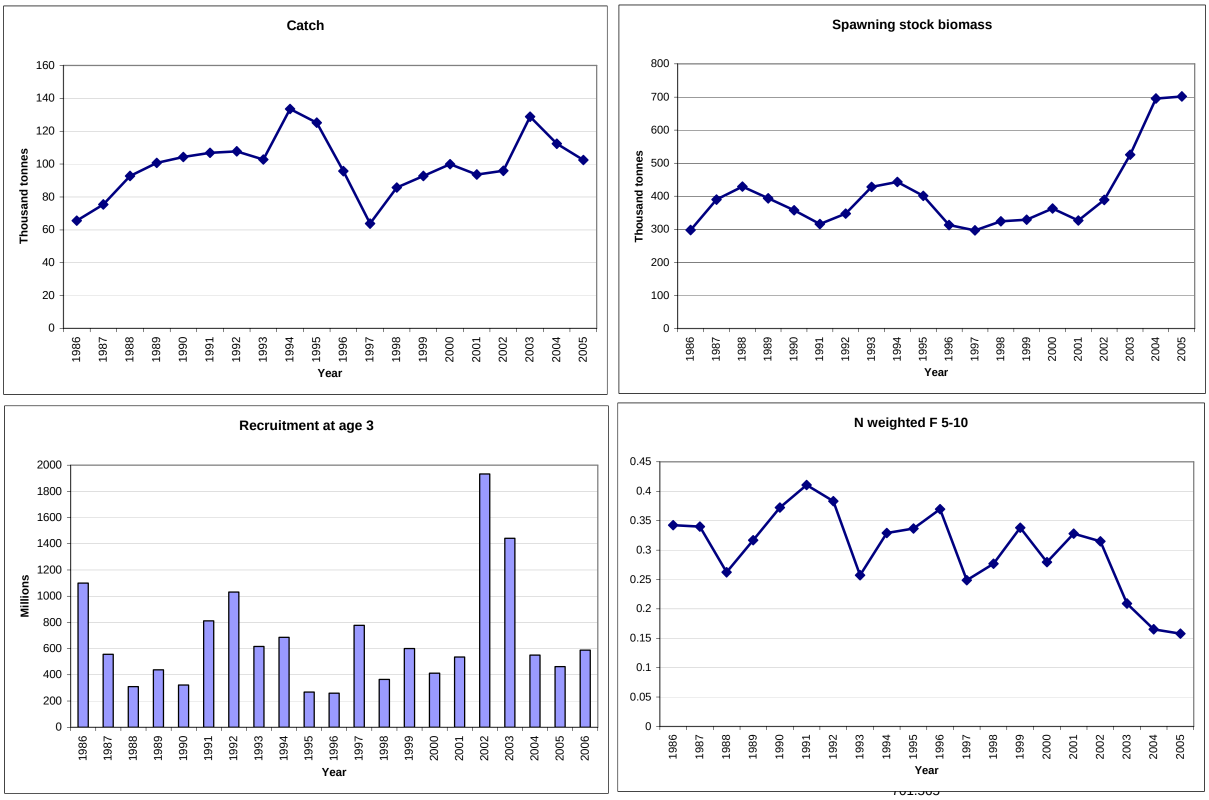


Figure 3.5.6.2 Icelandic herring. Stock summary 1986-2006. Recruitment at age 3 is set to geometric mean.

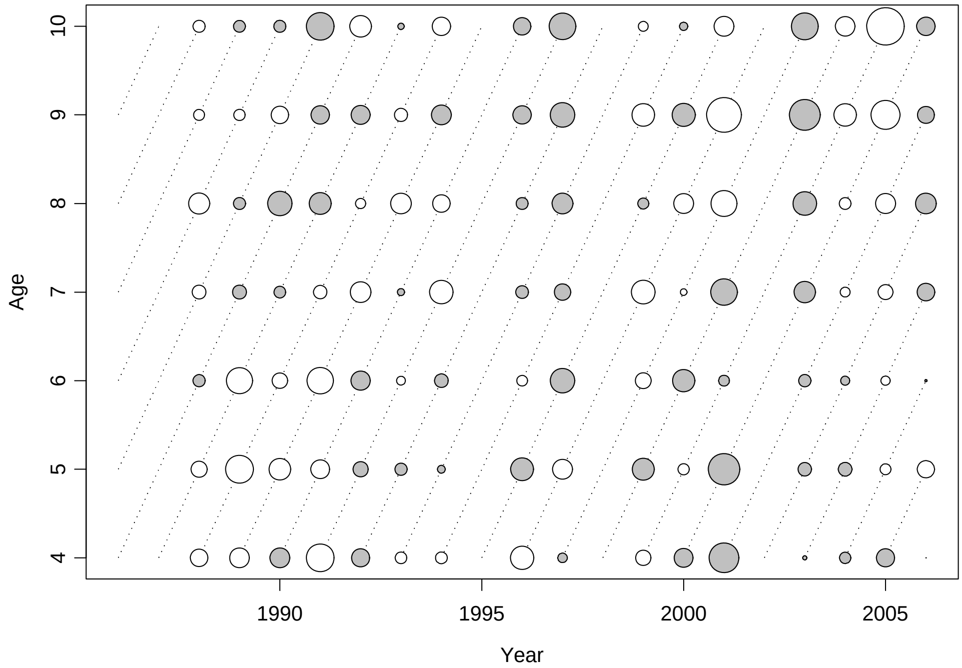


Figure 3.5.6.3 Icelandic summer spawning herring. Residuals from survey observations. Max bubble = 1.57

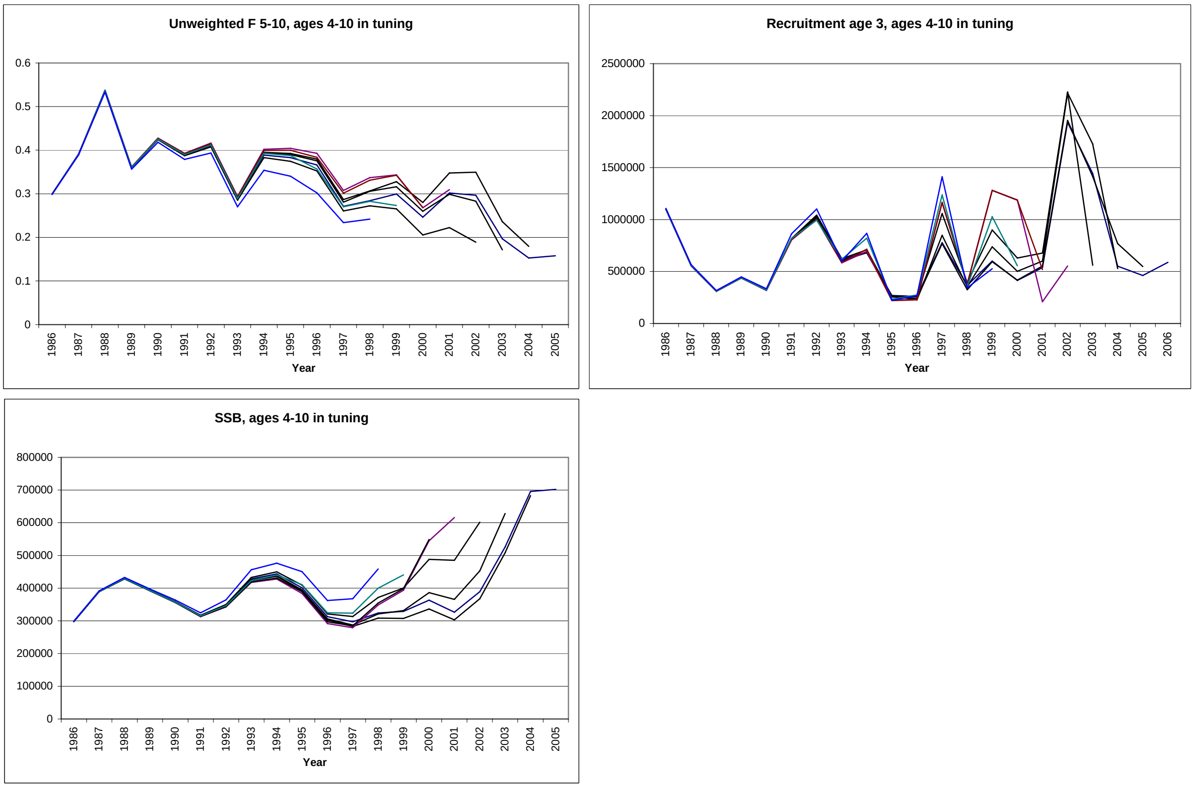
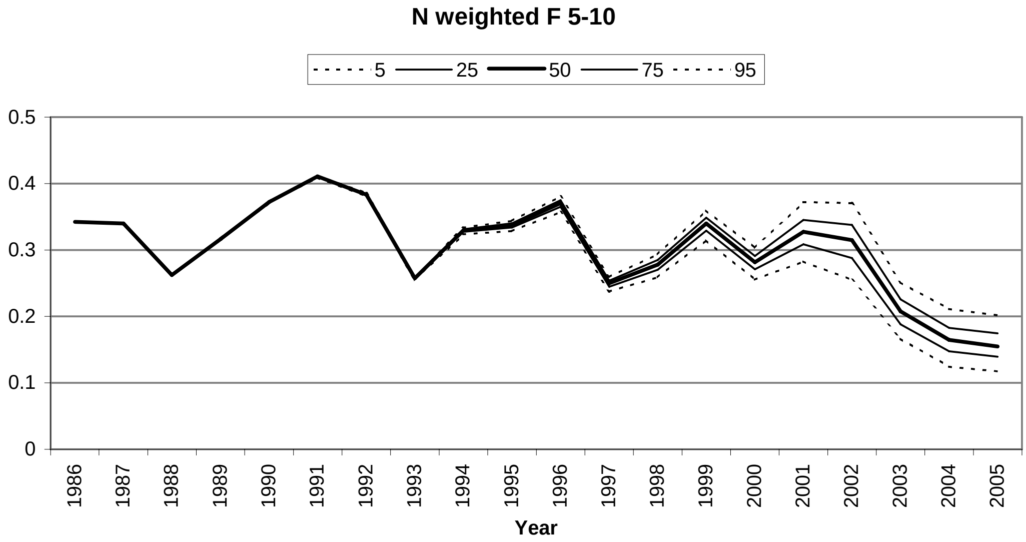
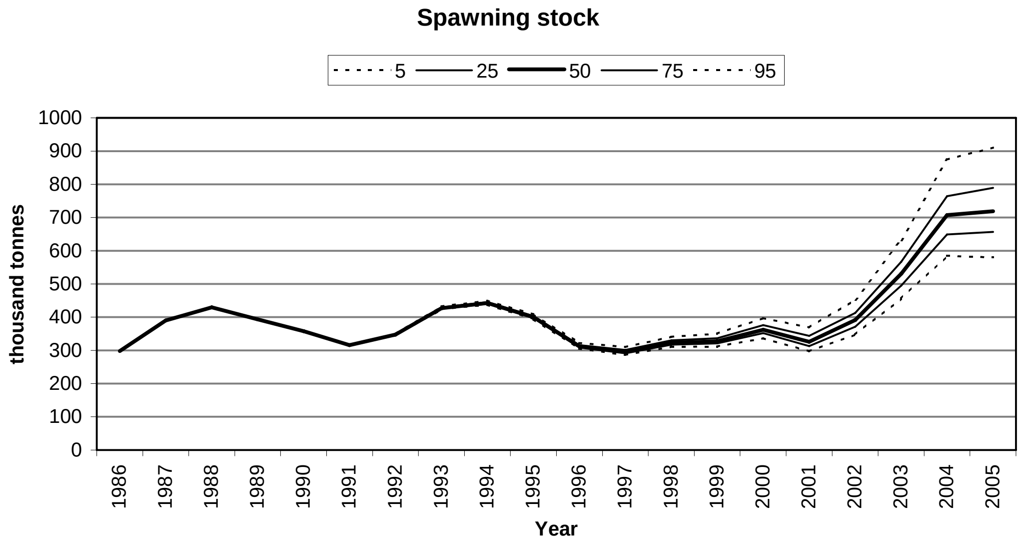


Figure 3.5.6.4. Icelandic summer spawning herring. Retrospective pattern in N weighted F, spawningstock biomass and recruitment.





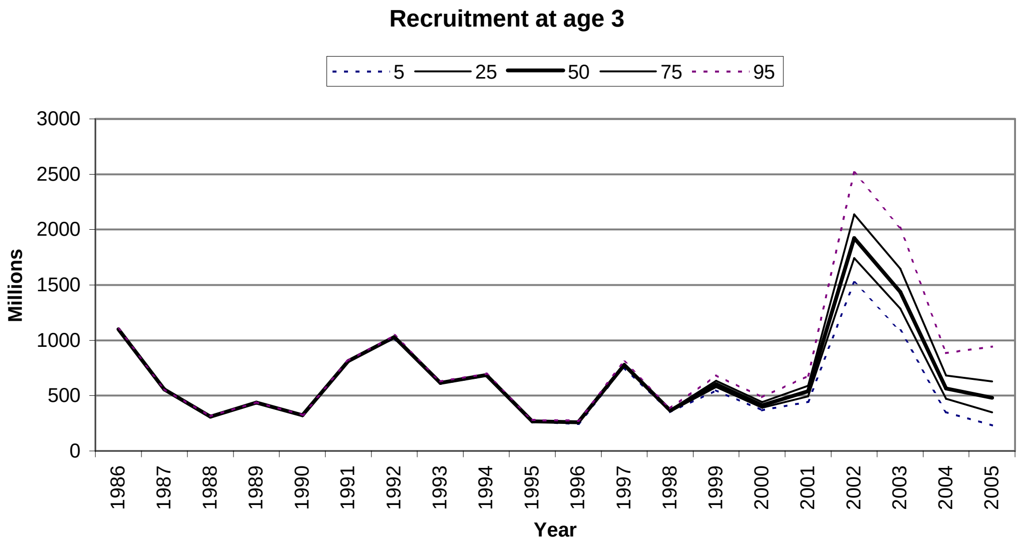


Figure. 3.5.6.5. Icelandic summerspawning herring. Results from bootstrapping with Adapt (1000 replicates).

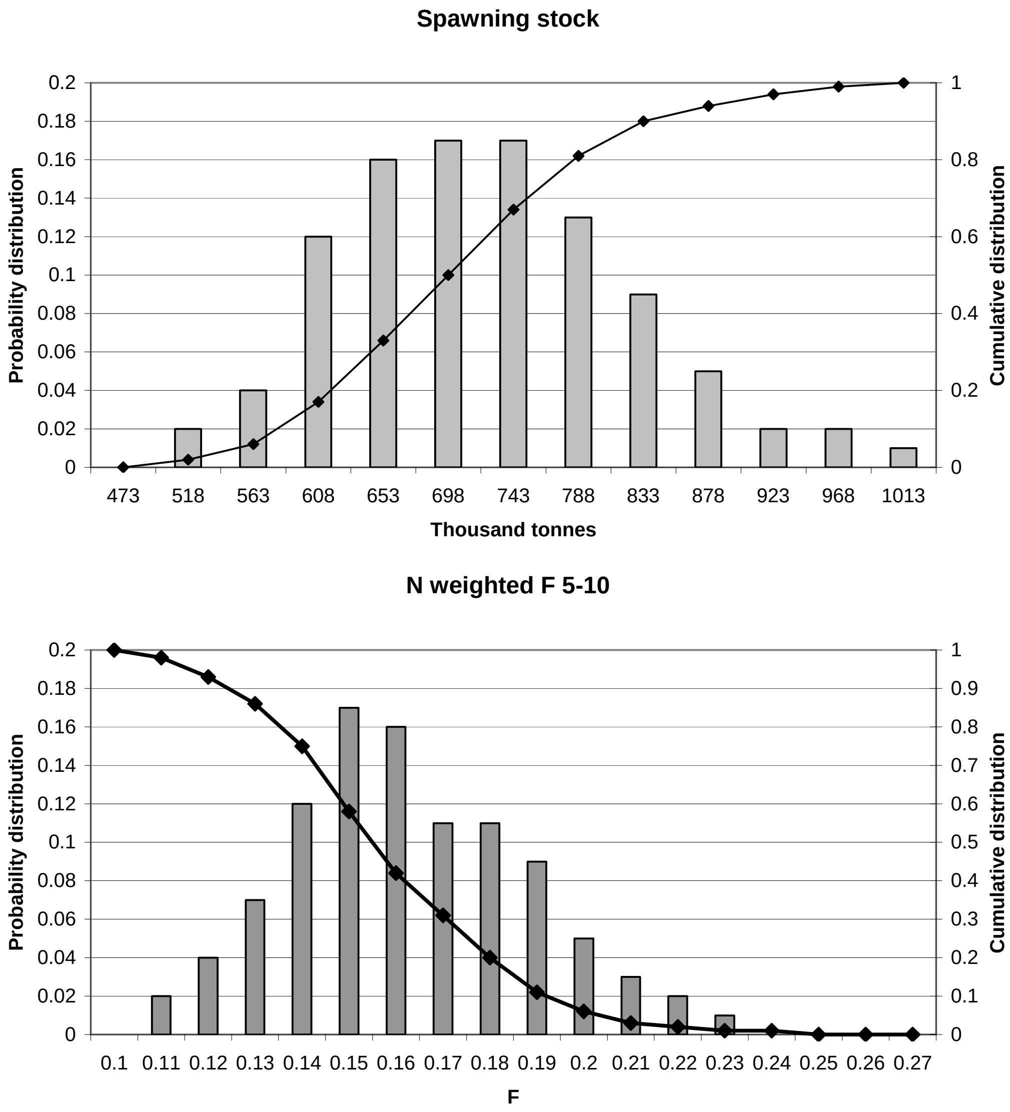
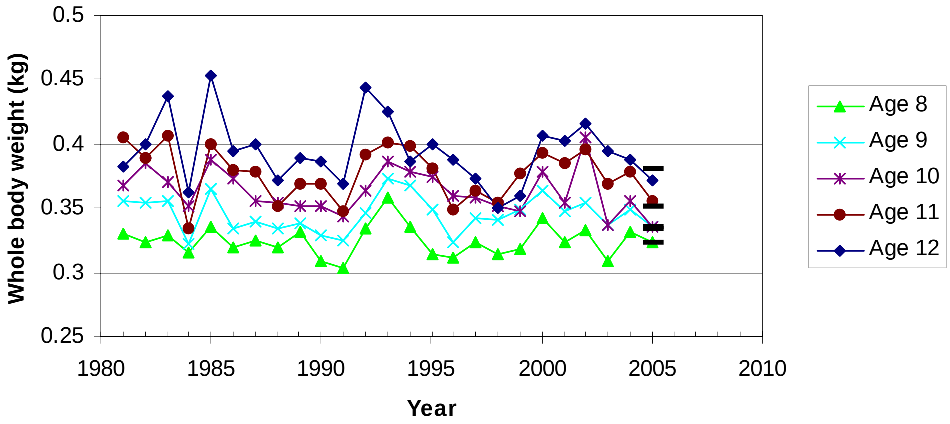


Figure 3.5.6.6 Icelandic summerspawning herring. Probability and cumulative distribution of SSB and N weighted F 5-10 in 2005.



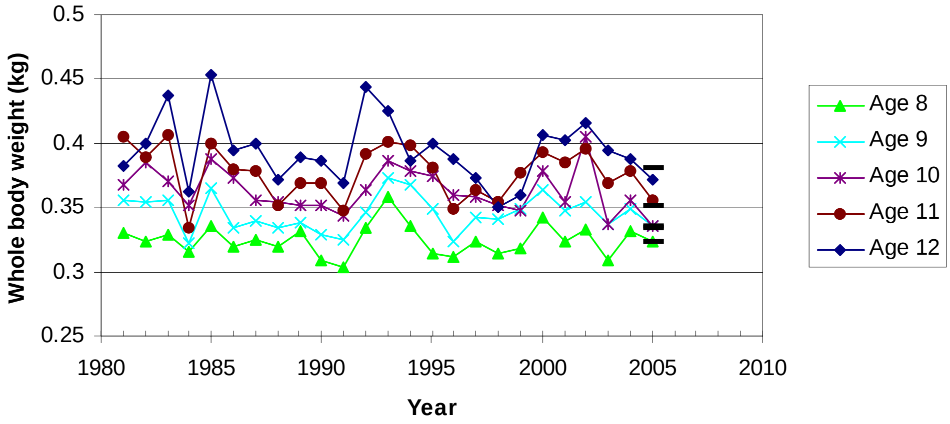


Figure 3.5.7.1. Mean weight at age over 1981 through 2005 predicted from annual weight/length relationships and the mean weight in 2005 (from raw data, denoted with -) of Icelandic summer-spawning herring (the years refers to the autumn of the fishing seasons).

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 water but an fishery have since been conducted in East Greenland. This fishery has been increasing in recent years due to a small longline fishery, but still minor. 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. Since 1992 the biomass of offshore cod at West Greenland have been negligible. The TAC for cod is given to the East and West Greenland waters combined. The quota has through a longer period not been fully utilized. In 1969 the offshore shrimp fishery started and has been increasing ever since reaching a historic high of close to 150 000t in 2003.

4.4 Description of the most important commercial fishery resources – except mammals

4.4.1 Shrimp

The shrimp Pandalus borealis stock in Greenland 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. Catch level advice remains at 130 000 tonnes for West Greenland shrimp and is set at 12 400 tonnes for East Greenland in 2006.".

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. TAC for 2005 was 6 736t. 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 4-600t yearly. Since then landings have increased to around 2000t. The fishery is based on license and is exclusively at the west coast between 20-60m. The growth rate is considered very low reaching the minimum landing size on 65mm on 10 years.

4.4.4 Squids

The status of squids in Greenland water is unknown.

4.4.5 Cod

In 2003, total landings of cod was reported as 5515t where only 300t were reported from the offshore areas. Although the landings are the highest in a 10-years period it is still only a fraction (5.5%) of the landings caught in 1990. Recruitment has been failing ever since the 1984 and 1985 year-class was observed, and no spawning takes at the moment place in the offshore waters. The present observations confirm the depleted status of the stock. The inshore fishery is not regulated and the offshore fishery is managed with license and minimum size. As a response to the favourable environmental conditions (large shrimp stock and high temperatures) cod could re-colonise the offshore areas and therefore a recovery plan is urgently required to rebuild the stock.

4.4.6 Redfish

4.4.7 Greenland halibut

Greenland halibut in the Greenland area consist of at least two stocks and more components; the status of the inshore component is not known but the component have sustained catches of 15.-20 000 t annually. The offshore stock 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 000t 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. A recovery plan is recommended to ensure a sustainable increase in SSB and recruitment. Such plan must include appropriate measures to avoid any cod by-catch in other fisheries deploying mobile gears capable of catching cod. Observers must monitor functionalism of measures.

Gordon, J.D.M., Bergstad, O.A., Figueiredo, I. And G. Menezes. 2003. Deep-water Fisheries of the Northeast Atlantic: I Description and current Trends. J. Northw. Atl. Fish. Sci. Vol: 31; 37-150.

East Greenland

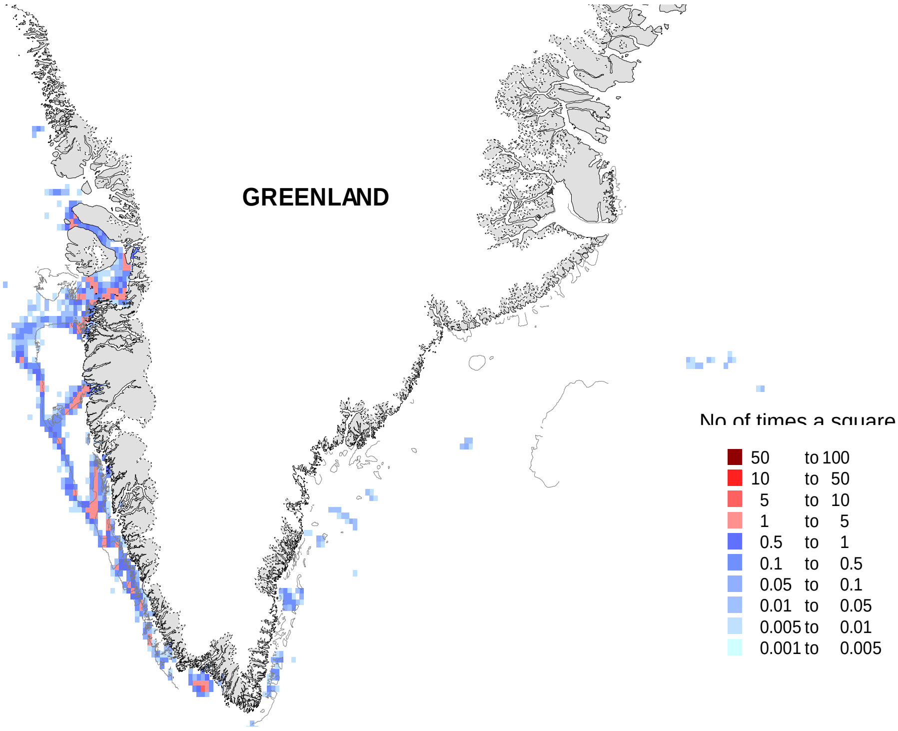
OFFSHORE:	VESSELS	TONNES	DICARD
Capelin	70	117838	0
G.halibut	26	8026	10
A.Halibut	10	248	0
Shrimp	28	7349	11
S. mentella Pel.	35	10680	11
Redfish sp.	2	106	0
S.Marinus	19	366	0
Roundn. grenadier	19	104	6
Wolffish	3	10	0
Mixed quota	3	485	1

West Greenland

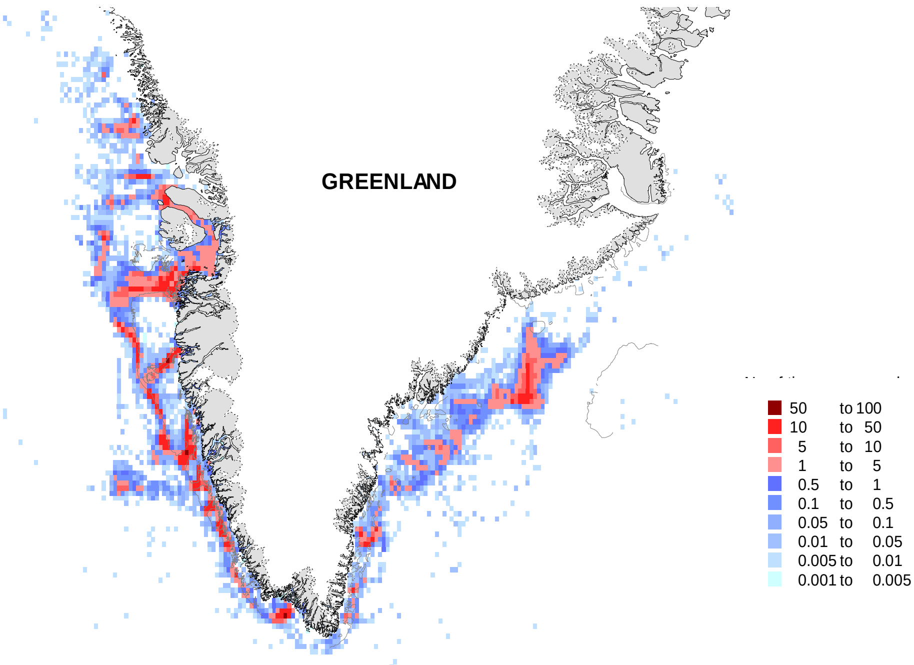
OFFSHORE:	VESSELS	TONNES	DICARD
G.halibut	17	9502	18
A.halibut	1	20	0
Shrimp	20	58623	9
Redfish sp.	14	2349	0
Roundn. grenadier	7	46	30
Cod	10	728	0
Inshore:			
Snow crab	12	2802	41
Scallops	4	2215	0

***vessels number included vessels from EU, Norway and Iceland**

Impact of shrimp fishery in 2002



Disturbance by fishing gear during the history of logbooks (~ 20 years)



5 COD STOCKS IN THE GREENLAND AREA (NAFO AREA 1 AND ICES SUBDIVISION XIVB)

5.1 Stock definition –offshore

Cod is described a common species in the Greenland fauna, although reaching here its ecological northern boundary. Given suitable environmental conditions, cod in the offshore areas of Greenland are considered to be self-sustaining. Stock parameters, slow growth and poor conditions (Lloret and Rätz 2000), late maturation, and highly variable recruitment strongly affected by environmental conditions, suggest that to be sustainable in long term, exploitation rates would need to be low, particularly in periods of cold water. In productive periods, higher exploitation rates could be sustainable, but it would be advisable to maintain a spawning stock biomass sufficiently large to buffer for brief periods of cold water. For assessment purposes Atlantic cod in Greenland waters is separated into three components: The offshore cod in East and West Greenland waters, West Greenland inshore cod and occasionally Icelandic offspring that are transported with the Irminger current to Greenland water (Storr-Paulsen et al. 2004). Historically spawning have occurred in East Greenland offshore water between approximately 62 and 66°N (Jónsson 1959; Meyer 1963), and eggs and larvae are transported towards Southeast and West Greenland (Wieland and Hovgård 2002). In addition, migration of immature cod from East to West Greenland has been seen in some years (Rätz 1994). In west Greenland offshore waters spawning has been observed at the offshore slope of Fylla Bank at 64 °N but more frequently at the various fishing banks further south including the northern part of Julianehåb Bight at 61 °N (Jónsson 1959; Meyer 1963; Diaz 1969). Eggs and larvae are transported along the coast towards Store Hellefisk Bank at about 67 - 68 °N.

5.1.1 Historic assessment

Prior to 1996, the cod stocks off Greenland have been divided into West and East Greenland or treated as one stock unit for assessment purposes to avoid migration effects. Fjord populations (inshore) have been included. In 1996, the offshore component off West and East Greenland, the so called Bank Cod, was assessed separately as one stock unit and distinguished from the inshore populations for the first time. The completion of a re-evaluation of available German sampling data for the offshore catches back to 1955 enabled such an analysis given in the 1996 North-Western Working Group report (ICES 1996/Assess:15). Due to the severely depleted status of the offshore stock component, the directed cod fishery was given up in 1992, the final year in the VPA. Since then, only provisional catch data were available as adopted from Horsted's (2000) analysis of catches 1910-1995 Information on the historic VPA is available in ICES 2001/Assess:20. Due to a strong recruiting yearclass (2003) there have been some attempts to make an analytic assessment for the offshore cod in 2005 (ICES 2005/ACFM: 25).

5.1.1.1 Trends in landings and fisheries (offshore component)

Officially reported landings are given in Tables 5.1.1 and 5.1.2 for West and East Greenland respectively and includes the inshore landings. Landings as used by the working group are listed in Table 5.1.3 by inshore areas for West Greenland and offshore areas for both West and East Greenland, their trends being illustrated in Figure 5.1.1.

In 1924 the offshore fishery at West Greenland took off and until 1929 the landings increased from 200t to 22000 t and exceeded the level of 120 000 t in 1931. The next 10 years landings were fluctuating in the range of 60 000 –130 000 t (Horsted 2000). During World War II landings decreased by 1/3 as only Greenland and Portugal participated in the fishery. Less is known about cod fisheries at East Greenland waters, but since 1954 landing statistics have been available. In the next 15 years the East Greenland landings were only contributing between 2-10 % of the total offshore landings (Figure 5.1.1.). During a period from the mid 1950s to 1960 the total annual landings taken offshore averaged about 270 000 t. In 1962 the offshore landings culminated with landings of 440 000 t. After this historic high, landings decreased sharply by 90 % to 46 000 t in 1974 and even further down in 1977. The level of 40 000 t was only exceeded during the periods 1982–83 and 1988–1990. Large changes in effort started in 1970, which increased during exploitation of the strong year classes born in 1973 and 1984. During 1989–91, the total landings decreased from 125 000 t by more than 65 %, in West Greenland waters the landings decreased 97 % in these three years. In 1992-2003 no directed cod fishery has taken place offshore in West Greenland, , although a high quota have been available. In West Greenland, only one longline vessel had a few settings in 2004 and caught 75 t in 2005. At East Greenland waters only a limited fishery has been conducted in this period amounting to 773 t in 2005. In 2005 no reports on discards have been available. Anecdotal information indicates that catches of close to 1000 t have been caught in East Greenland water although not registered in 2004.

Preliminary results from 2006 indicate that only a small portion of age-1 and partly age 2 cod is caught as by-catch in the shrimp fishery at West and East Greenland waters. The respective figures range from 1 t cod in 28 t of shrimp in 2004 and from 0.003 t cod in 140 t shrimp with mandatory sorting grids being applied in both cases. Investigations are ongoing in 2006. Logbook information about commercial catches and effort has been available from 1990-2005 from the offshore fishery in East Greenland. High landings occurred in the early 1990s reaching close to 35 000t. Since 1994 landings have fluctuated at low levels between 100-800t. In 2005, 9 trawlers and 4 longliners were involved in the fishery, of these had only 2 vessels their catch categorized as by-catch..

Miscellaneous gears, mainly long lines and gill nets, contributed 30–40% until 1977 but have disappeared since then (Horsted 2000), leaving otter trawl board (OTB) as the only operating fishing gear. In 2005 the longliners returned and caught 66 % of the total catch at East Greenland.

5.1.2 Surveys (offshore component)

5.1.2.1 Results of the German groundfish survey off West and East Greenland

Annual abundance and biomass indices have been derived using stratified random groundfish surveys covering shelf areas and the continental slope off West and East Greenland. Surveys commenced in 1982 and were primarily designed for the assessment of cod (*Gadus morhua* L.). A detailed description of the survey design and determination of these estimates was given in the report ICES 1993/Assess:18 and Working Doc. 4/2006. Figure 5.1.2 indicate names of the 14 strata, their geographic boundaries, depth ranges and areas in nautical square miles (nm^2). All strata were limited at the 3 mile line offshore except for some inshore regions off East Greenland where there is a lack of adequate bathymetric measurements. In 1984, 1992, and 1994 the survey coverage was incomplete off East Greenland and in 1995 and 2002 in West Greenland partly due to technical problems (Working Doc. 4/2006).

Stock abundance indices

Table 5.1.4 lists abundance and biomass indices for West and East Greenland, respectively and then combined for the years 1982–2005. Trends of the biomass estimates for West and East Greenland are shown in Figure 5.1.3, including the spawning stock. In 2005 the spawning stock biomass indices were revised and based on survey indices, 1982-2005, and historical maturity data presented by Horsted et al. (1983). The figure illustrate the pronounced increase in stock abundance and biomass indices from 23 million individuals and 45 000t in 1984 to 828 million individuals and 690 000t in 1987. This trend was the result of the recruitment of the predominating year classes 1984 and 1985, which were mainly distributed in the northern and the shallow strata off West Greenland during 1987–89. Such high indices were never observed in strata off East Greenland, although their abundance and biomass estimates increased during the period 1989–91 suggesting an eastward migration. During the period 1987–89, which were years with high abundance, the precision of survey indices was extremely low due to enormous variation in catch per tow data. Since 1988, stock abundance and biomass indices decreased dramatically by 99% to only 5 million fish and 6 000t in 1993. The 2005 survey results confirmed the severely depleted status of the SSB, although they represent the highest stock size in 15 years (17% of the abundance in 1987) and indicates a significant recovery signal as especially one strong year class (2003) has been registered in the survey. The total abundance and biomass indices amounted to 140 million individuals and 134 000 t, respectively, were 44 % of the stock in numbers were distributed off West Greenland but only 19 % of the biomass.

Age composition

Age disaggregated abundance indices for West, East Greenland and total are listed in Tables 5.1.5–7, respectively, and are based on 2045 individual age determinations. The year class 2003 was as 0-group by far the largest in the time series and is at age one in 2004 and age two in 2005 assessed as the second strongest year class and is in 2005 estimated to amount to 86 % of the strongest year class 1984 at age 2. The recruiting year classes 1998-2002 are considered weak as compared to the strong 1984- and 1985-year classes. The 0- group indices are considered unrepresentative of year class strength due to gear specifications while the age groups 1 and 2 seem to be quantitatively estimated and to represent a reasonable recruitment index , the latter being more precise.

Mean length at age

The trends of the mean length of the age groups 1–10 years for West and East Greenland are illustrated in Figure 5.1.5 and 5.1.6 respectively for the period 1982–2005. They reveal pronounced area and temperature effects. Age groups 3–10 years off East Greenland were found to be significant longer in average 15% than those off West Greenland. Driven by the high abundance of cod off West Greenland, weighted mean length and weight for the age groups 1–5 displayed a decrease during 1986–87 and remained at low levels until 1991. Since then, the length at age at ages 3 to 8 years increased significantly and remained at that high level until 2000, when low values were recorded. The 2005 values for East and West Greenland indicate a increase in mean length at age for all age classes except age 2 that remained at the same level. Mean weight at age can be obtained from regression $f(x)= 0.00895x^{3.00589}$, X=length in cm, the equation has been determined on the basis of historic measurements.

5.1.2.2 Results of the Greenland groundfish survey off West Greenland

Since 1988, the Greenland Institute of Natural Resources has conducted an annual stratified random trawl survey at West Greenland. The main purpose of the survey is to evaluate the biomass and abundance of the Northern shrimp (*Pandalus borealis*), but since 1992 data on fish species have been included. The survey covers the offshore areas at West Greenland between 59º15’N and 72º30’N and the inshore area of Disko Bay from the 3 mile limit down to the 600 m. (Figure 5.1.7). The survey area is divided into NAFO divisions and further subdivided into five depth strata (50-100, 101-150, 151-200, 201-400 and 401-600 m) on the basis of depth contour lines.

It is conducted with a 722 GRT trawler, equipped with a 3000/20-mesh Skjervøy with a twin cod end. 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 (Rosing and Wieland, 2005) but the results for cod are still awaiting final approval. To allow comparison of abundance and biomass throughout the time series, the 2005 results were divided by a preliminary conversion factor of 1.78 to adjust the Cosmos trawl catches to the former Skjervøy trawl standard. The preliminary conversion factor was derived as described by Rosing and Wieland (2005). Stratified abundance and biomass estimates are calculated from catch-per-tow data using the strata area as weighting factor (Cochran, 1977). The catchability coefficient is set at 1.0, implying that estimates are merely indices of abundance and biomass. Confidence intervals (CI) were set at the 95% level of significance of the stratified mean.

Stock abundance indices

The biomass indices for cod were in the survey estimated to be between 4000-7000 t in the period 1988-1990. In 1992 the biomass decreased by more than 95 % to only 250 t and remained at this low level until recent years. Since 2001 a slight improvement was detected in the biomass index and in 2005 the biomass level increased tenfold compared to 2004, estimated to be close to 24200 t (Table 5.1.8 and 5.1.9). Abundance was estimated to be 45 millions individuals, which is the highest number in the time series (1992-2005), and this is mainly caused by a high abundance of age 2 cod.

Age composition

Age disaggregated abundance indices are listed in Table 5.1.10 and indicates that more year-classes is occurring, although there still is a dominance of age group 2 contributing to 61 % of the total abundance. In 2005, age length keys were determined on the basis of 363 otoliths.

5.1.3 Biological sampling of commercial catches

Length measurements from samples taken on board one long-line vessel fishing in both East and West Greenland waters and one trawler fishing only in East Greenland waters in 2005 were available (Figure 5.1.8).

5.1.4 Stock assessment (offshore component)

To estimate the abundance of the strong 2003 year class in relation to historic year class strengths (Figure 5.1.9 and 5.1.10) an XSA model was used by the working group in 2005 to derive the strength of the 2003 year class at age 3 in 2006 estimated to 92 mill fish. This exercise was repeated and the updated estimate of the 2003 year-class is 136 mill fish. This year-class will produce a spawning stock of approx. 150 000 t in 2010-15 by a simple forward projection (Figure 5.1.11).

5.1.5 State of the stock (offshore component)

Age disaggregated abundance indices for West Greenland indicate the presence of a broader range of year classes than in the previous years. However, there is still a dominance of a single cohort, i.e. age group 2 of the 2003 year class, which contributes to 72 % of the total abundance.

From the survey index, the 2003 year class at age 2 is estimated to range in the order of 86 % of the last strong 1984 year class at similar age. Maps on the geographic distribution patterns of the 2 year classes are visualized in Figure 5.1.12, together with the consecutive year classes 2004 and 2005.

Mortality rates derived from the survey and low landings imply that the recent exploitation rate is very low (Figure 5.1.13).

5.1.6 Management considerations

There is strong evidence for a significant increase in the cod stock abundance in medium term, not only from a single strong recruiting year class but also from increased growth rates and earlier maturation probably enhanced by continued favourable environmental conditions (Fig. 5.1.5 and 5.1.6).

The working group notes that there exist no management objectives for the exploitation of the Greenland cod. No direct fishing should take place on the stock and maximum protection of juvenile cod is required to increase the recovery potential of the stock. Given the fishing possibilities of the stock, a recovery plan urgently needs to be developed. Such multi-annual harvest plan needs to account not only the stock dynamics but also needs to incorporate the ecological interaction with the shrimp stock and its exploitation as well as temperature effects.

5.1.7 Comments on the assessment

There is evidence from both the German and Greenland survey that the 2003 year class are strongly contributing to the offshore cod stock. However, the state of the spawning stock biomass will remain very low until 2008 and after that, still low compared to historically values (Figure 5.1.10). A significant part of the earlier strong 1984 year class was observed to have migrated to Iceland when ready for first spawning (Storr-Paulsen et al. 2004). Whether the 2003 year class will show a similar migration is uncertain as environmental conditions as well as optimal feeding conditions might influence the migration behaviour.

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Wieland, K. and H. Hovgård, 2002. Distribution and of Atlantic cod (*Gadus morhua*) eggs and larvae in Greenland offshore waters. J. Northw. Atl. Fish. Sci. 30: 61-76.5.1.1 Cod off Greenland (offshore component)

Table 5.1.1 Nominal catch (t) of Cod in NAFO Sub-area 1, 1988-2005 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	-	-				6043

[1]) Provisional data reported by Greenland authorities

[2]) Includes 3,000 t reported to be caught in ICES Sub-area XIV

[3]) Includes 2,741 t reported to be caught in ICES Sub-area XIV

[4]) Includes 29,513 t caught inshore

[5]) Transshipment from local inshore fishers

Table 5.1.2 Nominal catch (t) of cod in ICES Sub-area XIV, 1988-2005 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 5.1.3 Cod off Greenland (offshore component). Catches (t) from 1924 – 2005 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 figures.

COD	INSHORE			OFFSHORE			TOTAL
Year	Nafo 1 B	Nafo 1D	Total inshore	East	West	Total offshore	Greenland
1924	131	221	843		200	200	1043
1925	122	318	1024		1871	1871	2895
1926	97	673	2224		4452	4452	6676
1927	282	982	3570		4427	4427	7997
1928	426	1153	4163		5871	5871	10034
1929	1479	1335	7080		22304	22304	29384
1930	2208	1681	9658		94722	94722	104380
1931	1905	1520	9054		120858	120858	129912
1932	1713	1042	9232		87273	87273	96505
1933	1799	1148	8238		54351	54351	62589
1934	2080	952	9468		88122	88122	97590
1935	1870	769	7526		65846	65846	73372
1936	2039	705	7174		125972	125972	133146
1937	1982	854	6961		90296	90296	97257
1938	1743	703	5492		90042	90042	95534
1939	2256	896	7161		89807	89807	96968
1940	2478	1061	8026		43122	43122	51148
1941	3229	823	8622		35000	35000	43622
1942	3831	1332	12027		40814	40814	52841
1943	5056	1240	13026		47400	47400	60426
1944	4322	1547	13385		51627	51627	65012
1945	4987	1207	14289		45800	45800	60089
1946	5210	1438	15262		44395	44395	59657
1947	5261	2096	18029		63458	63458	81487
1948	5660	1657	18675		109058	109058	127733
1949	4580	2110	17050		156015	156015	173065
1950	6358	2357	21173		179398	179398	200571
1951	5322	2571	18200		222340	222340	240540
1952	4443	2437	16726		317545	317545	334271
1953	5030	5513	22651		225017	225017	247668
1954	6164	3275	18698	4321	286120	290441	309139
1955	5523	4061	19787	5135	247931	253066	272853
1956	5373	5127	21028	12887	302617	315504	336532
1957	6146	5257	24593	10453	246042	256495	281088
1958	6178	5456	25802	10915	294119	305034	330836
1959	6404	5009	27577	19178	207665	226843	254420
1960	6741	3614	27099	23914	215737	239651	266750
1961	6569	4178	33965	19690	313626	333316	367281
1962	7809	3824	35380	17315	425278	442593	477973
1963	4877	2804	23269	23057	405441	428498	451767
1964	3311	8766	21986	35577	327752	363329	385315
1965	5209	6046	24322	17497	342395	359892	384214
1966	8738	7022	29076	12870	339130	352000	381076
1967	5658	6747	27524	24732	401955	426687	454211
1968	1669	6123	20587	15701	373013	388714	409301
1969	1767	7540	21492	17771	193163	210934	232426

Table 5.1.3 Cod off Greenland (offshore component). Continued.

COD	INSHORE			OFFSHORE			TOTAL
Year	Nafo 1 B	Nafo 1D	Total inshore	East	West	Total offshore	Greenland
1970	1469	3661	15613	20907	97891	118798	134411
1971	1807	3802	13506	32616	107674	140290	153796
1972	1855	3973	14645	26629	95974	122603	137248
1973	1362	3682	9622	11752	53320	65072	74694
1974	926	2588	8638	6553	39396	45949	54587
1975	1038	1269	6557	5925	41352	47277	53834
1976	644	904	5174	13027	28114	41141	46315
1977	580	2946	13999	8775	23997	32772	46771
1978	1587	2614	19679	7827	18852	26679	46358
1979	1768	6378	35590	8974	12315	21289	56879
1980	2303	7781	38571	11244	8291	19535	58106
1981	2810	6119	39703	10381	13753	24134	63837
1982	2448	7186	26664	20929	30342	51271	77935
1983	2803	7330	28652	13378	27825	41203	69855
1984	3908	5414	19958	8914	13458	22372	42330
1985	2936	1976	8441	2112	6437	8549	16990
1986	1038	1209	5302	4755	1301	6056	11358
1987	2995	8110	18486	6909	3937	10846	29332
1988	6294	2992	18791	12457	36824	49281	68072
1989	8491	8212	38529	15910	70295	86205	124734
1990	9857	9826	28799	33508	40162	73670	102469
1991	8641	2782	18311	21596	2024	23620	41931
1992	2710	1070	5723	11349	4	11353	17076
1993	323	968	1924	1135	0	1135	3059
1994	332	914	2115	437	0	437	2552
1995	521	332	1710	284	0	284	1994
1996	211	164	948	192	0	192	1140
1997	446	99	1186	370	0	370	1556
1998	118	78	323	346	0	346	669
1999	142	336	622	112	0	112	734
2000	266	332	764	100	0	100	864
2001	1183	54	1680	221	0	221	1901
2002	1803	214	3698*	448	0	448	4146*
2003	1522	274	5215*	286	7	293	5515*
2004	1316	116	4948*	369	27	396*	5344*
2005	2351	1162	6043	773	75	847*	6890*

Table 5.1.4 Cod off Greenland (offshore component), German survey. Abundance (1000) and biomass indices (t) for West, East Greenland and total by stratum, 1982-2005. Confidence intervals (CI) are given in per cent of the stratified mean at 95% level of significance. () incorrect due to incomplete sampling. Spawning stock biomass indices (tons) based on survey indices, 1982-2005, and historical maturity data.

	Abundance					Biomass				
YEAR	WEST	EAST	TOTAL	CI	Spawn.	WEST	EAST	TOTAL	CI	Spawn.
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

Table 5.1.5 Cod off West Greenland (offshore component), German survey. Age disaggregate abundance indices (1000), 1982-2005. *) 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

Table 5.1.6 Cod off East Greenland (offshore component), German survey. Age disaggregate abundance indices (1000), 1982-2005. *) 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

Table 5.1.7 Cod off Greenland (total offshore component), German survey. Age disaggregate abundance indices (1000), 1982-2005. *) 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

Table 5.1.8 Cod off Greenland (offshore component), Greenland survey. Abundance indices (1000) for West Greenland by stratum, 1991-2005. Confidence intervals (CI) are given in percent of the stratified mean at 95% level of significance. () incorrect due to incomplete sampling.

YEAR	1AN	1AS	1AX	1BN	1BS	1C	1D	1E	1F	WEST GR.	CI
1991	0	0	10	6	10	337	481	*	*	(846)	51
1992	0	0	4	16	37	243	345	0	8	653	49
1993	0	0	2	0	16	54	135	286	18	512	68
1994	0	10	0	0	41	87	0	6	0	144	47
1995	0	0	0	40	11	380	44	62	39	578	55
1996	0	0	0	0	0	46	68	87	107	308	55
1997	0	0	0	0	7	31	0	0	0	38	68
1998	0	0	0	4	0	0	26	26	3	59	54
1999	0	12	20	90	46	16	23	6	0	213	29
2000	0	186	399	270	167	71	58	9	189	1349	23
2001	0	0	26	236	69	110	448	305	313	1508	26
2002	0	0	13	69	134	78	3294	114	457	4158	50
2003	0	112	380	1356	39	351	727	214	211	3391	22
2004	0	0	197	37	115	379	2630	1538	1610	6507	29
2005	0	19	57	404	83	1055	2830	3451	37110	45010	45

Table 5.1.9 Cod off Greenland (offshore component), Greenland survey. Biomass indices (t) for West Greenland by stratum, 1988-2005. Confidence intervals (CI) are given in per cent of the stratified mean at 95% level of significance. () incorrect due to incomplete sampling.

YEAR	1AN	1AS	1AX	1BN	1BS	1C	1D	1E	1F	WESTGR.	CI
1990	2	13	*	75	3	83	9005	*	*	(9180)	65
1991	0	0	7	2	15	151	310	*	*	(485)	44
1992	0	0	3	20	34	75	118	0	2	251	45
1993	0	0	2	0	5	25	39	124	5	200	70
1994	0	3	0	0	9	38	0	1	0	51	46
1995	0	0	0	5	1	120	23	3	4	155	63
1996	0	0	0	0	0	15	23	27	49	113	51
1997	0	0	0	0	2	53	0	0	0	55	76
1998	0	0	0	1	0	0	47	50	3	101	56
1999	0	1	5	23	5	1	17	1	0	53	47
2000	0	51	99	76	54	21	9	2	46	357	23
2001	0	0	15	125	30	56	178	98	100	603	23
2002	0	0	13	54	74	41	1489	42	150	1863	46
2003	0	18	111	315	8	264	453	118	46	1332	26
2004	0	0	496	46	7	176	680	685	305	2394	28
2005	0	9	18	185	11	254	758	604	22360	24199	46

Table 5.1.10 Cod off Greenland (offshore component), Greenland survey. Age disaggregate abundance indices (1000) for West Greenland, 1992-2005.

YEAR	0	1	2	3	4	5	6	7	8+	TOTAL
1992	0	0	221	126	123	63	10	3	1	547
1993	0	0	39	170	73	16	7	1	2	308
1994	0	0	10	126	22	8	1	0	0	167
1995	0	19	345	101	157	40	0	0	0	662
1996	0	0	14	203	78	3	0	0	0	298
1997	0	0	0	10	3	24	8	1	0	46
1998	0	0	17	25	20	0	0	0	0	62
1999	0	7	144	66	23	6	1	1	1	249
2000	0	90	711	363	92	13	52	0	0	1321
2001	0	97	540	546	376	0	0	0	0	1559
2002	0	0	603	2323	1078	245	0	4	0	4253
2003	0	81	1416	1037	433	135	18	0	0	3120
2004	0	1215	2812	1205	786	382	71	33	4	6508
2005	518	3208	27644	10380	1796	845	584	25	6	45006

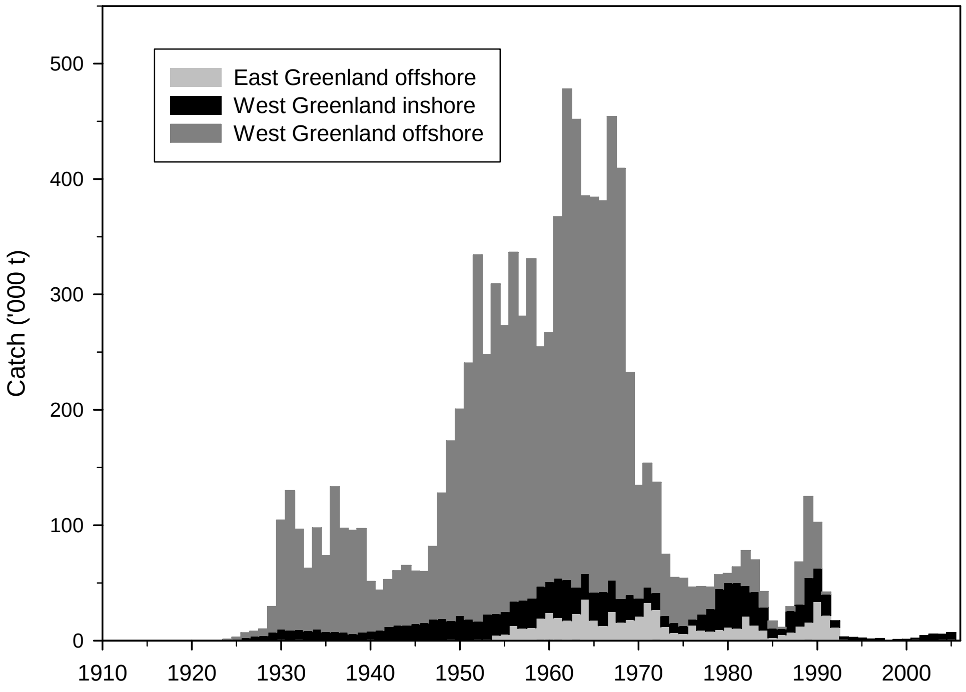


Figure 5.1.1 Cod off Greenland. Catches 1911-2005 as used by the Working Group, inshore and offshore by West and East Greenland (Horsted 1994,2000).

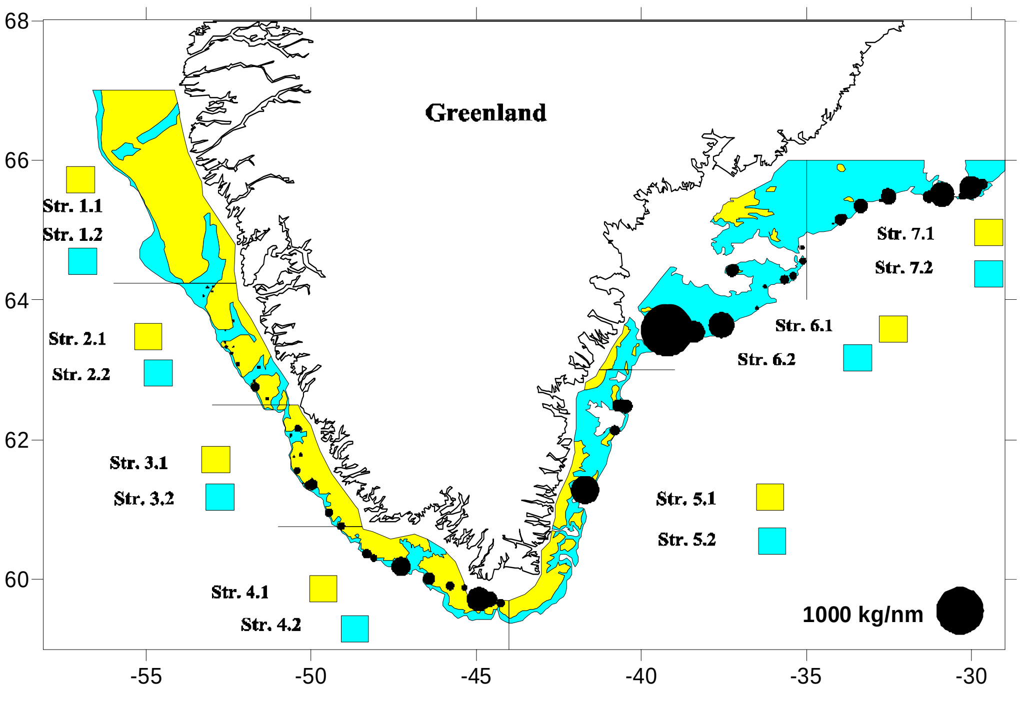


Figure 5.1.2 Cod off Greenland (offshore component), German survey. Survey area, stratification and position of hauls carried out in 2005.

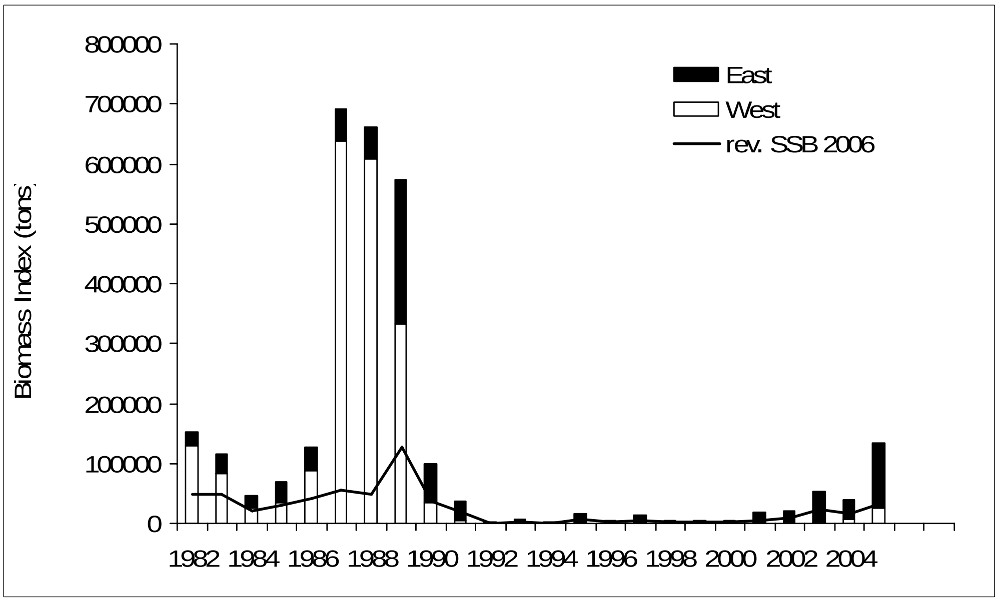


Figure 5.1.3 **Cod off Greenland (offshore component), German survey. Aggregated survey biomass indices for West and East Greenland and revised spawning stock biomass, 1982-2005. Incomplete survey coverage in 1984, 1992, and 1994.**

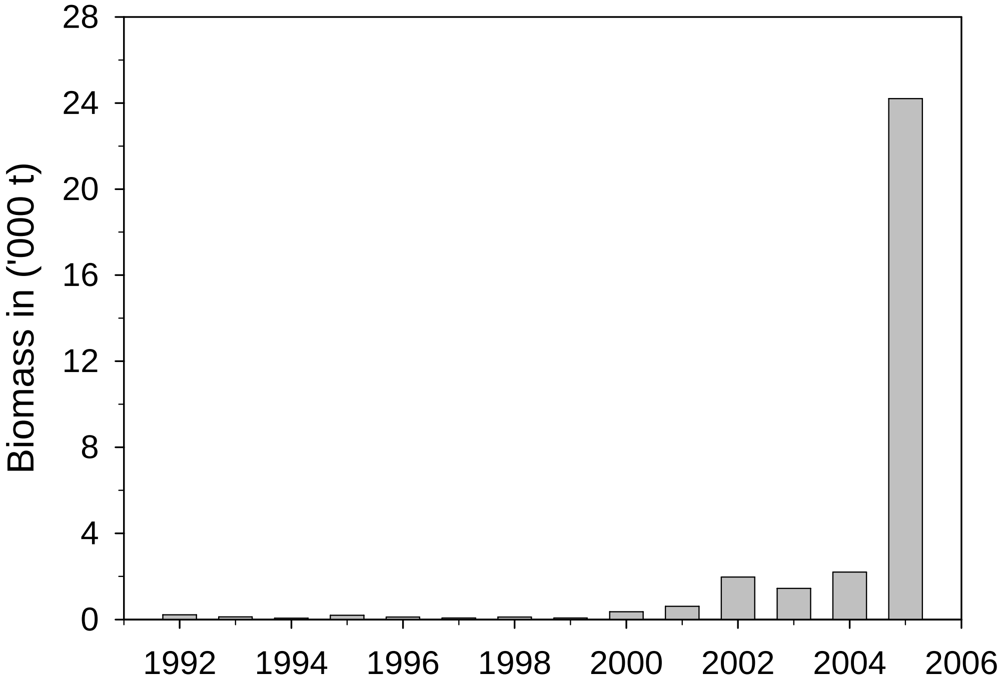


Figure 5.1.4 **Cod off Greenland (offshore component), Greenland survey. Aggregated survey biomass indices for West Greenland, 1992-2005.**

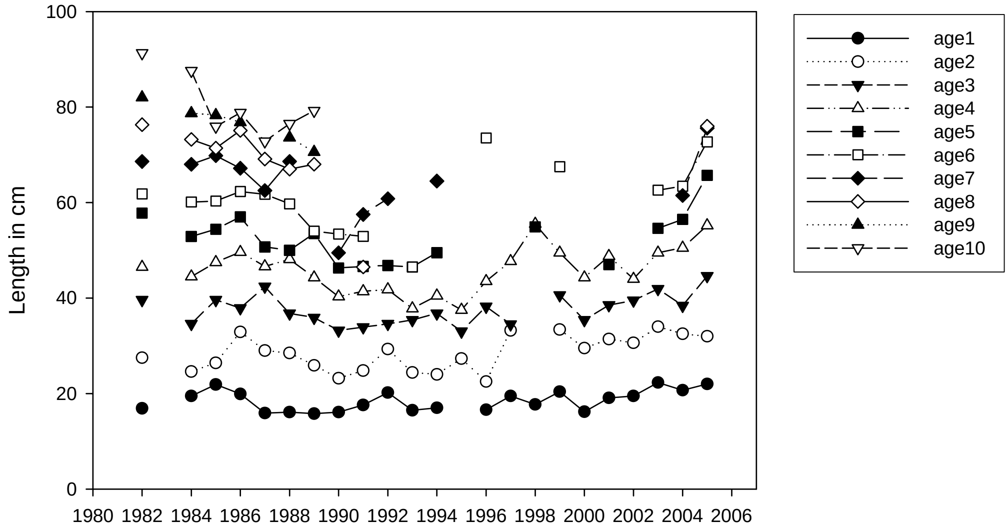


Figure 5.1.5 Weighted mean length at age 1-10 years 1982, 1984-2005 sampled in West Greenland. Data derived from German survey.

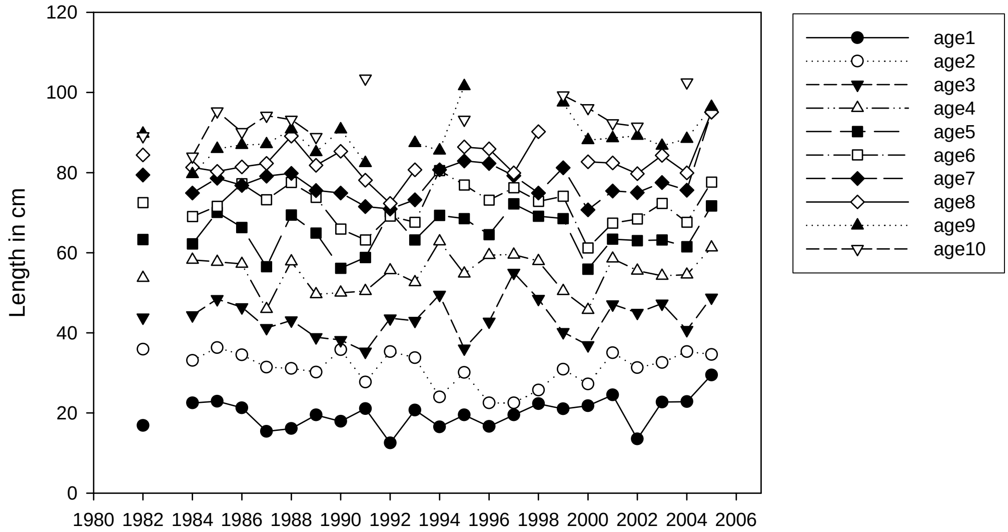


Figure 5.1.6 Weighted mean length at age 1-10 years 1982, 1984-2005 sampled in East Greenland. Data derived from German survey.

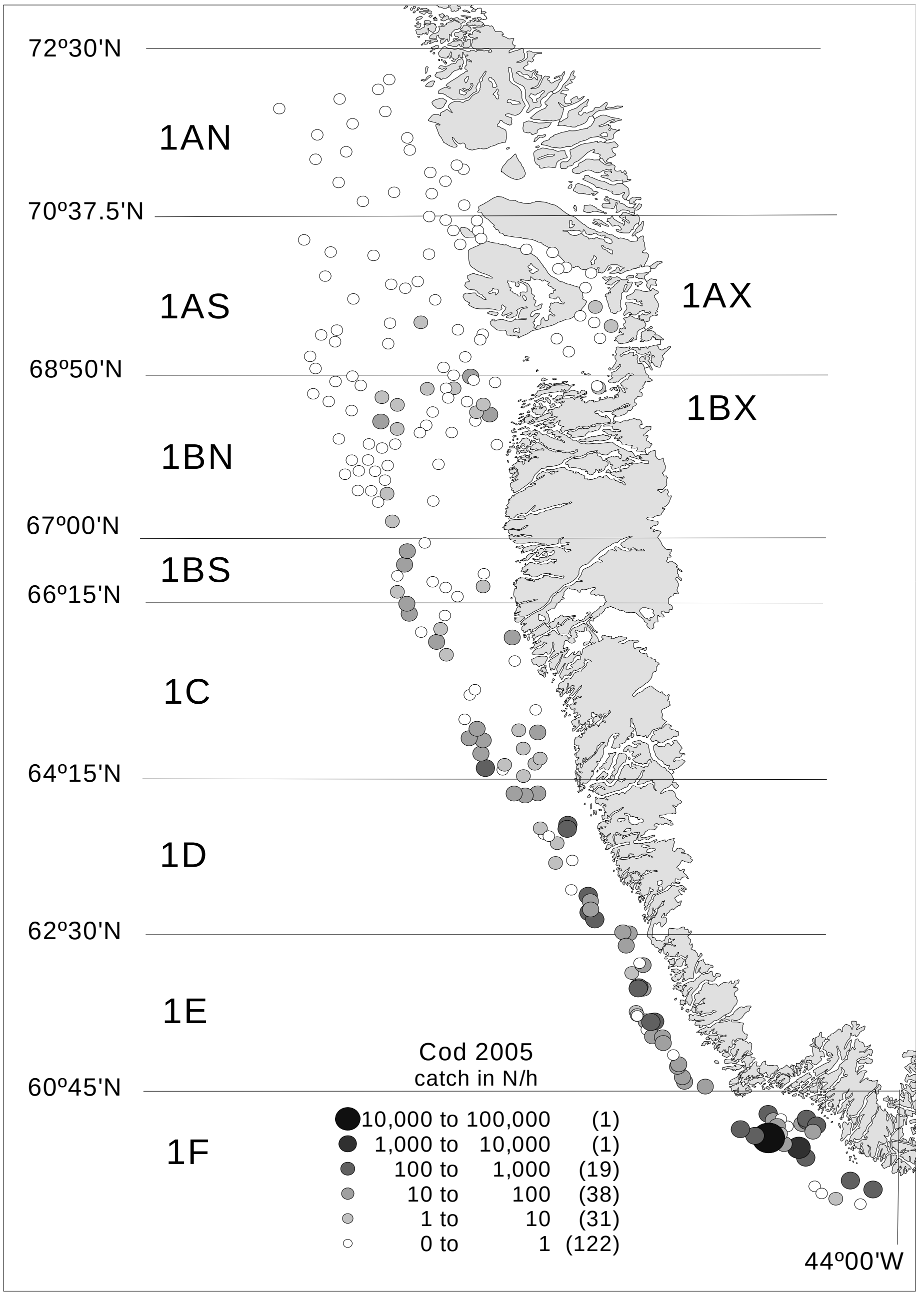
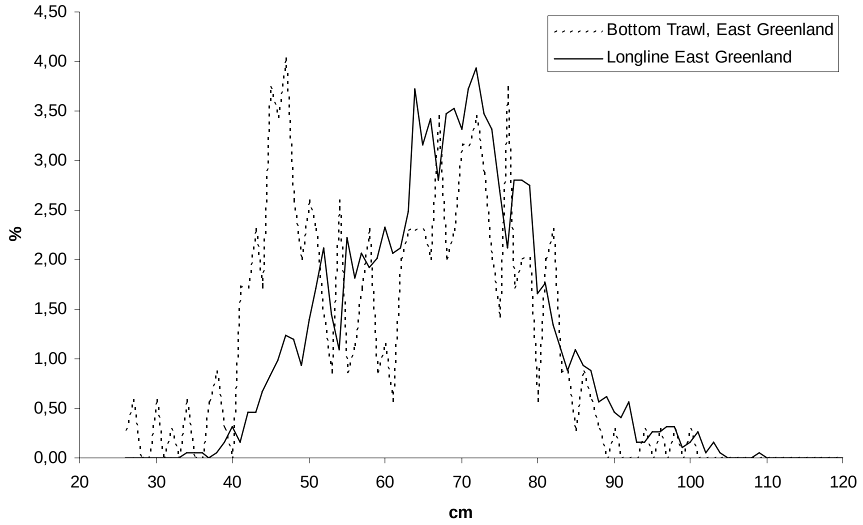


Figure 5.1.7 Number of cod /hour trawl off Greenland (offshore component), Greenland survey. Survey area, stratification and position of hauls carried out in 2005.



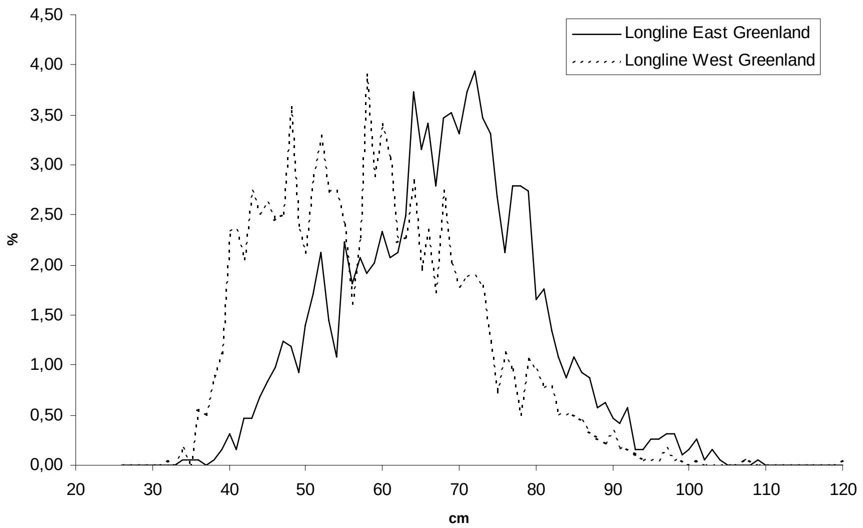


Figure 5.1.8 Length distributions of cod from the commercial fishery in 2005. From the longline vessel samples were present from both East and West Greenland, while the samples from the trawler were from East Greenland only.

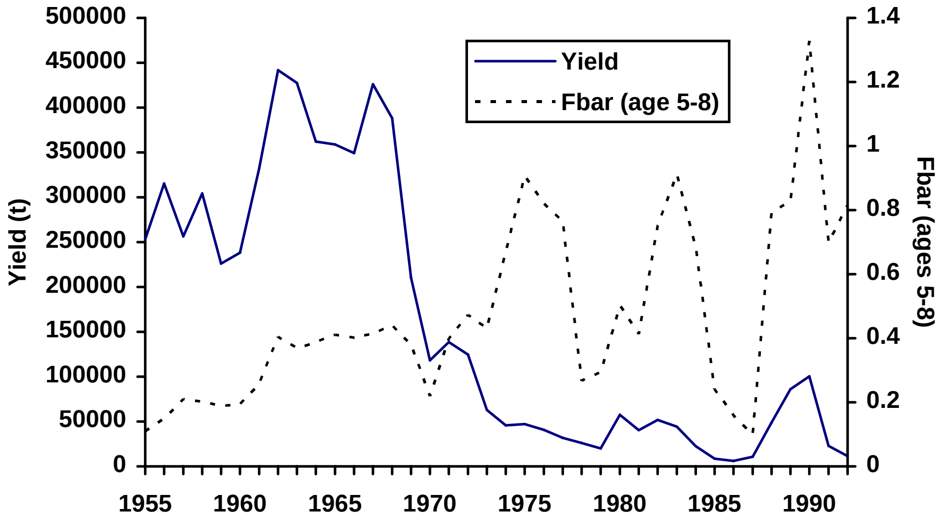


Figure 5.1.9 **Greenland cod (offshore component). Trends in yield and fishing mortality.**

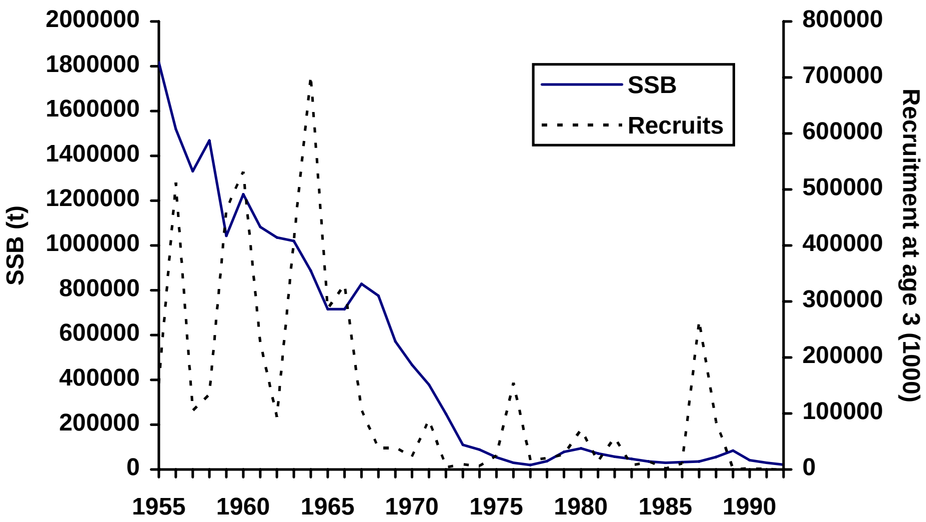


Figure 5.1.10 **Greenland cod (offshore component). Trends in spawning stock biomass (SSB) and recruitment.**

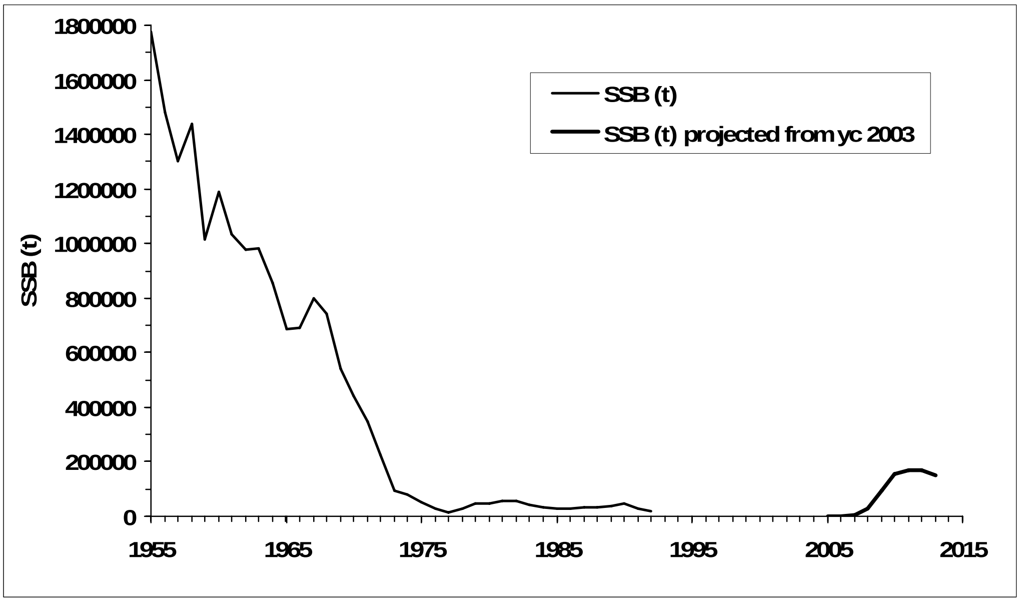
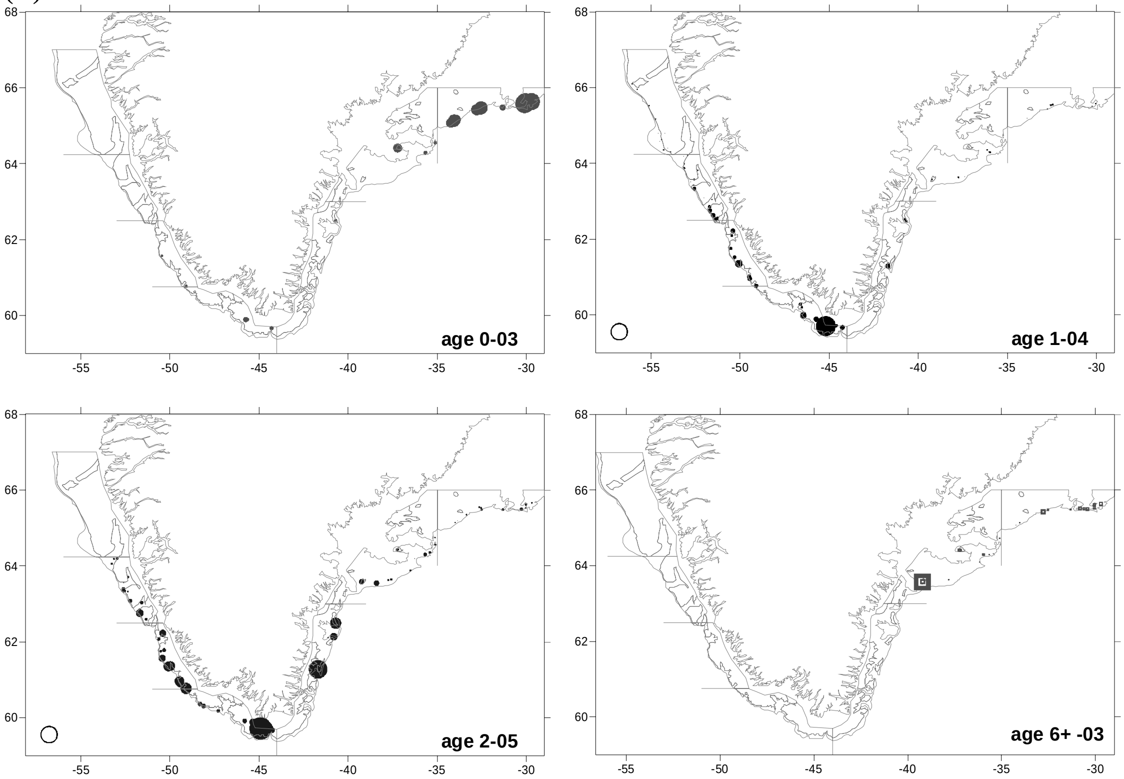
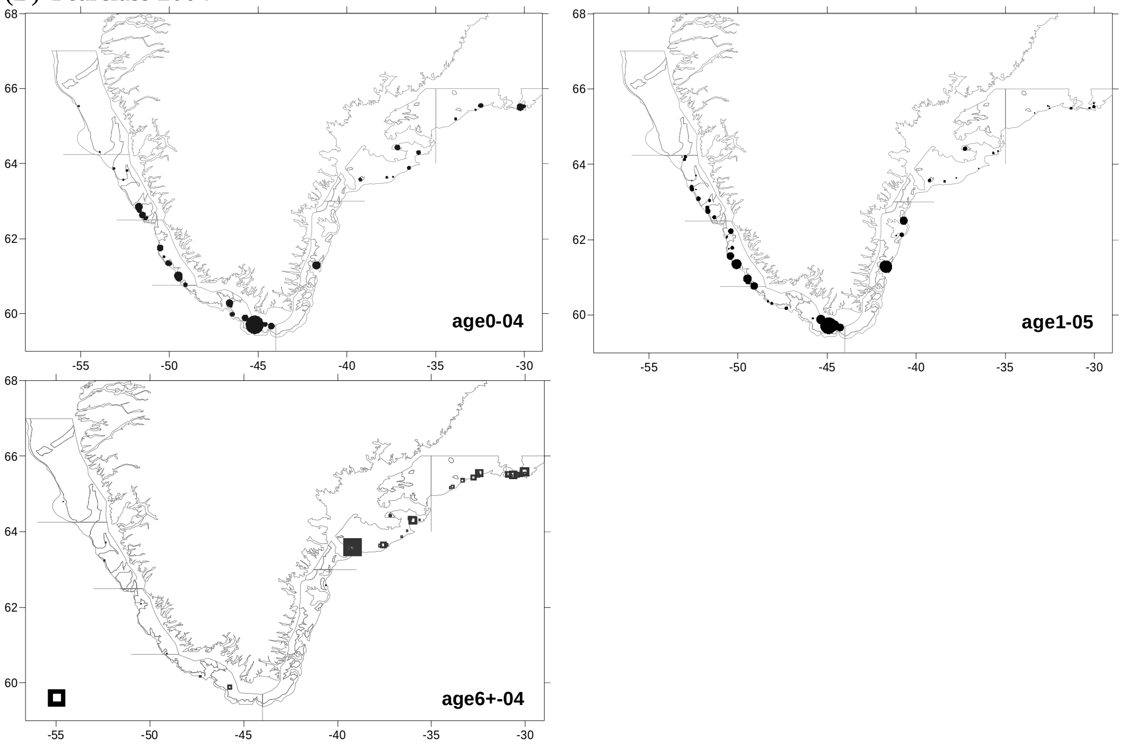


Figure 5.1.11 Greenland cod offshore component. Medium term projection of SSB from the year class 2003 in comparison with the historic SSB trajectory until 1991.

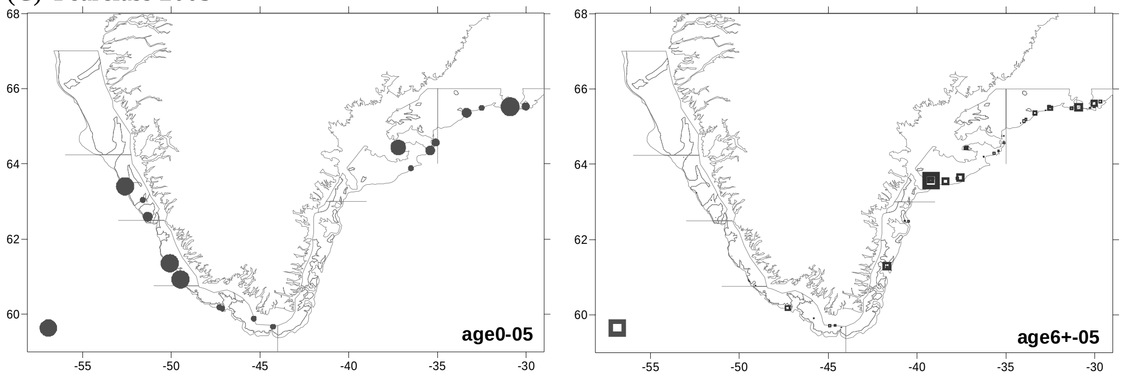
(A) Yearclass 2003



(B) Yearclass 2004



(C) Yearclass 2005



(D) Comparison at age 2 for yc's 1984 and 2003

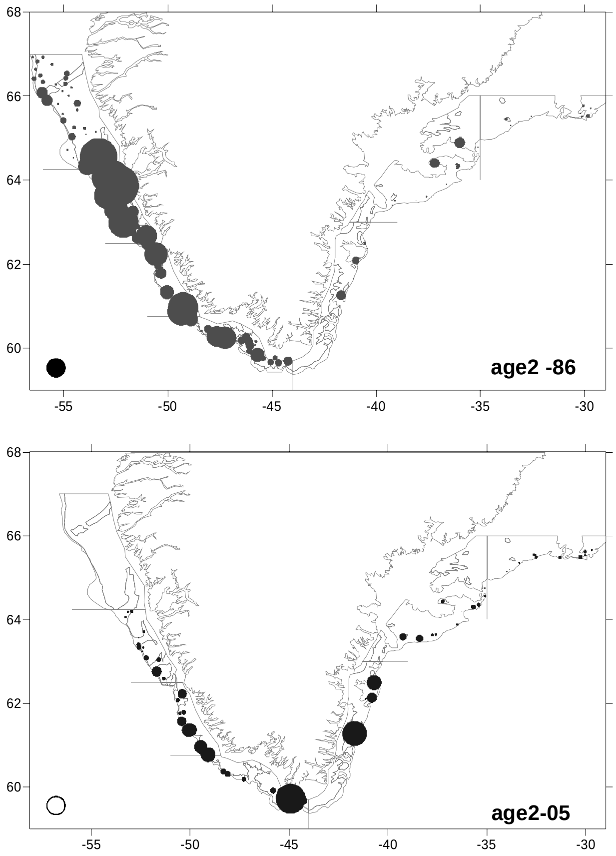


Figure 5.1.12 Relative distribution of the abundance by number of yearclasses (A) 2003, (B) 2004, (C) 2005 and (D) at age 2 in 1986 and 2003, each for consecutive years. Source German groundfish survey.

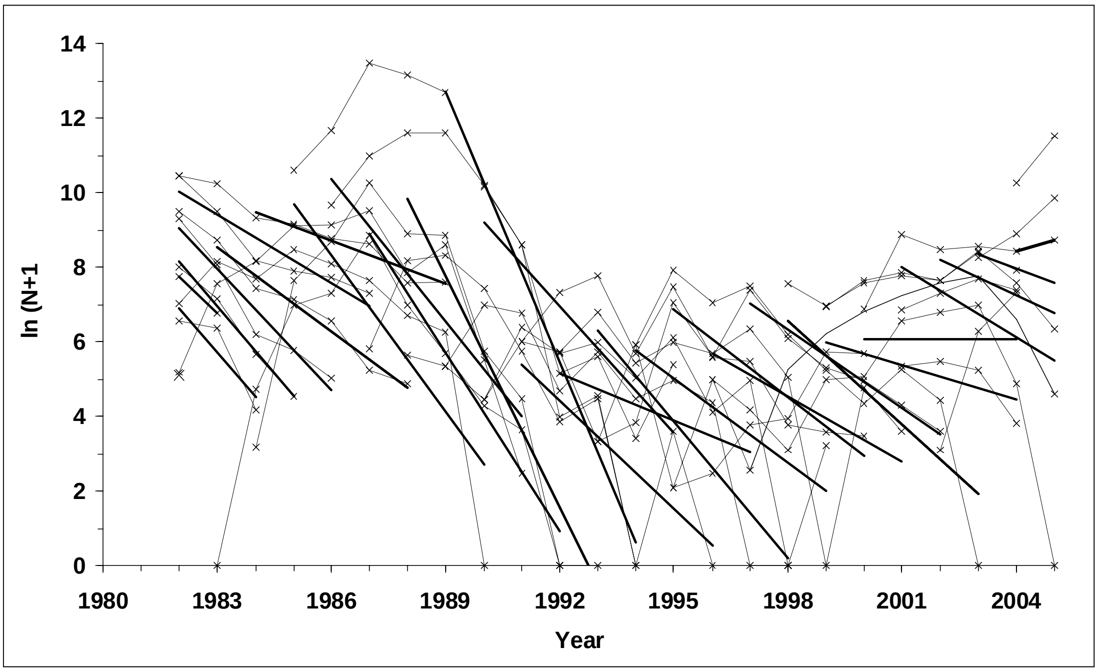


Figure 5.1.13 Catch curves as derived from log-transformed survey abundance values of the various cohorts 1972-2003 at ages 1 to 10 during 1982.- 2005. The slopes of the bold lines indicate total cohort mortality at ages 5 to 10.

5.2 Cod off Greenland (Inshore component)

Spawning cod is documented for several fjords and costal areas between 64 and 67°N in West Greenland (Hansen 1949, Smidt 1979, Buch *et al*., 1994). The inshore cod populations are believed to be relatively stationary, as most (82-86%) of the cod recaptured were found in the same area as they were tagged (Hovgård and Christensen 1990). Some interactions between the offshore and inshore cod stocks probably exist as the strong 1984- and partly 1985 year-class was registered in the inshore gillnet survey as well as in the inshore landings. These strong year-classes are believed to be Icelandic cod spawned off South-western Iceland. Some year's larvae are carried by the Irminger current to settle in South and West Greenland and contribute to the local fjord populations (Wieland and Hovgaard 2002).

5.2.1 Trends in landings and fisheries (Inshore component)

The Greenland commercial cod fishery started locally in West Greenland in 1911 at some localities where cod seemed to occur regularly during summer and autumn. It took 15 years to reach 1 000t (Hansen 1949). In 1924 an offshore fishery started and until 1974 the inshore landings have been of limited importance accounting for only 5-15% of the total fishery in Greenland water. Annual catches above 20 000t have been taken inshore during the period 1955-1969 and in 1980 and 1989 catches of approximately 40 000t were landed, partly driven by a few strong year classes entering from the offshore stock (Horsted 2000). Due to the very low offshore landings the importance of the inshore landings has increased accounting for between 50-90% landings in the period 1993 –2005. In the same period the inshore landings have been fluctuating between 500-6 000t.

A historic low was reached in 1998 with a total inshore catch at 326t, the lowest catch registered since 1918. Since 1998, slight improvements have been registered with catches increasing to approximately 4000t in 2002. Catch statistics for 2005 are approximately 6000t where NAFO division 1B is accounting for more than 1/3 of the total inshore landings (table 5.2.1). A commercial pound net CPUE series is available between 1992-1999. The mean catch per pound net setting decreased from 804 t in 1994 to 284 in 1999. No commercial effort data from 2000 to 2002 and catch at age data in 1997-1998 and 2000-2001 have been available to the working group.

5.2.2 Survey (Inshore component)

5.2.2.1 Results of the West Greenland young cod survey

A survey using gangs of gill nets with different mesh-sizes has been conducted since 1985 with the objective to assess the abundance and distribution of pre-recruit cod in inshore areas of Greenland. The survey has usually been carried out in three inshore areas off West Greenland: Qaqortoq (NAFO Div. 1F), Nuuk (Div. 1D) and Sisimiut (Div. 1B). The Greenland inshore cod stock is not distributed in the Qaqortoq area, but occasional inflow of pre-recruited cod from East Greenland and Iceland shows up here. Technical problems caused that only Division 1D was covered in 1999, and again in 2000 only Div. 1D and Div. 1F was covered. A more detailed description of the survey is provided in the 2001 report and WD 7/2006. No survey took place in 2001, in 2005 Div. 1B and 1D were covered.

The recruitment index of 2-year old cod is shown in Figure 5.2.1 and reveals a strong 1984 - year class. Between 1996 and 2000 the recruitment index was very low. An increase in 2-year recruits was observed in 2002 Div 1B, reaching the levels from 1986-87 suggesting a strong 2000 year-class in this division however as this area has not been covered during the three previous years, the size of the year class remains uncertain. The overall survey results for

2005 indicate an increase of the recruitment index in division 1B to a level that is above average (1985-2005). The recruitment index for division 1D decreased some for age group 2 and is still considered at a very low level.

5.2.3 Biological sampling of commercial landings

The commercial catches were according to the Greenland catch statistic and Greenland Fisheries License Control at 6043 t in 2005 witch corresponds to a increase at 22% compared to 2004. Pound nets are used to take about 60% of the inshore catch, handline, longline and set gillnets are accounting for 37%. Peak fishing time is June and July were more than 60% of the catches is taken. Catch-at-age and weight-at-age are showed in Table 5.2.1 and 5.2.2). The average weight of the measured fish in the catches increased from 0.78 kg in 2004 to 1.14 kg in 2005 and was for nearly all age groups above average.

5.2.4 Assessment of the stock

Previously an Schaefer general production model was fitted to the Greenland inshore cod landing data using the commercial pound net CPUE results for 1993 to 1997 as an index of stock biomass. Lack of contrast in data impeded the model to run satisfactory.

Catch-at-age and weight-at-age data for the period 1985-1996 and for 1999 and 2002-2005 were available to the working group (Table 5.2.2 and 5.2.3). A statistical age structured model implemented MS Excel on the inshore cod stock was used by the working group in 2002 as an exploratory tool to estimate the likely historical stock and exploitation dynamics. Due to insufficient data it was not accepted by the working group for assessment purpose (ICES CM 2003/ACFM:24,) and the model was not updated this year.

5.2.5 Comments on the assessment

The exploitation rate of the stock is unknown as no logbook information is available. However, a logbooks system will be implemented in summer 2006 for vessels larger than 30 feet only.

5.2.6 Status of the stock

The survey data presented indicate that the stock has undergone a series of poor recruitment in recent years, but recovery potential was observed in Div. 1B in 2002.

5.2.7 Biological reference points

No specific values can be put forward as reference points due to the depleted state of the stocks.

5.2.8 Management considerations

The inshore fishery exploiting possible self-sustained local fjord populations off West Greenland has historically been small, and the fishery has never been regulated. The data from the commercial fishery are considered insufficient to provide advice. If advice were required, additional information from the commercial fishery would be required. In particular logbook information would be very valuable. A recovery plan should be developed for this stock.

Table 5.2.1 Cod catches divided to NAFO -divisions, caught inshore from vessels 50 GRT (Horsted 2000, Statistic Greenland 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]

Table 5.2.2 Catch at age (abundance in millions) 1985-2005, missing values in 1997, 1998, 2000 and 2001.

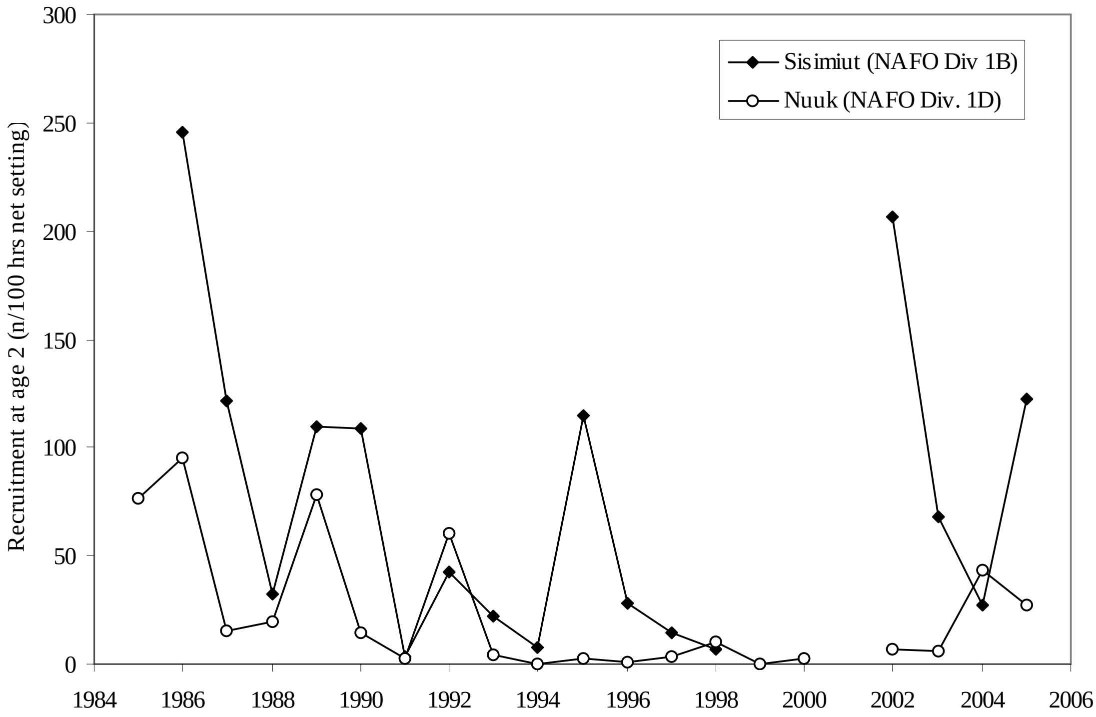
Year\Age	1	2	3	4	5	6	7	8	9
1985				0.742	0.588	2.464	0.154	0.604	0.016
1986				0.172	0.170	1.245	0.117	0.565	0.014
1987		0.043	0.594	7.638	4.153	0.320	0.877	0.229	0.415
1988		0.052	0.214	7.533	6.446	0.421	0.452	0.088	0.184
1989		0.006	0.218	11.813	12.619	1.318	1.369	0.172	0.276
1990		0.002	0.154	10.169	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	

Table 5.2.3 Weight at age in landing 1985-2005, 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	

Table 5.2.4 CPUE (number of age 1,2,3 and 4 cod caught per 100 hours net setting) in the Greenland Gill net cod survey covering West Greenland 1987-2005.

Age	1	2	3	4
1985	107.5	45.4	0.4	2.5
1986	6.2	124.0	11.8	1.3
1987	0.3	75.0	119.8	6.7
1988	0.0	15.3	72.3	34.3
1989	0.1	58.5	37.3	21.7
1990	0.0	24.1	35.0	12.2
1991	63.6	2.4	29.0	12.2
1992	0.1	38.2	13.1	7.7
1993	0.0	6.9	33.2	10.5
1994	0.7	1.4	6.4	4.3
1995	0.2	19.0	3.8	3.2
1996	0.0	7.5	10.3	1.7
1997	1.9	5.9	2.7	0.8
1998	0.3	7.7	13.5	1.3
1999	0.0	0.4	1.2	2.7
2000	0.1	7.0	4.1	0.4
2001	No	Survey		
2002	6.6	53.7	19.1	6.7
2003	0.5	20.2	19.1	6.7
2004	9.6	39.6	11.4	4.2
2005	17.9	49.1	13.4	3.1



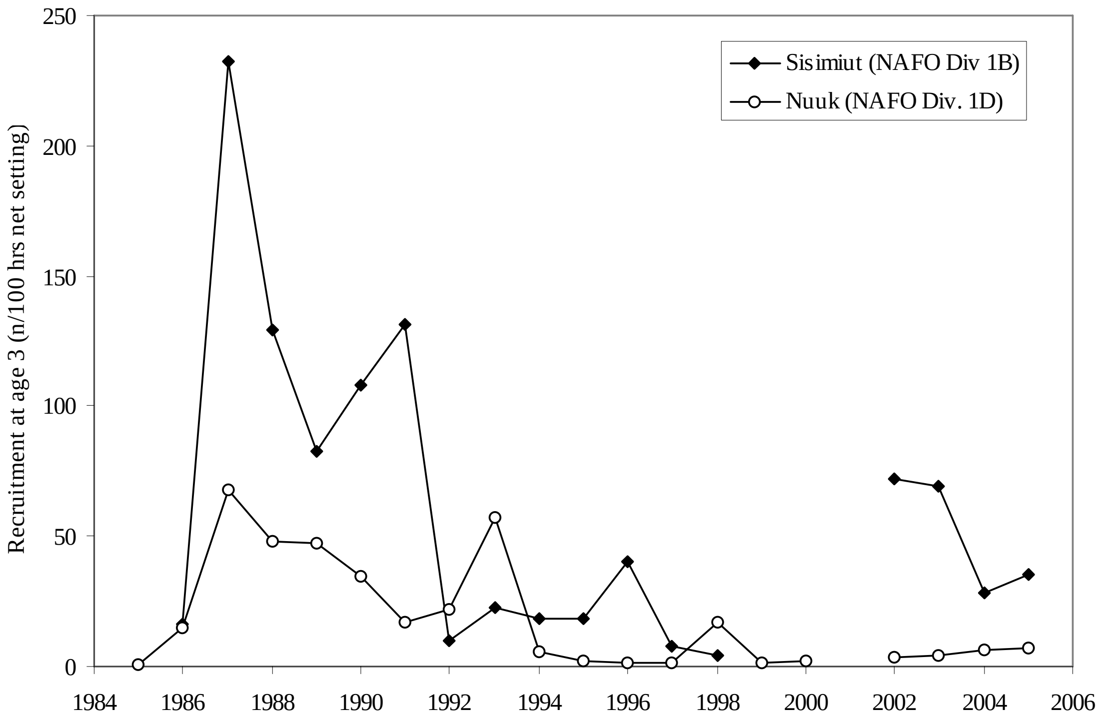


Figure 5.2.1. Recruitment index of age 2 and 3 cod in the inshore gillnet survey in NAFO division 1B and 1D between 1985 and 2005.

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 Excecutive summary

There have been no changes in **input data** to the assessment this year: current surveys have continued and sampling intensity and coverage remains also unchanged. Since 2003 no age readings of otoliths were available from the main fishing areas.

It was not possible to conduct either **ASPIC** or **age-disaggregated models** The overall assessment relies entirely on indices from surveys and the fishery.

A difference in the historic range of the biomass indices for the three areas Va, Vb and XIV should be kept in mind when assessing the entire stock. For the Icelandic area (Va) CPUE series are available 1985-2005, while the survey covers 1996-2005. For the Faroese area (Vb) CPUEs are available 1991-2005. In East Greenland (XIVb) CPUEs are available 1991-2005 and a survey have been conducted 1998-2005 with no survey in 2001.

The present state of the stock cannot be evaluated in with regard to biological reference points. Indices in Va and Vb, however, suggest that present biomass is low compared to historic levels. CPUE indices from Division Va suggest a low biomass in recent years compared to the mid-1980s, and survey indices support this status. In Div Vb indices and catches suggest a continuously decreasing biomass being low in 2005. Indices in XIV suggest that present biomass is stable within the last 10-12 years. 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 summarises as follows for the three areas:

Div. Va: Fishery and survey indices from Va show similar trends. The fall groundfish survey in Va (1996-2005) 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 (1998-2005) the Icelandic survey increased catch rates until 2001 followed by a decline until 2004. Icelandic trawl CPUE in 1993-2005 are less than half that observed in 1985-1989. CPUE declined since 2001 but has stabilised in 2005. 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 but is still high and is twice the 1998 effort. (Fig. 6.8.2)

Div. Vb: Faroese trawl CPUE (1991-2005) show a slight but continuous decrease in catch rates since 1994, following a significant decrease in the early years 1992-94.

Div. XIVb: The Greenland survey in XIV has stable biomass index in the entire period (1998-2005). Trawl CPUE's from the various fleets in XIVb have maintained two 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 CPUE increased significantly to the same level maintained in 1994-98, mainly due to an CPUE increase in southern areas of East Greenland. The catch rates in the fishery in XIVb adjacent to the Icelandic fishery, was stable.

An exploratory assessment for the stocks in Va and XIV suggest that 2005 biomass is about 40% of Bmsy and fishing mortality in 2005 is more than 2.5 times Fmsy.

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 1981–2005 in Tables 6.1.1–6.1.6 and since 1961 in Figure 6.1.1. Catches taken within the Icelandic EEZ in Division XIVb have historically been registrated in Division Va. Landings during the decade prior to the extension of the EEZ to 200 nm by coastal nations in 1976 were in the order of 20-35 000 t. From 1976 landings increased from a low of 5 000 t to a record high of about 61 000 t in 1989. Since then landings have decreased markedly to a low of 20 000 t in 1998-99, followed by an increase to about 30 000 t in 2003. Landings decreased to about 24 000 t in 2005.

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 increased their share of the total landings to about 30% - 50%. in the past decade. In 2005 landings in Va fell to 13 000 t., while landings increased to a record high of about 10 000 t in XIV. Divison Vb experienced decreased landings in 2005 to a historic low of about 900 t.

Fisheries and fleets

In 2005 quotas in Greenland EEZ were nearly fully utilised by the principal fleets. In the Iceland EEZ, quotas in the fishing year 2004/2005 were almost fully utilized (85%),while this is not likely for the fishing season 2005/2006 (Icelandic fishing year ending 30. July) . In the Faroe EEZ only by-catch regulations is limiting the individual trawlers.

Most of the fishery for Greenland halibut in Divisions Va, Vb and XIVb is a directed trawl fishery only minor catches in Va by Iceland, and in XIVb by Germany and the UK comes partly from a redfish fishery. Table 6.1.7 STILL MISSING !! describes the Working Group’s best landing estimates for the year 2005 with respect to area and gear.

Spatial distribution of 2005 and historic effort and catch in the trawl fishery in XIV and Va is provided in Figures 6.1.2.-3. Fishery in the entire area had previously occurred in a more or less continuous belt on the continental slope from 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 2005 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 2005 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 April through June.

The trawlers (single trawlers > 1000 Hp) fishing in Division Vb operate on relatively shallow parts of the continental slope, mainly in summer. The gillnet fishery in Division Vb started in 1993, and since then the fishing grounds have expanded. This fishery is carried out during the whole year with a peak activity in the spring.

The fishing grounds in Division XIVb are found on the continental slopes 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 commercial vessels that operated in the area through October and November. 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 6.1.5-6.1.6 derive from the Hatton Bank area. This fishery is considered to be in a period of learning.

By-catch and discard

By-catches in the Greenland halibut trawl fisheries 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 2000 are observed to have reduced by-catches considerably. Based on sampling from one trip (57 hauls) in 2006, scientific staff observed by-catches of Greenland halibut to be less than 1% by weight (3 g or 0.06 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 2000)..

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 show 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 have been presented in 2005/6 to contribute to the clarification of stock structure of Greenland halibut. However, compilation of fishery information given above provides an overview of the geographical distribution of the fishery over time (Fig. 6.1.2.-3.). 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 Chapter 6.11.

6.3 Trends in Effort and CPUE

Div. Va

Indices of CPUE for the Icelandic trawl fleet directed at Greenland halibut for the period 1985–2005 (Table 6.2.1, Fig. 6.2.1) were estimated from a GLM multiplicative model, taking into account changes in the Icelandic trawl catch due to vessel, statistical square, month, and year effects. All hauls with Greenland halibut exceeding 50% of the total catch were included in the CPUE estimation. The CPUE indices from the trawling fleets in Divisions Va, 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 6.2.1).

Catch rates of Icelandic bottom trawlers decreased for all fishing grounds during 1990–1996 (Fig. 6.2.1.), but increased until 2000-2001. Since 2001 catch rates decreased to a record low in 2004, but has stabilised in 2005. The tendency over time is the same for all fishing grounds in Va Fig, 6.2.2.) The derived effort has increased from a low in 1998 to a level similar to that prior to 1998. The directly measured effort from logbook information, 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. 6.8.2).

Div. Vb

Information from logbooks from the Faroese otterboard trawl fleet (>1000 hp) was available for the years 1991-2005 (Table 6.2.1, Fig. 6.2.3.-4.). 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 logbooks were standardised in the same way (GLM) as the Va fleet. CPUE decreased drastically in the early period by more than 50 % coinciding with a significant increase in effort. Since 1994 CPUE has been slightly decreasing reaching a record low in 2005.

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 2005 87%). 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 1991–2005 were standardised in the same way as described for fleets in Va and so was effort (Table 6.2.1, Fig.6.2.5). Previously logbook data was standardised according to season, area and fleet category, but analyses have shown that cpue variation among vessels within fleets are considerable. Therefore observations on the single vessel level are used directly as an effect in the model. 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 from 2004 to 2005 catch rates increased considerably by about 40%. 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 (Fig. 6.2.6)., while the areas adjacent to the Icelandic fishery in Va (XIVb3-4) has maintained unchanged CPUE since 2000.

The trend in CPUE series from Divisions Va, Vb and XIVb do not cohere in the period where time series are comparable. (Fig.6.2.1-6.2.5). 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 6.1.5-6.1.6).

6.4 Catch composition

Otoliths have been sampled from the Icelandic fishery in 2005 but no readings were available at the time the WG met. Thus, no age readings from Va is available for the recent 5 years. 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 analytical stock assessment. When the otoliths sampled by Iceland are age-read, the catch-at-age matrix will be updated accordingly.

Length compositions of catches from the commercial trawl fishery in Div. Va are stable from year to year. In Fig. 6.3.1 is shown length distributions since 1985 from the western area of Iceland, comprising the most important fishing grounds. For all the years catches were in the range 40 – 100 cm with a mode at about 60 cm. The 2005 distribution is composed of fish smaller than long-term average. Fig. 6.3.2. show length compositions of catches in XIVb from German and Norwegian trawl fisheries.in recent years. Most distributions are stable from year to year, but distributions show that smaller fish contribute more to both the 2004 and 2005 fishery as was also the case for the Icelandic fishery. This might indicate good year-classes entering the fishery as fishery pattern as well as selection in the trawl gear is unchanged. Catch distribution from an Icelandic shrimp survey supports an assumption on good year-classes entering the fishery, being about 50 cm in 2005(Fig. 6.3.3.).

6.5 Weight-at-age

Due to lack of age-readings as described in Sec. 6.3 no weight-at-age is provided.

6.6 Maturity-at-age

Due to lack of age-readings as described in Sec. 6.3 no maturity-at-age is provided.

6.7 Survey information

Div Va

An October groundfish survey in Icelandic waters (Fig. 6.6.1), covering the distributional area of Greenland halibut within the Icelandic EEZ, was started in 1996. The survey is a fixed station stratified random survey consisting of 300 stations on the continental shelf and slope down to a depth of 1300 m. Since 2001 the fishable biomass of Greenland halibut (fish of length equal to or greater than 50 cm) has decreased significantly, but stabilised in 2005 (Figure 6.6.2). Abundance indices of smaller fish (<50 cm) indicated signs of improved recruitment until 2001, but a significant decrease in abundance of 40-60cm fish has been seen 2002 -2004 (Fig. 6.6.2-6.6.3). from 2004 to 2005 fish sized less than 50 cm have increased. The trends in biomass and abundance since 2001 has occurred for the entire surveyed area (Fig.6.6.1)

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 (Fig. 6.6.4). 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. Further evaluation of the survey will be done next at NWWG meeting.

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. 6.6.6). No survey took place in 2001. In 2005 a total of 47 of the planned 70 stations were hauled. Total estimated biomass in 2005 was estimated at 13 500 t, which is a slight, but not significant, decrease from 2004 (16 000 t). (Fig. 6.6.7). Compared to the period 1999-2001, biomass estimates for the period 2002-2005 is somewhat lower, although not significant at the 5% level. This year an index is presented for strata covered in the entire surveyed period (Q2 and Q5). This index do not show any variation within the surveyed period like the total index, and is considered more reliable due to the varying survey coverage over time. A GLM conducted on the survey catch rates, taking into account area and depth did not reveal any significant year effect. The deep-water survey is mainly catching Greenland halibut in the length range 30-70cm (Fig. 6.6.8). Abundance estimates by age show that catches mainly consist of 4-8 year olds. From the short time series available it is not possible to identify consistent strong cohorts. (Fig. 6.6.8).

SURVEY /DIVISION	NO HAULS IN 2005 (PLANNED HAULS)	DEPTH RANGE (M)	COVERAGE (KM^2)
Va	150??(150)	500-1300	130 000
XIVb	47 (70)	400-1500	37 000

6.8 Stock Assessment

6.8.1 Summary of the various observation data

A number of indices from surveys and from the commercial fishery are available as indicators for the biomass development.

The surveys in Va and XIV are considered to cover the adult stock distribution in the two divisions adequately, while the survey/exploratory fishery in Vb has an insufficient coverage of the stock component in Vb due to the survey design.

The main fishing grounds are covered well by the logbook data in Va and XIV, while in Vb the logbook information does not include the principal fleet, gill netters, that covers other areas within Vb. The fleet behaviour is likely influenced by a number of factors, such as weather conditions and sea ice 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 (1996-2005) 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 (1998-2005) the Icelandic survey increased catch rates until 2001 followed by a decline until 2004. Icelandic trawl CPUE in 1993-2005 are less than half that observed in 1985-1989. CPUE declined since 2001 but has stabilised in 2005. 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 but is still high and is twice the 1998 effort. (Fig. 6.8.2)
- **Div. Vb:** Faroese trawl CPUE (1991-2005) show a slight but continuous decrease in catch rates since 1994, following a significant decrease in the early years 1992-94.
- **Div. XIVb:** The Greenland survey in XIV has stable biomass index in the entire period. (1998-2005). Trawl CPUE's from the various fleets in XIVb have maintained two 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 CPUE increased significantly to the same level maintained in 1994-98, mainly due to an CPUE increase in southern areas of East Greenland. The catch rates in the fishery in XIVb adjacent to the Icelandic fishery, was stable .

Formerly a stock-production model approach, ASPIC, has been performed ASPIC requires indices of stock biomass. However, as available series do show contradictory trends over time, and. taking into consideration the insolved nature of stock entities within the entire assessment area, it is not possible to pick one or the other series as a reliable biomass index. Exploratory exercises were carried out using only Icelandic indices as previously done to fit the ASPIC model to catch and effort data, but the model did not fit any of the indices satisfactory. Therefore ASPIC most be considered a poor performer of the recent biomass dynamics that the CPUE and survey indices are considered to reflect. Instead an alternative approach using a stock production model in a Bayesian framework was conducted as following.

6.8.2 Exploratory assessment

An alternative assessment approach using a stochastic version of the logistic production model and Bayesian inference to estimate the status of the stock and risks of transgressing reference points (Hvingel and Kingsley 2006) was investigated at the meeting. The biomass dynamic process equation of this model was similar to the one used in previous assessments (within the ASPIC framework). Input data series was 1: the Icelandic standardized CPUE (1985-2005); 2: the Icelandic fall groundfish survey (1996-2005); 3: the Greenlandic survey (1998-2005); 4: the total catch in the Greenland and Iceland EEZ. The Greenland CPUE-series were not used as it showed trends conflicting with those of the other biomass indices. Reference priors or low-informative priors were used for all parameters.

Results from the model are as follows:

Status of the Stock: The median 2005 estimate of relative stock biomass (B/Bmsy) was 0.42. The risk of the stock being below Bmsy was 99% and 14% of being below 0.3Bmsy (the

NAFO defined Blim for logistic production models (NAFO SCS Doc. 04/12)). The median 2005 fishing mortality ratio (F/Fmsy) was 2.7 with a 91% risk of being above Fmsy.

Production potential: The median of the posterior for MSY was 20 Ktons with an interquartile range of 11-34 Ktons.

Predictions: 10-year predictions were made with catch options of 5, 10 and 15 Ktons/year. Catches of 15 tons/year have a higher than 50% risk of inducing a declining trend in stock biomass while catches at or below 10 Ktons/year are likely to result in a stock increase.

The approach can only be adopted as an exploratory exercise at this point but will be further investigated inter-sessionally and thoroughly evaluated at NWWG in 2007.

6.8.3 State of the stock

The present state of the stock cannot be evaluated in with regard to biological reference points. Indices in Va and Vb, however, suggest that present biomass is low compared to historic levels. CPUE indices from Division Va suggest a low biomass in recent years compared to the mid-1980s, and survey indices support a this status. (Fig. 6.2.1 and 6.6.2). In Div Vb indices and catches suggest a continuously decreasing biomass being low in 2005 (Fig. 6.2.3 and 6.6.8). Indices in XIV suggest that present biomass is stable within the last 10-12 years. 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. (Fig. 6.6.5 and 6.2.4).

An exploratory assessment for the stocks in Va and XIV suggest that 2005 biomass is about 40% of Bmsy and fishing mortality in 2005 is more than 2.5 times Fmsy.

6.8.4 Biological reference points

No biological reference points are adopted.

6.9 Management Considerations

Available biological information and information on distribution of the fisheries suggest that Greenland halibut in XIV and Va 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.

6.10 Comments on the Assessment

The assessment relies on a number of indices from surveys and the commercial fishery in absence of material to age-disaggregate the catches. As the stock dynamics as well as stock structure in the entire distribution 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 in NAFO and ICES 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%.

6.11 Biological information on stock structure

The current definition of the Greenland halibut in East Greenland, Iceland, and Faroe waters as one stock, specified by ICES in 1976 was "based on a strong probability that the spawning grounds [for Greenland halibut in these waters] are the same". A summary of the current state of knowledge on Greenland halibut in the above-mentioned waters shows that key information on the life cycle is lacking (Woll 2000). Information on the spawning location and spawning time of the stock is very limited. It is hypothesised, based on information from one scientific bottom trawl cruise in 1977, that the major spawning grounds are located on the continental slopes west of Iceland at depths around and below 1000 m (Magnusson 1977; Sigurdsson 1977; Sigurdsson and Magnusson 1980). In recent years (1995 and 2000), some spawning has been observed in East Greenland waters (62°N and 64°N) in August (Gundersen *et al*. 1997; Fossen and Gundersen 2000).

Standard 0-group fish surveys have been carried out annually in late summer (mainly in August) in Icelandic and in East Greenland waters since 1970. Larvae are mainly observed along the shelf region off East Greenland and are in some years abundant all over the shelf area south to 60° N, which is the southernmost limit of the survey area. Highest abundance is observed on the continental shelf north of 64° N and just east off the continental shelf south of 64° N. 0-group larvae are only occasionally observed on the Icelandic shelf in very limited numbers. Nursery grounds for young Greenland halibut (ages 1-3, fish less than 45 cm long) are well known in West Greenland waters, where they are most abundant from Store Hellefiske Bank to Disko and in Disko Bay between 66^o-69^o latitude at depths of about 200 m (Riget and Boje, 1988). When it comes to knowledge on young fish in East Greenland and Icelandic waters, information is very sparse. A gillnet survey targeting young Greenland halibut, modelling of advection of eggs and larvae with currents from assumed spawning areas in Icelandic and East Greenland waters (Woll 2000), and results of historic Greenland ichtyoplankton surveys (Boje 1997), indicated that larvae were transported to Southwest Greenland waters before settling, mixing with specimens from the Greenland-Canadian stock complex. Analyses of shrimp surveys in Icelandic and Greenland waters (Boje and Hjørleifsson 2000) concluded that nursery grounds were neither to be found in Icelandic nor in East Greenland waters.

The highest aggregation of commercial-sized Greenland halibut is found just south of the Greenland-Iceland ridge. In this area the major portion of the annual catch in the past 10 to 15 years has been taken mainly at depths between 500 and 1000 meters. Other locations of Greenland halibut in exploitable densities (for trawl fisheries) are found along the north and east coast of Iceland, mainly at depths between 500 to 700 meters, in waters of Faroe Islands, as well as along the continental slope off East Greenland. The sizes of the Greenland halibut in the trawl fisheries depend largely on location and depth and to some extent on the season. In Icelandic waters, smaller fish are found along the east and north coast, with somewhat larger fish in the deeper waters south of the Faroe-Iceland ridge. The largest fish are, however, always found on the main fishing grounds between Iceland and Greenland.

Greenland halibut in Hatton Bank (Divisions VIb and XIIb) have until now not been considered in the current stock definition. Recent investigations in the Hatton Bank area (both VIb and XIIb) show that Greenland halibut in the area have sizes comparable to the exploited stock in V and XIV and catches are dominated by old females (Hareide et al 2002, Fossen 2003, 2004, WD 17). Spawning has been reported in the area in spring and maturity studies conducted (histological examinations of ovaries) from September indicate spawning to occur in the following autumn/winter (Tuene et al 2002). Considering the oceanic current system in this area it is likely that eggs and larvae will be transported out of the Hatton Bank area. Early development studies of Greenland halibut have shown an egg development phase of nearly two moths before hatching (2 dg C) (Stene et al 1999). Further the larval drift period is long, indicating settling after at least 5-6 months (results from the Barents Sea ,e.g Ådlandsvik et al 2004). Greenland halibut eggs have been described to be pelagic untill gastrulation (6-26 days after spawning) and then sink to deeper water masses. They are then transported bathypelagic (Ådlandsvik et al 2004).

**Table 6.1.1 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]
Denmark		-	-	-	-	-	-
Estonia		-	-	8	-	-	5
Faroe Islands	3 884	-	121	334	458	338	1 546
France	-	2	32	290	177	157	49
Germany	3 082	3 265	2 800	2 050	2 948	5 169	5 150
Greenland	200	1 740	1 553	1 887	1 459	-	-
Iceland	11 180	14 537	16 590	19 224	20 366	15 478	-
Ireland		-	56	-	-	-	-
Lithuania		-	-	-	2	1	-
Norway	1 187	1 750	2 243	1 998	1 074	1 233	1 024
Poland		-	2	16	93	207	-
Portugal		-	6	130	-	-	-
Russia	138	183	187	44	-	262	609
Spain		779	1 698	1 395	3 075	4 721	-
UK (Engl. and Wales)	261	370	227	71	40	49	-
UK (Scotland)	69	121	130	181	367	367	-
United Kingdom	-	166	252	255	841	1 304	570
Total	20 001	22 913	25 897	27 883	30 900	29 286	8 953
Working Group estimate	20 371	26 644	27 291	29 158	30 891	27 102	24 092

1) Provisional data

Table 6.1.2 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]
Faroe Islands	9		15	7	34	29	110
Germany	13	22	50	31	23	10	6
Greenland							
Iceland	11 087	14 507	2 310 [4]	2 277 [4]	20 360	15 478	
Norway							
Russia							1
UK (E/W/I)	26	73	50	21	16	8	
UK Scottland	3	5	12	16	5	2	
UK							38
Total	11 138	14 607	2 437	2 352	20 438	15 527	155
Working Group estimate		14 607	16 752	19 714	20 415	15 477	13 015

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 6.1.3 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]
Denmark							
Faroe Islands	3873		106	13	58	35	929
France		1	32	4	8	17	13
Germany	22						
Iceland							
Ireland							
Norway	87	1	2	1	1		1
UK (Engl. and Wales)	9	35	77	50	24	41	
UK (Scotland)	66	116	118	141	174	87	
United Kingdom							226
Total	4057	153	335	209	265	180	1 169
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 6.1.4 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]
Denmark							
Faroe Islands	2			274	366	274	507
Germany	3047	3243	2 750	2 019	2 925	5 159	5 144
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
Poland						205	
Portugal			6	130			
Russia	138	183	186	44		261	560
Spain		8	10		2 131	3 406	
UK (Engl. and Wales)	226	262	100				
UK (Scotland)				24	188	278	
United Kingdom				178	799	1 294	272
Total	4806	6627	20 316	23 163 0	8 720	11 991	7 506
Working Group estimate	5376 [11]	6958	6 588 [6]	6 750 [6]	8 017	9 854	10 185

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 6.1.5 GREENLAND HALIBUT. Nominal landings (tonnes) by countries in Sub-area XII, as officially reported to the ICES and estimated by WG

Country	1996	1997	1998	1999	2000	2001	2002	2003 [1]	2004 [1]	2005 [1]
Faroe Islands		47					40			
France					1			4	30	2
Ireland						49				
Lithuania								2	1	
Poland						2		2	1	
Spain [2]	2	42	67	137	751	1338	28	730	1145	
UK					7	5				3
Russia										46
Norway	2				553	500	316	201	119	
Total	4	89	67	137	1 312	1 894	384	939	1 296	51
WG estimate										

[1] Provisional data

[2] Based on estimates by observers onboard vessels

Table 6.1.6 GREENLAND HALIBUT. Nominal landings (tonnes) by countries in Division VIb, as officially reported to the ICES and estimated by WG.

Country	1996	1997	1998	1999	2000	2001	2002	2003 [1]	2004 [1]	2005 [1]
Estonia							8			5
Faroe Islands										
France							286	165	110	34
Poland							16	91	1	
Spain [2]			22	88	20	350	1367	214	170	
UK					159	247	77	42	10	31
Russia						1			1	2
Norway					35	317	21	26		
Total	0	0	22	88	214	915	1775	538	292	72
WG estimate										

[1] Provisional data

[2] Based on estimates by observers onboard vessels

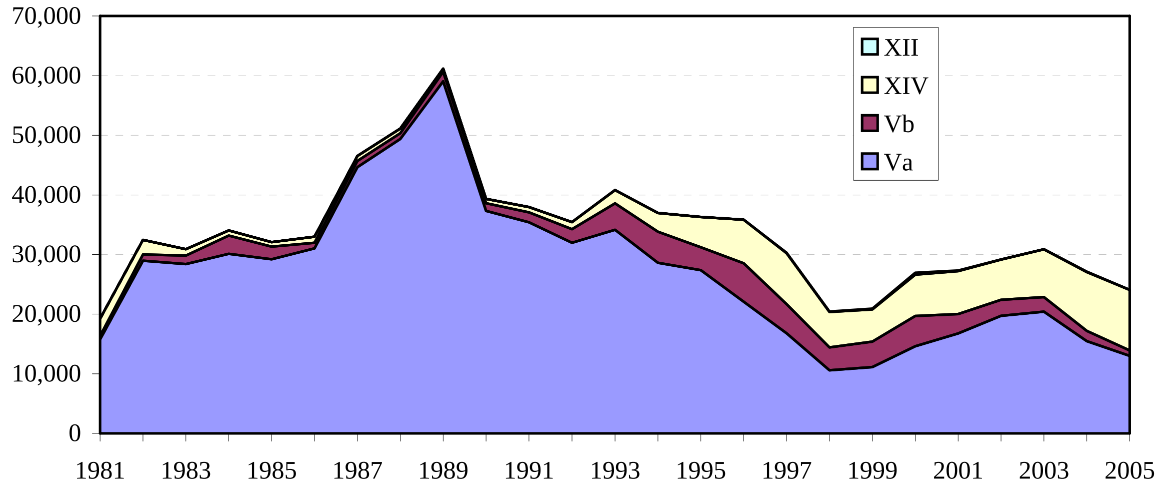
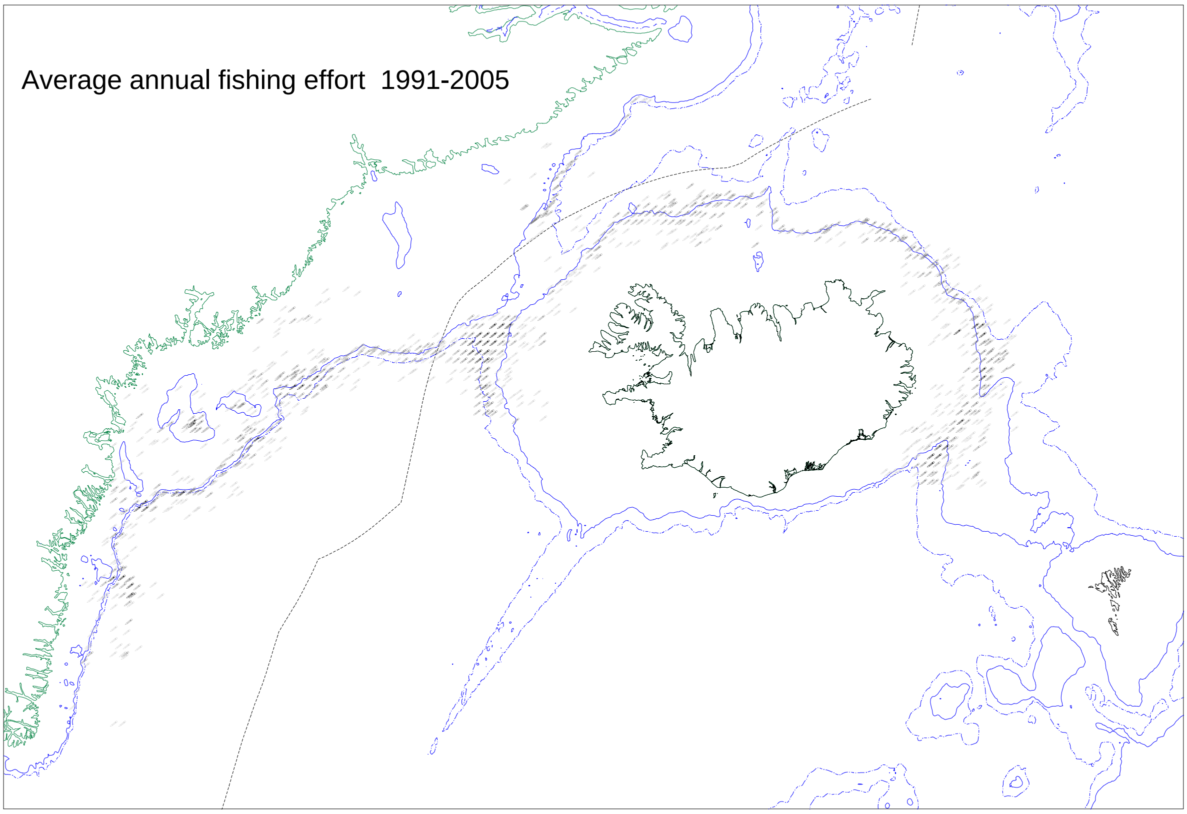


Figure 6.1.1. Landings of Greenland halibut in Divisions V, XI and XIV. As the landings within Icelandic waters, since 1976, have not officially been separated and reported according to the defined ICES statistical areas, they are set under area Va by the North Western Working Group.



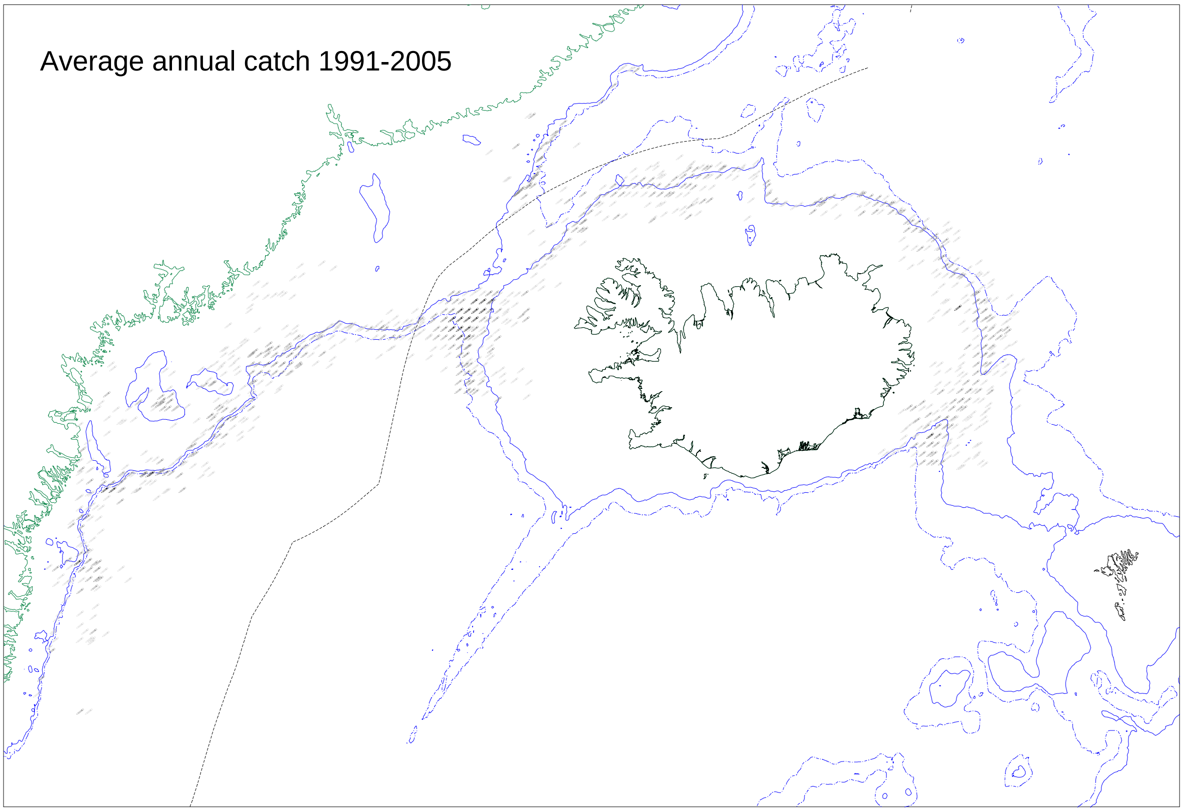
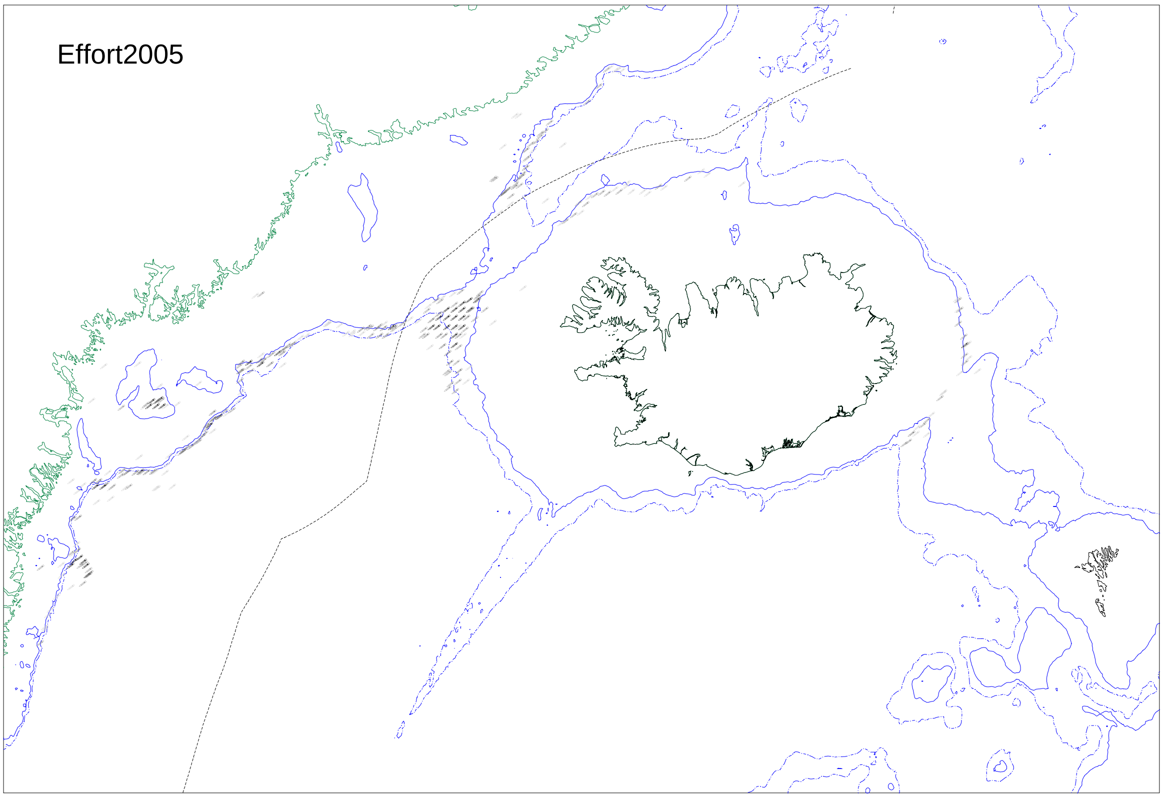


Figure 6.1.2. Greenland halibut in V-XIV. Catch and effort data based on logbook information from trawlers in Va and XIV.



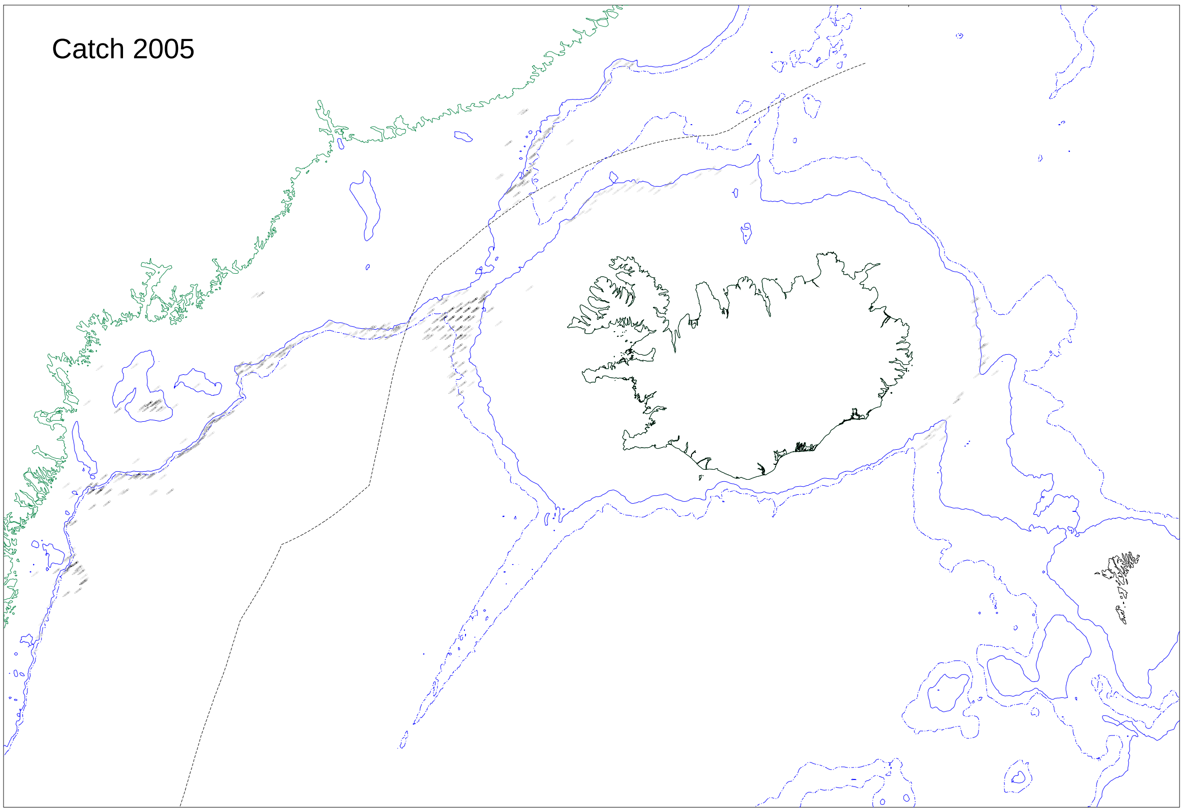


Figure 6.1.3. Greenland halibut in V-XIV. Catch and effort data based on logbook information from trawlers in Va and XIV.

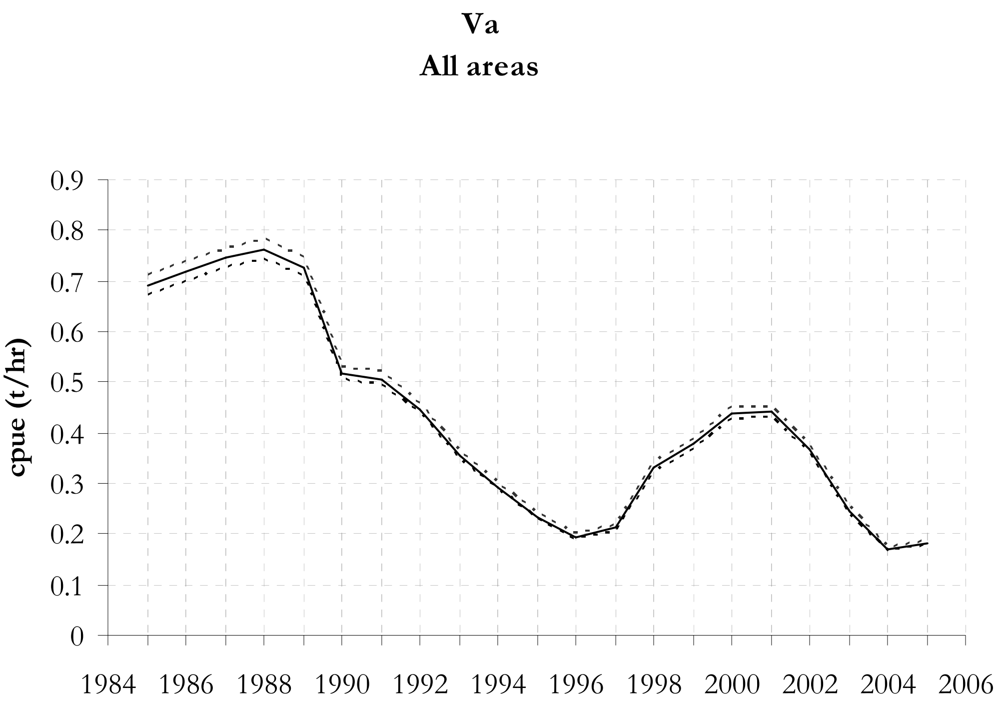


Figure 6.2.1 Standardised CPUE from the Icelandic trawler fleet in Va. 95% CI indicated.

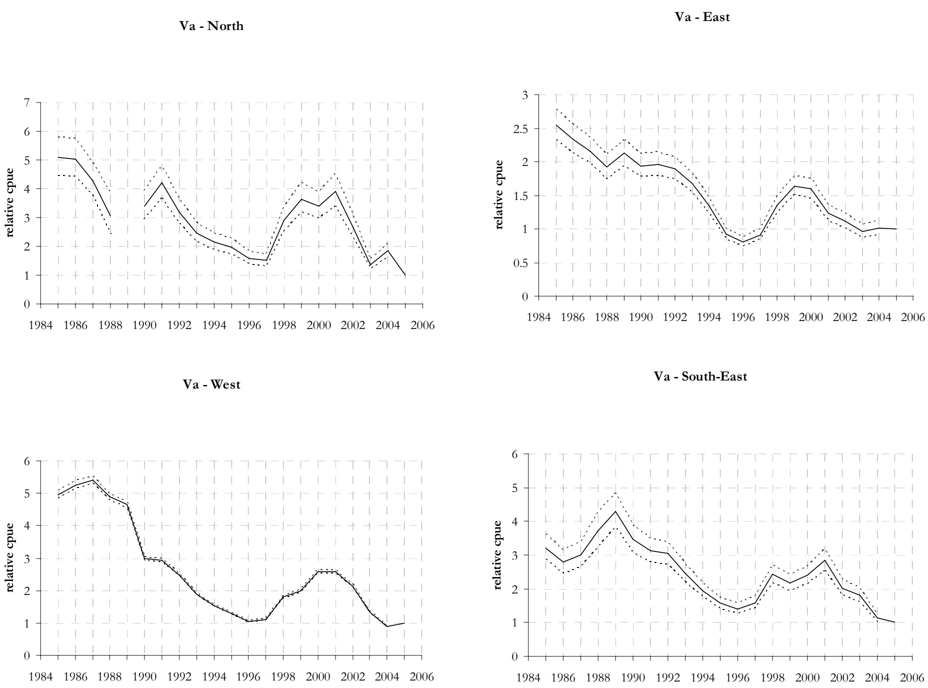


Figure 6.2.2 Standardised CPUE from the Icelandic trawler fleet in Va by four main fishing areas in Va. 95% CI indicated.

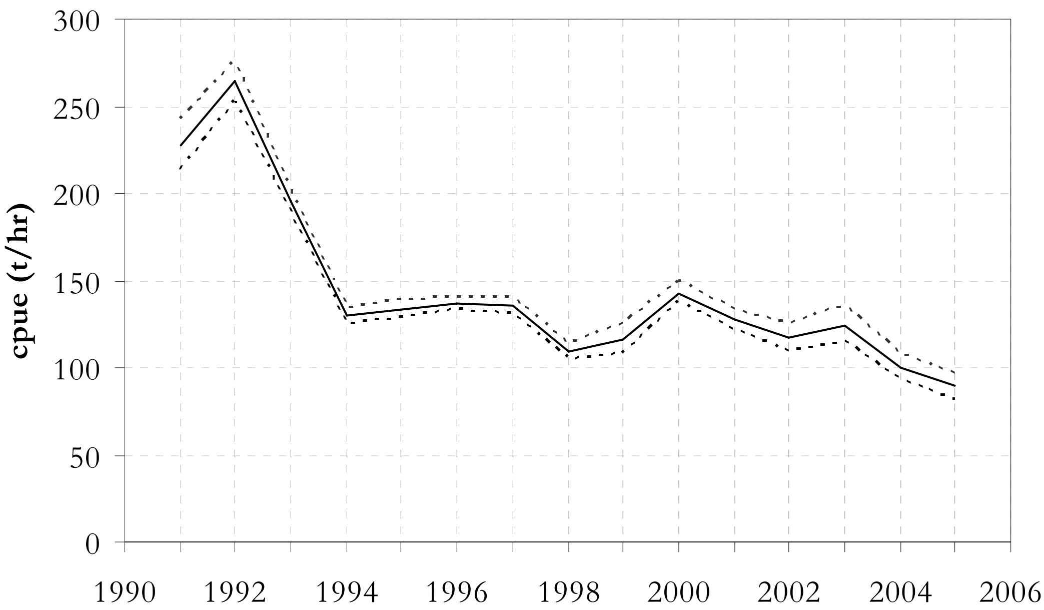


Figure 6.2.3. Standardised CPUE from the Faroese trawler fleet. 95% CI indicated.

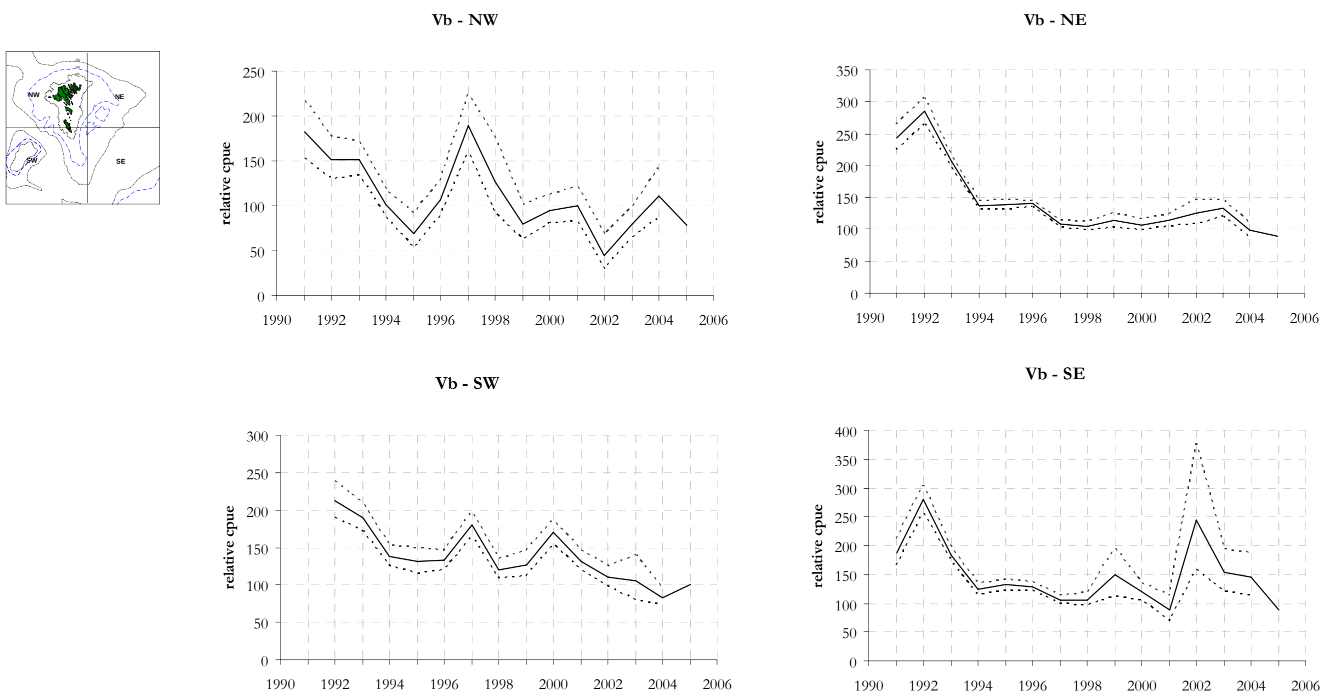


Figure 6.2.4. Standardised CPUE from the Faroese trawler fleet by four fishing areas as indicated on map. 95% CI indicated.

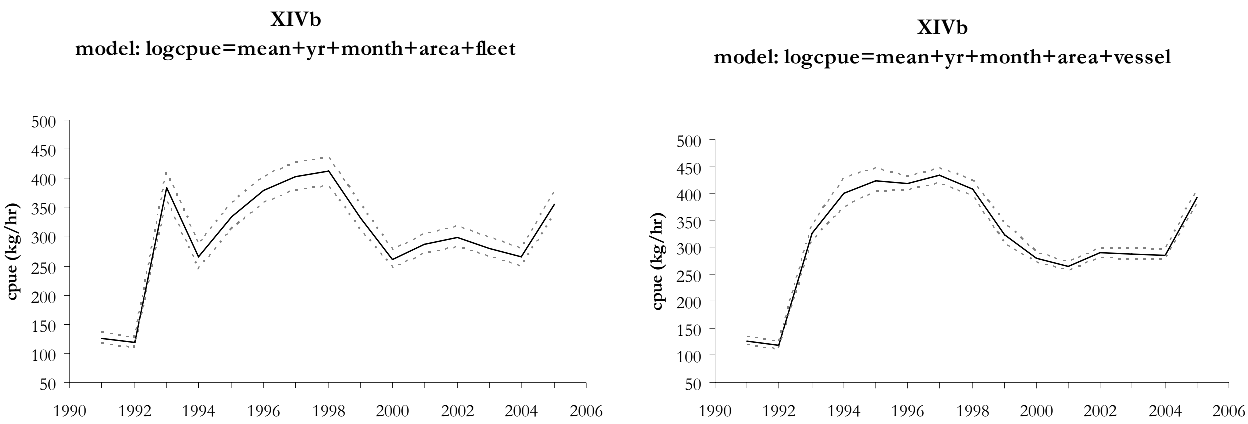


Figure. 6.2.5 Standardised CPUE from trawler fleets in XIVb. 95% CI indicated. Left: taking account of fleet effect in standardisation as previously used; right: taking account of vessel effect in standardisation – proposed as new model.

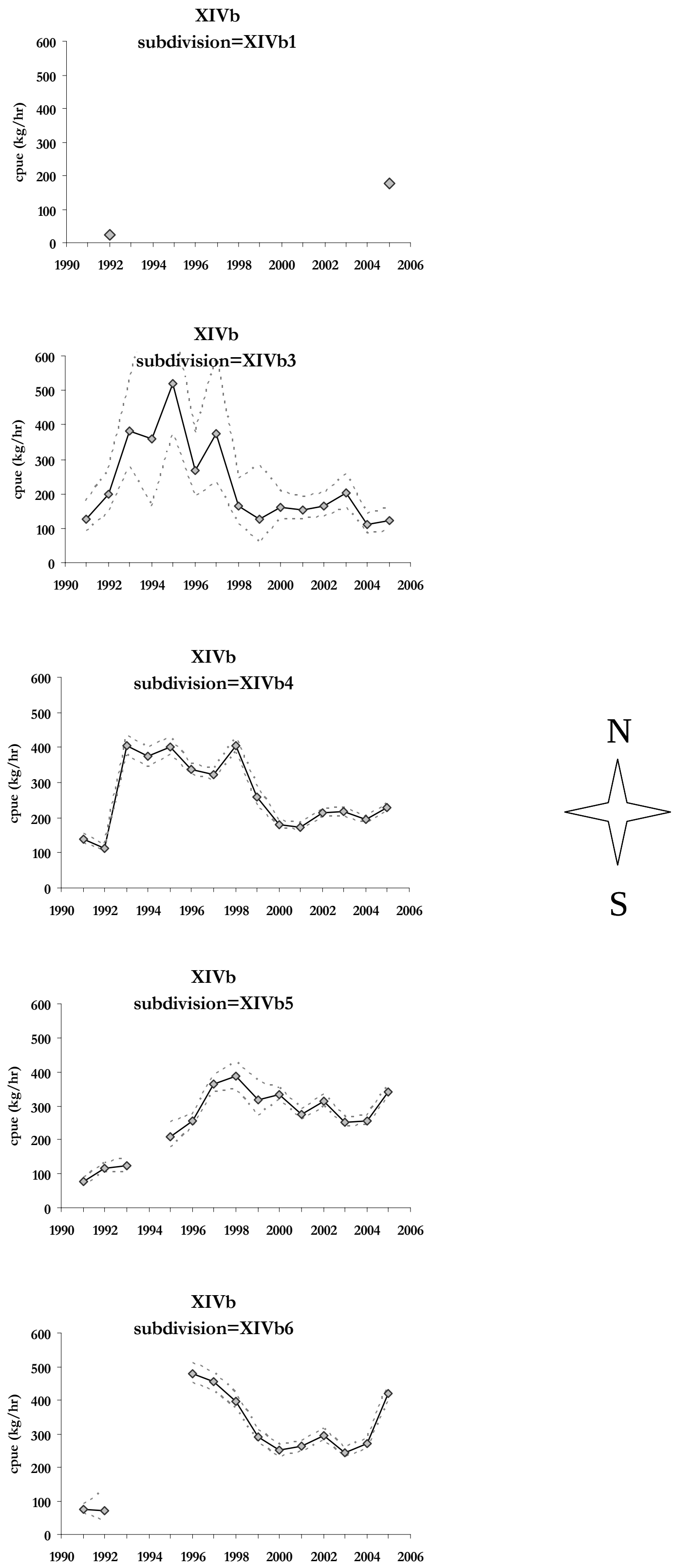


Figure 6.2.6 Standardised CPUE from trawler fleets in XIVb shown by subdivision in XIVb. 95% CI indicated.

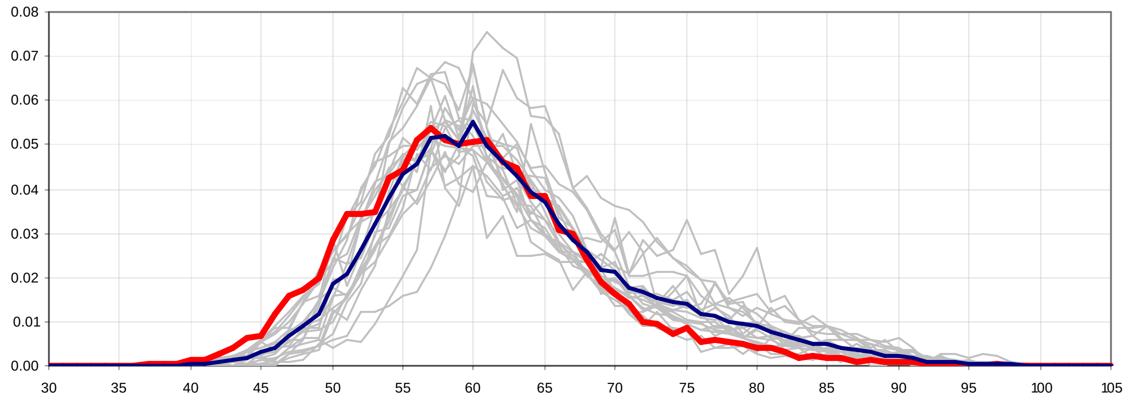
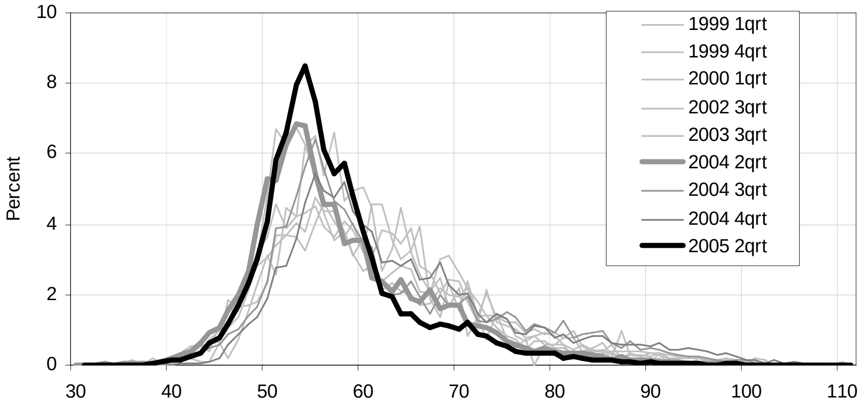


Figure 6.3.1 Length distributions from the commercial trawlfishery in the western fishing grounds of Iceland (Va) in the years 1985 – 2004. The thin solid line is average of 1985-2004 and the thick solid line is 2004 distribution



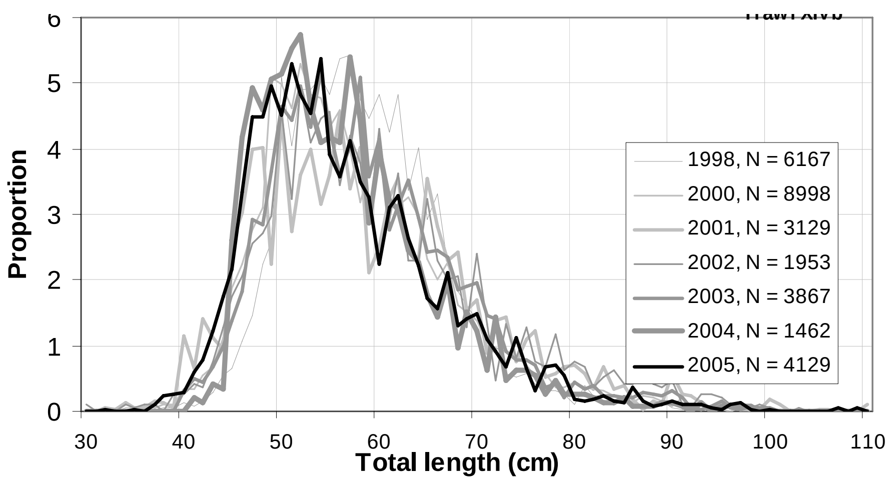


Figure. 6.3.2. Length distributions from the commercial trawlfishery in East Greenland (XIVb) . Upper: German trawl fishery 1999-2004 with indication of 2004. Lower: Norwegian trawl fishery 1998-2005.

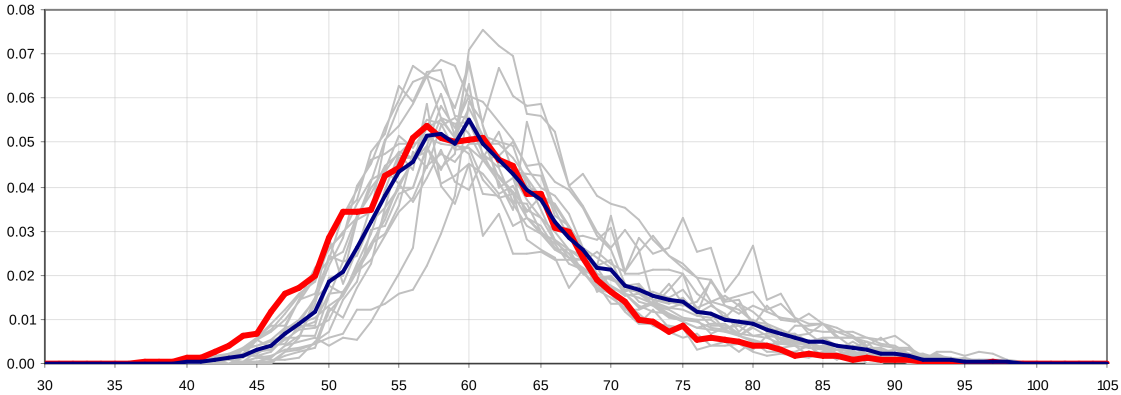
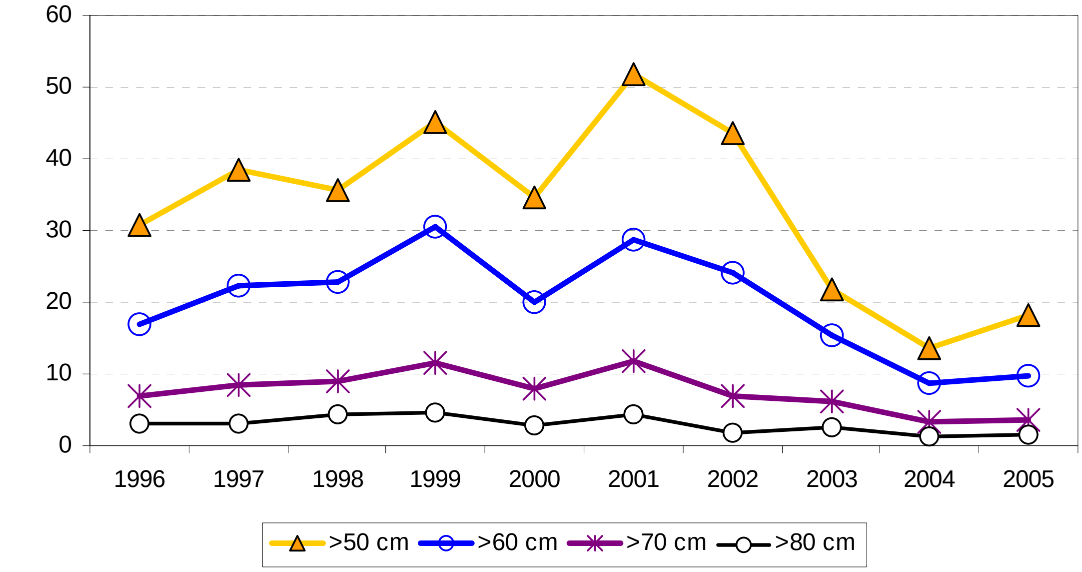


Figure 6.3.1 Length distributions from the commercial trawlfishery in the western fishing grounds of Iceland (Va) in the years 1985 – 2005. The thin solid line is average of 1985-2005 and the thick solid line is 2005 distribution.

Figure 6.6.1. Distribution of catches from the Icelandic fall survey 1996-2005.



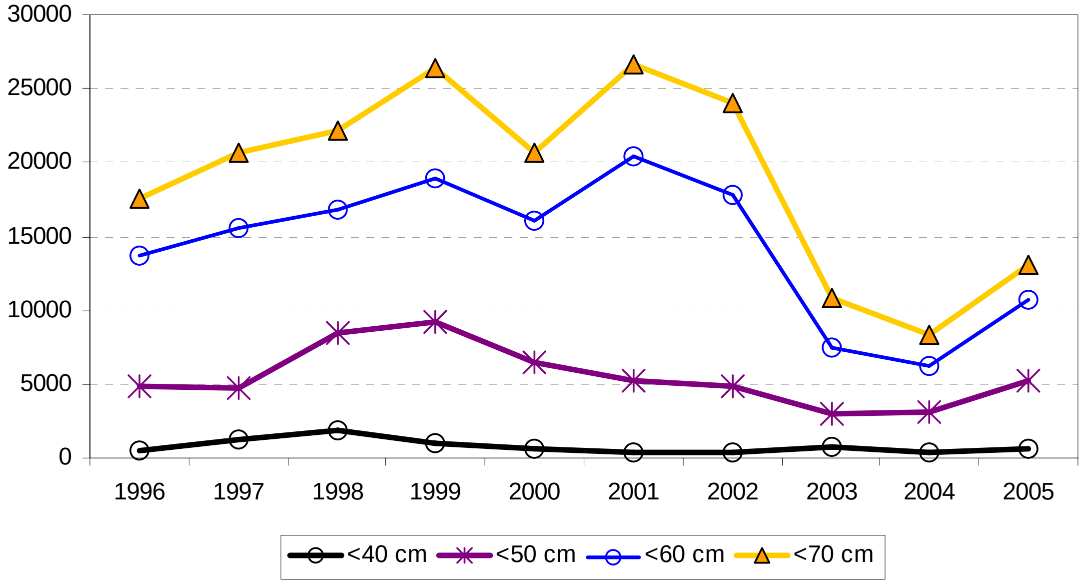


Figure 6.6.2. Greenland halibut in Icelandic fall groundfish survey; UPPER: biomass indices of lengths larger than indicated and, LOWER: abundance indices by length smaller than indicated.

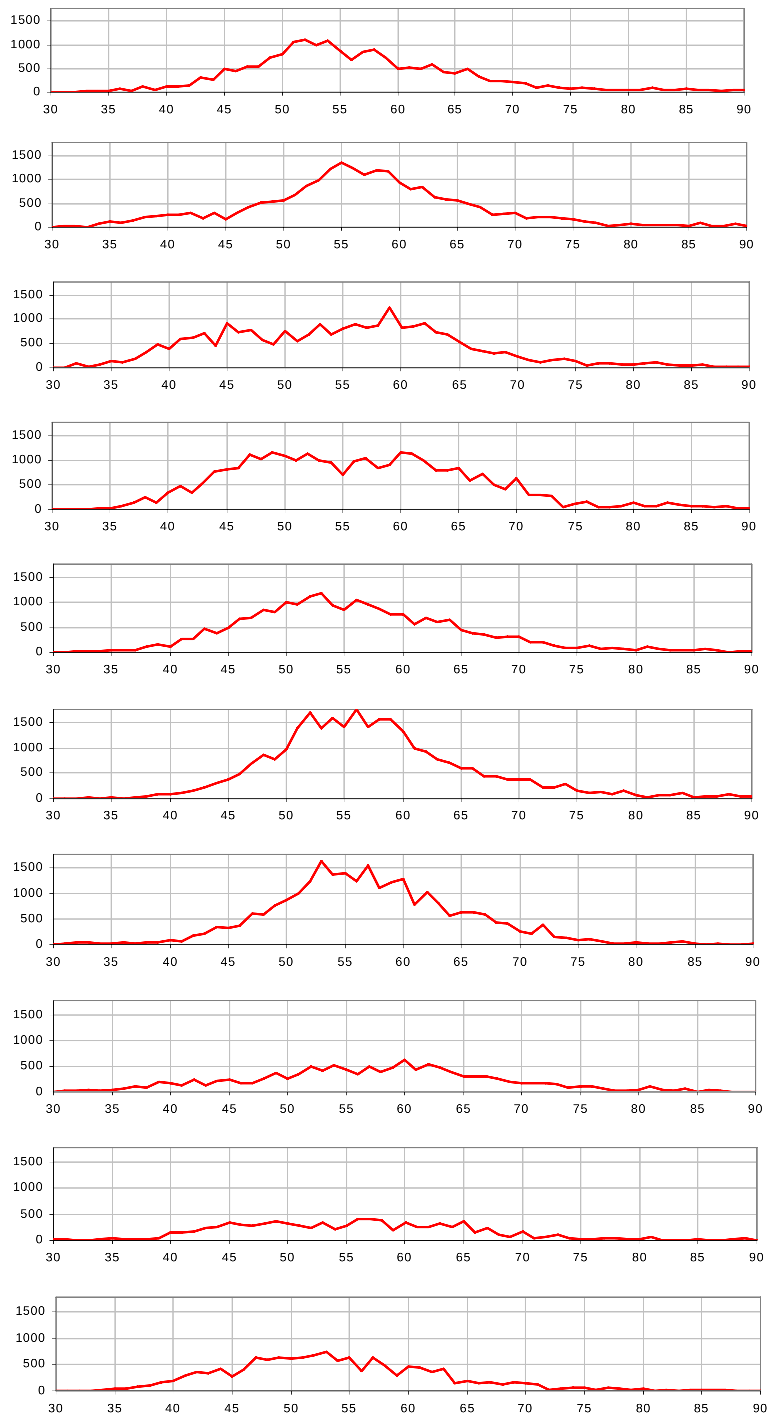


Figure 6.6.3. Abundance indices by length for the Icelandic fall survey 1996-2005.

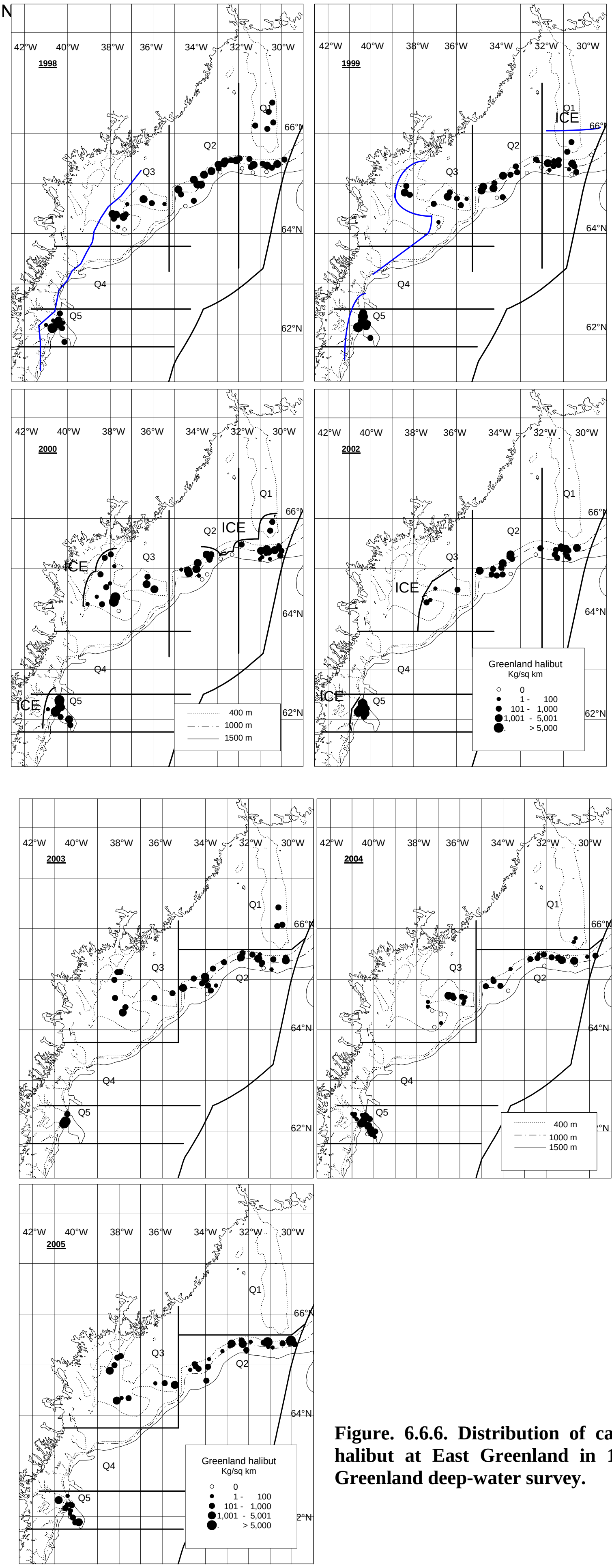


Figure. 6.6.6. Distribution of catches of Greenland halibut at East Greenland in 1998 – 2002 in the Greenland deep-water survey.

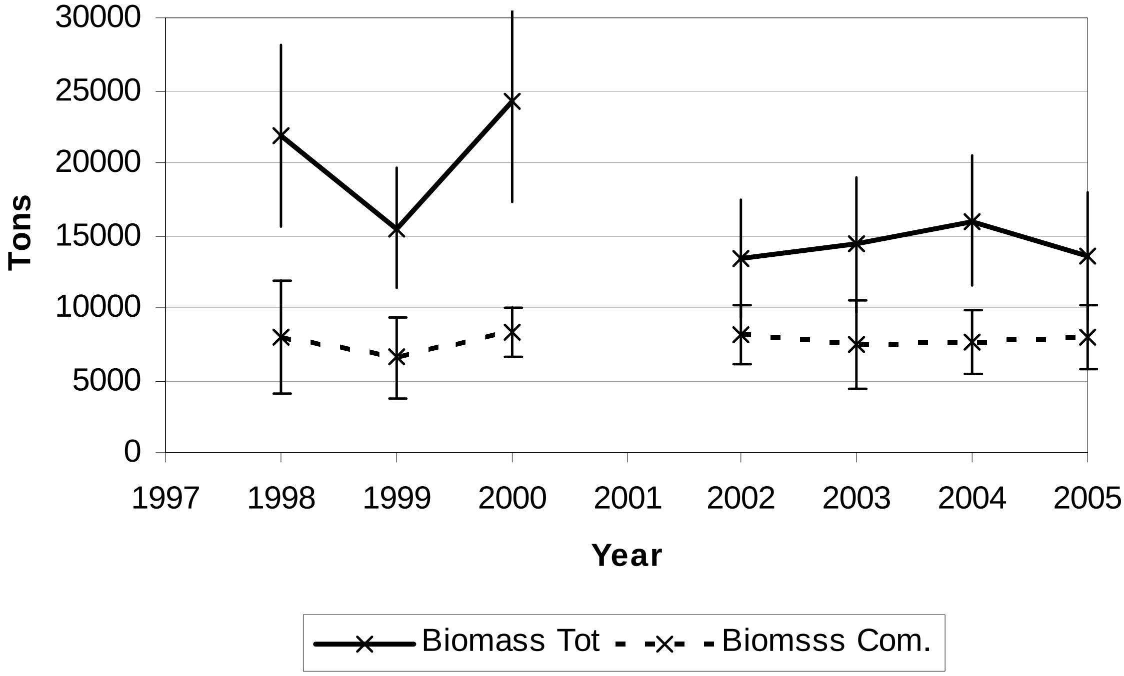


Figure 6.6.7. Estimated Biomass (t) in div. XIVb from the Greenland deep-water trawl survey with 95% CI indicated.Biomass Tot is is swept area estimates for the entire survey area, Biomass Com.is swept area estimates for strata Q2 and Q5 covered all years.

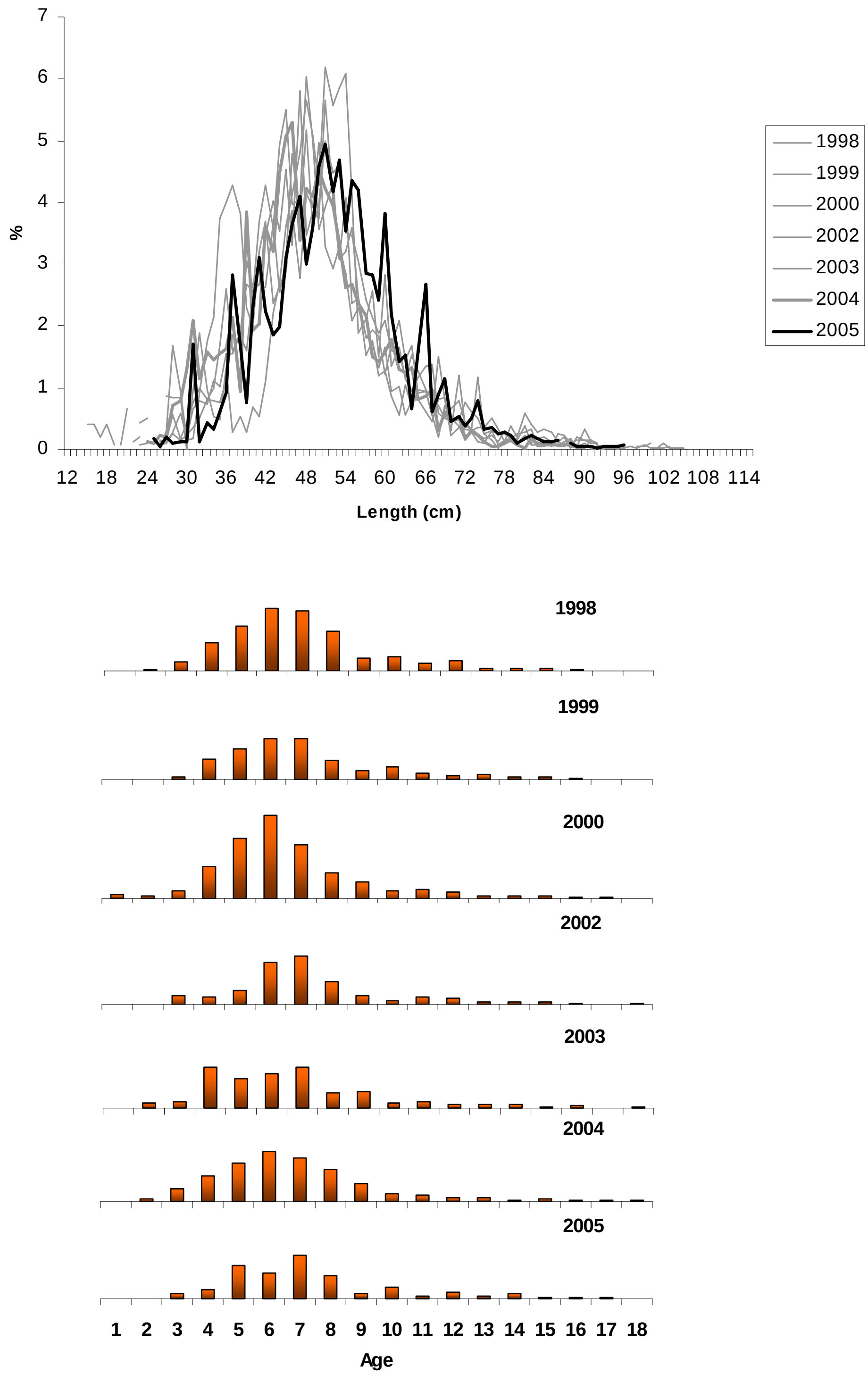


Figure 6.6.8. Greenland deep-water survey in Div. XIVb. Upper: Length frequencies in survey 1998-2004; Lower: Abundance estimates by age.

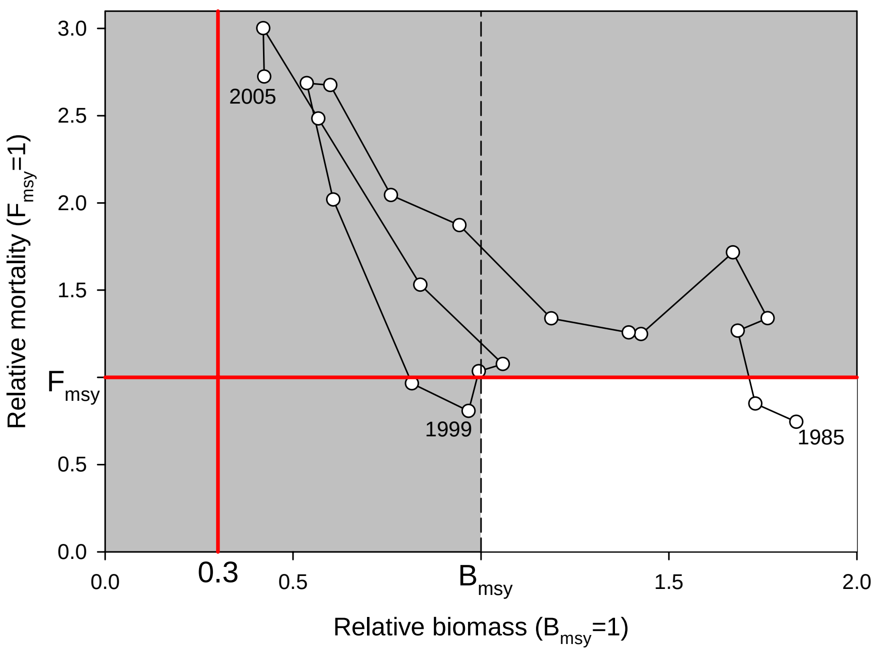


Figure 6.8.1. Greenland halibut in V-XIV. Stock trajectory on Greenland halibut in East Greenland/Iceland from an exploratory Bayesian production model: Stock, dynamics 1985 to 2005 in a mortality/biomass continuum. Points are the median values of the estimated posterior probability densities of the biomass and fishing mortality ratios. Red lines are reference points.

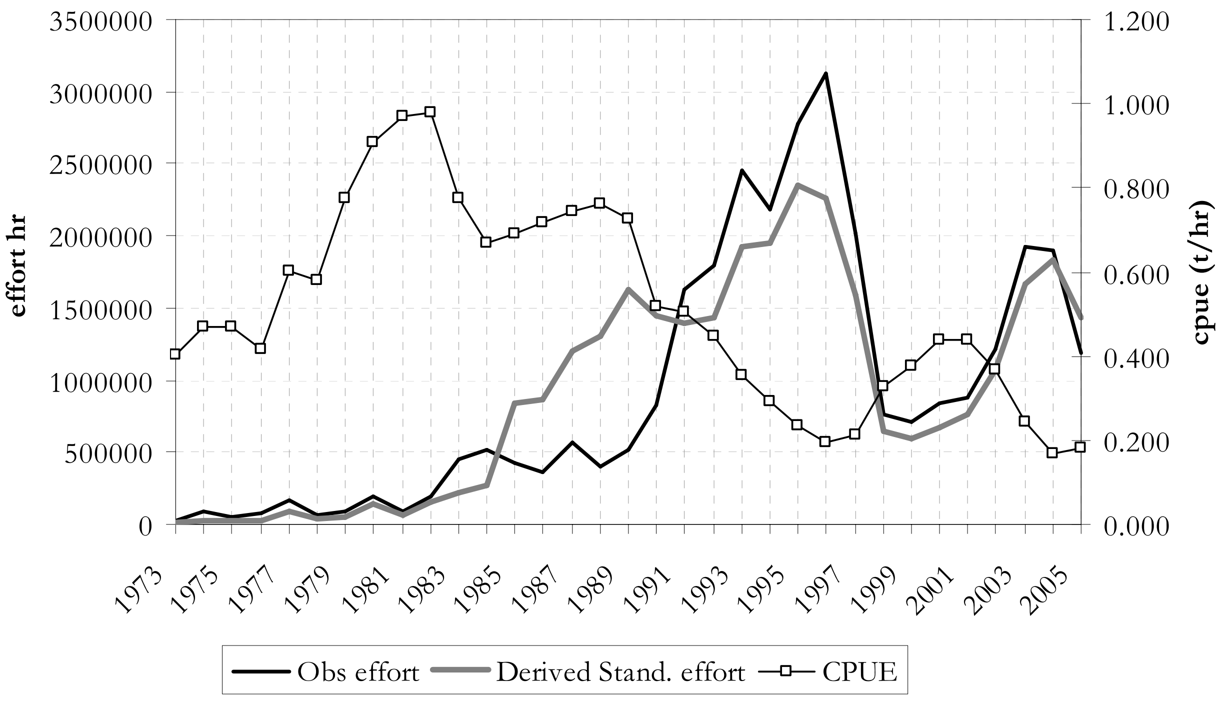


Figure 6.8.2 Standardised CPUE from the Icelandic trawler fleet. Stand. CPUE and stand. effort from GLM and observed effort summarized from logbooks.

7 Redfish in Subareas V, VI, XII and XIV

This chapter deals with redfish of the genus *Sebastes* in general, therefore the Group provides information on the redfish fisheries in Sub-areas V, VI, XII and XIV (chapter 7.1), the abundance and distribution of juveniles (chapter 7.2), discards and by-catches (chapter 7.3). Chapters 7.4 and 7.5 deal with the stock identity of *S. mentella* and related special requests.

Species of the genus *Sebastes* are common and widely distributed in the North Atlantic. They are found off the coast of Great Britain, along Norway and Spitzbergen, in the Barents Sea, off the Faroe Islands, Iceland, East and West Greenland, and along the east coast of North America from Baffin Island to Cape Cod. All *Sebastes* species are viviparous. The extrusion of the larvae takes place in late winter–late spring/early summer, but copulation occurs in autumn–early winter.

There are three species of redfish commercially exploited in ICES Sub-areas V, VI, XII, and XIV, *S. marinus*, *S. mentella*, and *S. viviparus*. The last one has only been of a minor commercial value in Icelandic waters and is exploited in two small areas south of Iceland at depths of 150-250 m. The landings of *S. viviparus* decreased from 1160 t in 1997 to 2-4 t in 2003-2005 (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 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 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. 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). In Division Va, if no direct information is available on the catches for a given vessel, the landings are allocated based on logbooks and samples from the fishery. According to the proportion of biological samples from each cell (one fourth of ICES statistical square), the unknown catches within that cell is split accordingly and raised to the landings of a given vessel. For other areas, samples from the landings are used as basis for dividing the demersal redfish catches between *S. marinus* and *S. mentella*.

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 NWWG 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." As the Review Group 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 (see below). Quantitative information on the fractions of the pelagic catches of demersal *S. mentella* is given in ch. 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 and 2005. As a pragmatic management measure in Iceland, the pelagic catches of *S. mentella* east of the 'redfish line' (chapter 9.1) are 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). The migration of juveniles is along the north coast towards the most important fishing areas off the west coast.

Indices for 0-group redfish in the Irminger Sea and at East Greenland areas were available from the Icelandic 0-group surveys from 1970–1995. Thereafter, the survey was discontinued. Above or average year-class strengths were observed in 1972, 1973–74, 1985–91, and in 1995.

Abundance and biomass indices of juvenile (<17 cm) redfish from the German annual groundfish survey, conducted on the continental shelf and slope of West and East Greenland down to 400 m, shows that juveniles were abundant in 1993 and 1995-1998 (Figure 7.3.1).

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 1999-2003 survey results indicate low abundance and are similar to those observed in the late 1980s. In 2004 and 2005, a minor increase in abundance was observed. To which extent the juvenile redfish recruit from the nursery grounds into the adult stocks on the shelves and into the pelagic zone in the Irminger Sea and adjacent waters, is unknown.

7.3 Discards and by-catch of small redfish

An offshore shrimp fishery with small meshed trawl (44 mm in the codend) began in the early 1970s off West Greenland. This fishery expanded to East Greenland in the beginning of the 1980s and was mainly conducted on the shallower part of the Dohrn Bank and on the continental shelf from 65°N to 60°N. Observer samples from the Greenland Fishery Licence Control showed that redfish is by-catch in the shrimp fishery off Greenland. No information was available in recent years to quantify the by-catch and about the length distribution of the fish caught. Since 1st October 2000, sorting grids with 22 mm bar spacing have been mandatory to reduce the by-catches. The documentation of the effect of sorting grids on the by-catches is needed in order to estimate the by-catch of young redfish in the shrimp fishery.

In late 1980's, Iceland introduced a sorting grid with a bar spacing of 22 mm in the shrimp fishery to reduce the by-catch of juveniles in the shrimp fishery north of Iceland. This was partly done to avoid redfish juveniles as a by-catch in the fishery, but also juveniles of other species. Since the large year-classes of *S. marinus* disappeared out of the shrimp fishing area, there in the early 1990's, observers report small redfish as being negligible in the Icelandic shrimp fishery.

7.4 Special Requests

Special request 1.a) from NEAFC (ToR c) of this Group), regarding the stock identity of *S. mentella*, is dealt with in chapter 7.5, whereas request 1.b) (contained in ToR d) of this Group) to “provide quantitative information to allow spatial and temporal limitations in catches and other measures to avoid disproportionate exploitation rate of any one component, especially to prevent local depletion” is dealt with in chapter 10.4.

NEAFC special request c) was “to provide clear definitions of the following terms with respect to *Sebastes mentella* in the Irminger Sea: population; stock; management unit and stock component”. The group refers to general definitions given in the literature (Cadrin et al. 2005) and recently reviewed definitions of the terms “population” and “stock” with regard to *S. mentella* in the Irminger Sea and adjacent waters (Saborido-Rey et al. 2004). The group considers “population” as a biological term, whereas “stock” and “management unit” are regarded as management terms. The term “stock component” and its use with regard to *S. mentella* in the Irminger Sea remains unclear. The group, however, is not in the position to provide any conclusive definition of these terms with regard to *S. mentella*.

Detailed descriptions of the fishery of different nations are given in chapters 8 for *S. marinus*, 9 for demersal *S. mentella*, and 10 for pelagic *S. mentella*, based on various working documents.

7.5 Stock identity and management units of *S. mentella*

The “Study Group on Stock Identity and Management Units of Redfishes” (SGSIMUR, 31 Aug-3 Sep 2004, Bergen, Norway) 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.

A working document, dealing with the population structure of *S. mentella* (ToR c) was sumitted to the Group. What follows is a summary of the content of the paper: WD12 presents Russian biological, ecological, genetic and parasitological studies that indicate that the main nursery area for *S. mentella* is on the East Greenland shelf, from where juveniles migrate to both pelagic waters in the Irminger Sea and to deep waters of the Iceland and Greenland slopes. It concludes that concentrations of pelagic and demersal *S. mentella* are ecological groups of a biologically single population of *S. mentella* in the Irminger Sea and adjacent waters.

In addition, two studies on geographic variation in otolith shapes and otolith microchemistry (Stransky et al. 2005a, b) have been published recently, showing high individual variation within areas and low separation between areas across the entire North Atlantic. Recent underwater tagging experiments (Sigurdsson et al. 2006) showed that *S. mentella* tagged in the pelagic fisheries areas southwest off Iceland were recaptured in shelf areas in Division Va.

The working group did not have sufficient expertise to thoroughly review the scientific content of these documents.

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

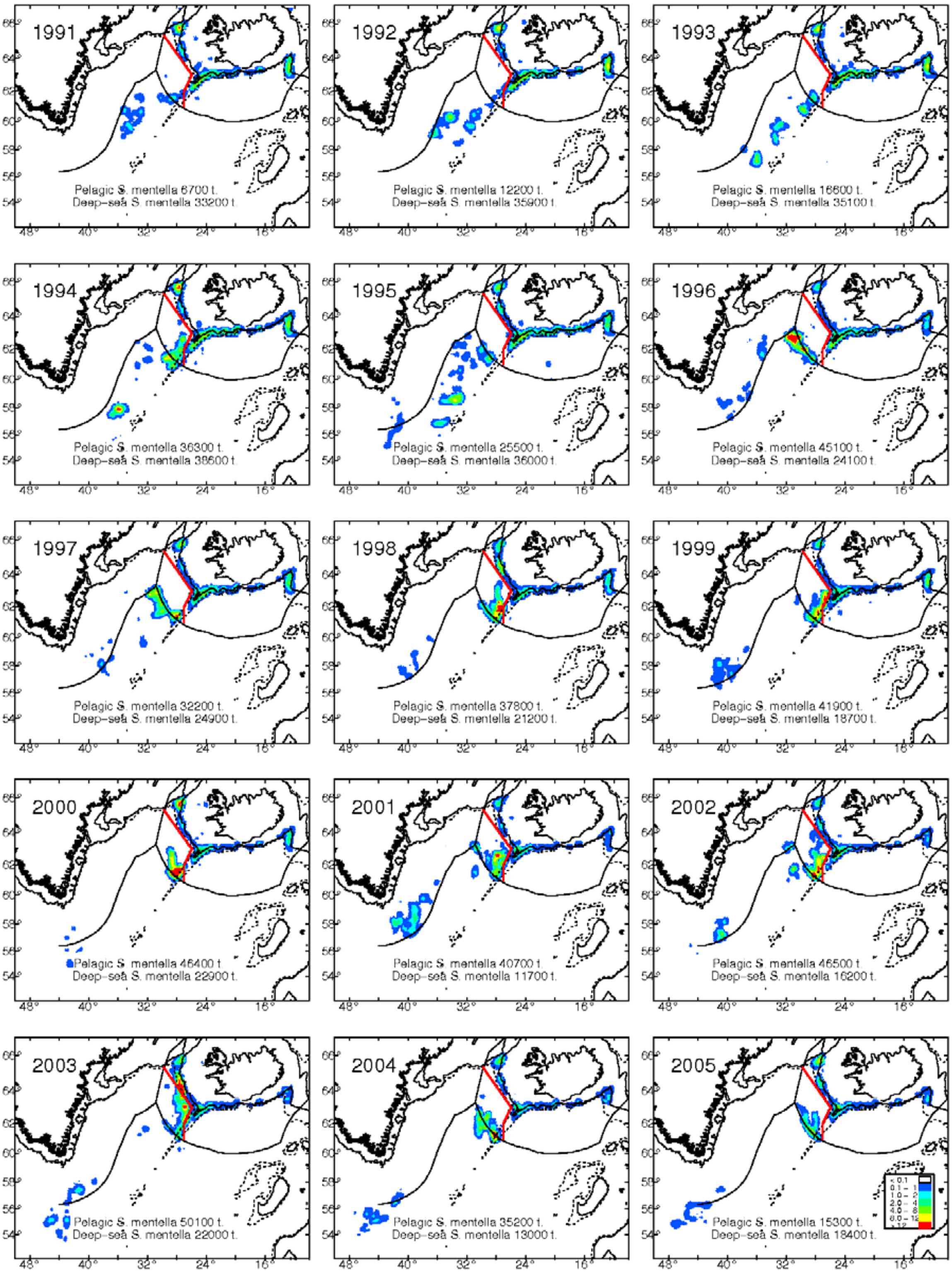


Figure 7.1.1 Geographical distribution of the Icelandic catches of *S. mentella.* The colour scale indicates catches (tonnes per NM^2).

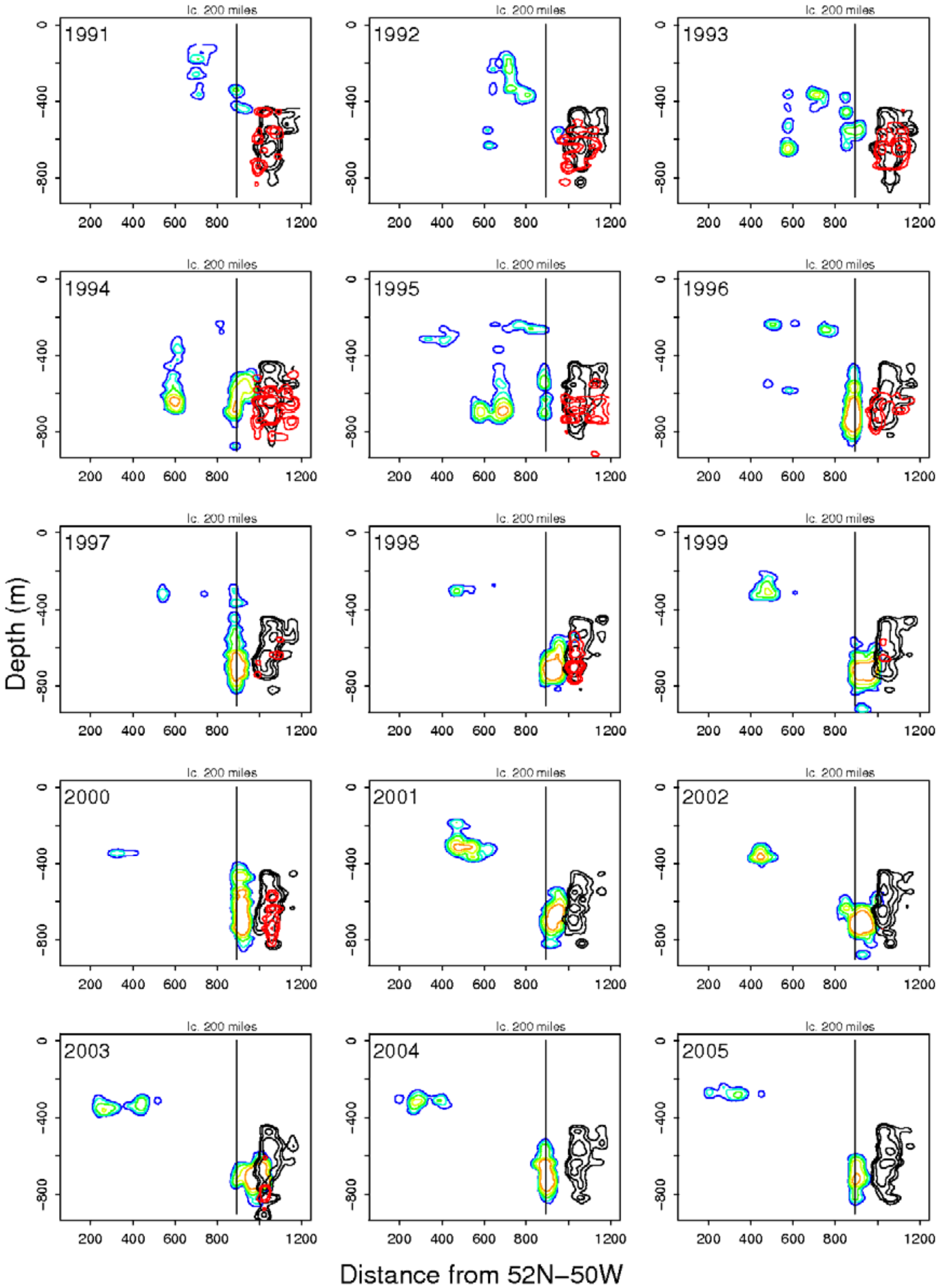


Figure 7.1.2 Distance-depth plot for Icelandic *S. mentella* catches, where distance (in NM) from a fixed position (52°N 50°W) is given. The contour lines indicate catches in a given area and distance. The coloured contours represent the fishery on pelagic *S. mentella*, the black contours indicate bottom trawl catches of demersal *S. mentella*, and the red contours represent catches of demersal *S. mentella* taken with pelagic trawls.

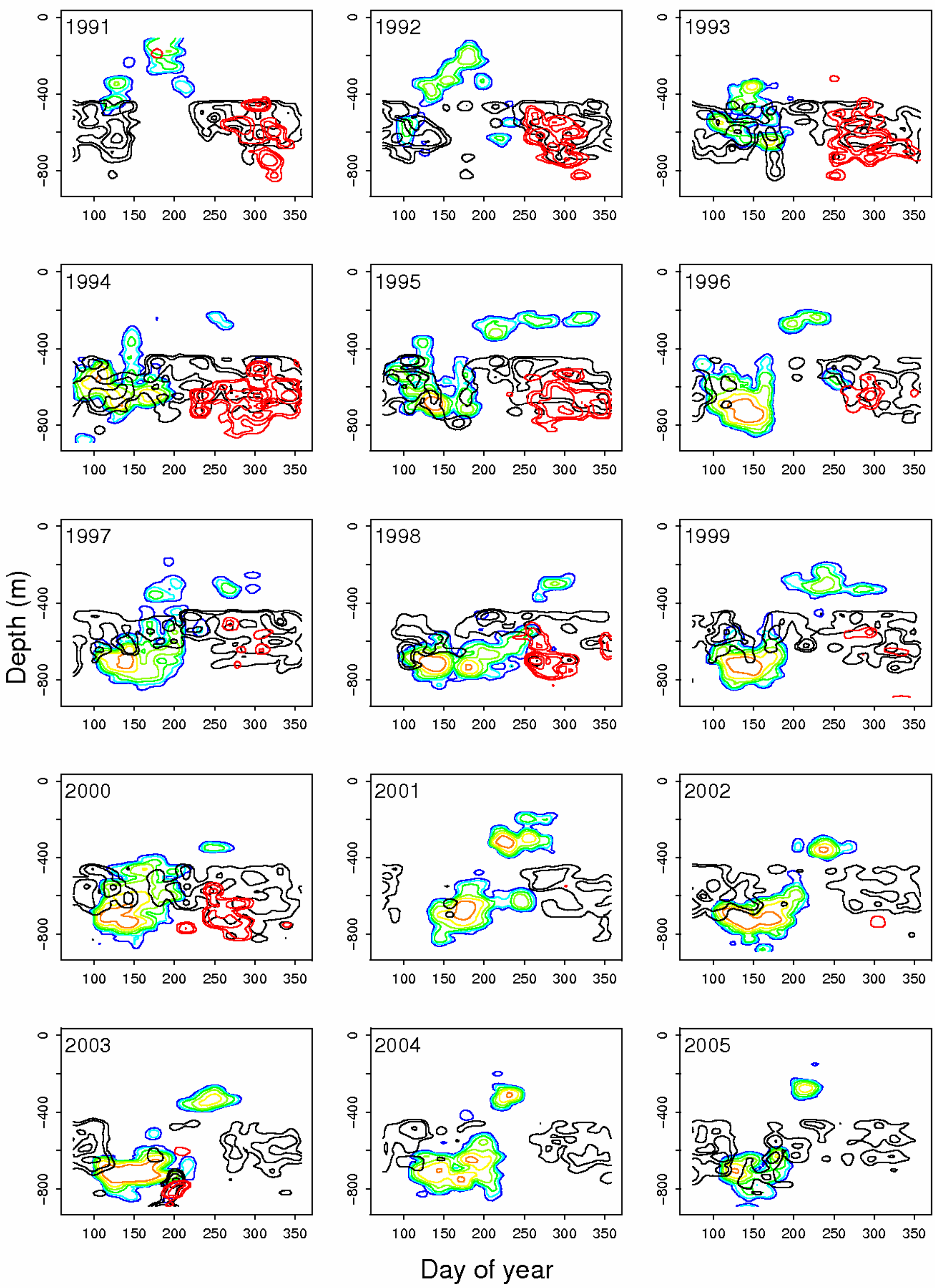


Figure 7.1.3 Depth-time plot for Icelandic *S. mentella* catches, where the y-axis is depth, the x-axis is day of the year and the colour indicates the catches. The coloured contours represent the fishery on pelagic *S. mentella*, the black contours indicate bottom trawl catches of demersal *S. mentella*, and the red contours represent catches of demersal *S. mentella* taken with pelagic trawls.

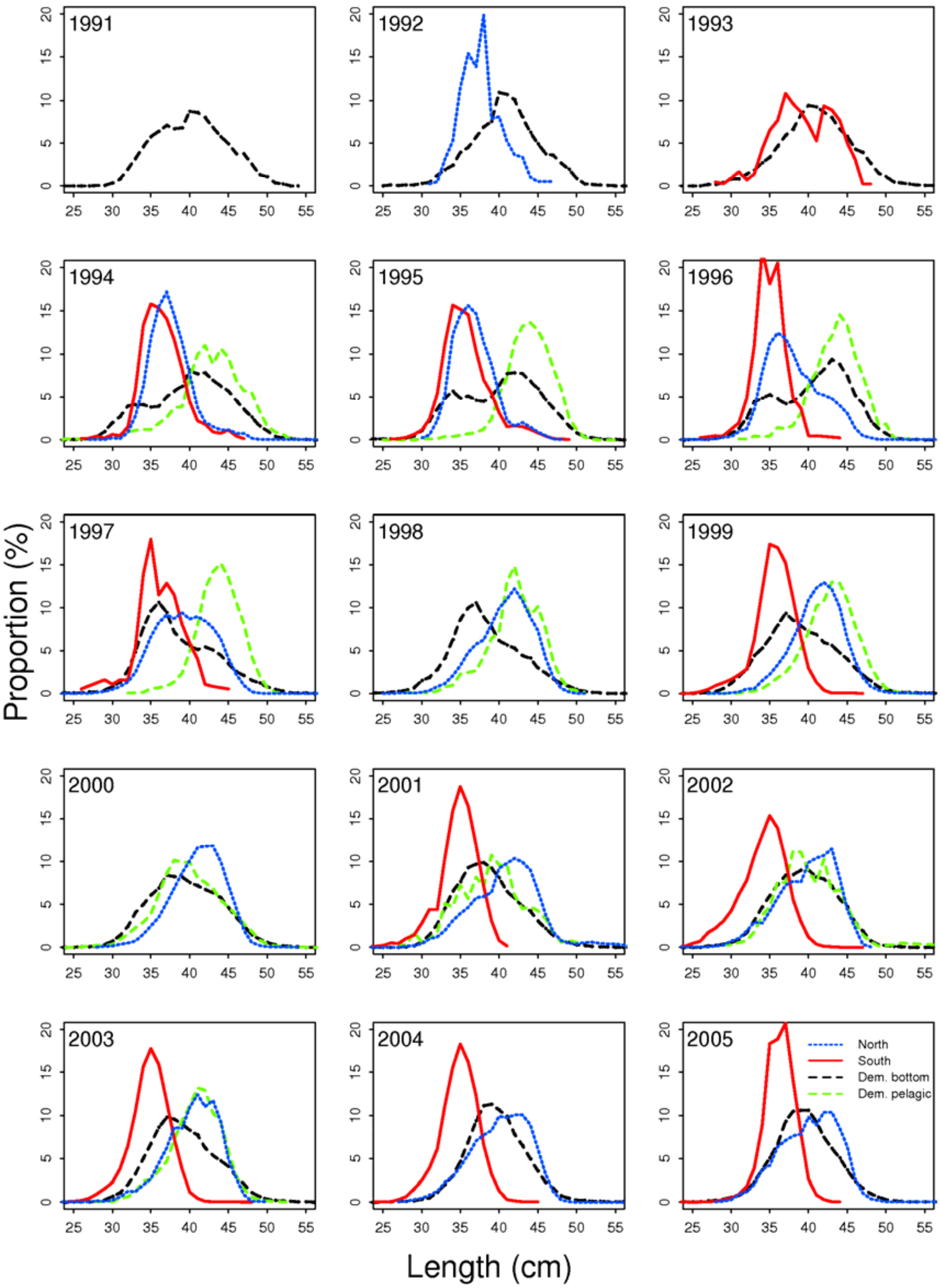


Figure 7.1.4 Length distributions from different Icelandic *S. mentella* fisheries. The coloured contours represent the fishery on pelagic *S. mentella*, the black contours indicate bottom trawl catches of demersal *S. mentella*, and the red contours represent catches of demersal *S. mentella* taken with pelagic trawls.

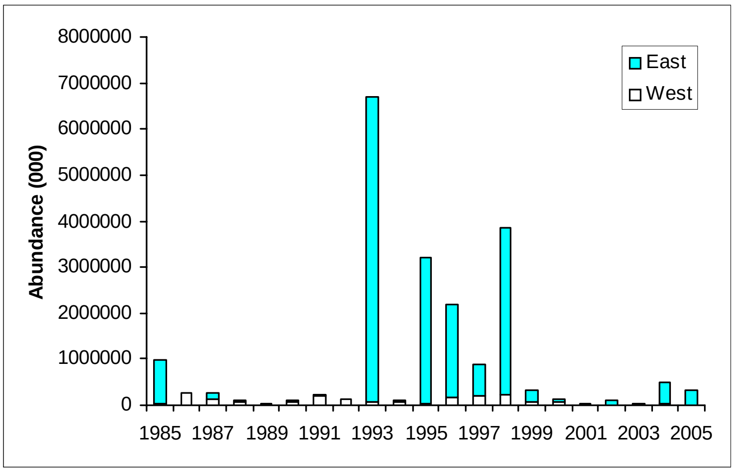


Figure 7.3.1 Survey abundance indices of juvenile *Sebastes* spp. (<17 cm) from the German groundfish survey conducted on the continental shelves off East and West Greenland 1985-2004.

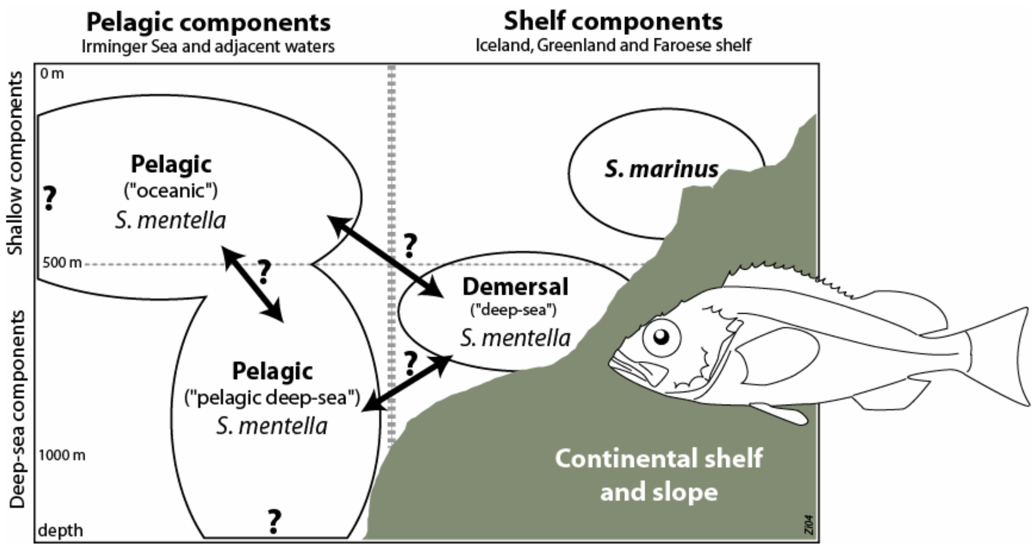


Figure 7.5.1 Possible relationship between redfish occurrences in the Irminger Sea and adjacent waters.

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

Since the early 1980s, total landings have decreased by more than 70% from about 130 000 t in 1982 to 37 000 t in 2001 (Table 8.1.1 and Figure 8.1.1). In 2002 the total landings increased to 50 000 t due to increased landings from Division Va, but decreased again to 39 000 t and to 33 500 t in 2003 and 2004 respectively. Total landings in 2005 increased from the previous year by 12 000 t, mainly due to increased landings in Va, and was 45 300 t. The majority of the *S. marinus* catch is taken in ICES Division Va and contributes between 90-95% of the total landings.

Landings of *S. marinus* in sub-Division Va declined from about 63 000 t in 1990 to 34 000 t in 1996. Since then landings have varied between 32 000 and 49 000 t, with the lowest landings in 2004 and the highest in 2002. The landings decreased in 2003 by about 12 000 t from the previous year and to 36 500 t and continued to decrease in 2004 to 32 000 t. The landings increased in 2005 by 11 000 t to 43 000 t. Between 90-95% of the annual *S. marinus* catch in Division Va is taken by bottom trawlers targeting redfish (both fresh fish and factory trawlers; vessel length 48-65 m). The remains are partly caught as by-catch in gillnet and longline fishery. In 2005, 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 (Table 8.1.1). The landings in increased by 1 400 t in 2005 and to 1 500 t, which is similar as in 1998. 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.

Annual landings from sub-area XIV have been more variable than in the other areas (Table 8.1.1). After the landings reached a record high of 31 000 t in 1982, the *S. marinus* fishery drastically reduced within the next three years (the landings from XIV are about 2 000 t in 1985). During the period 1985-1994 the annual landings from sub-area XIV varied between 600 and 4 200 t but since 1995, there has been little or no directed fishery for *S. marinus*. In recent years, landings have been 200 t or less and are mainly taken as by-catch in the shrimp fishery.

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	42,471	434	71,681
Va	Germany/UK	Bottom trawl	7		
Va	Faeroe	Longline	119		
Va	Norway	Longline	13		
Vb	Faeroe	Bottom trawl/gillnets	1,540	36	2,280
Vb	Various	Bottom trawl	944		
XIV	Various	Bottom trawl	85		
VI	Various	Bottom trawl	137		

The length distributions from the Icelandic commercial trawler fleet in 1989-2005 show that the majority of the fish caught range between 30 and 45 cm (Figure 8.1.3). From 2000 to 2005, the modes of the length distribution were around 35 cm whereas the modes in 1997-1999 were around 37 cm.

Catch-at-age data from the Icelandic fishery in Division Va shows that the 1985-year class dominated the catches from 1995-2002 (Figure 8.2.4 and Table 8.1.2) and in 2002, this year class contributed 25% of the total catch in weight. The 1990-year class is also strong, and this year-class dominated the catch in 2003-2005 contributing between 27-30% 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.

Length distribution from the Faeroes commercial catches for 2001-2005 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 1985-2005 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 CPUE index increased considerable in 2001 after being at low level 1993-1999 and has, since then, been high but stable (Figure 8.2.1). Effort towards *S. marinus* has gradually decreased from 1986 (Figure 8.2.1).

Un-standardized CPUE of the Faeroese otterboard (OB) trawlers 1991-2005 gradually declined to a record low in 1997 but has since then increased and is now about 80% of the 1991 value (Figure 8.2.2). 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 8.2.3 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 the March survey, 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 8.2.4) rising sharply from 34-36 cm (L_{50} = 35 cm), was calculated. The survey extends down to 500 m depth and the stations between 400 and 500 m are few and show the largest CV. Figure 8.2.5 shows this index of fishable biomass. The index indicates a decrease in the fishable biomass from 1985-1995, but an increasing trend since then. The lowest index was in 1995, only about 30% of the maximum in 1987, but the values in 2004-2006 are about 60% of the highest observed value. The total indices were on the other hand used in the BORMICON model (see below). The increase in biomass from 2003 to 2004 shown in Figure 8.2.3, compared to a decrease shown in Figure 8.2.4, is because of a sharp increase in biomass in the depth stratum 400-500 m, caused by few large hauls (Table 8.2.1). This estimate of the fishable biomass could be used as a proxy for the SSB. Figure 8.2.6 shows the proportion of mature *S. marinus* in the commercial catches 1995-2004 as a function of length. The estimated length at which 50% fish became mature (L_{50}) was estimated 33.2 cm, which is about 2 cm lower than the L_{50} of the catchability curve.

Length distributions from the Icelandic groundfish surveys show that the peak (Figure 8.2.7), which has been followed during the last years (first in 1987), has now reached the fishable stock. The increase in the survey index since 1995, therefore, reflects the recruitment of a relatively strong year classes (1985-year class and the 1990-year class). This has been confirmed by age readings (Figure 8.2.8). There is an indication of recruitment (fish less than 13 cm) observed in both groundfish surveys in 1998-2000 (Figure 8.2.9) and can be seen as 6-8 years old fish in the 2004 autumn survey (Figure 8.2.8). 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 a recruiting fish coming from East Greenland (Figure 8.2.11).

In Division Vb, CPUE of *S. marinus* were available from the Faeroes spring groundfish survey from 1994 to 2006 (Figure 8.2.10). 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 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 2005, CPUE decreased and was at the lowest level in the time series (Figure 8.2.10).

From 1985 to 2005, abundance and biomass indices from the German groundfish survey for *S. marinus* (fish >17 cm) are illustrated in Figures 8.2.11 and 8.2.12. 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 estimates in 2005 were among the highest recorded since 1990. 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 8.2.3). The length frequencies from the German groundfish survey are illustrated in Figure

8.2.1. It can 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. Although adults seem to be severely depleted in East Greenland waters there is a sign of increased number of larger fish.

8.2.3 Assessment by use of BORMICON model

Since 1999 the working group has discussed an alternative model (BORMICON (BOReal MIgration and CONsumption model) that has been applied to the stock in Va. The model, where *S. marinus* is used as an example, was described in details by Björnsson and Sigurdsson (2003). The BORMICON model is an age- and length based cohort model, where all the selection curves depend on the length of the fish and information on age is not a prerequisite but can be utilized if available. The commercial catch is modelled as one fleet with a fixed selection pattern described by a logistic function and total catch in tonnes specified for each time period.

The BORMICON model was run using the same settings as last year's base case. The simulation period is from 1970 to 2005. Two time steps are used each year. Natural mortality is set to 0.15 for the youngest age, decreasing gradually to 0.05 for age 5 and older. The ages used were 1 to 30 years, where the oldest age is treated as a plus group (fish 30 years and older). Recruitment was set at age 1. Length at recruitment was estimated separately prior to and after 1989.

An alternative configuration was also investigated. There the L_{50} in the selection pattern of the commercial fleet was allowed to vary annually after 1998 and the length at recruitment was estimated separately for the 1990-year class. The former change was to check the effects of the area closures to preserve the 1990-year class and the second change to look at problem that the model has in distinguishing between the 1990- and 1991-year classes.

Estimated parameters are:

- Number of fishes when the simulation starts (8 parameters).
- Recruitment each year (32 parameters).
- Length at recruitment (2 parameters).
- Parameters in the growth equation; (2 parameters).
- Parameter β of the beta-binomial distribution controlling the spread of the length distribution.
- Selection pattern of the commercial fleet (2 parameters).

Results for 2006 run are shown in Figure 8.2.14.

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 8.2.14-8.2.19 and compared to the results from two previous years in Figure 8.2.20. As may be seen the estimate on catchable biomass for 2006 is similar to the ones estimated in 2002 and 2003, although a little higher, with the difference probably driven by the high survey indices 2004 (Figure 8.2.18). Furthermore, the results for 2006 are similar to the one presented in Björnsson and Sigurdsson (2003), where they used data until 2000.

Figure 8.2.19 shows residuals from the model fit to the survey data, demonstrating large positive residuals in some years, most notably 1993, 1999, and 2003-2005. The large positive residuals for 22-37 cm fish observed in 2003-2005 indicate that survey results exceeded model prediction.

The indices from the groundfish survey are the main indicators of recruitment in the model. As described in section 8.2.2, the groundfish survey has indicated poor recruitment of redfish since the 1990-year class and the model mimics those results. The estimated average year class size in 1991-2001 is now estimated 80 million (at age 0) which is only enough to sustain an annual catch of 20 000 tonnes using estimated maximum yield per recruit of 250 g.

According to the predictions here, the stock is going to be stable for the next few years with an annual catch of 30 000-35 000 t (Figure 8.2.15). This value might though have to be reduced every new year with no sign of good recruitment. From the above-mentioned runs, it is clear that if the groundfish survey is to be accepted as a measure of recruitment, no new large year class will recruit to the fishable stock in the next 10 years.

The estimation of L_{50} in the selection pattern of the commercial fleet was estimated 32.3 cm, which is the lowest value estimated (Table 8.2.2). 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 8.2.15, 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 33 000 t.

8.2.4 State of the stock

S. marinus is mainly caught in ICES Division Va, contributing 90-95% of the total landings from Va, Vb, and XIV. The BORMICON model and available survey information from Division Va show that the *S. marinus* stock decreased considerably from 1985 to the lowest recorded biomass in 1995. An improvement in the fishable biomass has, however, been seen in the most recent years due to improved recruitment. During the last few years, the 1985-year class has contributed significantly to the fishable stock, and the 1990-year class has also contributed significantly to the fishable biomass in the last 5 years. It is expected that those year classes will dominate the catches in the next few years. There is 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. The BORMICON model estimated the exploitation rate to amount to F=0.16. 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 8.2.3. Based on the BORMICON model, a decrease in the fishable biomass is expected for all catch options above about 37 000 t and in total biomass for all options exceeding about 33 000 t. This is due to the poor recruitment after the 1990-year class. The estimated average year class since 1992 is about 80 millions (at age 0) and maximum yield-per-recruit is estimated to about 250 g. Based on the model results, a TAC below 35 000 t in the next 4 years would provide a fishable stock size above current biomass level at the end of that period and total biomass similar to current level (Table 8.2.3). A large proportion of the catch will be from the 1985- and 1990-year classes. Therefore, after these two strong year classes have passed the fishery, higher yield than about 20 000 t cannot be expected after 2010. The approximate **F** from the model would decrease from the current level and be close to $\mathbf{F_{max}}$.

8.3 Biological reference points

The biological reference points are given in Table 8.2.4.

F_{max} was calculated by following one year-class of million fishes for 50 years through the fisheries calculating total yield from the year-class as function of fishing mortality of fully recruited fish. From the plot of yield vs. fishing mortality F_{max} and $F_{0.1}$ were estimated. In the model, the selection of the fisheries is length based so only the largest individuals of recruiting year-classes are caught, reducing mean weight of the survivors, more as fishing mortality is increased. This is to be contrasted with age based yield per recruit where the same weights at age are assumed in the landings independent of the fishing mortality even when the catch weights are much higher hand the mean weight in the stock. Those effects can be seen in Figure 8.2.14 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 and lead to fishing mortality close to $\mathbf{F_{max}}$.

S. marinus is mainly caught in Division Va, and the relative state of the stock can be assessed through survey index series from that Division. ACFM accepted the proposal of the working group of defining reference points in terms of current state with respect to $U_{lim} = U_{max}/5$ and U_{pa} = 60% of U_{max}. U_{pa} corresponds to the fishable biomass associated with the last strong year class. Based on survey data, the highest recorded biomass was reached in 1987. Based on these definitions, the stock has been close to U_{pa} during the last years (Figure 8.2.5). The survey index series is only available from 1985.

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 2006 according to this year assessment using the BORMICON model in Va is 14% or 28 000 t lower than last year. Of this difference 7 500 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 42 500 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 2006 have been rather stable in recent years and are now similar to the estimates of the 2002 and 2003 estimates (Figure 8.2.21).

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). 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, 1978-2005 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 1)	42,660	2,484	137	85	45,366

1) Provisional

Table 8.1.2 *S. marinus*. Landings in Va in weight (tonnes) by age 1995-2005. Highlighted are the 1985- and 1990-yearclasses. It should be noted that the catch-at-age results for 1996 are only based on three samples, which explains that there are no specimen older than 23 years

Year/ Age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
7	62	0	**33**	24	7	40	*122*	130	201	227	82
8	374	360	230	**285**	350	65	138	*910*	211	849	548
9	1,596	825	482	596	**1,623**	852	395	767	*1,366*	499	1,389
10	**9,436**	3,701	1,039	1,211	1,259	**4,308**	1,623	841	1,120	*2,109*	1,396
11	2,719	**9,127**	2,702	1,132	1,855	1,894	**7,763**	3,188	1,197	795	*2,966*
12	1,319	2,102	**11,583**	3,252	2,528	2,277	1,807	**11,065**	3,952	982	2,342
13	3,534	1,317	2,828	**12,532**	2,450	1,703	1,983	3,095	**9,788**	2,035	1,716
14	5,671	1,477	1,373	2,085	**15,566**	2,375	1,252	2,630	2,361	**8,661**	3,049
15	5,971	4,347	3,142	2,039	1,244	**14,878**	839	1,856	1,978	2,158	**12,964**
16	1,730	5,456	3,666	2,413	1,276	1,777	**11,686**	3,029	1,218	1,723	2,100
17	852	934	3,035	3,416	1,823	1,184	523	**12,046**	2,267	826	1,481
18	368	379	900	2,051	2,665	1,624	787	2,097	**6,427**	1,401	1,110
19	1,134	259	642	1,018	2,228	2,427	1,068	1,174	761	**5,342**	1,280
20	1,144	340	925	729	1,271	2,191	1,801	663	410	1,120	**6,716**
21	503	1,157	449	523	479	544	970	1,411	604	336	470
22	677	988	520	391	217	447	420	1,028	791	491	545
23	1,427	791	681	427	341	270	437	743	755	620	799
24	664	0	587	665	218	64	169	363	379	600	614
25	762	0	749	516	930	393	130	294	303	284	409
26	365	0	271	401	279	340	126	185	75	106	49
27	350	0	136	427	649	193	293	83	83	180	403
28	725	0	192	360	228	528	204	297	27	153	123
29	0	0	149	54	105	371	153	500	106	138	0
30	133	0	30	226	231	441	375	174	197	161	58
Total	41,516	33,560	36,344	36,773	39,822	41,186	35,064	48,569	36,577	31,796	42,609

Table 8.2.1 Index on fishable stock of *S. marinus* in the Icelandic groundfish survey 1985-2006 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

Table 8.2.2 Results of the BORMICON model. BASE CASE, estimated value of L_{50}. in the selection pattern of the commercial fleet

YEAR	<1998	1998	1999	2000	2001	2002	2003	2004	2005
L_{50}	33.75	34.38	34.19	33.84	33.61	34.19	33.06	33.05	32.33

Table 8.2.3 *S. marinus* in Division Va. Output from short term prediction using results from the BORMICON model, where the annual landings after 2005 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
2005	167.9	0.26	313.2	42.5
2006	174.7	0.22	310.0	35.0
2007	183.2	0.20	305.9	35.0
2008	190.6	0.19	298.8	35.0
2009	195.3	0.18	288.8	35.0

Table 8.2.4 Biological reference points for *S. marinus* in Division Va.

PARAMETERS	ESTIMATION
F_{max}	0.16
$F_{0.1}$	0.09
SSB	167 900 t
Yield per recruit	250 g

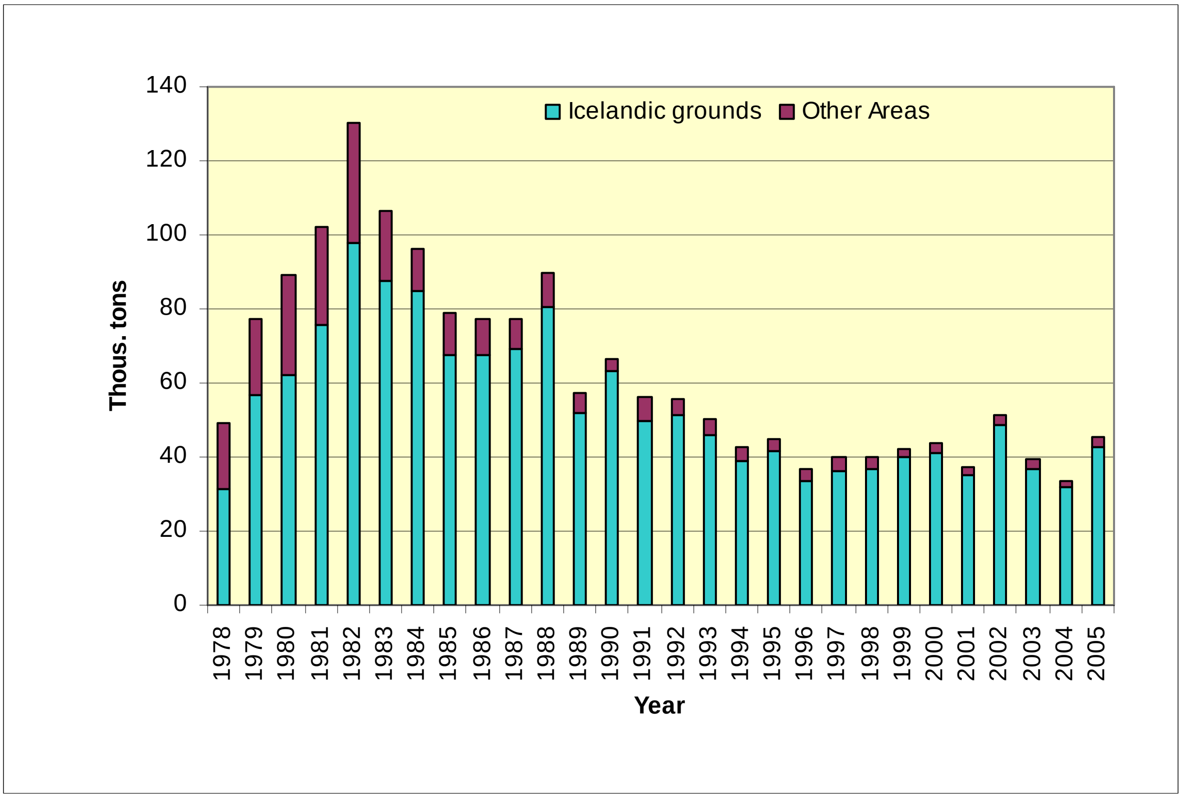


Figure 8.1.1 ***Sebastes marinus*. Nominal landings in tonnes in ICES Division Va and in other areas (landing statistics for ICES Divisions Vb, VI and XIV combined) 1978-2005. Landings statistics for 2005 are provisional.**

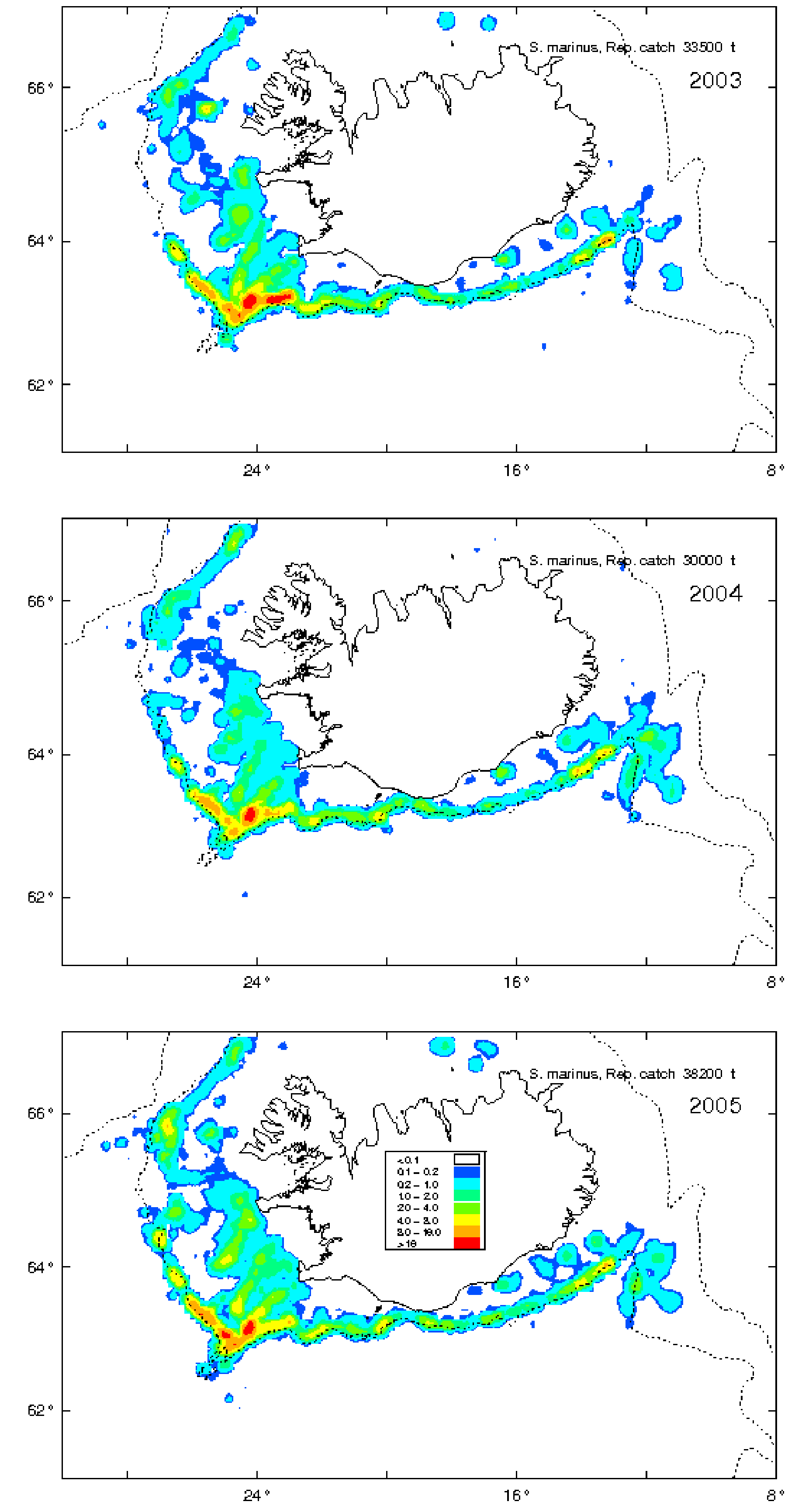


Figure 8.1.2 Geographical distribution of *S. marinus* catches in Division Va 2003-2005.

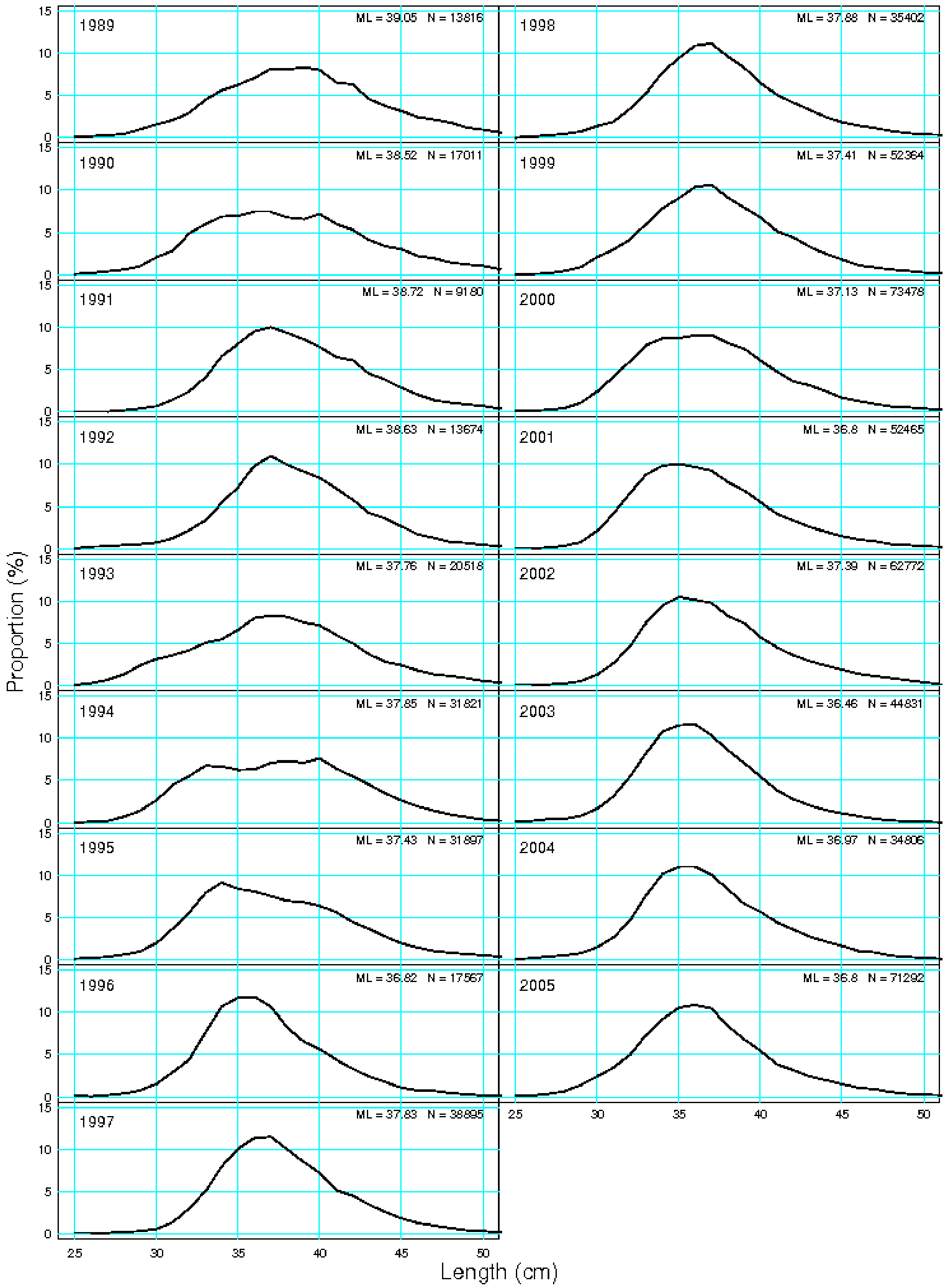


Figure 8.1.3 Length distribution of *S. marinus* in the commercial landings of the Icelandic bottom trawl fleet 1989-2005.

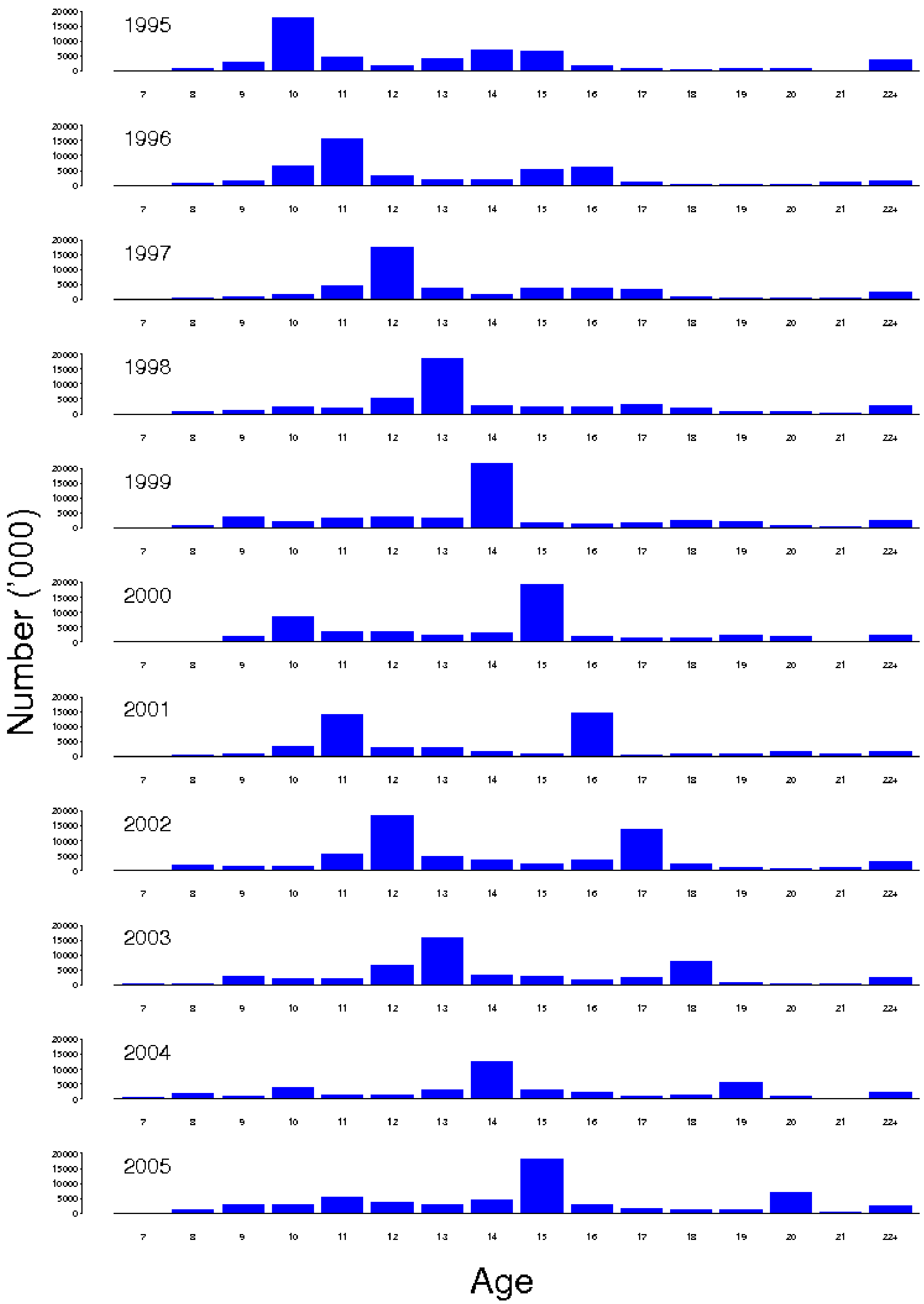


Figure 8.1.4 ***S. marinus.*** **Catch-at-age in numbers in ICES Subdivision Va 1995-2005.**

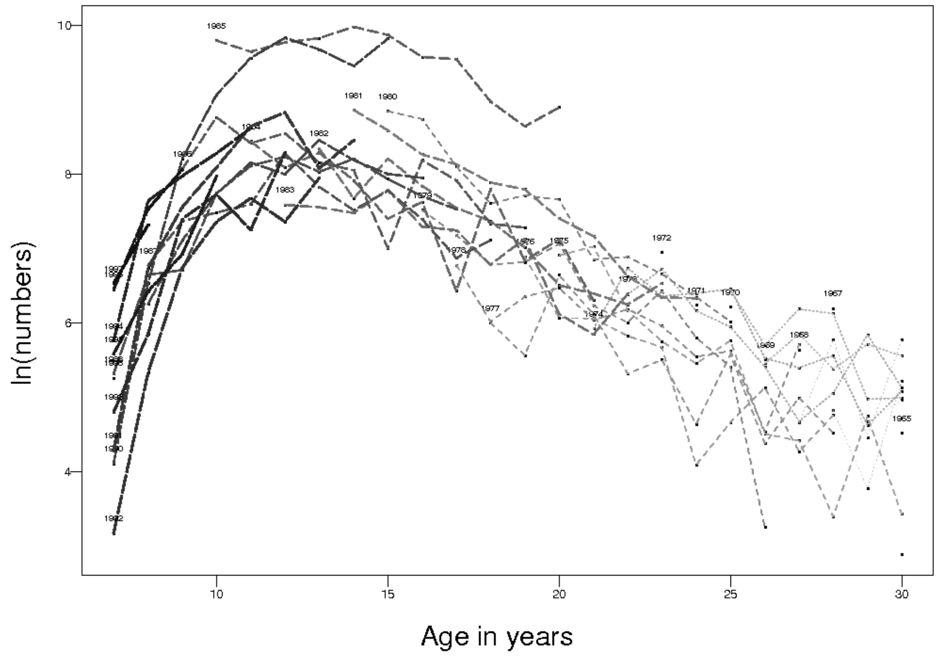


Figure 8.1.5 ***S. marinus.*** **Catch curve based on the catch-at-age data in ICES Division Va 1995-2004.**

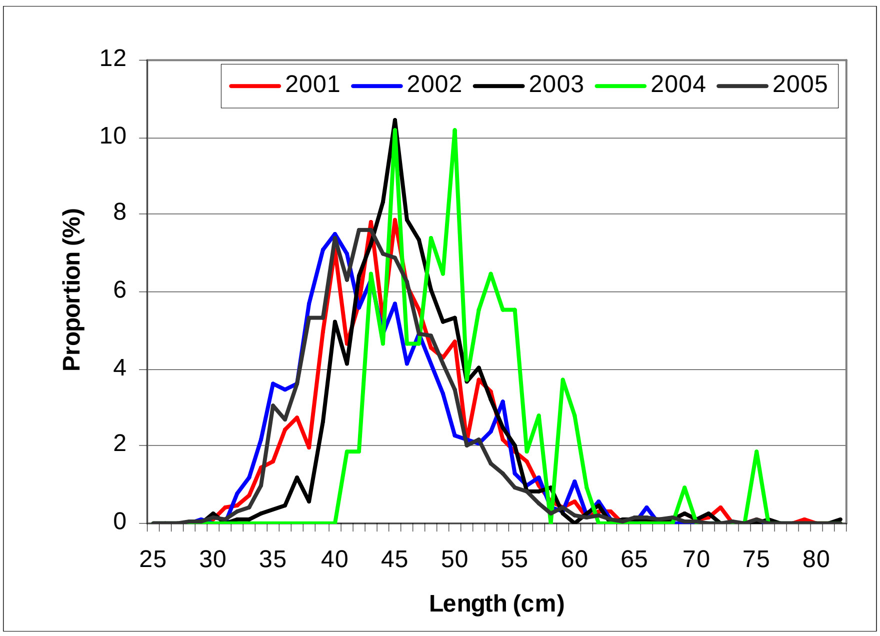


Figure 8.1.6 ***S. marinus.*** **Length distribution from Faroese catches in 2001-2005.**

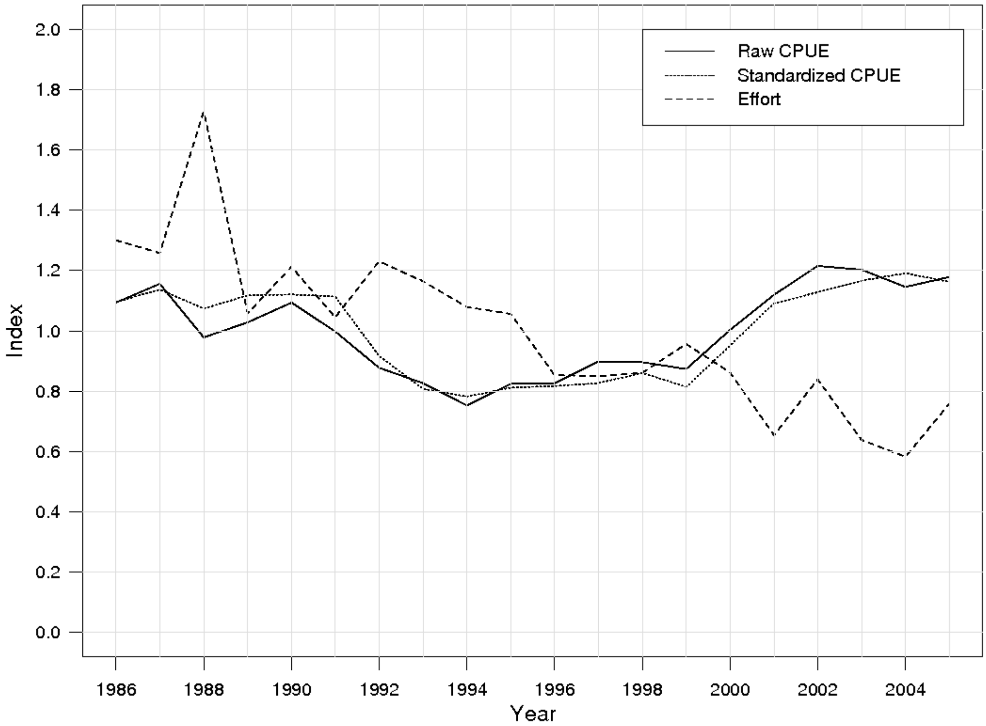


Figure 8.2.1 **CPUE of *S. marinus* from Icelandic trawlers based on results from the GLM model 1985-2005 where the *S. marinus* catch composed at least 50% of the total catch in each haul. The upper figure shows the raw CPUE index (sum(yield)/sum(effort)), standardized CPUE index estimated using a generalized linear model and effort. The lower figure shows the index estimated using a generalized linear model and associated standard error.**

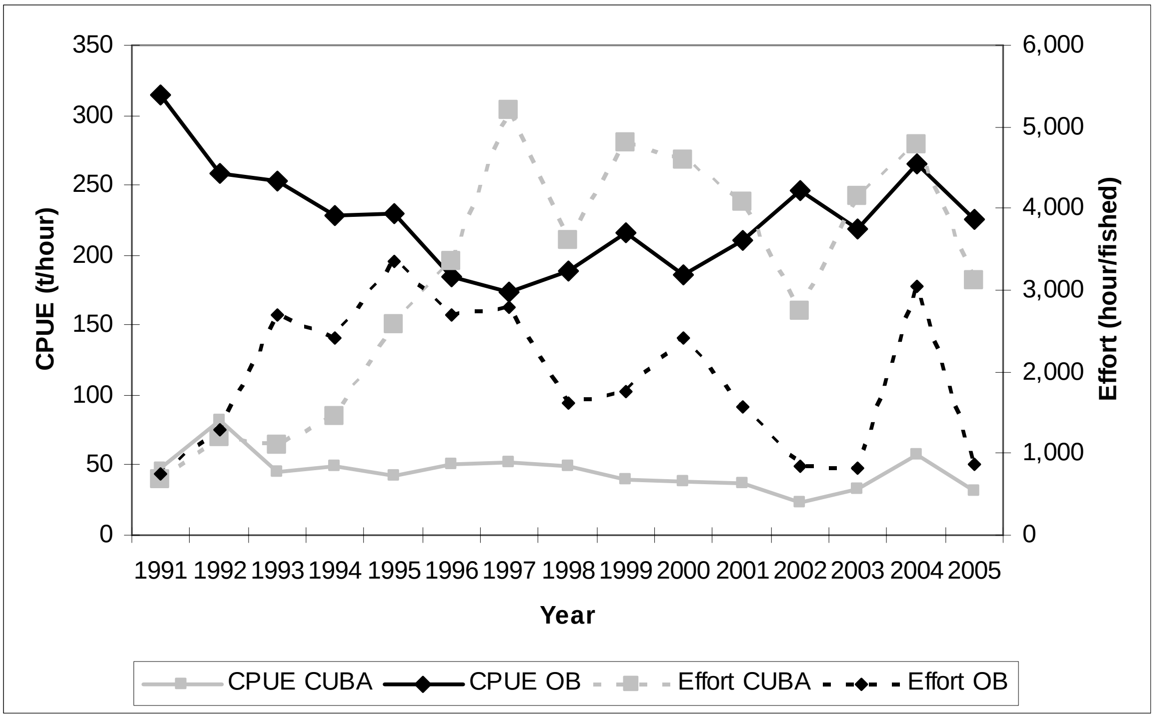


Figure 8.2.2 CPUE (solid lines) and effort (dotted lines) from the Faroese CUBA pair-trawlers (grey) and otterboard trawlers (black) in ICES Division Vb 1991-2005.

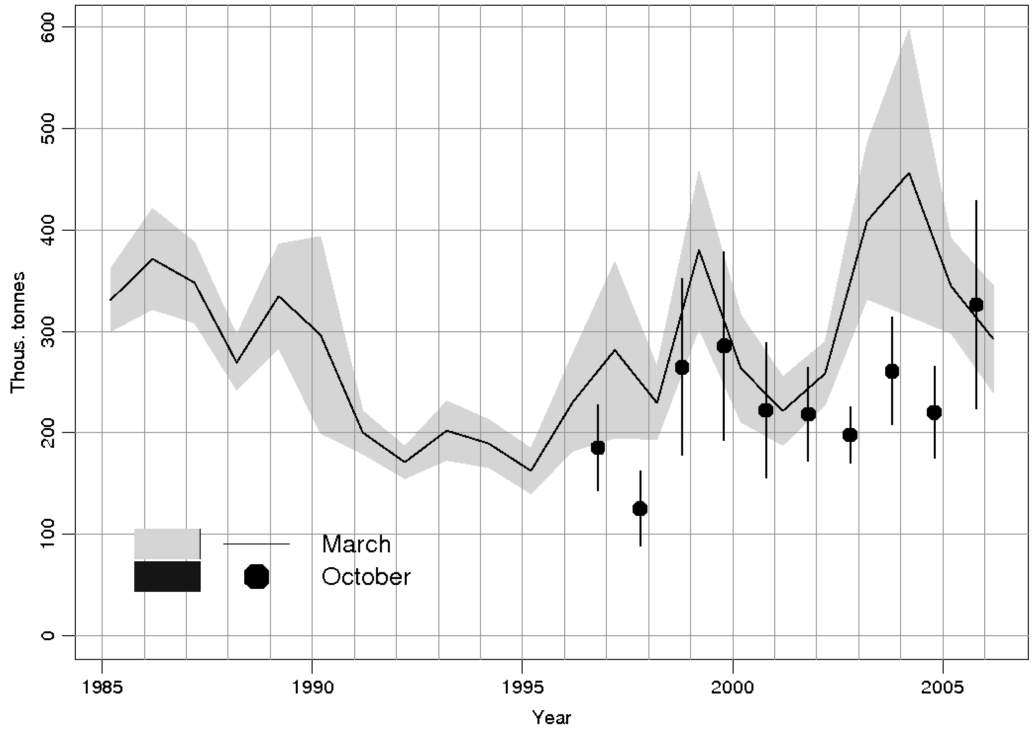


Figure 8.2.3 Total biomass indices from the groundfish surveys in March 1985-2006 (line) and October 1996-2005 (points). The shaded area and the vertical bar show ±1 standard error of the estimate.

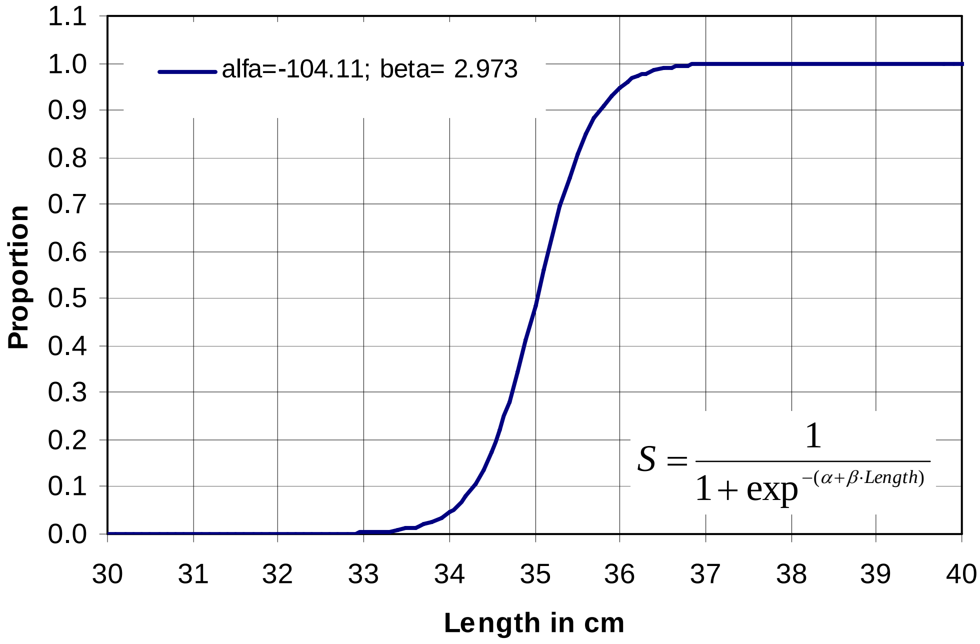


Figure 8.2.4 **Selection pattern of *S. marinus* from the commercial fishery used to estimate the abundance of the fishable stock abundance. L_{50} = 35 cm.**

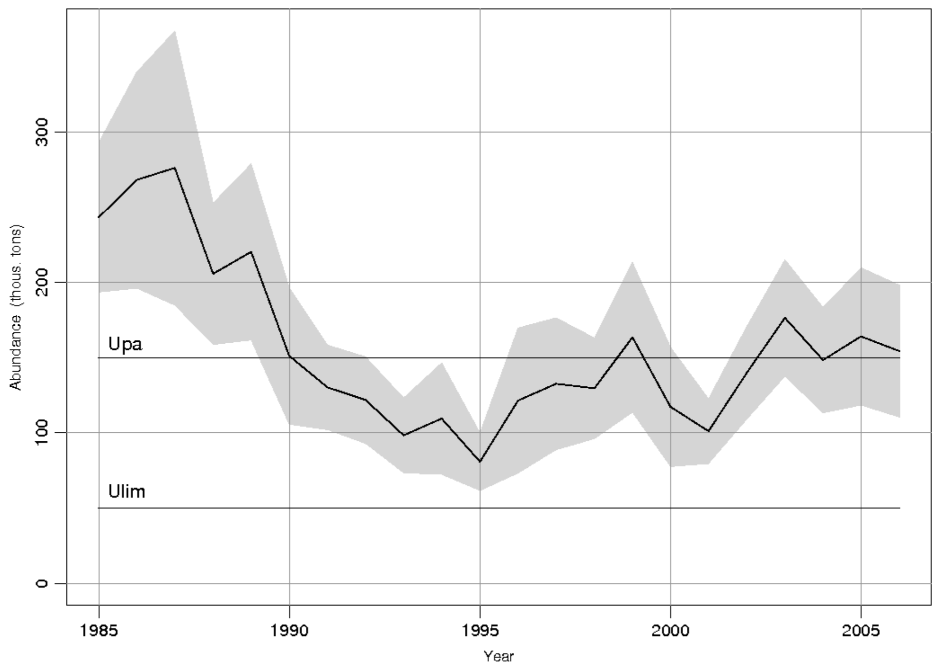


Figure 8.2.5 **Index on fishable stock of *S. marinus* from Icelandic groundfish survey 1985-2006. The shaded area and the vertical bar show ±1 standard error of the estimate.**

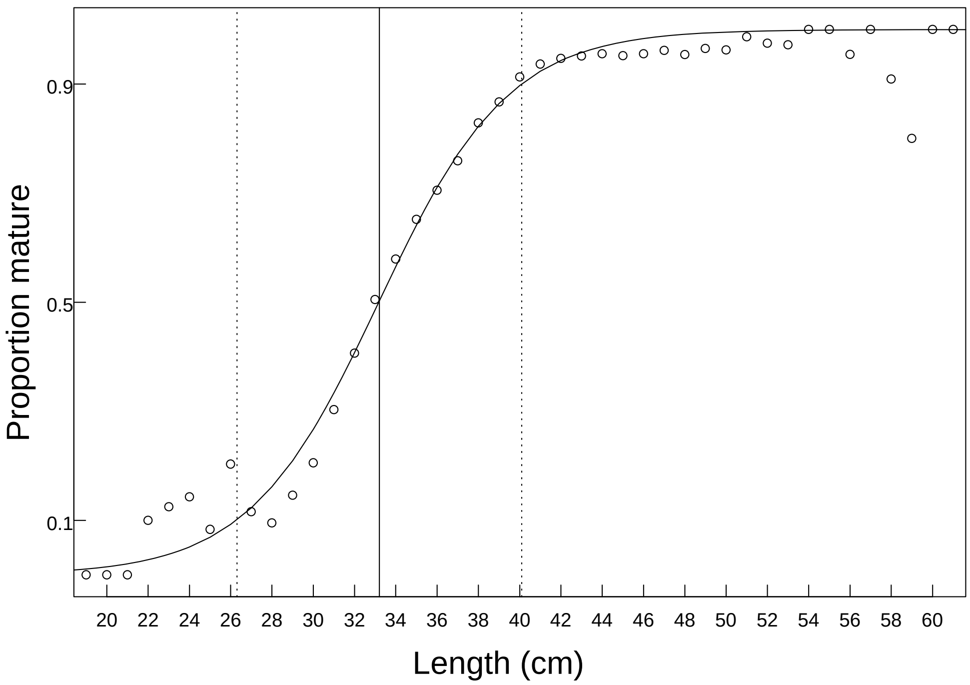


Figure 8.2.6 The proportion of mature *S. marinus* as a function of length from the commercial catch in Va 1995-2004 (all data pooled). The data points show the observed proportion mature and the lines the fitted maturity. The solid vertical line indicates the point where 50% of the fish mature and the two dotted lines indicate the 10% and 90% probability of being mature.

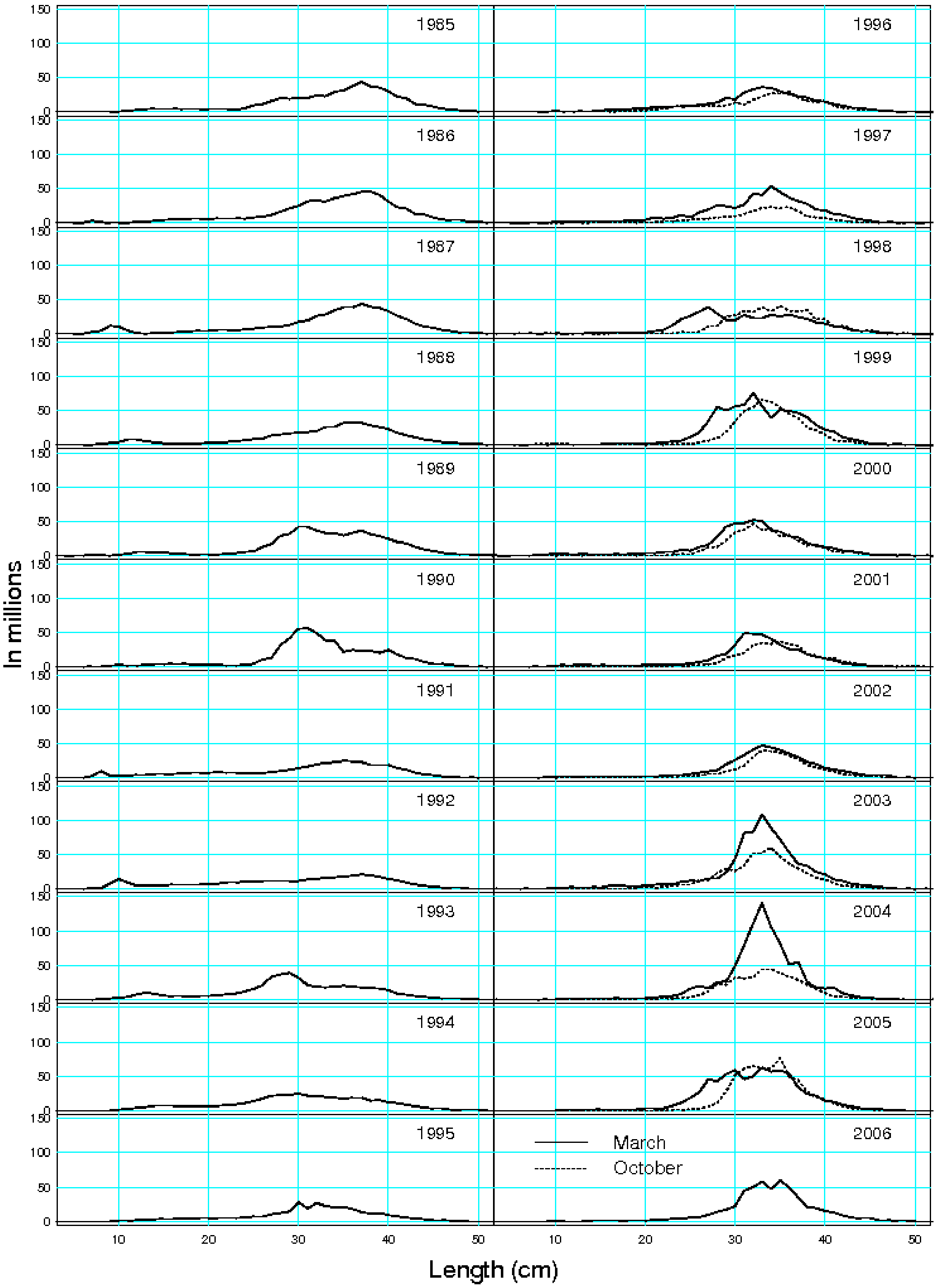


Figure 8.2.7 **Length distribution of *S. marinus* in the bottom trawl surveys in March 1985-2006 (solid line) and in October 1996-2005 (broken lines) conducted in Icelandic waters.**

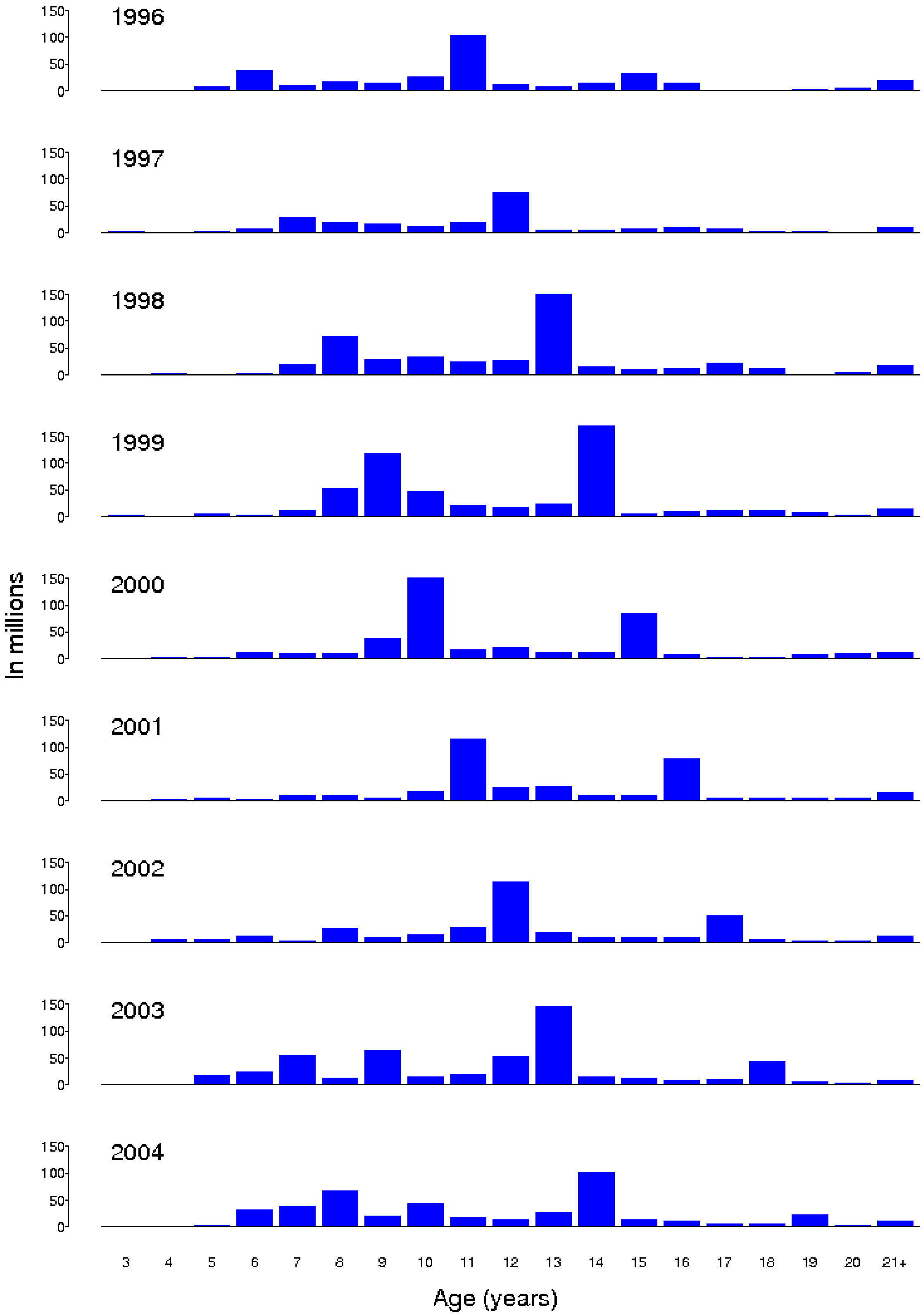


Figure 8.2.8 Age distribution of ***S. marinus*** in the bottom trawl survey in October conducted in Icelandic waters1996-2004. No age readings were available for 2005.

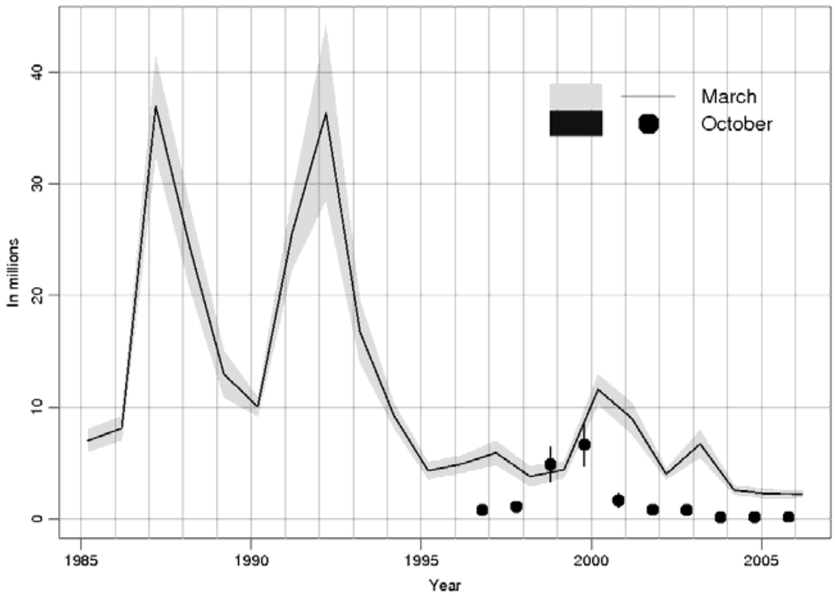


Figure 8.2.9 Indices of juvenile *S. marinus* (4-12) cm in millions from the grounfish surveys in March 1985-2006 (line) and October 1996-2005 (points) conducted on the continental shelf and slope of Iceland The shaded area and the vertical bar show ±1 standard error in the estimate of the indices.

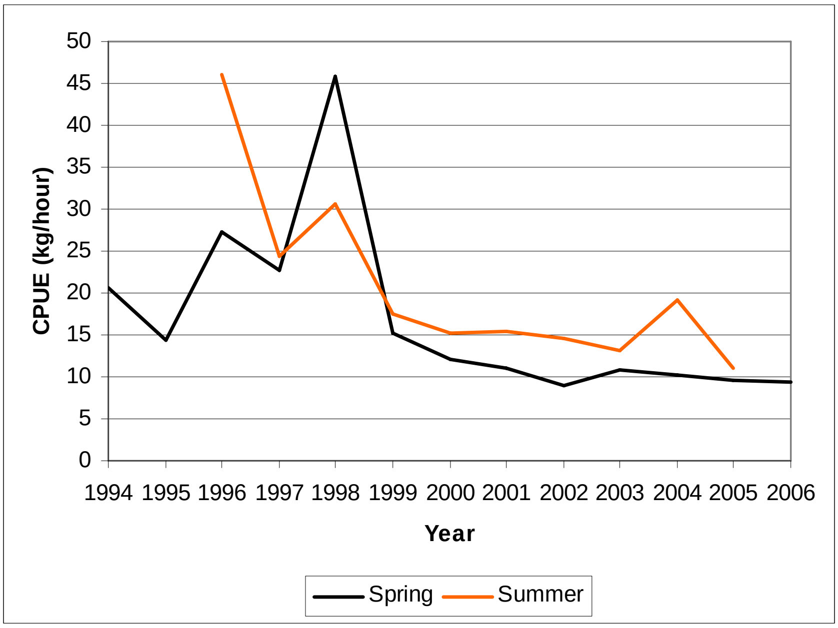


Figure 8.2.10 CPUE of *S.marinus* in the Faeroes spring groundfish survey 1994-2006 and the summer groundfish survey 1996-2005 in ICES Division Vb.

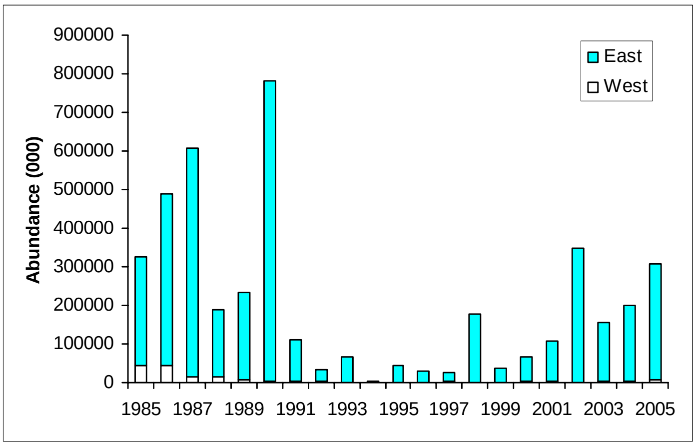


Figure 8.2.11 ***S. marinus*** **(≥17 cm). Survey abundance indices for East and West Greenland from the German groundfish survey 1985-2005.**

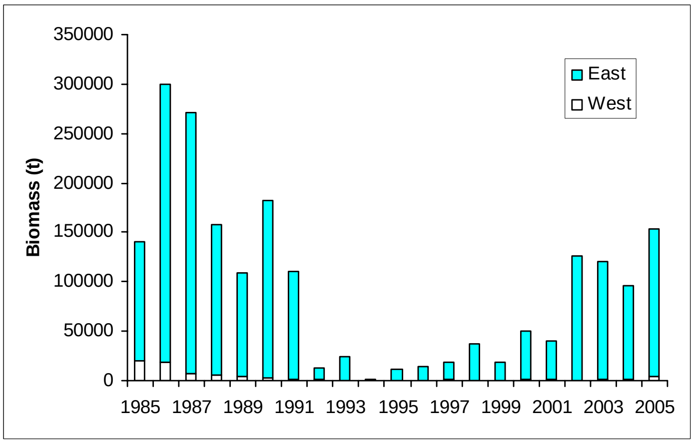


Figure 8.2.12 ***S. marinus*** **(≥17 cm). Survey biomass indices for East and West Greenland from the German groundfish survey1985-2005.**

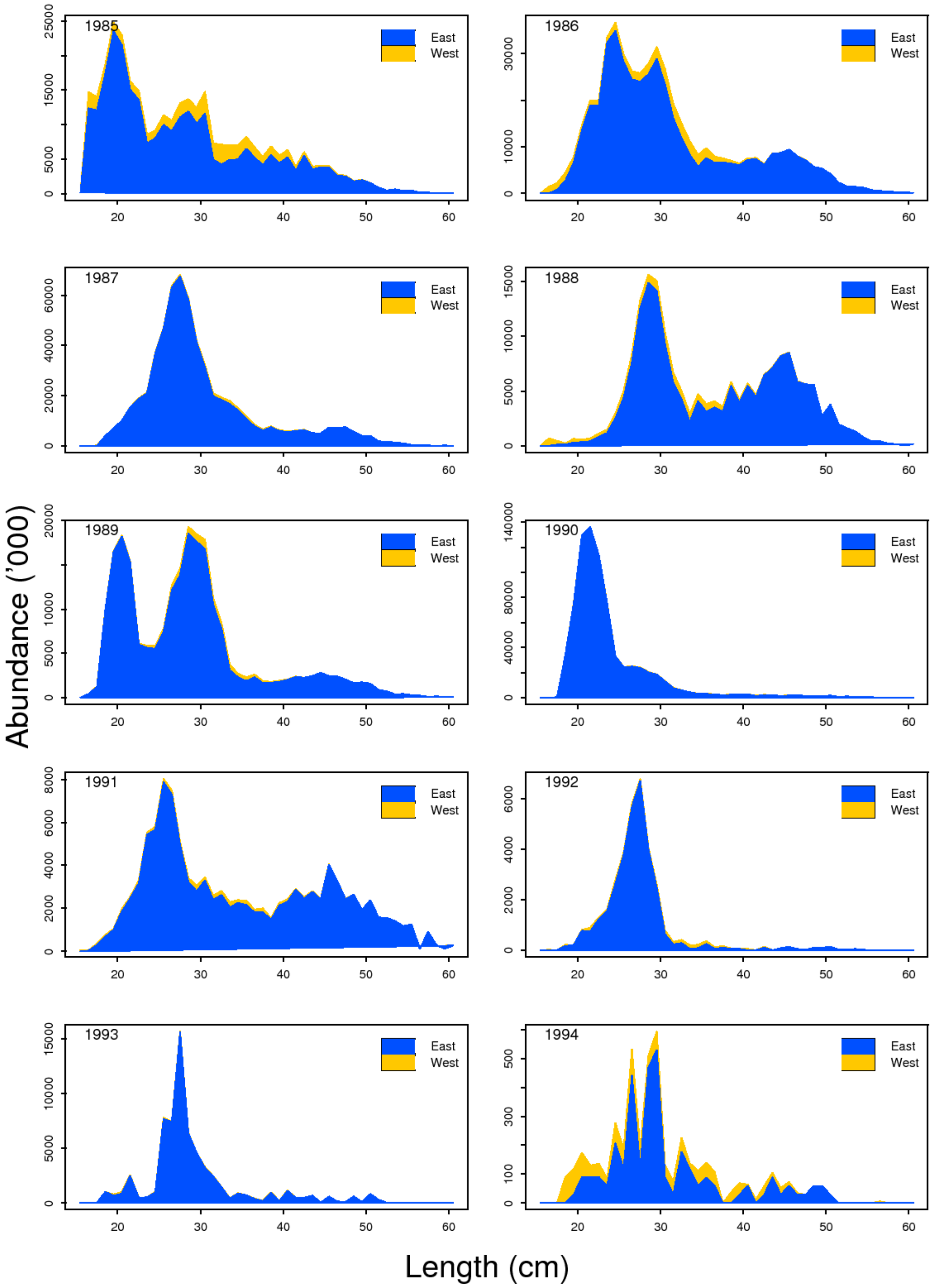


Figure 8.2.13 ***S. marinus*** **(>17 cm). Length frequencies for East and West Greenland 1985-1994.**

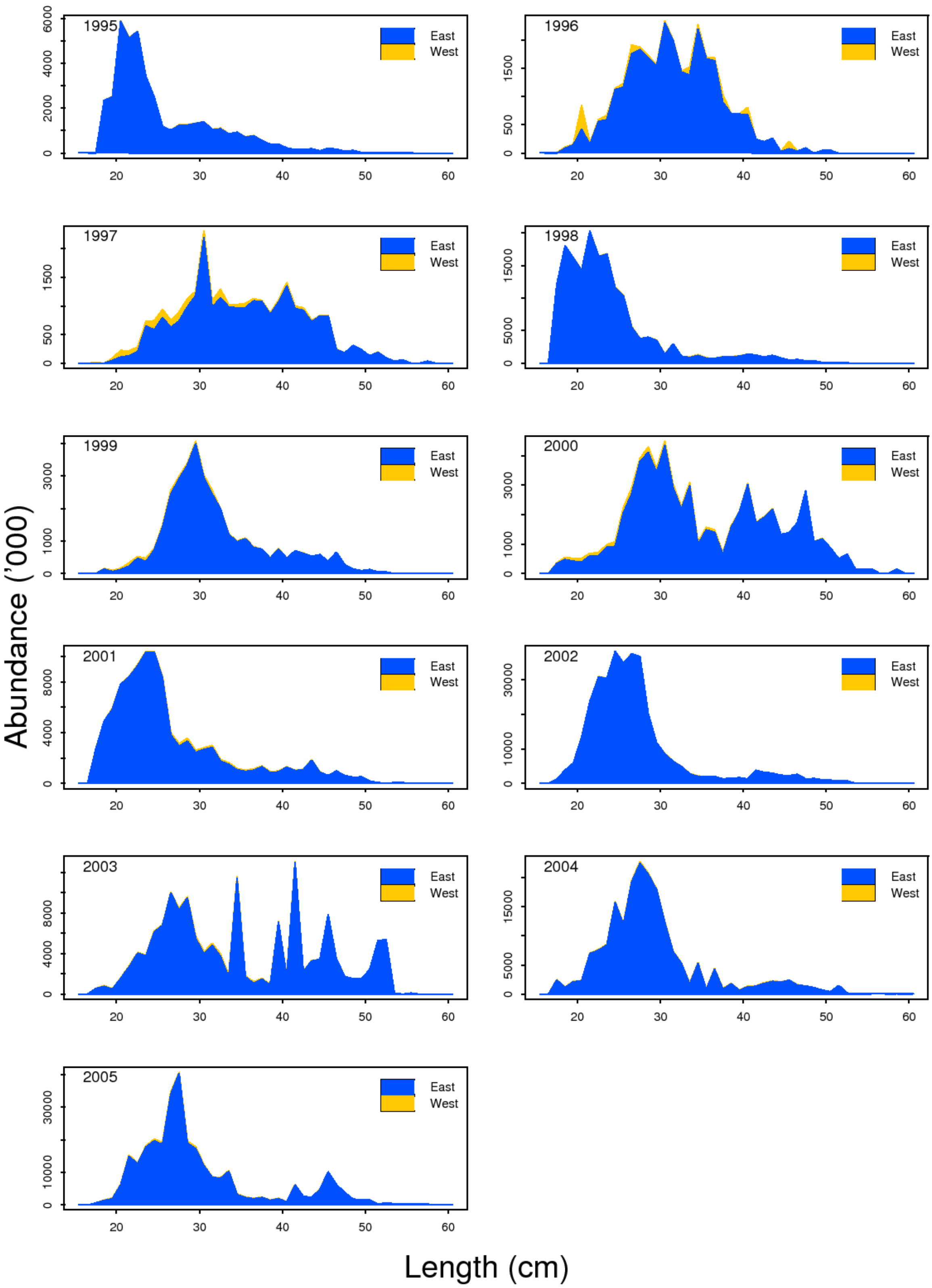


Figure 8.2.13 Continued. ***S. marinus*** **(>17 cm). Length frequencies for East and West Greenland 1995-2005.**

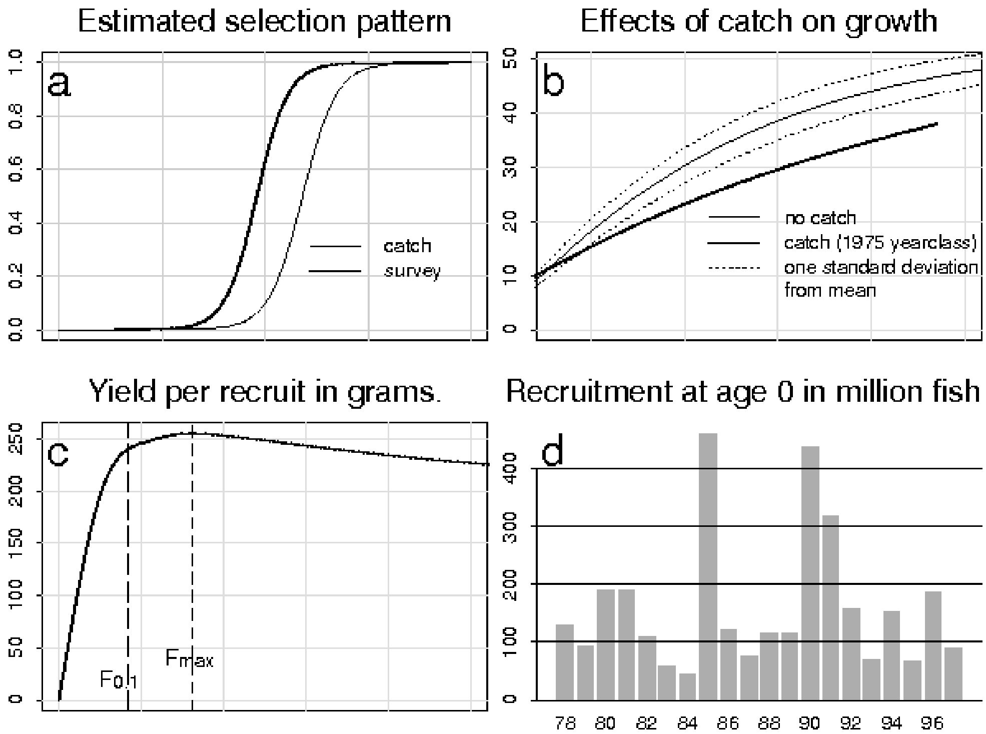


Figure 8.2.14 Results from the BORMICON model-BASE CASE, using catch data from ICES Division Va. a) Estimated selection pattern of the commercial fleet and the survey, b) Mean length (the Figure also demonstrates the effect of catch on length-at-age), c) Yield-per-recruit, and d) Estimated recruitment at age 0.

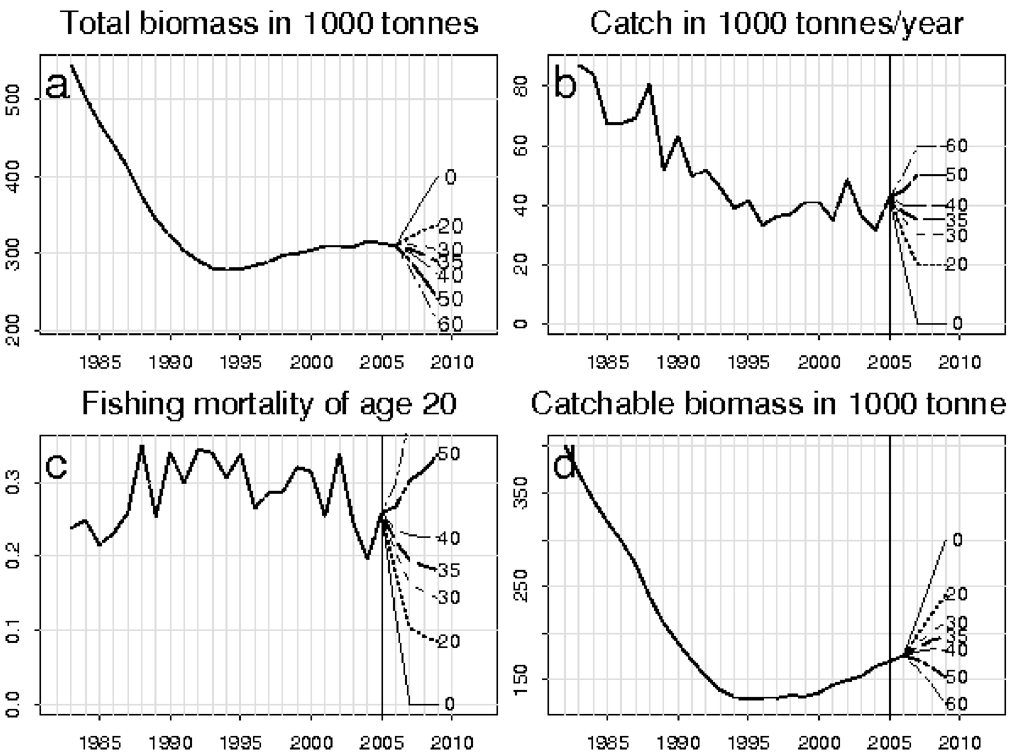


Figure 8.2.15 Results from the BASE CASE run, using catch data from ICES Division Va. The Figures show the development of biomass and F, using different catch options (0-60 000 t) after 2006.

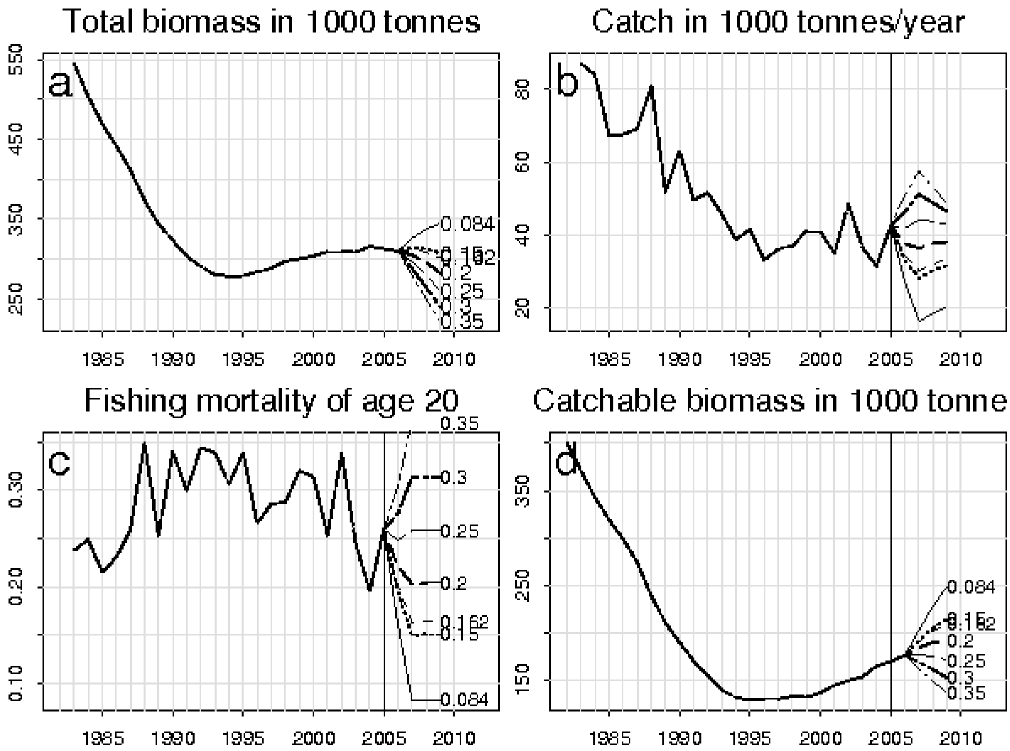


Figure 8.2.16 Results from the BASE CASE run, using catch data from ICES Division Va. The Figures show the development of biomass and F, using different effort after 2006.

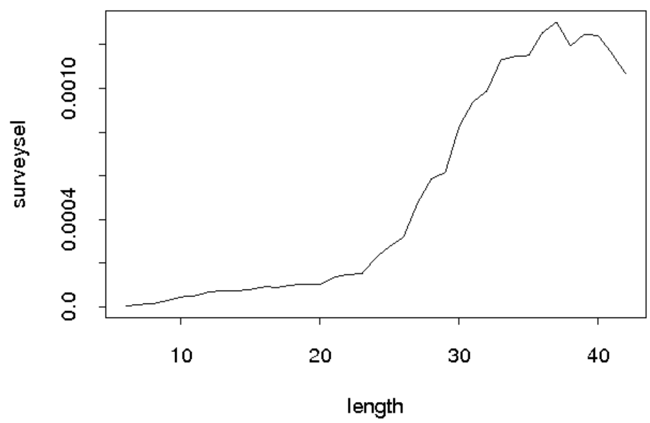


Figure 8.2.17 Estimated selection pattern as a function of length from the BASE CASE for *S. marinus* in the Icelandic groundfish survey.

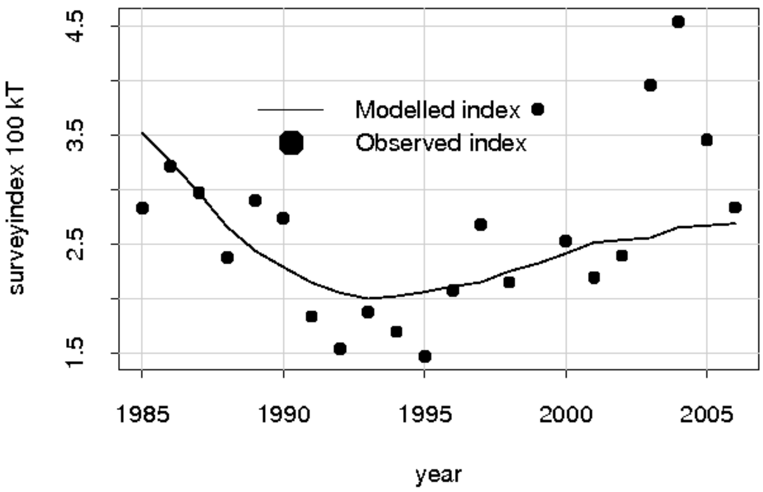


Figure 8.2.18 Results from the BASE CASE run, using only catch data from ICES Division Va. The Figure show comparison of observed and modelled survey biomass (total biomass).

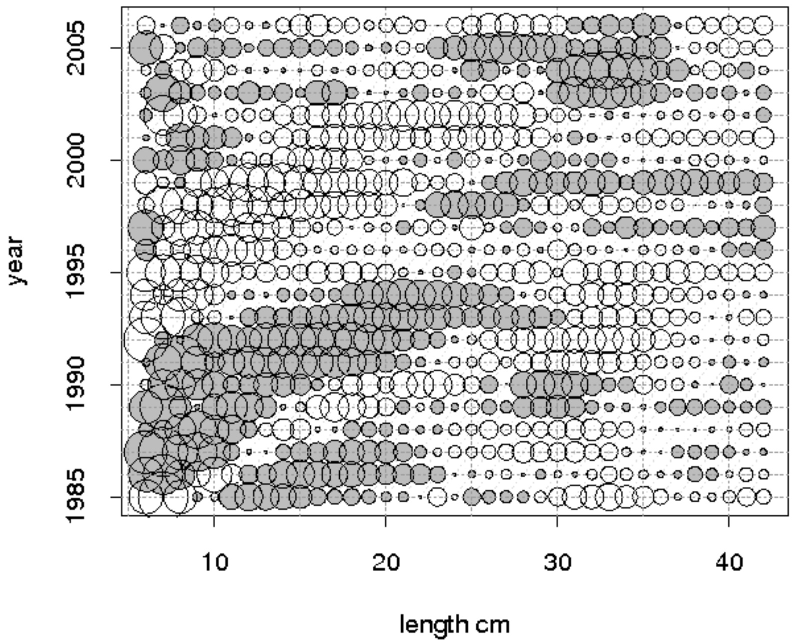


Figure 8.2.19 Results from the BASE CASE run, using catch data from ICES Division Va. Residuals from fit to survey data log(Isur/Imod). The shaded circles show positive residuals (survey results exceed model prediction).

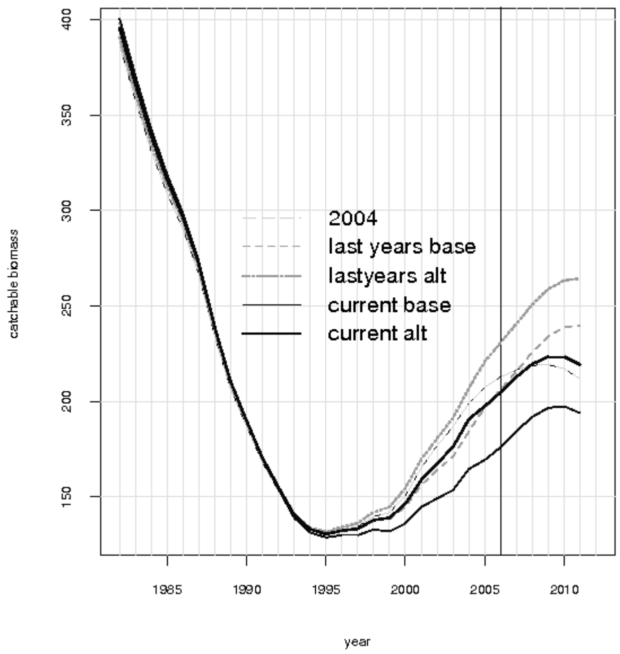


Figure 8.2.20 Comparison of catchable biomass (in thousand tonnes) using the data obtained now and last year, for same settings. Results are obtained using only the catch history from ICES Division Va. Note the scale on y-axis does not start with 0.

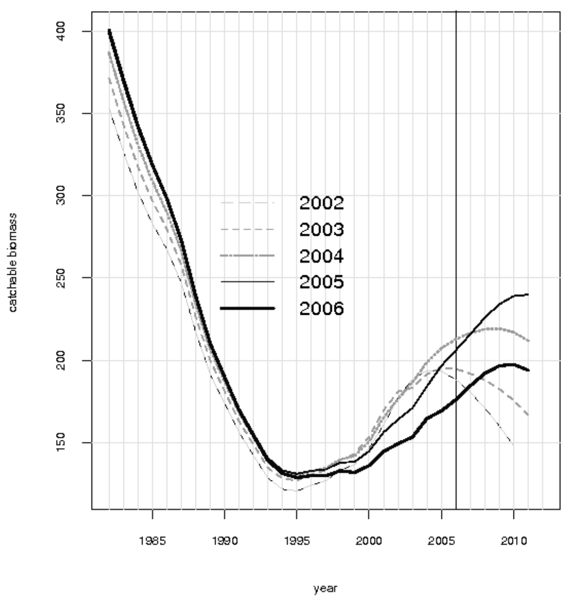


Figure 8.2.21 Real-time retrospective analysis of catchable biomass (in thousand tonnes) 2002-2006. Older runs use predicted catches of 35 000 t after the assessment years. Real landings are somewhat larger. Results are obtained using only the catch history from ICES Division Va. Note the scale on y-axis does not start with 0.

9 Demersal *Sebastes Mentella* on the Continental Shelf

Demersal *S. mentella* on the continental shelves and slopes around the Faeroe Islands, Iceland, and East Greenland is treated as one stock unit and separated from the stock fished in the Irminger Sea (pelagic *S. mentella*, see Chapter 10). It is believed to have a common area of larval extrusion southwest of Iceland, a drift of the pelagic fry towards the nursery areas on relatively shallow waters off East Greenland, and feeding and copulation areas on the shelves and banks around the Faeroe Islands, Iceland, and East-Greenland. The main fishing grounds are in Icelandic waters.

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 in 2003 increased by about 7 000 t from 2002 and was mainly due to increased landings from Va. Annual landings in 2004 and 2005 were about 22 000 t, which was the lowest landings recorded since 1978.

In Division Va, annual landings gradually decreased from a record high of 57 000 t in 1994 to 17 000 t and 19 000 t in 2001 and 2002 respectively. Landings in 2003 increased by an amount of 10 000 t and to 28 500 t, but decreased again to 18 000 t and 21 000 t in 2004 and 2005 respectively (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 2001-2005, 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 2001-2005 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 2004-2005. 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 10.1.3). The pelagic *S. mentella* fishery has in recent years moved more northwards, and in 2003 it merged with the demersal *S. mentella* fishery on the redfish line in July (Figure 10.1.4). When the pelagic *S. mentella* crossed the redfish line it was recorded as demersal *S. mentella* and caught either with pelagic or bottom trawls resulting in increased landings in 2003 (Figures 9.1.2-9.1.3 and 10.1.5-10.1.6). Length distributions of demersal *S. mentella* from the bottom trawl fishery show an increase in the number of small fish in the catch 1994-2003 compared to 1989-1993 (Figure 9.1.4). A peak of about 32 cm in 1994 can be followed by approximately 1 cm annual growth in 1996-2002. The fish caught in 2004 and 2005 peaked around 37 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. The record high was reported in 1986 as 15 000 t. Length distributions from the landings in 2001-2005 indicate that the fish caught are on average 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 and only 6 t were landed, which is the lowest recorded since 1978, but increased again in 2005 to 111 t.

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 by-catch in the shrimp fishery. In 1998, Germany started a directed fishery for redfish with annual landings around 1 000 t in 1998-2001, but landings increased to 1 900 t in 2002. Samples taken from the German fleet indicated that substantial quantities of the redfish caught, especially in 2002, were juveniles, i.e. fish less than 30 cm. There was very little demersal *S. mentella* fishery in XIV in 2003-2005, and only 150 t were landed from that area 2005.

The table below shows the 2005 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 2005.

AREA	NATION	LANDINGS	NOS. SAMPLES	NOS. FISH MEASURED
Va	Iceland	19,133	206	33,971
Vb	Faeroe Islands	1,593	37	1,902

9.2 Assessment

9.2.1 CPUE indices

Data used to estimate CPUE for demersal *S. mentella* in Division Va 1986-2005 were obtained from log-books of the Icelandic bottom trawl fleet. Only bottom trawl tows taken below 500 m depth were used and where *S. mentella* composed at least 50% of the total catch in each tow. Indices of CPUE were estimated from this data set using a GLM multiplicative model (generalized linear models). This model takes into account changes in vessels over time as well as difference in vessel size, area (ICES statistical square), and month and year effects.

From 1986 to 1989 CPUE in Division Va was relatively stable, but gradually decreased from 1989 to a record low in 1994 (Figure 9.1.7). From 1995 to 2000, CPUE slightly increased annually, but has since then been fairly stable. From 1991 to 1994, when CPUE decreased, the fishing effort increased drastically. From 1995 effort decreased between 10% and 20% each year to 2001. Since 2001 the effort has varied. ICES recommended 25% annual reduction in fishing effort during the same time period. Effort increased by about 5% between 2004 and 2005.

Non-standardized CPUE indices in Division Vb for demersal *S. mentella* were obtained from the Faeroese otterboard (OB) trawlers > 1000 HP towing deeper than 450 m and where demersal *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 1991 to 1993 by about 50% and has, since then, been at that level (Figure 9.1.8). Fishing effort has gradually decreased from 1992 and was in 2005 at the lowest level in the time series (Figure 9.1.8).

Non-standardized CPUE data from Division XIV were available from 1998 to 2002 when the German fleet fished for *S. mentella* by Germany along the continental slope of East Greenland. CPUE decreased between 1998 and 1999, but increased since then annually. No

CPUE and effort data were available from sub-area XIV in 2003-2005, as there was no effort exerted by the German fleet.

9.2.2 Survey indices

The German survey conducted on the continental shelf of West and East Greenland since 1985 cover only the distribution of juvenile demersal *S. mentella* (recruits). The results indicate that juveniles are most abundant off East Greenland, while a negligible part of juveniles is distributed off West Greenland (Figure 9.2.1). Figure 9.2.1 shows that the abundance was dominated by a single strong year class recorded for the first time in 1987 at a mean length of 20 cm. Annual growth of this cohort was about 2 cm and fully recruited to the survey gear in 1997 at a length of about 27 cm, when abundance and biomass reached its maximum (total abundance estimated 7 billion individuals and biomass 1.5 million tons). This year class seems to have left the survey area in the following years. The abundance and biomass in 2003-2005 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 Faeroese waters.

The Greenland halibut survey conducted on the continental shelf and slope of East Greenland 1998-2005 covers depths from 400 m down to 1 500 m (WD 20). Although relatively short survey series, 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 distribution in 2003-2005 are dominated by 15-30 cm fish (Figure 9.2.4) and length increases both by depth and from north to south.

The Icelandic autumn survey on the continental shelf and slope in Va 2000-2005, 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). The large measurement error in 2001 was caused by one tow accounting for a large part of the total amount caught. The biomass index in 2002-2005 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 use such data to explain any trend in biomass in the short term. The length of the demersal *S. mentella* in the autumn survey is between 30 and 47 cm with a modes ranging between 36 and 39 cm (Figure 9.2.6).

The Faeroes summer survey in Division Vb shows up to five-fold decrease in the catch rate from 1996 to 2004, from about 10 kg/h to about 2 kg/h (except in 1999 when the catches were over 10 kg/h) (Figure 9.2.7). The survey index decreased between 2004 and 2005 to a record low of 1 kg/h. The spring survey in the same area has varied more between 1994 and 2005 ranging between 0.5 kg/h and 6 kg/h (Figure 9.2.7). However, the surveys are mainly designed for species inhabiting depths down to 500 m and do not cover the entire vertical distribution of demersal *S. mentella*.

9.3 State of the stock

The Group concludes that the state of the stock is stable on a low level. With information at hand, current exploitation rates cannot be evaluated for the demersal *S. mentella* in 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 2002-2005 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 shows no clear trend during recent years. 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 of the commercial catch has stabilised close to the 50% of the maximum in 1991.

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. The present basis of the advice since 2004 has been the trend in the Icelandic autumn survey.

9.5 Management considerations

S. mentella is a slow growing, late maturing deep-sea species and is therefore considered vulnerable to overexploitation and advice has to be conservative.

The CPUE has been stable on a low level during recent years. It is, however, not known to what extent CPUE series reflect change in stock status of demersal *S. mentella*. The fishery is focusing on aggregations.

The landings increased in Division Va between 2002 and 2003 by about 10 000 t when the fishery of pelagic *S. mentella* merged with the demersal fishery on the redfish line. In 2001-2002 and 2004-2005, the landings were lower than the set quota (which was 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 of the pelagic fishery of 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.

By-catches of juvenile demersal *S. mentella* in the shrimp fishery off East Greenland cannot be quantified at present but are assumed to be considerably high (see chapter 7.3). The Working Group recommends, however, a maximum protection of the juveniles in Division XIV.

Table 9.1.1 Nominal landings (tonnes) of demersal *S. mentella* on the continental shelf and slopes 1978-2005, 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	17 604	3 931	6	0	389	21 930
2005[1)]	20 567	1 593	111	0	150	22 421

1) Provisional

Table 9.1.2 Proportion of the landings of demersal *S. mentella* taken in Va by pelagic and bottom trawls 1991-2005.

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%

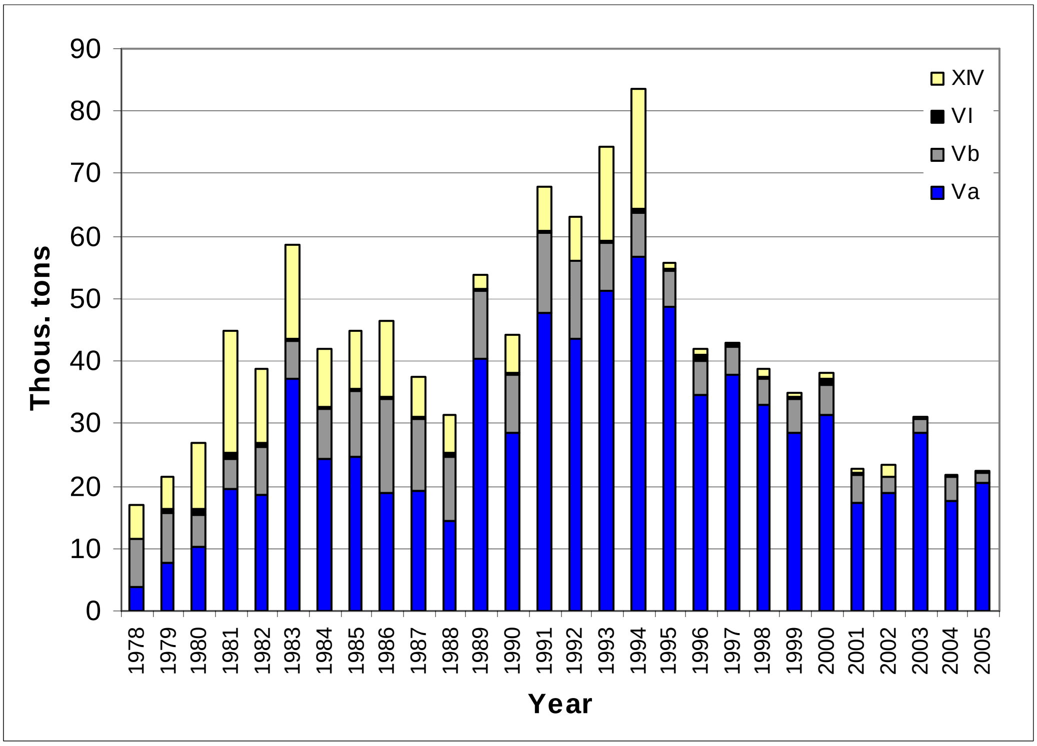


Figure 9.1.1 Nominal landings of demersal *S. mentella* (in tonnes) from ICES Divisions Va, Vb, VI and XIV 1978-2005.

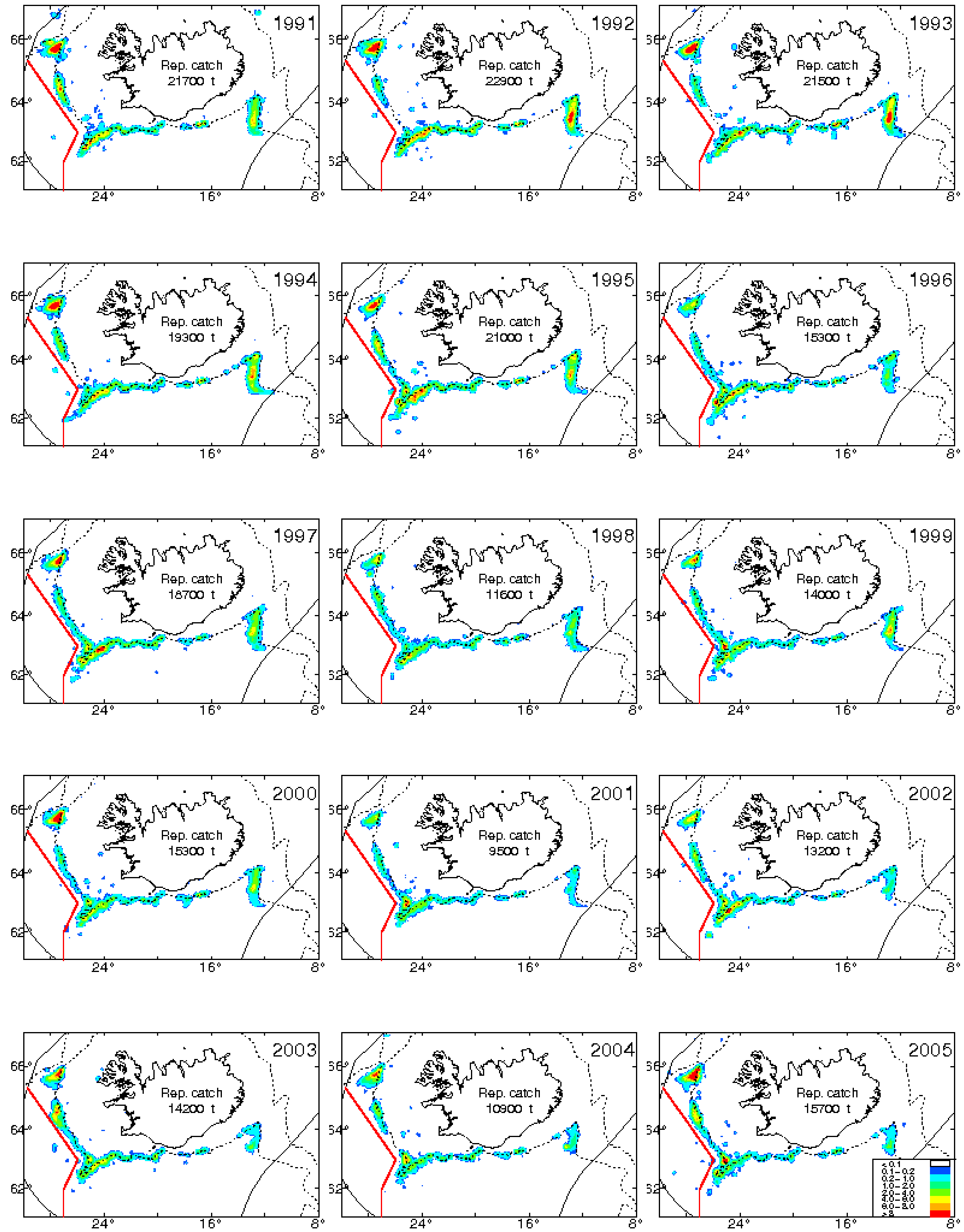


Figure 9.1.2 Geographical location of the demersal *S. mentella* catches in Icelandic waters 1991-2005 as reported in log-books of the Icelandic fleet using bottom trawl. The red line is the redfish line and the dotted line represents the 500 m isobaths.

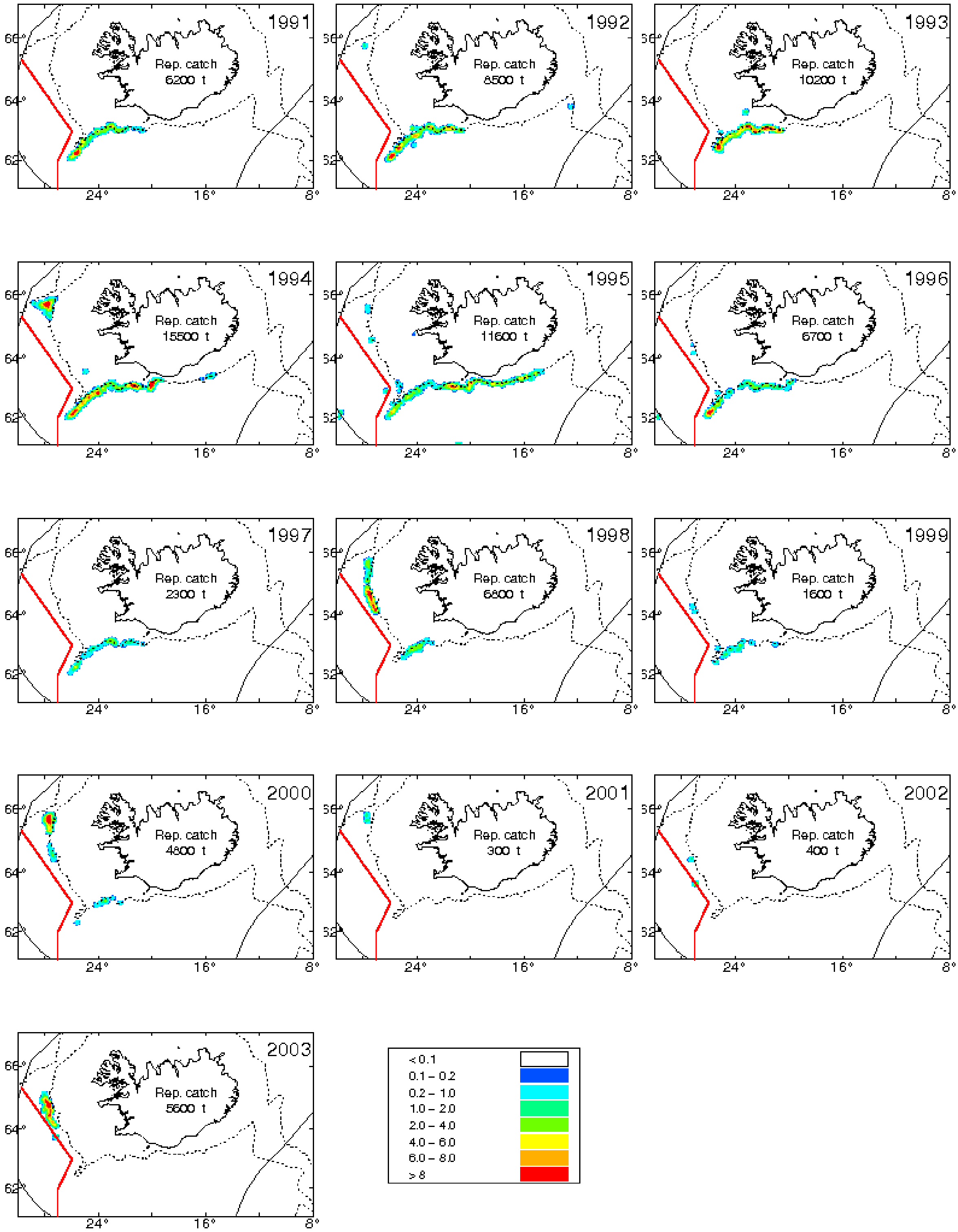


Figure 9.1.3 Geographical location of the demersal *S. mentella* catches in Icelandic waters 1991-2003 as reported in log-books of the Icelandic fleet using pelagic trawl. The red line is the redfish line and the dotted line represents the 500 m isobaths.

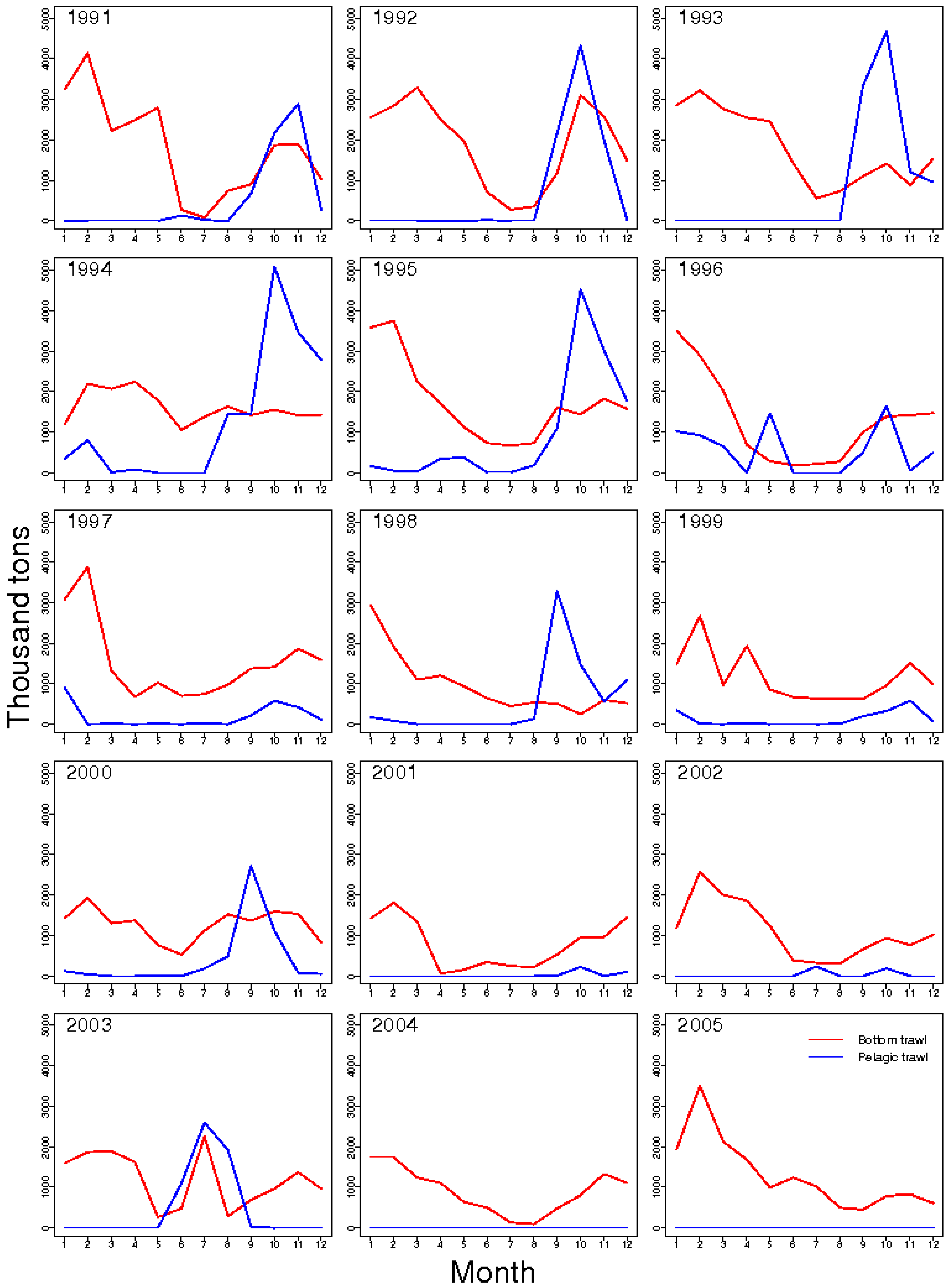


Figure 9.1.4 Nominal landings of demersal *S. mentella* (in tonnes) in Icelandic waters (ICES Division Va) of the Icelandic fleet using either bottom trawl (red line) or pelagic trawl (blue line) 1991-2005, divided by month.

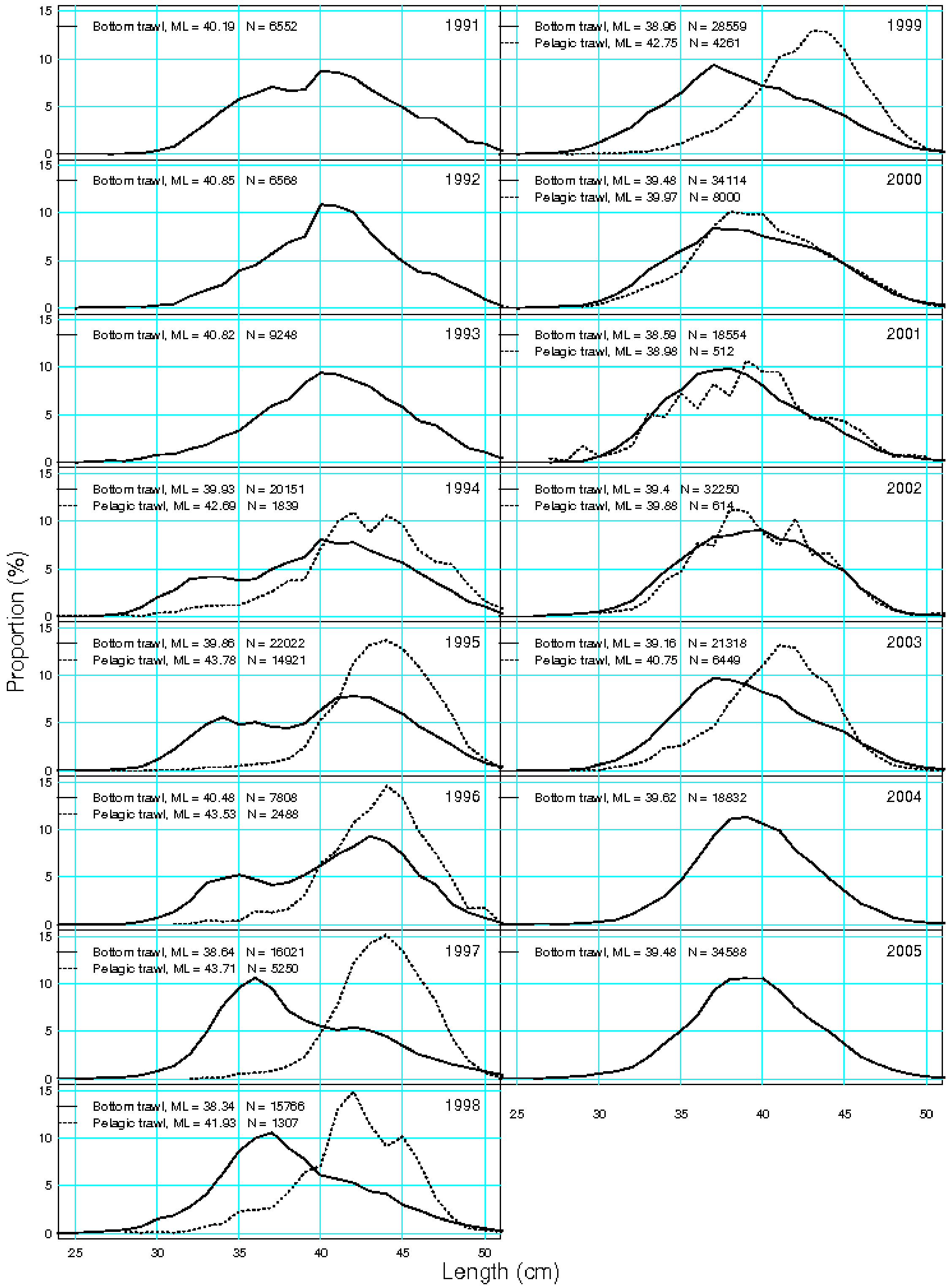


Figure 9.1.5 Length distributions of demersal *S. mentella* from the Icelandic landings taken with bottom trawl (solid line) and pelagic trawl (dotted line) in Division Va 1991-2005.

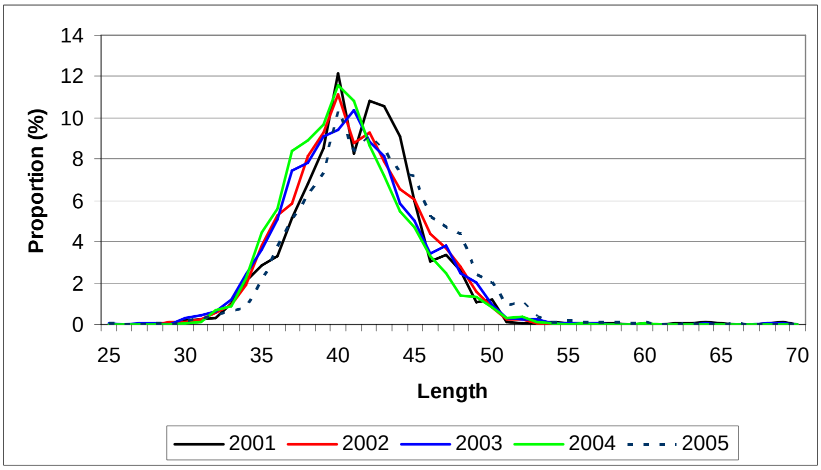


Figure 9.1.6 **Length distribution of demersal *S. mentella* from landings of the Faeroese fleet in Division Vb 2001-2005.**

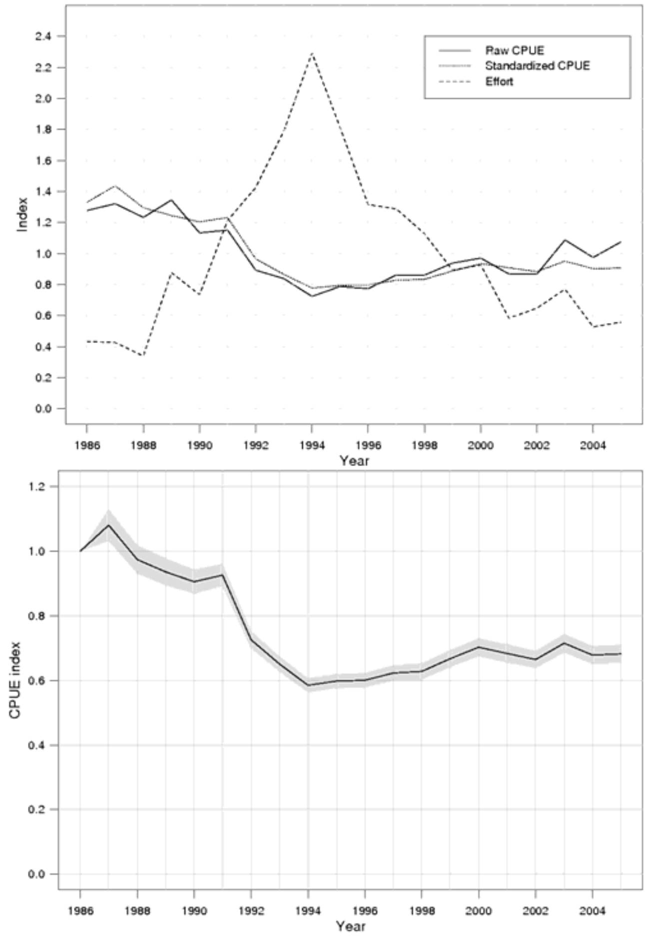


Figure 9.1.7 **CPUE, relative to 1986, of demersal *S. mentella* from the Icelandic bottom trawl fishery in Division Va. CPUE based on a GLM model, based on data from log-books and where at least 50% of the total catch in each tow was demersal *S. mentella*. Also shown is fishing effort (hours fished in thousands).**

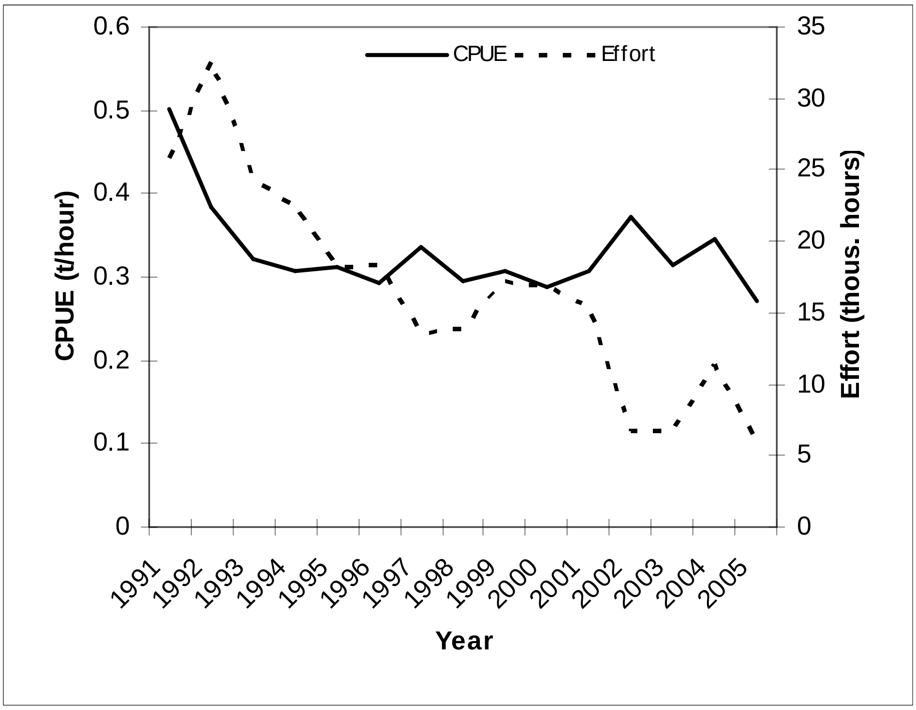


Figure 9.1.8 Demersal *S. mentella*.. CPUE (t/hour) and fishing effort (in thousands hours) from the Faeroese OB fleet 1991-2005 and where 70% of the total catch was demersal *S. mentella* .

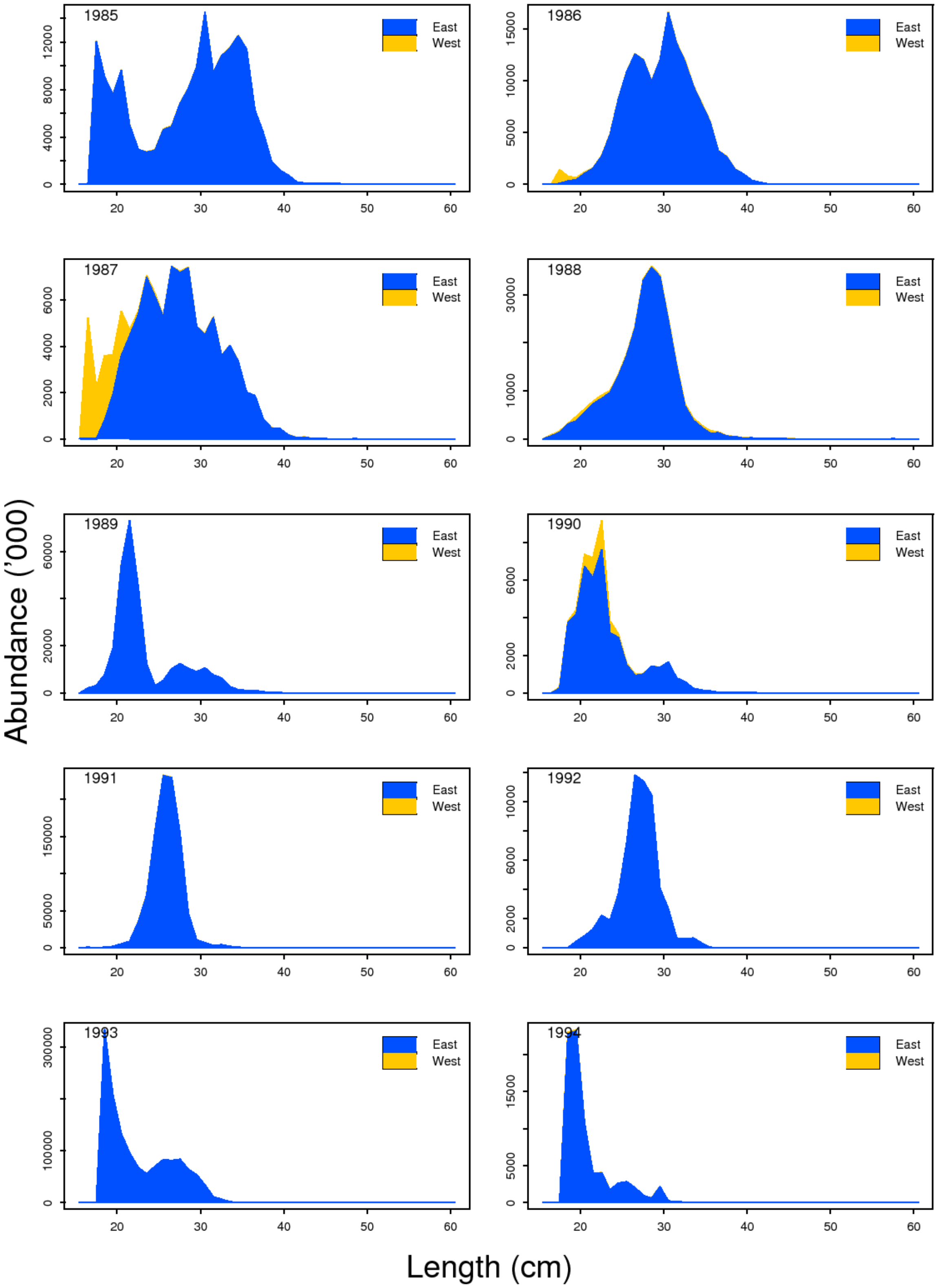


Figure 9.2.1 Demersal *S. mentella* (15-35 cm) on the continental shelves off West- and East-Greenland. Length composition off Greenland is derived from the German and groundfish survey 1985-2005. Note different scale on y-axis.

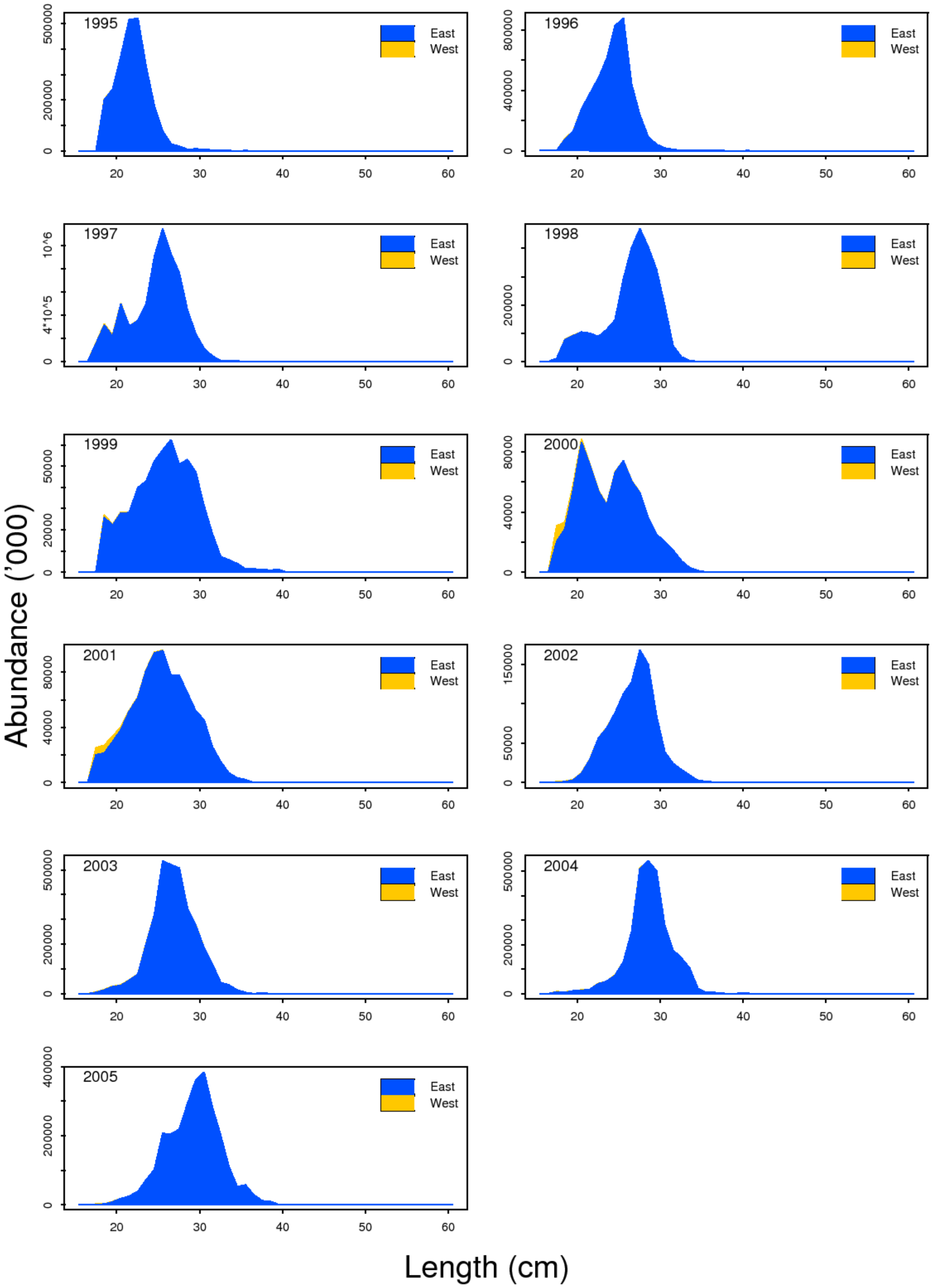


Figure 9.2.1 Continued.

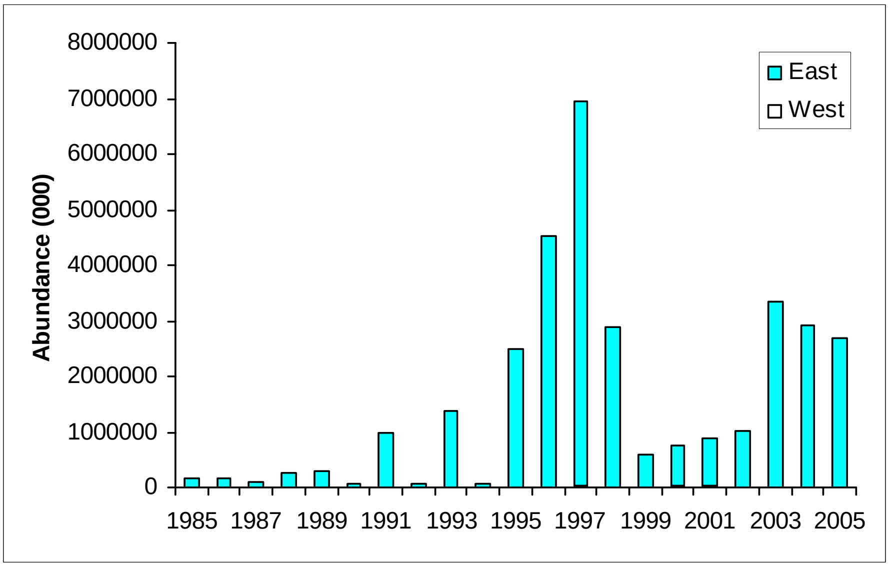


Figure 9.2.2 Demersal *S. mentella* (>=17 cm) on the continental shelf. Survey abundance indices for East and West Greenland derived from the German groundfish survey 1985–2005.

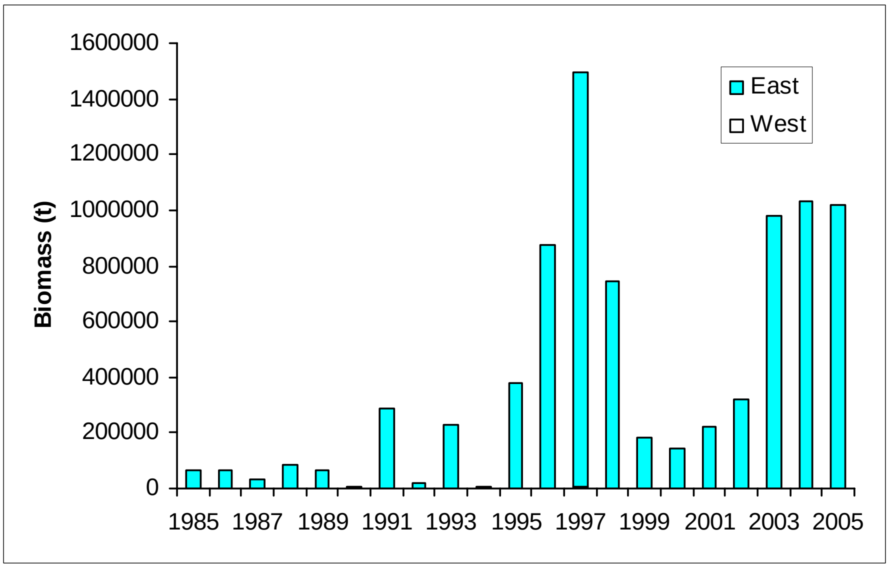
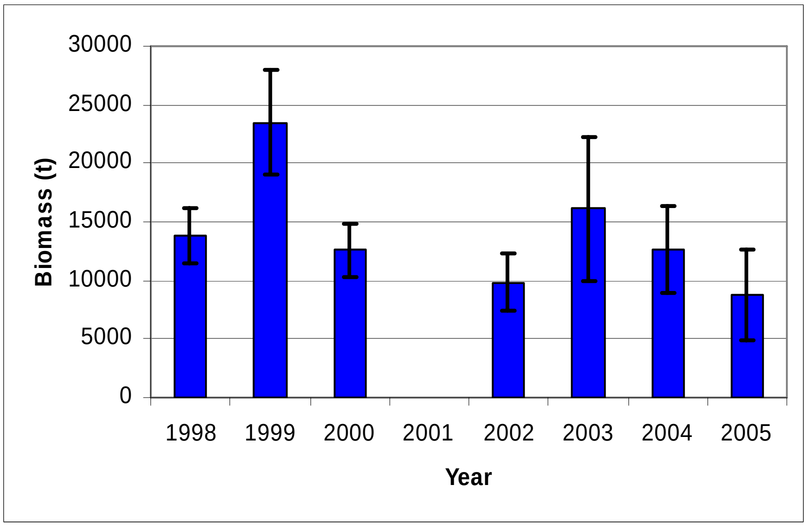
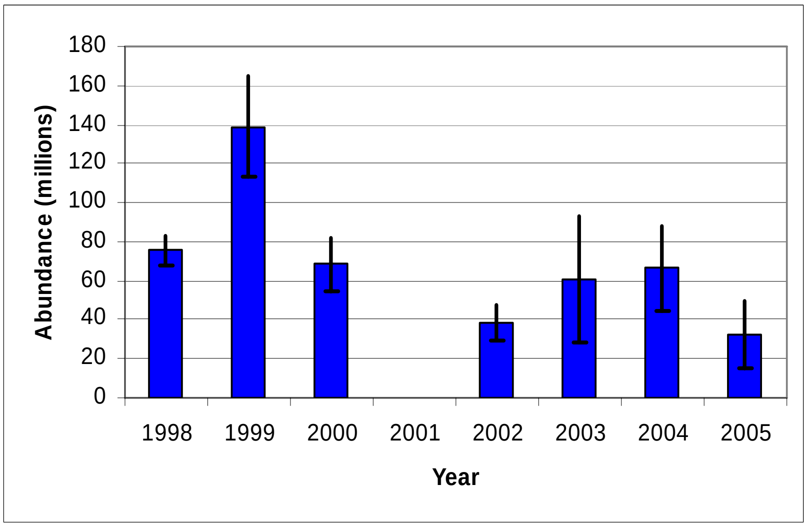


Figure 9.2.3 Demersal *S. mentella* (>=17 cm) on the continental shelf. Survey biomass indices for East and West Greenland from the German groundfish surveys 1985-2005.





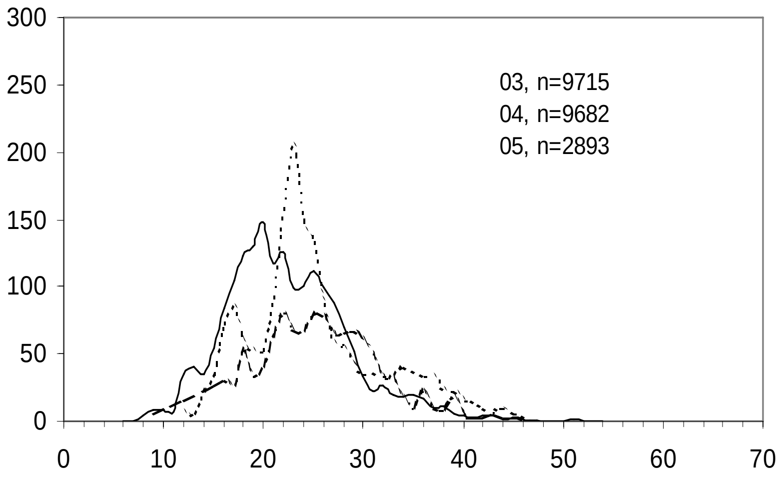


Figure 9.2.4 **Total biomass (top), abundance (middle) estimates and associated standard error of demersal *S. mentella* from the Greenland halibut bottom trawl survey of East Greenland (ICES Division XIV) 1998-2005. No survey was conducted in 2001. Also shown is the overall length distribution (number per km^2) from the same surveys 2003-2005 (bottom). Dashed line 2003, dotted line 2004, and solid line 2005.**

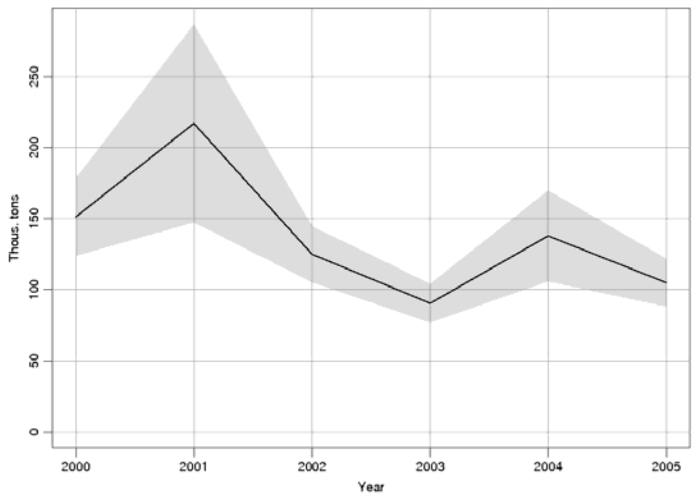


Figure 9.2.5 Total biomass index of demersal *S. mentella* in the Icelandic autumn survey in Division Va 2000-2005.

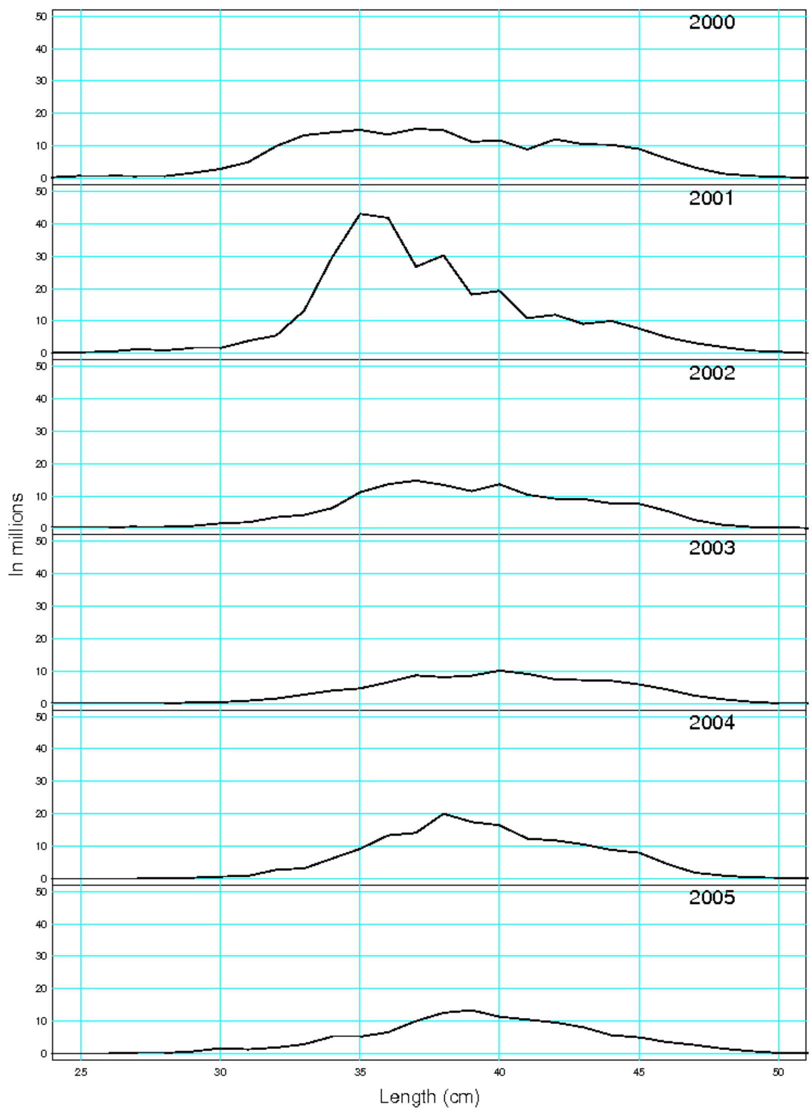


Figure 9.2.6 Length distribution of shelf demersal *S. mentella* in the bottom trawl surveys in October 2000-2005 in ICES Division Va.

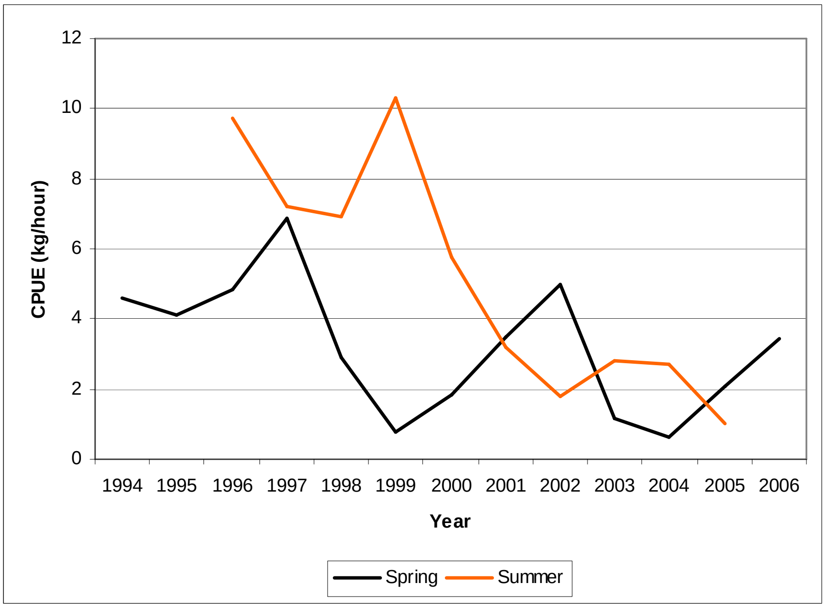


Figure 9.2.7 Demersal *S. mentella*. CPUE (kg/hour) from the Faeroese spring survey 1994-2006 and the summer survey 1996-2005 in ICES Division Vb.

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 requests 1.a) and 1.c) requesting new information on stock identity of *S. mentella* is dealt with in the introductory chapter 7, whereas the requested fishery and survey information on pelagic *S. mentella* (ToR d) and e)) is given in this chapter (10.1 and 10.2).

Pelagic redfish 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 both agreed among NEAFC and NAFO member states and also autonomously set in addition. Some NEAFC parties have objected to the decision of NEAFC and set their own national TAC. The autonomous TAC set by Iceland for 2005 was 34 500 t, and the Russian autonomous TAC was 45 000 t. The NEAFC TAC for pelagic redfish for 2005 was 75,200 t (of which 4,700 t were allocated to NAFO and 200 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 116 000 t in 2005, based on splitting factors set for 2004 and taking into account the autonomous quotas of Iceland and Russia. The total landings in 2005 (74 000 t) were well below this total TAC in force.

ACFM has advised for 2006 "that catches should not exceed catches exerted in the period 1989-1992, corresponding to less than 41 000 t." For 2006, NEAFC has set a TAC of 62,416 t, "of which 3,901 tonnes will be allocated to NAFO, and 166 tonnes will be available to co-operating non contracting parties". In addition, NEAFC Contracting Parties have agreed that "a maximum of 80% of the catches of pelagic redfish can be taken prior to 1 July 2006". For the same reasons as in 2005, the total TAC in force for 2006 is about 99 000 t.

10.1 Fishery

10.1.1 Summary of the development of the fishery

Russian trawlers started fishing pelagic *S. mentella* in 1982. Vessels from Bulgaria, the former GDR and Poland joined those from in 1984. Total catches increased from 60 600 t in 1982 to 105 000 t. in 1986. Since 1987, the total landings decreased to a minimum in 1991 of 28 000 t mainly due to effort reduction. Since 1989, the number of countries participating in the pelagic *S. mentella* fishery gradually increased. As a consequence, total catches also increased after the 1991 minimum and reached a historical high of 180 000 t in 1996 (Tables 10.1.1–10.1.2, Figure 10.1.1). Since 2000, the WG estimate of the catch has been between 124 000 and 161 000 t, highest in 2003. This is probably an underestimate due to incomplete reporting of catches (see section 10.1.4), especially in Subarea XII, where significant catches were taken by some countries in the past. The increase in the total figures since 2000 is mainly due to significant catches in NAFO Divisions 1F and 2J, up to 20 000 t (28% of total catches) in 2005. A small fraction of the catches reported as demersal catches in Division Va was caught with pelagic trawls (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, however, the fishery already stopped in early September.

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 1998-2005, but mainly deeper than 600 m in the first and second quarter but at depths shallower than 500 m in third and fourth quarter.

Discard is at present not considered to be significant for this fishery (see 10.1.3). The WG acknowledges information on trawling depth as provided by some nations, but recommends that all nations should provide depth information in accordance with the NEAFC logbook format.

The following text table summarises the available information from fishing fleets in the Irminger Sea in 2005:

Faroes	4 factory trawlers
Germany	4 factory trawlers
Greenland	1 factory trawler
Iceland	18 factory trawlers
Poland	1 factory trawler
Portugal	5 factory trawlers
Russia	35 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. In 2004 and 2005, this pattern has not changed.

10.1.2.2 Germany

The reported effort in 2005 is by far the lowest observed in the past decade and amounted to 5700 hours (WD01). As observed in the previous year, the 2005 effort was applied exclusively during the second and third quarters. During the second quarter in 2005, the hauls were almost exclusively distributed in NEAFC Regulatory Area of ICES Division XIV between the Greenlandic and Icelandic EEZs. As in 2004, there was significant fishing effort exerted in the NAFO Division 1F in 2005, mainly within the NAFO Regulatory Area. There was also some effort recorded in NAFO Division 2J since 2003. The overall decrease of annual landings continued in 2005 with a figure of 3 000 tons, representing a drastic drop to below one fourth of the average landings observed in 2000-2003, due to a reallocation of effort to the Greenland halibut fishery off East Greenland. In 2005, 35% or 1 033 tons of the total landings were taken in the NAFO Divisions. 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. 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 record low CPUE gives 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 Greenland EEZ and the Reykjanes Ridge. Since 1996, the catches have mostly been taken close to or inside the 200-mile boundary southwest of Iceland. In recent years, the fishery has started in April close to the Icelandic 200-mile boundary and then moved northward in May-July. In the springtime and until June, the largest proportions of the catches were taken deeper than 500 m. In 1998, the fishery expanded further north in July-September. In 1999, a similar pattern was ob-served, except that the fishery did not continue close to the shelf of Iceland. The few vessels that had quota left after that, moved about 480 nautical miles to Southwest, to the area S-SE of Cape Farewell (Sub-area XII), where they fished shallower than 500 m depth in July-September. In 2000, the fishery started in April at the same locations as in the past and moved slowly northward until the fishery ended in July due to quota limitation. The Icelandic trawlers fished mainly at a depth of 600-800 m during the period 1995-2000. In 2000, less than 8% of the catches in the log-books were reported shallower than 500 m depth and no catches were reported at depths shallower than 400 m. In 2001-2003, the fishery started in late April and until middle of July, the fishery was nearly exclusively within the Icelandic EEZ moving slowly in northward direction. In May-July, over 90% of the catches were taken deeper than 600 m. From the middle of July until the end of the fishing season, the fishery continued in the area Southeast of Cape Farwell, mostly between 38 and 42°W. In 2001 and 2002, about 33% and 15% of the catch was taken south of Cape Farewell, respectively, due to changes in effort regulation for the fishery. Each vessel was forced to fish given proportion of its catches south of ca. 62°N in order to spread the effort. Only about 11% of the Icelandic catches in 2003 were taken in the “south-western” fishing area shallower than 400 m depth. In 2004, only 36% where caught within the Icelandic EEZ and about 50% of the catches just outside the EEZ. 10% of the catches were taken south of Cape Farewell in ICES Sub-area XII and NAFO Division 1F). In 2005, 65% of the catches were caught inside the Icelandic EEZ and 15% just outside the EEZ (WD25). About 16% of the total catches were caught in NAFO

Div. 1F. The total pelagic *S. mentella* catch of the Icelandic fleet in 2005 was 16,005 t which is about 19,500 t less than in 2004 and the lowest reported catch since 1992.

A fraction of the catches reported as demersal *S. mentella* in Division Va was caught with pelagic trawls (see chapters 7.1 and 9.1). As a pragmatic management measure in Iceland, the pelagic catches of *S. mentella* east of the 'redfish line' (chapter 9.1) are 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 200 miles boundary (Subarea XIV). The fishery continued there until June and over 80-85% of the total catch was caught below 600 m. Then the fleet moved to Subarea XII between 55 and 58°N and between 40 and 42°W. There is no information available on length distributions in the catches. In 2004 and 2005, 72% and 55% of the catches were taken in Subarea XIV, respectively.

10.1.2.6 Poland

The Group had a detailed description of the Polish fishery on pelagic redfish available for the first time 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 (WD10). The catches of pelagic redfish lasted from late April to the beginning of September. Catches begun in April in the north-eastern 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 south-western 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.

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 (WD05). 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.

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 (WD11). 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 Regulatory 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.

10.1.2.9 Spain

The redfish Spanish trawl pelagic fishery start 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 is occasional and very low. Effort in 2004 increased by more than 150 fishing days, and most of this increase was carried out inside the Greenland EEZ in the third quarter. The fishing season 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 till 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 (WD16). The effort during 2005 was 627 days and it was applied principally during the second (97% Division XIV) and third quarters (31% Division XII and 50% 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 (4 423 tons in ICES Subareas XII and XIV and 1 005 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. Measurement from 1998 shows that the discard rate had decreased to 2%. Information from observers from 2000-2005 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 2005 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.

The Spanish discards are based on measurements made by the scientific observers. Discard of the Spanish fleet were often composed of fish infested with *Sphyrion lumpi*. In 1995, about 4% of the total catches were discarded, while in 1996, it was 6.5 %. In recent years, the discards quantities varied annually, from almost no discards in 2000, 2001 and 2002 to 6% of total catches in 2003. This variability can also be observed by area, and in 2004, the discarded percentage is larger in the Divisions XII, 1F and 2J. In Division XIV, this variability can be due to that the percentage of discards does not depend directly on fish infested by *Sphyrion lumpi*, but it is related with the haul catch. When the haul catch is very much, the fish is discarded under worse conditions by the lack of time to process the whole catch. When the catches are between the standard values, there is enough time to work up the whole fish, even the one infested, and there is not discards. In Subarea XII, Div. 1F and 2J, the discards rates are more related with the fraction of parasited fish. In 2005, the level of redfish discarded was negligible (0,2% of the total catch).

The level of redfish discarded by the Portuguese fleet, based on the observer reports, has been very small, between 0.6 and 1.0% of the catch. In 2003 and 2004, discards amounted to 3.8% and 2.1%, respectively.

No information on possible discards was available from other countries participating in this fishery.

10.1.4 Illegal Unregulated and Unreported Fishing (IUU)

The WG has during the last years identified problems with of unreported catches of pelagic redfish. There have been observations of individual vessels from nations not reporting catches to international organisations like ICES/NEAFC/FAO/NAFO. These unreported catches have, however, not been quantified as the number of nations not reporting has been unknown and hence the effort of their vessels is unknown. During the NWWG meeting in 2004, a presentation of 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).

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. 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 2005, about 20 000 t (28% 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.

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, particularly evident in Subarea XII. Furthermore, as described in section 10.1.4, there is information on vessels from nations not reporting catches to any international organisation. According to the data available to the Group, the total estimated reported landings in 2005 amounted to 74 000 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 2005 (WD01, WD05, WD10, WD11, WD16, WD25). The length distributions by ICES and NAFO areas are given in Figures 10.1.9 and 10.1.10 for 2000-2005. 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).

During recent years, decreasing mean lengths of the fish caught in this area were observed. It is, however, unknown to which extent fishing pressure, environmental effects or recruitment has contributed to this decrease.

The biological sampling from catches and landings of pelagic *S. mentella* in each Subarea/Division and by gear type in 2005 is shown in the text table below.

Country	Area	Gear	Landings (t)	No. of samples	No. of fish measured
Germany	XII, XIV and NAFO 1F, 2J	Pelagic	2,988	56	46,413
Iceland	XII, XIV and NAFO 1F	Pelagic	16,005	71	15,096
Poland	XII and NAFO 1F, 2J	Pelagic	2,410	?	18,013
Portugal	XII, XIV and NAFO 1F	Pelagic	3,868	97	7,760
Russia	XII, XIV and NAFO 1F, 2J	Pelagic	31,885	367	108,311
Spain	XII, XIV and NAFO 1F	Pelagic	5,428	73	7,438

Biological samples from the catches in recent years, and also the acoustic survey in 1999, suggested that a new cohort is entering into the fishable stock of pelagic redfish (Stransky, 2000). Age readings within an otolith exchange between Germany, Iceland, Norway, and Spain, based on material collected in July 1999, showed that this cohort is mainly consisting of 10 year old fish and that ageing error for fish older than 20 years is relatively high (Stransky et al. 2005a). If agreement is defined as ± 5 years, approximately 90% agreement would be obtained. A second set of age reading results within an otolith exchange program between Germany, Iceland, Norway and Spain based on material collected in 1998 and 1999 (Stransky et al. 2005a), showed the same results. Radiometric ageing (Stransky et al. 2005b), however, indicated that especially larger pelagic *S. mentella* from depths >500 m are generally underestimated by traditional otolith annuli counts. From 28 Aug to 1 Sep 2006, a Workshop on Age Determination of Redfish [WKADR] will be held in Vigo, Spain, to collate the latest knowledge on age determination methodology.

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 south-westerly 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.

As observed in the length distributions from samples taken in the commercial fishery, the mean lengths by depth have decreased recently, especially the fraction of females larger than 40 cm (Fig. 10.1.8).

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 north-eastern and the south-western are, 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.

The time series of standardised CPUE, derived from a GLM CPUE model (Tables 10.2.5.a-c) incorporating data from Germany (1995-2005), Iceland (1995-2005), Greenland (1999-2003), Faroe Islands (1995-2005), Russia (1997-2005) 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 a joint database (WD26) and the outcome of three model runs are given in Tables 10.2.5.a-c. 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 north-eastern area. The CPUE in the southwestern area remains 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 entire time series of biomass estimates in the acoustic layer since 1991, a drastic decreasing trend has been observed in the late 1990’s. The trawl estimates deeper than the acoustic layer, derived since 1999, are considered as highly uncertain due to the short time series and methodological difficulties.

Although varying, the available commercial CPUE series has been relatively stable since 1995, but has decreased markedly from 2003 to a record low in 2005. This recent decrease is most pronounced in the north-eastern 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, which is assumed to contribute to the pelagic stock. Most fleets in the 2005 fishery experienced a decrease in mean length in their catches compared to previous years, both in the north-eastern and in the south-western area.

10.4 Management considerations

The working group had again difficulties in obtaining catch estimates from the various fleets like in the past and information presented during the meeting indicates that unreported catches might be of substantial amount. Furthermore, landings data were missing from some nations. The group encourages NEAFC to try to provide ICES with all information that might enable the WG to come up with more reliable catch statistics.

An update on the pelagic fishery, in particular with respect to seasonal and area distribution, was requested in the ToR. Catch rates in the southwestern area (almost exclusively shallower than 500 m) have decreased slightly during 2004-2005, and in the northeastern area (deeper than 500 m) decreased considerably. The main feature of the fishery in recent years is a clear distinction between two widely separated grounds fished at different seasons and different depths. Since 2000, the southwestern fishing grounds extended also into the NAFO Convention Area. The parameters analysed so far do suggest, however, that the aggregations in the NAFO Convention Area do not form a separate stock. NAFO Scientific Council agrees with this conclusion (NAFO, 2005).

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

The Group concludes that at this time there is not enough scientific basis available to propose an appropriate split of catches among the two fisheries/areas.

Some biological features distinguish the fisheries in the two areas: The length distributions of the catches differ between the described two main fishing ground/seasons. The fisheries in the northeastern area (2nd quarter) is mainly targeting at larger and postspawning fish.

The Group expects that under the current TAC regulations, a greater share of the catches in 2006 will be taken in the northeastern area.

10.5 Comments on the assessment

The results of the international trawl-acoustic survey are given in chapters 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 chapter 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 survey. 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 has been sent to other nations which take part in the pelagic redfish fisheries.

It is not known to what extent CPUE reflect changes in the stock status of pelagic *S. mentella*. The fishery is focusing on aggregations. Therefore, CPUE series might not indicate or reflect actual trends in stock size.

The WG has during the last years identified problems with of unreported catches of pelagic redfish. There have been observations of individual vessels from nations not reporting catches. These unreported catches have, however, not been quantified as the number of nations not reporting has been unknown and hence the effort of their vessels is unknown.

10.6 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 exact share in Sub-areas XII and XIV is only approximate in latest years.

YEAR	VA	XII	XIV	NAFO 1F	NAFO 2J	NAFO 2H	TOTAL
1982		39,783	20,798				60,581
1983		60,079	155				60,234
1984		60,643	4,189				64,832
1985		17,300	54,371				71,671
1986		24,131	80,976				105,107
1987		2,948	88,221				91,169
1988		9,772	81,647				91,419
1989		17,233	21,551				38,784
1990		7,039	24,477	385			31,901
1991		10,061	17,089	458			27,608
1992	1,968	23,249	40,745				65,962
1993	2,603	72,529	40,703				115,835
1994	15,472	94,189	39,028				148,689
1995	1,543	132,039	42,260				175,842
1996	4,744	42,603	132,975				180,322
1997	15,301	19,826	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	8,206	32,627	16,260	4,899	5	73,723

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	2196		4,582	2,410	3,868	31,885	5,428			73,723

Table 10.1.3 Pelagic *S. mentella* catches (in tonnes) in 2005 by countries and depth (A), and in 1996-2005 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	2,010	100 %		
Germany	2,988		39 %	61 %
Greenland	1,431	100 %		
Iceland	16,005		19 %	81 %
Lithuania	2,196	100 %		
Norway	4,582	100 %		
Poland	2,410		49 %	51 %
Portugal	3,868		70 %	30 %
Russia	31,885		44 %	56 %
Spain	5,428		29 %	71 %
Total	73,723			

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	125,495	10 %	23 %	67 %
2005	73,723	14 %	32 %	53 %

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 (south-western area) including single tow data from Germany (1995-2005), Iceland (1995-2005), Greenland (1999-2003), Faroe Islands (1995-2005), Russia (1997-2005) and Norway (1995-2003). Note that the full output is not shown.

"**Southern area**"

	Value	Std..Error	t.value	ar	index	lower	upper
factor(yy)1990	0.000	0.000	0.000	1990	1.000	1.000	1.000
factor(yy)1996	0.005	0.296	0.018	1996	1.005	0.748	1.351
factor(yy)1997	-0.341	0.106	-3.227	1997	0.711	0.640	0.790
factor(yy)1998	-0.314	0.112	-2.810	1998	0.730	0.653	0.817
factor(yy)1999	-0.705	0.102	-6.879	1999	0.494	0.446	0.548
factor(yy)2000	-0.369	0.120	-3.070	2000	0.692	0.613	0.780
factor(yy)2001	-0.181	0.101	-1.800	2001	0.834	0.754	0.923
factor(yy)2002	-0.366	0.112	-3.278	2002	0.693	0.620	0.775
factor(yy)2003	-0.250	0.112	-2.226	2003	0.779	0.696	0.871
factor(yy)2004	-0.558	0.119	-4.696	2004	0.572	0.508	0.645
factor(yy)2005	-0.653	0.119	-5.508	2005	0.520	0.462	0.586

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			626	1521.951		
ltogtimi	1	1186.451	625	335.500	4603.228	0
factor(yy)	10	53.037	615	282.463	20.578	0
factor(mm)	10	47.386	605	235.077	18.385	0
factor(skip)	74	98.216	531	136.862	5.149	0

Table 10.2.5. b. Results of the GLM model to calculate standardized CPUE for pelagic redfish fishery, by depths deeper than 500 m (north-eastern area) including single tow data from Germany (1995-2005), Iceland (1995-2005), Greenland (1999-2003), Faroe Islands (1995-2005), Russia (1997-2005) and Norway (1995-2003). Note that the full output is not shown.

"**Northern area**"

	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	-0.028	0.085	-0.331	1996	0.972	0.893	1.058
factor(yy)1997	-0.429	0.077	-5.562	1997	0.651	0.603	0.703
factor(yy)1998	-0.168	0.078	-2.142	1998	0.846	0.782	0.914
factor(yy)1999	-0.236	0.081	-2.906	1999	0.790	0.728	0.857
factor(yy)2000	0.052	0.081	0.647	2000	1.054	0.972	1.142
factor(yy)2001	-0.331	0.079	-4.178	2001	0.718	0.664	0.777
factor(yy)2002	0.045	0.081	0.559	2002	1.046	0.965	1.134
factor(yy)2003	0.134	0.082	1.628	2003	1.143	1.053	1.241
factor(yy)2004	-0.385	0.084	-4.576	2004	0.680	0.626	0.740
factor(yy)2005	-0.721	0.087	-8.287	2005	0.486	0.446	0.530

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			1413	2633.780		
ltogtimi	1	1971.974	1412	661.806	9288.939	0
factor(yy)	10	61.798	1402	600.009	29.110	0
factor(mm)	11	44.526	1391	555.482	19.067	0
factor(skip)	86	278.440	1305	277.042	15.251	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 (1995-2005), Iceland (1995-2005), Greenland (1999-2003), Faroe Islands (1995-2005), Russia (1997-2005) and Norway (1995-2003). Note that the full output is not shown (lafli= log catch; ltogtimi=log trawling time).

```
glm(formula = log(catch) ~ log(trawling_time) + factor(year) + factor(month) +
factor(vessel), family = gaussian(), data = tmp.data)
```

"Combined areas"

	Value	Std..Error	t.value	ar	index	lower	upper
factor(yy)1990	0.000	0.000	0.000	1990	1.000	1.000	1.000
factor(yy)1996	-0.098	0.069	-1.411	1996	0.907	0.846	0.972
factor(yy)1997	-0.453	0.057	-7.948	1997	0.636	0.601	0.673
factor(yy)1998	-0.228	0.059	-3.878	1998	0.796	0.750	0.844
factor(yy)1999	-0.396	0.059	-6.735	1999	0.673	0.635	0.714
factor(yy)2000	-0.064	0.061	-1.059	2000	0.938	0.883	0.996
factor(yy)2001	-0.314	0.059	-5.359	2001	0.731	0.689	0.775
factor(yy)2002	-0.087	0.061	-1.430	2002	0.917	0.863	0.974
factor(yy)2003	0.001	0.061	0.012	2003	1.001	0.941	1.064
factor(yy)2004	-0.449	0.065	-6.962	2004	0.638	0.598	0.681
factor(yy)2005	-0.715	0.066	-10.869	2005	0.489	0.458	0.522

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			2040	4194.920		
ltogtimi	1	3190.706	2039	1004.214	12906.01	0.0000000
factor(yy)	10	74.640	2029	929.574	30.19	0.0000000
factor(mm)	11	74.259	2018	855.315	27.31	0.0000000
factor(reitur)	1	0.323	2017	854.991	1.31	0.2529669
factor(skip)	92	379.081	1925	475.911	16.67	0.0000000

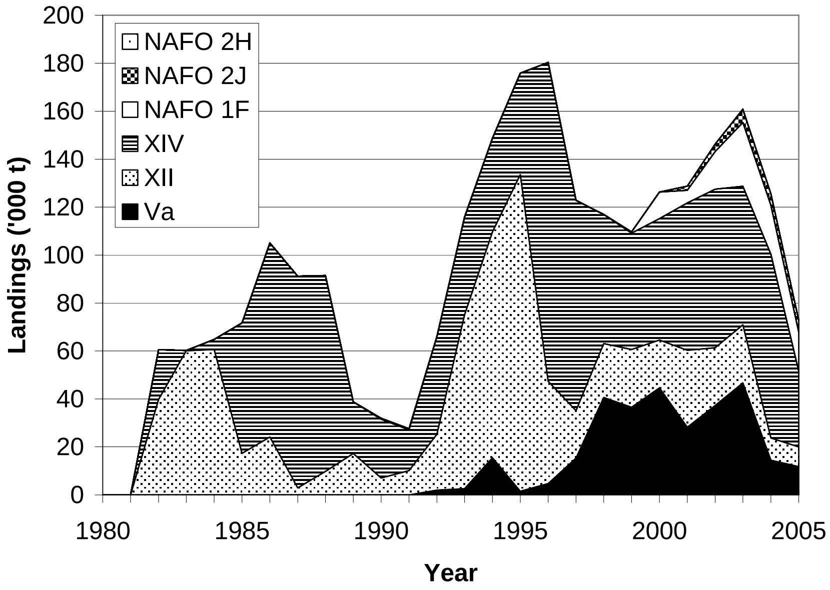


Figure 10.1.1 Landings of pelagic *S. mentella* (Working Group estimates, see Table 10.1.1).

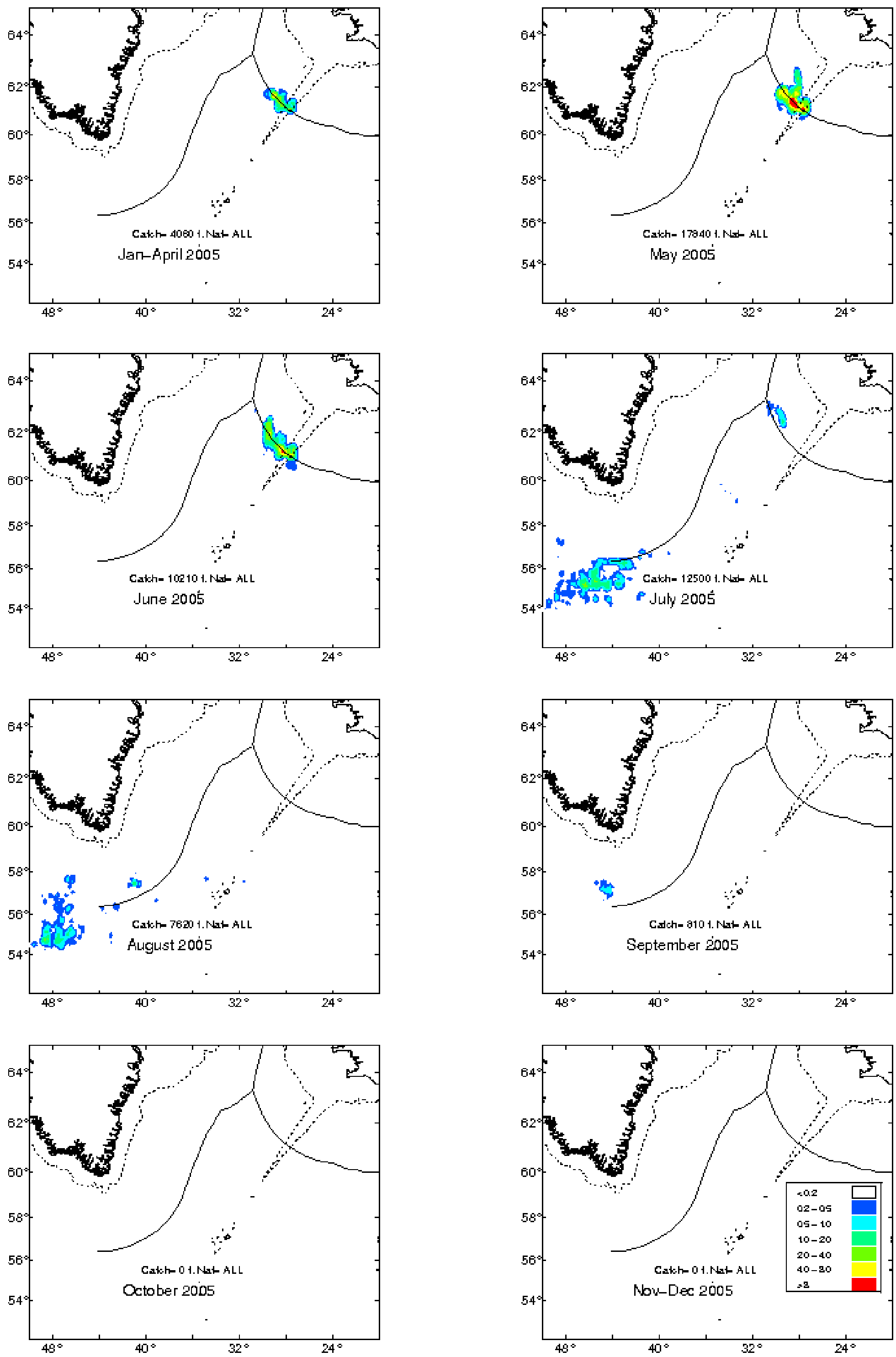


Figure 10.1.2 Fishing areas and total catch of pelagic redfish (*S. mentella*) by month(s) in 2005, derived from catch statistics provided by the Faroe Islands, Germany, Iceland and Russia. The catches are given as tonnes per square nautical mile.

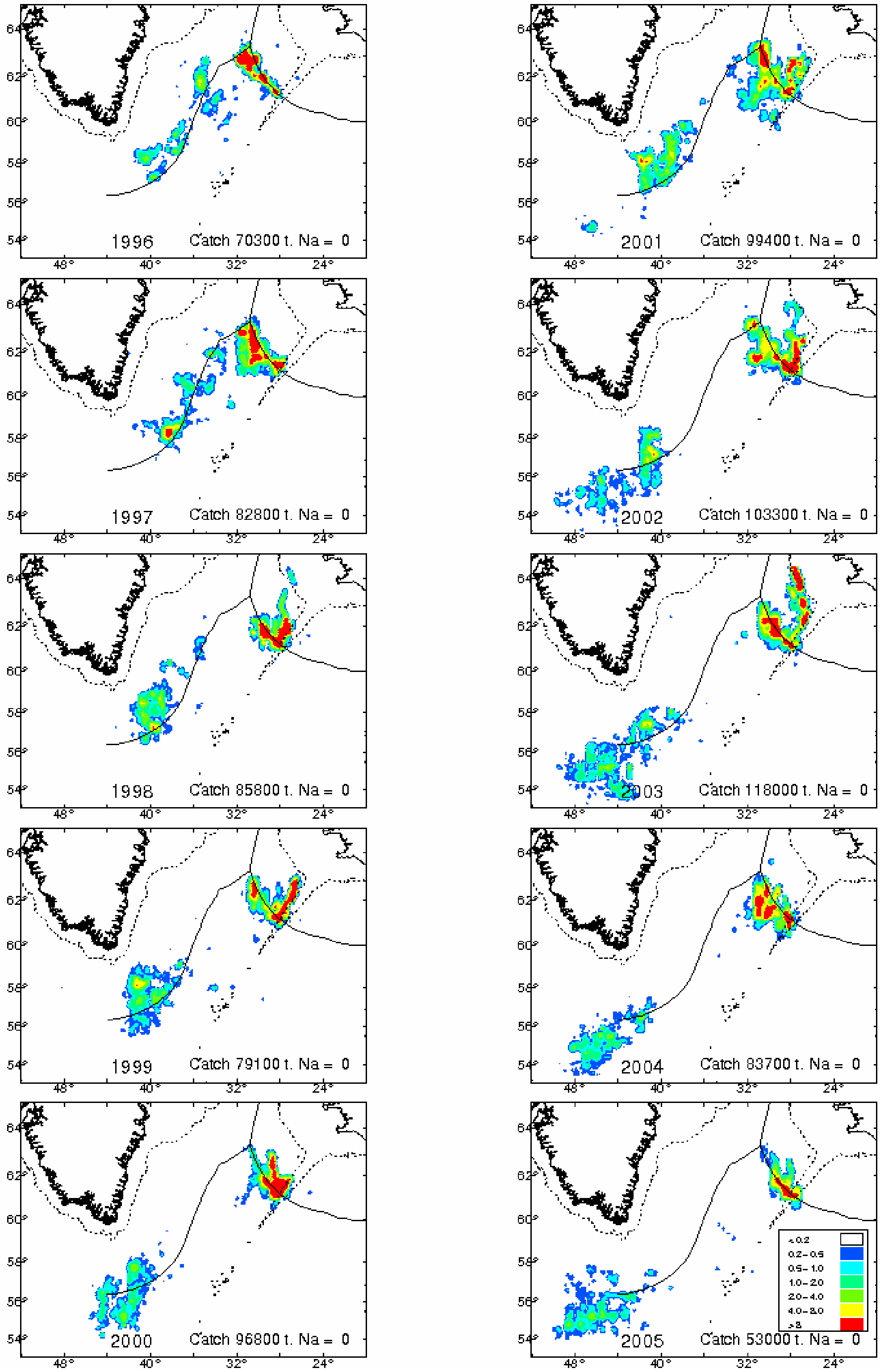


Figure 10.1.3 Fishing areas and total catch of pelagic redfish (*S. mentella*) in the Irminger Sea and adjacent waters 1996-2005. Data are from the Faroe Islands (1995-2005), Germany (1995-2005), Greenland (1999-2003), Iceland (1995-2005), Norway (1995-2003) and Russia (1997-2005). The catches are given as tonnes per square nautical mile.

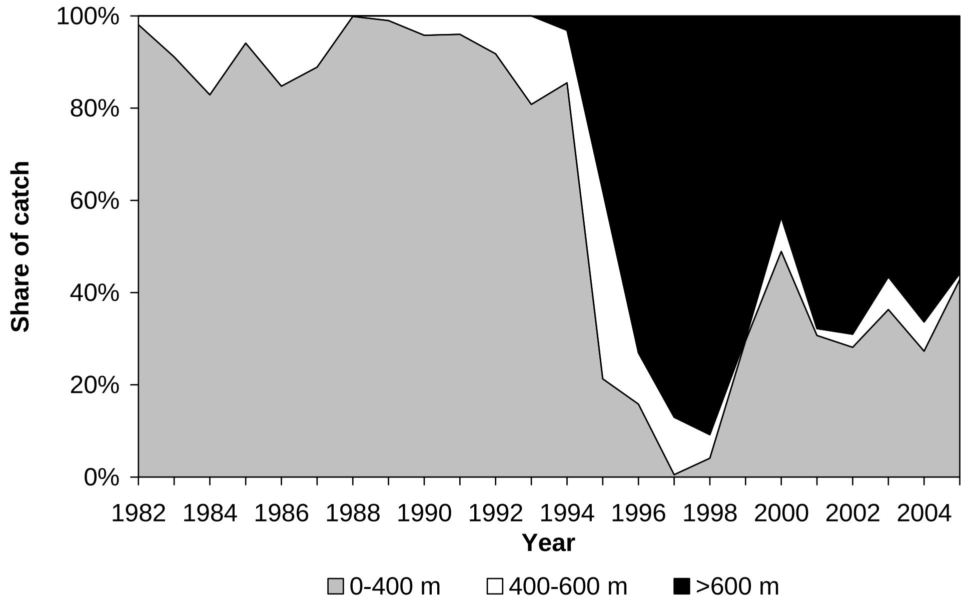


Figure 10.1.4 Percentage of the catch *of S. mentella* by Russian vessels by depth in the Irminger Sea in 1982-2004.

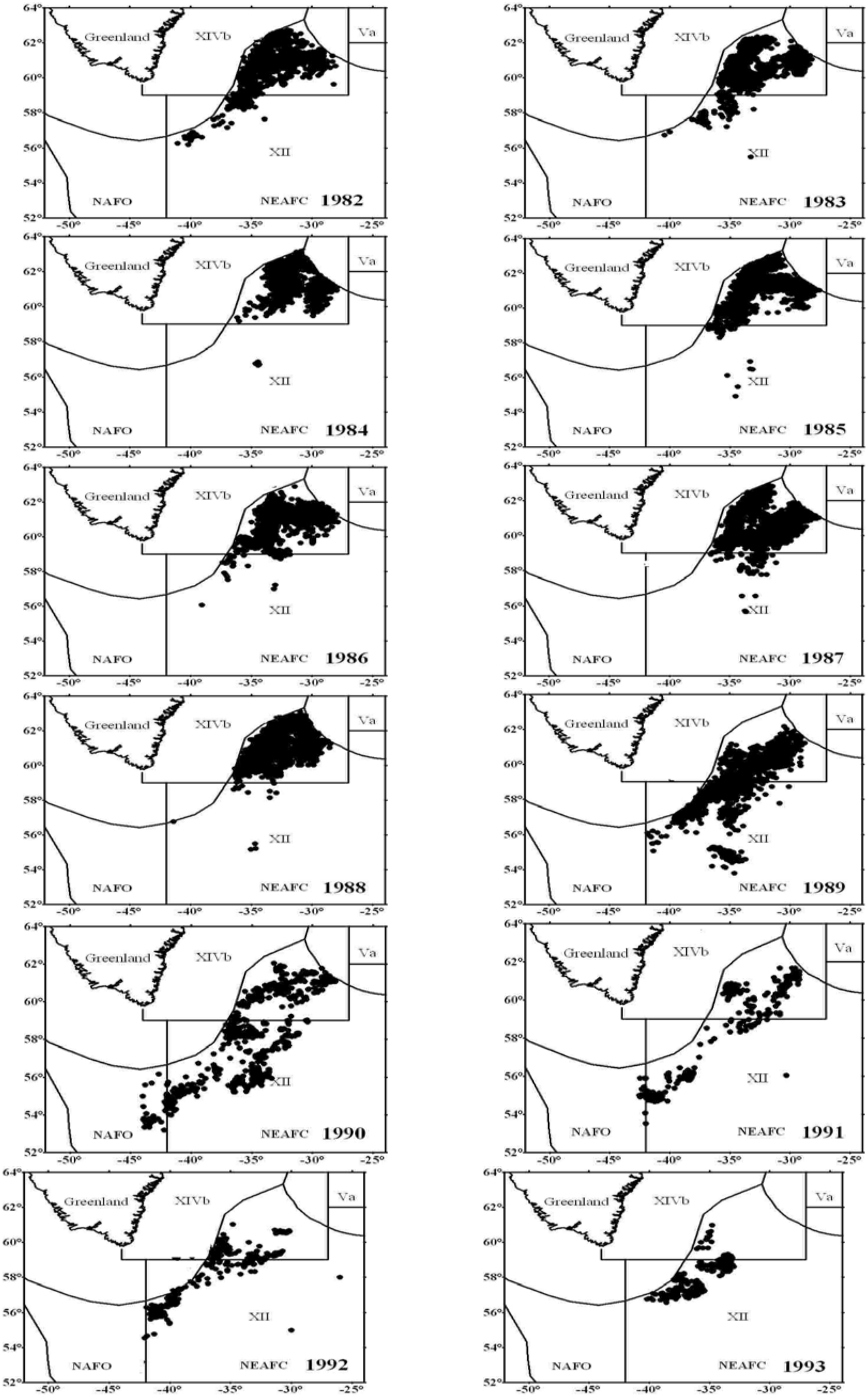


Figure 10.1.5 Location of the Russian fleet during fishery for *S. mentella* in the Irminger Sea in 1982-1993.

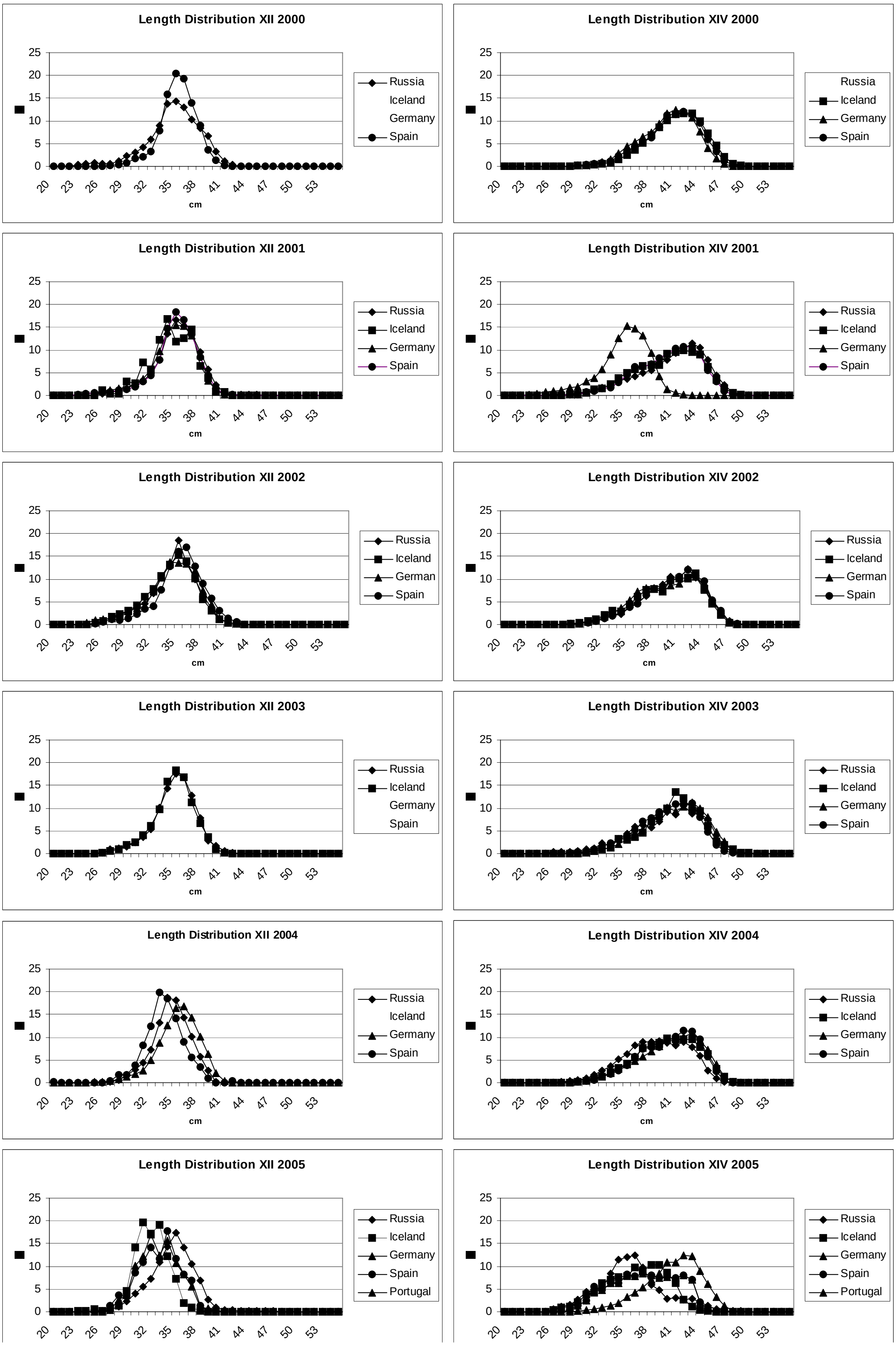


Figure 10.1.6 Length distributions from landings of pelagic *S. mentella* by ICES Sub-areas XII and XIV and country in 2000-2005.

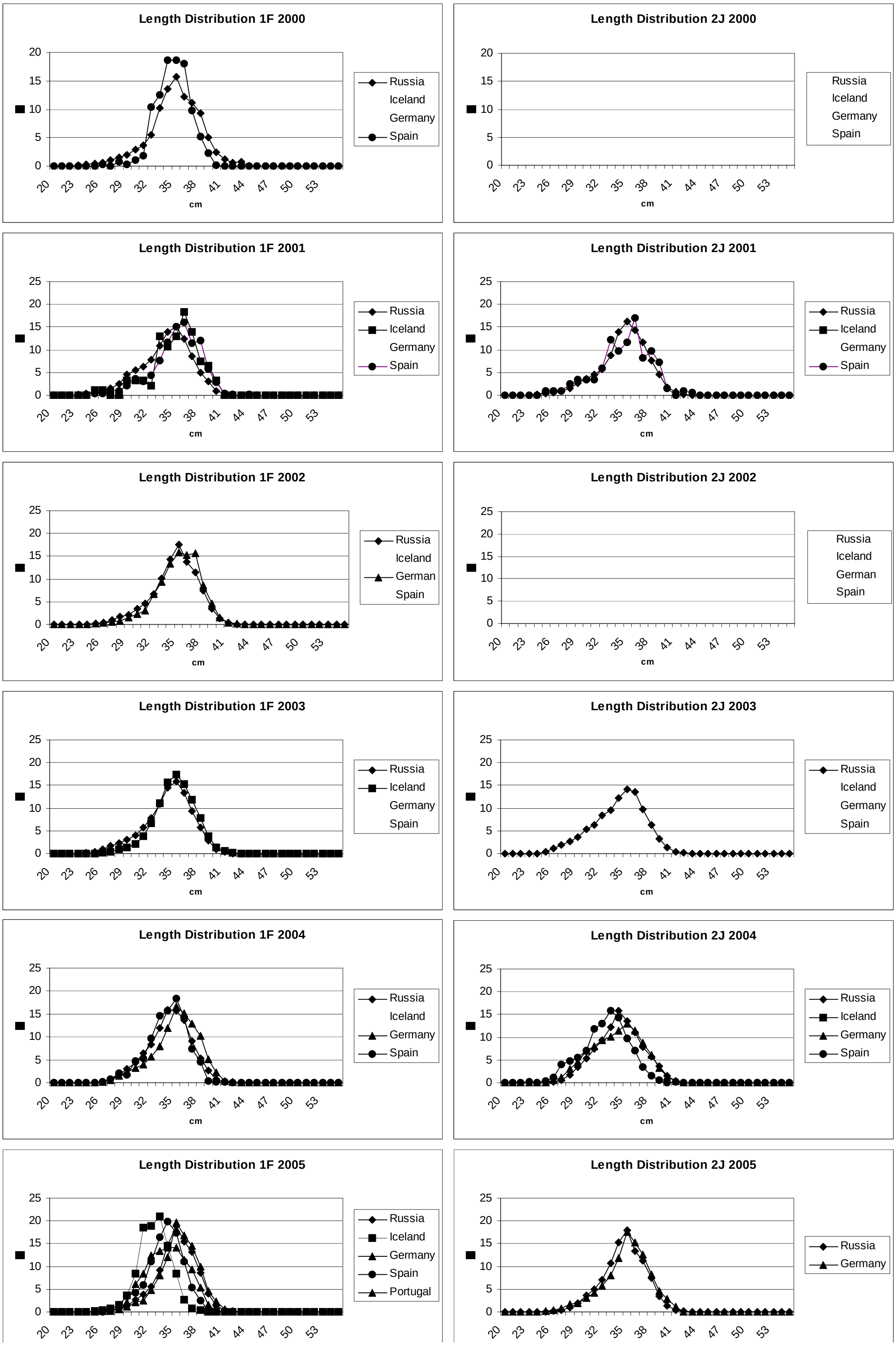


Figure 10.1.7 Length distributions from landings of pelagic *S. mentella* by NAFO Divisions 1F and 2J and country in 2000-2005.

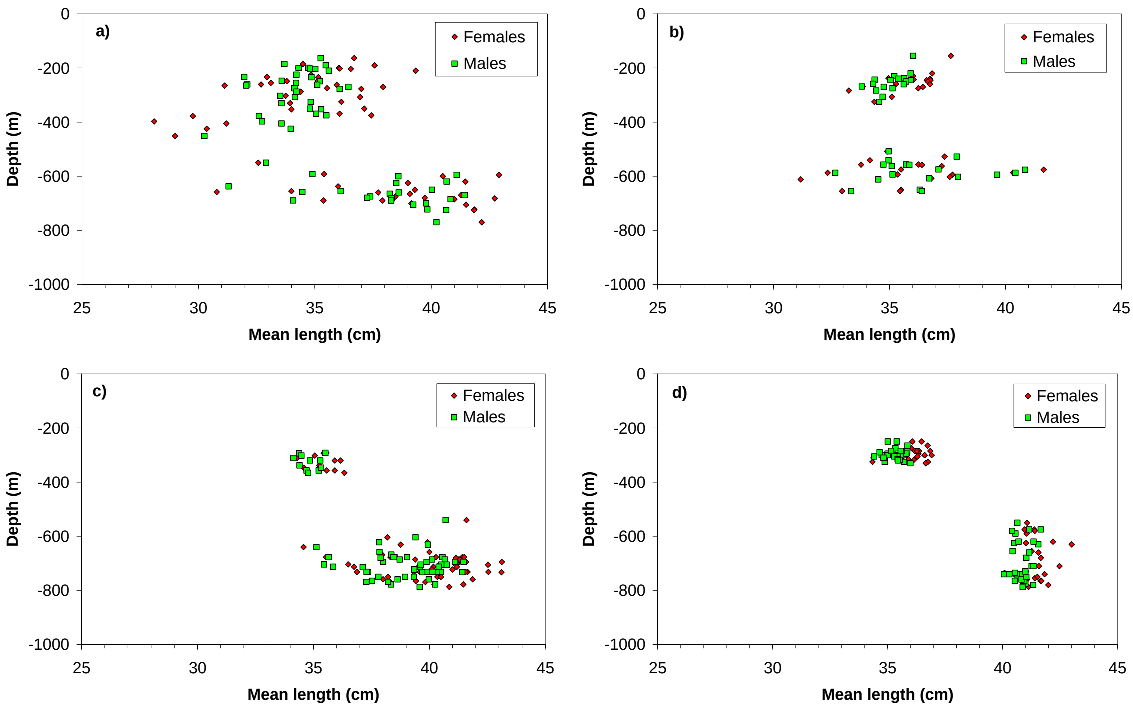


Figure 10.1.8 Pelagic *S. mentella*. Mean length by trawling depth. a) International survey 2001, b) International survey 2005, c) Icelandic commercial fishery in 2002-2004, d) German commercial fishery in 2005.

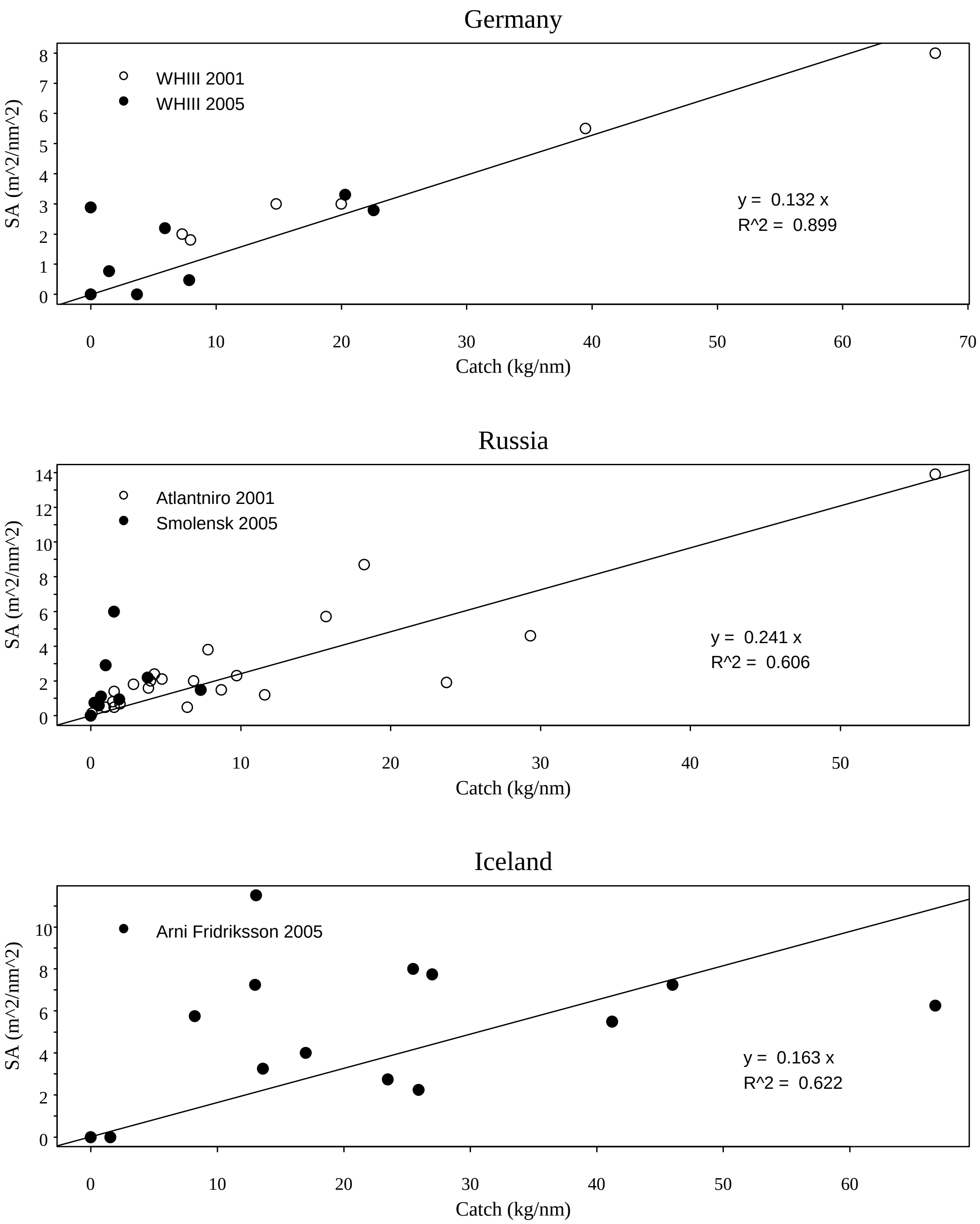


Figure 10.2.1 Regressions between catches and observed hydroacoustic s_A values, observed on the German, Russian and Icelandic vessel(s) shallower than the DSL and used in the biomass calculations.

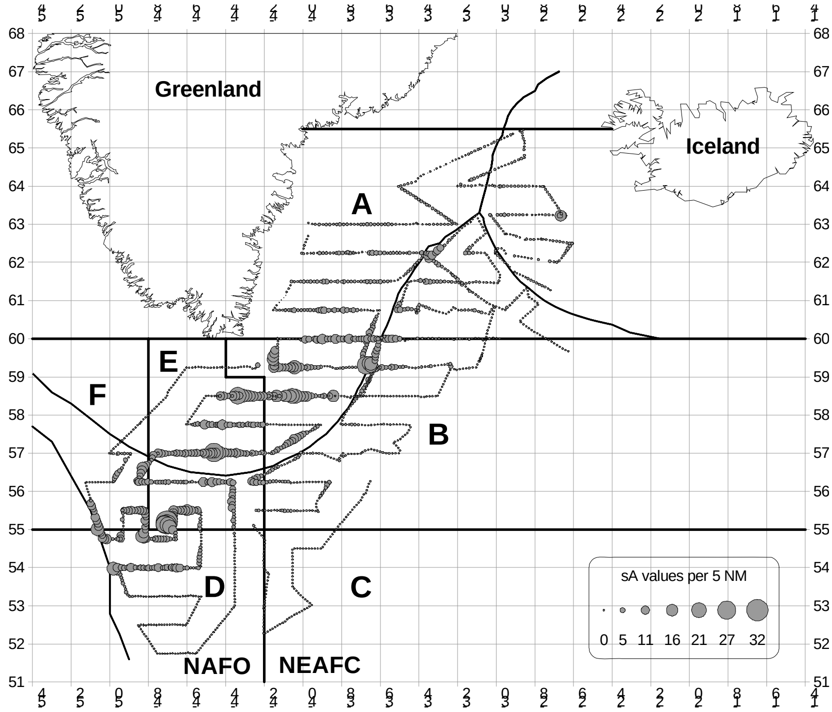


Figure 10.2.2 Pelagic *S. mentella*. Acoustic estimates (average s_A values by 5 NM sailed) shallower than the deep-scattering layer (DSL) from the joint trawl-acoustic survey in June/July 2005.

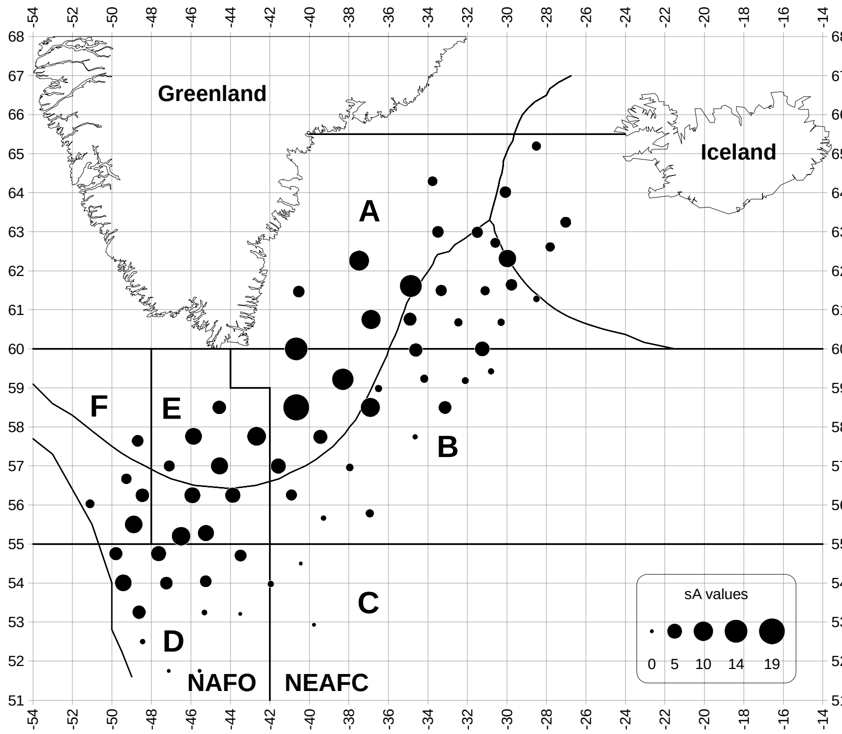
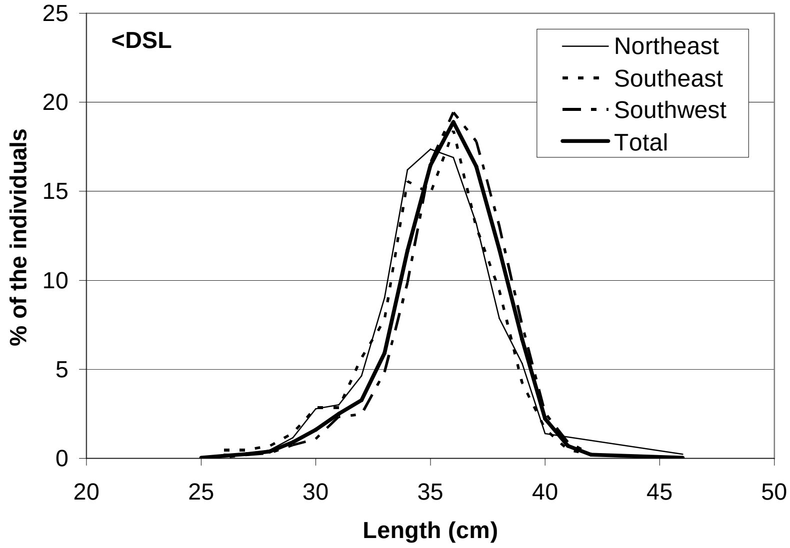


Figure 10.2.3 Pelagic *S. mentella*. Trawl estimates (s_A values calculated from trawls; ICES CM 2005/D:03) within and deeper than the deep-scattering layer (DSL) from the joint trawl-acoustic survey in June/July 2005.



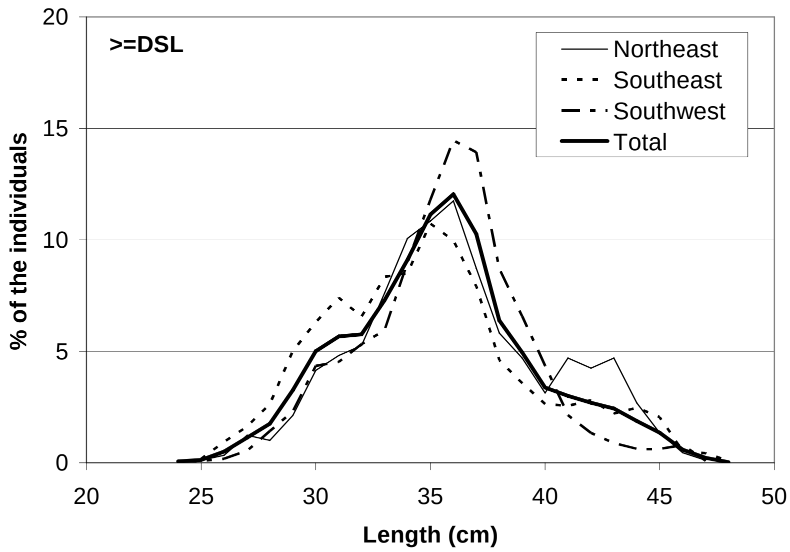


Figure 10.2.4 Length distribution of pelagic *S. mentella* redfish in the trawls, by geographical areas (ICES CM 2005/D:03) and total, shallower than the DSL, and within and deeper than the DSL from the joint trawl-acoustic survey in June/July 2005.

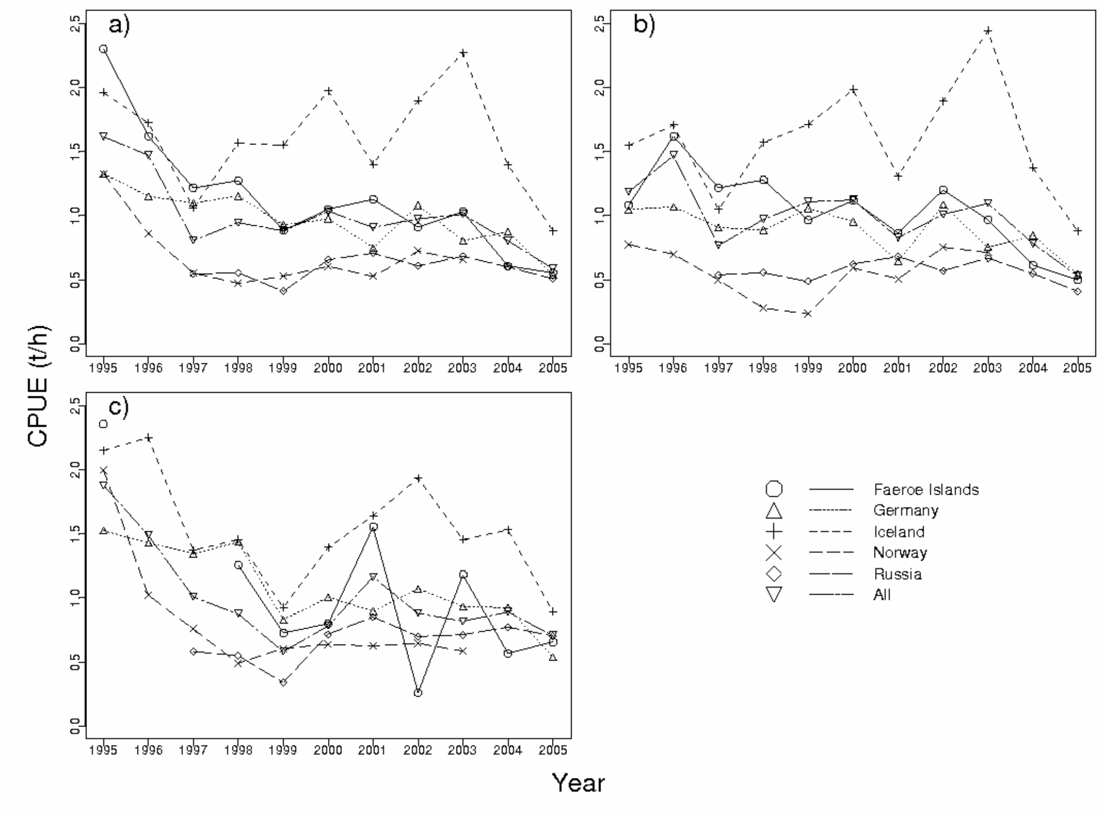


Figure 10.2.5 Trends in national non-standardised CPUE of the pelagic *S. mentella* fishery in the Irminger Sea and adjacent waters, based on log-book statistics in the joint international database. a) all areas, b) north-eastern area, c) south-western area.

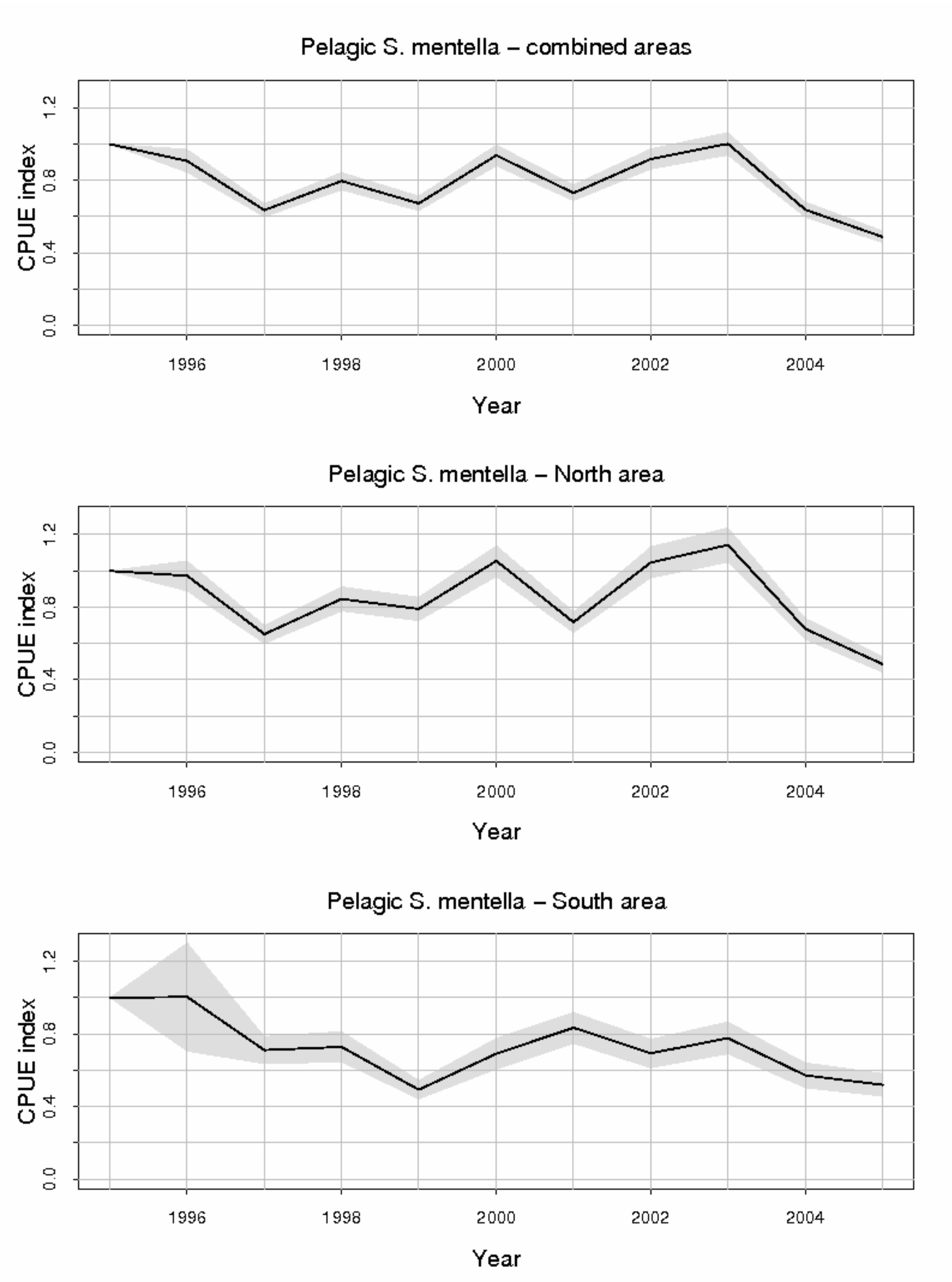


Figure 10.2.6 Standardised CPUE, as calculated by using data from Germany (1995-2005), Iceland (1995-2005), Greenland (1999-2003), Faroe Islands (1995-2005), Russia (1997-2005) and Norway (1995-2003) in the GLM model (see chapter 10.2.2), divided by depths shallower (south-western area) and deeper than 500 m (north-eastern area) and both depth layers (areas) combined. 95% confidence limits are shown. Further details of the GLM models are given in Tables 10.2.5a-c.

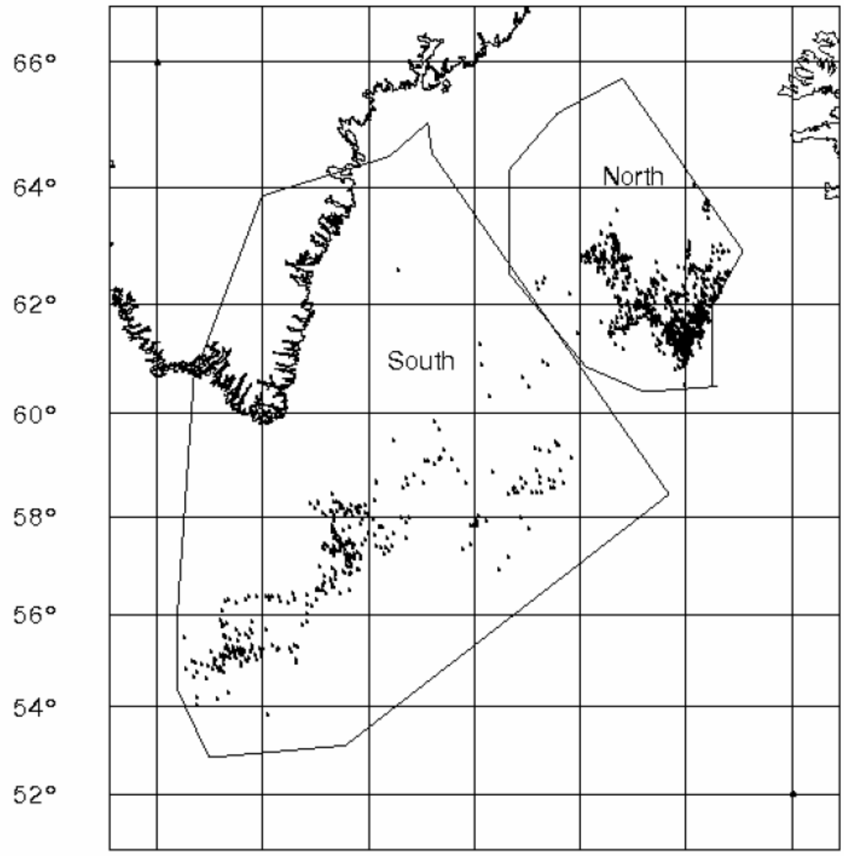


Figure 10.2.7. Division of areas between south an north. The points indicate positions of Icelandic available samples from the catches 1995-2005.

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NORTH-WESTERN WORKING GROUP

ICES, Headquarters, 25 April – 4 May 2006

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Annex 2: Technical minutes

North-Western WG I (Iceland and Greenland stocks)
ICES Headquarters 22-24 May 2006.

Reviewers:
Dankert Skagen (chair)
Jan Horbowy
Jakup Reinert

Presenter:
Einar Hjörleifsson

General remarks

The WG is very active in developing and implementing a variety of models for assessment of some stocks. The review group (RG) appreciates and encourages this attitude towards analysis of the data. This development enables the WG to find tools that are well suited for the stock, but also implies a challenge to demonstrate that the choices made are really the right ones. Regrettably, background documentation for the methods (e.g. AD-CAM, „camera" model) and details of their fitting needed to enable the reviewers to evaluate the method and the results properly, was clearly insufficient. Reference to previous working documents alone is not sufficient as such document rarely are readily available, and in particular if there may have been further developments of the method. For methods that are not commonly used in the ICES community, there should be sufficient documentation both of the method as such, and the application to the stock in question, to allow the reviewers to critically evaluate the decisions made, and the interpretation of the data inherent in the assessment. Diagnostics that may help to elucidate the performance of the model should be presented. In particular, diagnostics that are not routine with other methods but which the developer of the method has experienced as useful, should be presented and discussed. Documentation of the method could be presented in Stock Annexes (Quality Handbook), or annexed to the report.

For the stocks where an analytical assessment is possible, the WG explores a wide range of assessment methods. It is reassuring that these methods give rather similar results. However, to take full advantage of that exercise would require extensive scrutiny of how differences are generated, and of how the various elements in the information about the stock influences the assessment under different assumptions. The value of the broad methodological screening would be greatly increased if such analyses were made and used to give a solid basis for the decisisons that are made. But then, once a method has been established, the RG would suggest to apply fewer assessment models, but rather go deeper into those that are most relevant.

For some stocks, a summary of the main findings was presented. RG found this very helpful, the WG is encouraged to present similar summaries for all its stocks.

The RG notices that the WG has not made a clear distinction between update and benchmark assessments. Given that assessments are largely done with non-standard methods, the RG accepts that the WG is in a learning process and that refinements of the methods are appropriate. The WG should, however, be careful to have clear justifications for alterations that are made.

Icelandic cod

It was found that some catches taken by Faroese fleet were not included in the analysis. Even if this part was small, the assessment taking it into account and projection based on this corrected assessment was requested and provided to the RG. As it was expected the differences between corrected and WG assessments and projections were very low, at the level of 1% . The main results of the corrected assessment are presented below. As the change was minor, the RG saw no reason to redo all data exploration with the revised data.

The assessment uses ages 0-14 while in CANUM ages 3-14 are presented and tuning series covers ages 0-8. So, there is little information in the data to tune assessment for older ages. Did WG investigate assessment sensitivity to so many ages without tuning data? Was it attempted to combine some older ages into plus group? Some experience with other stocks indicates that the assessment may be sensitive to the choice of the plus group. The RG finds it reassuring that TSA, which uses only ages 0-11 gives similar results, but suggests to explore sensitivity of the assessment to the plus group. Also sensitivity of assessment to different constrains in F random walk should be investigated.

Mean weights in prediction were taken as most recent year value. Why they were not as e.g. 3 recent years averages ? (no clear trend in weights in these years has been observed). The WG is encouraged to revisit the issue next year even if it was explored in 2005.

The marked decline in recruitment in middle of 1980s should be commented (p. 323, Fig. 3.3.22B). Were environmental conditions responsible for that? If there are indications that the recruitment has changed due to external influences, the medium-term projections should rather base on recruitment from this lower productivity period.

In the prediction, the selection at age is taken as a three year average. The WG should consider if this is appropriate when the assessment method itself implies a smoothing of the fishing mortalities.

Iceland Cod. Results of assessment with revised catch data

Table 3.3.14 Fishing mortalities at age

Year/age	3	4	5	6	7	8	9	10	11	12	13	14	F5-10
1955	0.04	0.17	0.25	0.27	0.30	0.30	0.28	0.32	0.32	0.31	0.32	0.32	0.29
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	0.29
1957	0.08	0.21	0.27	0.27	0.30	0.33	0.33	0.36	0.36	0.33	0.30	0.30	0.31
1958	0.11	0.25	0.30	0.29	0.32	0.37	0.40	0.44	0.44	0.39	0.33	0.33	0.35
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	0.32
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	0.37
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	0.36
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	0.38
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	0.46
1964	0.13	0.29	0.37	0.36	0.43	0.57	0.74	0.81	0.83	0.61	0.39	0.39	0.55
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	0.58
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	0.59
1967	0.08	0.23	0.30	0.34	0.48	0.61	0.75	0.88	0.93	0.72	0.46	0.46	0.56
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	0.72
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	0.56
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	0.61
1971	0.09	0.31	0.48	0.53	0.62	0.72	0.80	0.96	1.04	0.88	0.58	0.58	0.68
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	0.69
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	0.70
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	0.76
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	0.81
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	0.75
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	0.59
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	0.48
1979	0.03	0.17	0.27	0.34	0.50	0.57	0.50	0.49	0.42	0.39	0.25	0.25	0.45
1980	0.03	0.17	0.31	0.39	0.54	0.62	0.56	0.55	0.47	0.44	0.29	0.29	0.49
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	0.66
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	0.73
1983	0.02	0.18	0.38	0.55	0.71	0.88	0.92	0.86	0.74	0.68	0.53	0.53	0.72
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	0.64
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	0.67
1986	0.06	0.26	0.52	0.71	0.82	0.96	0.88	0.78	0.66	0.63	0.50	0.50	0.78
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	0.87
1988	0.05	0.26	0.52	0.79	0.92	1.10	1.09	0.95	0.88	0.84	0.74	0.74	0.90
1989	0.04	0.24	0.46	0.65	0.79	0.90	0.81	0.73	0.65	0.64	0.52	0.52	0.72
1990	0.05	0.25	0.47	0.66	0.79	0.86	0.75	0.69	0.62	0.61	0.50	0.50	0.70
1991	0.09	0.30	0.56	0.81	0.88	0.95	0.85	0.78	0.71	0.70	0.59	0.59	0.80
1992	0.10	0.32	0.59	0.86	0.92	1.01	0.91	0.81	0.74	0.73	0.62	0.62	0.85
1993	0.14	0.31	0.55	0.79	0.89	1.03	1.04	0.95	0.90	0.88	0.79	0.79	0.87
1994	0.09	0.24	0.38	0.53	0.68	0.76	0.73	0.71	0.65	0.65	0.56	0.56	0.63
1995	0.06	0.20	0.32	0.42	0.57	0.62	0.56	0.58	0.52	0.53	0.45	0.45	0.51
1996	0.04	0.16	0.28	0.41	0.56	0.62	0.58	0.60	0.54	0.55	0.47	0.47	0.51
1997	0.03	0.15	0.27	0.42	0.58	0.67	0.67	0.69	0.64	0.64	0.56	0.56	0.55
1998	0.03	0.16	0.33	0.51	0.67	0.78	0.84	0.85	0.81	0.80	0.74	0.74	0.66
1999	0.05	0.18	0.39	0.64	0.74	0.85	0.94	0.92	0.88	0.87	0.81	0.81	0.75
2000	0.06	0.18	0.39	0.62	0.75	0.87	0.97	0.97	0.94	0.93	0.88	0.88	0.76
2001	0.07	0.19	0.39	0.58	0.70	0.84	0.99	1.02	1.00	0.98	0.95	0.95	0.75
2002	0.04	0.17	0.34	0.48	0.61	0.71	0.85	0.89	0.86	0.85	0.80	0.80	0.65
2003	0.03	0.15	0.33	0.48	0.58	0.66	0.74	0.80	0.75	0.75	0.69	0.69	0.60
2004	0.03	0.15	0.34	0.49	0.59	0.67	0.77	0.82	0.77	0.77	0.72	0.72	0.61
2005	0.03	0.14	0.30	0.44	0.54	0.62	0.73	0.80	0.75	0.76	0.70	0.70	0.57
2006	0.03	0.13	0.28	0.41	0.49	0.56	0.64	0.69	0.65	0.65	0.60	0.60	0.51
2007	0.02	0.12	0.25	0.37	0.45	0.51	0.59	0.63	0.60	0.60	0.55	0.55	0.47
2008	0.02	0.12	0.26	0.38	0.46	0.52	0.60	0.65	0.61	0.61	0.56	0.56	0.48

Table 3.3.15 Iceland cod: Stock in Numbers at age

Year/age	3	4	5	6	7	8	9	10	11	12	13	14
1955	151.999	217.646	211.979	115.439	36.024	24.551	12.935	87.480	9.184	7.792	8.112	2.635
1956	152.824	119.562	150.298	134.773	71.820	21.798	14.830	7.977	51.763	5.434	4.683	4.800
1957	170.655	118.905	81.585	95.881	85.188	44.002	13.172	9.039	4.635	29.686	3.180	2.746
1958	220.730	128.830	78.534	50.804	59.824	51.637	35.166	7.773	5.144	2.635	17.432	1.930
1959	289.146	161.189	82.274	47.542	31.100	35.434	51.521	19.340	4.100	2.701	1.466	10.310
1960	154.362	216.183	104.524	50.791	30.116	18.886	20.617	37.478	10.619	2.289	1.604	0.954
1961	192.924	114.280	140.200	63.733	31.064	17.587	10.389	10.997	19.044	5.404	1.273	1.001
1962	128.943	143.806	74.712	88.569	40.168	18.220	23.600	5.597	5.687	10.038	3.117	0.830
1963	177.569	94.428	91.877	46.156	55.715	23.259	9.764	12.113	2.743	2.858	5.627	2.008
1964	204.140	127.712	58.263	54.193	27.749	31.104	11.644	4.447	5.198	1.202	1.473	3.460
1965	216.454	147.393	78.218	32.884	30.943	14.712	14.400	4.548	1.619	1.847	0.535	0.817
1966	229.181	157.043	90.831	43.585	17.988	15.815	6.597	5.599	1.593	0.550	0.785	0.286
1967	320.272	170.778	99.786	52.866	24.363	9.014	6.951	2.474	1.834	0.476	0.205	0.377
1968	171.873	242.862	111.203	60.328	30.868	12.296	4.011	2.689	0.842	0.593	0.189	0.106
1969	247.573	130.324	155.383	64.692	32.934	41.229	4.684	1.166	0.663	0.177	0.164	0.074
1970	180.451	191.691	84.586	92.163	37.177	32.925	18.374	1.869	0.413	0.227	0.071	0.086
1971	188.614	137.934	119.850	46.917	49.280	17.539	14.069	7.031	0.627	0.131	0.083	0.034
1972	139.177	141.358	82.909	60.798	22.550	21.694	23.275	5.175	2.209	0.182	0.044	0.038
1973	273.156	104.394	85.591	42.027	28.625	9.643	8.565	8.637	1.623	0.626	0.060	0.020
1974	178.940	198.602	62.027	42.996	19.567	12.019	3.713	3.153	2.723	0.468	0.207	0.027
1975	260.872	130.798	117.521	30.830	19.803	7.958	4.282	1.210	0.897	0.684	0.137	0.084
1976	367.953	191.677	78.573	58.236	13.842	7.873	2.690	1.261	0.320	0.209	0.185	0.051
1977	143.268	281.918	121.208	41.939	27.456	5.653	2.747	0.852	0.376	0.090	0.066	0.078
1978	226.858	113.778	189.858	71.374	22.372	12.215	2.249	1.084	0.333	0.153	0.039	0.036
1979	244.160	180.742	78.282	117.351	41.006	10.832	5.474	1.065	0.512	0.168	0.080	0.024
1980	139.817	194.338	124.744	48.713	71.822	20.303	5.029	2.726	0.533	0.276	0.092	0.051
1981	140.788	111.296	133.573	75.202	27.104	47.157	8.937	2.355	1.291	0.273	0.145	0.056
1982	131.962	112.680	76.416	76.847	37.767	11.599	17.004	3.115	0.848	0.498	0.111	0.070
1983	233.316	105.103	76.129	42.183	36.028	15.354	3.862	5.306	1.064	0.328	0.206	0.054
1984	138.571	186.597	71.996	42.800	19.851	14.560	5.196	1.256	1.840	0.416	0.136	0.099
1985	137.466	109.157	125.061	40.480	20.670	8.287	5.327	1.990	0.507	0.827	0.193	0.071
1986	334.232	107.010	70.967	67.185	18.629	8.284	2.949	2.015	0.804	0.228	0.382	0.101
1987	264.967	257.253	67.365	34.685	26.978	6.685	2.608	0.999	0.759	0.339	0.100	0.190
1988	174.960	205.232	160.358	31.712	12.626	8.927	1.894	0.783	0.347	0.294	0.137	0.045
1989	86.896	136.661	129.745	77.846	11.804	4.119	2.423	0.522	0.248	0.118	0.104	0.054
1990	130.319	68.288	87.785	100.524	33.172	4.364	1.377	0.886	0.207	0.106	0.051	0.050
1991	104.162	101.452	43.501	44.992	42.590	12.334	1.516	0.531	0.363	0.091	0.047	0.025
1992	173.485	78.227	61.398	20.348	16.456	14.393	3.910	0.529	0.200	0.146	0.037	0.021
1993	136.558	128.168	46.453	27.812	7.051	5.344	4.309	1.295	0.192	0.078	0.058	0.016
1994	75.825	97.394	76.625	21.936	10.292	2.375	1.560	1.248	0.412	0.064	0.026	0.022
1995	152.220	56.802	62.543	42.767	10.582	4.278	0.906	0.618	0.504	0.176	0.027	0.012
1996	166.613	117.178	38.193	37.254	22.961	4.888	1.879	0.422	0.284	0.245	0.085	0.014
1997	85.381	131.577	81.669	23.626	20.284	10.734	2.152	0.861	0.190	0.135	0.116	0.043
1998	162.279	68.125	93.103	50.867	12.747	9.258	4.517	0.905	0.354	0.082	0.058	0.054
1999	67.609	129.083	47.755	54.970	24.888	5.364	3.492	1.598	0.317	0.128	0.030	0.023
2000	177.298	52.904	88.344	26.448	23.753	9.696	1.873	1.117	0.519	0.107	0.044	0.011
2001	160.650	136.873	36.002	48.802	11.656	9.223	3.341	0.579	0.345	0.166	0.035	0.015
2002	161.305	123.131	92.514	20.050	22.382	4.725	3.257	1.012	0.171	0.104	0.051	0.011
2003	190.272	126.591	85.286	53.793	10.115	9.958	1.896	1.143	0.339	0.060	0.036	0.019
2004	60.841	151.195	89.071	50.227	27.344	4.632	4.224	0.738	0.422	0.132	0.023	0.015
2005	164.380	48.210	106.369	52.020	25.074	12.469	1.944	1.608	0.266	0.160	0.050	0.009
2006	127.211	130.625	34.359	64.264	27.396	11.928	5.473	0.769	0.593	0.102	0.061	0.020
2007	87.504	101.429	94.218	21.294	35.093	13.739	5.584	2.360	0.315	0.253	0.044	0.027
2008	165.518	69.925	73.947	59.781	12.033	18.344	6.743	2.541	1.025	0.142	0.114	0.021

Table 3.3.18. Icelandic cod (Division Va)
Summary table

Year	Recruitment Age 4 Thousands	SSB Thous. tonnes	Mean F Ages 5-10	B4+ Thous. tonnes	Landings Thous. tonnes	Exploitation rate
1955	151999	941	0.29	2360	545	0.23
1956	152824	795	0.29	2084	487	0.23
1957	170655	774	0.31	1880	455	0.24
1958	220730	874	0.35	1867	517	0.28
1959	289146	852	0.32	1828	459	0.25
1960	154362	708	0.37	1753	470	0.27
1961	192924	467	0.36	1496	377	0.25
1962	128943	569	0.38	1492	389	0.26
1963	177569	508	0.46	1316	409	0.31
1964	204140	451	0.55	1219	437	0.36
1965	216454	318	0.58	1023	387	0.38
1966	229181	277	0.59	1032	353	0.34
1967	320272	256	0.56	1103	336	0.30
1968	171873	222	0.72	1223	382	0.31
1969	247573	314	0.56	1326	403	0.30
1970	180451	331	0.61	1337	475	0.36
1971	188614	242	0.68	1098	444	0.40
1972	139177	222	0.69	997	395	0.40
1973	273156	245	0.70	844	369	0.44
1974	178940	187	0.76	918	368	0.40
1975	260872	168	0.81	895	365	0.41
1976	367953	138	0.75	955	346	0.36
1977	143268	198	0.59	1290	340	0.26
1978	226858	212	0.48	1298	330	0.25
1979	244160	304	0.45	1396	366	0.26
1980	139817	356	0.49	1489	432	0.29
1981	140788	264	0.66	1242	465	0.37
1982	131962	167	0.73	971	380	0.39
1983	233316	129	0.72	791	298	0.38
1984	138571	141	0.64	914	282	0.31
1985	137466	172	0.67	928	323	0.35
1986	334232	198	0.78	850	365	0.43
1987	264967	149	0.87	1032	390	0.38
1988	174960	172	0.90	1041	378	0.36
1989	86896	172	0.72	1009	363	0.36
1990	130319	214	0.70	840	335	0.40
1991	104162	161	0.80	696	308	0.44
1992	173485	152	0.85	546	265	0.49
1993	136558	123	0.87	590	251	0.43
1994	75825	153	0.63	574	178	0.31
1995	152220	178	0.51	553	169	0.30
1996	166613	158	0.51	668	181	0.27
1997	85381	189	0.55	784	203	0.26
1998	162279	211	0.66	718	244	0.34
1999	67609	185	0.75	730	260	0.36
2000	177298	168	0.76	587	235	0.40
2001	160650	162	0.75	694	234	0.34
2002	161305	196	0.65	731	208	0.29
2003	190272	185	0.60	741	206	0.28
2004	60841	202	0.61	818	226	0.28
2005	164380	234	0.57	715	214	0.30
2006	127211	229		753		

Table 3.3.19 Iceland cod: Short term predictions

Input:

Selection pattern from a AD-CAM:

age\year	2000	2001	2002	2003	2004	2005	03-05	Used
3	0.077	0.088	0.065	0.050	0.053	0.052	0.052	0.052
4	0.243	0.254	0.258	0.254	0.248	0.242	0.248	0.248
5	0.516	0.511	0.528	0.551	0.552	0.531	0.545	0.545
6	0.813	0.769	0.747	0.798	0.808	0.771	0.793	0.793
7	0.979	0.933	0.940	0.972	0.956	0.948	0.959	0.959
8	1.136	1.116	1.099	1.101	1.092	1.089	1.094	1.094
9	1.278	1.319	1.306	1.245	1.251	1.270	1.255	1.255
10	1.279	1.351	1.379	1.333	1.341	1.392	1.355	1.355
11	1.237	1.324	1.321	1.248	1.255	1.316	1.272	1.229
12	1.218	1.301	1.312	1.253	1.261	1.327	1.280	1.229
13	1.156	1.255	1.236	1.154	1.169	1.227	1.183	1.229
14	1.156	1.255	1.236	1.154	1.169	1.227	1.183	1.229
Ave(5-10)	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Given stock numbers ***Mortality proportions before spawning***

age\year	2006	2007	2008	2009	F	M
3	127.21	88.00	166.00	160.00	0.085	0.250
4	130.63				0.180	0.250
5	34.36				0.248	0.250
6	64.26				0.296	0.250
7	27.40				0.382	0.250
8	11.93				0.437	0.250
9	5.47				0.477	0.250
10	0.77				0.477	0.250
11	0.59				0.477	0.250
12	0.10				0.477	0.250
13	0.06				0.477	0.250
14	0.02				0.477	0.250

Icelandic COD. Division Va.

Prognosis - Summary table (nwwg2006)

2006				2007				2008				2009			
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)*
204	753	228	0.525	150	745	255	0.368	150	752	280	0.331	150	860	318	0.297
				187	745	245	0.479	182	709	247	0.450	186	781	258	0.444
				160	745	253	0.397	160	740	271	0.364	160	837	301	0.333
				180	745	247	0.457	180	718	253	0.437	180	791	267	0.417
				200	745	242	0.519	200	695	234	0.522	200	745	233	0.522

Iceland Cod: Revised figures for the management option table in the summary sheet, including percentage change in catch and SSB:

Projection of stock and spawning stock biomass (thousand tonnes) in 2006-2007 for different management strategies.

2006				2007				2008				2009			
Stofn 4+ *Stock 4+*	Hrygn-stofn *Spawning stock*	F	Afli *Catch*	Afli *Catch*	Stofn 4+ *Stock 4+*	Hrygn-stofn *Spawn. stock*	F	Afli *Catch*	Stofn 4+ *Stock 4+*	Hrygn-stofn *Spawn. stock*	F	Stofn 4+ *Stock 4+*	Hrygn-stofn *Spawn. stock*		
753	227	0.53	204	0	745	291	0.00	0	922	422	0.00	1199	591	45	24
				201	745	242	0.52	201	694	234	0.53	743	232	-3	-7
				133	745	260	0.32	133	771	296	0.28	899	348	14	3
				19	745	287	0.04	19	901	404	0.03	1157	556	41	21
				47	745	281	0.10	47	869	377	0.08	1094	504	34	17
				93	745	269	0.22	93	816	333	0.18	988	418	24	10
				140	745	258	0.34	140	763	289	0.30	882	335	12	2
				168	745	250	0.42	168	731	263	0.39	818	287	5	-2
				187	745	245	0.48	182	710	248	0.45	781	259	1	-5
				206	745	240	0.54	206	689	229	0.55	732	224	-5	-8
				234	745	233	0.63	234	657	204	0.69	668	179	-12	-12

Greenland cod

Assessing this stock with a VPA type method like XSA when recent catch at age data are at best provisional is not recommended. Rather, the WG should explore methods to analyze the data that actually are present, in particular survey data, like simple analysis of log survey ratios, SURBA or similar approaches, supplemented with the total catches to scale the results to absolute values.

Icelandic haddock

This stock was marked for a benchmark assessment. The WG treated it more as an 'observation list' assessment. The RG accepted this approach, realizing that this assessment is in a continuous learning process. The assessment done was similar to last years assessment.

The WG and RG noticed differences in the assessments depending on which survey is used – spring or autumn. It is suggested to go deeper into the problem, explore the reasons for the differences in assessments in light of rather mutually consistent surveys. Such explorations should include the use of both surveys simultaneously in tuning. There are strong year effects in the survey residuals, which should be explored. Would a random walk model for the catchabilities be worth looking at?

Retrospective analysis included also projections. It would be more instructive to at least mark the projection parts separately. However, the basis for "projections" was not explained in the WG report (it was provided during the RG meeting – the projections used realized catches).

The calculation of weights and maturities for catch predictions should be described in more detail in WG Report.

Yield and SSB per recruit should be provided. The WG should consider ways of taking into account growth, maturity and selection, for example stochastic Y/R, taking density dependence into account etc.

Icelandic saithe

The problem of sensitivity to age ranges and plus group for Icelandic cod applies also for the saithe stock.

The presented data give the impression that there may be some changes in the selection at age (Fig. 3.2.3.3). The WG should explore splitting the long separable period into shorter time intervals.

Blocks of negative residuals have been observed when comparing IGFS indices (Fig. 3.2.7.9, p. 246). The reason for this should be analyzed.

Fbar covers ages 3-9 while ages 3 and 4 have much lower F than the older ages. Is this selection of ages for reference F justified ?

More detailed description of how the weight and maturities were predicted is suggested.

Redfish general

The RG notices that the stock identity problem for redfish is still unresolved, and recognizes that the WG has limited opportunities to solve this problem on its own.

The WG has done a good job in producing maps showing the location of the fisheries, both by area and by depth strata.

The RG noticed the practice of reporting catches by pelagic gear inside the Icelandic 'demersal line' as demersal S. mentella. Normally, these catches have been small, but in 2003 this was a problem which influences both catch statistics and the CPUE series for both units. Given the unclear stock identity of S. mentella in general, the RG finds it hard to insist on different practices for the time being.

Surveys in East Greenland give some early indications of incoming year classes. The RG recognisies the problems with species id. for the smallest redfish and stock id for those above 17 cm. Nevertheless, the WG should have a closer look at the feasibility of systematizing the information from the various surveys in this area to develop comprehensive indices of recruitment.

'Pelagic' *S. mentella.*

The CPUE indices are derived from the raw data to take into account year, season and vessel effects. The WG should present some more detailed output from these analysis, including residuals, to allow a proper evaluation of the procedure. The RG notes that that even though vessel effects are included, this does not take into account possible improvements in the performance of the vessels. The WG should explore the possibility of doing so. Likewise, any information, even anecdotal, that could help in understanding how the fleet operates, would be useful for the interpretation of the CPUE data, in particular because the rapid decline in CPUE in recent years became a crucial argument for the advise.

The graphs of the survey indices that go into the ACFM report have been redrawn to improve the lay-out and update them. The lack of updated figures in the draft for the ACFM report led to an impression that there was little change in the state of the stock in 2005. Further scrutiny of the report revealed a dramatic reduction in CPUE in particular in the North, which gradually led the subgroup to revise its perception of the state of the stock, and led ACFM to recommend a closure of the fishery.

'Demersal' *S. mentella*

The CPUE series, which is part of the background for the advise on this stock, is adjusted for several factors in a GLM model. The RG approves this kind of procedure, but would have liked to see some more documentation of the performance, including selected residuals. It notices that although ship effect is included, improvements to each vessel is not, impling that effort creeping due to technological improvements is not fully accounted for. The WG should consider if there are ways to compensate more completely for effort creeping.

At present, the advise is based on the trends in surveys and CPUE. The WG is encouraged to attempt to synthetise this information by applying simple models, which could be (but need not be) production models. Such considerations would clearly be experimental, but may nevertheless be useful in a longer perspective.

S. marinus.

The WG has performed analytic assessments with Bormicon for several years, and the results of this assessments are used to quantify the advise. The assessment has been accepted over the years. Nevertheless, so far the advise has been based on survey reference points. It is suggested that the WG prepares the ground for a change of reference points to be related to the Bormicon estimates. This will include both proposal of candidate reference points and providing background information to allow a full evaluation of the Bormicon assessment for this stock.

Greenland halibut.

Maps showing the distribution of catches and effort were very instructive, and were much appreciated.

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.

Annex 3: TECHNICAL MINUTES

ACFM Sub-group Review of the Report of the North-Western Working Group [NWWG]

Review Group II - RGNW2

ICES HQ, Copenhagen, Denmark

18th-19th May 2006

ACFM Sub-group chair: Carl O'Brien (United Kingdom)
ICES NWWG chair: Einar Hjörleifsson (Iceland)
Reviewers: Pablo Abaunza (Spain) and Evgeny Shamray (Russia – by e-mail)

Additionally, the review group was assisted by the participation of Jakup Reinert (Faroe Islands).

GENERAL CONSIDERATIONS

The members of ACFM review group [RGNW2] commended the chair of the ICES NWWG for the way in which the working group had managed to deal with a lengthy list of terms of reference (ToRs), without disregarding the need to address the basic data problems associated with many of the stocks and their assessments.

This review group RGNW2 was tasked with reviewing the following five stocks:

Faroe Plateau cod	Observation
Faroe Bank cod	Experimental (no analytical assessment)
Faroe haddock	Benchmark
Faroe saithe	Update but technical issues to be resolved
Icelandic summer spawning herring	Benchmark but technical issues to be resolved

In previous years, the capelin stock in the Iceland-East Greenland-Jan Mayen area (Sub-areas V and XIV and Division IIa west of 5°W) has been included within this review group but that stock is now assessed by the ICES Northern Pelagic and Blue Whiting Fisheries Group [WGNPBW] which does not meet until later in the year; and has been excluded from the present review.

The workload of the ICES NWWG was discussed in detail and RGNW2 made a number of suggestions as to how this might be addressed in the future. Specifically, the following issues were raised and discussed.

a) Whenever possible, the NWWG uses a number of assessment models for each stock that it assesses - the choice of models often being a matter of preference of the individual stock co-ordinator. Normally, the results are compared with the results from XSA. In the case of the Faroese stocks, XSA is then adopted as the final assessment and forms the basis for advice. For a number of the stocks within the NWWG, assessments are undertaken with models that correspond to a constant q assumption and low shrinkage within XSA. For comparison, an ADAPT model is routinely performed and the NFS tool-pack used to produce bootstrap simulations. RGNW2 encourages the further development of this approach but would like to see the bootstraps taken forward into probabilistic advice (c.f. blue whiting advice produced at the May 2004 ACFM meeting). This would negate the need to run XSA and present its results as the ICES' stock assessment.

b) Within the EU and EU-Norway, there is a move towards the proposal and development of harvest control rules (HCRs) for the long-term management and sustainability of stocks and their fisheries. Typically, these involve proposing target fishing mortalities and are relying to a lesser extent upon the PA framework as currently implemented by ICES. For depleted stocks, the PA framework as currently implemented by ICES results in next year's advice being driven by a desire to reach B_{pa} in one year. A consequence of which is that advice often leads to draconian cuts in quota/effort. The HCR framework is focused on insuring that stocks do not fall below B_{lim} in the long-term. The NWWG has started to investigate target fishing mortalities for Faroese demersal stocks in relation to the risk of future predicted SSB falling below B_{lim} (c.f. Figure 2.1.13). RGNW2 encourages further discussion and development of such an approach along the lines presented in last year's ACFM advice for the West of Scotland herring and Western Channel sole.

c) A number of the stock chapters in the report of the NWWG begin with a summary of the major findings of the current year's assessment; e.g. Icelandic cod in Section 3.3. RGNW2 applauds this development by the NWWG and encourages other ICES' stock assessment WGs to adopt this idea for their assessment chapters. Such summaries could detail, for example, changes and updates to input data, the assessment models used and any changes since the last assessment, perceptions of the stock, quality control and other relevant information. This would greatly assist the ACFM review process and should be at a level of detail that is consistent with the information required for the ACFM stock summary sheets.

d) A number of the generic stock assessment ToRs in the ICES' resolution for the NWWG this year are inappropriate to Faroese and Icelandic stocks given that ICES provides advice on only a limited selection of stocks in the regions.

e) As an illustration of point d) above, the NWWG was requested to provide an overview of the sampling of the basic assessment data for the stocks that it considers for assessment purposes. The NWWG attempted to complete the table provided by the ICES' Secretariat for the few stocks that ICES assesses but felt that the audit nature of the table did not address the stated purpose of quality control and quality assurance. RGNW2 agreed with the NWWG.

f) There is a need to clearly specify the aims of any YPR analyses undertaken, as there is often a difference between the results produced by NWWG and those subsequently produced by ACFM. RGNW2 discussed this and concluded that the differences result from the assumptions regarding the input parameters and values (c.f. Figure 1.1).

The stock specific deliberations and technical reviews of the RGNW2 are presented next. Note that the Section and Figure references refer to the latest report of the ICES NWWG, namely, document ICES CM 2006/ACFM:26.

STOCK REVIEWS

Faroe Plateau cod – observation

According to data presented to this year's NWWG, ~4 kt of Faroes annual landings during the period 2003-2005 were caught at the Faroe-Icelandic ridge (Section 3.3.2.1.1). These landings were regarded as being taken from the Icelandic cod stock and have been subtracted from the Faroese landings and added to the Icelandic cod landings. This is supported by the results from tagging experiments conducted by Iceland and the Faroe Islands (Section 2.2.1); together with the observed distributional pattern of catches from logbooks.

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. It would be informative to have details of the model fits, residuals and diagnostics; together with options for a projection model. RGNW2 encourages NWWG to address these issues and to display weight-at-age and maturity-at-age graphically – data and model fits. The next benchmark assessment should address the issue of the SOP correction factors.

A SPALY (XSA) assessment was performed with the revised input data. However, this did not change the historical perception of the stock as reported in the ICES' assessment quality control tables. RGNW2 suggested that in future a graphical display of the information provided in the ICES' assessment quality control tables would be helpful. The assessment was accepted by RGNW2 as the basis for a short-term forecast and advice.

A figure showing the contribution by year-class to the age composition of the predicted 2007 catch and the 2008 SSB is not provided for this stock (c.f. Figure 2.4.21 for Faroe haddock).

RGNW2 discussed the choice of input parameters to the short-term prediction and agreed with the choices made by the NWWG.

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).

Recommendations:

1. Further analyses should be undertaken into the influence of environmental factors on stock parameters.
2. Weight-at-age and SOP correction factors should be further investigated before the next benchmark assessment.
3. A graphical display of the information provided in the ICES' assessment quality control tables should be provided.

Faroe Bank cod – experimental (no analytical assessment)

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. Larger vessels (> 110 GRT) complete landing slips and logbooks but smaller vessels are not obliged to complete logbooks. Unless there are improvements in the recording, and assignment to area, of catch then the landings will continue to remain uncertain.

The poor sampling for age composition has continued in 2005, 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. RGNW2 propose that the NWWG investigate appropriate sampling levels and targets for this stock. In addition, NWWG should provide a summary of the historical sampling intensity for commercial and survey data.

Recommendations:

1. In order to improve catch and landings statistics, vessels should be required to fish in one area only during a trip and record all trips.
2. Identify the target levels for biological sampling needed to improve the basis for scientific assessment and advice.

Faroe haddock – benchmark

This year's assessment is designated as a benchmark. Substantial effort was devoted by the NWWG to the re-analysis and revision of the basic input data to catch-at-age based assessment models (see Sections 2.4.2 to 2.4.5) rather than changes to the model settings of XSA *per se*. Survey series were revised (Section 2.4.6.1).

No estimates of discards of haddock are available but there is no incentive to discard in order to high-grade landings as quotas are not used in the management of this stock. Additionally, there is a ban on discarding. Hence, the landings statistics are regarded as reflecting the true level of catch and are considered to be appropriate for assessment purposes.

A SPALY (XSA) assessment was performed with the revised input data. However, this did not change the historical perception of the stock as reported in the ICES' assessment quality control tables. RGNW2 suggested that in future a graphical display of the information provided in the ICES' assessment quality control tables would be helpful.

The RGNW2 encourages the NWWG to continue in its application of different assessment tools to this stock (Section 2.4.10). RGNW2 recommended that the last two paragraphs in Section 2.4.10 of the draft report of the NWWG (ICES CM 2006/ACFM:26) be condensed and re-worded as a separable model does not seem appropriate for this stock. Subsequently, this was undertaken as part of this review process.

RGNW2 identified the need to update the Figures 2.4.16 and 2.4.17 in this year's ACFM draft stock summary sheet and this was undertaken as part of this review process.

A minor transcription error was noticed in the input data (Table 2.4.14) for the short-term prediction table – in 2008, N at age 2 should be 13795 not 13750. Given the accuracy of results presented in the management option table by ACFM in the stock summary sheet, this was not considered by RGNW2 to be a problem.

In common with last year's report, the NWWG has again proposed a revision to the biomass reference points - a reduction in the limit biomass reference point from 40 kt to 23 kt. RGNW2 had a lengthy technical and detailed discussion on BRPs and concluded that it is inappropriate to change the reference points at the present time. The reasons are essentially those previously articulated and again presented in Section 2.4.7.2; namely, that with the current B_{lim}, 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. Given the small number of data points below the biomass of 40 kt, the review group concluded that the existing biomass reference points should remain unchanged for the present.

Recommendations:

1. RGNW2 recommends adopting this year's assessment as a benchmark.
2. The existing biomass reference points should not be revised.
3. A graphical display of the information provided in the ICES' assessment quality control tables should be provided.

Faroe saithe – update but technical issues to be resolved

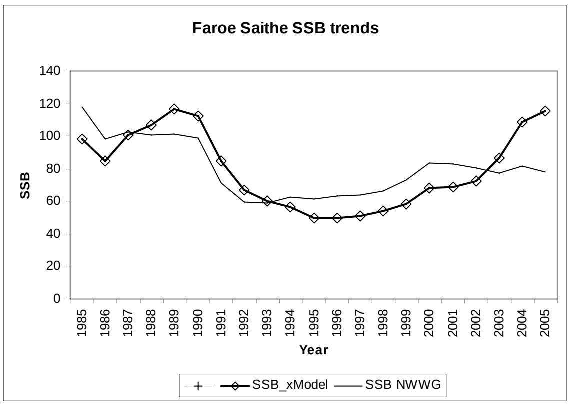
Prior to the RGNW2 convening at ICES HQ, the chair of the NWWG raised reservations about the quality of this stock assessment which was benchmarked last year. At the NWWG last year the group had focused on issues relating to the tuning fleet (a commercial CPUE for 1995-2005) used in the assessment and the modeling of the maturity-at-age ogives.

Unlike last year's benchmark assessment, this year's NWWG used a 3-year moving average of maturity-at-age data for the period from 1983 to estimate maturity-at-age rather than the GLM model previously used (see WD12 presented to the 2005 meeting of NWWG). RGNW2 questioned this and a quick re-examination of the basis and fits of the GLM revealed its tendency to either systematically over- or under-estimate maturity-at-age for ages 4 and older. The change in modeling approach this year by NWWG was accepted by the RGNW2 but subsequently during this review, further questions were raised about the validity of the previous benchmark assessment.

Mean weight-at-age in the catch has varied by a factor of ~2 during the period 1961-2005 and for all ages has displayed a declining trend since 1996. Weight-at-age for 2005 is the lowest since 1991 (Figure 2.5.3.1). Catchability (q) may change as a result of changes in weight-at-age given the high variability in the weight-at-age for saithe. q is calculated as the catch number-at-age in the tuning fleet series divided by the stock number-at-age. There appears to be an indication of a relationship between weight-at-age and catchability at age 3 (Figure 2.5.3.2). This may have an effect on the assessment of this stock which assumes a constant q within an age-based assessment model. RGNW2 discussed the possibility of using a length-based assessment model for this stock and the NWWG is encouraged to consider this possibility for the future. Such modeling should take into account the issue of migration (Section 2.5.8) and concerns regarding the by-catch of saithe in the blue whiting fisheries around the Faroe Islands and Iceland (also in Section 2.5.8).

As already mentioned, this year's assessment has highlighted the possibility that the assumptions underlying the assessment model used last year may be violated and that there is now considerable uncertainty in the point estimates produced and their utility as inputs to predictions. Alternative analyses were presented to the RGNW2 and discussed:

> The sensitivity of the XSA result to the effect of the systematic change in weight-at-age in recent years was explored by applying a model where selectivity was modeled as a logistic function of weight; i.e. fn(1/(1-exp(-alpha(W_{ay}-W_{50})). In addition, as the observations used were only the catch-at-age matrix, a penalty function was used in the fitted objective function to constrain the variation in fishing mortality between consecutive years. The results indicate that the SSB and recruitment may be substantially larger in certain years (see Figure 1 below in these technical minutes) and fishing mortality somewhat lower than implied by the XSA analysis. The violation of the constant q assumption may thus have a significant effect on the conclusion regarding the state of the stock; and warrant a rejection of the XSA analysis as a basis for recent stock developments.



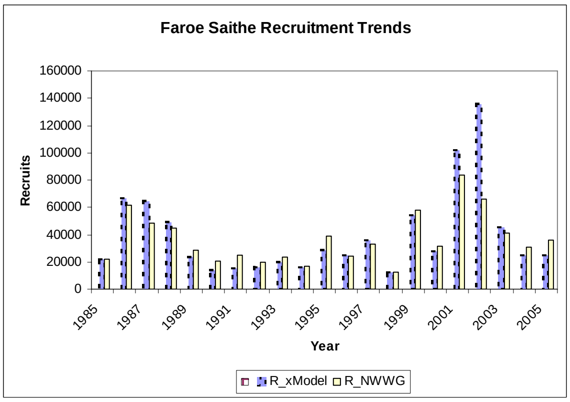


Figure 1: Time series trends in SSB and recruitment in Faroe saithe using two assessment models. In the legends, *xModel* denotes the model described above this Figure and *NWWG* denotes the XSA model presented in this year's NWWG report (ICES CM 2006/ACFM:26).

In the absence of an accepted analytical assessment, the RGNW2 considered the use of survey data and an approach analogous to that adopted previously for providing an indication of stock status and advice for Icelandic summer-spawning herring.

In common with last year's report, the NWWG has again proposed a revision to the biomass reference points - a reduction in the pa biomass reference point from 85 kt to 60 kt (the current limit biomass reference point). RGNW2 had a lengthy technical and detailed discussion on BRPs but concluded that it is inappropriate to change the reference points at the present time. The lack of an accepted analytical assessment being a mitigating factor.

Recommendations:

1. RGNW2 recommends rejecting the previous benchmark assessment.
2. The existing biomass reference points should not be revised.
3. In the long-term, the NWWG should investigate length-based assessment approaches that can accommodate, for example, rapid changes in weight-at-age and non-constant catchability. In the short-term, the alternative model presented to this review group or a re-iterative F *tuning* of the VPA should be explored.
4. The routine collection of information on the by-catch of saithe in the blue whiting fishery in ICES Division Vb should be undertaken by those prosecuting the fisheries.

Icelandic summer-spawning herring - benchmark but technical issues to be resolved

No analytical assessment was accepted last year but during the past year the NWWG has devoted considerable activity to improving the basic input data used in the assessment of this stock and as in recent years, several assessment models were applied at this year's meeting of the NWWG.

The catch-at-age data for the fishing seasons 2000/2001 to 2004/2005 have been re-calculated since the last assessment in 2005 (see Section 3.5.3) but the catch data for the earlier fishing seasons have yet to be re-worked in the same way. Further work on the re-ageing of herring from the catch samples taken during the fishing seasons 1992/1993 to 1999/2000 is ongoing at the Marine Research Institute and is anticipated to be completed before the next ICES NWWG in 2007 (see Section 3.5.11).

Using the revised input data to the assessment has improved the model fits from those produced last year but the models still show the same retrospective pattern in over-estimating the spawning stock biomass for the recent years (1997 to 2003) which cannot be explained satisfactorily at present. The NWWG investigated a possible explanation in a working document (WD21). Quoting from that document:

There have been substantial changes in the behaviour of this stock and how it was caught during the 20 years included in the present estimation. It has been suggested that catches with pelagic trawl kill a substantial number of herring that is not caught. This has been modelled by assuming a constant M from until 1993, rising linearly to a new constant estimated value from 1997-2006, or by the regression model

M = 0.1 + const(proportion of herring caught by pelagic trawl).*

All models behaved better retrospectively with this *natural mortality* proxy composed of two components – one of which is still a component of fishing activity! RGNW2 commended the NWWG for their ingenuity but could not accept this alternative approach as a basis for advice. However, RGNW2 encourages the NWWG to investigate further plausible assessment models and hypotheses.

In the absence of an accepted analytical assessment, the RGNW2 considered the catch curve analyses presented by the NWWG for the fishing seasons 1985/1986 to 2005/2006. These indicate a noisy total mortality (M+F) estimate (Z) of ~0.4. There are indications that there has been inadequate sampling of basic data (scales) in the surveys (Table 3.5.4.2) which might explain the noisy estimates. RGNW2 noted that the survey-based estimate of Z is consistent with the estimates from catch curves and estimates from a TSA-based catch-at-age analysis (M=0.1) excluding survey data (c.f. page 28 in WD21 – stock estimates and fishing mortality estimates).

RGNW2 raised a number of issues and concerns regarding the acoustic survey. The NWWG is requested to provide details on the survey design over time and to provide quantitative estimates of the quality of the survey indices. Such details should provide evidence for any hypothesised catchability assumption. The recent total biomass indices from the acoustic surveys for ages 4+ are slightly larger than those presented to ACFM last year, as a consequence of the re-worked input data. In addition, it now transpires that there was incomplete survey coverage in 1997 and 2001 and that the indices for these years should be excluded from Figure 3.5.4.1 and the ACM summary sheet for this stock.

Recommendations:

1. Given the increased activity in re-working basis input data to this assessment, the NWWG is encouraged to complete the task of re-working historic data.
2. RGNW2 recommends awaiting the outcome of that process before addressing the issue of a benchmark assessment for this stock.
3. No benchmark assessment available for this stock.

Annex 4: List of working documents

WD01 Christoph Stransky and Hans-Joachim Rätz. On the German fishery and biological characteristics of pelagic redfish (Sebastes mentella Travin) 1991-2005

WD02 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 1985-2005

WD03 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, 1995-2005

WD04 Heino Fock, Christoph Stransky and Hans-Joachim Rätz. Update of Groundfish Survey Results for the Atlantic Cod Greenland offshore component 1982-2005

WD05 R. Alpoim, J. Vargas and E. Santos. Report of the Portuguese Sebastes mentella fishery in 2005 ICES Div. XII, XIVb and NAFO Div. 1F.

WD06 J. Boje. The fishery for Greenland halibut in ICES Div. XIVb in 2005

WD07 Kaj Sünksen, Marie Storr-Paulsen and Kai Wieland . Greenland survey results and commercial data for Atlantic cod in Greenland inshore and offshore waters for 2005

WD08 Petra Jantschik and Christoph Stransky. Preparation methods and age reading comparisons on otoliths of Greenland halibut (Reinhardtius hippoglossoides) from ICES Division XIVb

WD09 Lise Helen Ofstad. Preliminary Assessment Of Faroe Saithe

WD10 Jerzy Janusz. Description of Polish fishery of pelagic redfish (Sebastes mentella) in the Irminger Sea and adjacent waters in 2005

WD11 S.P. Melnikov. Preliminary Information about Russian Fishery for the Oceanic *S. Mentella* in ICES Subareas XII, XIV, in NAFO Divisions 1F, 2J in 2005 and Biological Sampling from Commercial Catches

WD12 Melnikov S., Yu. Bakay, G. Novikov, A. Stroganov, M. Kalashnikova and G. Rodkina. Return migration and recruitment to redfish Sebastes mentella stock in the Irminger Sea and adjacent waters

WD13 V.I. Vinnichenko and K.V. Gorchinsky. Russian investigations and fishery for Greenland halibut (Reinhardtius hippoglossoides) in the Northeast Atlantic in 2005

WD14 F. González, J. L. del Rio and A. Gago. Results of the 2005 Spanish Experimental Fishing in Greenland Waters

WD15 Petur Steingrund. Preliminary assessment of Faroe Plateau cod

WD16 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 2005

WD17 Faroe Bank cod. Preliminary assessment

WD18 Guðmundur J. Óskarsson and Ásta Guðmundsdóttir. Maturity estimations of the Icelandic summer spawning herring

WD19 Höskuldur Björnsson. Prediction of weights at age for Icelandic haddock

WD20 O.A. Jørgensen. Survey for Greenland halibut in ICES Division 14B, June 2005

WD21 Gudmundur Gudmundsson . Time series analyses of catch-at-age and CPUE observations of Icelandic cod, haddock, saithe and herring

WD22 Kristján Kristinsson, Thorsteinn Sigurdsson and Hoskuldur Bjornsson. Stock assessment of Sebastes marinus from Iceland grounds (ICES Division Va) in 2005.

WD23 Kristján Kristinsson and Thorsteinn Sigurdsson. Stock assessment of demersal Sebastes mentella from Iceland grounds (ICES Division Va) in 2005.

WD 24 Kristjan Kristinsson And Thorsteinn Sigurdsson. Information on the Icelandic Pelagic Fishery of Demrsal Sebastes Mentella on the Continental Shelf and Slope of Iceland.

WD25 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

WD26 Kristjan Kristinsson, Thorsteinn Sigurdsson, Cristoph 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.

WD27 JRC's REDFISH CAMPAIGNs. A summary prepared for the ICES study group on redfish stocks

WD28 Hjálmar Vilhjálmsson. On changes of larval drift, distribution of juvenile and adult capelin in the Iceland-Greenland-Jan Mayen area since 2001

WD29 Inge Fossen. Norwegian Commercial Fisheries on demersal species in ICES VIb and XII during 2004 and 2005.

WD30 Gudmundur Thordarson, Höskuldur Björnsson, Einar Hjörleifsson and Björn Ævarr Steinarsson.Are Fmax and F0.1 really illusive as fisheries reference points?

WD31 Höskuldur Björnsson. Tittlingaskítur

WD32 Höskuldur Björnsson. Prediction of weights at age for Icelandic cod

WD33 Höskuldur Björnsson. Icelandic cod: Catch in numbers calculation

WD34 Höskuldur Björnsson. Icelandic haddock: Catch in numbers calculation