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Demersal stocks in the Faroe Area (Div Vb and Subdivision. IIa4)

Faroe Bank Cod

Landings of Faroe Bank cod amounted to 450 tonnes in 2007, which is the lowest recorded since 1993. Results from the summer and spring surveys indicate that the stock is currently well below its average level and there is no indication of strong year classes from the surveys. Exploitation rate decreased in 2007 but is still above the 1996-2007 average.

Faroe Plateau cod

The fishing mortality in 2007 (average of ages 3-7 years) was estimated at 0.70 for Faroe Plateau cod, which was considerably higher than the precautionary fishing mortality of 0.35 and also higher than the limit fishing mortality of 0.68. The total stock size (age 2+) in the beginning of 2007 was estimated at 21 000 tonnes and the spawning stock biomass at 14 000 tonnes, which was considerably below the limit biomass (which should be avoided) of 21 000 tonnes. The estimates of stock size were the lowest during the 1906-2007 period.

The short term prediction until year 2010 showed a steady-state situation with a stock size of around 20 000 tonnes and a spawning stock biomass of around 12 000 tonnes.

Managers should realize the poor state of the stock. In low-productive periods (as has been the case since 2002) fishing mortality tends to be high because the catchability with longlines is high and slight reductions in the number of fishing days will not be sufficient to reduce fishing mortality. It will therefore be necessary to extend area-closures, preferably for all fishing.

Faroe haddock

The main assessment tool used for Faroe haddock is XSA tuned with 2 research vessel bottom trawl surveys. The results are in line with those from 2007, showing a declining SSB mainly due to poor recruitment. SSB is still above Bpa but is predicted to be less than Bpa in 2009 and close to Blim in 2010. Fishing mortality in 2007 is estimated at 0.28 (Fpa = 0.25) and landings in 2007 were at the long term average since 1903 (12 500 t). In recent years there has been a tendency to overestimate SSB and underestimate F.

Faroe Saithe

The most recent benchmark assessment for Faroe Saithe was completed in 2005. The 2006 and 2007 assessments were rejected because of a retrospective pattern believed to be due to decreased size at age. As size at age has not increased markedly, the retrospective pattern, which underestimates stock size and overestimates fishing mortality, is expected to continue to exist. As in last accepted assessment of Faroe saithe XSA using only the pair trawl CPUE index is used as a base case and the results are compared with those from an XSA using the pair trawlers and survey results, with those from ADAPT calibrated with the same data as the base case XSA and also using surveys, with those from TSA using survey indices and with those from Xcam model (exploratory model setup in excel), and iterative cohort model (also in excel) which do not use tuning fleets

The working group concludes that the XSA assessment is useful to indicate stock trends, but that recent year classes are probably underestimated because of changes in catchability (q) due to slower growth, and fishing mortality is probably overestimated. The Faroe saithe biomass is estimated to be average in 2007. In addition to the SPALY short term forecast, two additional scenarios were explored, assuming lower and higher recruitment at age 3.

For Faroe saithe, the highest recruitment has been observed at or near the lowest SSB. The NWWG in 2007 therefore suggested that Bloss should be used as Bpa, not Blim. The working group recommended that Bpa for saithe be set at Bloss = 60 000t and that Blim be set at an arbitrarily lower value (45-50 000t) until more stock and recruitment data pairs are observed below Bloss. NWWG 2008 re-iterates this recommendation. Fishing mortality reference points need to be further considered.

The Faroese authorities have set up a committee to review the effort management system implemented in 1996, consistent with a NWWG 2007 recommendation. A report from the committee is expected before the end of 2008.

Demersal stocks in Icelandic waters (Div Va)

Icelandic saithe

Icelandic saithe was not assessed by NWWG in 2007. The Assessment method was changed from separable model used in 2006 to ADCAM in the domestic MRI assessment in 2007. The reason for the change in method in 2007 was a shift in the fishing pattern which the separable model did not account for. The problem has persisted and therefore the group adopted the ADCAM which can deal with a more flexible fishing pattern. Low mean weight at age for most ages, a shift in fishing pattern towards younger fish and reduction of survey indices resulted in the last assessments being overestimates of the stock. The SSB at the beginning of 2008 is estimated to be 156, 000 and fishing mortality in 2007 to be 0.33. Year classes 1998-2000 and 2002 is estimated to have been strong but the year classes after 2003 considerably smaller.

Short term prediction for Icelandic saithe indicate that the SSB in 2009 and 2010 will be below 150 000 tons if fished at Bpa, fishing mortality in 2009 will have to be reduced to 0.15 if the stock in 2010 is to be above Bpa. Landings are predicted to decrease in coming years due to the large year classes from 1998-2000 and 2002 disappearing from the fishery. If fished at Fpa the landings in 2003 are predicted to be 50 000 tons but 44 000 tons in 2010.

Icelandic cod

The total reported landings of Icelandic cod in 2007 were 170 kt. The TAC for the current fishing year is set to a historical low of 130 kt with the expectation that this action will result in a significant reduction in fishing mortalities in the current calendar year.

Mean weight at age in landings have been declining in the last 6 years and are in 2007 at historical low in many age groups. Weights at age in the spring survey have also been declining over the same period. Abundance indices by age from the spring and the fall surveys show that the year classes from 2001 onward are on average smaller than the ones from 1997 to 2000.

The estimates of reference fishing mortality from ADCAM in 2006 and the reference stock (B4+) and SSB in 2008 are very similar to that estimated last year. The retrospective pattern of recruitment estimates in recent years, both historical and analytical, indicates a minor but constantly downward revision of year classes 2001 and younger. Since these revisions are on pre-recruits that have not entered the fishery they have minor effect on the estimates of the post-recruit metrics.

The spawning stock has been relatively small in the last 35 years compared with the long term. It reached a historical low in 1993 (120 kt) but has since then increased and is estimated to be about 230 kt at present. Exploitation rate and fishing mortality have been lower after the implementation of the catch rule in 1995 compared with the past. The seven most recent year classes are estimated to be below the long-term average. The low recruitment is addition to historical low weight at age means that the productivity of the stock at present is very low.

Icelandic haddock

Icelandic haddock was assessed using Adapt type model tuned with both the spring and autumn surveys as was done last year. In terms of the assessment slow growth is of concern, specially the prediction of growth of the large cohorts currently in the stock. This results in low mean weight at age means that same age based fishing mortality means higher fishing effort. The group proposes lowering the target F from 0.47 to 0.35. In terms of management the high TAC of haddock compared to cod results in to high effort towards haddock.

Short term predictions show that both stock size and landings will decrease rapidly in coming years when the large year classes disappear, how rapidly depends on fishing mortality and growth. In the beginning of 2008 SSB of Icelandic haddock is estimated to be 165,708 tonnes and assuming a 100,000 tonnes TAC will result in F of 0.425

Icelandic summer spawning herring

The total reported landings of Icelandic summer spawning herring in 2007/08 were 159 thous. tons while the TAC was 150 thous. tons. Around 87% of the catch was taken in the small fjord Grundarfjörður, and adjoining areas, in W Iceland.

The total estimate of the adult stock in the herring acoustic surveys in December 2007 was 850 thous. tons, confirming the historically high estimate in the January 2007 survey.

The analytical assessment has suffered from a retrospective pattern in recent years and has therefore been rejected by the NWWG and ACFM. The pattern from the analytical assessment model NFT-Adapt, is now diminishing in the third year in a row, and the last four years in the assessment harmonize in a retrospective sense.

According to the analytical assessment the biomass of age 3+ is estimated at 734 thousands tons and SSB is 686 thousands tons in the end of year 2007. Around 26% of the spawning stock consists of the 1999 year class, 19% of the 2000 year class and 20% of the 2002 year class. Fishing at F0.1= 0.22 in the fishing season 2008/09 will give at catch of 131 thousands tons, where 25% derives from the 1999 year class. The stock has been managed at F0.22 since the re-opening of the fishery in the 1970s and an approximation of F (Fproxy=total catch / survey biomass) indicates that it has been successful from 1993 to present.

Capelin in the Iceland-East Greenland-Jan Mayen area

The initial TAC in 2007 for capelin in the Iceland-East Greenland-Jan Mayen area was 205kt.

The fishery started in January 2008, but was closed 20th of February as acoustic surveys had not confirmed available biomass for the initial TAC. The fishery was reopened on the 27th of February. The stock has been at low levels the last 3 year and as a very low abundance of 1 year old capelin was measured in November 2007 no initial TAC can be recommended.

The advice is therefore not to open the fishery in the season 2008/09 until acoustic assessment surveys have verified that a catch can be allowed with the usual prerequisite of a remaining spawning stock of 400 000 t after taking account of natural mortality.

Demersal stocks in Greenland waters

Cod stocks in Greenland

The two survey abundance indices both indicate that the Greenland cod stock is presently significantly above the very depressed state that was experienced in the 1990's. The increase in abundance appears to be affecting all stock components found in Greenland. Off East Greenland a small offshore spawning stock has been building up in the most recent years and spawning has been inferred since 2004. Both surveys indicate that all year classes since 2002 are larger than any of the year class since the 1985 year class. The increase is mainly attributed to occurrence of the 2003 year class that is estimated at ca. 25% of the size of the very large 1984 year class. Another important year class is that of 2005 which may be of Greenland origin is estimated by the surveys as about a third of the 2003 YC size.

A multi-annual management plan should be developed to ensure that the quotas are sat at low levels until a substantial increase in biomass and recruitment is evident in the Greenland cod stocks. The management plan may incorporate the knowledge on the stock structure, inter alia. by differentiating management objectives for the inshore and offshore stock components.

Greenland halibut

Input data to the Greenland halibut assessment this year is unchanged from recent years, except from the catch series that has been prolonged back to the beginning of this fishery fishery in 1961. As in 2007 a logistic production model in a Bayesian framework was used to assess stock status and for making predictions.

Estimated stock biomass showed an overall decline throughout most of the time series. Since 2004 the stock has been stable at relative low levels well below BMSY and fishing mortality exceeds the value that maximizes yield (FMSY). Stock biomass is estimated at 0.4BMSY, close to Blim and the projected risk of exceeding this reference point will be relatively high at any catch level due to the inherent uncertainty in making projections. Setting TAC at 15kt will result in stock biomass remaining at a low level and the risk of going below Blim is high. On the other hand setting TAC at 10kt, median fishing mortality will decrease towards FMSY. In spite of this there is still relatively high risk of exceeding Blim due to the low stock size.

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.

Redfish in Subareas V, VI, XII and XIV

*Golden redfish (*S. marinus*)*

Total landings of golden redfish (S.marinus) in 2007 were about 40 500 t, about 2 000 t less than in 2006. About 98% of the catches were taken in Division Va.

Catch-at-age data from Va shows that the catch is dominated by two strong year-classes. It is expected that the 1990 year class will be important in the catches in the next few years but the 1985 year class is disappearing. Survey indices of the fishable stock in Va decreased in recent years and was in 2008 13% below the defined Bpa. The fishable stock in Vb remains at low level, but has improved in XIV. Recruitment in Va has been low since 1993, but there are indications of new year-classes observed as aged 8-10 years old in the Icelandic autumn survey in 2006. There are also signs of improved recruitment in XIV.

The basis for advice and the relative state of the stock is based on projection derived from the analytical GADGET model and survey index series. The model uses catches and survey indices from Va and predicts that catches in Va below 30 000 t would result in an increase in the fishable stock for the next 5 year but after that the stock will only sustain catch around 22,000 tonnes as large year classes disappear from the stock.

Demersal S.mentella

Total landings of demersal S.mentella in 2007 were about 17 500 t, about 3 000 t less than in 2006. About 92% of the catches were taken in Division Va. No formal assessment was conducted and there are no biological reference points for the species. Survey indices are used as basis for the advise.

Available survey biomass indices show that in Division Va the biomass has been low but stable in the last 6 years, but has increased in Subarea XIV. In Division Vb, there is no reliable survey information available on fishable biomass. In recent years, good recruitment has been observed on the East Greenland shelf which is assumed to contribute to both the demersal and pelagic stock at unknown shares.

Pelagic S.mentella

Reported catch statistics to the group for 2007 are 64,000t compared to 83,000 tonnes in 2006. In the absence of reference points and an analytical assessment, the state of the pelagic S.mentella stock cannot be fully evaluated. Stock status is based mainly on the perception of stock trends derived from survey indices. The acoustic estimates from the survey in 2007 indicate that the stock size is low compared to the early 1990s. The stock size has not shown any clear trends since 1999.

Above-average recruitment can be derived from recent survey observations on the East Greenland shelf, which is assumed to contribute to the pelagic stock. The mean lengths of pelagic S. mentella in the fishery both in the north-eastern and in the south-western area were relatively stable.

1 Introduction

1.1 Terms of Reference (ToR)

1.1.1 Specific ToR

2007/2/ACOM03 The **North-Western Working Group** [NWWG] (Chair: Guðmundur Þórðarson*, Iceland) will meet at ICES Headquarters, 21–29 April 2008 to:

a) compile, update, analyse and document time-series of relevant fisheries, environmental data and regulatory changes (see generic ToRs)

b) Summarise the findings for the following stocks (see ToR (4)):

- i) redfish in Subareas V, VI, XII and XIV,
- ii) Greenland halibut in Subareas V, VI, XII and XIV,
- iii) cod in Subarea XIV, NAFO Subarea 1, and Division Va,
- iv) cod in Division Vb (including effort options)
- v) saithe in Division Va,
- vi) saithe in Division Vb (including effort options)
- vii) haddock in Division Va,
- viii) haddock in Division Vb (including effort options)
- ix) Icelandic summer spawning herring
- x) capelin in Subareas V and XIV and Division IIa west of 5°W (Iceland, East Greenland, Jan Mayen);

NWWG will report by 29 April 2008 for the attention of ACOM.

1.1.2 Generic ToR for fish stock assessment working groups

Applies to AFWG, HAWG, NWWG, NIPAG, WGWDS

(1) Assemble national data on relevant fisheries and environmental data

a. Input and quality check all input data and where possible input into the InterCatch database

b. Produce an overview of the sampling activities on a national basis (if possible derived from the InterCatch database)

c. Recommend specific actions to be taken to improve the basis for the advice in future (including improvements in data collection).

d. When appropriate, conduct a Data Compilation Workshop as part of the expert group meeting where stakeholders are invited to contribute data including data from nontraditional sources. At these workshops stakeholders can also contribute to data preparation and evaluation of data quality. Data that are to be included in the analysis of the Expert Group shall satisfy quality criteria established by ACOM.

(2) Update time-series of relevant fisheries and environmental data:

a. catches (landings, discards, bycatch) - (by fisheries/fleets). Where misreporting is considered significant, provide qualitative and where possible quantitative information and the describe the methods used to obtain the information.

b. fishing effort (by fisheries/fleets)

c. surveys

d. environmental drivers

(3) Update the agreed analytical method to assess the state of the stocks and short term outlooks or update the agreed indicator(s) of stock trends

(4) Update description of major regulatory changes (technical measures, TACs, effort control and management plans) and report on evaluations of their (potential) effects.

(5) Produce a brief report of the work carried out by the working Group. It should be possible to summarize the report as the basis for the advice.

(6) Prepare draft advice on the fish stocks and fisheries under considerations according to the guidelines by the Advisory Committee. Advice should take account of:

a. Mixed fisheries

b. Ecosystem effects of fisheries

c. Regulatory changes

d. Agreed or proposed management plans

e. Species interaction effects where appropriate

1.2 NWWG 2008 work in relation to the ToR

The ToR where not addressed systematically for all the stocks. The following points highlight the WG response to these ToR.

Generic ToR 1: The stocks where analytical assessments are done are for all practical purposes native fisheries. In these cases "The stock coordinator" is in principal also the supervisor of the national collection on commercial catch, participant in the scientific surveys, compiles individual measurement into suitable form for assessment purposes, performs the assessment, presents it to the group and writes up the report. The stock coordinator therefore is also the person responsible for quality control of data. This year two of the stocks assessed by nwwg were tested in InterCatch (see section below).

1.3 InterCatch

Henrik Kjems-Nielsen from the ICES secretariat gave a presentation of the status of InterCatch (IC). The group expressed the view that for nationally managed and assessed stocks where the same organisation collects the data and calculates catch in numbers, as is the case for most of the stocks assessed by NWWG, IC was of little relevance. On the other hand for internationally managed stocks with many data collectors IC might be a valuable tool.

IC was tested on two stocks, Icelandic summer spawning herring and Icelandic haddock. There was no difference between the results obtained from the routines used at the Marine Research Institute, Iceland and IC. It should be noted that no rising was done to any of the fleet/area/period cells.

1.4 Integration of the ICES advice procedure

In a joint session with AFWG, Martin Pastoors the vice chairman of ACOM presented the integrated advice procedure of ICES. The presentation seemed to answer whatever questions the members of AFWG/NWWG had, at least there where no questions to the vice chairman of ACOM following his presentation except from the chairman of the NWWG.

1.5 Integrated fisheries advice

Before the meeting the chairman asked representatives from Iceland, Faroe, Greenland and the redfish experts to present to the group their outlook on integrated advice. There was some confusion in the group about what was meant by "Integrated fisheries advice" and some members took this as being the integration of the ICES advice procedure.

After going through the definitions of integrated advice from the WGRED 2008 report the group concluded that integration of advice i.e. ecological factors, multispecies- mixed fisheries issues etc. into the single-stock advice was the way forward. There was a consensus in the group that a clear definition and framework for integration of advice had to be developed and it would need a commitment from all parties such as ICES, research institutes, stakeholders, and policy makers etc. for it to be successful.

1.6 Stocks for benchmark assessment in 2009

NWWG recommends that the following stocks should be considered for a benchmark assessment in 2009:

Faroe saithe

Icelandic saithe

Icelandic summer spawning herring

Greenland halibut

1.7 NWWG review of Draft Advice Summary Sheets

The group welcomes the change in the ICES advisory procedure to have the EG draft the advice. However better guidelines should be given to the extent of advice drafting by the EG. Should the group for example write the whole advice sheet or add in bullet points for the Advice Drafting Group. The group spent one day drafting the advice and another going through the draft advice sheets in a plenary. In retrospect more time should have be allocated to this so that a second round of plenary would be possible for those stocks that have proven to be problematic, i.e. redfish and Greenland Halibut.

2 Demersal Stocks in the Faroe Area (Division Vb and Subdivision IIa4)

2.1 Overview

2.1.1 Fisheries

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

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

Demersal Fisheries. Although they are conducted by a variety of 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. The following describes the Faroese fleets first followed by the fleets of foreign nations. The 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. A majority of open boats participating in the fisheries are 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 around the areas closed 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 miles territorial fishing limit, targeting lemon sole and plaice.

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

Otter board trawlers >1000 HP. This group, also called the deep-water trawlers, target several deep-water fish species, especially redfish, blue ling, Greenland halibut, grenadier and black scabbard fish. Saithe is also a target species and in recent years they have been allocated individual quotas for cod and haddock on the Faroe Plateau. The distribution of hauls by this fleet in 2000-2005 is shown in Figure 2.1.0.

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

Pair trawlers >1000 HP. This category targets mainly saithe, but their by-catch of cod and haddock is important to their profit margin. In addition, some of these vessels during the summers have special licenses to fish in deep water for greater silver smelt. The areas fished by these vessels are the deeper parts of the Faroe Plateau and the banks to the southwest of the islands (Figure 2.1.0).

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

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

Foreign longliners. These are mainly Norwegian vessels of the same type as the Faroese longliners larger than 110 GRT. They target mainly ling and tusk with by-catches of cod, haddock and blue ling. Norway has a bilateral fishery agreement with the Faroes for a total quota of these species while the number 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 a total quota of these species while the number 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 licenses 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 numbers) 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 licenses and buy-back of old licenses.

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

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

The individual transferable effort quotas apply to 1) the longliners less than 110 GRT, the jiggers, and the single trawlers less than 400 HP, 2) the pair trawlers and 3) the longliners greater than 110 GRT. The single trawlers greater than 400 HP do not have effort limitations, but they are not allowed to fish within the 12 nautical mile limit and the areas closed to them, as well as to the pair trawlers, have increased in area and time. Their catch of cod and haddock is limited by maximum by-catch allocation. The single trawlers less than 400 HP are given special licenses to fish inside 12 nautical miles with a by-catch allocation of 30% cod and 10% haddock. In addition, they are obliged to use sorting devices in their trawls in order to minimize their by-catches. One fishing day by longliners less than 110 GRT is considered equivalent to two fishing days for jiggers in the same gear category. Longliners less than 110 GRT could therefore double their allocation by converting to jigging. Table 2.1.1 shows the number of fishing days used by fleet category for 1985–1995 and 1998–2005 and Table 2.1.2 shows the number of allocated days inside the outer thick line (the "ring") in Figure 2.1.1. Holders of individual transferable effort quotas who fish outside this line can fish for 3 days for each day allocated inside the line. Trawlers are generally not allowed to fish inside the 12 nautical mile limit. Inside the innermost thick line only longliners less than 100 GRT and jiggers less than 110 GRT are allowed to fish. The Faroe Bank shallower than 200 m is closed to trawling.

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

The effort quotas are transferable within gear categories. The allocations of number of fishing days by fleet categories was made such that together with other regulations of the fishery they should result in average fishing mortalities on each of the 3 stocks of 0.45, corresponding to average annual catches of 33% of the exploitable stocks in numbers. Built into the system is also an assumption that the day system is self-regulatory, because the fishery will move between stocks according to the relative availability of each of them and no stock will be overexploited. These target fishing mortalities have been evaluated during the 2005 and 2006 NWWG meetings (2.1.6) The realized fishing mortalities have been substantially higher than the target for cod, appear to have exceeded the target for saithe in recent years, while for haddock, fishing mortality remains below the target.

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 expected 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 %

The technical measures as mentioned above are still in effect.

2.1.3 The marine environment

The waters around the Faroe Islands are in the upper 500 m dominated by the North Atlantic current, which to the north of the islands meets the East Icelandic current. Clockwise current systems create retention areas on the Faroe Plateau (Faroe shelf) and on the Faroe Bank. In deeper waters to the north and east and in the Faroe Bank channel is deep Norwegian Sea water, and to the south and west is Atlantic water. From the late 1980s the intensity of the North Atlantic current passing the Faroe area decreased, but it has increased again in the most recent years. The productivity of the Faroese waters was very low in the late 1980s and early 1990s. This applies also to the recruitment of many fish stocks, and the growth of the fish was poor as well. From 1992 onwards the conditions have returned to more normal values which also is reflected in the fish landings. There has been observed a very clear relationship, from primary production to the higher trophic levels (including fish and seabirds), in the Faroe shelf ecosystem, and all trophic levels seem to respond quickly to variability in primary production in the ecosystem (Gaard, E. et al. 2001). There is a positive relationship between primary production and the cod and haddock individual fish growth and recruitment 1-2 years later. The indices for primary production have been at or below average since 2002. The primary production in 2008 will not be available until July, but potential positive effect of this on the recruitment will not influence the fishery before 2-3 years. The effects of primary production on catchability are discussed further in section 2.1.4 below.

The index of primary production applies to the shallow waters around Faroe Island (Faroe Shelf, depth < 130 m) whereas little has been known about the primary production or food availability over the deeper areas. This year new information is available on the productivity over the deep areas and is outlined in Working Document 20 (Steingrund and Hátún, 2008). The working document describes an empirical relationship between the strength of the subpolar gyre (SPG) and the biomass of saithe in Faroese waters four years later. An index was developed that described the strength of the gyre. The gyre index was given the opposite sign of the strength/extension of the SPG so that the index was positively related to temperature and phytoplankton/zooplankton abundance in a large area south-west of the Faroe Islands and saithe biomass at the Faroes. There was a strong positive relationship between the gyre index and the total biomass of saithe in Faroese waters four years later over a 40-year period, the causal link hypothesized to be food availability. The relationship between the gyre index and saithe suggested that saithe biomass estimated in the 2008 SPALY XSA assessment was underestimated in the recent years.

The temporal development of the gyre index was different from the phytoplankton index over the shallow areas, these two indices often showing opposite trends, especially during recent years when phytoplankton production has been low whereas the gyre index has been high (Figure 2.1.3.1). This means that the conditions are poor for cod and haddock, which are strongly influenced by the phytoplankton index whereas the conditions for saithe are good. The overall situation for the Faroese fisheries in 2008 seems therefore not as bad as in the beginning of the 1990s when both these indices were low and the three species had low biomasses.

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 (Figure 2.1.3). The primary production seems to be negatively correlated with the catchability of longlines (Figure 2.1.4), suggesting that cod attack longline baits more when natural food abundance is low. Since longliners usually take a large proportion of the cod catch, the total fishing mortality fluctuates in the same way as the long line catchability and thus there is a negative relationship between primary production and fishing mortality (Fig. 2.1.4).

Also for haddock there seems to be similar relationship between primary production, growth, catchability and fishing mortality as for cod. The negative relationship between primary production and fishing mortality as shown in Fig. 2.1.5 suggests, that the same mechanism is valid for haddock as for cod.

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

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

The analysis reported above suggests that natural factors may have a larger influence than technological ones, at least for Faroe Plateau cod and Faroe haddock on changes in catchability. In addition, the available data indicate that there has not been sufficient time since the implementation of the effort management system in 1996 to detect convincing changes in catchability. However, from a management perspective, if the hypothesis that catchability is related to productivity is true, and if productivity is low, there is the potential for very high fishing mortality to be exerted on cod. It could therefore be prudent to consider substantial reductions in fishing effort when periods with low primary production occur.

2.1.5 Summary of the 2008 assessment of Faroe Plateau cod, haddock and saithe

A summary of selected parameters from the 2008 assessment of Faroe Plateau cod, Faroe haddock and Faroe saithe is shown in Figure 2.1.7. Landings of cod, haddock and saithe on the Faroes appear to be closely linked with the total biomass of the stocks. For cod, the peaks and valleys are generally of the same height, suggesting that the exploitation ratio has remained relatively stable over time. For haddock, the difference at the beginning of the series suggest that the exploitation rate was decreasing during that period, while it would have been relatively steady since the mid 1970s. For saithe, there is a suggestion that the exploitation rate was increasing at the beginning of the period, it decreased from the early 1990s to 1998 and has increased since to close to the highest values observed.

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 since 1995. The most recent biomass estimates, however, are most likely to change in future assessments, and the trend could therefore change as a result of future stock assessments.

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

2.1.6 Reference points for Faroese stocks and evaluation of the Faroese management system

The NWWG has evaluated the relevance of existing reference points for Faroese demersal stocks on several occasions in recent years, mostly by investigating the development of fishing mortality and SSB and by doing medium term simulations. Except for the biomass reference points for Faroe Plateau cod, which are considered appropriate, the NWWG suggested changes to all other reference points and did so again in 2007 based on the guidelines provided in the report of the Study Group on Precautionary Reference Points for Advice on Fishery Management, held at ICES HQ from 24-26 February 2003 (SGPRP 2003) and the results of the current assessments. A summary of past work by the NWWG was presented at the end of this reference points section in the 2007 overview. ICES revised the haddock biomass reference points in 2007 but not those for saithe because the assessment was not accepted due to retrospective pattern where biomass was consistently underestimated. The fishing mortality reference points need to be revised for the three Faroese stocks.

2.1.7 Faroe saithe

The NWWG understands that ICES could not revise the biomass reference points for Faroe saithe because the assessment was not accepted. Figure 2. 1.8 and Figure 6.5.1.2 of the 2008 SPALY XSA assessment shows that recruitment is not impaired at 60 000t, the current Blim. Larger year classes appear to have been observed at the lower end of the SSB range. As suggested by SGPRP 2003, NWWG 2005 and NWWG 2006, Bloss for Faroe saithe should be interpreted as Bpa, not as Blim, that is Bpa = 60 000t. Blim could be arbitrarily set prudently lower at 45-50 000t until more stock and recruitment pairs are observed or it could be left undefined. Fishing mortality reference points remain to be identified.

2.1.8 Review of the management system

The Faroese authorities have set up a committee to review the effort management system implemented in 1996, consistent with a NWWG 2007 recommendation. The members of the Fisheries Efficiency Committee participate in a personal capacity and cover expertise in trawl and linefisheries, fisheries biology and stock assessment, the Faroese fishing industry, fisheries technology and capacity, fisheries economy and fisheries law and administration. A report is expected before the end of 2008.

2.1.9 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.Steingrund, P., and Hátún, H. 2008. Relationship between the North Atlantic subpolar gyre and fluctuations of the saithe stock in Faroese waters. NWWG 2008 Working Document 20.

Table 2.1.1. Number of fishing days used by various fleet groups in Vb1 1985-95 and 1998-07. 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
1985	13449	2973	8582
1986	11399	2176	11006
1987	11554	2915	11860
1988	20736	3203	12060
1989	28750	3369	10302
1990	28373	3521	12935
1991	29420	3573	13703
1992	23762	2892	11228
1993	19170	2046	9186
1994	25291	2925	8347
1995	33760	3659	9346
Average(85-95)	22333	3023	10778
1998	23971	2519	6209
1999	21040	2428	7135
2000	24820	2414	7167
2001	29560	2512	6771
2002	30333	2680	6749
2003	27642	2196	6624
2004	22211	2728	7059
2005	21829	3123	6377
2006	14094	2764	5411
2007	10653	3279	5971
Average(98-06)	22615	2664	6547

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

Fishing year	Group 1 Single trawlers > 400 HP	Group 2 Pair trawlers > 400 HP	Group 3 Longliners > 110 GRT	Group 4 Longliners and jiggers 15-110 GRT, single trawlers < 400 HP	Group 5 Longliners and jiggers < 15 GRT
1996/1997		8225	3040	9320	22000
1997/1998		7199	2660	9328	23625
1998/1999		6839	2527	8861	22444
1999/2000	Regulated by area	6839	2527	8861	22444
2000/2001	and by-catch	6839	2527	8861	22444
2001/2002	limitations	6839	2527	8861	22444
2002/2003		6771	2502	8772	22220
2003/2004		6636	2452	8597	21776
2004/2005		6536	2415	8468	21449
2005/2006		5752	3578	5603	21335
2006/2007		5752	3471	5435	20598
2007/2008		5637	3402	5327	20186
No. of licenses	12	29	25	65	593

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

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

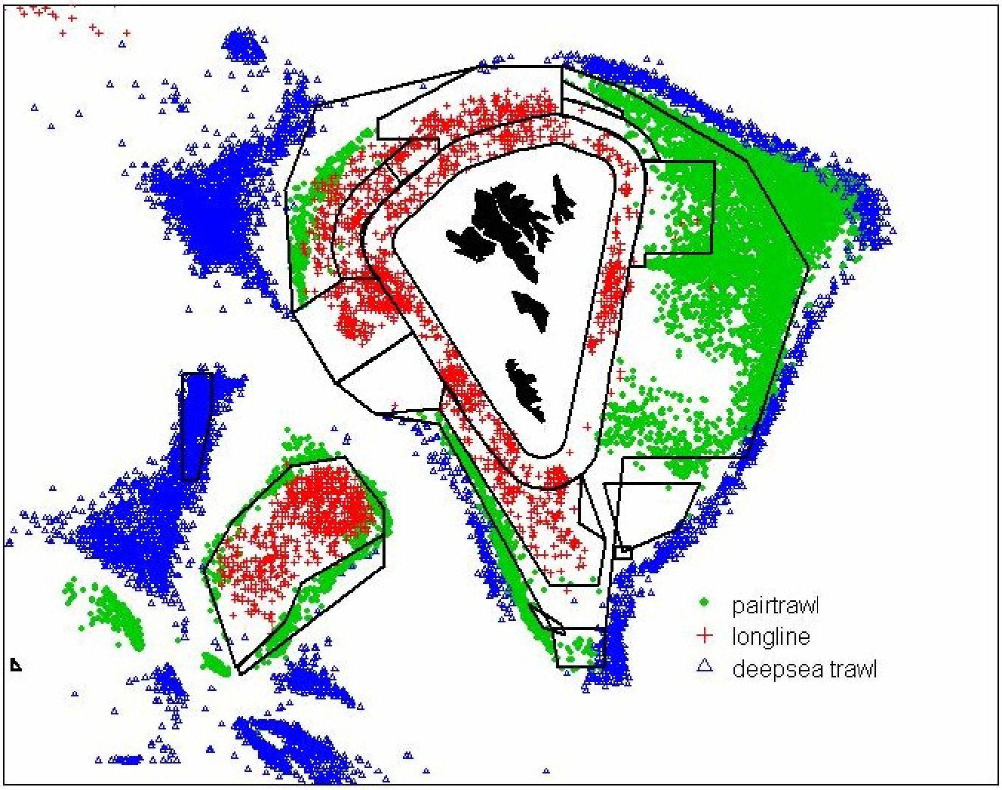
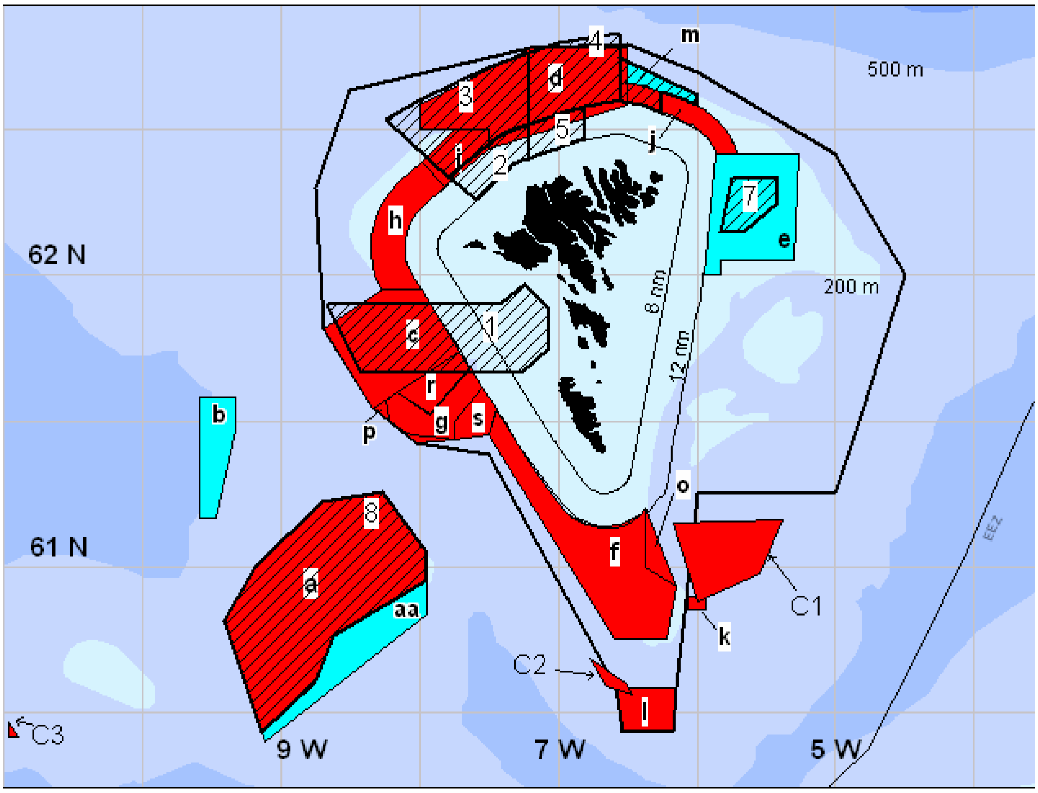


Figure 2.1.1. The 2000-2005 distribution of fishing activities by some major fleets.



Exclusion zones for trawling

Area	Period
a	1 jan - 31 des
aa	1 jun - 31 aug
b	20 jan - 1 mar
c	1 jan - 31 des
d	1 jan - 31 des
e	1 apr - 31 jan
f	1 jan - 31 des
g	1 jan - 31 des
h	1 jan - 31 des
i	1 jan - 31 des
j	1 jan - 31 des
k	1 jan - 31 des
l	1 jan - 31 des
m	1 feb - 1 jun
n	31 jan - 1 apr
o	1 jan - 31 des
p	1 jan - 31 des
r	1 jan - 31 des
s	1 jan - 31 des
C1	1 jan - 31 des
C2	1 jan - 31 des
C3	1 jan - 31 des

Spawning closures

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

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

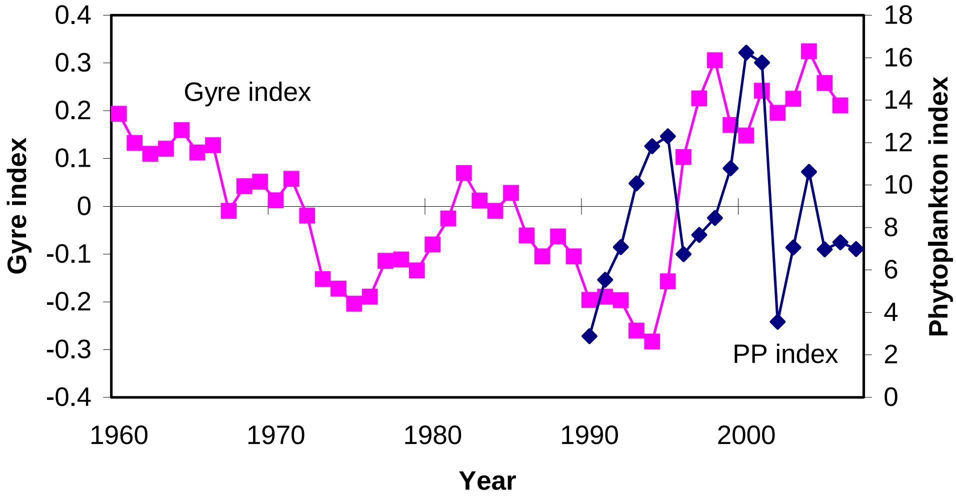


Figure 2.1.3.1. Temporal development of the phytoplankton index over the Faroe Shelf area (< 130 m) and the subpolar gyre index which indicates productivity in deeper waters.

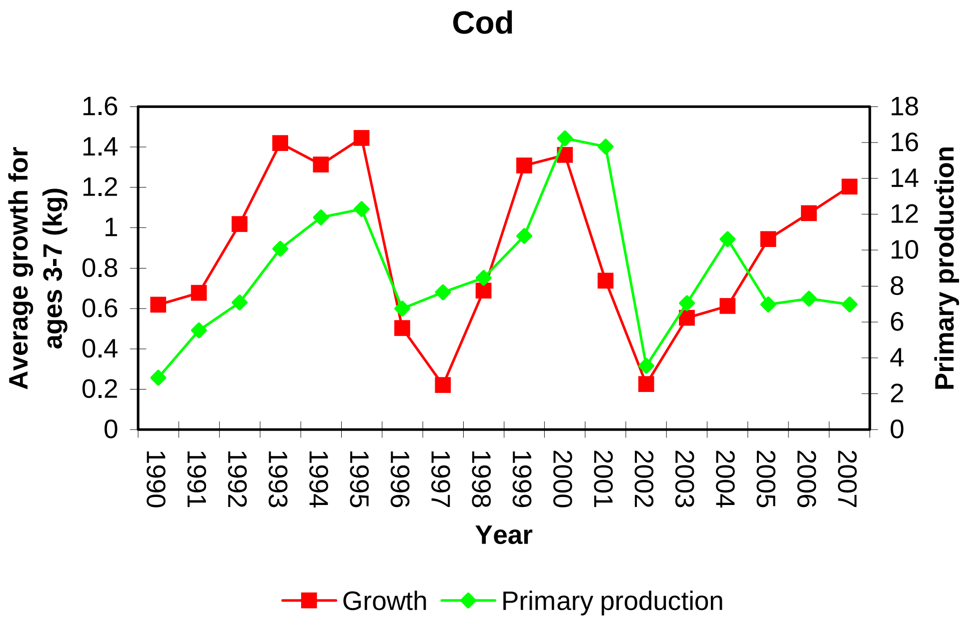


Figure 2.1.3 Faroe Plateau Cod. Relationship between primary production and growth of cod during the last 12 months.

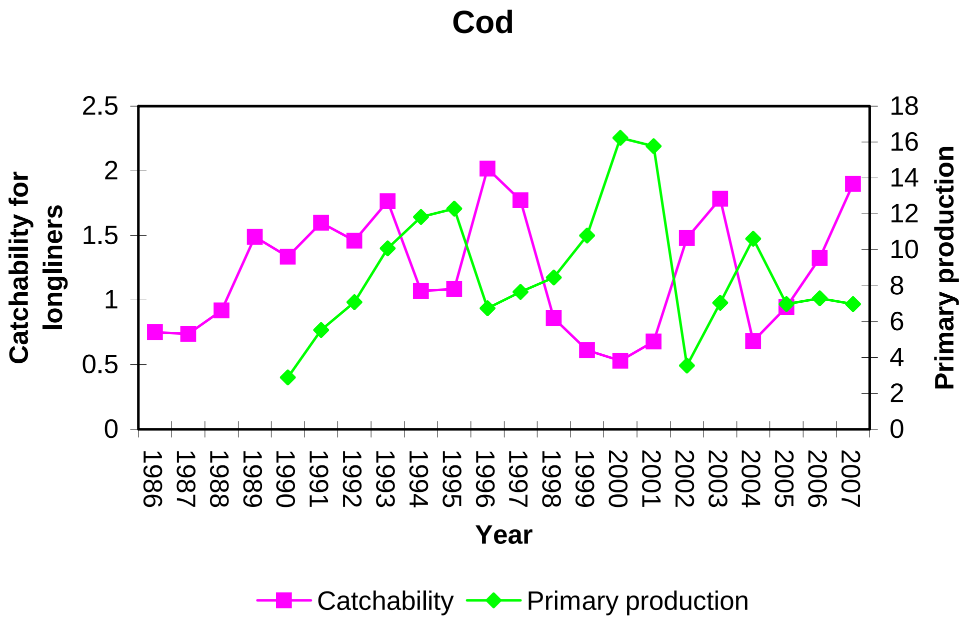


Figure 2.1.4. Faroe Plateau Cod. Relationship between long line catchability and primary production.

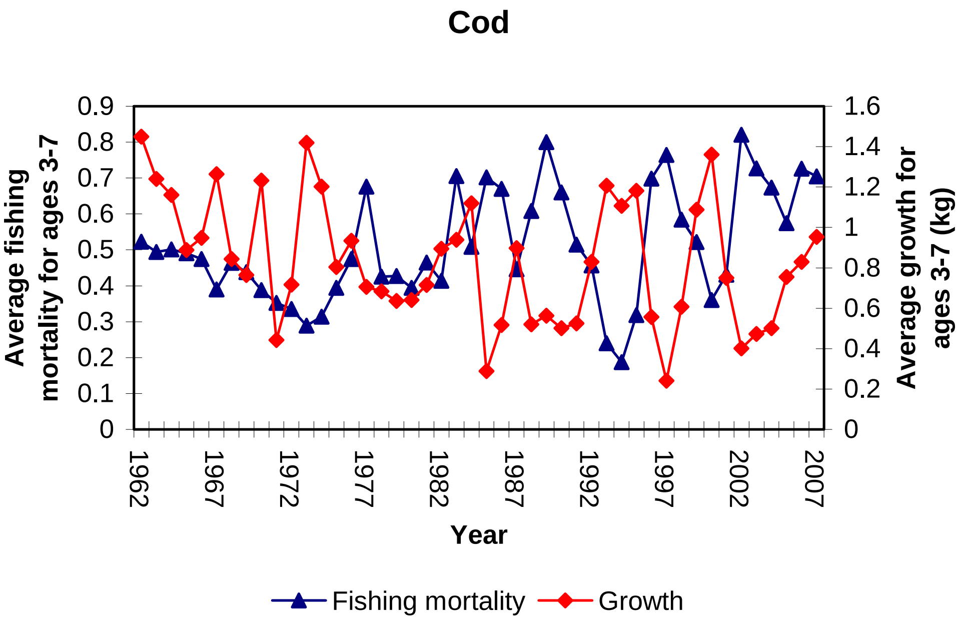


Figure 2.1.5. Faroe Plateau Cod. Relationship between fishing mortality and growth of cod during the last 12 months.

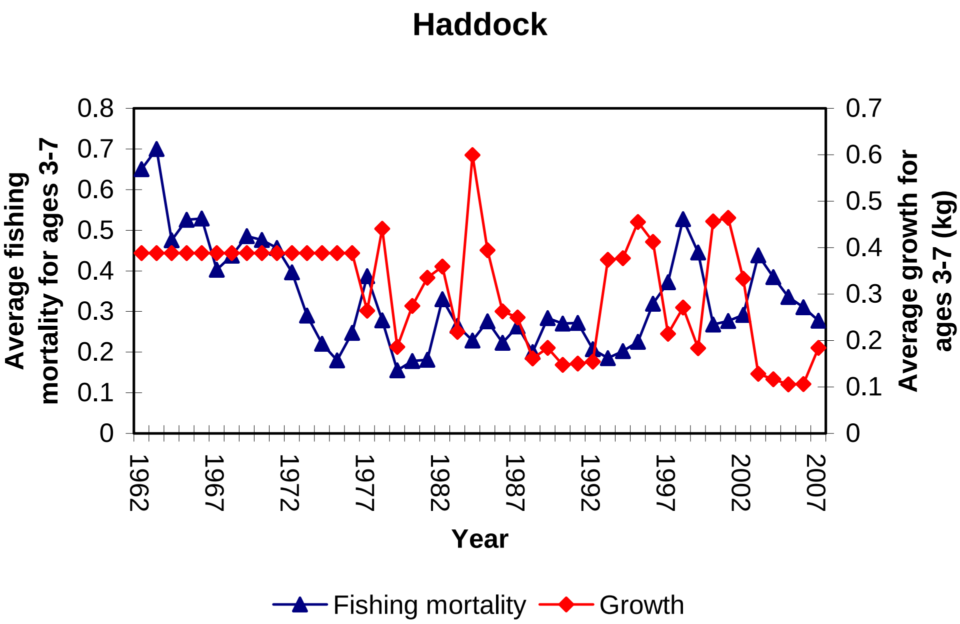


Figure 2.1.6. Faroe Haddock. Relationship between fishing mortality and growth of haddock during the last 12 months.

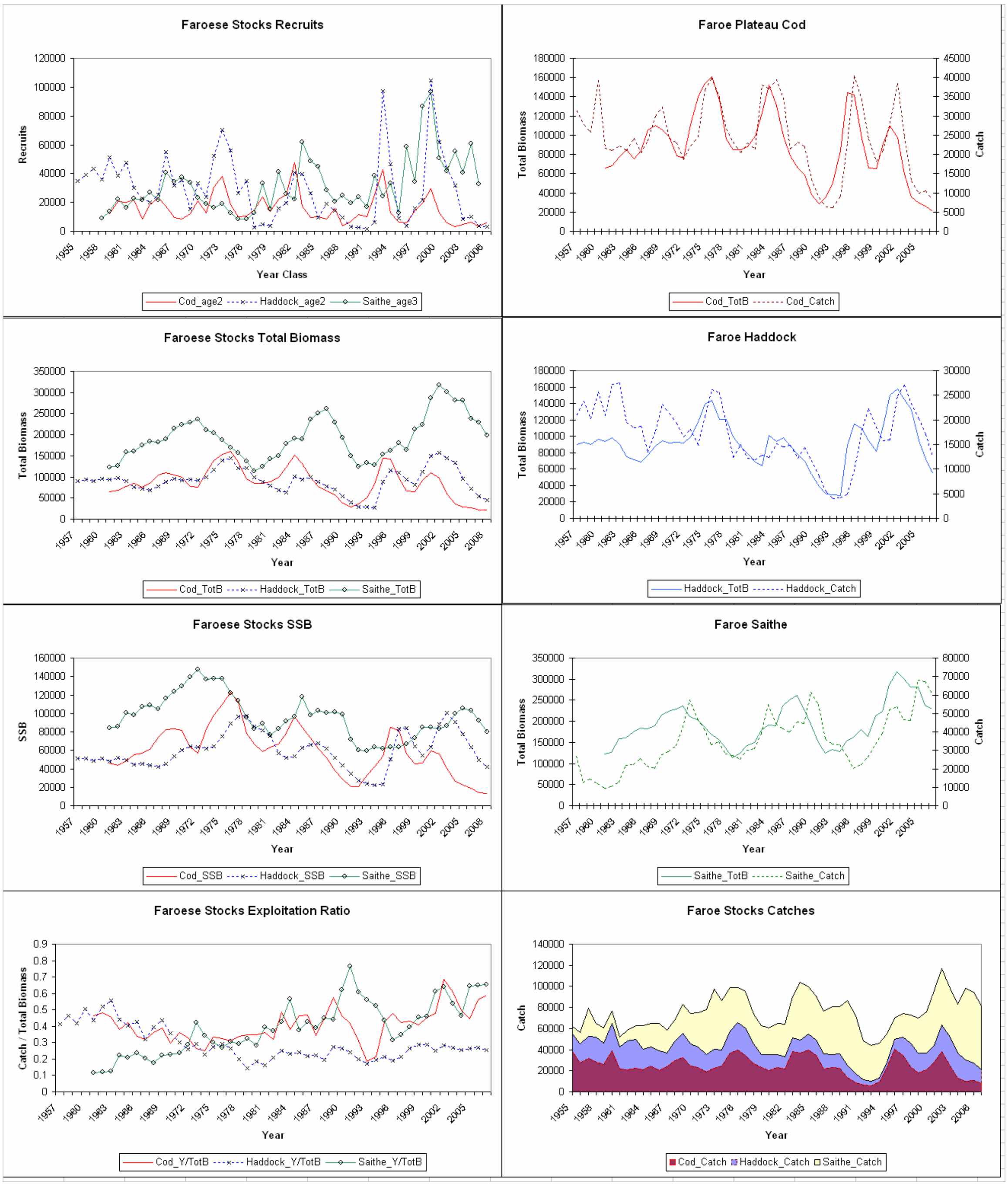


Figure 2.1.7. Faroe Plateau cod, Faroe haddock and Faroe saithe. 2008 stock summary. The Faroe saithe assessment is exploratory, recent estimates uncertain.

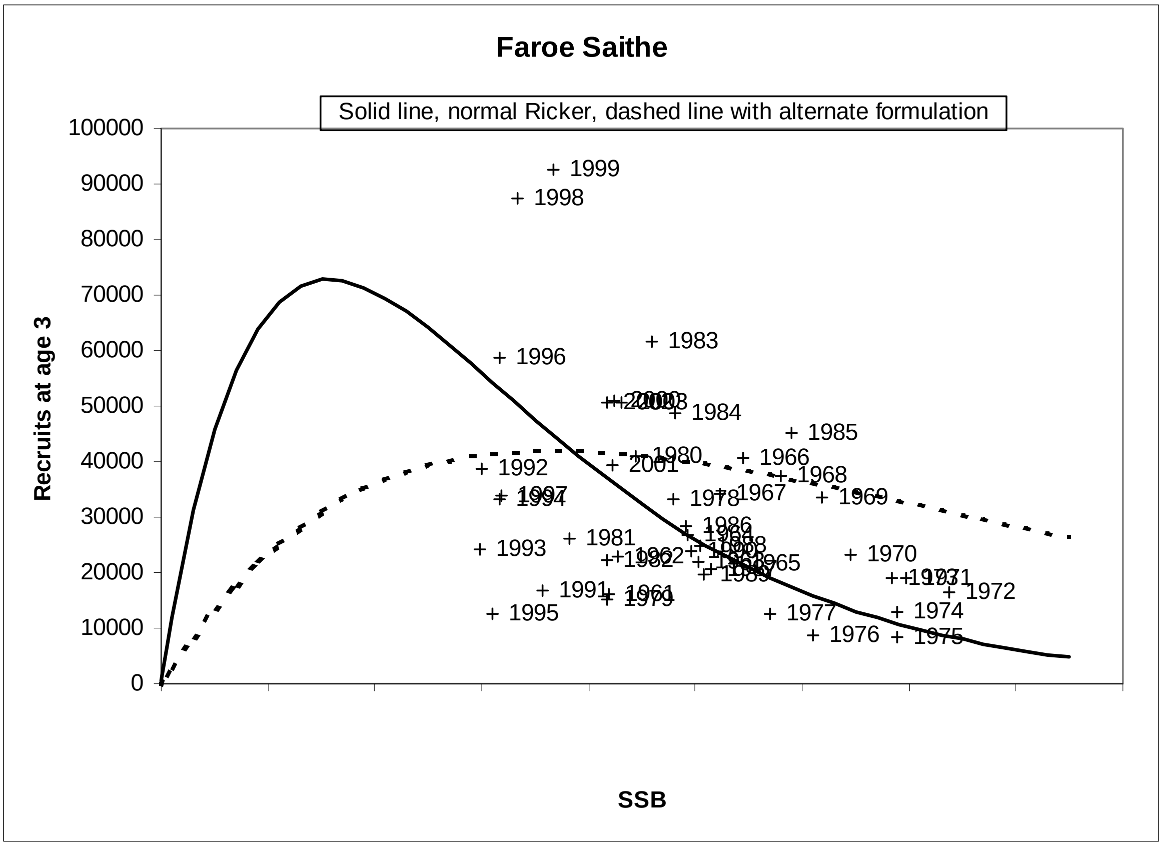


Figure 2.1.8. Ricker stock and recruitment relationships for Faroe saithe. The alternate formulation fixes the SSB where R is maximum, as the average SSB that produced the four strongest year classes.

3 Faroe Bank Cod

Summary

- The total reported landings in 2007 were 450 tonnes the lowest since 1993.
- The summer and spring index suggest the stock is well below average while there is no indication of strong incoming year classes.
- The exploitation ratio decreased in 2007 with respect to 2006 but it remains higher than average.

3.1 Stock description and management units.

The Faroe Bank cod is distributed South-West of the Faroe Bank under ICES management unit Vb2. 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 on the Plateau. Tagging experiments have shown 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 expected that the juveniles are widely distributed on the Bank, finding shelter in areas difficult to access by fishing gear (Jákupsstovu, 1999).

3.2 Scientific data

3.2.1 Biological

Biological samples have been taken from the groundfish survey since 1983.

3.2.2 Surveys

Two research vessel survey series for cod in Vb2 are available to the Working Group in 2008, the Faroese groundfish survey (FGFS) in the spring (1983-2008) and in the summer season (1996-2007). The FGFS spring survey was interrupted in 2004 and 2005. The gear used in both surveys is a bottom trawl and the design is a depth-stratified survey with a total of 29 randomised stations of which 20 are taken in the 200m depth contour. The towing time by station is one hour. There were only 17 stations sampled in the spring survey of 2008 due to logistic problems.

3.3 Information from the fishing industry

3.3.1 Landings

The source of landings data for the Faroe Bank cod are from the Faroe Islands, Norway, UK (E/W/NI) and UK (Scotland). UK 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.

3.3.2 Commercial cpue.

A commercial cpue series from longliners is available but has never been used in the final assessment by the WG.

3.3.3 Biological

Biological samples have been taken from commercial landings since 1974 (the 2007 sampling intensity is shown in table 3.4.3.1.)

3.3.4 Other relevant data

The number of fishing days by the longline fleet is provided by the Faroese Coastal Guard and consist of realised days at sea.

3.4 Methods (Justification for the assessment method adopted. Not a general description of the method.)

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. Since then several tools have been used to assess the status of the stock including a surplus production model and statistical catch at age all providing unrealistic estimates of fishing mortalities and stock size. Therefore the WG has agreed to use the survey catch rates (kg/hr) as indicative to follow stock trends.

3.5 Reference points

There are not analytical basis to suggest reference points based on XSA, general production and statistical catch at age analysis.

3.6 State of the stock - historical and compared to what is now.

Total nominal catches of the Faroe Bank cod from 1987 to 2006 as officially reported to ICES are given in Table 3.7.1 and since 1965 in Figure 3.7.1 UK 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 variable from 1965 to the mid-1980s, reflecting the opportunistic nature of the cod fishery on the Bank, with peak landings slightly exceeding 5 000t in 1973 and 2003. The trend of landings has been smoother since 1987, declining from about 3 500t in 1987 to only 330 t in 1992 before increasing to 3 600t in 1997. In 2007 landings were estimated at 450t less than half the previous year (Figure 3.7.1). 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 3.7.1). Since 2006 the effort has been reduced substantially to about the same levels as in early 1990s.

[ToR 11] The Faroese groundfish surveys (spring and summer) cover the Faroe Bank and cod is mainly taken within the 200 m depth contour. The catches of cod per trawl hour in depths shallower than 200 meter are shown in Figure 3.7.2.

The spring survey was initiated in 1983 and discontinued in 2004 and 2005. The summer survey has been carried out since 1996. The CPUE of the spring survey was low during 1988 to 1995 varying between 73 and 95 kg per tow. Although noisy, the survey suggests higher, possibly increasing biomass during 1995 - 2003. The 2008 index is 98 kg per tow, which is slightly higher than in 2007 but well below the average in the period 1996-2004. The2007 summer index (33 kg per tow) is almost the same as in 2006. The agreement between the summer and spring index is good during 1996 to 2001 and since 2006, but they diverged in 2002 and 2003.

The figure of length distributions (figure 3.7.3 and figure 3.7.4) 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 from 2006 to2008 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 3.7.5 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 2007.

Figure 3.7.6 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 3.7.1). The exploitation ratio decreased in 2007 with respect to 2006 but it remains higher than average.

3.7 Short term forecast

None

3.8 (Medium term forecasts)

None

3.9 Uncertainties in assessment and forecast

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 catches of cod on Faroe Bank are sometimes reported on the landing slips and only the vessels larger than 15 GRT are obliged to have logbooks. The Faroes Coastal Guard is splitting the landings into Vb1 and Vb2 on the basis of landing slips and logbooks. Since small boats do not fill out logbooks and may not sell their 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.

3.10 Comparison with previous assessment and forecast

The status of the stock remains almost unchanged with respect to last year assessment. Although the spring survey in 2008 shows some improvement with respect to 2007 both indexes suggest the stock is well bellow average.

3.11 Management plans and evaluations (Could just be a reference to the year when the plan was agreed/evaluated. Include proposed/agreed management plan.)

None

3.12 Management considerations (what do managers need to consider when managing this stock.)

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

The WG suggests the closure of the fishery until the recovery of the stock is confirmed. The reopening of the fishery should not be considered until both surveys indicate a biomass at or above the average that of the period 1996-2002.

3.13 Ecosystem considerations (Known/new impacts of the fisheries on the ecosystem)

None

3.14 Regulations and their effects (Include new regulations (e.g. gear restrictions, TAC etc). Focus on effects of regulations.)

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.

A total fishing ban during the spawning period (1 March to 1 May) has been enforced since 2005.

3.15 Changes in fishing technology and fishing patterns

None

3.16 Changes in the environment

None

3.17 References

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

Table 3.4.3.1. Samples of lengths, otoliths, and individual weights of Faroe Bank cod in 2007.

Fleet	Size	Samples	Length	Otoliths	Weights
Longliners	>100 GRT	5	797	120	568
Total		5	797	120	568

Table 3.7.1. Faroe Bank (sub-division Vb2) cod. Nominal catches (tonnes) by countries 1986-2007 as officially reported to ICES. From 1992 the catches by Faroe Islands and Norway are used in the assessment.

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Faroe Islands	1836	3409	2966	1270	289	297	122	264	717	561	2051
Norway	6	23	94	128	72	38	32	2	8	40	55
UK (E/W/NI)	-	-	-	-	2 [2]	1 [2]	74 [2]	186 [2]	56 [2]	43 [2]	126 [3]
UK (Scotland)	63 [3]	47 [3]	37 [3]	14 [3]	205 [3]	90 [3]	176 [3]	118 [3]	227 [3]	551 [3]	382 [3]
Total	1905	3479	3091	1412	566	425	330	385	953	1152	2488
Used in assessment					289	297	154	266	725	601	2106

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Faroe Islands	3459	3092	1001		1094	1840	5957	3607	1270	1005	470 *
Norway	135	147	88	49	51	25	72	18	37	10	7 *
UK (E/W/NI)	61 [3]	27 [3]	51 [3]	18 [3]	50 [3]	42 [3]	15 [3]	15 [3]	24 [3]	1 [3]	
UK (Scotland)	277 [3]	265 [3]	210 [3]	245 [3]	288 [3]	218 [3]	254 [3]	244 [3]	1129 [3]	278 [3]	
Total	3871	3504	1350	312	1483	2125	6298	3884	2460	1294	477 *
Correction of Faroese catches in Vb2					-65	-109	-353	-214	-75	-60	-28 *
Used in assessment	3594	3239	1089	1194	1080	1756	5676	3411	1232	955	449 *

* Preliminary
[1] Includes Vb1.
[2] Included in Vb1.
[3] Reported as Vb.

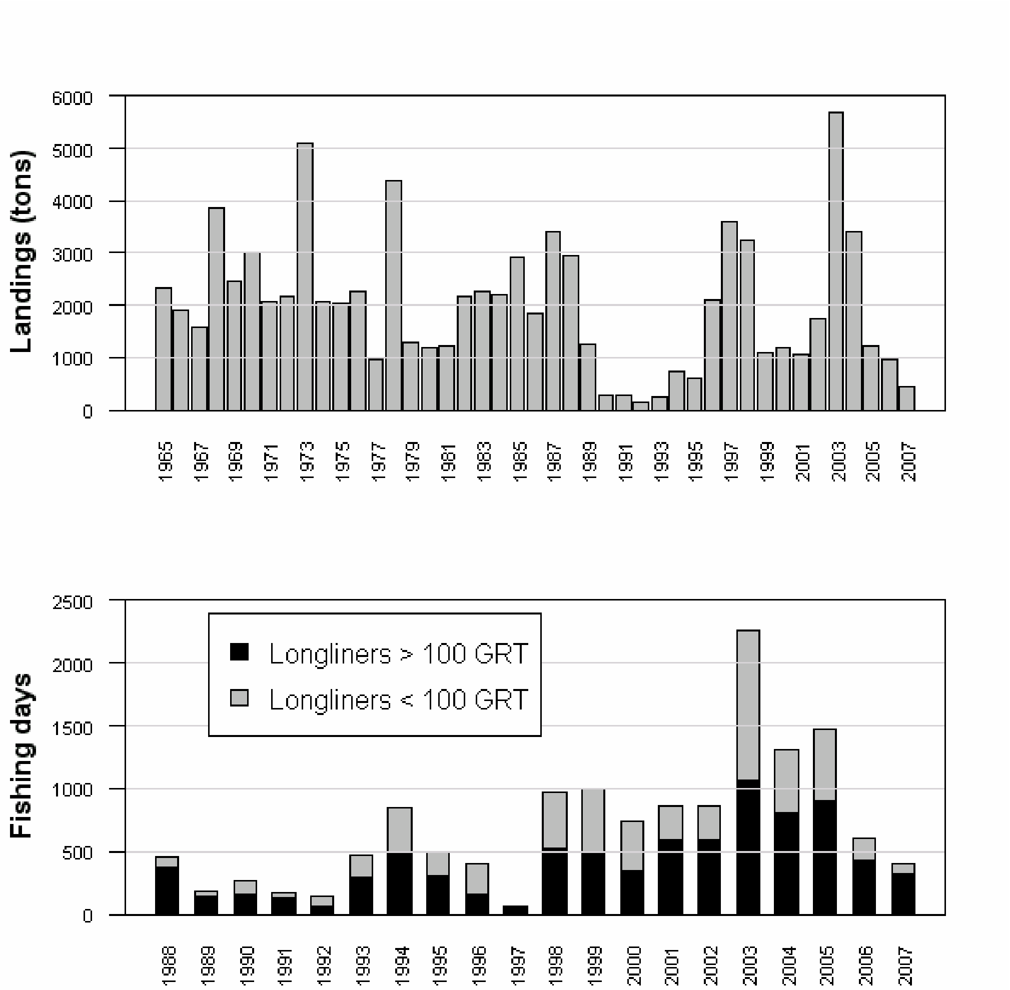


Figure 3.7.1. Faroe Bank (sub-division Vb2) cod. Reported landings 1965-2007. Since 1992 only catches from Faroese and Norwegian vessels are considered to be taken on Faroe Bank. Lower plot: fishing days 1988-2007 for long line gear type in the Faroe Bank (realised).

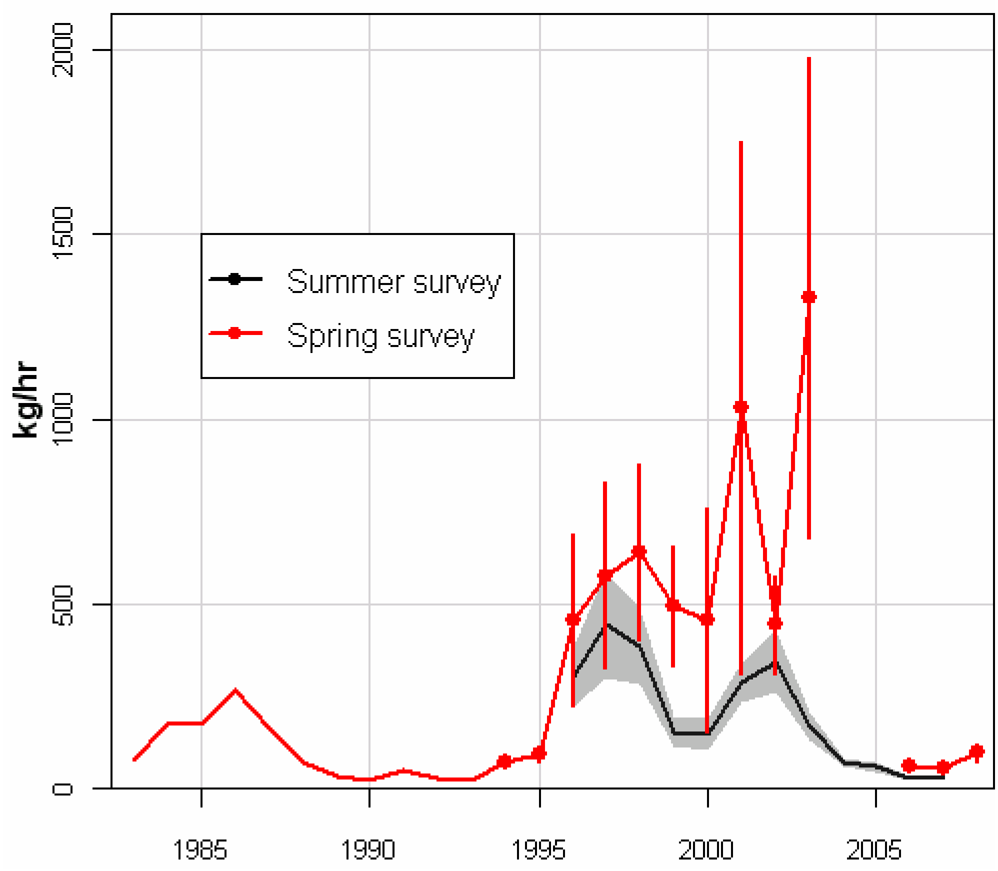


Figure 3.7.2. Faroe Bank (sub-division Vb2) cod. Catch per unit of effort in the spring groundfish survey and summer survey. Vertical bars and shaded areas show the standard error in the estimation of indexes.

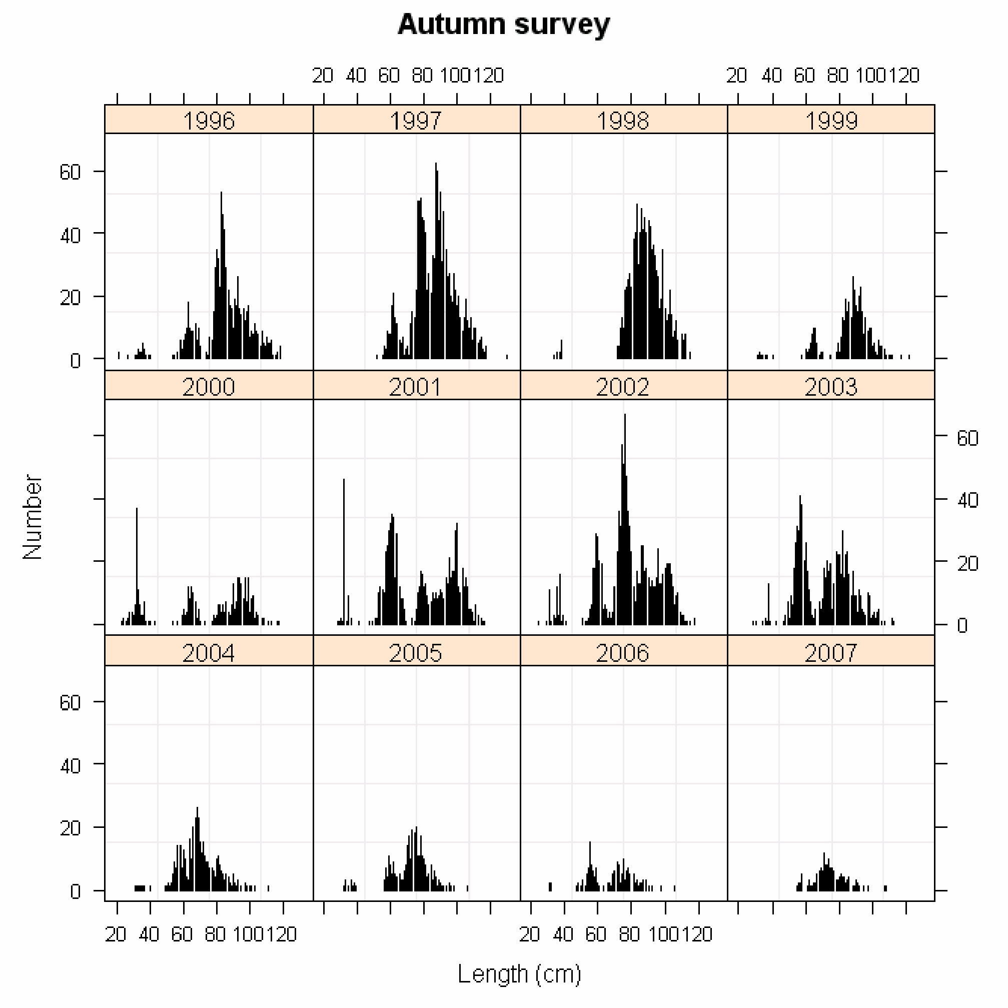


Figure 3.7.3. Faroe Bank (sub-division Vb2) cod. Length distributions in summer survey.

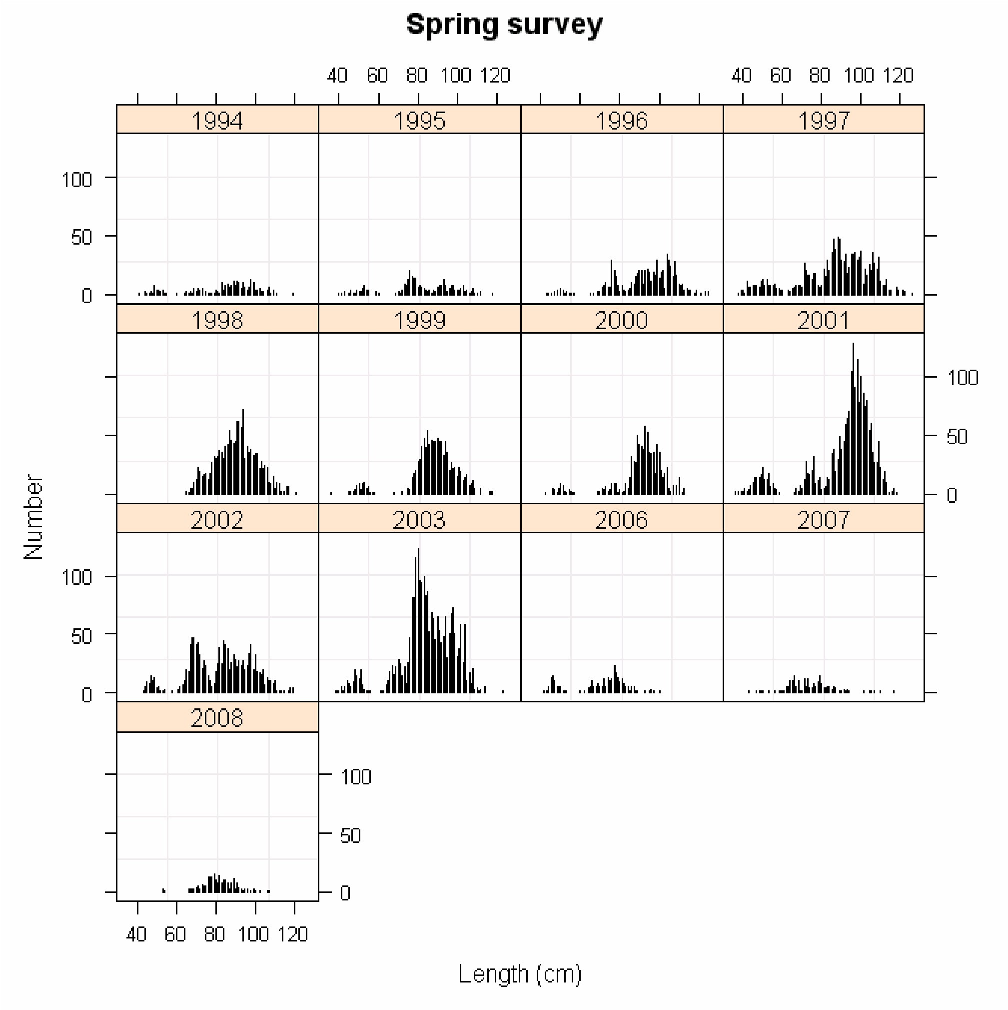


Figure 3.7.4. Faroe Bank (sub-division Vb2) cod. Length distributions in spring survey.

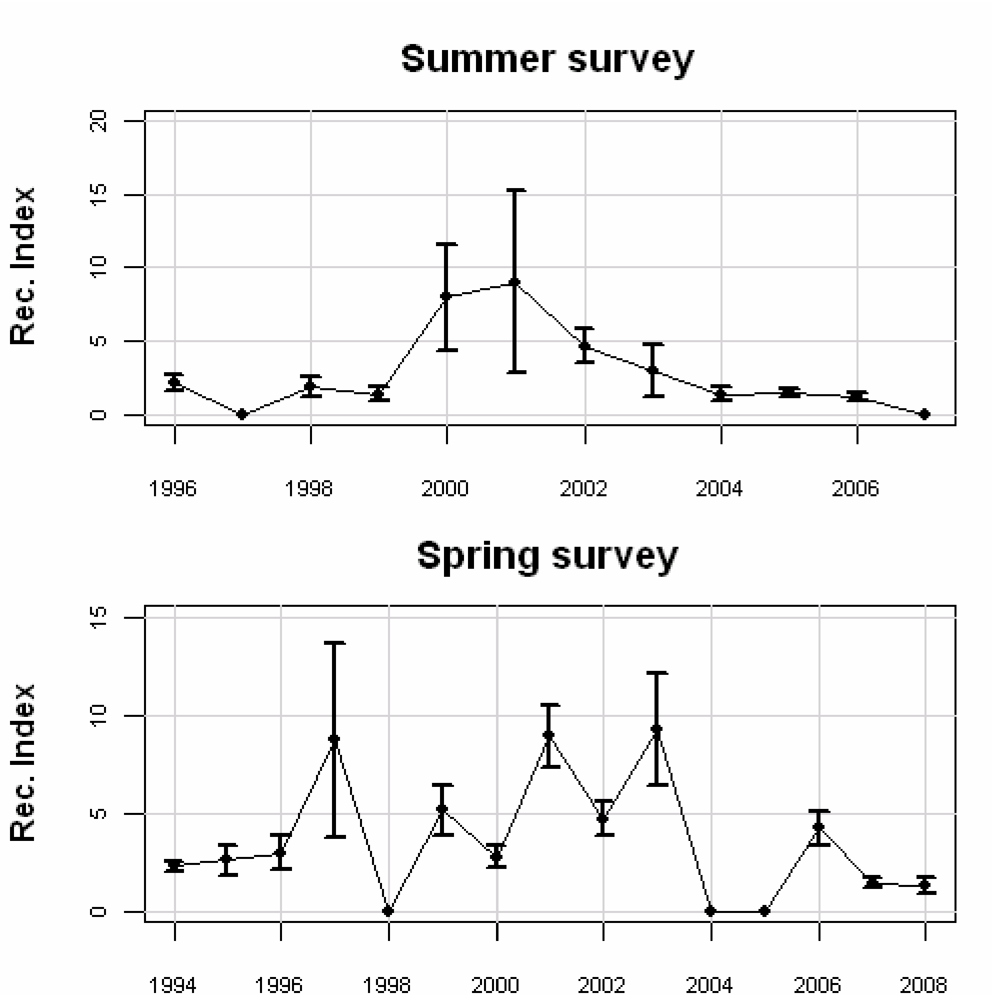


Figure 3.7.5a. Estimated recruitment index in summer (upper panel) and in spring survey (lower panel). In summer surveys the 1 year old recruitment is estimated. In spring surveys the recruitment of 2 year old is estimated. Dashed lines show the standard error in the estimated indices.

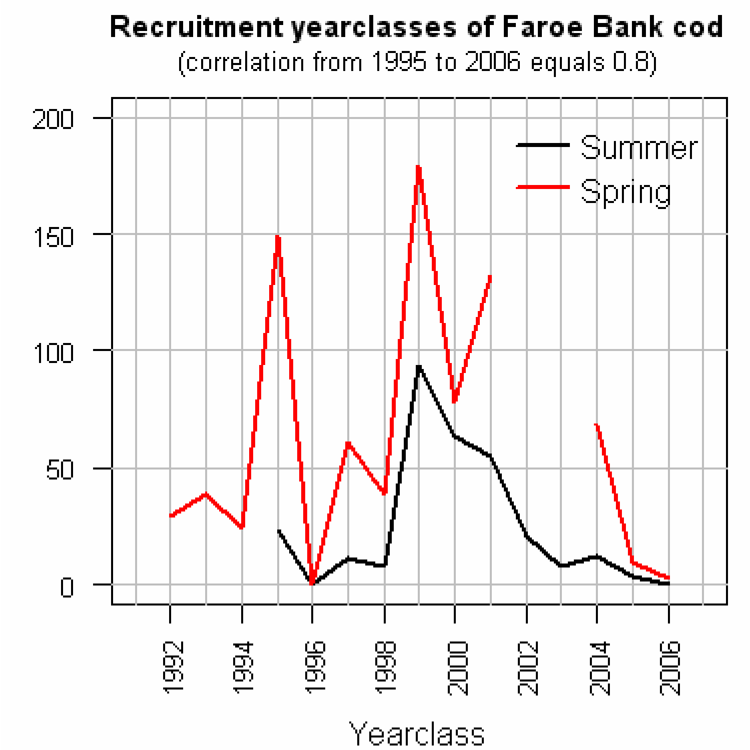


Figure 3.7.5b. Correlation between recruitment year classes.

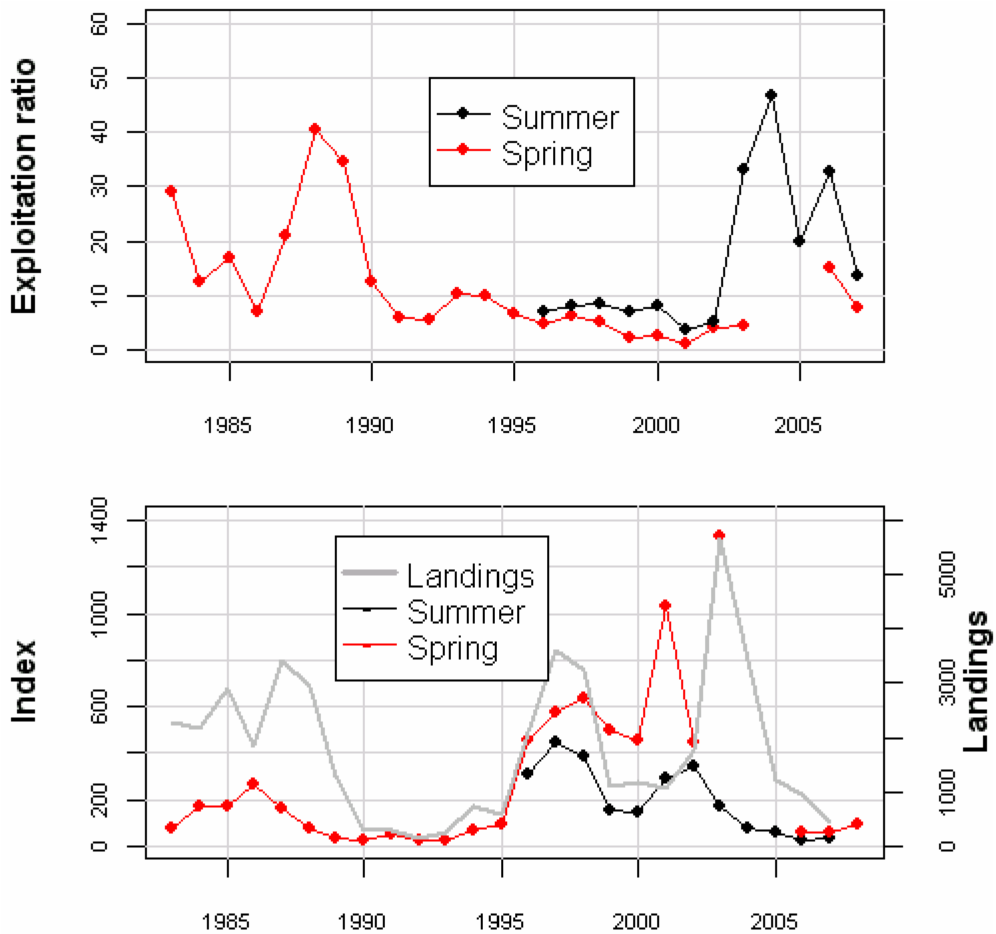


Figure 3.7.6. Faroe Bank (Sub-division Vb2) cod. Exploitation ratio (ratio of landings to survey interpreted as an index of exploitation rate). Lower plot: Landings and cpue (kg/hr) in spring and summer survey.

4 Faroe Plateau cod

Summary

The input data consisted of the catch-at-age matrix (ages 2-10+ years) for the period 1961-2007 and two age-disaggregated abundance indices obtained from the two Faroese groundfish surveys: the spring survey 1994-2008 (shifted back to the previous year) and the summer survey 1996-2007. The maturities were obtained from the spring survey 1983-2008.

The assessment settings were the same as in the 2007 assessment. An XSA was run and tuned with the two survey indicies. The fishing mortality in 2007 (average of ages 3-7 years) was estimated at 0.70, which was considerably higher than the precautionary fishing mortality of 0.35 and also higher than the limit fishing mortality (when 'bad things' may happen) of 0.68. The total stock size (age 2+) in the beginning of 2007 was estimated at 21 000 tonnes and the spawning stock biomass at 14 000 tonnes, which was considerably below the limit biomass (which should be avoided) of 21 000 tonnes. The estimates of stock size were the lowest during the 1906-2007 period.

The short term prediction until year 2010 showed a steady-state situation with a stock size of around 20 000 tonnes and a spawning stock biomass of around 12 000 tonnes.

Managers should realize the poor state of the stock. In low-productive periods (as has been the case since 2002) fishing mortality tends to be high because the catchability with longlines is high and slight reductions in the number of fishing days will not be sufficient to reduce fishing mortality. It will therefore be necessary to extend area-closures, preferably for all fishing. Candidate areas are parts of Mýlingsgrunnur (north of the Faroes), Mykinesgrunnur (west of the Faroes) as well as areas east of Faroe Islands.

4.1 Stock description and management units

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

Icelandic and Faroese tagging experiments suggest that the cod population on the Faroe-Icelandic ridge mainly belongs to the Icelandic cod stock. Faroese Fisheries

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

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

4.2 Scientific data

When calculating the 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 and 2007 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.

The landing figures were obtained from the Fisheries Ministry and Statistics Faroe Islands (Table 4.2.1) and the working group estimates are presented in Table 4.2.2. The catches on the Faroe-Iceland ridge, i.e. for the large single trawlers (Table 4.2.3) and the large longliners were not included in the catch-at-age calculations. In recent years the longliners have taken the majority of the cod catches (Table 4.2.4). The catch-at-age was updated to account for a change in the nominal landings for 2002, 2004 and 2006. Landings-at-age for 2007 are provided for the Faroese fishery in Table 4.2.5. Faroese landings from most of the fleet categories were sampled (see text table below). Catch-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. Catch-at-age from 1961 to 2007 are shown in Table 4.2.6. Catch curves are shown in Fig. 4.2.1. 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 2007.

Fleet	Size	Samples	Lengths	Otoliths	Weights
Open boats		50	1,335	1,034	4,369
Longliners	<100 GRT	21	1,526	360	1,979
Longliners	>100 GRT	40	2,133	660	6,025
Jiggers		2	212	60	60
Sing. trawlers	<400 HP	2	467	0	0
Sing. trawlers	400-1000 HP	8	146	239	1,348
Sing. trawlers	>1000 HP	4	0	60	663
Pair trawlers	<1000 HP	13	852	420	1,688
Pair trawlers	>1000 HP	20	1,936	359	2,127
Total		110	7,272	2,158	13,890

Mean weight-at-age data for 1961-2007 are provided for the Faroese fishery in Table 4.2.7. 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 2007 showed a discrepancy of 0 %.

Figure 4.2.2 shows the mean weight-at-age for 1961 to 2007. For 2008-2010 the values used in the short term predictions are shown on this graph in order to put them in perspective with previous observations. The weights increased from 1998 to 2000, but have decreased since, although they appear to have increased in 2007. The expected weights in the commercial catches in 2008 (catch weights over the entire year: CW) were estimated by the weights in the commercial catches in January-February (January-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 1996-2007 and between the CW and the SW for the years 1996-2007 by each age. The correlation that was higher was chosen for prediction of the value in 2008.

The proportion of mature cod by age during the Faroese groundfish surveys carried out during the spawning period (March) are given in Table 4.2.8 (1961 - 2007) and shown in Figure 4.2.3 (1983 - 2007). The observed values in 2008 and the estimated values in 2009-2010 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.

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 4.2.4).

The stratified mean catch of cod per unit effort in 1994-2008 is given in Figure 4.2.5. The CPUE increased substantially in 1995 and remained high up to 1998. The CPUE decreased from 2002 to 2004 and was low in 2006-2007 and increased slightly in 2008. 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 4.2.4). 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 1996-2008.

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) 1996-2007 is shown in Figure 4.2.5, and catch curves in Figure 4.2.6. The catch curves show that the fish are fully recruited to the survey gear at an age of 4 or 5 years.

The abundance index was calculated as the stratified mean number of cod at age. The age length key was based on otolith samples pooled for all stations. Due to incomplete otolith samples for the youngest age groups, all cod less than 15 cm were considered being 0 years and between 15-34 cm 1 year (15-26 cm for 2005 because of abnormally small 2 year old fish). Since the age length key was the same for all strata, a mean length distribution was calculated by stratum and the overall length distribution was calculated as the mean length distribution for all strata weighted by stratum area. Having this length distribution and the age length key, the number of fish at age per station was calculated, and scaled up to 200 stations. The tuning series are presented in Table 4.2.9.

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 pair trawlers could be influenced by other factors than stock size, for example the price differential between cod and saithe. These two cpue series are presented in Tables 4.2.10 and 4.2.11, as well as Figure 4.2.7, although they were not used as tuning series.

4.3 Information from the fishing industry

The sampling of the catches is included in the 'scientific data'. The fishing industry has during a ten year period gathered data on the size composition of the landings but this information has not been used in this assessment.

4.4 Methods

This an update assessment and the results of the assessment is mostly data-driven implying that there may be limited need to use other assessment methods.

4.5 Reference points

The reference points are dealt with in the general section of Faroese stocks. The reference points for Faroe Plateau cod are the following: Bpa = 40kt, Blim = 21kt, Fpa = 0.35 and Flim = 0.68.

4.6 State of the stock - historical and compared to what is now

Since the current assessment is an update assessment, the same procedure is followed as in the 2007 assessment: to use the two surveys for tuning and not the commercial series. The commercial series showed a similar overall tendency as the surveys (Figure 4.2.7). The XSA-run is presented in Table 4.6.1 and the results are shown in the Table 4.6.2 (fishing mortality at age), Table 4.6.3 (population numbers at age) and Table 4.6.4 (summary table).

The log catchability residuals from the adopted XSA run are shown in Figure 4.6.1. The spring survey shows no overall trends while for the summer survey there was a year effect in 2003-2007. The surveys tended to pull the stock estimates in different directions in different years making the stock estimates somewhat uncertain in relative terms, albeit not in absolute terms. There was also an effect of year class.

The results from the retrospective analysis of the XSA (Figure 4.6.2) show that there has been a tendency to overestimate recruitment whereas the estimates of fishing mortality, stock biomass and spawning stock biomass have differed little.

The estimated fishing mortalities are shown in Tables 4.6.2 and 4.6.4 and Figures 4.6.3 and 4.6.4. The average F for age groups 3 to 7 in 2007 (F3-7) is estimated at 0.70, considerably higher than Fpa = 0.35 and also higher than Flim = 0.68.

The F3-7 (Figure 4.6.5) 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 4.6.5: weighting by stock numbers, stock biomasses or catch weights. All measures of fishing mortality show, however, that the fishing mortality has increased since the introduction of the effort management system in 1996 but that there have been oscillations around this increasing trend. The fishing mortality in 2007 was above Flim.

The stock size in numbers is given in Table 4.6.3. A summary of the XSA, with recruitment, biomass and fishing mortality estimates is given in Table 4.6.4 and in Figure 4.6.3. The stock-recruitment relationship is presented in Figure 4.6.6. The stock trajectory with respect to existing reference points is illustrated in Figure 4.6.7.

Figure 4.6.8 shows the F and SSB's from a 1000 bootstraps of the ADAPT with the two surveys. The figure also shows the point estimate of F and SSB from the XSA assessment. The XSA point estimate of F and SSB falls in the middle of the cloud of bootstrapped pairs of F and SSB’s. From the NFT Adapt results, there is a 100% probability that the Faroe cod 2007 SSB was less than Blim = 21 000t. There is nearly a 100% probability that F 3-7 is higher than the target exploitation rate F = 0.45, a 100% probability that it is higher than the existing Fpa = 0.35, and 70% probability that it is higher than the existing Flim.

The assessment shows the poor recruitment for the 1984 to 1991 year classes, and the strong 1992 and 1993 year classes. Due to the continuous poor recruitment from 1984 to 1991 and the high fishing mortalities, the spawning stock biomass declined steadily from 1983 to 1992 when it was the lowest on record at 20 000 t. It increased sharply to above 80 000 t in 1996 and 1997 before declining to about 45 000 t in 1999.

The spawning stock biomass increased to 59 000 t in 2001 but dropped to about 14 000 t in 2007 which is the lowest value observed during the assessment period from 1961-2007. The 2002 year class is likely the lowest observed and the 2003-2005 year classes are also weak according to the XSA run. The estimate of the 2006 year class relies solely on the spring survey estimate in 2008 (shifted to 2007 in the tuning) and is also low.

In order to put the stock estimates in 2007 into a wider perspective, we have estimated the stock biomass back to 1906. A cpue series (tonnes per million tonn-hours) for British trawlers 1924-1972 was available from the data presented in Jákupsstovu and Reinert (1994). The cpue series was also used, and explained, in Jones (1966). There was an overlap between the cpue series and the stock assessment for the years 1961-1972. It was assumed that the british trawlers caught relatively few 2-year-old fish, and that their cpue reflected the abundance of age 3+. Another cpue series (cwts per day of absence from port) was available for British steam trawlers 1906-1925. The overlap was two years (1924 and 1925) and the 1906-1925 series was scaled to the 1924-1972 series. The results are presented in Figure 4.6.9. There was a decreasing trend in biomass from around 100 thousand tonnes to around 80 tonnes prior to World War II, and since then a decreasing trend from around 100 thousand tonnes to around 50 thousand tonnes. The biomass in 2007 was the lowest during the entire period.

4.7 Short term forecast

The input data for the short term prediction are given in Table 4.7.1. The 2006-2008 year classes were estimated as the average of the 2002-2005 year classes. Estimates of stock size (ages 3+) were taken directly from the XSA stock numbers. The exploitation pattern was estimated as the average fishing mortality for 2005-2007 and rescaled to the level in 2007. The weights at age in the catches in 2008 were estimated from the commercial catches in January-February or the spring survey (ages 2-5 years). Regression analyses were made between weights in January-February (or March), and the weights during the whole year 1996-2007. The weights in the catches in 2008 were predicted from the regressions. The weights in the catches in 2009-2010 were set to the values in 2008. The proportion mature in 2008 was set to the 2008 values from the spring groundfish survey, and for 2009-2010 to the average values for 2006-2008.

Table 4.7.2 shows that the landings in 2008 are expected to be 7 000 tonnes (the landings from the Faroe-Icelandic ridge should be added to this figure in order to get the total Faroese landings within the Vb1 area). The spawning stock biomass is expected to be 13 000 tonnes in 2008, 12 000 tonnes in 2009 and eventually 11 000 tonnes in 2010. The current short term prediction is therefore very pessimistic. The contribution of the various year-classes to the SSB in 2009 and 2010 is shown in Figure 4.7.1. It shows that the incoming year-classes (YC 2004-YC 2007) dominate the SSB.

4.8 Long term forecast

The input to the long term forecast in presented in Table 4.2.16 and the result is presented in Table 4.8.1 and Figure 4.8.1.

4.9 Uncertainties in assessment and forecast

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

The sampling of the catches for length measurements and length-weight relationships is considered to be adequate but the number of otoliths could be higher.

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

The quality of the assessment is believed to be high – in the sense that there seems to be no doubt that the stock size is amongst the lowest observed during a century. There was a good agreement between the survey indicies and when compared to the commercial tuning series.

A model incorporating cannibalism indicated slightly higher recruitment in recent years, but SSB was, nevertheless, predicted to be below Blim in 2010. A high phytoplankton production in 2008 could result in a moderately strong 2007 year class, but the effect on the SSB in 2009 would be little whereas the SSB in 2010 could increase slightly above Blim.

4.10 Comparison with previous assessment and forecast

New or changed things compared to last years report: the assessment settings were the same as last year.

4.11 Management plans and evaluations

The effort management system was introduced in 1996 and aims at a target F of 0.45. The management plan is discussed in the overview section for Faroese stocks.

4.12 Management considerations

The current assessment shows that the spawning stock biomass in 2007 was below Blim of 21 000 tonnes and that it is expected to stay as low as about 12 000 tonnes in 2009-2010. The catch in 2008-2009 is predicted to be around 7 000 tonnes, which is as low as the catch in 1991-1993. The decrease in the stock is due to a combination of poor recruitment since 2002 and high fishing mortality. The low recruitment is believed to be a result of poor primary production since 2002 and the poor state of the stock. High primary production in 2008 and onwards could produce stronger recruitment than have been assumed in the assessment, but the SSB will, nevertheless, most likely be below Blim in 2010.

Biomass estimates of Faroe Plateau cod reconstructed back in time (Figure 4.2.16) show that the biomass fluctuated around 100 000 tonnes during the period 1906-1957, around 80 000 tonnes during 1958-1987 and eventually around 60 000 tonnes since 1988. The catches fluctuated between 20 000 and 40 000 tonnes, except in 1990-1994 and 2004-2007. Similar catches from smaller biomasses imply that the exploitation rates have increased.

There has been a long held view on the Faroe Islands that the cod stock is very resilient to exploitation and that a collapse in the fishery is nearly impossible – people bear in mind the rapid recovery of the cod stock during 1994-1996. The collapse in the fisheries during 1991-1994 has been regarded as an exceptional event. Figure 4.2.16 indicates that, although more resilient than some other cod stocks in the North

Atlantic, Faroe Plateau cod does show a decreasing trend since World War II. This trend is likely caused by a combination of environmental factors and fishing effort, but the contribution from each of these two factors is unknown. While there is no direct information about environmental condition for cod such as the primary production index to evaluate possible environmental changes prior to 1990, there are reasons to believe that the fishing effort has increased during the period.

The catchability hypothesis presented in the overview section for Faroese stocks states that the fishing mortality is high when the primary production is low and *vice versa*. The primary production has been low, or average, since 2002 and the high fishing mortality in 2005-2007 were therefore expected. If the primary production stays average or low in 2008 or 2009 fishing mortality may remain high and the cod stock may be reduced even further than estimated in the prediction as a result of poor recruitment and high fishing mortality. If, on the other hand, the primary production is high in 2008 and 2009 then the cod stock may recover somewhat, but the SSB in 2010 will likely be below Blim.

Although the extremely low cod stock biomass is a serious problem for the Faroese fisheries sector it may not cause as intense a crisis as occurred in the early 1990s because the biomass of saithe is higher than in the early 1990s.

Given the very poor state of the cod stock the WG considers that measures should be taken to reduce fishing mortality significantly in 2008. This is would require a substantial reduction in the number of fishing days in 2008/2009. A small reduction in the number of days is unlikely to have a detectable effect because the price of cod is higher than for the other two groundfish species and because the use of snail-baits in the longline fishery close to land has probably increased fishing efficiency. Area closures may therefore be necessary in order to reduce fishing mortality on the cod stock. Figures 4.12.1 and 4.12.2 show the average abundance of cod in March (1998-2006) and August (1997-2005) and provides a basis for area closures.

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

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

4.13 Ecosystem considerations

The issue is not dealt with in this assessment and there is little information available how the fisheries affect the ecosystem.

4.14 Regulations and their effects

As mentioned earlier, there seems to be a poor relationship between the number of fishing days and the fishing mortality because of large fluctuations in catchability. Area restrictions may be the only alternative that may reduce fishing mortality.

4.15 Changes in fishing technology and fishing patterns

Fishing effort per fishing day may have increased gradually since the effort management system was introduced in 1996, although little direct quantitative information exists. There also seems to have been substantial increases in fishing power when new vessels are replacing old vessels.

The fishing pattern in 2006-2007 has changed in comparison to previous years. The large longliners seem to have exploited the deep areas (> 200 m) to a larger extent (ling and tusk) because the catches in shallower waters of cod and haddock have been so poor – which was also observed in the beginning of the 1990s. This could reduce the fishing mortality on cod and haddock, but the small longliners still exploit the shallow areas.

4.16 Changes in the environment

The primary production has been low for a number of years, but it is not believed that this has any relationship with a change in the environment.

4.17 References

Gaard, E., Hansen B, and Heinesen, S. P. 1998. Phytoplankton variability on the Faroe shelf. ICES Journal of Marine Science, 55: 688-696.

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

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

ICES, 2005. Report of the North-Western Working Group. ICES CM 2005/ACFM:21.

Jákupsstovu, S. H. and Reinert, J. 1994. Fluctuations in the Faroe Plateau cod stock. ICES Marine Science Symposia, 198:194-211.

Jones, B. W. 1966. The cod and the cod fishery at the Faroe. Fishery Investigations, London, 24.

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

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

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

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

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

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

Table 4.2.1. Faroe Plateau (Sub-division Vb1) COD. Nominal catches (tonnes) by countries, 1986-2007, as officially reported to ICES.

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

	1999	2000	2001	2002	2003	2004	2005	2006	2007 *
Denmark	-								
Faroe Islands	19,156		29,762	40,602	30,259	17,540	13,556	11,629	9,996
France	- *	1	9 [2]	20	14	2		7	1 [2]
Germany	39	2	9	6	7	3 [2]		1 [2]	
Iceland	-	-	-	5	-				
Norway	450	374	531 *	573	447	414	201	49	71
Greenland	-	-	-		-				
Portugal						1			
UK (E/W/NI)[2]	51	18	50	42	15	15	24		
UK (Scotland)[1]	-	-	-	-	-	-	-	-	-
United Kingdom									[1]
Total	19,696	395	30,361	41,248	30,742	17,975	13,781	11,686	10,068

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

Table 4.2.2. Nominal catch (tonnes) of COD in sub-division Vb1 (Faroe Plateau) 1986-2007, as used in the assessment.

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

	1999	2000	2001	2002	2003	2004	2005	2006	2007 *
Officially reported	19,696	395	30,361	41,248	30,742	17,975	13,781	11,686	10,068
Faroese catches in Vb1		21,793 *							
Correction of Faroese catches in Vb1 [1]			-1,766	-2,409	-1,795	-1,041	-804	-690	-593
Faroese catch on the Faroe-Iceland ridge	-1,600	-1,400	-700	-600	-4,700	-4,000	-4,200	-800	-1,800
Greenland[2]									6
France[2]									
Catches reported as Vb2:									
UK (E/W/NI)	-	-	-	-	-	-			
UK (Scotland)	210	245	288	218	254	244			
United Kingdom				-	-	-	1,129	279	413
Used in the assessment	18,306	21,033	28,183	38,457	24,501	13,178	9,906	10,475	8,094

*) Preliminary

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

2) Reported to Faroese Coastal Guard.

Table 4.2.3. 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	ST>1000HP Landings	Round weight	Ratio Icelandic ridge	Tonnes Icelandic ridge (rounded)
1991	329	365	0.23	100
1992	196	218	0.51	100
1993	179	199	0.38	100
1994	449	498	0.02	0
1995	862	957	0.05	0
1996	667	740	0.06	0
1997	985	1093	0.15	200
1998	1359	1508	0.13	200
1999	2074	2302	0.7	1600
2000	2515	2792	0.49	1400
2001	1649	1831	0.37	700
2002	2267	2516	0.26	600
2003	4492	4986	0.94	4700
2004	3826	4247	0.94	4000
2005	3933	4365	0.95	4200
2006	1097	1217	0.63	800
2007	1335	1482	0.25	400

Table 4.2.4. Faroe Plateau (sub-division Vb1) COD. The landings of Faroese fleets (in percents) of total catch. Note that the catches on the Faroe-Iceland ridge (mainly belonging to single trawlers > 1000 HP) are included in this table, but excluded in the XSA-run.

Year	Open boats	Longliners <100 GRT	Singletrawl <400 HP	Gill net	Jiggers	Singletrawl 400-1000 HP	Singletrawl >1000 HP	Pairtrawl <1000 HP	Pairtrawl >1000 HP	Longliners >100 GRT	Industrial trawlers	Others	Faroe catch Round.weight
1986	9.5	15.1	5.1	1.3	2.9	6.2	8.5	29.6	14.9	5.1	0.4	1.3	34,492
1987	9.9	14.8	6.2	0.5	2.9	6.7	8.0	26.0	14.5	9.9	0.5	0.1	21,303
1988	2.6	13.8	4.9	2.6	7.5	7.4	6.8	25.3	15.6	12.7	0.6	0.2	22,272
1989	4.4	29.0	5.7	3.2	9.3	5.7	5.5	10.5	8.3	17.7	0.7	0.0	20,535
1990	3.9	35.5	4.8	1.4	8.2	3.7	4.3	7.1	10.5	19.6	0.6	0.2	12,232
1991	4.3	31.6	7.1	2.0	8.0	3.4	4.7	8.3	12.9	17.2	0.6	0.1	8,203
1992	2.6	26.0	6.9	0.0	7.0	2.2	3.6	12.0	20.8	13.4	5.0	0.4	5,938
1993	2.2	16.0	15.4	0.0	9.0	4.1	3.6	14.2	21.7	12.6	0.8	0.4	5,744
1994	3.1	13.4	9.6	0.5	19.2	2.7	5.3	8.3	23.7	13.7	0.5	0.1	8,724
1995	4.2	17.9	6.5	0.3	24.9	4.1	4.7	6.4	12.3	18.5	0.1	0.0	19,079
1996	4.0	19.0	4.0	0.0	20.0	3.0	2.0	8.0	19.0	21.0	0.0	0.0	39,406
1997	3.1	28.4	4.4	0.5	9.8	5.1	2.9	4.8	11.3	29.7	0.0	0.1	33,556
1998	2.4	31.2	6.0	1.3	6.5	6.3	5.5	3.1	8.6	29.1	0.1	0.0	23,308
1999	2.7	24.0	5.4	2.3	5.4	5.2	11.8	6.4	14.5	21.9	0.4	0.1	19,156
2000	2.3	19.3	9.1	0.9	10.5	9.6	12.7	5.7	13.9	15.7	0.1	0.1	21,793
2001	3.7	28.3	7.4	0.2	15.6	6.4	6.4	5.2	9.2	17.8	0.0	0.0	28,838
2002	3.8	32.9	5.8	0.3	9.9	6.7	6.6	2.5	7.2	24.4	0.0	0.0	38,347
2003	4.9	28.7	4.0	1.5	7.4	3.0	14.4	2.2	7.4	26.5	0.0	0.0	29,382
2004	4.4	31.1	2.1	0.5	6.6	1.6	12.9	2.2	11.7	26.8	0.0	0.0	16,772
2005	3.7	27.5	5.1	0.8	5.4	2.4	28.1	1.7	6.4	18.8	0.0	0.0	15,472
2006	6.2	35.0	3.2	0.2	7.1	1.6	12.9	2.5	6.6	24.7	0.0	0.0	8,636
2007	5.1	28.2	2.6	0.3	6.1	1.7	17.5	1.7	4.8	32.0	0.0	0.0	8,866
Average	**4.2**	**24.9**	**6.0**	**0.9**	**9.5**	**4.5**	**8.6**	**8.8**	**12.5**	**19.5**	**0.5**	**0.1**	

Table 4.2.5. Faroe Plateau COD. Catch in numbers at age per fleet in 2006. Numbers are in thousands and the catch is in tonnes, round weight.

Age\Fleet	Open boats	Longliners < 100 GRT	Jiggers	Single trwl 0-399HP	Single trwl 400-1000HP	Single trwl > 1000 HP	Pair trwl 700-999 HP	Pair trwl > 1000 HP	Longliners > 100 GRT	Gillnetters	Others (scaling)	Catch-at-age
2	62	296	61		32	7	0	3	24		61	546
3	110	612	109		89	67	1	25	163		145	1321
4	56	276	63		34	109	2	36	117		86	779
5	16	79	26		11	91	3	23	55		36	340
6	18	97	36		13	45	1	12	55		34	311
7	16	86	18		3	51	2	12	57		30	275
8	3	17	4		2	20	1	6	29		10	92
9	0	8	1		0	4	0	1	5		3	22
10+	0	0	0		0	0	0	0	3		0	3
Sum	281	1471	318		184	394	10	118	508		405	3689
G.weight	404	2251	490		341	1335	37	381	1252		801	7292

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 4.2.6. Faroe Plateau COD. Catch in numbers at age 1961-2007.

year \ age	1	2	3	4	5	6	7	8	9	10
1961	0	3093	2686	1331	1066	232	372	78	29	0
1962	0	4424	2500	1255	855	481	93	94	22	0
1963	0	4110	3958	1280	662	284	204	48	30	0
1964	0	2033	3021	2300	630	350	158	79	41	0
1965	0	852	3230	2564	1416	363	155	48	63	0
1966	0	1337	970	2080	1339	606	197	104	33	0
1967	0	1609	2690	860	1706	847	309	64	27	0
1968	0	1529	3322	2663	945	1226	452	105	11	0
1969	0	878	3106	3300	1538	477	713	203	92	0
1970	0	402	1163	2172	1685	752	244	300	44	0
1971	0	328	757	821	1287	1451	510	114	179	0
1972	0	875	1176	810	596	1021	596	154	25	0
1973	0	723	3124	1590	707	384	312	227	120	97
1974	0	2161	1266	1811	934	563	452	149	141	91
1975	0	2584	5689	2157	2211	813	295	190	118	150
1976	0	1497	4158	3799	1380	1427	617	273	120	186
1977	0	425	3282	6844	3718	788	1160	239	134	9
1978	0	555	1219	2643	3216	1041	268	201	66	56
1979	0	575	1732	1673	1601	1906	493	134	87	38
1980	0	1129	2263	1461	895	807	832	339	42	18
1981	0	646	4137	1981	947	582	487	527	123	55
1982	0	1139	1965	3073	1286	471	314	169	254	122
1983	0	2149	5771	2760	2746	1204	510	157	104	102
1984	0	4396	5234	3487	1461	912	314	82	34	66
1985	0	998	9484	3795	1669	770	872	309	65	80
1986	0	210	3586	8462	2373	907	236	147	47	38
1987	0	257	1362	2611	3083	812	224	68	69	26
1988	0	509	2122	1945	1484	2178	492	168	33	25
1989	0	2237	2151	2187	1121	1026	997	220	61	9
1990	0	243	2849	1481	852	404	294	291	50	26
1991	0	192	451	2152	622	303	142	93	53	24
1992	0	205	455	466	911	293	132	53	30	34
1993	0	120	802	603	222	329	96	33	22	25
1994	0	573	788	1062	532	125	176	39	23	16
1995	0	2615	2716	2008	1012	465	118	175	44	49
1996	0	351	5164	4608	1542	1526	596	147	347	47
1997	0	200	1278	6710	3731	657	639	170	51	120
1998	0	455	745	1558	5140	1529	159	118	28	25
1999	0	1185	993	799	1107	2225	439	59	17	7
2000	0	2091	2637	782	426	674	809	104	7	1
2001	0	3912	3759	2101	367	367	718	437	36	6
2002	0	2079	7283	3372	1671	470	533	413	290	7
2003	0	678	2128	4572	1927	640	177	91	115	20
2004	0	100	691	1263	2105	736	240	65	42	37
2005	0	494	592	877	1122	823	204	41	19	30
2006	0	1181	1167	499	706	852	355	81	11	3
2007	0	546	1321	779	340	311	275	92	22	3

Table 4.2.7. Faroe Plateau COD. Catch weight at age 1961-2007.

	age									
year	1	2	3	4	5	6	7	8	9	10
1961	0	1.080	2.220	3.450	4.690	5.520	7.090	9.910	8.030	0.000
1962	0	1.000	2.270	3.350	4.580	4.930	9.080	6.590	6.660	0.000
1963	0	1.040	1.940	3.510	4.600	5.500	6.780	8.710	11.720	0.000
1964	0	0.970	1.830	3.150	4.330	6.080	7.000	6.250	6.190	0.000
1965	0	0.920	1.450	2.570	3.780	5.690	7.310	7.930	8.090	0.000
1966	0	0.980	1.770	2.750	3.510	4.800	6.320	7.510	10.340	0.000
1967	0	0.960	1.930	3.130	4.040	4.780	6.250	7.000	11.010	0.000
1968	0	0.880	1.720	3.070	4.120	4.650	5.500	7.670	10.950	0.000
1969	0	1.090	1.800	2.850	3.670	4.890	5.050	7.410	8.660	0.000
1970	0	0.960	2.230	2.690	3.940	5.140	6.460	10.310	7.390	0.000
1971	0	0.810	1.800	2.980	3.580	3.940	4.870	6.480	6.370	0.000
1972	0	0.660	1.610	2.580	3.260	4.290	4.950	6.480	6.900	0.000
1973	0	1.110	2.000	3.410	3.890	5.100	5.100	6.120	8.660	7.570
1974	0	1.080	2.220	3.440	4.800	5.180	5.880	6.140	8.630	7.620
1975	0	0.790	1.790	2.980	4.260	5.460	6.250	7.510	7.390	8.170
1976	0	0.940	1.720	2.840	3.700	5.260	6.430	6.390	8.550	13.620
1977	0	0.870	1.790	2.530	3.680	4.650	5.340	6.230	8.380	10.720
1978	0	1.112	1.385	2.140	3.125	4.363	5.927	6.348	8.715	12.229
1979	0	0.897	1.682	2.211	3.052	3.642	4.719	7.272	8.368	13.042
1980	0	0.927	1.432	2.220	3.105	3.539	4.392	6.100	7.603	9.668
1981	0	1.080	1.470	2.180	3.210	3.700	4.240	4.430	6.690	10.000
1982	0	1.230	1.413	2.138	3.107	4.012	5.442	5.563	5.216	6.707
1983	0	1.338	1.950	2.403	3.107	4.110	5.020	5.601	8.013	8.031
1984	0	1.195	1.888	2.980	3.679	4.470	5.488	6.466	6.628	10.981
1985	0	0.905	1.658	2.626	3.400	3.752	4.220	4.739	6.511	10.981
1986	0	1.099	1.459	2.046	2.936	3.786	4.699	5.893	9.700	8.815
1987	0	1.093	1.517	2.160	2.766	3.908	5.461	6.341	8.509	9.811
1988	0	1.061	1.749	2.300	2.914	3.109	3.976	4.896	7.087	8.287
1989	0	1.010	1.597	2.200	2.934	3.468	3.750	4.682	6.140	9.156
1990	0	0.945	1.300	1.959	2.531	3.273	4.652	4.758	6.704	8.689
1991	0	0.779	1.271	1.570	2.524	3.185	4.086	5.656	5.973	8.147
1992	0	0.989	1.364	1.779	2.312	3.477	4.545	6.275	7.619	9.725
1993	0	1.155	1.704	2.421	3.132	3.723	4.971	6.159	7.614	9.587
1994	0	1.194	1.843	2.613	3.654	4.584	4.976	7.146	8.564	8.796
1995	0	1.218	1.986	2.622	3.925	5.180	6.079	6.241	7.782	8.627
1996	0	1.016	1.737	2.745	3.800	4.455	4.978	5.270	5.593	7.482
1997	0	0.901	1.341	1.958	3.012	4.158	4.491	5.312	6.172	7.056
1998	0	1.004	1.417	1.802	2.280	3.478	5.433	5.851	7.970	8.802
1999	0	1.050	1.586	2.350	2.774	3.214	5.496	8.276	9.129	10.652
2000	0	1.416	2.170	3.187	3.795	4.048	4.577	8.182	11.895	13.009
2001	0	1.164	2.076	3.053	3.976	4.394	4.871	5.563	7.277	12.394
2002	0	1.017	1.768	2.805	3.529	4.095	4.475	4.650	6.244	7.457
2003	0	0.820	1.362	2.127	3.329	4.092	4.670	6.000	6.727	6.810
2004	0	1.037	1.154	1.693	2.363	3.830	5.191	6.326	7.656	9.573
2005	0	0.986	1.373	1.760	2.293	3.138	5.287	8.285	8.703	9.517
2006	0	0.839	1.304	1.988	2.386	3.330	4.691	7.635	9.524	11.990
2007	0	0.937	1.324	1.970	3.076	3.529	4.710	6.464	9.461	9.509

Table 4.2.8. Faroe Plateau (sub-division Vb1) COD. Proportion mature at age 1983-2007. From 1961-1982 the average from 1983-1996 is used.

year \ age	1	2	3	4	5	6	7	8	9	10
1961	0	0.17	0.64	0.87	0.95	1.00	1.00	1.00	1	1
1962	0	0.17	0.64	0.87	0.95	1.00	1.00	1.00	1	1
1963	0	0.17	0.64	0.87	0.95	1.00	1.00	1.00	1	1
1964	0	0.17	0.64	0.87	0.95	1.00	1.00	1.00	1	1
1965	0	0.17	0.64	0.87	0.95	1.00	1.00	1.00	1	1
1966	0	0.17	0.64	0.87	0.95	1.00	1.00	1.00	1	1
1967	0	0.17	0.64	0.87	0.95	1.00	1.00	1.00	1	1
1968	0	0.17	0.64	0.87	0.95	1.00	1.00	1.00	1	1
1969	0	0.17	0.64	0.87	0.95	1.00	1.00	1.00	1	1
1970	0	0.17	0.64	0.87	0.95	1.00	1.00	1.00	1	1
1971	0	0.17	0.64	0.87	0.95	1.00	1.00	1.00	1	1
1972	0	0.17	0.64	0.87	0.95	1.00	1.00	1.00	1	1
1973	0	0.17	0.64	0.87	0.95	1.00	1.00	1.00	1	1
1974	0	0.17	0.64	0.87	0.95	1.00	1.00	1.00	1	1
1975	0	0.17	0.64	0.87	0.95	1.00	1.00	1.00	1	1
1976	0	0.17	0.64	0.87	0.95	1.00	1.00	1.00	1	1
1977	0	0.17	0.64	0.87	0.95	1.00	1.00	1.00	1	1
1978	0	0.17	0.64	0.87	0.95	1.00	1.00	1.00	1	1
1979	0	0.17	0.64	0.87	0.95	1.00	1.00	1.00	1	1
1980	0	0.17	0.64	0.87	0.95	1.00	1.00	1.00	1	1
1981	0	0.17	0.64	0.87	0.95	1.00	1.00	1.00	1	1
1982	0	0.17	0.64	0.87	0.95	1.00	1.00	1.00	1	1
1983	0	0.03	0.71	0.93	0.94	1.00	1.00	1.00	1	1
1984	0	0.07	0.96	0.98	0.97	1.00	1.00	1.00	1	1
1985	0	0.00	0.50	0.96	0.96	1.00	1.00	1.00	1	1
1986	0	0.00	0.38	0.93	1.00	1.00	0.96	0.94	1	1
1987	0	0.00	0.67	0.91	1.00	1.00	1.00	1.00	1	1
1988	0	0.06	0.72	0.90	0.97	1.00	1.00	1.00	1	1
1989	0	0.05	0.54	0.98	1.00	1.00	1.00	1.00	1	1
1990	0	0.00	0.68	0.90	0.99	0.96	0.98	1.00	1	1
1991	0	0.00	0.72	0.86	1.00	1.00	1.00	1.00	1	1
1992	0	0.06	0.50	0.82	0.98	1.00	1.00	1.00	1	1
1993	0	0.03	0.73	0.78	0.91	0.99	1.00	1.00	1	1
1994	0	0.05	0.33	0.88	0.96	1.00	0.96	1.00	1	1
1995	0	0.09	0.35	0.33	0.66	0.97	1.00	1.00	1	1
1996	0	0.04	0.43	0.74	0.85	0.94	1.00	1.00	1	1
1997	0	0.00	0.64	0.91	0.97	1.00	1.00	1.00	1	1
1998	0	0.00	0.62	0.90	0.99	0.99	1.00	1.00	1	1
1999	0	0.02	0.43	0.88	0.98	1.00	1.00	1.00	1	1
2000	0	0.02	0.39	0.69	0.92	0.99	1.00	1.00	1	1
2001	0	0.07	0.47	0.86	0.94	1.00	1.00	1.00	1	1
2002	0	0.04	0.37	0.76	0.97	0.93	0.97	1.00	1	1
2003	0	0.00	0.29	0.79	0.88	0.98	1.00	1.00	1	1
2004	0	0.00	0.51	0.78	0.92	0.89	0.87	1.00	1	1
2005	0	0.05	0.66	0.90	0.93	0.98	0.92	1.00	1	1
2006	0	0.04	0.59	0.80	0.99	0.99	1.00	1.00	1	1
2007	0	0.00	0.47	0.78	0.91	0.99	0.97	1.00	1	1

Table 4.2.9. 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 2007
1 1 0.6 0.7
2 8
 200  707.3   6614.6   3763     1322.2   714     236.2   49
 200  513.1   1502.1   6771     1479.9   180.8   139.5   30.4
 200  527      509.1    989.1   3723.7   915.6    50.5   37.2
 200  373.4   1257.4    753.8    676.1  1424.8   239.1   40.5
 200 1364.1   1153.3    673.8    309.6   436.9   600.8   35.4
 200 3422.1   2458.7   1537.8    415.9   234.8   283    242
 200 2326     5562.9   1816.5    810.8   147.7    83.3   69.5
 200  354     1038.8   2209.2    565.9   123.4    17.6   11.9
 200  437      839.9   1080.2   1550.2   344.2    80.2   25.7
 200  616.5    735.1    872.1   1166.3   756     142.5   44.8
 200  978.4    684.2    349.3    312     256.6   123     28.2
 200  234.1    448.7    314.2    179.7   134.5    75.9   30.9
SPRING SURVEY (shifted back to december)
1993 2007
1 1 0.9 1.0
1 8
 100   567.8    335.1     906.5     504.7     128.9    186.1    28.5     0.1
 100   706      785.9    1453.4    1480.1    1179      284     349      48.6
 100   393.6   3975      3606.1    1768.2    1314.2    403.6    79.6   161.3
 100    90.7    935.7    5474      2309.5     328.8    223.9    57.8     5.2
 100    76.2    424.4    1548.5    4857.6    1126.2     81.7    40.5    34.8
 100   530.1    644.9     972.5    1204.4    2047.4    250      25.1    13.3
 100   288.8   1402.2     735.7     436.6     502.1    829.6    63.4     3.1
 100   874.1   2282.9    1953.5     448.8     320.4    572.5   128       3.9
 100   345.9   4193.7    2789.9    1544.1     323.2    225.7   174.1   128.1
 100   79.1     720.2    4343.4    1350.6     548.9     63.3    48.2    36.9
 100   426.8    450.2     786.3    1198.8     297.7     65.8    21.9    11.8
 100   293.4    400.4    1100.5    1409.9     837.9    139.7    14       3.8
 100   129.7    144.5     166.1     340.7     281.1     92.1    15.2     3.9
 100    40.5    255.7     270.6     148.3     164.1    102.9    37.5    14.3
 100   147.2    411.3     764.3     445.6     144.4     80.9    38.5    13.3
```

Table 4.2.10. Faroe Plateau (sub-division Vb1) COD. Pairtrawler abundance index (number of individuals per 1000 fishing hours). This series was not used in the tuning of the XSA.

Year	Stand. effort	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10+
1985	1000	0	332	8712	5134	2308	918	1108	400	142	93
1986	1000	0	211	3288	12317	4777	2043	544	333	98	88
1987	1000	0	77	1313	3584	5438	1944	515	112	90	21
1988	1000	0	73	1707	2067	1942	2962	713	265	47	42
1989	1000	0	137	991	2061	1616	1409	1343	339	97	26
1990	1000	0	31	2130	2282	1409	720	444	444	76	31
1991	1000	0	12	245	1562	956	525	291	199	92	34
1992	1000	0	25	366	694	1993	807	366	151	63	63
1993	1000	20	78	1551	2081	942	1258	472	136	99	78
1994	1000	0	497	1615	2182	2679	763	939	211	141	35
1995	1000	0	1142	3129	5199	3864	1930	434	517	162	83
1996	1000	0	407	13198	12929	4454	2764	667	17	269	43
1997	1000	0	38	1201	10428	8738	1569	795	165	0	104
1998	1000	0	27	1082	2611	5887	3666	554	306	57	0
1999	1000	0	350	2114	2336	2482	4412	1508	93	38	0
2000	1000	0	2717	3467	1896	949	1217	1317	185	0	0
2001	1000	0	3298	7725	3205	642	351	899	407	14	8
2002	1000	0	497	6856	5154	1362	272	203	132	211	9
2003	1000	0	61	1652	5102	2866	679	107	56	73	10
2004	1000	0	0	307	1622	3809	2321	745	149	39	80
2005	1000	0	57	489	797	2470	2113	510	124	45	12
2006	1000	0	124	588	986	1020	1579	707	208	43	7
2007	1000	0	138	1132	1614	1038	566	541	254	64	0

Table 4.2.11. Faroe Plateau (sub-division Vb1) COD. Longliner abundance index (number of individuals per 100000 hooks). This series was not used in the tuning of the XSA. The age composition was obtained from all longliners > 100 GRT. The area was restricted to the area west of Faroe Islands at depths between 100 and 200 m, i.e. different settings than in last year's report.

Year	Stand. effort	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9
1986	100000	0	0	250	875	375	188	63	63	0
1987	100000	0	0	53	263	447	237	105	53	26
1988	100000	0	44	393	393	349	480	131	87	0
1989	100000	0	587	573	545	307	363	349	98	28
1990	100000	0	56	585	304	225	152	129	129	22
1991	100000	0	28	138	799	275	138	83	55	28
1992	100000	0	80	208	208	384	144	64	32	16
1993	100000	7	23	583	570	195	352	91	46	23
1994	100000	39	705	904	452	282	88	160	58	34
1995	100000	0	405	1039	596	410	242	75	158	42
1996	100000	0	49	1528	1492	598	822	360	110	248
1997	100000	0	26	302	2094	1336	300	293	87	38
1998	100000	16	101	159	270	1016	339	48	26	11
1999	100000	4	331	180	136	151	324	96	22	7
2000	100000	75	517	653	125	59	117	189	35	5
2001	100000	11	1030	746	393	62	80	200	157	22
2002	100000	0	544	2085	816	442	164	181	123	137
2003	100000	0	151	697	1653	729	271	76	44	76
2004	100000	0	11	57	210	335	132	43	18	14
2005	100000	0	10	39	102	220	234	83	24	10
2006	100000	5	136	233	112	102	277	165	49	10
2007	100000	5	60	410	295	137	137	144	74	14

Table 4.6.1. Faroe Plateau (sub-division Vb1) COD. The XSA-run.

```
Lowestoft VPA Version 3.1

   17/04/2008   9:13

 Extended Survivors Analysis

 COD FAROE PLATEAU (ICES SUBDIVISION Vb1)                 COD_ind_Surveys10.txt

 CPUE data from file Surveys.TXT

 Catch data for  47 years. 1961 to 2007. Ages  1 to  10.

      Fleet,            First, Last, First, Last, Alpha,  Beta
                    ,    year, year,  age ,  age
 SUMMER SURVEY       ,   1996, 2007,   2,     8,   .600,   .700
 SPRING SURVEY (shift,   1993, 2007,   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   37 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,  1998,  1999,  2000,  2001,  2002,  2003,  2004,  2005,  2006,  2007

      1,  .000,  .000,  .000,  .000,  .000,  .000,  .000,  .000,  .000,  .000
      2,  .089,  .096,  .125,  .158,  .197,  .134,  .035,  .116,  .226,  .197
      3,  .176,  .284,  .319,  .345,  .493,  .319,  .196,  .294,  .438,  .427
      4,  .273,  .290,  .379,  .455,  .599,  .671,  .318,  .409,  .435,  .594
      5,  .646,  .318,  .248,  .307,  .819,  .851,  .771,  .521,  .685,  .603
      6, 1.053,  .654,  .327,  .350,  .827,  .899,  .984,  .809, 1.004,  .755
      7,  .773, 1.062,  .528,  .698, 1.364,  .896, 1.100,  .837, 1.069, 1.143
      8, 1.142,  .752,  .794,  .613, 1.237,  .934, 1.050,  .542, 1.008,  .931
      9,  .820,  .470,  .177,  .718, 1.159, 1.783, 2.051, 1.089,  .269,  .862


1
```

XSA population numbers (Thousands)

YEAR	AGE 1	2	3	4	5	6	7	8	9
1998	1.75E+04	5.93E+03	5.10E+03	7.20E+03	1.19E+04	2.60E+03	3.26E+02	1.92E+02	5.53E+01
1999	2.41E+04	1.44E+04	4.44E+03	3.51E+03	4.49E+03	5.12E+03	7.41E+02	1.23E+02	5.01E+01
2000	3.61E+04	1.97E+04	1.07E+04	2.74E+03	2.15E+03	2.67E+03	2.18E+03	2.10E+02	4.76E+01
2001	1.57E+04	2.96E+04	1.43E+04	6.36E+03	1.53E+03	1.37E+03	1.58E+03	1.05E+03	7.77E+01
2002	7.32E+03	1.28E+04	2.07E+04	8.27E+03	3.30E+03	9.23E+02	7.91E+02	6.43E+02	4.67E+02
2003	3.96E+03	5.99E+03	8.62E+03	1.03E+04	3.72E+03	1.19E+03	3.31E+02	1.66E+02	1.53E+02
2004	6.09E+03	3.24E+03	4.29E+03	5.13E+03	4.33E+03	1.30E+03	3.98E+02	1.11E+02	5.33E+01
2005	7.87E+03	4.99E+03	2.57E+03	2.89E+03	3.06E+03	1.64E+03	3.98E+02	1.08E+02	3.17E+01
2006	4.12E+03	6.44E+03	3.64E+03	1.56E+03	1.57E+03	1.49E+03	5.97E+02	1.41E+02	5.16E+01
2007	7.47E+03	3.37E+03	4.20E+03	1.92E+03	8.29E+02	6.49E+02	4.46E+02	1.68E+02	4.21E+01

Estimated population abundance at 1st Jan 2008

, 0.00E+00, 6.11E+03, 2.27E+03, 2.25E+03, 8.68E+02, 3.71E+02, 2.50E+02, 1.16E+02, 5.42E+01,

Taper weighted geometric mean of the VPA populations:

, 1.59E+04, 1.32E+04, 1.01E+04, 6.31E+03, 3.47E+03, 1.71E+03, 7.71E+02, 3.06E+02, 1.24E+02,

Standard error of the weighted Log(VPA populations) :

, .6533, .6437, .6094, .5982, .5726, .5697, .6153, .7064, .8268,
1

Log catchability residuals.

Fleet : SUMMER SURVEY

Age	1993	1994	1995	1996	1997
1	No data for this fleet at this age				
2	99.99	99.99	99.99	-.50	-.13
3	99.99	99.99	99.99	.11	-.24
4	99.99	99.99	99.99	.19	.30
5	99.99	99.99	99.99	.71	-.02
6	99.99	99.99	99.99	.24	-.12
7	99.99	99.99	99.99	.36	.03
8	99.99	99.99	99.99	-.12	-.23

Age	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
1	No data for this fleet at this age									
2	.02	-1.21	-.21	.33	.80	-.36	.40	.37	.64	-.16
3	-.61	.50	-.44	.04	.58	-.33	.07	.52	.19	-.38
4	-.60	-.14	.06	.09	.08	.10	-.14	.28	-.01	-.21
5	.28	-.66	-.75	-.08	.16	-.30	.50	.40	-.14	-.11
6	.68	.18	-.57	-.50	-.26	-.65	.34	.79	-.07	-.05
7	-.33	.59	.09	-.23	-.33	-1.32	.15	.55	.15	.00
8	.14	.41	-.23	-.04	-.39	-.99	.26	.50	.08	-.05

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	-7.5499	-6.7449	-6.3788	-6.1975	-6.2019	-6.2019	-6.2019
S.E(Log q)	.5542	.4049	.2474	.4411	.4643	.5084	.4013

Regression statistics :

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2,	1.16,	-.555,	7.31,	.55,	12,	.66,	-7.55,
3,	1.01,	-.034,	6.73,	.78,	12,	.43,	-6.74,
4,	.92,	.944,	6.56,	.93,	12,	.23,	-6.38,
5,	.88,	.745,	6.43,	.78,	12,	.39,	-6.20,
6,	.81,	.947,	6.43,	.71,	12,	.38,	-6.20,
7,	.83,	.795,	6.27,	.69,	12,	.43,	-6.23,
8,	1.25,	-1.176,	6.47,	.69,	12,	.49,	-6.26,

1

Fleet : SPRING SURVEY (shift

Age	1993,	1994,	1995,	1996,	1997
1 ,	-.07,	-.38,	.24,	-.54,	-.63
2 ,	-.85,	-.90,	.24,	-.04,	-.14
3 ,	-.56,	.03,	.09,	.05,	-.09
4 ,	-.50,	.03,	.60,	.00,	.25
5 ,	-.56,	.78,	.37,	-.12,	.28
6 ,	-.59,	.82,	.43,	-.15,	-.11
7 ,	-.37,	.42,	.07,	-.22,	-.30
8 ,	-4.75,	.70,	.09,	-1.60,	.80

Age	1998,	1999,	2000,	2001,	2002,	2003,	2004,	2005,	2006,	2007
1 ,	.43,	-.50,	.20,	.11,	-.60,	1.70,	.89,	-.18,	-.70,	.00
2 ,	.41,	.31,	.51,	.74,	-.14,	.09,	.49,	-.88,	-.46,	.63
3 ,	.16,	.12,	.25,	.35,	.56,	-.44,	.48,	-.81,	-.53,	.35
4 ,	-.16,	-.43,	-.07,	.39,	.13,	-.15,	.38,	-.38,	-.57,	.48
5 ,	.20,	-.53,	-.31,	.09,	.34,	-.36,	.44,	-.54,	-.25,	.18
6 ,	.19,	.33,	.30,	.05,	-.37,	-.52,	.23,	-.58,	-.19,	.16
7 ,	-.30,	.08,	-.81,	-.01,	.02,	-.34,	-.77,	-.94,	-.23,	.16
8 ,	-.06,	-1.44,	-1.70,	.00,	-.16,	-.23,	-.85,	-1.28,	.20,	-.12

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,	-8.3418,	-6.9623,	-6.0660,	-5.7879,	-5.7696,	-5.9423,	-5.9423,	-5.9423,
S.E(Log q),	.6509,	.5570,	.4100,	.3702,	.4148,	.4074,	.4537,	1.5525,

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,	1.17,	-.657,	8.16,	.53,	15,	.78,	-8.34,
2,	.99,	.068,	6.99,	.67,	15,	.57,	-6.96,
3,	.83,	1.374,	6.56,	.84,	15,	.33,	-6.07,
4,	.86,	1.249,	6.19,	.85,	15,	.31,	-5.79,
5,	.87,	.937,	6.06,	.80,	15,	.36,	-5.77,
6,	1.00,	-.010,	5.94,	.65,	15,	.42,	-5.94,
7,	.90,	.659,	6.21,	.77,	15,	.35,	-6.18,
8,	.57,	1.667,	6.10,	.54,	15,	.74,	-6.64,

1

Terminal year survivor and F summaries :

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

Year class = 2006

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,	6114.,	.672,	.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,	
6114.,	.67,	.00,	1,	.000,	.000

1

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

Year class = 2005

Fleet,	Estimated,	Int,	Ext,	Var,	N,	Scaled,	Estimated
,	Survivors,	s.e,	s.e,	Ratio,	,	Weights,	F
SUMMER SURVEY ,	1936.,	.577,	.000,	.00,	1,	.352,	.227
SPRING SURVEY (shift,	2431.,	.437,	.655,	1.50,	2,	.613,	.185
F shrinkage mean ,	3234.,	2.00,,,,				.036,	.142

Weighted prediction :

Survivors,	Int,	Ext,	N,	Var,	F
at end of year,	s.e,	s.e,	,	Ratio,	
2267.,	.34,	.31,	4,	.888,	.197

Age 3 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 ,	2081.,	.342,	.470,	1.38,	2,	.442,	.454
SPRING SURVEY (shift,	2371.,	.306,	.252,	.82,	3,	.537,	.408
F shrinkage mean ,	2850.,	2.00,,,,				.021,	.350

Weighted prediction :

Survivors,	Int,	Ext,	N,	Var,	F
at end of year,	s.e,	s.e,	,	Ratio,	
2247.,	.23,	.19,	6,	.814,	.427

1

Age 4 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 ,	814.,	.231,	.156,	.68,	3,	.542,	.624
SPRING SURVEY (shift,	931.,	.245,	.347,	1.42,	4,	.443,	.564
F shrinkage mean ,	1115.,	2.00,,,,				.015,	.490

Weighted prediction :

Survivors,	Int,	Ext,	N,	Var,	F
at end of year,	s.e,	s.e,	,	Ratio,	
868.,	.17,	.17,	8,	.984,	.594

Age 5 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       ,       405.,   .210,       .136,    .65,   4,  .509,     .565
 SPRING SURVEY (shift,       341.,   .218,       .331,   1.51,   5,  .476,     .643

   F shrinkage mean  ,       283.,   2.00,,,,                         .015,     .736

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
       371.,       .15,      .16,   10,   1.085,   .603


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

 Year class = 2001

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SUMMER SURVEY       ,       256.,   .214,       .093,    .44,   5,  .475,     .741
 SPRING SURVEY (shift,       246.,   .217,       .133,    .61,   6,  .505,     .762

   F shrinkage mean  ,       188.,   2.00,,,,                         .020,     .914

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
       250.,       .15,      .08,   12,    .491,   .755

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

 Year class = 2000

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SUMMER SURVEY       ,       118.,   .246,       .102,    .42,   6,  .451,    1.136
 SPRING SURVEY (shift,       114.,   .241,       .117,    .49,   7,  .510,    1.155

   F shrinkage mean  ,       131.,   2.00,,,,                         .040,    1.066

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
       116.,       .18,      .07,   14,    .389,  1.143

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

 Year class = 1999

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SUMMER SURVEY       ,        59.,   .294,       .102,    .35,   7,  .665,     .883
 SPRING SURVEY (shift,        45.,   .286,       .127,    .45,   8,  .286,    1.042

   F shrinkage mean  ,        51.,   2.00,,,,                         .049,     .965

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
        54.,       .23,      .08,   16,    .326,   .931

 Age  9   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       ,        17.,   .286,       .084,    .29,   7,  .606,     .770
 SPRING SURVEY (shift,        10.,   .286,       .211,    .74,   8,  .284,    1.101

   F shrinkage mean  ,        16.,   2.00,,,,                         .110,     .814

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
        15.,       .29,      .11,   16,    .368,   .862
```

Table 4.6.2. Faroe Plateau (sub-division Vb1) COD. Fishing mortality at age.

	2	3	4	5	6	7	8	9	10+	FBAR 3- 7
1961	0.3346	0.5141	0.4986	0.5737	0.4863	0.9566	0.8116	0.6715	0.6715	0.6059
1962	0.2701	0.4982	0.4838	0.7076	0.5569	0.3662	0.6826	0.5641	0.5641	0.5226
1963	0.2534	0.4138	0.5172	0.5124	0.5405	0.4879	0.3269	0.4806	0.4806	0.4944
1964	0.1086	0.2997	0.4523	0.5229	0.5659	0.6677	0.3531	0.5164	0.5164	0.5017
1965	0.1209	0.2518	0.4498	0.5622	0.6604	0.5305	0.4345	0.5318	0.5318	0.4909
1966	0.0829	0.1969	0.2552	0.4499	0.5016	0.968	0.852	0.6106	0.6106	0.4743
1967	0.0789	0.2389	0.2687	0.3442	0.5779	0.5203	1.0438	0.5556	0.5556	0.39
1968	0.101	0.2318	0.3949	0.5339	0.4472	0.7132	0.3331	0.4882	0.4882	0.4642
1969	0.1099	0.3063	0.3806	0.418	0.5709	0.5118	0.8457	0.5499	0.5499	0.4375
1970	0.053	0.2081	0.3654	0.3409	0.3709	0.6559	0.4208	0.4339	0.4339	0.3882
1971	0.0309	0.1337	0.2225	0.3845	0.5572	0.4651	0.7528	0.48	0.48	0.3526
1972	0.0464	0.1476	0.207	0.2497	0.6058	0.4686	0.2464	0.3578	0.3578	0.3358
1973	0.0657	0.2322	0.3048	0.2813	0.2526	0.3722	0.3259	0.3091	0.3091	0.2886
1974	0.0816	0.1568	0.2046	0.2953	0.3797	0.533	0.3052	0.3457	0.3457	0.3139
1975	0.0774	0.3193	0.4359	0.4134	0.4544	0.3504	0.4485	0.4235	0.4235	0.3947
1976	0.0933	0.1723	0.3665	0.5568	0.5167	0.7619	0.6429	0.5738	0.5738	0.4749
1977	0.0481	0.3036	0.4748	0.7532	0.7333	1.1138	0.7776	0.7783	0.7783	0.6757
1978	0.0588	0.1896	0.4291	0.4289	0.4851	0.5968	0.5674	0.5054	0.5054	0.4259
1979	0.0433	0.2623	0.4309	0.5049	0.4906	0.448	0.6903	0.517	0.517	0.4273
1980	0.0544	0.2391	0.3695	0.4337	0.5182	0.4119	0.6437	0.479	0.479	0.3945
1981	0.0523	0.2877	0.3409	0.4369	0.5644	0.694	0.5015	0.5115	0.5115	0.4648
1982	0.0586	0.2227	0.3602	0.3887	0.4047	0.6926	0.5526	0.4834	0.4834	0.4138
1983	0.0992	0.4673	0.5585	0.6411	0.7836	1.078	0.9417	0.8088	0.8088	0.7057
1984	0.1073	0.3712	0.5791	0.661	0.4534	0.4762	0.4792	0.5341	0.5341	0.5082
1985	0.0658	0.3545	0.5077	0.6136	0.9237	1.1085	1.3206	0.9045	0.9045	0.7016
1986	0.0247	0.3547	0.6229	0.7035	0.826	0.8404	0.5411	0.7136	0.7136	0.6695
1987	0.0291	0.2211	0.4759	0.4856	0.5563	0.49	0.6229	0.5304	0.5304	0.4458
1988	0.067	0.3534	0.5648	0.55	0.7751	0.8002	0.8657	0.718	0.718	0.6087
1989	0.169	0.4429	0.7629	0.7644	0.9656	1.0632	1.1073	0.943	0.943	0.7998
1990	0.076	0.3375	0.6323	0.7865	0.7036	0.8421	1.1265	0.8267	0.8267	0.6604
1991	0.0323	0.1971	0.4627	0.6022	0.7326	0.5769	0.7143	0.6232	0.6232	0.5143
1992	0.0201	0.0999	0.3215	0.3627	0.6449	0.8555	0.4398	0.5291	0.5291	0.4569
1993	0.0132	0.1018	0.1863	0.2493	0.2142	0.4502	0.5327	0.3285	0.3285	0.2404
1994	0.0255	0.1127	0.1904	0.2494	0.2166	0.1697	0.3315	0.9135	0.9135	0.1878
1995	0.0701	0.1617	0.4639	0.2799	0.3601	0.3268	0.2544	0.7802	0.7802	0.3185
1996	0.0306	0.1926	0.4521	0.8067	0.9037	1.135	0.8873	1.2096	1.2096	0.698
1997	0.0348	0.1489	0.4112	0.8332	1.0372	1.3908	1.3299	0.9297	0.9297	0.7643
1998	0.0887	0.1759	0.2731	0.646	1.0529	0.773	1.1417	0.8196	0.8196	0.5842
1999	0.0957	0.2839	0.2903	0.3182	0.654	1.0623	0.752	0.4703	0.4703	0.5217
2000	0.1247	0.3187	0.3795	0.2476	0.3266	0.5276	0.7936	0.1773	0.1773	0.36
2001	0.158	0.3446	0.4545	0.3073	0.3504	0.6983	0.6134	0.7177	0.7177	0.431
2002	0.1975	0.4931	0.5994	0.8187	0.827	1.364	1.2372	1.1592	1.1592	0.8204
2003	0.1336	0.3188	0.6708	0.8511	0.8988	0.8958	0.9345	1.7829	1.7829	0.7271
2004	0.0347	0.1958	0.3177	0.771	0.9839	1.1002	1.0501	2.0512	2.0512	0.6737
2005	0.1159	0.2945	0.4085	0.5205	0.8094	0.8371	0.5418	1.0885	1.0885	0.574
2006	0.2265	0.438	0.4346	0.6855	1.0035	1.0694	1.0082	0.2687	0.2687	0.7262
2007	0.1972	0.4266	0.5944	0.6034	0.7546	1.1431	0.9308	0.8615	0.8615	0.7044

Table 4.6.3. Faroe Plateau (sub-division Vb1) COD. Stock number at age.

year	age 1	2	3	4	5	6	7	8	9	10+
1961	25227	12019	7385	3747	2699	666	668	155	66	0
1962	24782	20654	7042	3616	1863	1245	335	210	56	0
1963	26668	20290	12907	3503	1825	752	584	190	87	0
1964	10100	21834	12893	6986	1710	895	358	294	112	0
1965	22676	8269	16037	7823	3639	830	416	151	169	0
1966	28643	18566	5999	10207	4085	1698	351	200	80	0
1967	21475	23451	13990	4034	6475	2133	842	109	70	0
1968	11390	17582	17744	9020	2525	3757	980	410	31	0
1969	10514	9325	13012	11522	4976	1212	1967	393	240	0
1970	14569	8608	6840	7843	6447	2682	561	965	138	0
1971	26041	11928	6684	4548	4456	3754	1516	238	519	0
1972	15356	21320	9469	4788	2981	2483	1760	779	92	0
1973	37229	12573	16664	6689	3187	1901	1109	902	499	400
1974	46803	30480	9639	10816	4037	1969	1209	626	533	342
1975	22687	38319	23000	6747	7217	2460	1103	581	378	476
1976	12208	18575	29035	13683	3572	3908	1279	636	304	466
1977	13128	9995	13853	20010	7765	1676	1909	489	274	18
1978	18318	10748	7799	8372	10190	2993	659	513	184	154
1979	28803	14997	8298	5282	4463	5433	1509	297	238	103
1980	17100	23582	11759	5226	2811	2206	2723	789	122	52
1981	27026	14000	18286	7579	2957	1491	1076	1477	339	150
1982	30726	22127	10878	11228	4413	1564	694	440	732	348
1983	58325	25157	17085	7128	6412	2449	854	284	207	200
1984	21145	47752	18652	8766	3339	2765	916	238	91	174
1985	11605	17312	35119	10535	4022	1411	1439	466	121	146
1986	12098	9502	13271	20171	5191	1783	459	389	102	81
1987	10597	9905	7589	7621	8858	2103	639	162	185	69
1988	19417	8676	7877	4981	3877	4463	987	321	71	53
1989	4485	15897	6643	4529	2318	1831	1683	363	110	16
1990	8152	3672	10991	3493	1729	884	571	476	98	50
1991	13932	6674	2786	6421	1519	645	358	201	126	57
1992	12355	11407	5291	1873	3310	681	254	165	81	91
1993	30763	10115	9154	3920	1112	1886	293	88	87	98
1994	52122	25187	8173	6769	2664	710	1246	153	42	29
1995	15708	42674	20103	5978	4581	1700	468	861	90	99
1996	7885	12861	32572	14001	3078	2835	971	276	547	72
1997	7238	6456	10212	21995	7294	1125	940	255	93	216
1998	17530	5926	5105	7204	11937	2596	326	192	55	49
1999	24081	14353	4440	3505	4489	5122	742	123	50	20
2000	36128	19716	10679	2737	2147	2673	2180	210	48	7
2001	15659	29579	14250	6357	1533	1372	1579	1053	78	13
2002	7320	12820	20678	8266	3304	923	791	643	467	11
2003	3962	5993	8615	10340	3716	1193	331	166	153	26
2004	6092	3244	4294	5128	4328	1299	397	110	53	45
2005	7866	4988	2565	2890	3056	1639	398	108	32	49
2006	4119	6440	3636	1564	1573	1487	597	141	51	14
2007	7468	3372	4204	1921	829	649	446	168	42	6

Table 4.6.4. Faroe Plateau (sub-division Vb1) COD. Summary table (1961-2007) and results from the short term prediction (2008-2010) are shown in bold.

	R (age 2)	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	F 3- 7
1961	12019	65428	46439	21598	0.4651	0.6059
1962	20654	68225	43326	20967	0.4839	0.5226
1963	20290	77602	49054	22215	0.4529	0.4944
1964	21834	84666	55362	21078	0.3807	0.5017
1965	8269	75043	57057	24212	0.4244	0.4909
1966	18566	83919	60629	20418	0.3368	0.4743
1967	23451	105289	73934	23562	0.3187	0.39
1968	17582	110433	82484	29930	0.3629	0.4642
1969	9325	105537	83487	32371	0.3877	0.4375
1970	8608	98398	82035	24183	0.2948	0.3882
1971	11928	78218	63308	23010	0.3635	0.3526
1972	21320	76439	57180	18727	0.3275	0.3358
1973	12573	110713	83547	22228	0.2661	0.2886
1974	30480	139266	98434	24581	0.2497	0.3139
1975	38319	153663	109565	36775	0.3356	0.3947
1976	18575	161260	123077	39799	0.3234	0.4749
1977	9995	136211	112057	34927	0.3117	0.6757
1978	10748	96227	78497	26585	0.3387	0.4259
1979	14997	85112	66722	23112	0.3464	0.4273
1980	23582	85037	58886	20513	0.3484	0.3945
1981	14000	88409	63560	22963	0.3613	0.4648
1982	22127	98960	67031	21489	0.3206	0.4138
1983	25157	123244	78539	38133	0.4855	0.7057
1984	47752	152128	96759	36979	0.3822	0.5082
1985	17312	131199	84764	39484	0.4658	0.7016
1986	9502	99218	73658	34595	0.4697	0.6695
1987	9905	78292	62186	21391	0.344	0.4458
1988	8676	66051	52055	23182	0.4453	0.6087
1989	15897	58618	38285	22068	0.5764	0.7998
1990	3672	37885	28946	13487	0.4659	0.6604
1991	6674	28527	20925	8750	0.4182	0.5143
1992	11407	35533	20567	6396	0.311	0.4569
1993	10115	50873	32857	6107	0.1859	0.2404
1994	25187	83719	42298	9046	0.2139	0.1878
1995	42674	144126	53996	23045	0.4268	0.3185
1996	12861	142290	84991	40422	0.4756	0.698
1997	6456	96897	81616	34304	0.4203	0.7643
1998	5926	66172	55813	24005	0.4301	0.5842
1999	14353	65036	45015	18306	0.4067	0.5217
2000	19716	91135	46176	21033	0.4555	0.36
2001	29579	109822	59040	28183	0.4774	0.431
2002	12820	97751	55918	38457	0.6877	0.8204
2003	5993	59635	40189	24501	0.6097	0.7271
2004	3244	35809	26473	13178	0.4978	0.6737
2005	4988	29418	22279	9906	0.4446	0.574
2006	6440	26495	18655	10475	0.5615	0.7262
2007	3372	20990	13732	8094	0.5894	0.7044
2008	**6114**	**21058**	**13407**	**6965**	**0.5195**	**0.7044**
2009	**4511**	**19956**	**12032**	**6623**	**0.5504**	**0.7044**
2010	**4511**	**18923**	**11400**			
Avg.61-07	15934	87551	60668	23591	0.4053	0.5135

Table 4.7.1. Faroe Plateau (sub-division Vb1) COD. Input to management option table.

	Recr.	Source
YC2005	3372	XSA-output
YC2006	6114	XSA-output
YC2007	4511	Average R in 2004-2007
YC2008	4511	Same as YC2007

Age	Stock size 2008	Source
2	6114	XSA-output
3	2267	XSA-output
4	2247	XSA-output
5	868	XSA-output
6	371	XSA-output
7	250	XSA-output
8	116	XSA-output
9	54	XSA-output
10+	17	XSA-output

	Maturity			Exploitation pattern (rescaled to 2007 level)			Weights		
	Observed	Av. 06-08	Av. 06-08	Av. 05-07	Av. 05-07	Av. 05-07		As 2008	As 2008
Age	2008	2009	2010	2008	2009	2010	2008	2009	2010
2	0.10	0.05	0.05	0.1896	0.1896	0.1896	1.125	1.125	1.125
3	0.78	0.61	0.61	0.4073	0.4073	0.4073	1.515	1.515	1.515
4	0.91	0.83	0.83	0.5051	0.5051	0.5051	1.908	1.908	1.908
5	0.90	0.93	0.93	0.6358	0.6358	0.6358	2.822	2.822	2.822
6	0.95	0.98	0.98	0.9022	0.9022	0.9022	3.986	3.986	3.986
7	1	0.99	0.99	1.0716	1.0716	1.0716	4.962	4.962	4.962
8	1	1	1	0.8717	0.8717	0.8717	5.785	5.785	5.785
9	1	1	1	0.7796	0.7796	0.7796	8.187	8.187	8.187
10+	1	1	1	0.7796	0.7796	0.7796	10.354	10.354	10.354

Table 4.7.2. Faroe Plateau (sub-division Vb1) COD. Management option table.

MFDP version 1
Run: Run3
Index file 22/4-2008
Time and date: 12:29 25/04/2008
Fbar age range: 3-7

2008				
Biomass	**SSB**	**FMult**	**FBar**	**Landings**
21058	13407	1.0000	0.7044	6965

2009					**2010**	
Biomass	**SSB**	**FMult**	**FBar**	**Landings**	**Biomass**	**SSB**
19956	12032	0.0000	0.0000	0	26761	18370
.	12032	0.1000	0.0704	839	25761	17471
.	12032	0.2000	0.1409	1632	24818	16625
.	12032	0.3000	0.2113	2382	23928	15829
.	12032	0.4000	0.2818	3090	23088	15080
.	12032	0.5000	0.3522	3761	22294	14374
.	12032	0.6000	0.4227	4396	21544	13708
.	12032	0.7000	0.4931	4998	20834	13080
.	12032	0.8000	0.5635	5568	20162	12488
.	12032	0.9000	0.6340	6109	19526	11928
.	12032	1.0000	0.7044	6623	18923	11400
.	12032	1.1000	0.7749	7111	18352	10901
.	12032	1.2000	0.8453	7574	17810	10428
.	12032	1.3000	0.9157	8015	17296	9982
.	12032	1.4000	0.9862	8434	16808	9559
.	12032	1.5000	1.0566	8833	16344	9158
.	12032	1.6000	1.1271	9213	15903	8779
.	12032	1.7000	1.1975	9575	15484	8419
.	12032	1.8000	1.2680	9921	15085	8078
.	12032	1.9000	1.3384	10250	14706	7754
.	12032	2.0000	1.4088	10565	14344	7447

Input units are thousands and kg - output in tonnes

Table 4.8.1. Faroe Plateau (sub-division Vb1) COD. Input to yield per recruit calculations (long term prediction).

	Exploitation pattern	Weightatage	PropMature
Age	Average 2000-2007 Not rescaled	Average 1978-2007	Average 1983-2008
2	0.1485	1.0488	0.08
3	0.3538	1.5760	0.56
4	0.4824	2.2663	0.84
5	0.6006	3.0676	0.94
6	0.7443	3.8349	0.98
7	0.9544	4.8572	0.99
8	0.8887	6.0795	1.00
9	1.0134	7.6587	1.00
10+	1.0134	9.5177	1.00

Table 4.2.19. Faroe Plateau (sub-division Vb1) COD. Output from yield per recruit calculations (long term prediction).

MFYPR version 1
Run: Run1
Time and date: 17:03 21/04/2008
Yield per results

FMult	Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNosJan	SSBJan	SpwnNosSpwn	SSBSpwn
0.0000	0.0000	0.0000	0.0000	5.5167	23.3722	4.0836	21.4432	4.0836	21.4432
0.1000	0.0627	0.2127	1.0045	4.4577	15.1365	3.0404	13.2459	3.0404	13.2459
0.2000	0.1254	0.3273	1.3173	3.8889	11.2581	2.4863	9.4030	2.4863	9.4030
0.3000	0.1881	0.4017	1.4176	3.5208	9.0497	2.1321	7.2273	2.1321	7.2273
0.4000	0.2508	0.4553	1.4417	3.2565	7.6401	1.8808	5.8480	1.8808	5.8480
0.5000	0.3136	0.4964	1.4369	3.0539	6.6675	1.6907	4.9035	1.6907	4.9035
0.6000	0.3763	0.5294	1.4213	2.8917	5.9568	1.5402	4.2190	1.5402	4.2190
0.7000	0.4390	0.5568	1.4023	2.7576	5.4143	1.4173	3.7011	1.4173	3.7011
0.8000	0.5017	0.5800	1.3828	2.6442	4.9858	1.3144	3.2957	1.3144	3.2957
0.9000	0.5644	0.6000	1.3642	2.5464	4.6379	1.2268	2.9695	1.2268	2.9695
1.0000	0.6271	0.6176	1.3467	2.4610	4.3492	1.1510	2.7013	1.1510	2.7013
1.1000	0.6898	0.6331	1.3305	2.3854	4.1052	1.0847	2.4767	1.0847	2.4767
1.2000	0.7525	0.6471	1.3156	2.3179	3.8959	1.0261	2.2857	1.0261	2.2857
1.3000	0.8152	0.6596	1.3017	2.2571	3.7141	0.9738	2.1212	0.9738	2.1212
1.4000	0.8780	0.6711	1.2889	2.2020	3.5544	0.9268	1.9781	0.9268	1.9781
1.5000	0.9407	0.6815	1.2770	2.1517	3.4129	0.8844	1.8524	0.8844	1.8524
1.6000	1.0034	0.6911	1.2658	2.1056	3.2865	0.8459	1.7411	0.8459	1.7411
1.7000	1.0661	0.7000	1.2555	2.0631	3.1729	0.8107	1.6418	0.8107	1.6418
1.8000	1.1288	0.7082	1.2457	2.0238	3.0701	0.7784	1.5528	0.7784	1.5528
1.9000	1.1915	0.7159	1.2366	1.9873	2.9766	0.7487	1.4725	0.7487	1.4725
2.0000	1.2542	0.7230	1.2280	1.9532	2.8911	0.7213	1.3997	0.7213	1.3997

Reference point	F multiplier	Absolute F
Fbar(3-7)	1.0000	0.6271
FMax	0.4211	0.2641
F0.1	0.1961	0.123
F35%SPR	0.2842	0.1782
Flow	0.1605	0.1007
Fmed	0.5494	0.3445
Fhigh	1.4447	0.906

Weights in kilograms

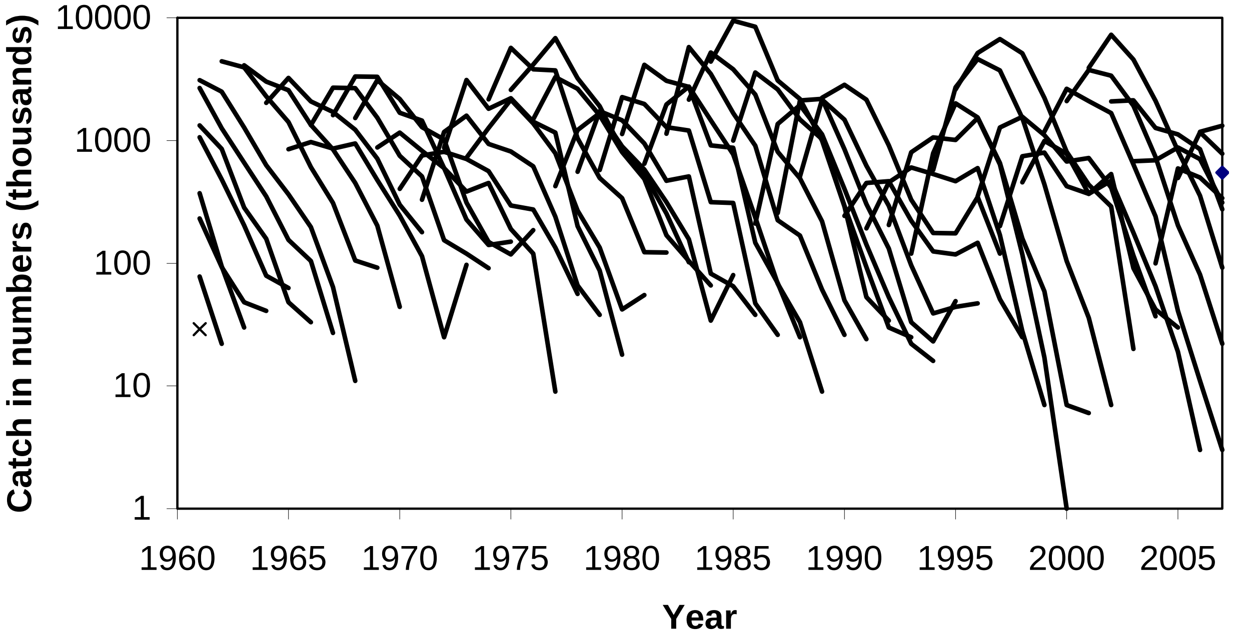


Figure 4.2.1. Faroe Plateau (sub-division VB1) COD. Catch in numbers at age shown as catch curves.

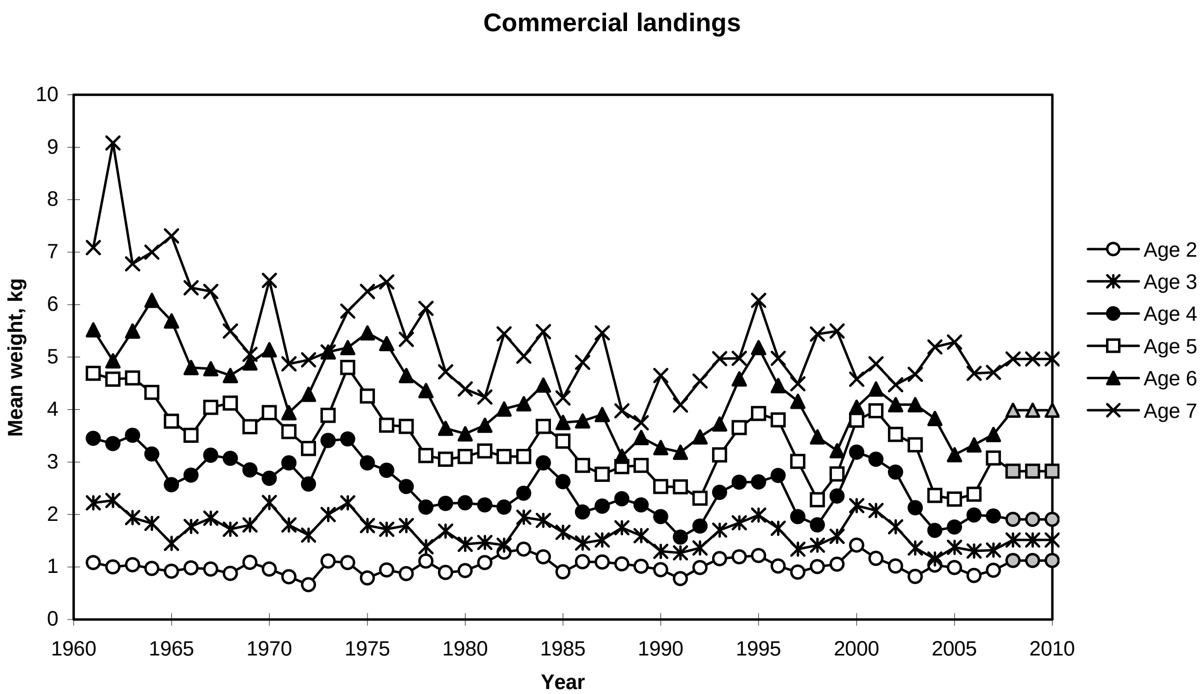


Figure 4.2.2. Faroe Plateau (sub-division VB1) COD. Mean weight at age 1961-2007. The estimated weights in 2008 are also shown. The weights in 2009 and 2010 are set to the 2008 values.

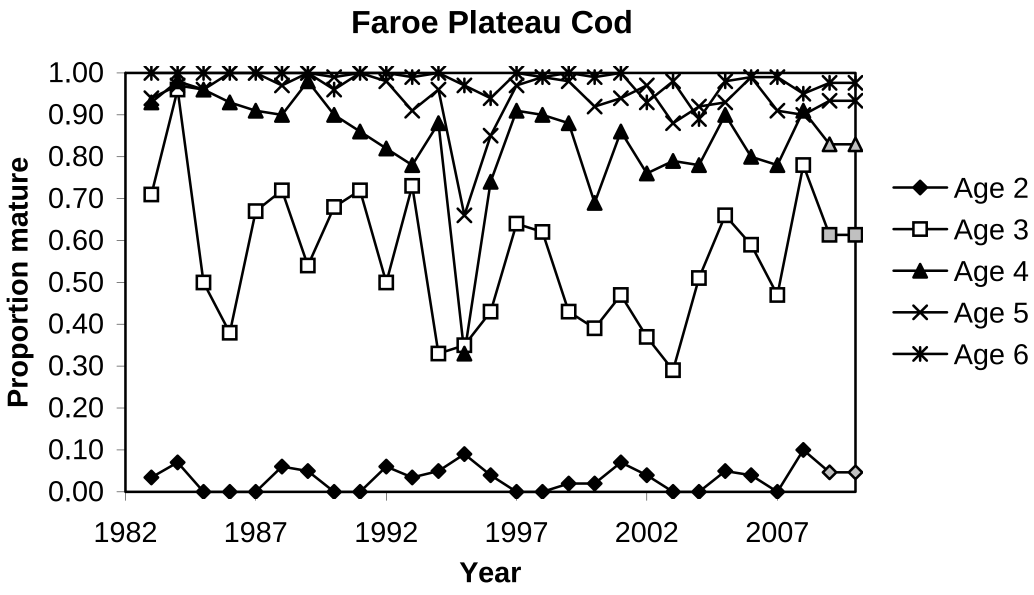


Figure 4.2.3. Faroe Plateau (sub-division VB1) COD. Proportion mature at age as observed in the spring groundfish survey. The values in 2008 and 2009 are estimated as the average of the 2005-2007 values.

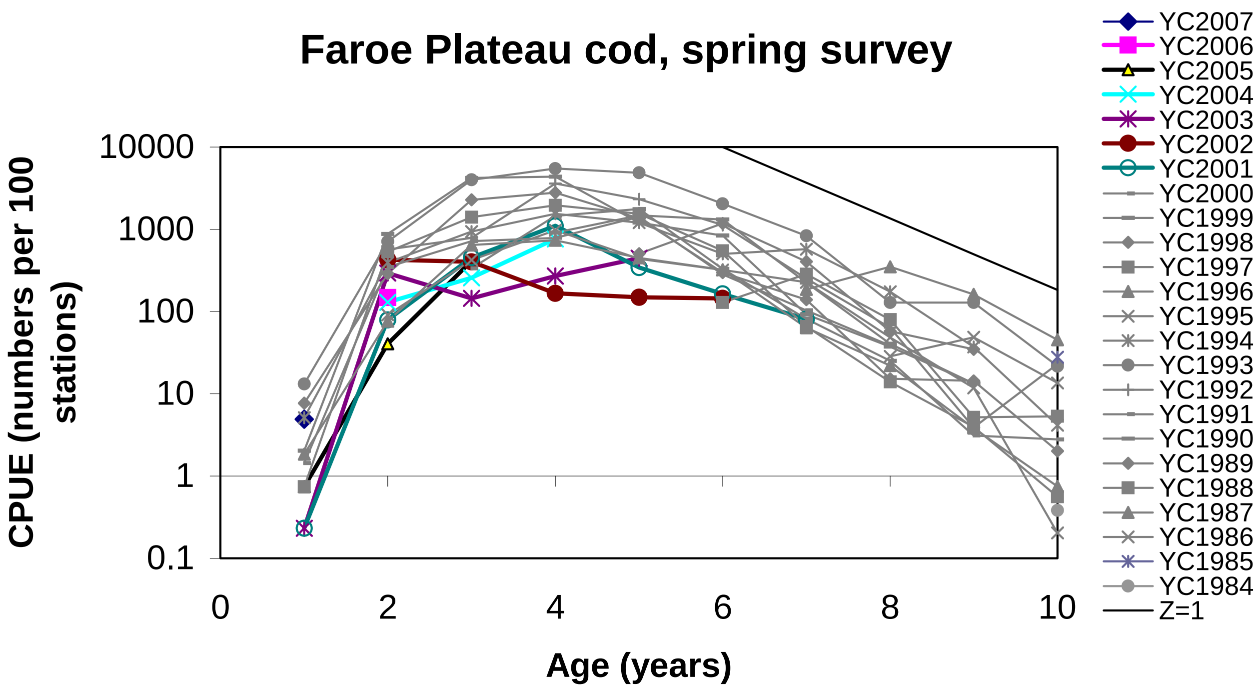


Figure 4.2.4. Faroe Plateau (sub-division VB1) COD. Catch curves from the spring groundfish survey.

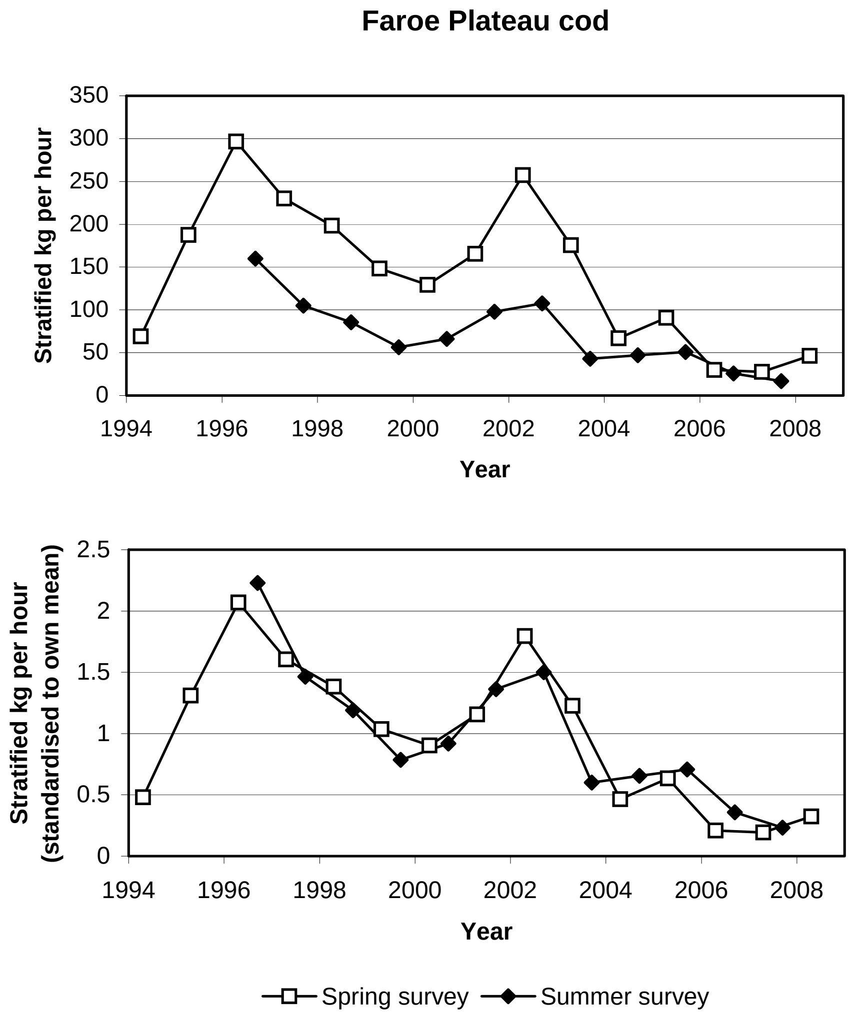


Figure 4.2.5. Faroe Plateau (sub-division VB1) COD. Stratified kg/hour in the spring and summer surveys.

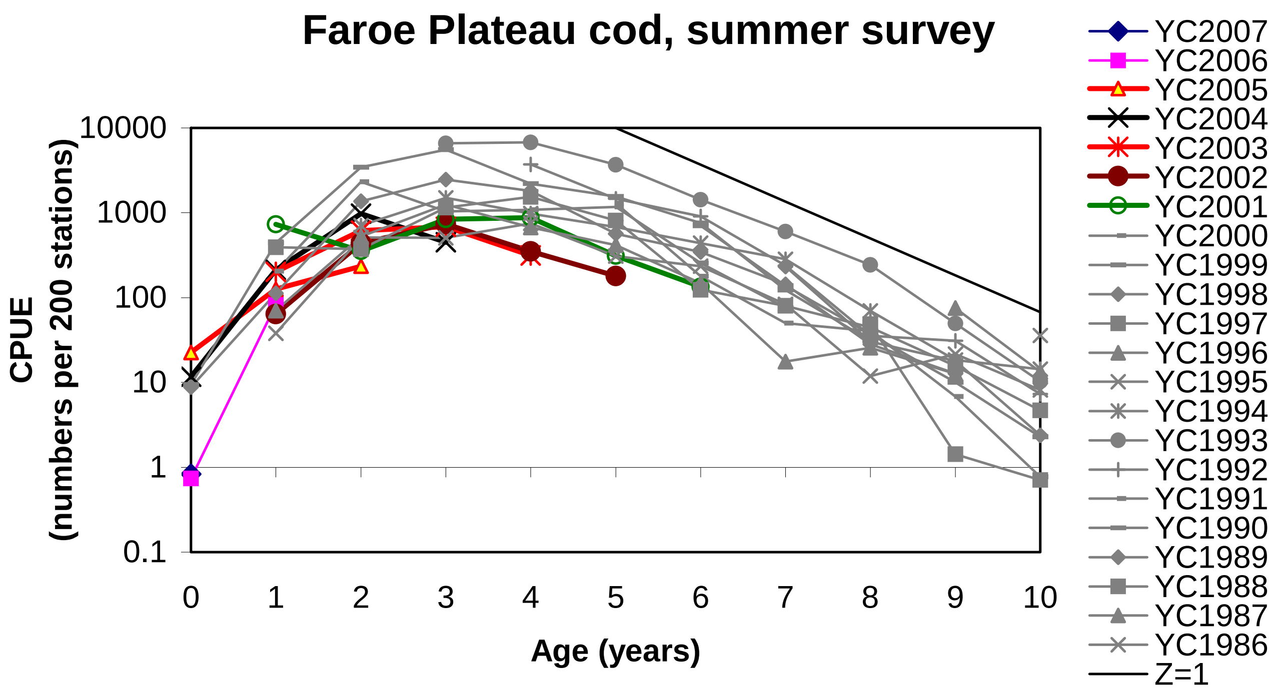


Figure 4.2.6. Faroe Plateau (sub-division VB1) COD. Catch curves from the summer groundfish survey.

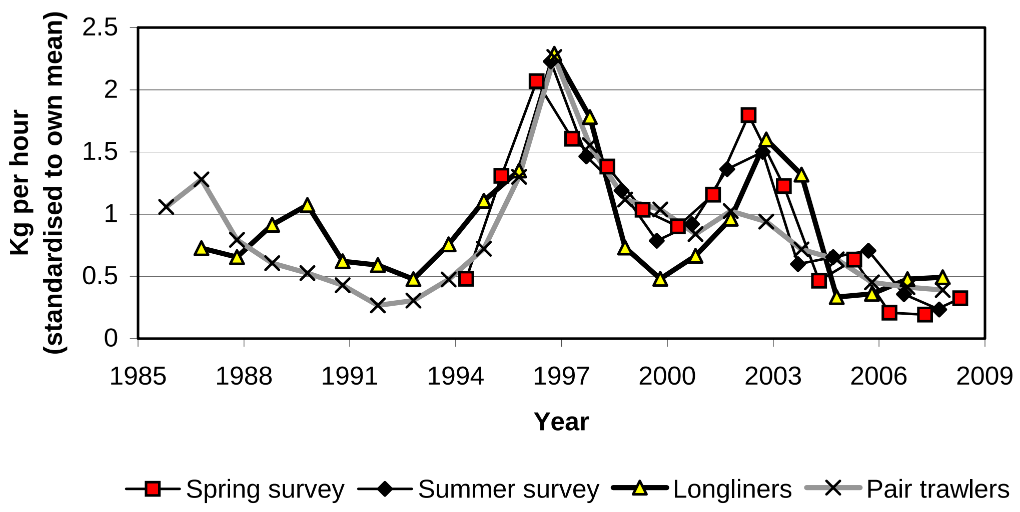
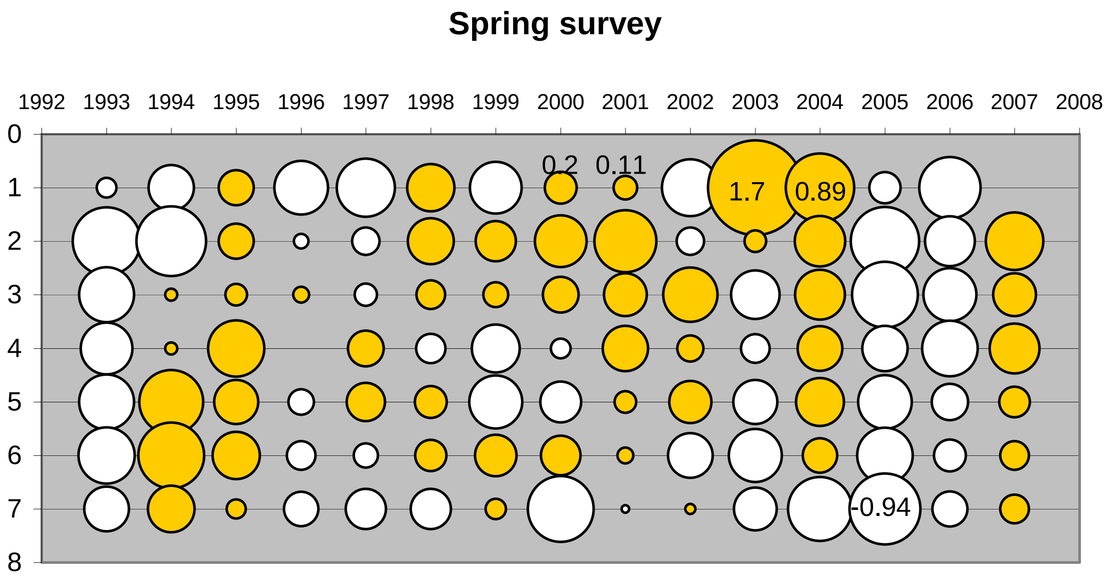


Figure 4.2.7. Faroe Plateau (sub-division VB1) COD. Standardised catch per unit effort for pair trawlers and longliners. The two surveys are shown as well.



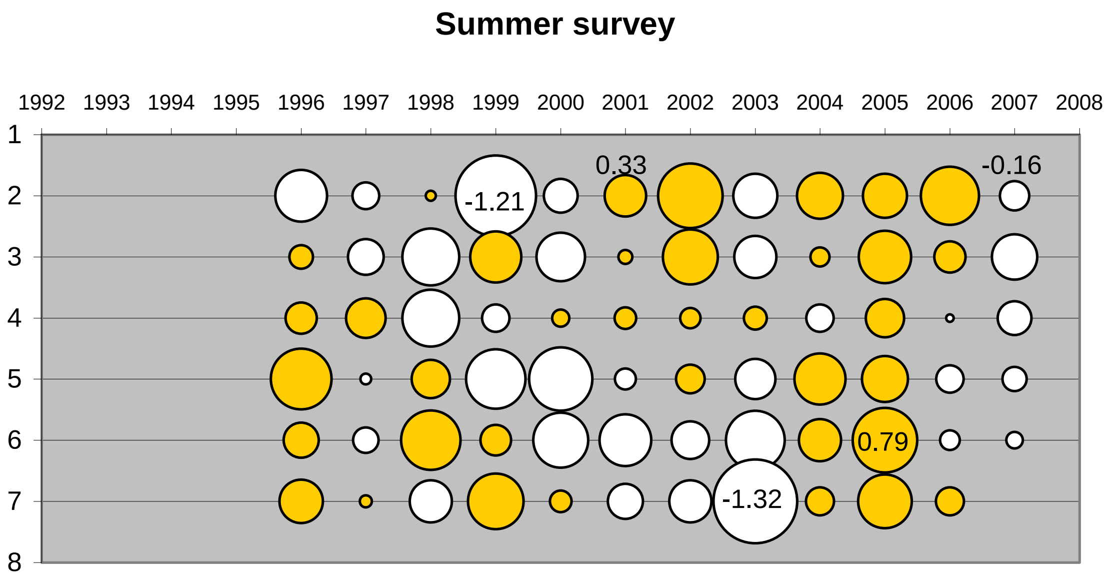


Figure 4.6.1. Faroe Plateau (sub-division VB1) COD. Log catchability residuals for the spring and summer survey. The residuals for age 8 are not presented because some values were off scale. White bubbles indicate negative residuals.

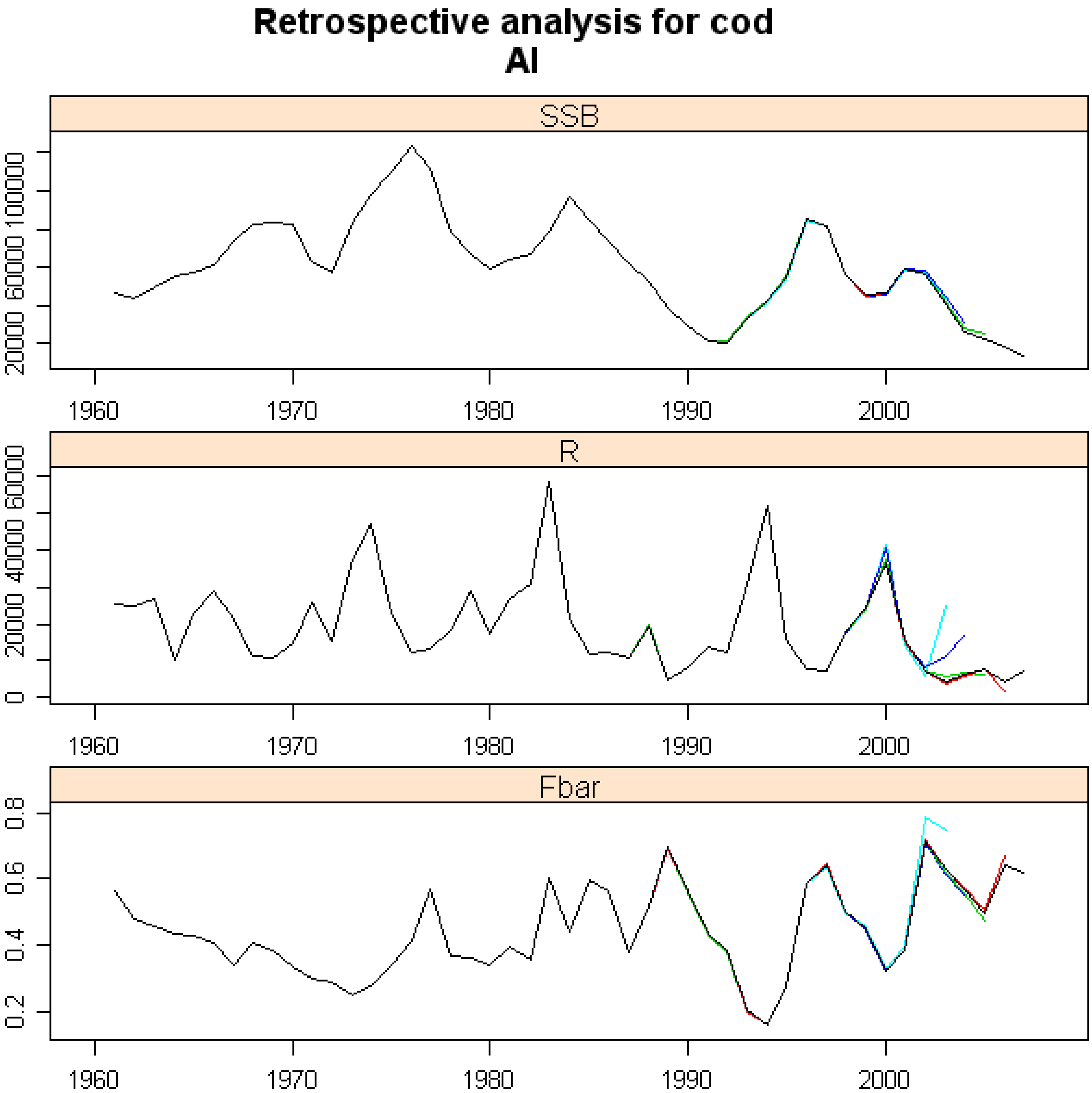
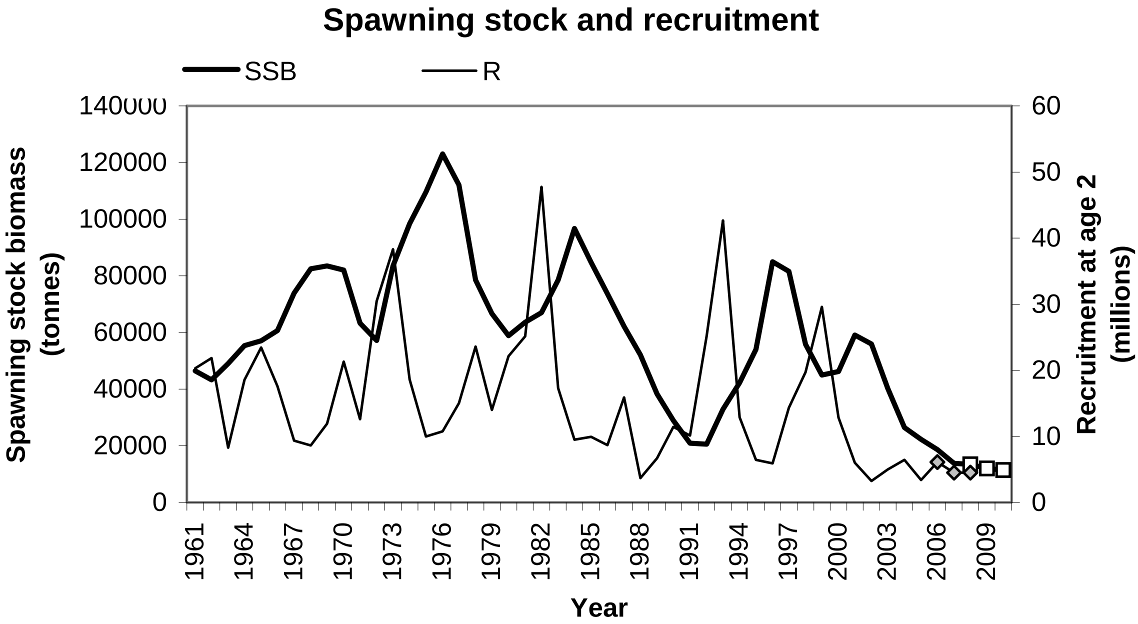


Figure 4.6.2. Faroe Plateau (sub-division VB1) COD. Results from the XSA retrospective analysis.



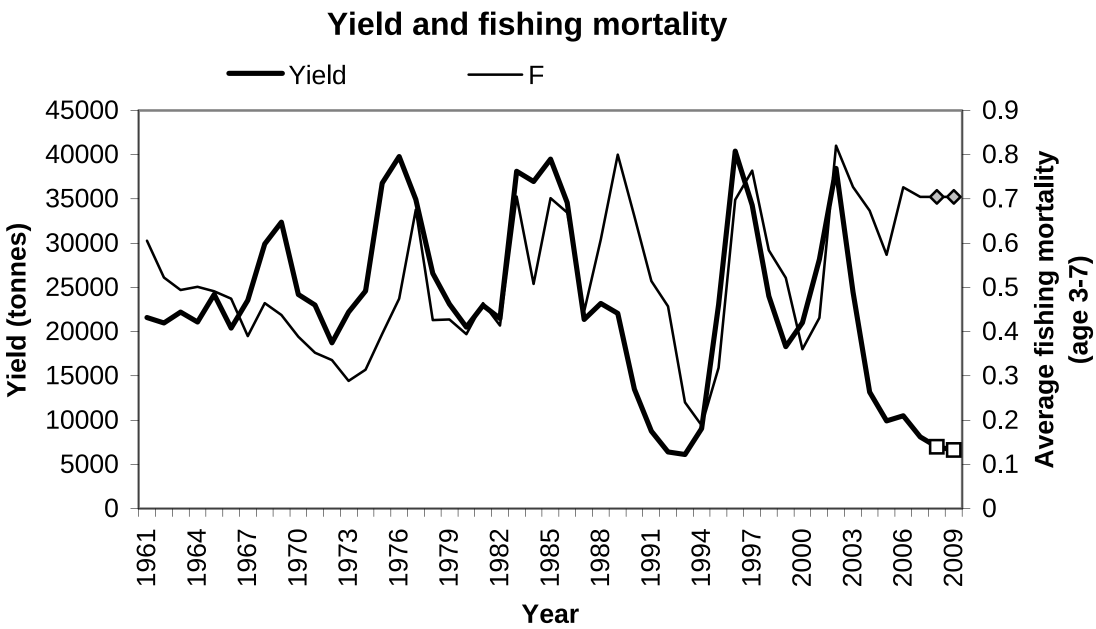


Figure 4.6.3. Faroe Plateau (sub-division VB1) COD. Yield and fishing versus year. Spawning stock biomass (SSB) and recruitment (year class) versus year. Points (white and grey) are taken from the short term projections.

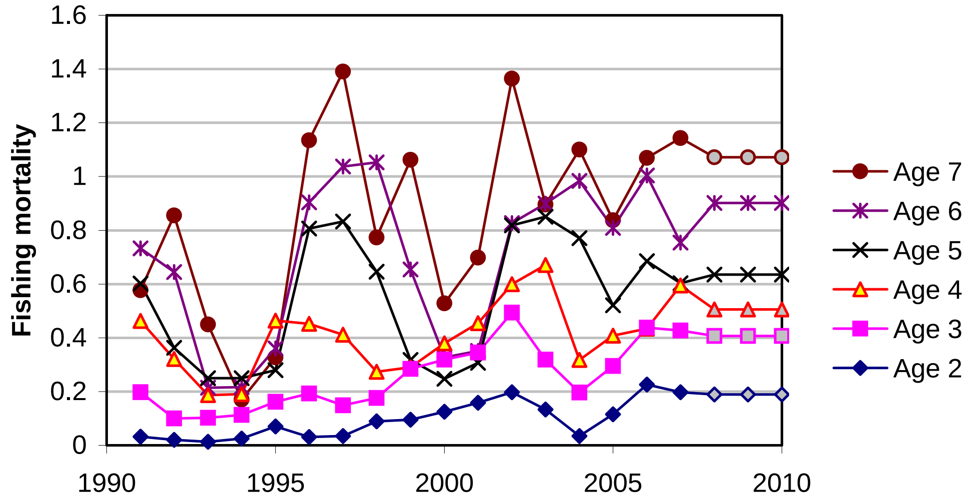


Figure 4.6.4. Faroe Plateau (sub-division VB1) COD. Fishing mortalities by age. The F-values in 2008-2010 are set to the average values in 2005-2007 rescaled to the 2007 level.

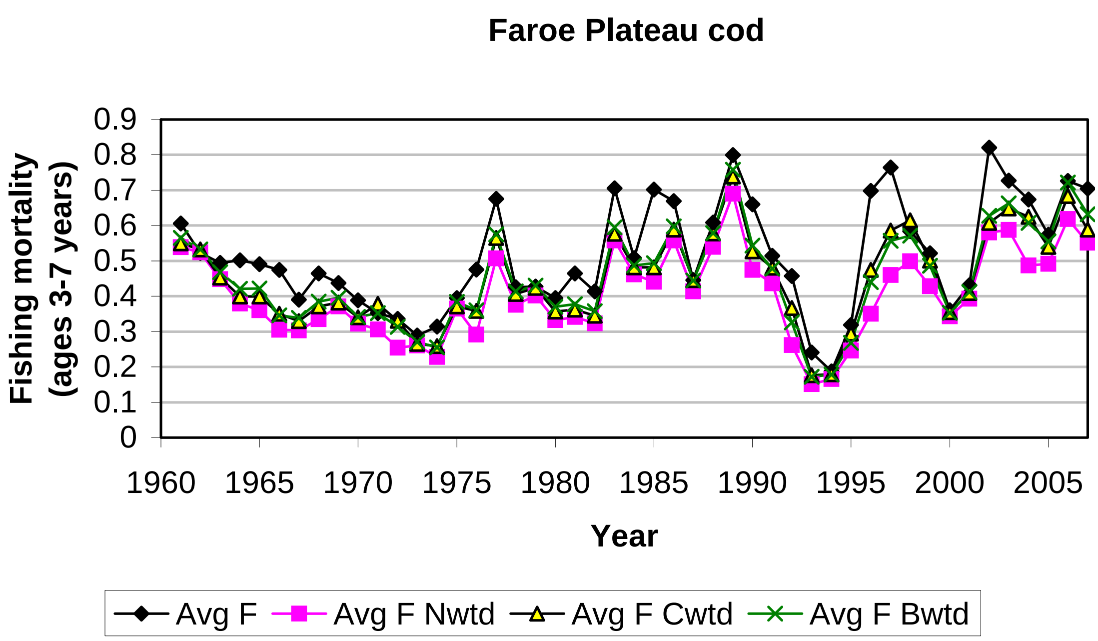


Figure 4.6.5. Faroe Plateau (sub-division VB1) COD. Different measures of fishing mortality: straight arithmetic average (Avg F), weighted by stock numbers (Nwtd), weighted by stock biomass (Bwtd) or weighted by catch (Cwtd).

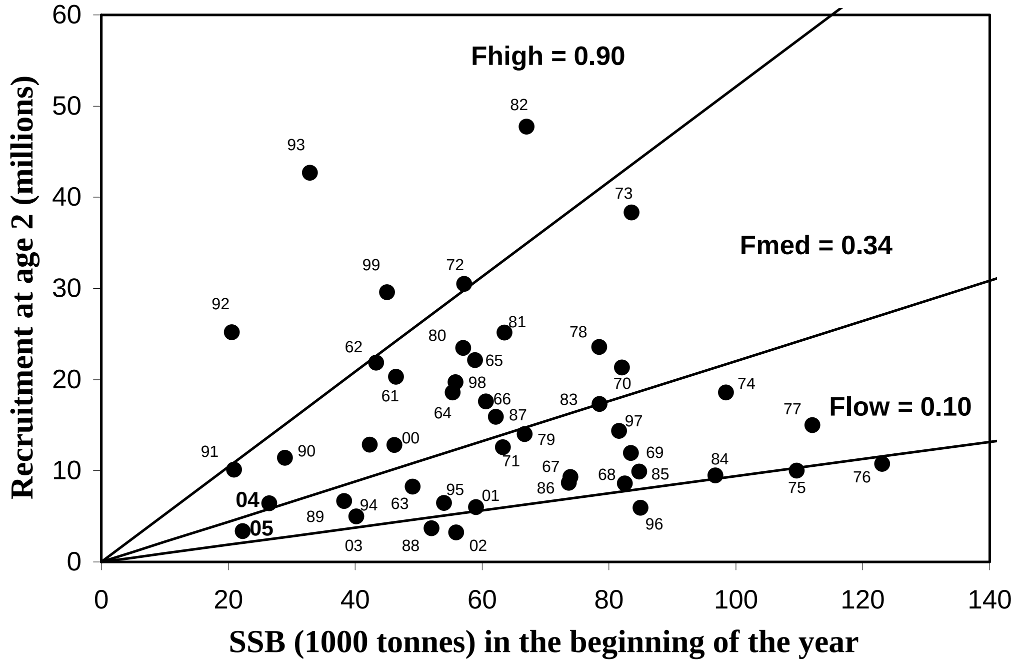


Figure 4.6.6. Faroe Plateau (sub-division VB1) COD. Spawning stock – recruitment relationship 1961-2004. Years are shown at each data point.

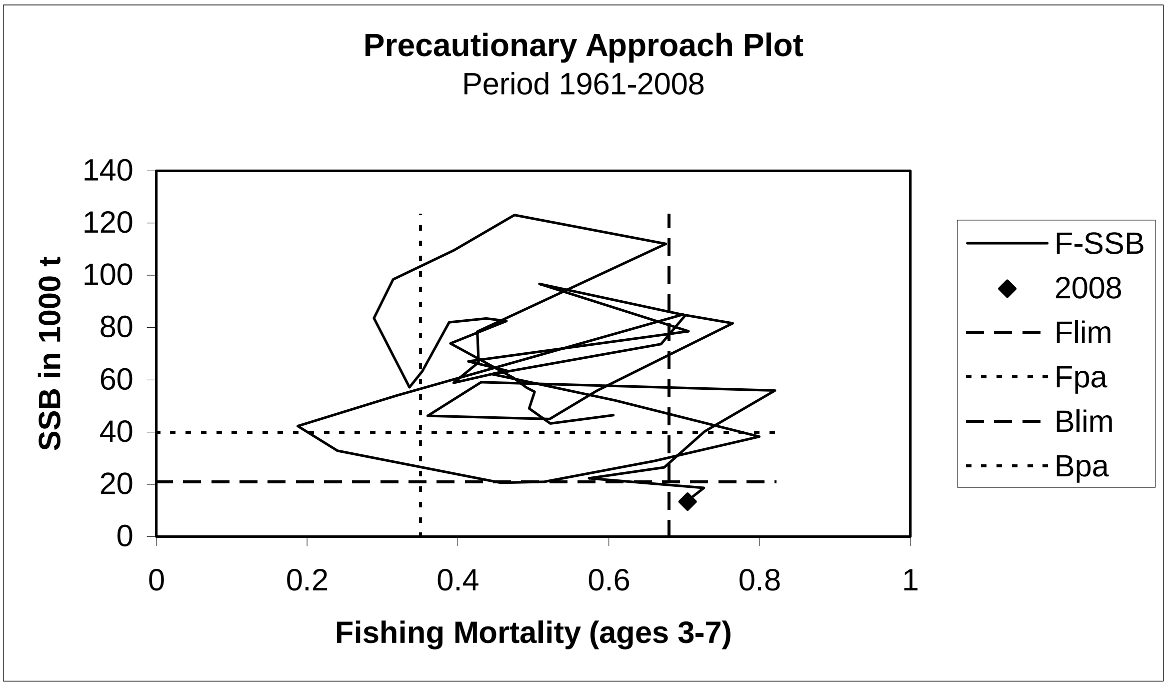


Figure 4.6.7. Faroe Plateau (sub-division VB1) COD. Spawning stock biomass versus fishing mortality 1961-2008.

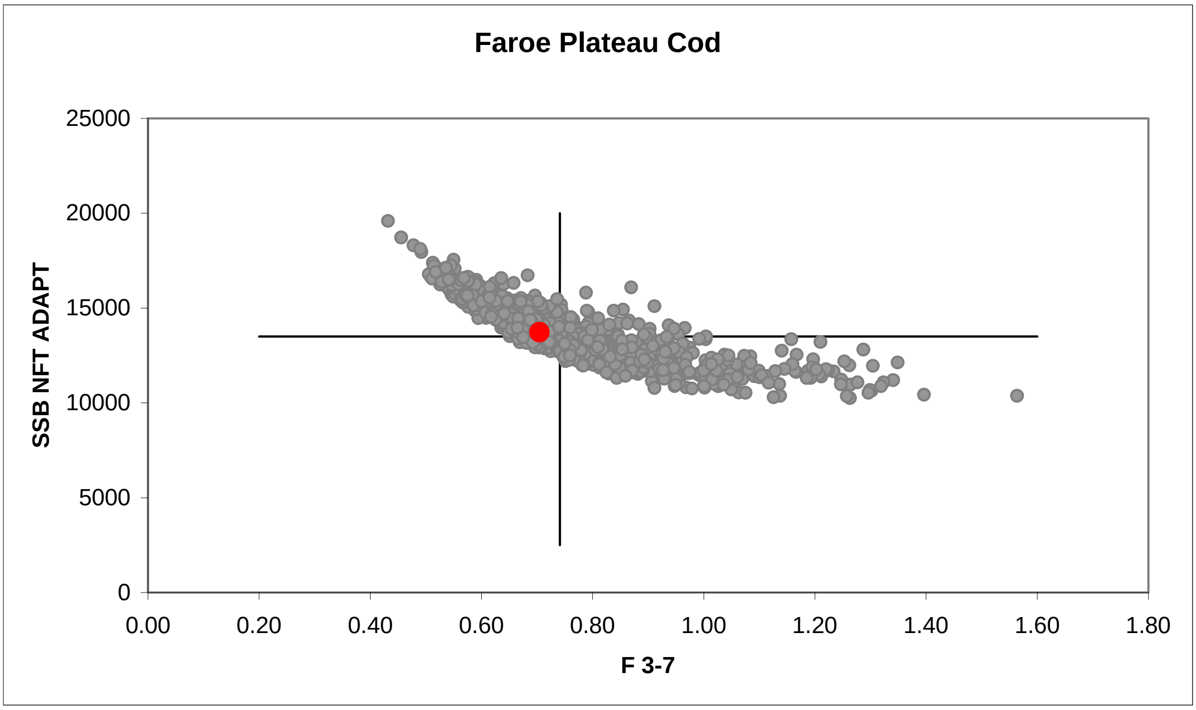


Figure 4.6.8. F and SSB's for 2006 from a 1000 bootstraps of the ADAPT with the two surveys. The XSA estimate is shown as a red point.

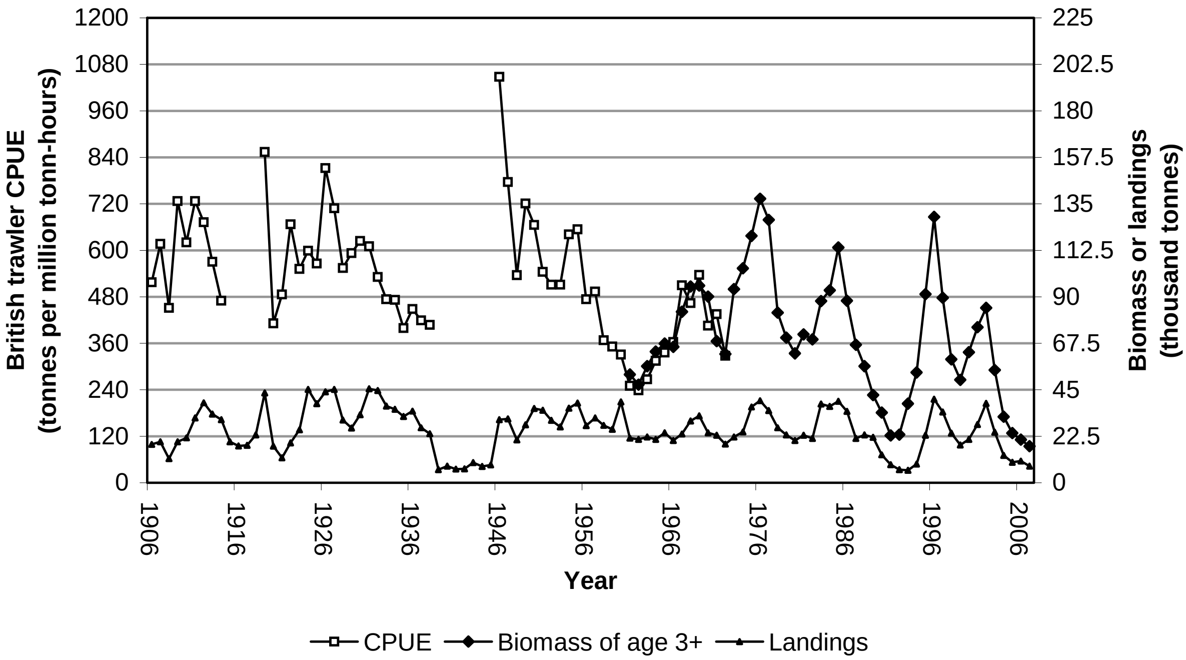
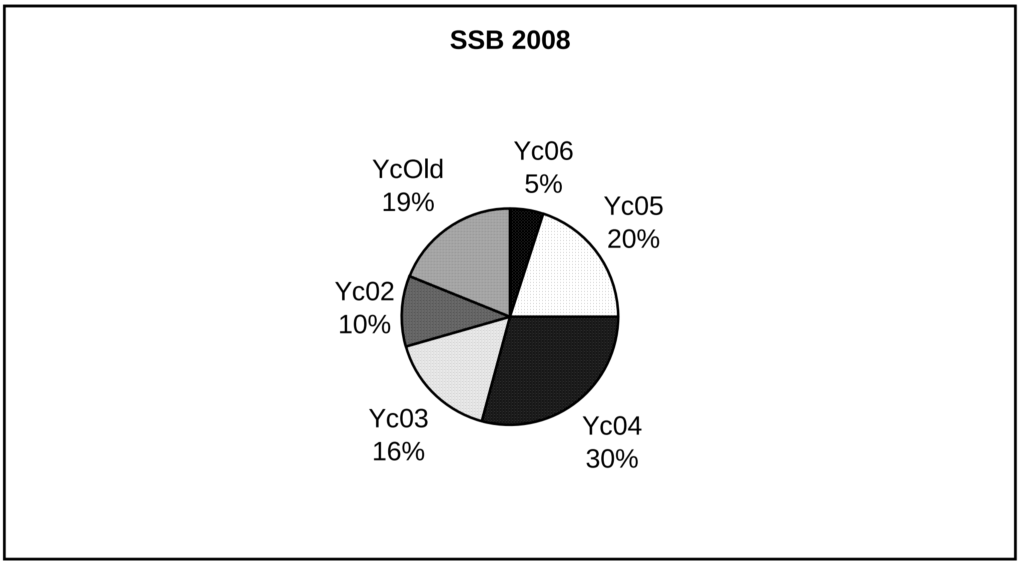


Figure 4.6.9. Faroe Plateau Cod. Stock development 1906-2007 based on cpues from british steam trawlers (1906-1925: cwts per days of absence from port), cpues from british trawlers (1924-1972: tonnes per million tonn hours) and the XSA-estimates (1961-2006: absolute biomass). The 1906-1925 series was scaled to the 1924-1972 series and the CPUEs refer to the first (left) axis while the XSA-estimates refer to the second axis.



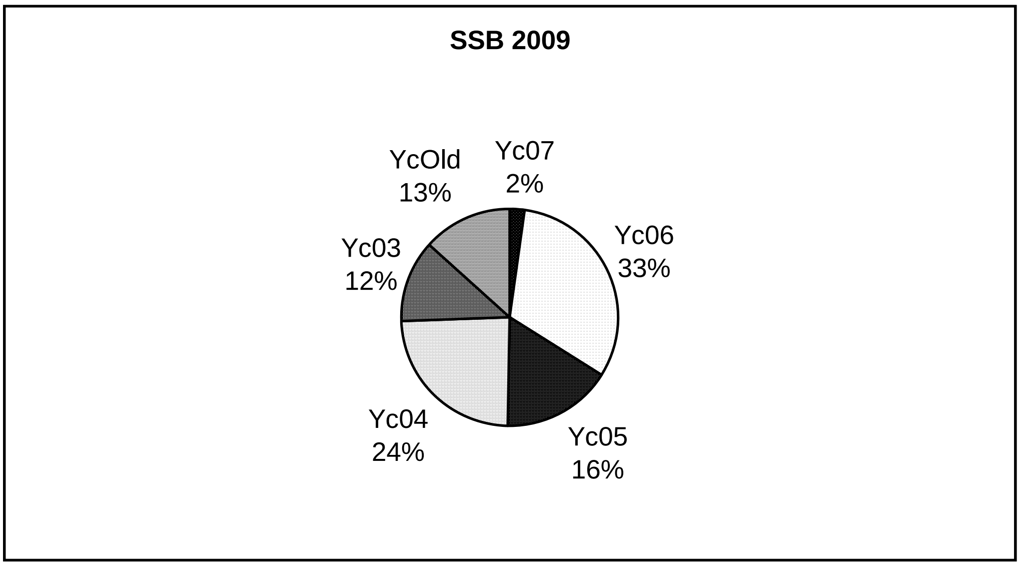
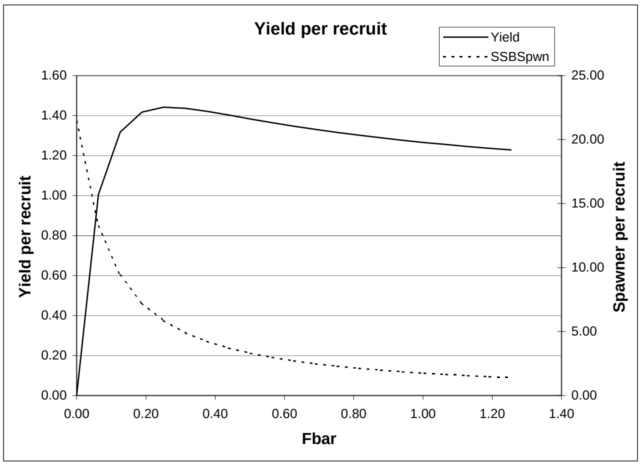
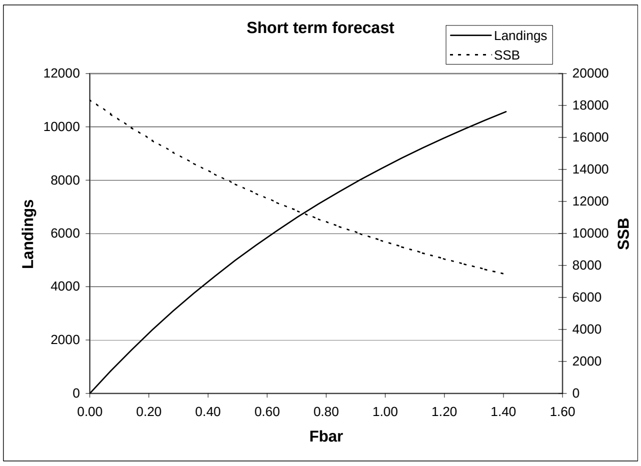


Figure 4.7.1. Contribution of various year classes to the spawning stock biomass in 2008 and 2009.





MFYPR version 1
Run: Run1
Time and date: 17:03 21/04/2008

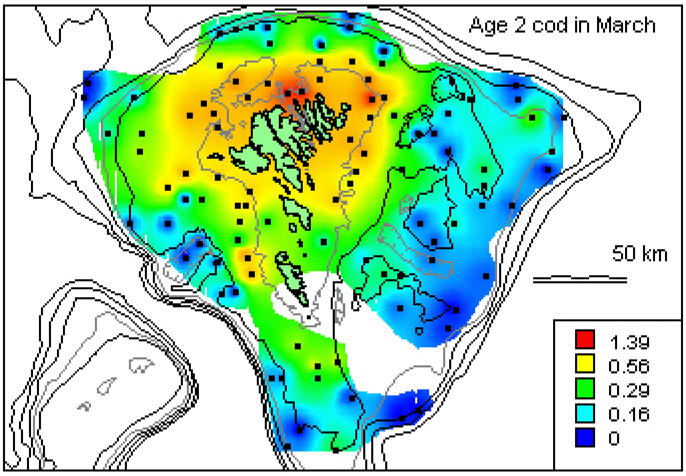
Reference point	F multiplier	Absolute F
Fbar(3-7)	1.0000	0.6271
FMax	0.4211	0.2641
F0.1	0.1961	0.1230
F35%SPR	0.2842	0.1782
Flow	0.1605	0.1007
Fmed	0.5494	0.3445
Fhigh	1.4447	0.9060

Weights in kilograms

MFDP version 1
Run: Run3
Index file 22/4-2008
Time and date: 12:29 25/04/2008
Fbar age range: 3-7

Input units are thousands and kg - output in tonnes

Figure 4.8.1. Faroe Plateau (sub-division VB1) COD. Yield per recruit and spawning stock biomass (SSB) per recruit versus fishing mortality (left figure). Landings and SSB versus Fbar (3-7).



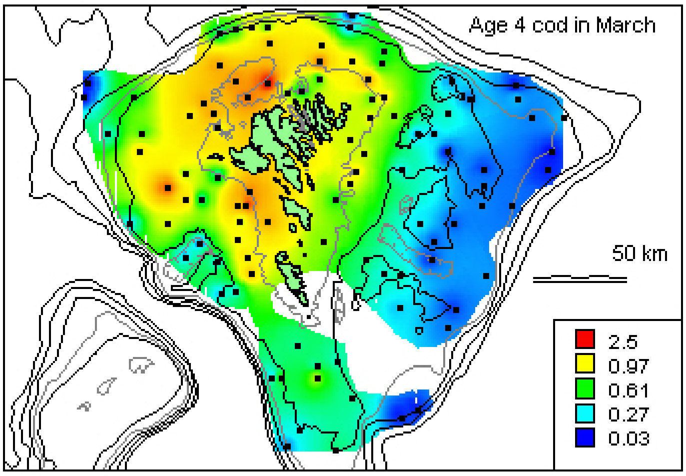
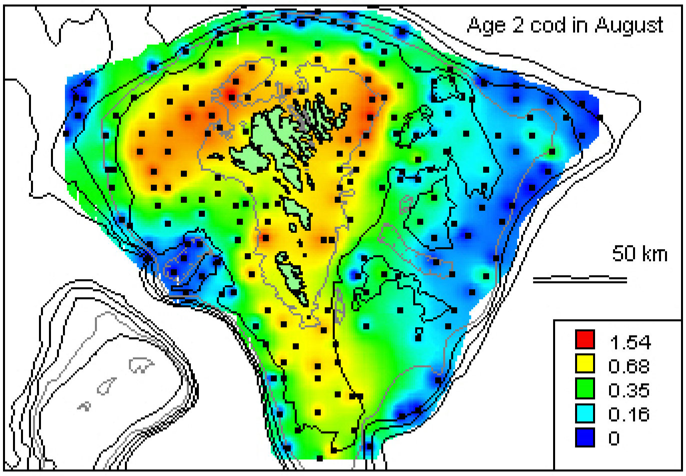


Figure 4.12.1. Mean abundance (log_{10}(numbers+1)) of 2 and 4 year-old cod in March 1998-2006 as observed in the spring groundfish survey (from Steingrund et al., in prep.). 100 m depth contours are shown.



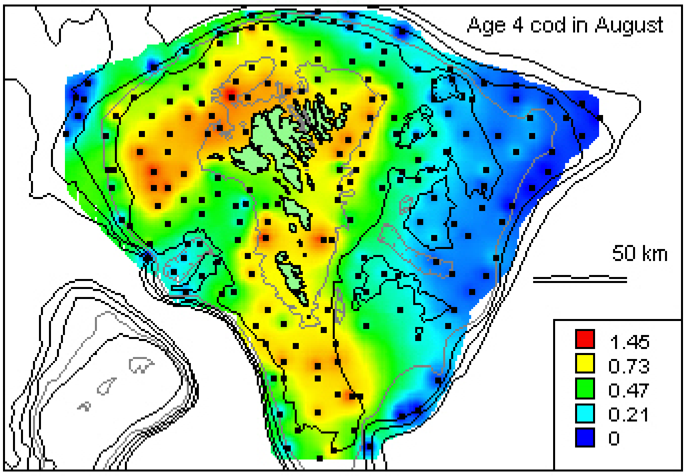


Figure 4.12.2. Mean abundance ($\log_{10}$(numbers+1)) of 2 and 4 year-old cod in August 1997-2005 as observed in the summer groundfish survey (from Steingrund et al., in prep.). 100 m depth contours are shown.

5 Faroe haddock

Executive summary

Being an update assessment, the only changes compared to last year are additions of new data from 2007 and some minor revisions of the landings data for 2005 and 2006 with corresponding revisions of the catch@age data. The main assessment tool is XSA tuned with 2 research vessel bottom trawl surveys. ADAPT has also been applied using the same input data as for the XSA mostly to evaluate the uncertainties in the assessment. The results are in line with those from 2007, showing a declining SSB mainly due to poor recruitment. SSB is still above B_{pa} but is predicted to be less than B_{pa} in 2009 and close to B_{lim} in 2010. Fishing mortality in 2007 is estimated at 0.28 (F_{pa} = 0.25) and landings in 2007 were at the long term average since 1903 (12 500 t). In recent years there has been a tendency to overestimate SSB and underestimate F.

5.1 Stock description and management units

Haddock in Faroese Waters, i.e. ICES Subdivisions Vb1 and Vb2 and in the southern part of ICES Division IIa, close to the border of Subdivision 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 considered very stationary as seen in tagging experiments. Figures 5.8-5.9 show the age-aggregated distribution by year as seen in the two regular groundfish surveys in the area.

5.2 Scientific data

5.2.1 Trends in landings and fisheries

Nominal landings of Faroe haddock have in recent years increased very rapidly from only 4 000 t in 1993 to 27 000 t in 2003; they have declined since and amounted in 2007 to about 12 600t which is around the average since 1903. Most of the landings are taken from the Faroe Plateau; the landings from the Faroe Bank (Sub-Division Vb2) in 2007 were about 800 t (Tables 5.1 and 5.2). As can be seen from Figure 5.1, landings in 2002-2004 reached historical highs. The cumulative landings by month (Figure 5.2) suggest that landings in 2008 may be smaller than those in 2007.

Faroese vessels have taken almost the entire catch since the late 1970s (Figure 5.1). Table 5.3 shows the Faroese landings since 1985 and the proportion taken by each fleet category. The longliners have taken most of the catches in recent years followed by the trawlers, of which the otter board trawlers increased their share in 2007.

5.2.2 Catch-at-age

For the Faroese landings, catch-at-age data were provided for fish taken from the Faroe Plateau and the Faroe Bank. The sampling intensity in 2007 is shown in Table 5.4 and was somewhat lower than in recent years.

As has been the practise in the past, samples from each fleet category were disaggregated by season (Jan-Apr, May-Aug and Seep-Dec) and then raised by the catch proportions to give the 2007 catch-at-age in numbers for each fleet (Table 5.4). Catches of some minor fleets have been included under the "Others" heading. No catch-at-age data were available from other nations fishing in Faroese waters. Therefore, catches by UK and France trawlers were assumed to have the same age composition as Faroese otter board trawlers larger than 1 000 HP. The Norwegian longliners were assumed to have the same age distribution as the Faroese longliners greater than 100 GRT. The most recent data were revised according to the final catch figures. The resulting total catch-at-age in numbers is given in Tables 5.4 and 5.5, and in Figure 5.3 the LN(catch-at-age in numbers) is shown for the whole period of analytical assessments.

In general the catch-at-age matrix in recent years appears consistent although from time to time a few small year classes are disturbing this consistency, both in numbers and mean weights at age. Also there are some problems with what ages should be included in the plus group; there are some periods where only a few fishes are older than 9 years, and other period with a quite substantial plus group (10+). These problems have been addressed in former reports of this WG and will not be further dealt with here. No estimates of discards of haddock are available. However, since almost no quotas are used in the management of the fisheries on this stock, the incentive 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.

5.2.3 Weight-at-age

Mean weight-at-age data are provided for the Faroese fishery (Table 5.4). Figure 5.5 shows the mean weights-at-age in the landings for age groups 2-7 since 1976. During the period, weights have shown cyclical changes, and have decreased during the most recent years to very low values in 2006, but most ages show a small increase in 2007. The mean weight at age in the stock are assumed equal to those in the landings.

5.2.4 Maturity-at-age

Maturity-at-age data is available from the Faroese Spring Groundfish Surveys 1982–2008. 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 5.7 and Figure 5.5).

5.3 Information from the fishing industry

There exists a considerable amount of data on fish size in the fishing industry. No such information was used in the 2008 assessment.

5.4 Methods

This assessment is an update of the 2007 assessment, with exactly the same settings of the XSA. The only changes are minor revisions of recent landings according to revised data and corresponding revisions of the c@age input file. All other input files (VPA and tuning fleets) are the same except for the addition of the 2007 and 2008 data.

5.4.1 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; 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 5.6. In general the two series show the same trends although in some periods the two series are conflicting; this has been explained by variations in catchability of the longlines due to the above mentioned changes in productivity of the ecosystem (see chapter 2).

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 5.8 (spring surveys 1994-2008) and Figure 5.9 (summer surveys 1996-2007). Biomass estimates (kg/hour) are available for both series since they were initiated (Figure 5.7), and in general, there is a good agreement between them. Age disaggregated data are available for the whole summer series, but due to problems with the database (see earlier reports), age disaggregated data for the spring survey are only available since 1994. The calculation of indices at age is based on age-length keys and a smoother is applied. This is a useful method but by analyzing the number of otoliths for the youngest ages and comparing it with the length distributions some artifacts may be introduced because the smoothing can assign wrong ages to some lengths, especially for the youngest and oldest specimen. As last year the length distributions have been used more directly for calculation of indices at age for ages 0-3. LN(numbers at age) for the surveys are presented in Figures 5.10-5.11 and show consistent patterns. Further analysis of the performances of the two series are shown in figures 5.12 – 5.14. In general there is a good relationship between the indices for one year class in two successive years (Figures 5.12-5.13). The same applies when comparing the corresponding indices at age from the two surveys (Figure 5.14).

A spaly (same procedure as last year) run, with the same settings of the XSA as in 2007 and tuned with the two surveys combined (Table 5.8), with 2007 data included and some minor revisions of recent catch figures (Table 5.9), gave similar 2006 estimates as the 2007 assessment, although the recruitment and biomass were overestimated and the fishing mortality underestimated in the 2007 assessment (Section 5.10). The log q residuals for the two surveys are shown in Figure 5.15.

The retrospective pattern for fishing mortality, recruitment and spawning stock biomass of this XSA is shown in Figure 5.16. There has been a tendency to overestimate SSB and underestimate F in recent years. The retrospective pattern of the fishing mortality is hampered by strange values of some small poorly sampled year classes which in some years are included in the FBAR reference ages 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 5.10 and in Figure 5.17. 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 it has decreased again to being about 0.28 in 2007.

5.5 Reference points

The yield- and spawning stock biomass per recruit (age 2) based on the long-term data are shown in Table 5.17 and Figure 5.19. From Figure 5.18, showing the recruit/spawning stock relationship, and from Table 5.17, $\mathbf{F}_{med}$, and $\mathbf{F}_{high}$ were calculated at 0.33 and 1.66, respectively. F_{max} is estimated at 0.5, and $F_{0.1}$ at 0.16.

The precautionary reference fishing mortalities were set in 1998 by ACFM with F_{pa} as the $\mathbf{F}_{med}$ value of 0.25 and F_{lim} two standard deviations above $\mathbf{F}_{pa}$ equal to 0.40. The precautionary reference spawning stock biomass levels were changed by ACFM in 2007. B_{lim} was set at 22 000 t (B_{loss}) and B_{pa} at 35 000 t based on the formula $B_{pa} = B_{lim}e^{1.645\sigma}$, assuming a σ of about 0.3 to account for the uncertainties in the assessment.

5.6 State of the stock - historical and compared to what is now.

The stock size in numbers is given in Table 5.11 and a summary of the VPA with the biomass estimates is given in Table 5.12 and in Figure 5.17. According to this assessment, the spawning stock biomass has shown big changes in recent years. It decreased from 67 000 t in 1987 to 22 000 t in 1994, increased again to 84 000 t in 1997 and 1998, decreased to 55 000 t in 2000 and has increased since to 101 000 t in 2003; the 2007 point estimate is 49 000t. The decline in the spawning stock began in the late 1970s due to very poor recruitment in the years before. The stabilization at relatively high SSB's in the mid–1980s was due to the relatively good 1982 and 1983 year classes, but the decline since was partly due to poor year classes since the mid–1980s, as well as the pronounced decline in the mean weights-at-age in the stock. The main reason for the very abrupt increase in the spawning stock biomass is the recruitment and growth of the very large 1993 year class and the well-above-average 1994 year class. The most recent increase in the spawning stock is due to new strong year classes entering the fishery of which the 1999 year class is the highest on record (105 mio. at age 2). Also the YC's from 2000 and 2001 are estimated well above average and the 2002 YC slightly above average, but all more recent YC's are estimated or predicted to be small.

5.7 Short term forecast

5.7.1 Input data

The input data for the short-term predictions are estimated in the same way as last year and given in Tables 5.13-14. All year classes up to 2006 are from the final VPA, the 2007 year class at age 2 is estimated from the 2008 XSA applying a natural mortality of 0.2 in a forward calculation of the numbers using basic VPA equations. The YC 2008 at age 2 in 2010 is estimated as the geometric mean of the 2-year-olds in 1980-2009. This period has been selected, because the recruitment in earlier years was more stable and not characteristic for the recent years.

The exploitation pattern used in the prediction was derived from averaging the 2005–2007 fishing mortality matrices from the final VPA without rescaling. The same exploitation pattern was used for all three years.

The mean weight@age have been declining in recent years to low values but from inspection of Figure 5.5 most ages were increasing again in 2007. The mean weight-at-age for ages 2-10 in 2008-2010 was therefore set equal to the average of the weights for 2005-2007.

The maturity ogive for 2008 is based on samples from the Faroese Groundfish Spring Survey 2008 and the ogives in 2009-2010 are estimated as the average of the smoothed 2006-2008 values.

5.7.2 Results

Given the stability in the allocation of fishing days, it should not be unrealistic to assume fishing mortalities in 2008 as the average of some recent years, here the average of F(2005-2007); however, possible changes in the catchability of the fleets (which seem to be linked to productivity changes in the environment) could undermine this assumption. The fleet is almost the same and the number of fishing days for most fleets was only reduced marginally for the fishing year 1 Sept 2007 – 31 Aug 2008 and for pairtrawlers there was no change as compared to the year before. The landings in 2008 are then predicted to be about 13 000 t, and continuing with this fishing mortality will result in 2009 landings of about 9 000 t. The SSB will decrease to 42 000 t in 2008, 30 000 t in 2009, and to 20 000 t in 2010 which is below B_{lim}. The results of the short-term prediction are shown in Table 5.15 and in Figure 5.19. The contribution by year-classes to the age composition of the predicted 2009 and 2010 SSB's is shown in Figure 5.21. The contributions to the SSB's of new predicted incoming year-classes are minor.

5.8 Medium term forecasts and yield per recruit

No medium term projections are presented in this years report.

The input data for the long-term yield and spawning stock biomass (yield-per-recruit calculations) are listed in Table 5.16. Mean weights-at-age (stock and catch) are averages for the 1977–2007 period. The maturity ogives are averages for the years 1982-2007. The exploitation pattern is the same as in the short term prediction.

The results are given in Table 5.17 and under Biological reference points.

5.9 Uncertainties in assessment and forecast

Misreporting is not believed to be a problem under the current effort management system and since almost no quotas are used in the management of the fisheries on this stock, the incentive to discard in order to high grade the catches should be low. Moreover there is a ban on discarding. The landings statistics is therefore regarded as being adequate for assessment purposes.

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

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

As in 2005-07, 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.

Figure 5.20 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.

5.10 Comparison with previous assessment and forecast

As explained previously in the report, this assessment is an update of the 2007 assessment. The only changes are minor revisions of recent landings according to revised data and corresponding revisions of the c@age input file. All other input files (VPA and tuning fleets) are the same except for the addition of the 2007-2008 data. Following differences in the 2006 estimates were observed as compared to last year:

Assessment year	Recruitment age 2 in 2006	Exploitable biomass in 2006	Spawning stock biomass in 2006	Fishing mortality (F_{3-7}) in 2006
2007	12 950 000	81 300 t	71 800 t	0.25
2008	10 150 000	72 200 t	63 600 t	0.31

It can be seen, that recruitment and biomass has been overestimated while fishing mortality has been underestimated.

5.11 Management plans and evaluations

A management system based on number of fishing days, closed areas and other technical measures was introduced in 1996. See overview in section 2 for details.

5.12 Management considerations

Management of fisheries on haddock also needs to take into account measures for cod and saithe.

5.13 Ecosystem considerations

Since about 80% of the catches are taken by longlines and the remaining by trawls, effects of the haddock fishery on the bottom is moderate.

5.14 Regulations and their effects

As explained in the overview (section 2), the fishery for haddock in Vb is regulated through a maximum number of fishing days, closed areas during spawning times and large areas closed to trawling. As a consequence, around 80% of the landings derive from long line fisheries. Since the minimum mesh size in the trawls (codend) is 145 mm, the trawl catches consist of fewer small fish than the long line fisheries.

Other nations fishing in Faroese waters are regulated by TAC's obtained during bilateral negotiations; their total landings are minimal, however. Discarding of haddock is considered minimal and there is a ban to discarding.

5.15 Changes in fishing technology and fishing patterns

See section 2.

5.16 Changes in the environment

See section 2.

Table 5.1 Faroe Plateau (Sub-division Vb1) HADDOCK. Nominal catches (tonnes) by countries 1982-2007, I.e. Working Group estimates in Vb1.

Country	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Denmark	-	-	-	-	1	8	4	-	-	-			
Faroe Islands	10,319	11,898	11,418	13,597	13,359	13,954	10,867	13,506	11,106	8,074	4,655	3,622	3,675
France [1]	2	2	20	23	8	22	14	-	-	-	164	-	
Germany	1	+	+	+	1	1	-	+	+	+		-	
Norway	12	12	10	21	22	13	54	111	94	125	71	28	22
UK (Engl. and Wales)	-	-	-	-	-	2	-	-	7	-	54	81	31
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	5,722
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	4,252

Country	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004 #	2005	2006	2007 [2]
Faroe Islands	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	15,600	11,688
France [1]				2 [2,7]	- [2]	6	8 [7]	2	4	1 [5]	+	6 [5]	3 [5]
Germany	5	-	-		33	1	2	6	1	6		1 [5]	
Greenland					30 [6]	22 [6]	0 [6]	4 [6]				+ [8]	13 [5]
Iceland								4					
Norway	28	45	45	71	411	355	257 [2]	227	265	229	212	56	61
Russia										16			
Spain										49			
UK (Engl. and Wales)	23	5	22	30 [1]	59 [7]	19 [7]	4 [7]	11 [7]	14 [7]	8 [7]	1 [7]		
UK (Scotland) [11]	-	…	…	…					185 [7]	186 [7]	126 [7]		
United Kingdom												107 [1]	50
Total	4,605	9,202	16,652	19,238	17,176	14,023	13,728	21,030	22,084	19,490	18,361	15,770	11,815
Working Group estimate [4,5,8]	4,948	9,642	17,924	22,210	18,482	15,821	15,890	24,933	27,128	23,287	20,305	17,074	12,633

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 5.2 Faroe Bank (Sub-division Vb2) HADDOCK. Nominal catches (tonnes) by countries,
1982-2007, I.e. Working Group estimates in Vb2.

Country	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Faroe Islands	1,533	967	925	1,474	1,050	832	1,160	659	325	217	338	185	353
France1	-	-	-	-	-	-	-	-	-	-	-	-	-
Norway	1	2	5	3	10	5	43	16	97	4	23	8	1
UK (Engl. and Wales)	-	-	-	-	-	-	-	-	-	-	+	+	+
UK (Scotland)3	48	13	+	25	26	45	15	30	725	287	869	102	170
Total	1,582	982	930	1,502	1,086	882	1,218	705	1,147	508	1,230	295	524

Country	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007 [2]
Faroe Islands	303	338	1,133	2,810	1,110	1,565 [5]	1,948	3,698	4,804	3,594	1,899	1,375	810
France1	-	-	-								+		
Norway	1	40	4	60	3	48	66	28	54	17	45	1	8
UK (Engl. and Wales)	... [1]	… [1]	… [1]	… [1]	[1]	[1]	[1]	[1]	[1]	[1]	[1]	[4]	[4]
UK (Scotland)3	39	62	135	102	193	185	148	177	[4]	[1]	[4]	[4]	[4]
Total	343	440	1,272	2,972	1,306	1,798	2,162 1	3,903	5,044	3,797	1,944	1,304	818

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 5.4

Catch at age 2007

Age	Vb1 Open Boats	Vb1 LLiners < 100GRT	Vb1 LLiners > 100GRT	Vb1 OB. trawl. < 1000HP	Vb1 OB. trawl. > 1000HP	Vb1 Pair trawl. < 1000HP	Vb1 Pair trawl. > 1000HP	Vb 1 Others (+ scaling)	Vb1 All Faroese Fleets	Vb2 All Faroese LLiners	Vb2 All Faroese Pairtrawlers	Vb2 Others	Vb2 All Faroese Fleets	Vb Foreign Trawlers
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	6	33	4	4	1	1	1	22	75	0	0	0	0	0
3	62	423	71	40	34	8	17	311	973	0	3	0	3	4
4	26	151	96	25	31	6	24	210	535	0	6	0	6	4
5	114	649	653	94	134	28	105	837	2648	9	46	0	55	16
6	126	728	848	117	173	35	141	1100	3235	4	33	0	37	21
7	106	605	775	58	134	25	112	907	2706	2	18	0	20	16
8	42	235	295	22	77	13	54	376	1095	1	6	0	6	9
9	2	15	35	1	3	0	3	51	88	0	0	0	0	0
10	0	2	2	0	1	0	0	1	7	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	1	0	0	0	0	2	2	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total no.	485	2840	2781	360	587	117	457	3818	11365	15	111	0	127	70
Catch, t.	449	2686	2930	289	556	109	439	3655	11110	18	117	0	135	66

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 tr Pair Trawl. = Pair trawlers

Sampling 2007	Vb1 Open Boats	Vb1 LLiners < 100GRT	Vb1 LLiners > 100GRT	Vb1 OB. trawl. < 1000HP	Vb1 OB. trawl. > 1000HP	Vb1 Pair trawl. < 1000HP	Vb1 Pair trawl. > 1000HP	Vb 1 Others	Vb1 All Faroese Fleets	Vb2 All Faroese LLiners	Vb2 All Faroese trawlers	Vb2 Others	Vb2 All Faroese Fleets	Vb Foreign Trawlers
No. samples	20	28	350	12	10	18	27	0	465	7	0	0	7	0
No. lengths	3477	5648	11343	2562	1974	4026	5441	0	34471	1573	0	0	1573	0
No. weights	2454	3165	7037	1757	590	1913	2568	0	19484	1236	0	0	1236	0
No. ages	635	300	1131	120	60	60	410	0	2716	240	0	0	240	0

Table 5.3 Total Faroese landings of haddock from Division Vb 1985-2007 and the contribution (%) by each fleet category (metier).
Total catch in this table may deviate from official landings.

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Open boats	7	7	11	2	3	2	3	2	1	1	1	2	2	2	2	1	2	3	4	4	4	6	6
Longliners < 100GRT	39	39	39	49	58	60	56	46	24	18	23	28	31	30	23	24	29	31	34	40	41	47	35
Longliners > 100GRT	13	12	13	19	18	18	18	22	25	25	38	36	38	40	40	36	38	34	42	42	43	36	39
Otter board trawlers < 1000HP	7	5	7	6	4	4	3	3	11	10	12	13	9	8	7	9	7	6	4	3	3	1	4
Otterboard trawlers > 1000HP	8	5	2	2	2	2	2	1	1	3	2	2	3	3	7	5	5	11	3	1	1	2	8
Pairtrawlers < 1000HP	19	20	17	11	7	5	7	11	13	10	8	7	6	5	6	7	6	4	4	2	2	2	3
Pairtrawlers > 1000HP	6	10	9	9	6	8	11	14	22	29	16	13	12	12	14	19	12	10	8	7	4	5	6
Nets	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jigging	1	0	0	0	1	1	1	0	0	0	0	1	1	0	0	0	1	2	1	1	1	0	1
Other gears	0	1	1	2	1	1	1	1	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0
Total catch, tonnes gutted	13570	12967	13829	10697	12866	10319	7469	4103	3275	3629	4371	8535	15890	19669	16062	13881	13555	21842	22516	19396	16328	11962	7648

Table 5.5 Faroe haddock. Catch number-at-age

Run title : FAROE HADDOCK (ICES DIVISION Vb) HAD_IND

At 17/04/2008 19:07

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

YEAR,	1957,
AGE	
0,	0,
1,	45,
2,	4133,
3,	7130,
4,	8442,
5,	1615,
6,	894,
7,	585,
8,	227,
9,	94,
+gp,	58,
TOTALNUM,	23223,
TONSLAND,	20995,
SOPCOF %,	89,

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

YEAR,	1958,	1959,	1960,	1961,	1962,	1963,	1964,	1965,	1966,	1967,
AGE										
0,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
1,	116,	525,	854,	941,	784,	356,	46,	39,	90,	70,
2,	6255,	3971,	6061,	7932,	9631,	13552,	2284,	1368,	1081,	1425,
3,	8021,	7663,	10659,	7330,	13977,	8907,	7457,	4286,	3304,	2405,
4,	5679,	4544,	6655,	5134,	5233,	7403,	3899,	5133,	4804,	2599,
5,	3378,	2056,	2482,	1937,	2361,	2242,	2360,	1443,	2710,	1785,
6,	1299,	1844,	1559,	1305,	1407,	1539,	1120,	1209,	1112,	1426,
7,	817,	721,	1169,	838,	868,	860,	728,	673,	740,	631,
8,	294,	236,	243,	236,	270,	257,	198,	1345,	180,	197,
9,	125,	98,	85,	59,	72,	75,	49,	43,	54,	52,
+gp,	105,	47,	28,	13,	22,	23,	7,	8,	9,	13,
TOTALNUM,	26089,	21705,	29795,	25725,	34625,	35214,	18148,	15547,	14084,	10603,
TONSLAND,	23871,	20239,	25727,	20831,	27151,	27571,	19490,	18479,	18766,	13381,
SOPCOF %,	90,	90,	88,	88,	89,	89,	101,	94,	109,	101,

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

YEAR,	1968,	1969,	1970,	1971,	1972,	1973,	1974,	1975,	1976,	1977,
AGE										
0,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
1,	49,	95,	57,	55,	43,	665,	253,	94,	40,	0,
2,	5881,	2384,	1728,	717,	750,	3311,	5633,	7337,	4396,	255,
3,	4097,	7539,	4855,	4393,	3744,	8416,	2899,	7952,	7858,	4039,
4,	2812,	4567,	6581,	4727,	4179,	1240,	3970,	2097,	6798,	5168,
5,	1524,	1565,	1624,	3267,	2706,	2795,	451,	1371,	1251,	4918,
6,	1526,	1485,	1383,	1292,	1171,	919,	976,	247,	1189,	2128,
7,	923,	1224,	1099,	864,	696,	1054,	466,	352,	298,	946,
8,	230,	378,	326,	222,	180,	150,	535,	237,	720,	443,
9,	68,	114,	68,	147,	113,	68,	68,	419,	258,	731,
+gp,	12,	20,	10,	102,	95,	11,	147,	187,	318,	855,
TOTALNUM,	17122,	19371,	17731,	15786,	13677,	18629,	15398,	20293,	23126,	19483,
TONSLAND,	17852,	23272,	21361,	19393,	16485,	18035,	14773,	20715,	26211,	25555,
SOPCOF %,	102,	108,	102,	97,	96,	97,	97,	117,	107,	98,

Table 5.5 Faroe haddock. Catch number-at-age (cont.)

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

YEAR,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,	1986,	1987,
AGE										
0,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
1,	0,	1,	0,	0,	0,	0,	25,	0,	0,	0,
2,	32,	1,	143,	74,	539,	441,	1195,	985,	230,	283,
3,	1022,	1162,	58,	455,	934,	1969,	1561,	4553,	2549,	1718,
4,	4248,	1755,	3724,	202,	784,	383,	2462,	2196,	4452,	3565,
5,	4054,	3343,	2583,	2586,	298,	422,	147,	1242,	1522,	2972,
6,	1841,	1851,	2496,	1354,	2182,	93,	234,	169,	738,	1114,
7,	717,	772,	1568,	1559,	973,	1444,	42,	91,	39,	529,
8,	635,	212,	660,	608,	1166,	740,	861,	61,	130,	83,
9,	243,	155,	99,	177,	1283,	947,	388,	503,	71,	48,
+gp,	312,	74,	86,	36,	214,	795,	968,	973,	712,	334,
TOTALNUM,	13104,	9326,	11417,	7051,	8373,	7234,	7883,	10773,	10443,	10646,
TONSLAND,	19200,	12424,	15016,	12233,	11937,	12894,	12378,	15143,	14477,	14882,
SOPCOF %,	99,	104,	100,	109,	92,	106,	106,	106,	101,	102,

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

YEAR,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997,
AGE										
0,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
1,	0,	0,	0,	0,	0,	43,	1,	0,	1,	0,
2,	655,	63,	105,	77,	40,	113,	277,	804,	326,	77,
3,	444,	1518,	1275,	1044,	154,	298,	191,	452,	5234,	2913,
4,	2463,	658,	1921,	1774,	776,	274,	307,	235,	1019,	10517,
5,	3036,	2787,	768,	1248,	1120,	554,	153,	226,	179,	710,
6,	2140,	2554,	1737,	651,	959,	538,	423,	132,	163,	116,
7,	475,	1976,	1909,	1101,	335,	474,	427,	295,	161,	123,
8,	151,	541,	885,	698,	373,	131,	383,	290,	270,	93,
9,	18,	133,	270,	317,	401,	201,	125,	262,	234,	220,
+gp,	128,	81,	108,	32,	162,	185,	301,	295,	394,	516,
TOTALNUM,	9510,	10311,	8978,	6942,	4320,	2811,	2588,	2991,	7981,	15285,
TONSLAND,	12178,	14325,	11726,	8429,	5476,	4026,	4252,	4948,	9642,	17924,
SOPCOF %,	97,	100,	102,	106,	106,	103,	100,	103,	100,	103,

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

YEAR,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	2005,	2006,	2007,
AGE										
0,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
1,	0,	9,	73,	19,	0,	0,	3,	0,	0,	0,
2,	106,	174,	1461,	4380,	1515,	133,	245,	84,	246,	76,
3,	1055,	1142,	3061,	3128,	14039,	3443,	2023,	1659,	444,	982,
4,	5269,	942,	210,	2423,	2879,	13579,	4841,	3824,	2554,	547,
5,	9856,	4677,	682,	173,	1200,	2229,	10510,	6703,	3931,	2732,
6,	446,	6619,	2685,	451,	133,	951,	1172,	6082,	5397,	3310,
7,	99,	226,	2846,	1151,	239,	163,	412,	538,	3263,	2758,
8,	87,	26,	79,	1375,	843,	335,	90,	146,	136,	1117,
9,	95,	20,	1,	17,	1095,	860,	167,	28,	63,	89,
+gp,	502,	192,	71,	18,	33,	935,	818,	153,	70,	9,
TOTALNUM,	17515,	14027,	11169,	13135,	21976,	22628,	20281,	19217,	16104,	11620,
TONSLAND,	22210,	18482,	15821,	15890,	24933,	27128,	23287,	20305,	17074,	12633,
SOPCOF %,	101,	100,	103,	100,	100,	100,	99,	100,	100,	100,

Table 5.6 Faroe haddock. Catch weight-at-age.

Run title : FAROE HADDOCK (ICES DIVISION Vb) HAD_IND

At 17/04/2008 19:07

Table 2 Catch weights at age (kg)

YEAR,	1957,
AGE	
0,	.0000,
1,	.2500,
2,	.4700,
3,	.7300,
4,	1.1300,
5,	1.5500,
6,	1.9700,
7,	2.4100,
8,	2.7600,
9,	3.0700,
+gp,	3.5500,
SOPCOFAC,	.8937,

Table 2 Catch weights at age (kg)

YEAR,	1958,	1959,	1960,	1961,	1962,	1963,	1964,	1965,	1966,	1967,
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,
SOPCOFAC,	.8983,	.9034,	.8832,	.8832,	.8929,	.8915,	1.0111,	.9383,	1.0885,	1.0117,

Table 2 Catch weights at age (kg)

YEAR,	1968,	1969,	1970,	1971,	1972,	1973,	1974,	1975,	1976,	1977,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.2500,	.2500,	.2500,	.2500,	.2500,	.2500,	.2500,	.2500,	.2500,	.0000,
2,	.4700,	.4700,	.4700,	.4700,	.4700,	.4700,	.4700,	.4700,	.4700,	.3110,
3,	.7300,	.7300,	.7300,	.7300,	.7300,	.7300,	.7300,	.7300,	.7300,	.6330,
4,	1.1300,	1.1300,	1.1300,	1.1300,	1.1300,	1.1300,	1.1300,	1.1300,	1.1300,	1.0440,
5,	1.5500,	1.5500,	1.5500,	1.5500,	1.5500,	1.5500,	1.5500,	1.5500,	1.5500,	1.4260,
6,	1.9700,	1.9700,	1.9700,	1.9700,	1.9700,	1.9700,	1.9700,	1.9700,	1.9700,	1.8250,
7,	2.4100,	2.4100,	2.4100,	2.4100,	2.4100,	2.4100,	2.4100,	2.4100,	2.4100,	2.2410,
8,	2.7600,	2.7600,	2.7600,	2.7600,	2.7600,	2.7600,	2.7600,	2.7600,	2.7600,	2.2050,
9,	3.0700,	3.0700,	3.0700,	3.0700,	3.0700,	3.0700,	3.0700,	3.0700,	3.0700,	2.5700,
+gp,	3.5500,	3.5500,	3.5500,	3.5500,	3.5500,	3.5500,	3.5500,	3.5500,	3.5500,	2.5910,
SOPCOFAC,	1.0246,	1.0787,	1.0249,	.9688,	.9597,	.9690,	.9678,	1.1696,	1.0741,	.9784,

Table 5.6 Faroe haddock. Catch weight-at-age (cont.).

Table 2 Catch weights at age (kg)

YEAR,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,	1986,	1987,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0000,	.3000,	.0000,	.0000,	.0000,	.0000,	.3590,	.0000,	.0000,	.0000,
2,	.3570,	.3570,	.6430,	.4520,	.7000,	.4700,	.6810,	.5280,	.6080,	.6050,
3,	.7900,	.6720,	.7130,	.7250,	.8960,	.7400,	1.0110,	.8590,	.8870,	.8310,
4,	1.0350,	.8940,	.9410,	.9570,	1.1500,	1.0100,	1.2550,	1.3910,	1.1750,	1.1260,
5,	1.3980,	1.1560,	1.1570,	1.2370,	1.4440,	1.3200,	1.8120,	1.7770,	1.6310,	1.4620,
6,	1.8700,	1.5900,	1.4930,	1.6510,	1.4980,	1.6600,	2.0610,	2.3260,	1.9840,	1.9410,
7,	2.3500,	2.0700,	1.7390,	2.0530,	1.8290,	2.0500,	2.0590,	2.4400,	2.5190,	2.1730,
8,	2.5970,	2.5250,	2.0950,	2.4060,	1.8870,	2.2600,	2.1370,	2.4010,	2.5830,	2.3470,
9,	3.0140,	2.6960,	2.4650,	2.7250,	1.9610,	2.5400,	2.3680,	2.5320,	2.5700,	3.1180,
+gp,	2.9200,	3.5190,	3.3100,	3.2500,	2.8560,	3.0400,	2.6860,	2.6860,	2.9220,	2.9330,
SOPCOFAC,	.9947,	1.0380,	1.0017,	1.0870,	.9238,	1.0554,	1.0593,	1.0559,	1.0141,	1.0197,

Table 2 Catch weights at age (kg)

YEAR,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.3600,	.0000,	.0000,	.3600,	.0000,
2,	.5010,	.5800,	.4380,	.5470,	.5250,	.7550,	.7540,	.6660,	.5340,	.5190,
3,	.7810,	.7790,	.6990,	.6930,	.7240,	.9820,	1.1030,	1.0540,	.8580,	.7710,
4,	.9740,	.9230,	.9390,	.8840,	.8170,	1.0270,	1.2540,	1.4890,	1.4590,	1.0660,
5,	1.3630,	1.2070,	1.2040,	1.0860,	1.0380,	1.1920,	1.4650,	1.7790,	1.9930,	1.7990,
6,	1.6800,	1.5640,	1.3840,	1.2760,	1.2490,	1.3780,	1.5930,	1.9400,	2.3300,	2.2700,
7,	1.9750,	1.7460,	1.5640,	1.4770,	1.4300,	1.6430,	1.8040,	2.1820,	2.3510,	2.3400,
8,	2.3440,	2.0860,	1.8180,	1.5740,	1.5640,	1.7960,	2.0490,	2.3570,	2.4690,	2.4750,
9,	2.2480,	2.4240,	2.1680,	1.9300,	1.6330,	1.9710,	2.2250,	2.4900,	2.7770,	2.5010,
+gp,	3.2950,	2.5140,	2.3350,	2.1530,	2.1260,	2.2400,	2.4230,	2.6780,	2.5820,	2.6760,
SOPCOFAC,	.9695,	1.0025,	1.0195,	1.0635,	1.0554,	1.0320,	.9969,	1.0331,	1.0043,	1.0250,

Table 2 Catch weights at age (kg)

YEAR,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	2005,	2006,	2007,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0000,	.2780,	.2800,	.2800,	.0000,	.0000,	.3670,	.0000,	.0000,	.0000,
2,	.6220,	.5040,	.6610,	.6080,	.5840,	.5710,	.5740,	.5380,	.4750,	.6280,
3,	.8460,	.6240,	.9360,	.9400,	.8570,	.7150,	.7700,	.6490,	.6010,	.6690,
4,	1.0160,	.9740,	1.1660,	1.3740,	1.4050,	1.0080,	.8870,	.7970,	.7680,	.8590,
5,	1.2830,	1.2200,	1.4830,	1.7790,	1.7990,	1.5370,	1.1590,	1.0200,	.9110,	.9690,
6,	2.0800,	1.4900,	1.6160,	1.9710,	1.9740,	1.9110,	1.6380,	1.2450,	1.1260,	1.0600,
7,	2.5560,	2.4560,	1.8930,	2.1190,	2.3010,	2.0910,	1.8700,	1.8430,	1.3740,	1.2450,
8,	2.5720,	2.6580,	2.8210,	2.3730,	2.3700,	2.3010,	2.4380,	2.0610,	2.1580,	1.4750,
9,	2.4520,	2.5980,	3.7490,	2.7500,	2.6260,	2.4060,	2.3570,	2.2630,	2.2110,	2.2660,
+gp,	2.7530,	2.9530,	3.1960,	3.9660,	3.1300,	2.5350,	2.4170,	2.5790,	2.5690,	2.2560,
SOPCOFAC,	1.0106,	.9973,	1.0349,	.9960,	1.0010,	1.0040,	.9928,	.9988,	.9985,	.9999,

Table 5.7 Faroe haddock. Proportion mature-at-age.

Run title : FAROE HADDOCK (ICES DIVISION Vb) HAD_IND

At 17/04/2008 19:07

Table 5 Proportion mature at age

YEAR,	1957,
AGE	
0,	.0000,
1,	.0000,
2,	.0600,
3,	.4800,
4,	.9100,
5,	1.0000,
6,	1.0000,
7,	1.0000,
8,	1.0000,
9,	1.0000,
+gp,	1.0000,

Table 5 Proportion mature at age

YEAR,	1958,	1959,	1960,	1961,	1962,	1963,	1964,	1965,	1966,	1967,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.0600,	.0600,	.0600,	.0600,	.0600,	.0600,	.0600,	.0600,	.0600,	.0600,
3,	.4800,	.4800,	.4800,	.4800,	.4800,	.4800,	.4800,	.4800,	.4800,	.4800,
4,	.9100,	.9100,	.9100,	.9100,	.9100,	.9100,	.9100,	.9100,	.9100,	.9100,
5,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
6,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
7,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
8,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
9,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
+gp,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,

Table 5 Proportion mature at age

YEAR,	1968,	1969,	1970,	1971,	1972,	1973,	1974,	1975,	1976,	1977,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.0600,	.0600,	.0600,	.0600,	.0600,	.0600,	.0600,	.0600,	.0600,	.0600,
3,	.4800,	.4800,	.4800,	.4800,	.4800,	.4800,	.4800,	.4800,	.4800,	.4800,
4,	.9100,	.9100,	.9100,	.9100,	.9100,	.9100,	.9100,	.9100,	.9100,	.9100,
5,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
6,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
7,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
8,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
9,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
+gp,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,

Table 5.7 Faroe haddock. Proportion mature-at-age (cont.).

Table 5 Proportion mature at age

YEAR, AGE	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,	1986,	1987,
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,	.0800,	.0800,	.0800,	.0300,	.0300,	.0500,
3,	.4800,	.4800,	.4800,	.4800,	.6200,	.6200,	.7600,	.6200,	.4300,	.3200,
4,	.9100,	.9100,	.9100,	.9100,	.8900,	.8900,	.9800,	.9600,	.9500,	.9100,
5,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	.9900,	.9800,
6,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
7,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
8,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
9,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
+gp,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,

Table 5 Proportion mature at age

YEAR, AGE	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997,
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.0500,	.0200,	.0800,	.1600,	.1800,	.1100,	.0500,	.0300,	.0300,	.0100,
3,	.2400,	.2200,	.3700,	.5800,	.6500,	.5000,	.4200,	.4700,	.4700,	.4700,
4,	.8900,	.8700,	.9000,	.9300,	.9100,	.8500,	.8600,	.9100,	.9300,	.9100,
5,	.9800,	.9900,	1.0000,	1.0000,	1.0000,	.9700,	.9600,	.9600,	.9800,	1.0000,
6,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	.9900,	.9900,	.9900,	1.0000,	1.0000,
7,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
8,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
9,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
+gp,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,

Table 5 Proportion mature at age

YEAR, AGE	1998,	1999,	2000,	2001,	2002,	2003,	2004,	2005,	2006,	2007,
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.0100,	.0100,	.0200,	.0900,	.0800,	.0700,	.0000,	.0100,	.0100,	.0200,
3,	.3600,	.3500,	.3600,	.5400,	.4900,	.4500,	.3500,	.3400,	.4200,	.5200,
4,	.8700,	.8600,	.8700,	.9300,	.9700,	.9700,	.9400,	.9100,	.9100,	.9200,
5,	.9900,	.9900,	.9900,	1.0000,	1.0000,	.9900,	.9900,	.9900,	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 5.8 Faroe haddock. 2008 tuning file.

```
FAROE Haddock (ICES SUBDIVISION VB)       COMB-SURVEY-SPALY-08-jr.txt
102
SUMMER SURVEY
1996 2007
1 1 0.6 0.7
1 8
200   42362.00 38050.46 60866.49   1138.05   210.25   286.72  238.48  416.44
200    6851.83 12379.93 24184.20  47016.45   852.22   177.11   81.49  163.30
200   18825.00  2793.18  2545.32  14600.59 18399.09   285.78   89.61   73.64
200   24115.03  9521.26  5553.74   1548.70  8698.75  9829.62  204.06    7.89
200  161583.90 18837.41  7340.20    371.40  1301.41  4638.88 5699.14   85.81
200   98708.03 96675.44 11962.07   4424.74   174.57   629.27 2615.71 3209.95
200   89340.23 52092.34 57922.78   5538.84  1909.63   162.47  395.07 1256.27
200   47450.28 36196.89 22847.00  35941.83  3962.64   621.93  101.63  428.87
200    9049.95 33653.00 15117.67  16561.09 16561.09   885.34  185.66   24.20
200   14574.15  7694.99 12936.61  16513.01 11635.42 11963.56  517.84   36.46
200    3484.57  9591.77  2004.49   8969.12  8908.60  6973.94 3364.52  125.74
200    3295.49  3250.16  1707.14   6581.63  5809.35  3985.64 1821.87   56.85
SPRING SURVEY SHIFTED
1993 2007
1 1 0.95 1.0
0 6
100  16009.60   1958.70    216.70    338.10    172.80   305.30    399.60
100  35395.20  19462.60    702.20    216.60    150.70    48.80    141.10
100   6611.80  33206.50  19338.50    663.10     98.20    73.90     56.00
100    371.70   8095.00  15618.00  25478.90    628.10   146.10     37.00
100   3481.60   1545.80   3353.40  10120.10  12687.60   336.20      9.90
100   4459.50   6739.70    112.20   1517.30   4412.30  3139.20     48.70
100  25964.40   8354.40   4858.70    198.10    443.90  1669.60   1940.70
100  25283.30  36311.20   3384.70   1056.60     26.70   106.60    427.70
100  21111.90  17809.30  25760.60   1934.70    684.90    40.60    101.70
100   9391.10  22335.10  13272.70  12734.40    776.10   230.10     19.30
100   1823.10  16068.30  10327.10   7487.70  11212.50   487.50     79.10
100   5798.80   6022.70   7742.00   6165.00   4565.90  4912.80    238.60
100    705.50   6284.80   1574.60   4457.00   3250.40  3267.50   1577.20
100   1173.20   1891.90   4313.40   1010.00   3511.30  3712.50   2874.90
100    637.40   1688.00   1924.00    591.00   1745.90  1626.20   1027.20
```

Table 5.9 Faroe haddock 2008 xsa.

```
Lowestoft VPA Version 3.1     17/04/2008  19:05

Extended Survivors Analysis

FAROE HADDOCK (ICES DIVISION Vb)                HAD_IND

CPUE data from file d:\vpa\vpa2008\vpa\input-files\comb-survey-spaly-08-jr.txt

Catch data for  51 years. 1957 to 2007. Ages  0 to  10.

     Fleet,             First, Last, First, Last, Alpha,  Beta
                   ,     year, year,  age ,  age
SUMMER SURVEY       ,    1996, 2007,   1,     8,   .600,   .700
SPRING SURVEY SHIFTE,    1993, 2007,   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   43 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,  1998,  1999,  2000,  2001,  2002,  2003,  2004,  2005,  2006,  2007

     0,  .000,  .000,  .000,  .000,  .000,  .000,  .000,  .000,  .000,  .000
     1,  .000,  .000,  .001,  .000,  .000,  .000,  .000,  .000,  .000,  .000
     2,  .032,  .012,  .078,  .047,  .028,  .003,  .009,  .011,  .027,  .023
     3,  .170,  .551,  .312,  .238,  .210,  .081,  .064,  .075,  .072,  .144
     4,  .231,  .226,  .180,  .437,  .359,  .323,  .156,  .166,  .157,  .120
     5,  .322,  .331,  .254,  .222,  .403,  .526,  .447,  .335,  .257,  .252
     6,  .615,  .374,  .322,  .266,  .266,  .653,  .588,  .509,  .497,  .359
     7, 1.298,  .745,  .272,  .222,  .219,  .608,  .669,  .595,  .570,  .513
     8, 1.041, 1.920,  .640,  .204,  .251,  .544,  .831,  .531,  .289,  .387
     9,  .775,  .723,  .320,  .269,  .248,  .439,  .580,  .677,  .462,  .312
```

Table 5.9 Faroe haddock 2008 xsa (cont.)

XSA population numbers (Thousands)

YEAR	AGE 0	1	2	3	4	5	6	7	8	9
1998	3.22E+04	1.91E+04	3.76E+03	7.46E+03	2.82E+04	3.95E+04	1.07E+03	1.51E+02	1.49E+02	1.95E+02
1999	1.57E+05	2.63E+04	1.56E+04	2.98E+03	5.15E+03	1.83E+04	2.35E+04	4.75E+02	3.37E+01	4.30E+01
2000	9.21E+04	1.28E+05	2.16E+04	1.26E+04	1.41E+03	3.36E+03	1.08E+04	1.32E+04	1.85E+02	4.04E+00
2001	6.57E+04	7.54E+04	1.05E+05	1.63E+04	7.57E+03	9.61E+02	2.14E+03	6.40E+03	8.25E+03	7.98E+01
2002	4.69E+04	5.38E+04	6.17E+04	8.19E+04	1.05E+04	4.00E+03	6.30E+02	1.34E+03	4.20E+03	5.51E+03
2003	1.29E+04	3.84E+04	4.41E+04	4.92E+04	5.44E+04	6.02E+03	2.19E+03	3.95E+02	8.82E+02	2.67E+03
2004	1.51E+04	1.06E+04	3.15E+04	3.60E+04	3.71E+04	3.22E+04	2.91E+03	9.33E+02	1.76E+02	4.19E+02
2005	5.60E+03	1.24E+04	8.67E+03	2.55E+04	2.76E+04	2.60E+04	1.69E+04	1.33E+03	3.91E+02	6.29E+01
2006	4.62E+03	4.59E+03	1.01E+04	7.02E+03	1.94E+04	1.91E+04	1.52E+04	8.30E+03	5.98E+02	1.88E+02
2007	3.15E+03	3.78E+03	3.76E+03	8.08E+03	5.35E+03	1.36E+04	1.21E+04	7.59E+03	3.85E+03	3.67E+02

Estimated population abundance at 1st Jan 2008

, 0.00E+00, 2.58E+03, 3.10E+03, 3.01E+03, 5.73E+03, 3.89E+03, 8.64E+03, 6.93E+03, 3.72E+03, 2.14E+03,

Taper weighted geometric mean of the VPA populations:

, 2.69E+04, 2.34E+04, 2.00E+04, 1.60E+04, 1.07E+04, 6.44E+03, 3.71E+03, 1.97E+03, 9.22E+02, 4.16E+02,

Standard error of the weighted Log(VPA populations) :

, 1.0829, 1.0437, 1.0126, .9623, .9640, .9592, .9546, .9763, 1.1269, 1.3953,

Log catchability residuals.

Fleet : SUMMER SURVEY

Age	1993	1994	1995	1996	1997
0	No data for this fleet at this age				
1	99.99	99.99	99.99	1.12	.20
2	99.99	99.99	99.99	-.08	.42
3	99.99	99.99	99.99	.30	.12
4	99.99	99.99	99.99	-.42	.41
5	99.99	99.99	99.99	-.11	.04
6	99.99	99.99	99.99	.24	.45
7	99.99	99.99	99.99	-.01	-.32
8	99.99	99.99	99.99	-.09	.17

Age	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
0	No data for this fleet at this age									
1	-.22	-.29	.03	.07	.30	.01	-.36	-.04	-.48	-.34
2	-.16	-.37	.03	.06	-.04	-.08	.18	.00	.07	-.02
3	-.45	1.49	.17	.35	.30	-.20	-.31	-.12	-.70	-.95
4	.01	-.54	-.70	.26	.11	.31	-.19	.11	-.15	.80
5	.07	.10	-.15	-.93	.15	.55	.26	.04	.03	-.05
6	-.25	.05	.04	-.38	-.51	-.16	-.14	.66	.21	-.21
7	1.00	.31	.01	-.08	-.41	-.29	-.51	.12	.14	-.42
8	.65	.47	.32	-.14	-.37	.30	-.77	-1.36	-.70	-3.29

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	8
Mean Log q	-4.9650	-5.2800	-5.6787	-5.6834	-5.7992	-5.8410	-5.8410	-5.8410
S.E(Log q)	.4274	.1905	.6270	.4284	.3464	.3433	.4179	1.1590

Table 5.9 Faroe haddock 2008 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,	.94,	.567,	5.26,	.90,	12,	.41,	-4.97,
2,	1.00,	.046,	5.29,	.97,	12,	.20,	-5.28,
3,	1.04,	-.190,	5.52,	.73,	12,	.68,	-5.68,
4,	.85,	1.683,	6.23,	.93,	12,	.34,	-5.68,
5,	.89,	1.832,	6.13,	.97,	12,	.28,	-5.80,
6,	.96,	.662,	5.94,	.96,	12,	.34,	-5.84,
7,	1.09,	-1.006,	5.75,	.92,	12,	.45,	-5.88,
8,	1.43,	-1.561,	6.18,	.57,	12,	1.45,	-6.24,

Fleet : SPRING SURVEY SHIFTE

Age	1993	1994	1995	1996	1997
0	-.61	.93	.87	-1.11	-.30
1	-.40	-.83	.45	.65	-.11
2	-.51	-.62	-.06	.47	.55
3	.07	.06	-.15	.71	.54
4	-.26	-.14	-.08	.49	.56
5	-.22	-1.00	-.16	1.12	.72
6	.46	-.28	-.18	.03	-.55
7	No data for this fleet at this age				
8	No data for this fleet at this age				

Age	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
0	-.38	-.20	.31	.46	-.01	-.36	.64	-.47	.23	.00
1	-.06	-.17	-.28	-.46	.10	.11	.42	.30	.10	.17
2	-1.93	.39	-.23	.19	.04	.10	.15	-.15	.72	.90
3	.34	-.41	-.41	-.14	.11	-.04	.06	.09	-.11	-.71
4	.27	-.33	-1.88	-.07	-.35	.64	-.04	-.07	.35	.90
5	-.13	.02	-1.11	-.86	-.37	.09	.65	.34	.70	.21
6	-.11	.26	-.53	-.40	-.84	-.30	.46	.51	1.20	.27
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,	-6.0095,	-5.3918,	-5.9572,	-6.1733,	-6.3153,	-6.5002,	-6.7966,
S.E(Log q),	.5746,	.3909,	.6828,	.3619,	.6470,	.6571,	.5296,

Table 5.9 Faroe haddock 2008 xsa (cont.)

Regression statistics :

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

Age,	Slope ,	t-value ,	Intercept,	RSquare,	No Pts,	Reg s.e,	Mean Q
0,	.93,	.588,	6.28,	.86,	15,	.55,	-6.01,
1,	1.16,	-1.639,	4.68,	.89,	15,	.43,	-5.39,
2,	.86,	1.122,	6.48,	.83,	15,	.58,	-5.96,
3,	.89,	1.698,	6.52,	.95,	15,	.30,	-6.17,
4,	.82,	2.030,	6.81,	.90,	15,	.48,	-6.32,
5,	.89,	.947,	6.72,	.86,	15,	.59,	-6.50,
6,	.81,	2.771,	7.02,	.94,	15,	.35,	-6.80,

Terminal year survivor and F summaries :

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

Year class = 2007

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,	2583.,	.593,	.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
2583.,	.59,	.00,	1,	.000,	.000

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

Year class = 2006

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
SUMMER SURVEY ,	2202.,	.445,	.000,	.00,	1,	.360,	.000
SPRING SURVEY SHIFTE,	3752.,	.334,	.025,	.08,	2,	.640,	.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
3096.,	.27,	.18,	3,	.680,	.000

Table 5.9 Faroe haddock 2008 xsa (cont.)

Age 2 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 ,	2557.,	.249,	.213,	.86,	2,	.517,	.027
SPRING SURVEY SHIFTE,	3309.,	.302,	.318,	1.05,	3,	.352,	.021
F shrinkage mean ,	4399.,	.50,,,,				.131,	.016

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
3006.,	.18,	.16,	6,	.913,	.023

Age 3 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 ,	5232.,	.232,	.238,	1.02,	3,	.446,	.157
SPRING SURVEY SHIFTE,	5693.,	.235,	.343,	1.46,	4,	.440,	.145
F shrinkage mean ,	8390.,	.50,,,,				.114,	.101

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
5730.,	.16,	.18,	8,	1.151,	.144

Age 4 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 ,	4031.,	.206,	.271,	1.31,	4,	.484,	.116
SPRING SURVEY SHIFTE,	4420.,	.222,	.197,	.89,	5,	.417,	.106
F shrinkage mean ,	1882.,	.50,,,,				.099,	.233

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
3885.,	.14,	.16,	10,	1.121,	.120

Table 5.9 Faroe haddock 2008 xsa (cont.)

```
Age  5   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       ,      8753.,   .180,       .065,    .36,   5,  .530,     .249
 SPRING SURVEY SHIFTE,      9844.,   .211,       .042,    .20,   6,  .367,     .224

   F shrinkage mean  ,      5083.,    .50,,,,                        .103,     .396

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      8643.,       .13,      .07,   12,    .511,   .252


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

 Year class = 2001

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SUMMER SURVEY       ,      6655.,   .163,       .075,    .46,   6,  .549,     .372
 SPRING SURVEY SHIFTE,      8475.,   .200,       .087,    .43,   7,  .340,     .303

   F shrinkage mean  ,      4543.,    .50,,,,                        .111,     .506

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      6926.,       .13,      .07,   14,    .577,   .359


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

 Year class = 2000

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SUMMER SURVEY       ,      3451.,   .164,       .095,    .58,   7,  .564,     .544
 SPRING SURVEY SHIFTE,      4554.,   .202,       .231,   1.14,   7,  .261,     .437

   F shrinkage mean  ,      3514.,    .50,,,,                        .175,     .537

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      3722.,       .14,      .10,   15,    .694,   .513
```

Table 5.9 Faroe haddock 2008 xsa (cont.)

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

Year class = 1999

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
SUMMER SURVEY       ,      2293.,   .182,       .337,   1.86,   8,  .523,     .365
SPRING SURVEY SHIFTE,      2698.,   .216,       .141,    .65,   7,  .199,     .318

  F shrinkage mean  ,      1586.,    .50,,,,                         .278,     .493

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
     2138.,       .17,      .18,   16,   1.042,   .387


Age  9   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       ,       228.,   .192,       .116,    .60,   8,  .476,     .303
SPRING SURVEY SHIFTE,       224.,   .223,       .126,    .56,   7,  .167,     .307

  F shrinkage mean  ,       207.,    .50,,,,                         .357,     .328

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
      220.,       .20,      .07,   16,    .319,   .312
```

Table 5.10 Faroe haddock. Fishing mortality (F) at age.

Run title : FAROE HADDOCK (ICES DIVISION Vb) HAD_IND

At 17/04/2008 19:07

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR,	1957,
AGE	
0,	.0000,
1,	.0010,
2,	.1394,
3,	.3707,
4,	.6163,
5,	.3909,
6,	.4380,
7,	.6340,
8,	.5599,
9,	.5321,
+gp,	.5321,
FBAR 3- 7,	.4900,

Table 8 Fishing mortality (F) at age

YEAR,	1958,	1959,	1960,	1961,	1962,	1963,	1964,	1965,	1966,	1967,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0024,	.0132,	.0150,	.0219,	.0149,	.0106,	.0018,	.0017,	.0032,	.0012,
2,	.1939,	.1066,	.2074,	.1875,	.3232,	.3801,	.0876,	.0691,	.0610,	.0641,
3,	.4378,	.3860,	.4599,	.4162,	.5866,	.5639,	.3723,	.2354,	.2370,	.1873,
4,	.5737,	.4782,	.6926,	.4209,	.5980,	.7261,	.5193,	.4767,	.4515,	.2971,
5,	.5386,	.4195,	.5260,	.4387,	.3480,	.5591,	.5369,	.3678,	.5006,	.2997,
6,	.6346,	.6458,	.6591,	.5879,	.6706,	.4026,	.6107,	.5882,	.5421,	.5406,
7,	.9504,	.9184,	1.2130,	.9483,	1.0499,	1.2493,	.3375,	.9618,	.9128,	.6906,
8,	.7839,	.8206,	.9667,	.8742,	.9736,	1.1139,	1.2027,	2.3618,	.7509,	.6634,
9,	.7028,	.6625,	.8198,	.6600,	.7351,	.8185,	.6472,	.9619,	.6373,	.5022,
+gp,	.7028,	.6625,	.8198,	.6600,	.7351,	.8185,	.6472,	.9619,	.6373,	.5022,
FBAR 3- 7,	.6270,	.5696,	.7101,	.5624,	.6506,	.7002,	.4753,	.5260,	.5288,	.4031,

Table 8 Fishing mortality (F) at age

YEAR,	1968,	1969,	1970,	1971,	1972,	1973,	1974,	1975,	1976,	1977,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0014,	.0024,	.0033,	.0015,	.0016,	.0114,	.0033,	.0015,	.0014,	.0000,
2,	.1261,	.0860,	.0551,	.0526,	.0253,	.1677,	.1266,	.1230,	.0908,	.0108,
3,	.2647,	.2363,	.2528,	.1936,	.4225,	.4320,	.2172,	.2650,	.1878,	.1128,
4,	.3483,	.5320,	.3344,	.4186,	.2853,	.2392,	.3730,	.2412,	.3810,	.1814,
5,	.2847,	.3330,	.3639,	.2754,	.4517,	.3143,	.1279,	.2116,	.2216,	.5272,
6,	.4540,	.4975,	.5561,	.5560,	.1495,	.2703,	.1714,	.0957,	.2871,	.7245,
7,	.8367,	.8277,	.8740,	.8385,	.6720,	.1951,	.2134,	.0859,	.1601,	.3903,
8,	.5851,	1.0631,	.5430,	.4224,	.4066,	.2907,	.1433,	.1599,	.2538,	.3787,
9,	.5057,	.6566,	.5386,	.5061,	.3957,	.2633,	.2067,	.1595,	.2621,	.4437,
+gp,	.5057,	.6566,	.5386,	.5061,	.3957,	.2633,	.2067,	.1595,	.2621,	.4437,
FBAR 3- 7,	.4377,	.4853,	.4762,	.4564,	.3962,	.2902,	.2206,	.1799,	.2475,	.3873,

Table 5.10 Faroe haddock. Fishing mortality (F) at age (cont.).

Table 8 Fishing mortality (F) at age

YEAR,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,	1986,	1987,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0000,	.0002,	.0000,	.0000,	.0000,	.0000,	.0006,	.0000,	.0000,	.0000,
2,	.0010,	.0004,	.0325,	.0237,	.0383,	.0251,	.0329,	.0279,	.0096,	.0335,
3,	.0547,	.0457,	.0285,	.1373,	.4615,	.1915,	.1165,	.1691,	.0937,	.0923,
4,	.1665,	.1255,	.2024,	.1313,	.3707,	.3477,	.3892,	.2387,	.2485,	.1837,
5,	.2115,	.1913,	.2748,	.2111,	.2914,	.3495,	.2169,	.3469,	.2591,	.2614,
6,	.3819,	.1408,	.2135,	.2263,	.2773,	.1381,	.3332,	.4156,	.3580,	.3070,
7,	.5759,	.2721,	.1701,	.2003,	.2522,	.2988,	.0852,	.2080,	.1569,	.4731,
8,	.4967,	.3302,	.3952,	.0919,	.2264,	.3099,	.2925,	.1717,	.5167,	.5828,
9,	.3689,	.2129,	.2525,	.1729,	.2852,	.2904,	.2648,	.2777,	.3096,	.3639,
+gp,	.3689,	.2129,	.2525,	.1729,	.2852,	.2904,	.2648,	.2777,	.3096,	.3639,
FBAR 3- 7,	.2781,	.1551,	.1779,	.1813,	.3306,	.2651,	.2282,	.2757,	.2233,	.2635,

Table 8 Fishing mortality (F) at age

YEAR,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0060,	.0000,	.0000,	.0001,	.0000,
2,	.0392,	.0049,	.0123,	.0289,	.0167,	.0709,	.0489,	.0092,	.0078,	.0093,
3,	.0676,	.1200,	.1281,	.1632,	.0742,	.1662,	.1644,	.1052,	.0761,	.0893,
4,	.1854,	.1353,	.2195,	.2644,	.1754,	.1832,	.2581,	.3128,	.3646,	.2156,
5,	.2355,	.3307,	.2314,	.2166,	.2658,	.1830,	.1475,	.3076,	.4181,	.4690,
6,	.3048,	.3185,	.3543,	.3142,	.2575,	.1968,	.2073,	.1833,	.3816,	.5290,
7,	.2072,	.5141,	.4193,	.3993,	.2640,	.1952,	.2367,	.2185,	.3562,	.5590,
8,	.2369,	.3861,	.4583,	.2648,	.2270,	.1558,	.2392,	.2505,	.3188,	.3593,
9,	.2351,	.3390,	.3386,	.2935,	.2391,	.1836,	.2188,	.2558,	.3292,	.4679,
+gp,	.2351,	.3390,	.3386,	.2935,	.2391,	.1836,	.2188,	.2558,	.3292,	.4679,
FBAR 3- 7,	.2001,	.2837,	.2705,	.2715,	.2074,	.1849,	.2028,	.2255,	.3193,	.3724,

Table 8 Fishing mortality (F) at age

YEAR,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	2005,	2006,	2007,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0000,	.0004,	.0006,	.0003,	.0000,	.0000,	.0003,	.0000,	.0000,	.0000,
2,	.0317,	.0124,	.0779,	.0473,	.0275,	.0033,	.0086,	.0108,	.0272,	.0226,
3,	.1700,	.5511,	.3119,	.2379,	.2100,	.0806,	.0642,	.0745,	.0724,	.1442,
4,	.2311,	.2258,	.1805,	.4368,	.3595,	.3231,	.1556,	.1661,	.1572,	.1199,
5,	.3222,	.3311,	.2536,	.2219,	.4025,	.5260,	.4472,	.3350,	.2574,	.2516,
6,	.6146,	.3737,	.3219,	.2655,	.2657,	.6533,	.5879,	.5085,	.4966,	.3594,
7,	1.2976,	.7453,	.2717,	.2216,	.2192,	.6079,	.6691,	.5955,	.5698,	.5132,
8,	1.0411,	1.9203,	.6399,	.2036,	.2510,	.5439,	.8305,	.5315,	.2894,	.3872,
9,	.7753,	.7226,	.3196,	.2686,	.2481,	.4393,	.5800,	.6771,	.4616,	.3123,
+gp,	.7753,	.7226,	.3196,	.2686,	.2481,	.4393,	.5800,	.6771,	.4616,	.3123,
FBAR 3- 7,	.5271,	.4454,	.2679,	.2768,	.2914,	.4382,	.3848,	.3359,	.3107,	.2776,

Table 5.11 Faroe haddock. Stock number (N) at age.

Run title : FAROE HADDOCK (ICES DIVISION Vb) HAD_IND

At 17/04/2008 19:07

Terminal Fs derived using XSA (With F shrinkage)

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

YEAR	1957
AGE	
0	64927
1	47944
2	35106
3	25440
4	20280
5	5517
6	2786
7	1377
8	585
9	252
+gp	154
TOTAL	204367

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

YEAR	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967
AGE										
0	54061	77651	58761	71715	45400	33843	30192	37948	81925	47768
1	53158	44261	63576	48109	58715	37170	27709	24719	31069	67074
2	39212	43417	35763	51279	38537	47362	30110	22644	20203	25356
3	25003	26445	31954	23796	34806	22837	26515	22585	17302	15563
4	14377	13213	14717	16517	12850	15850	10638	14961	14613	11176
5	8965	6632	6706	6028	8877	5786	6278	5182	7604	7617
6	3055	4284	3570	3245	3182	5132	2708	3005	2937	3774
7	1472	1326	1839	1512	1476	1332	2809	1204	1366	1398
8	598	466	433	448	480	423	313	1641	377	449
9	274	224	168	135	153	148	114	77	127	146
+gp	227	106	54	29	46	45	16	14	21	36
TOTAL	200401	218024	217540	222811	204522	169929	137402	133981	177544	180358

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

YEAR	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
AGE										
0	53239	23137	49623	35419	78974	104872	83647	39140	52382	4157
1	39109	43588	18943	40628	28999	64659	85862	68484	32045	42887
2	54852	31976	35601	15458	33214	23703	52336	70069	55985	26200
3	19470	39588	24022	27584	12007	26515	16411	37752	50729	41859
4	10566	12234	25590	15275	18609	6443	14093	10813	23714	34423
5	6798	6106	5884	14997	8229	11454	4153	7946	6955	13264
6	4622	4187	3583	3348	9322	4289	6849	2992	5265	4563
7	1800	2403	2084	1682	1572	6573	2680	4724	2226	3235
8	574	638	860	712	595	657	4428	1772	3550	1553
9	189	262	180	409	382	325	402	3141	1237	2255
+gp	33	45	26	281	319	52	865	1396	1515	2613
TOTAL	191253	164164	166398	155793	192222	249541	271726	248230	235602	177008

Table 5.11 Faroe haddock. Stock number (N) at age (cont.).

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

YEAR	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
AGE										
0	7380	5210	23638	29306	60903	59033	39632	14146	28110	21452
1	3403	6042	4266	19353	23994	49863	48332	32448	11582	23015
2	35113	2786	4946	3492	15845	19644	40824	39549	26566	9483
3	21220	28719	2280	3920	2792	12485	15684	32343	31488	21542
4	30617	16449	22461	1814	2798	1441	8440	11429	22360	23474
5	23507	21223	11879	15020	1303	1581	833	4683	7370	14279
6	6410	15578	14351	7389	9958	797	913	549	2710	4657
7	1810	3582	11079	9491	4824	6178	568	535	297	1551
8	1793	833	2234	7652	6360	3069	3752	427	356	208
9	871	893	490	1232	5715	4152	1843	2293	295	174
+gp	1109	424	423	249	947	3463	4571	4407	2935	1201
TOTAL	133231	101739	98049	98920	135438	161708	165394	142809	134070	121035

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

YEAR	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
AGE										
0	14137	4463	3986	2723	9629	145235	69214	13715	5602	23290
1	17563	11574	3654	3263	2229	7883	118909	56667	11229	4587
2	18843	14379	9476	2992	2672	1825	6415	97353	46395	9193
3	7508	14835	11716	7663	2380	2151	1392	5002	78979	37690
4	16083	5745	10772	8438	5330	1809	1492	967	3686	59926
5	15993	10939	4108	7081	5304	3661	1233	943	579	2096
6	9001	10347	6434	2669	4668	3329	2496	871	568	312
7	2805	5433	6160	3696	1596	2954	2239	1661	594	317
8	791	1867	2660	3316	2030	1003	1990	1446	1093	341
9	95	511	1039	1377	2084	1325	703	1283	922	651
+gp	671	309	412	138	837	1213	1684	1436	1541	1512
TOTAL	103490	80403	60418	43357	38757	172390	207766	181345	151189	139915

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

YEAR	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
AGE											
0	32172	156550	92096	65741	46928	12943	15136	5602	4619	3155	0
1	19068	26340	128172	75402	53824	38422	10597	12392	4586	3782	2583
2	3755	15612	21557	104872	61717	44068	31457	8673	10146	3755	3096
3	7457	2979	12624	16327	81899	49159	35959	25533	7025	8084	3006
4	28222	5151	1405	7566	10537	54350	37132	27610	19404	5350	5730
5	39547	18339	3365	961	4002	6022	32211	26021	19145	13575	3885
6	1074	23461	10783	2138	630	2191	2914	16863	15239	12118	8643
7	151	475	13219	6399	1342	395	933	1325	8303	7593	6926
8	149	34	185	8247	4197	882	176	391	598	3845	3722
9	195	43	4	80	5508	2674	419	63	188	367	2138
+gp	1014	407	285	84	165	2881	2031	339	207	37	242
TOTAL	132803	249389	283695	287817	270751	213987	168967	124813	89461	61661	39971

Table 5.12. Faroe haddock. Stock summary of the 2008 VPA.

Run	title	FAROE	HADDOCK	(ICES	DIVISION	Vb)	HAD_IND
At	17/04/2008	19:07					
Table	16		Summary	(without	SOP	correction)	
Terminal	Fs	derived	using	XSA	(With	F	shrinkage)
	Recruits	Recruits	Total	Total	Landings	Yield/SSB	FBAR(3-7)
	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	33843	47362	90204	49706	27571	0.5547	0.7002
1964	30192	30110	75561	44185	19490	0.4411	0.4753
1965	37948	22644	71884	45605	18479	0.4052	0.526
1966	81925	20203	68774	44027	18766	0.4262	0.5288
1967	47768	25356	77101	42086	13381	0.3179	0.4031
1968	53239	54852	87972	45495	17852	0.3924	0.4377
1969	23137	31976	94879	53583	23272	0.4343	0.4853
1970	49623	35601	92144	59959	21361	0.3563	0.4762
1971	35419	15458	92933	63922	19393	0.3034	0.4564
1972	78974	33214	91510	63136	16485	0.2611	0.3962
1973	104872	23703	98981	61624	18035	0.2927	0.2902
1974	83647	52336	116884	64634	14773	0.2286	0.2206
1975	39140	70069	138918	75410	20715	0.2747	0.1799
1976	52382	55985	143643	89229	26211	0.2937	0.2475
1977	4157	26200	121064	96392	25555	0.2651	0.3873
1978	7380	35113	120608	97256	19200	0.1974	0.2781
1979	5210	2786	99533	85426	12424	0.1454	0.1551
1980	23638	4946	87670	81933	15016	0.1833	0.1779
1981	29306	3492	79000	75882	12233	0.1612	0.1813
1982	60903	15845	68345	56836	11937	0.21	0.3306
1983	59033	19644	64014	51849	12894	0.2487	0.2651
1984	39632	40824	100823	53877	12378	0.2297	0.2282
1985	14146	39549	94135	62687	15143	0.2416	0.2757
1986	28110	26566	98754	65732	14477	0.2202	0.2233
1987	21452	9483	87907	67487	14882	0.2205	0.2635
1988	14137	18843	77709	62126	12178	0.196	0.2001
1989	4463	14379	69981	51973	14325	0.2756	0.2837
1990	3986	9476	53993	44004	11726	0.2665	0.2705
1991	2723	2992	39137	35010	8429	0.2408	0.2715
1992	9629	2672	29455	27310	5476	0.2005	0.2074
1993	145235	1825	29122	23546	4026	0.171	0.1849
1994	69214	6415	27786	21927	4252	0.1939	0.2028
1995	13715	97353	88990	23090	4948	0.2143	0.2255
1996	5602	46395	115071	50682	9642	0.1902	0.3193
1997	23290	9193	109449	83575	17924	0.2145	0.3724
1998	32172	3755	94326	83741	22210	0.2652	0.5271
1999	156550	15612	81966	64720	18482	0.2856	0.4454
2000	92096	21557	112477	54799	15821	0.2887	0.2679
2001	65741	104872	150223	63299	15890	0.251	0.2768
2002	46928	61717	157496	88097	24933	0.283	0.2914
2003	12943	44068	145133	100664	27128	0.2695	0.4382
2004	15136	31457	132749	90457	23287	0.2574	0.3848
2005	5602	8673	95044	77242	20305	0.2629	0.3359
2006	4619	10146	72192	63631	17074	0.2683	0.3107
2007	3155	3755	54401	49126	12633	0.2572	0.2776
Arith.							
Mean	42050	29447	91395	59977	17087	0.2924	0.3587
Units	(Thousands)	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

Table 5.13. Management options table - INPUT DATA descriptions.

Stock size

The stock in numbers 2008 is taken directly from the 2008 XSA. The year class 2007 at age 2 (in 2009) is estimated from the 2008 XSA age 1 applying a natural mortality of 0.2 in foreward calculation of the number using the standard VPA equation. The year class 2008 at age 2 (in 2010) is estimated as the geomean of the year classes since 1980.

Age	2008	2009	2010
2	3096	2115	12330
3	3006		
4	5730		
5	3885		
6	8643		
7	6926		
8	3722		
9	2138		
10+	242		

Numbers in thousands (rounded).

Proportion mature at age

The proportion mature at age in 2008 is estimated as the average of the observed data in 2007 and 2008. For 2009 and 2010, the average for 2008 to 2010 is used.

Age	2008	2009	2010
2	0.01	0.02	0.02
3	0.68	0.54	0.54
4	0.93	0.92	0.92
5	1.00	1.00	1.00
6	1.00	1.00	1.00
7	1.00	1.00	1.00
8	1.00	1.00	1.00
9	1.00	1.00	1.00
10+	1.00	1.00	1.00

Catch & Stock weights at age

Catch and stock weights at age 2008-2010 were estimated as the average weights at age in the catch 2006-2008 and kept constant for all years.

Age	2008	2009	2010
2	0.547	0.547	0.547
3	0.640	0.640	0.640
4	0.808	0.808	0.808
5	0.967	0.967	0.967
6	1.144	1.144	1.144
7	1.487	1.487	1.487
8	1.898	1.898	1.898
9	2.247	2.247	2.247
10+	2.468	2.468	2.468

Exploitation pattern

The exploitation pattern is estimated as the average fishing mortality matrix in 2005-2007 from the final VPA in 2008, not re-scaled, and kept constant for all 3 years.

Age	2008	2009	2010
2	0.0182	0.0182	0.0182
3	0.0874	0.0874	0.0874
4	0.1331	0.1331	0.1331
5	0.2535	0.2535	0.2535
6	0.4098	0.4098	0.4098
7	0.5041	0.5041	0.5041
8	0.3629	0.3629	0.3629
9	0.4358	0.4358	0.4358
10+	0.4358	0.4358	0.4358

Table 5.14 **Faroe haddock. Management option table - Input data**

MFDP version 1
Run: man
Time and date: 19:04 4/19/2008
Fbar age range: 3-7

2008

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
2	3096	0.2	0.01	0	0	0.547	0.0202	0.547
3	3006	0.2	0.68	0	0	0.640	0.0970	0.640
4	5730	0.2	0.93	0	0	0.808	0.1477	0.808
5	3885	0.2	1	0	0	0.967	0.2813	0.967
6	8643	0.2	1	0	0	1.144	0.4548	1.144
7	6926	0.2	1	0	0	1.487	0.5595	1.487
8	3722	0.2	1	0	0	1.898	0.4027	1.898
9	2138	0.2	1	0	0	2.247	0.4837	2.247
10	242	0.2	1	0	0	2.468	0.4837	2.468

2009

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
2	2115	0.2	0.02	0	0	0.547	0.0202	0.547
3	.	0.2	0.54	0	0	0.640	0.0970	0.640
4	.	0.2	0.92	0	0	0.808	0.1477	0.808
5	.	0.2	1	0	0	0.967	0.2813	0.967
6	.	0.2	1	0	0	1.144	0.4548	1.144
7	.	0.2	1	0	0	1.487	0.5595	1.487
8	.	0.2	1	0	0	1.898	0.4027	1.898
9	.	0.2	1	0	0	2.247	0.4837	2.247
10	.	0.2	1	0	0	2.468	0.4837	2.468

2010

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
2	12330	0.2	0.02	0	0	0.547	0.0202	0.547
3	.	0.2	0.54	0	0	0.640	0.0970	0.640
4	.	0.2	0.92	0	0	0.808	0.1477	0.808
5	.	0.2	1	0	0	0.967	0.2813	0.967
6	.	0.2	1	0	0	1.144	0.4548	1.144
7	.	0.2	1	0	0	1.487	0.5595	1.487
8	.	0.2	1	0	0	1.898	0.4027	1.898
9	.	0.2	1	0	0	2.247	0.4837	2.247
10	.	0.2	1	0	0	2.468	0.4837	2.468

Input units are thousands and kg - output in tonnes

Table 5.15 Faroe haddock. Management option table - Results

MFDP version 1
Run: man
Index file 19/04/2008
Time and date: 19:04 4/19/2008
Fbar age range: 3-7

2008 Biomass	SSB	FMult	FBar	Landings
44653	42037	1	0.3081	12974

2009 Biomass	SSB	FMult	FBar	Landings	2010 Biomass	SSB
31579	29570	0	0	0	37459	30208
.	29570	0.1	0.0308	1122	36255	29007
.	29570	0.2	0.0616	2196	35106	27860
.	29570	0.3	0.0924	3223	34008	26764
.	29570	0.4	0.1232	4207	32959	25717
.	29570	0.5	0.154	5148	31956	24717
.	29570	0.6	0.1849	6050	30998	23761
.	29570	0.7	0.2157	6913	30082	22847
.	29570	0.8	0.2465	7740	29206	21974
.	29570	0.9	0.2773	8531	28369	21139
.	29570	1	0.3081	9290	27569	20340
.	29570	1.1	0.3389	10017	26803	19577
.	29570	1.2	0.3697	10713	26071	18847
.	29570	1.3	0.4005	11381	25371	18149
.	29570	1.4	0.4313	12021	24700	17481
.	29570	1.5	0.4621	12634	24059	16842
.	29570	1.6	0.4929	13223	23446	16230
.	29570	1.7	0.5237	13787	22859	15645
.	29570	1.8	0.5546	14328	22297	15085
.	29570	1.9	0.5854	14847	21759	14549
.	29570	2	0.6162	15346	21243	14036

Input units are thousands and kg - output in tonnes

Table 5.16 Faroe haddock. Long-term Prediction - Input data

MFYPR version 1
Run: ypr
Index file 19/04/2008
Time and date: 19:37 4/19/2008
Fbar age range: 3-7

Age	M	Mat	PF	PM	SWt	Sel	CWt
2	0.2	0.06	0	0	0.523	0.0202	0.523
3	0.2	0.47	0	0	0.773	0.0970	0.773
4	0.2	0.91	0	0	1.091	0.1477	1.091
5	0.2	1.00	0	0	1.453	0.2813	1.453
6	0.2	1.00	0	0	1.805	0.4548	1.805
7	0.2	1.00	0	0	2.157	0.5595	2.157
8	0.2	1.00	0	0	2.439	0.4027	2.439
9	0.2	1.00	0	0	2.706	0.4837	2.706
10	0.2	1.00	0	0	3.080	0.4837	3.080

Weights in kilograms

Table 5.17 Faroe haddock. Long-term Prediction - Results

MFYPR version 1
Run: ypr
Time and date: 19:37 4/19/2008
Yield per results

FMult	Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNosJan	SSBJan	SpwnNosSpwn	SSBSpwn
0	0	0	0	5.5167	9.1224	4.076	8.2231	4.076	8.2231
0.1	0.0308	0.1135	0.2428	4.9514	7.5311	3.5124	6.6334	3.5124	6.6334
0.2	0.0616	0.1915	0.3889	4.5636	6.4741	3.1263	5.578	3.1263	5.578
0.3	0.0924	0.2488	0.4819	4.2791	5.7242	2.8434	4.8296	2.8434	4.8296
0.4	0.1232	0.293	0.5435	4.06	5.1661	2.6259	4.273	2.6259	4.273
0.5	0.154	0.3284	0.5855	3.885	4.7354	2.4526	3.8438	2.4526	3.8438
0.6	0.1849	0.3575	0.6147	3.7413	4.3934	2.3105	3.5033	2.3105	3.5033
0.7	0.2157	0.382	0.6353	3.6206	4.1153	2.1913	3.2267	2.1913	3.2267
0.8	0.2465	0.4029	0.65	3.5172	3.8847	2.0895	2.9976	2.0895	2.9976
0.9	0.2773	0.4212	0.6605	3.4273	3.6902	2.0012	2.8046	2.0012	2.8046
1	0.3081	0.4373	0.668	3.3481	3.5239	1.9236	2.6397	1.9236	2.6397
1.1	0.3389	0.4517	0.6732	3.2776	3.3798	1.8546	2.4971	1.8546	2.4971
1.2	0.3697	0.4647	0.6769	3.2142	3.2536	1.7927	2.3723	1.7927	2.3723
1.3	0.4005	0.4764	0.6793	3.1566	3.1421	1.7367	2.2621	1.7367	2.2621
1.4	0.4313	0.4872	0.6809	3.1041	3.0425	1.6856	2.164	1.6856	2.164
1.5	0.4621	0.4971	0.6817	3.0558	2.953	1.6388	2.0759	1.6388	2.0759
1.6	0.4929	0.5062	0.682	3.0111	2.872	1.5956	1.9962	1.5956	1.9962
1.7	0.5237	0.5148	0.6818	2.9696	2.7982	1.5556	1.9237	1.5556	1.9237
1.8	0.5546	0.5227	0.6814	2.9308	2.7305	1.5183	1.8575	1.5183	1.8575
1.9	0.5854	0.5302	0.6807	2.8945	2.6682	1.4834	1.7965	1.4834	1.7965
2	0.6162	0.5372	0.6798	2.8603	2.6106	1.4507	1.7403	1.4507	1.7403

Reference point	F multiplier	Absolute F
Fbar(3-7)	1	0.3081
FMax	1.6139	0.4972
F0.1	0.5256	0.1619
F35%SPR	0.86	0.2649
Flow	-99	
Fmed	1.0782	0.3322
Fhigh	5.3882	1.66

Weights in kilograms

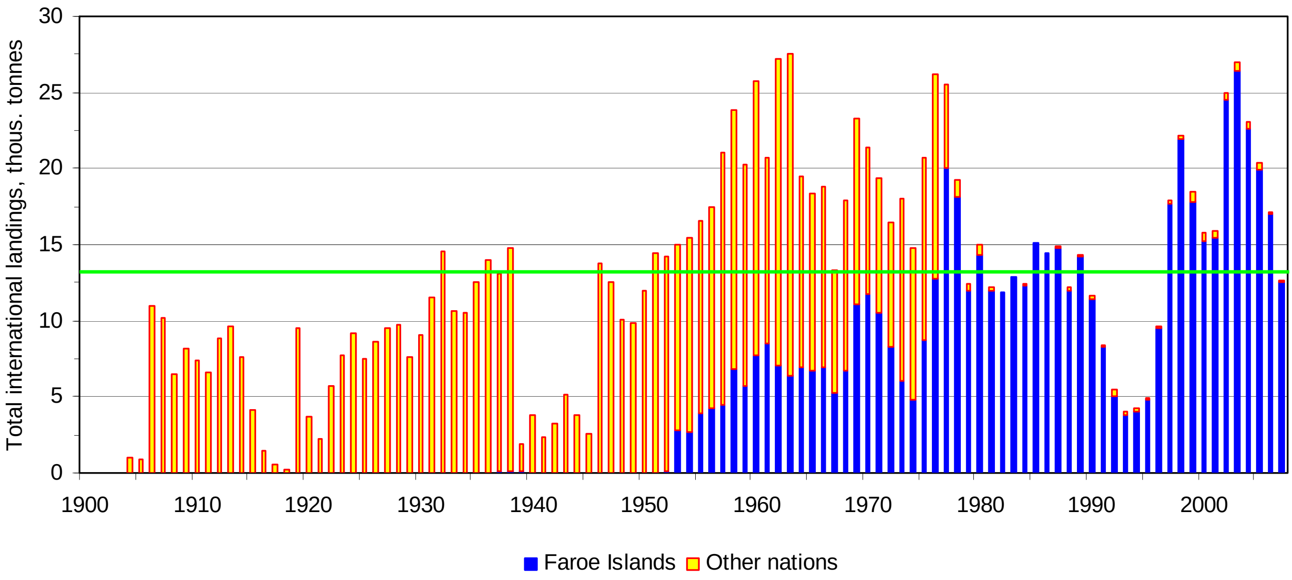


Figure 5.1. Haddock in ICES Division Vb. Landings by all nations 1904-2007. Horisontal line average for the whole period.

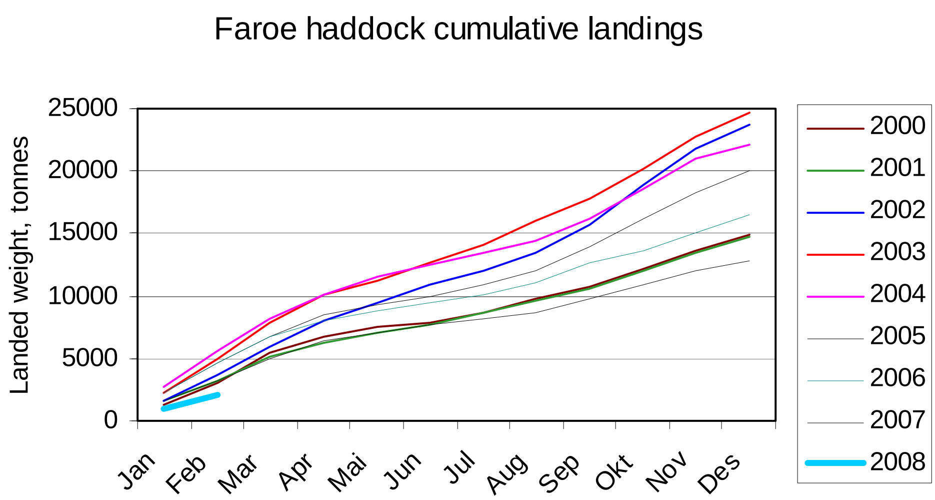


Figure 5.2. Faroe haddock. Cumulative Faroese landings from Vb.

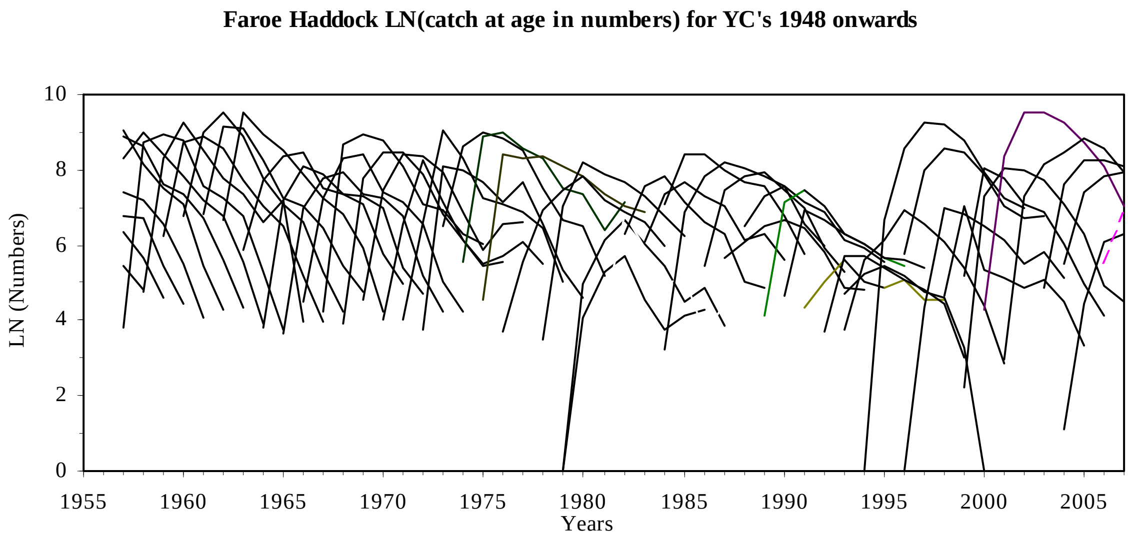


Figure 5.3. Faroe haddock. LN(catch@age in numbers) for YC's 1948 onwards.

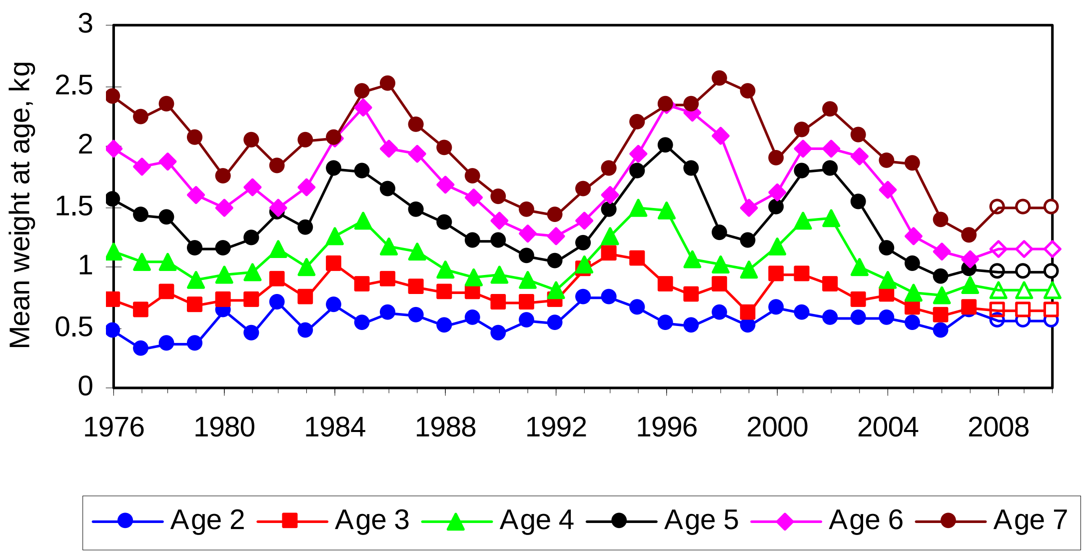


Figure 5.4. Faroe haddock. Mean weight at age (2-7). 2008-2010 are predicted values used in the short term prediction (open symbols).

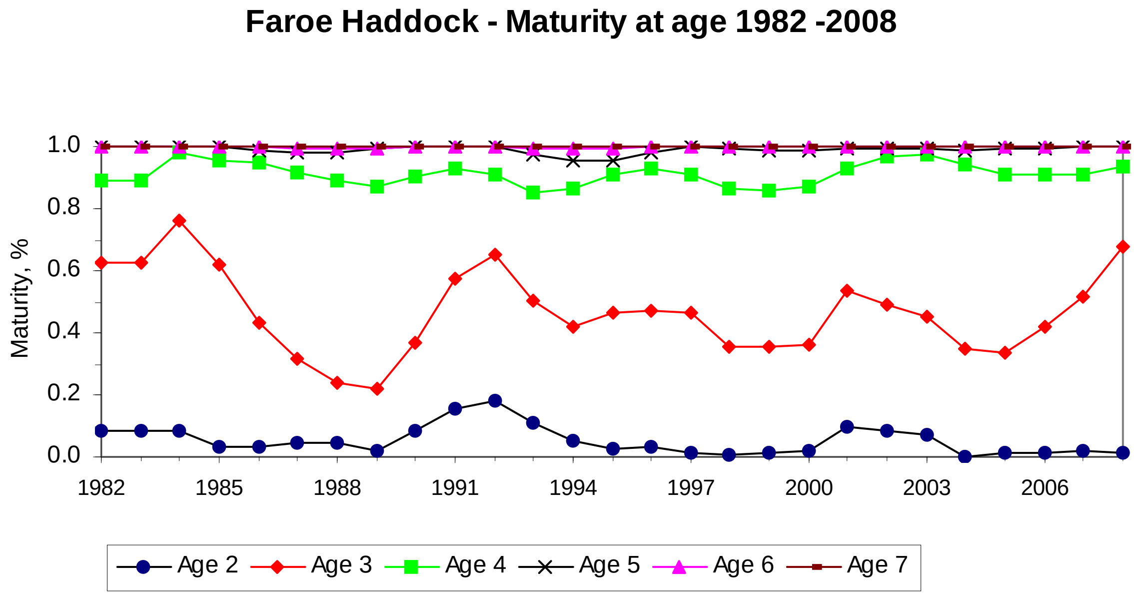


Figure 5.5. Faroe haddock. Maturity at age since 1982. Running 3-years average of survey observations.

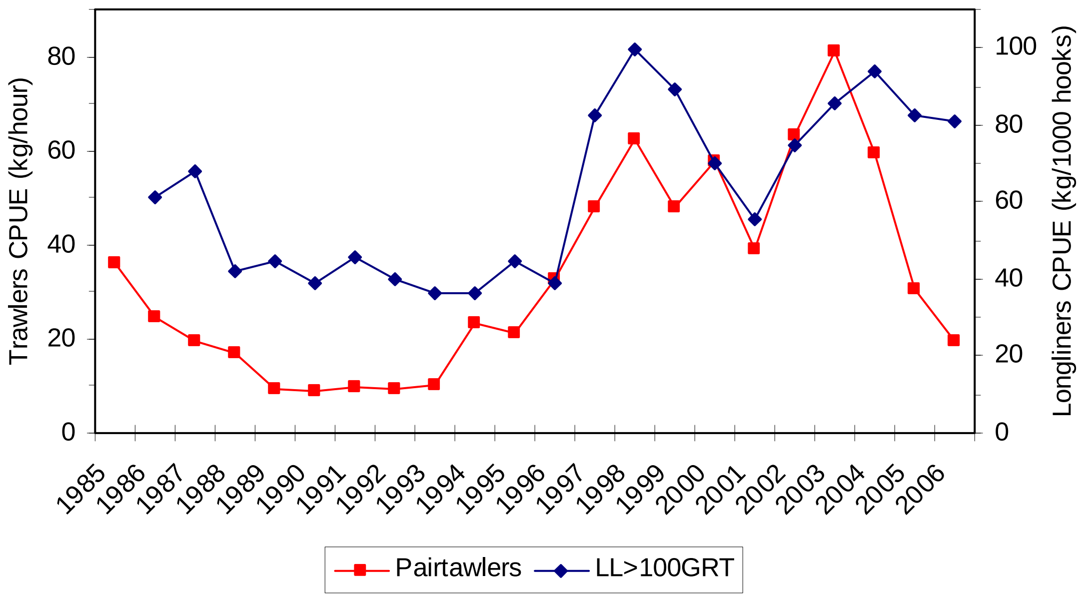


Figure 5.6. Pair trawlers > 1000HP and longliners > 100 HP.

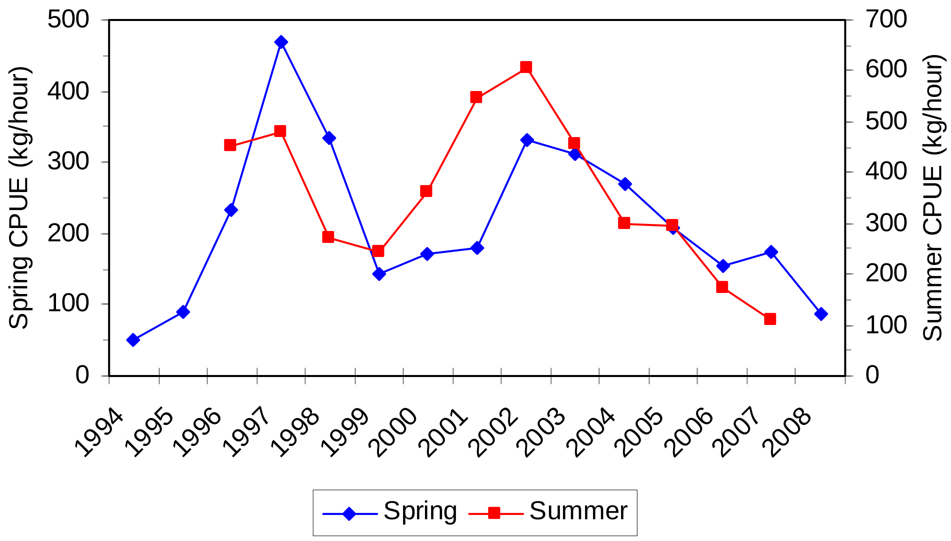
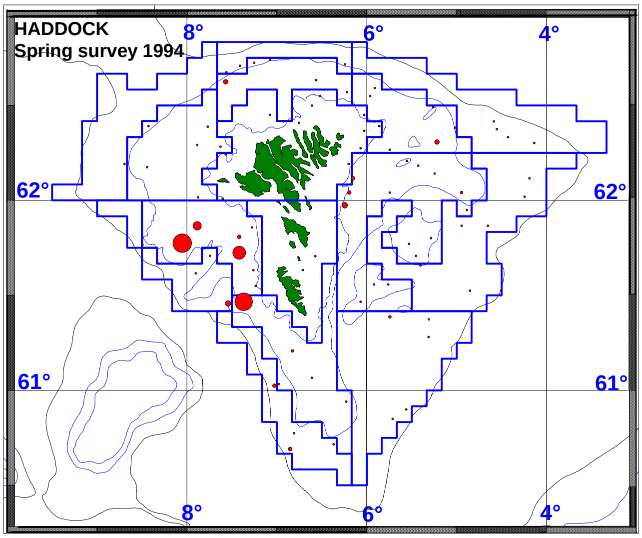
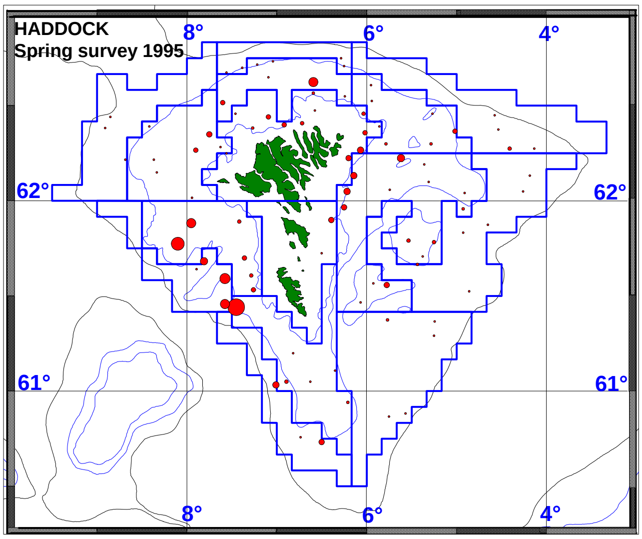
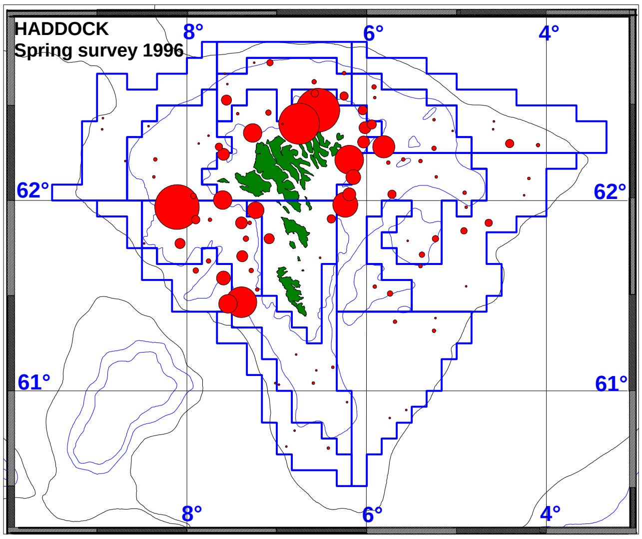
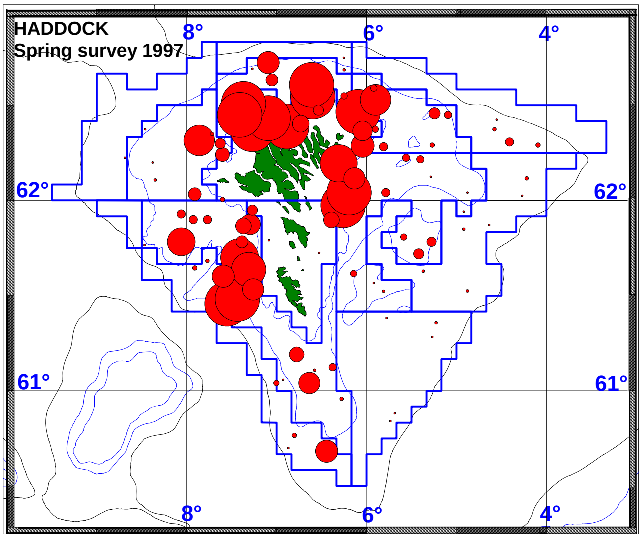


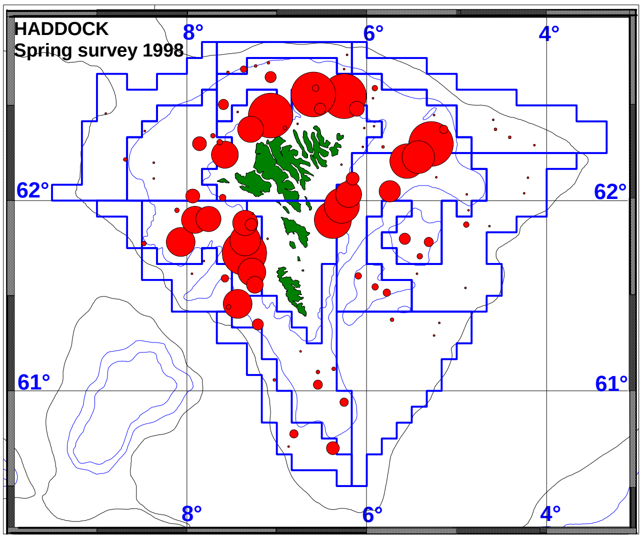
Figure 5.7. Faroe haddock. CPUE (kg/trawlhour) in the spring and summer surveys.


HADDOCK
Spring survey 1994
8°
6°
4°
62°
62°
61°
61°
8°
6°
4°


HADDOCK
Spring survey 1995
8°
6°
4°
62°
62°
61°
61°
8°
6°
4°


HADDOCK
Spring survey 1996
8°
6°
4°
62°
62°
61°
61°
8°
6°
4°


HADDOCK
Spring survey 1997
8°
6°
4°
62°
62°
61°
61°
8°
6°
4°


HADDOCK
Spring survey 1998
8°
6°
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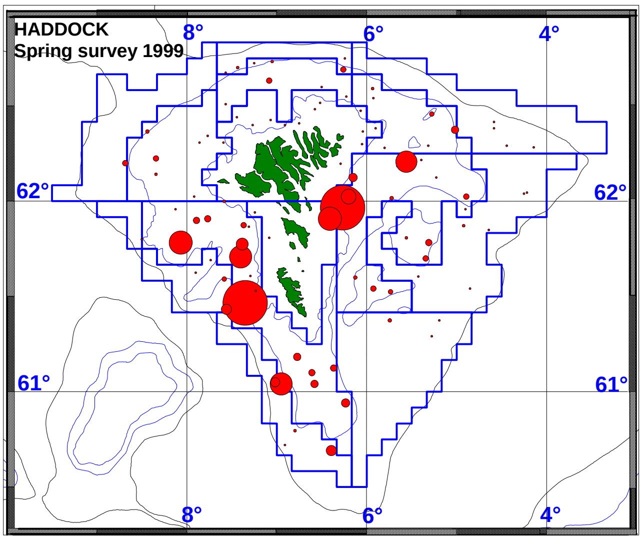
HADDOCK
Spring survey 1999
8°
6°
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62°
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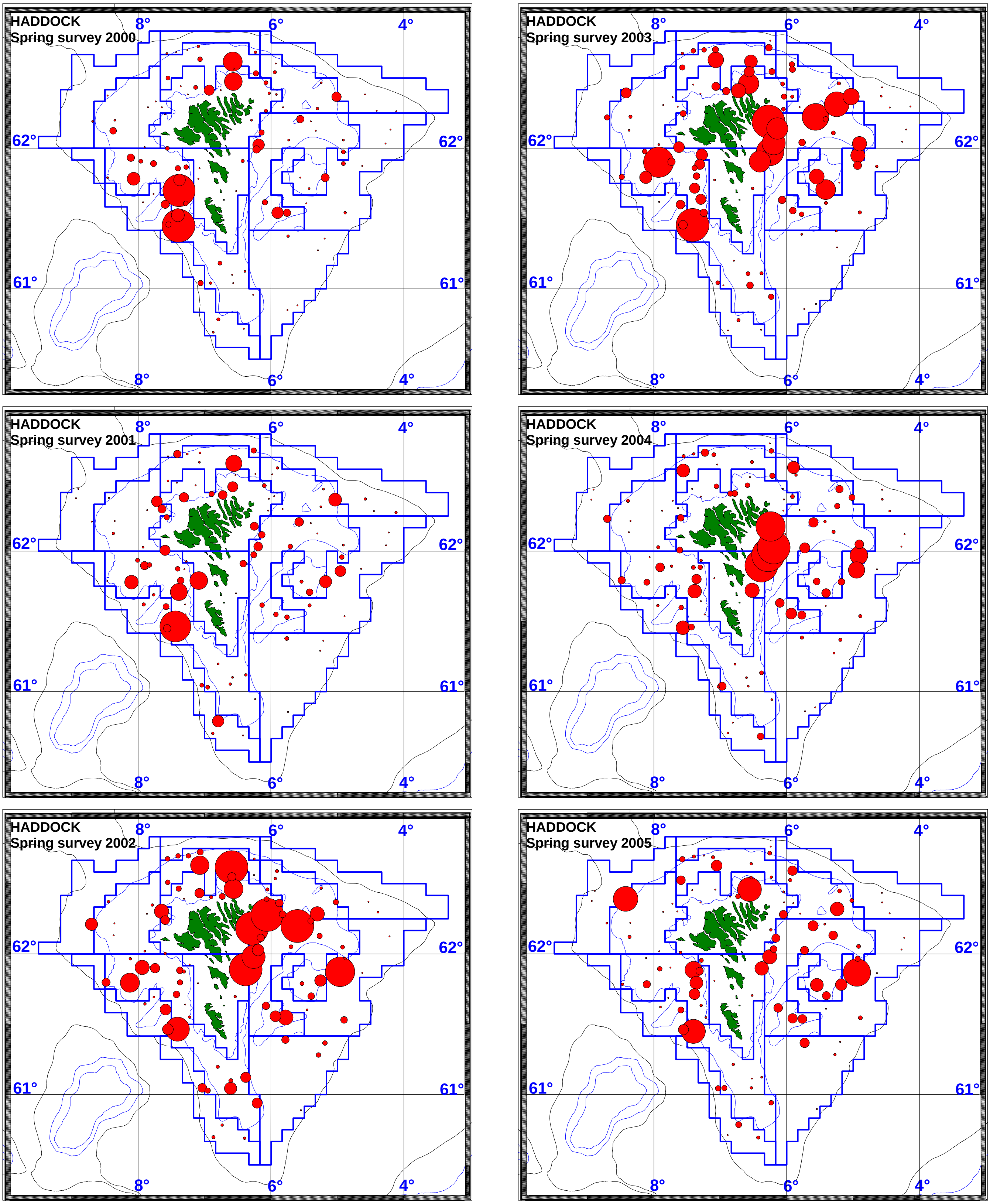
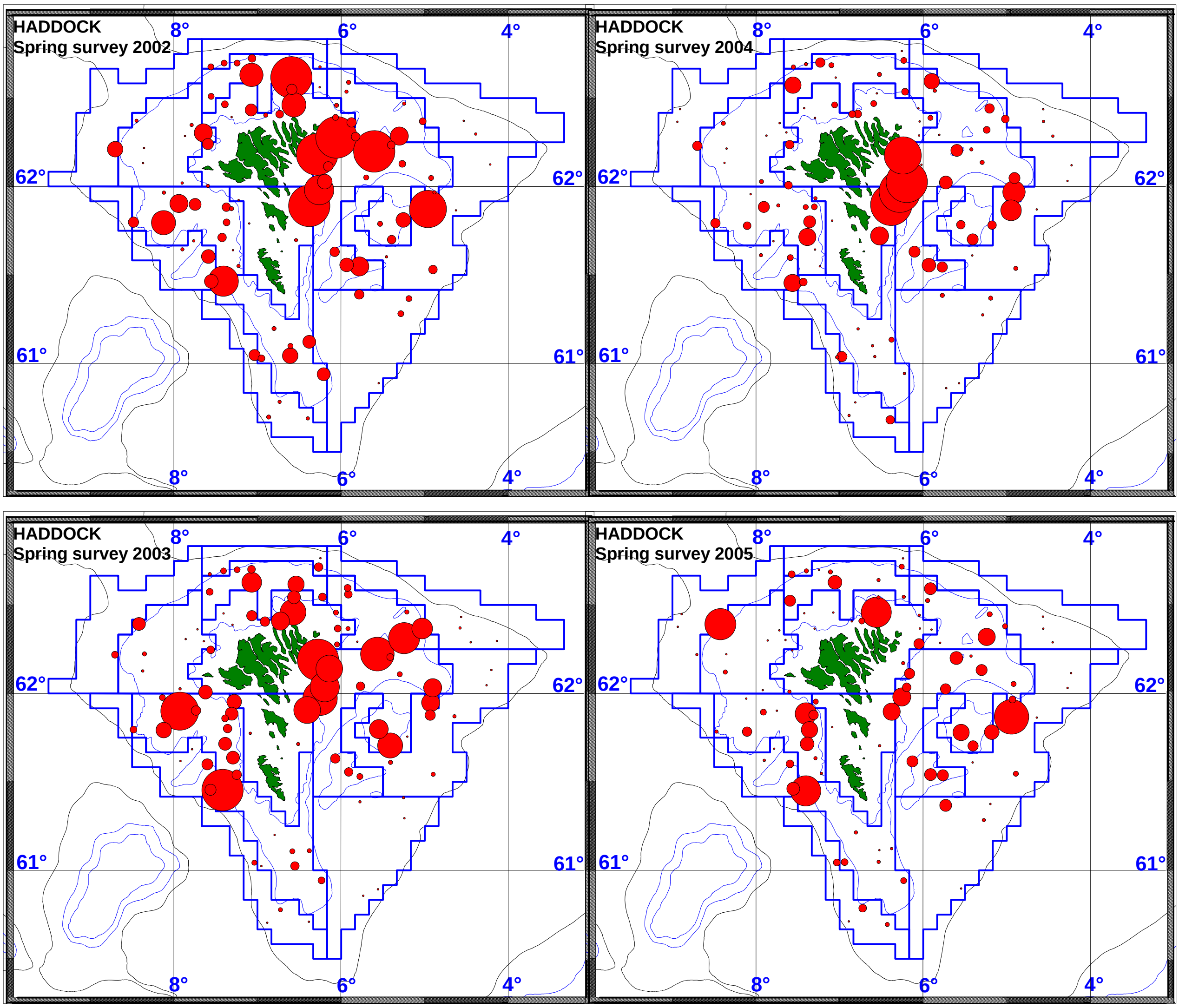
61°
8°
6°
4°


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°


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

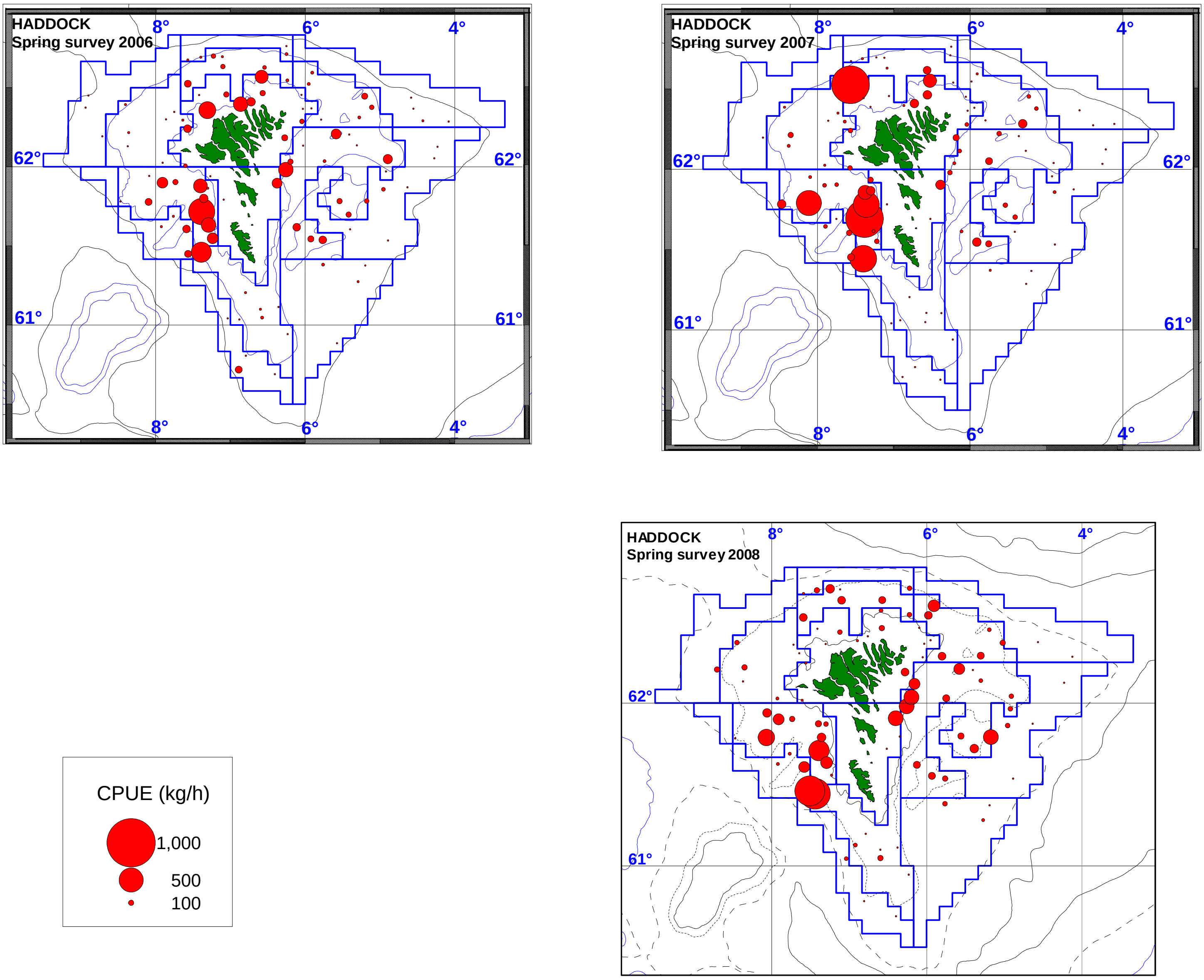
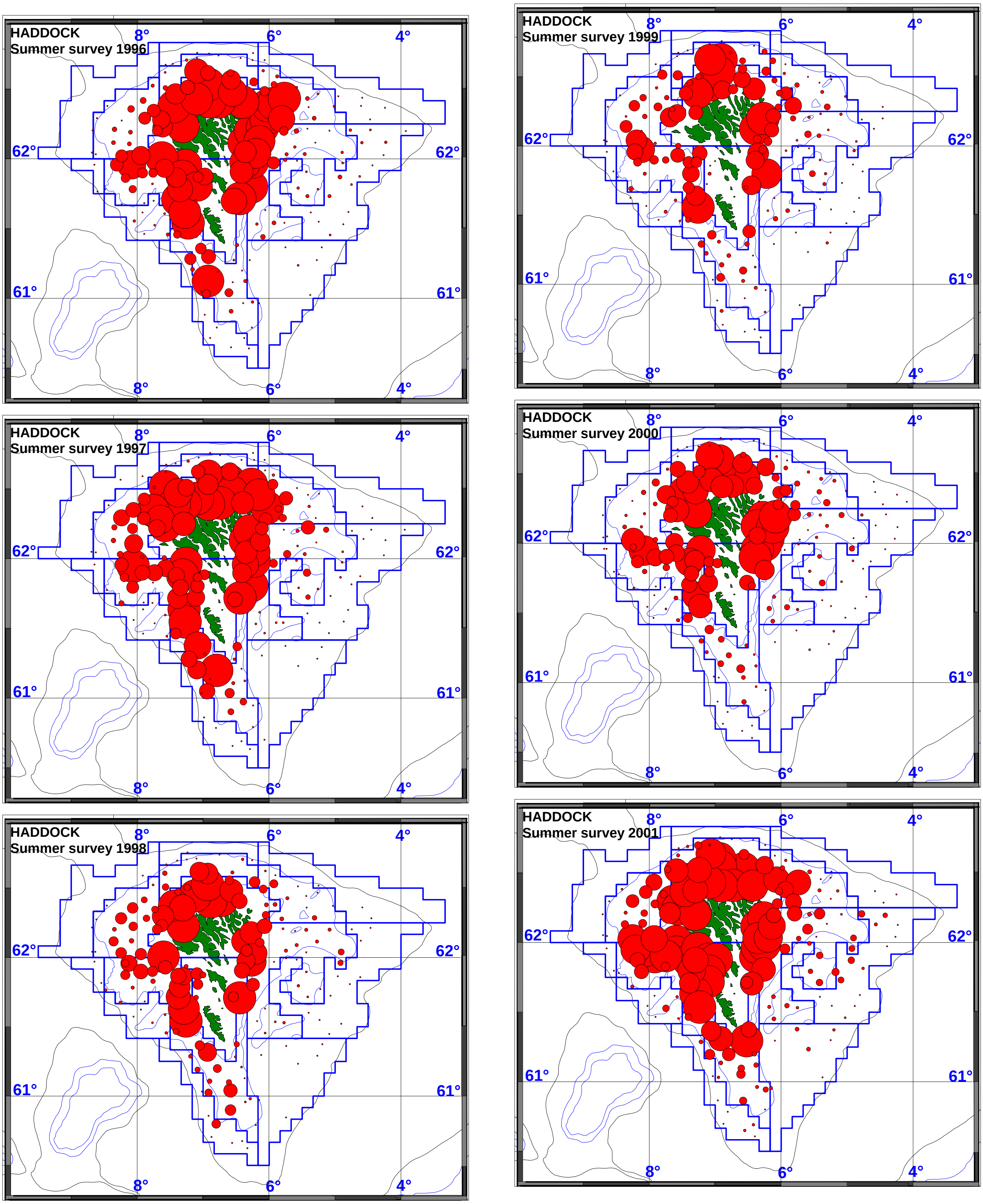


Figure 5.8. Distribution of Faroe haddock catches by year in the spring surveys.


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

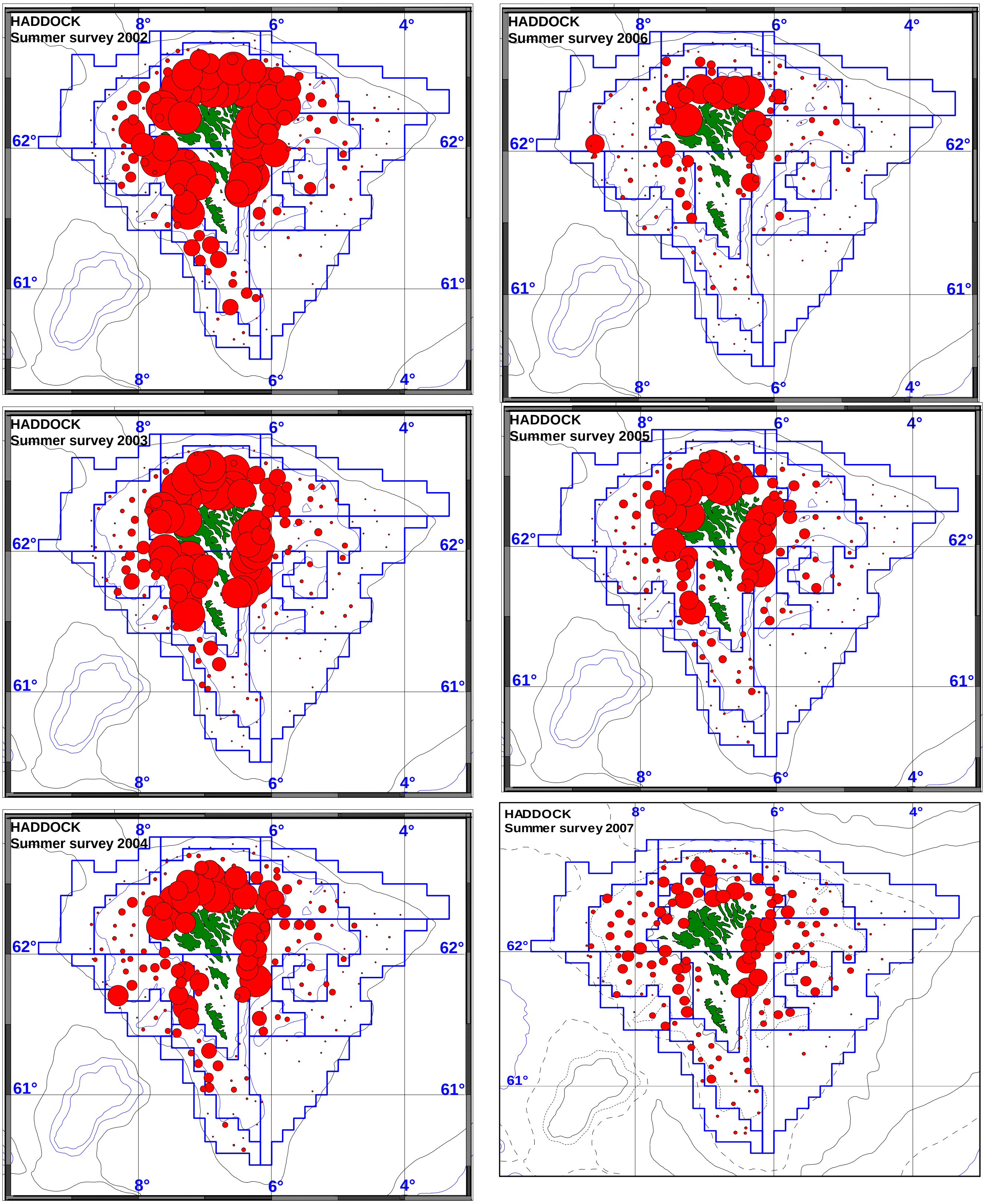


Figure 5.9. Distribution of Faroe haddock catches by year in the summer surveys

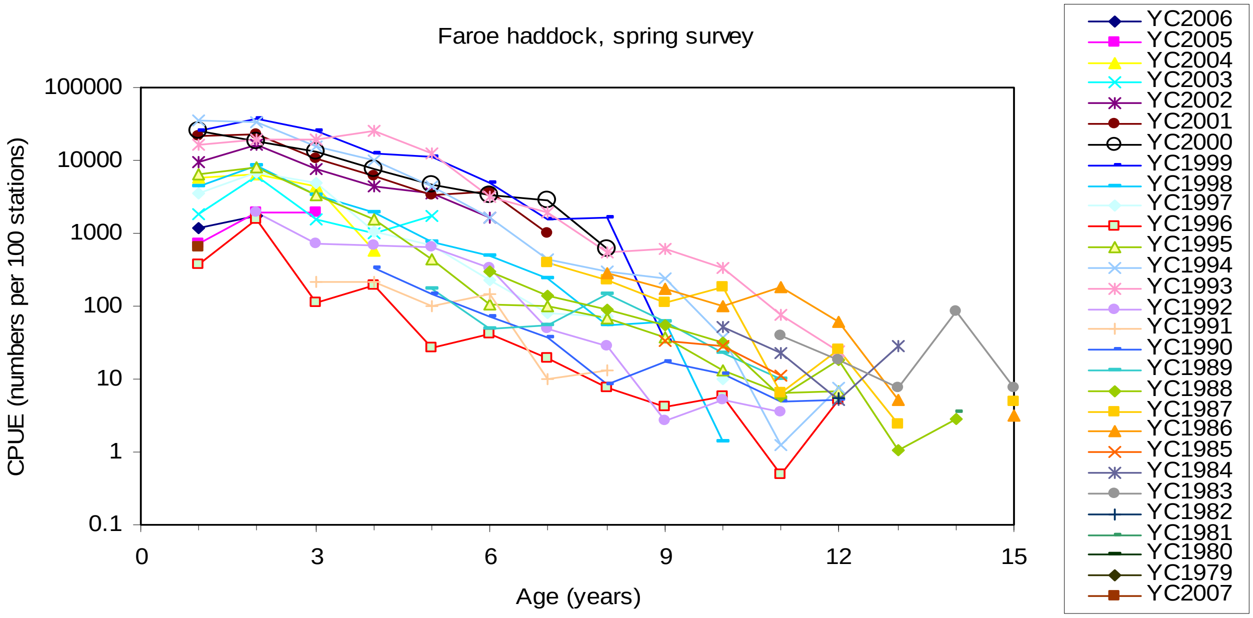
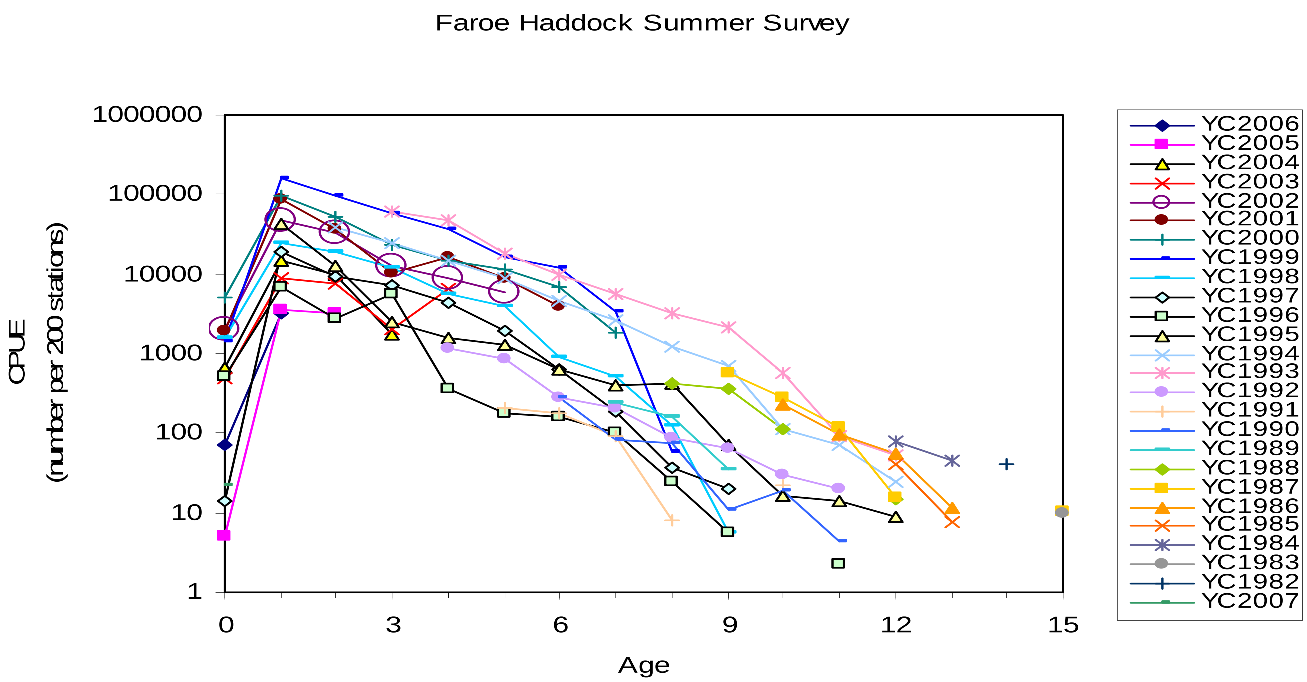


Figure 5.10. Faroe haddock. LN (c@age in numbers) in the spring survey.



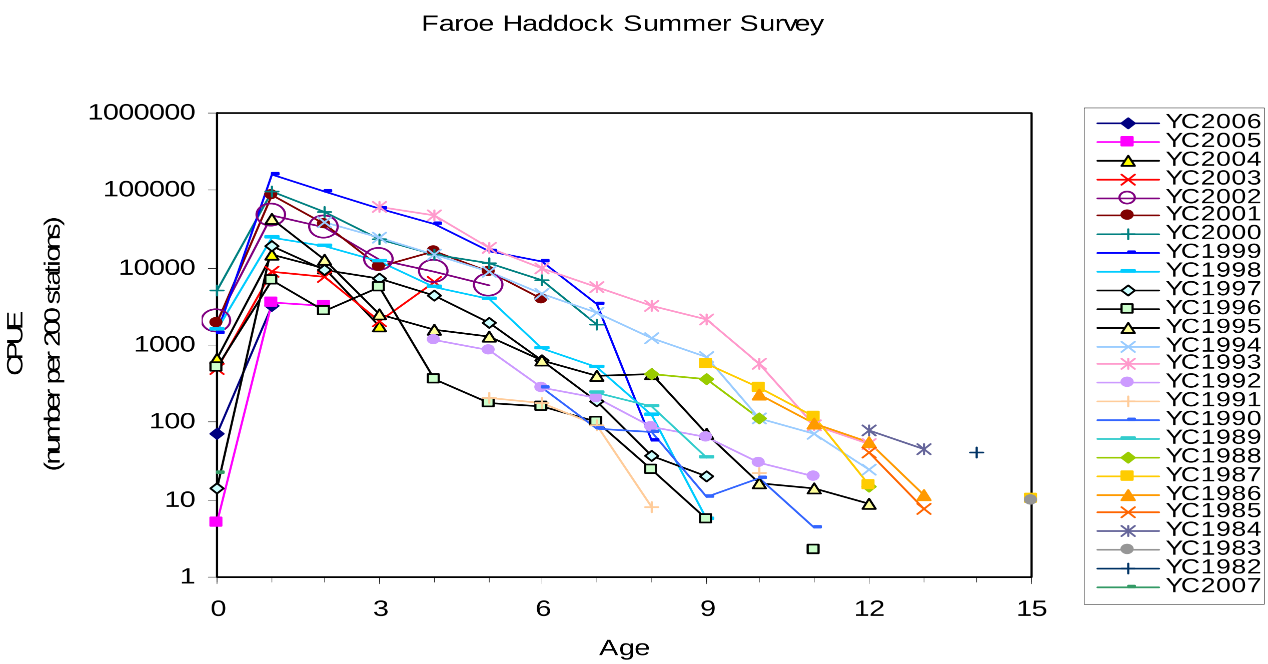


Figure 5.11. Faroe haddock. LN (c@age in numbers) in the summer survey.

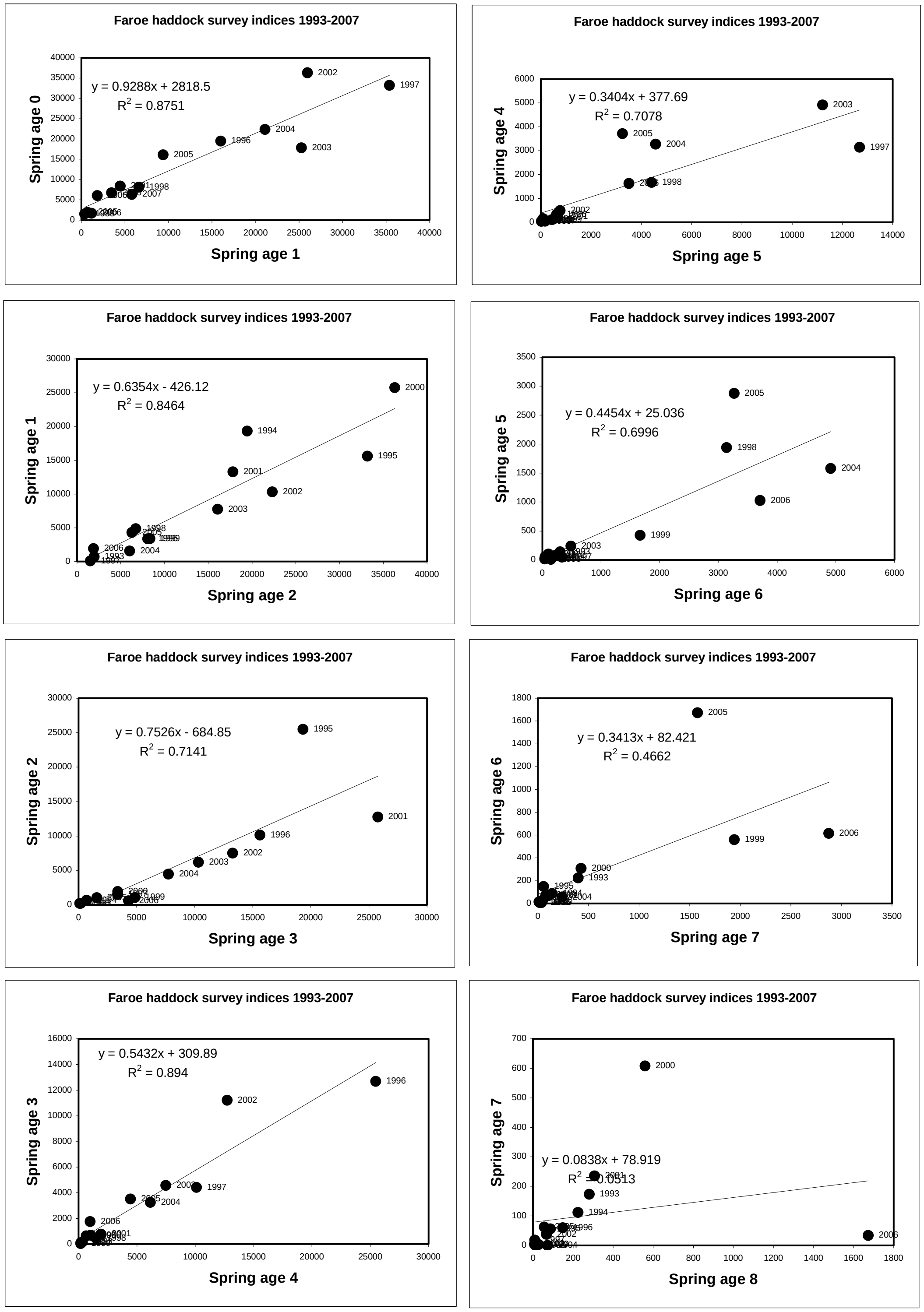


Figure 5.12. Faroe haddock. Comparison between spring survey indices (shifted) at age and the indices of the same YC one year later.

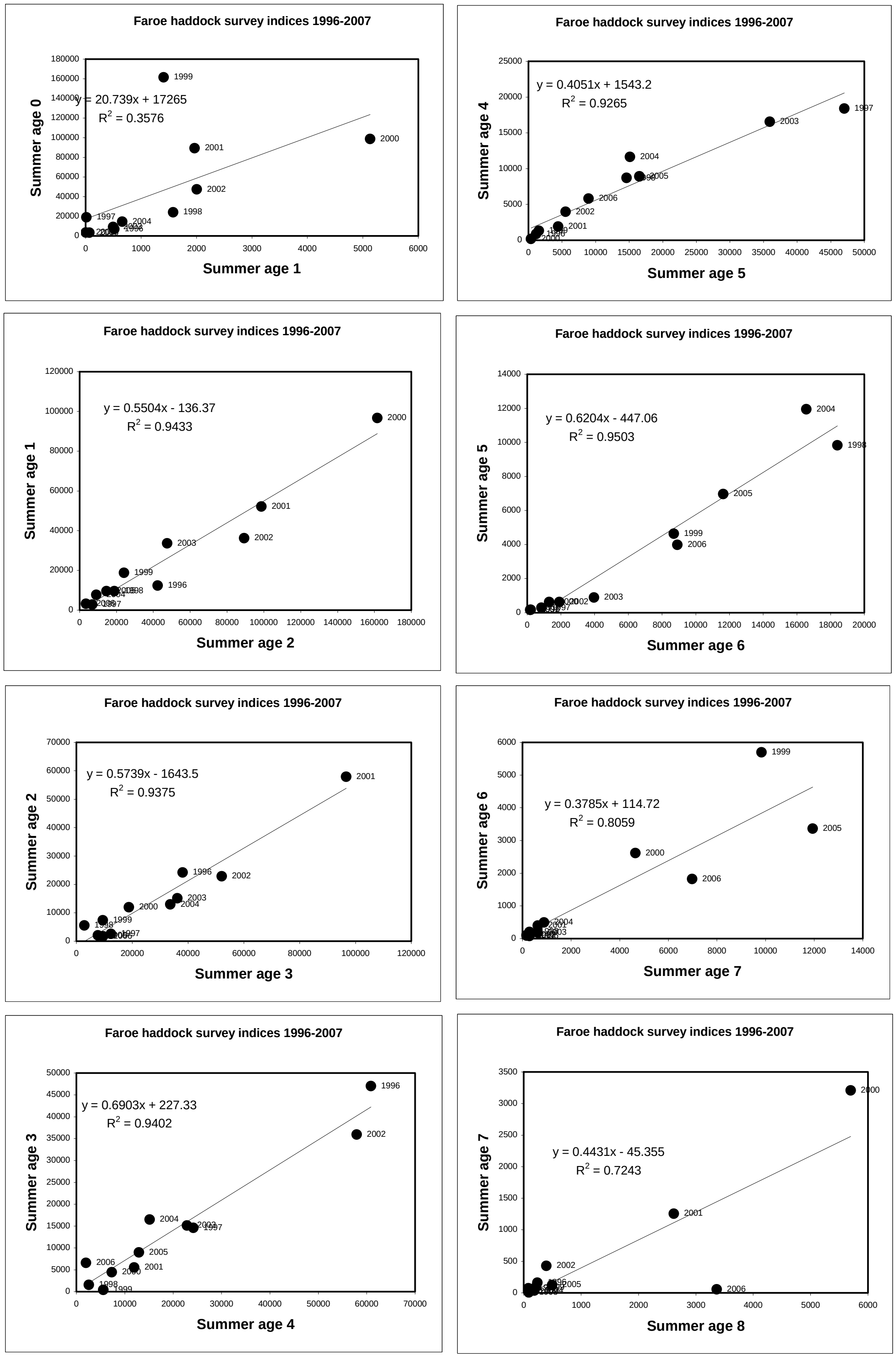


Figure 5.13. Faroe haddock. Comparison between summer survey indices at age and the indices of the same YC one year later.

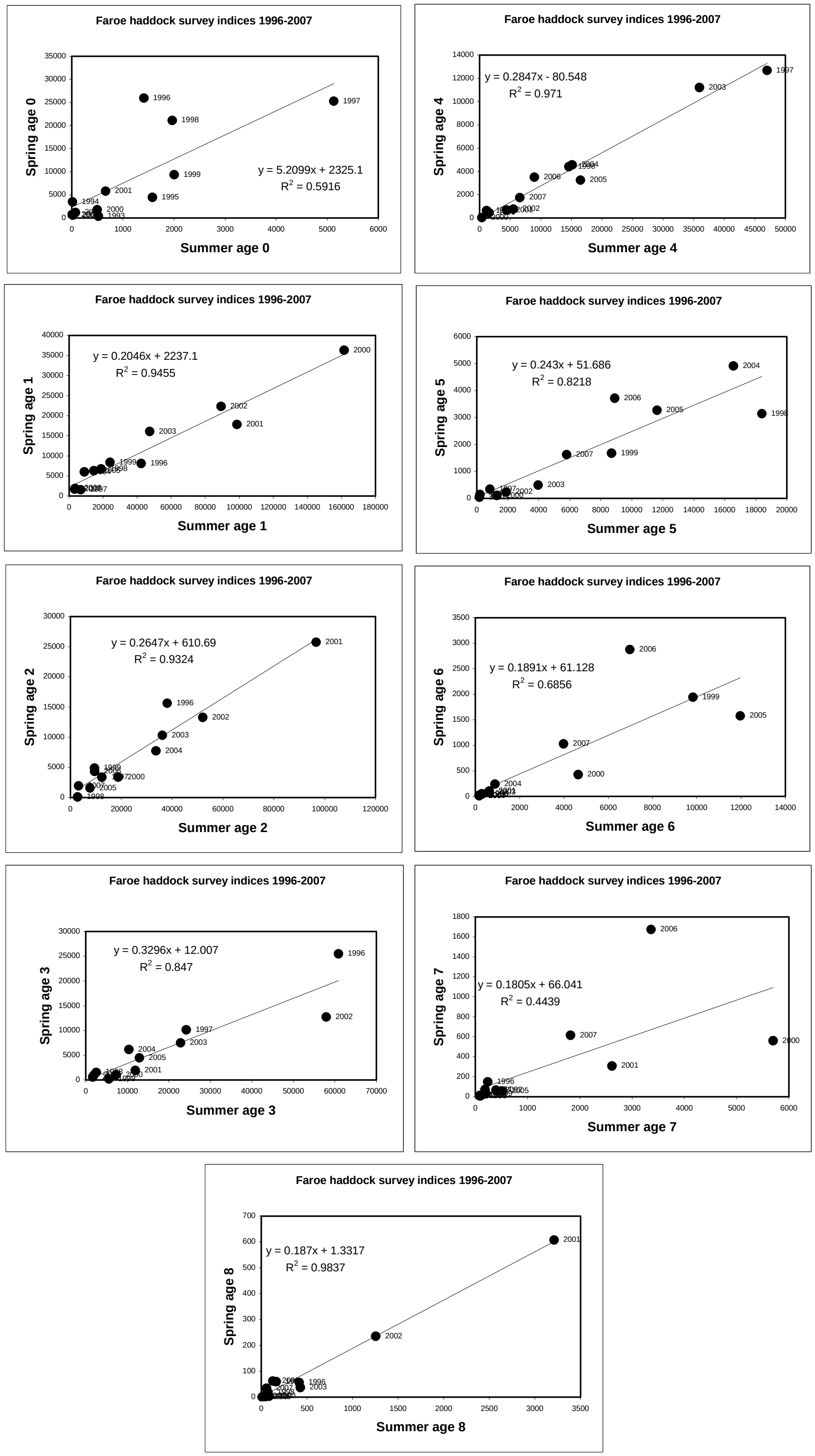
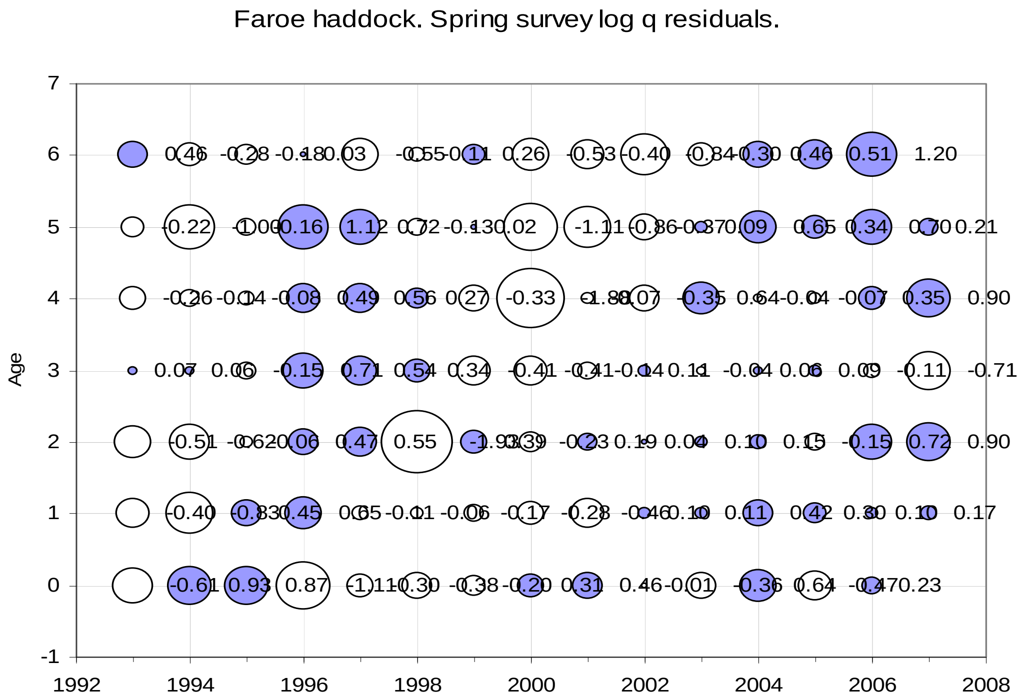


Figure 5.14. Faroe haddock. Comparison between indices at age from the spring (shifted) and summer surveys.



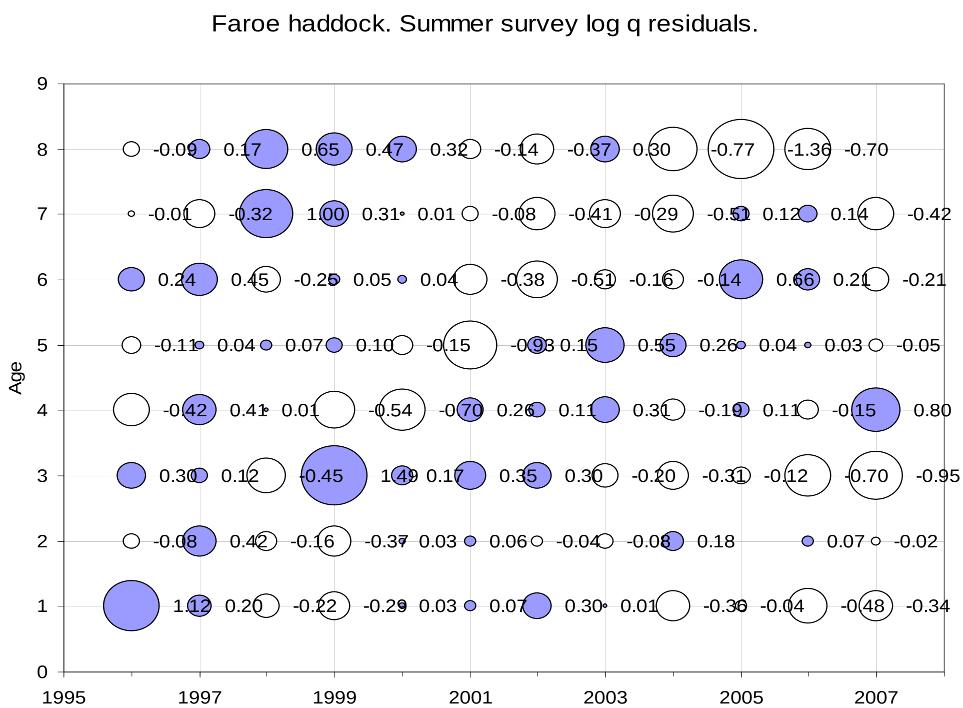


Figure 5.15. Faroe haddock survey log q residuals.

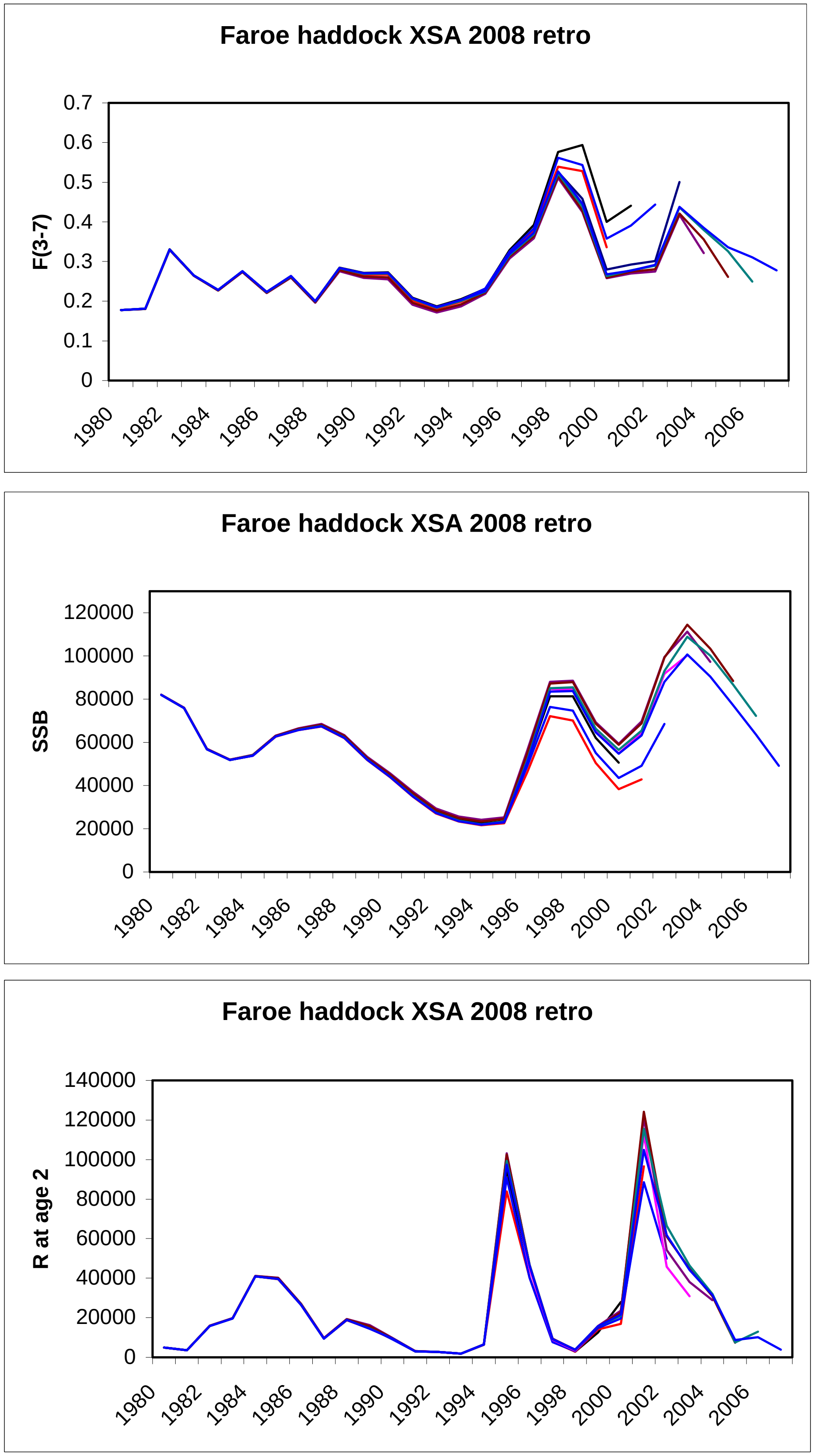
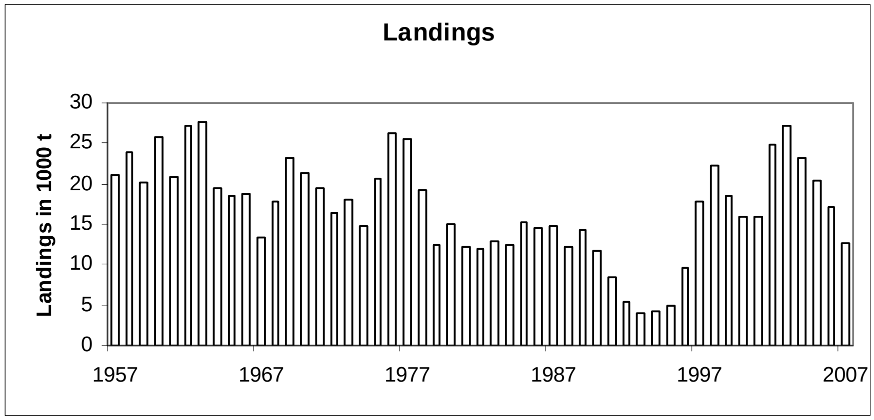
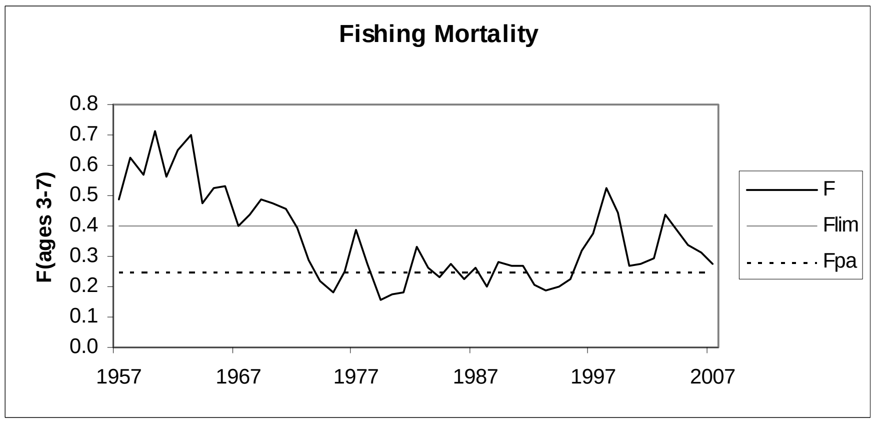
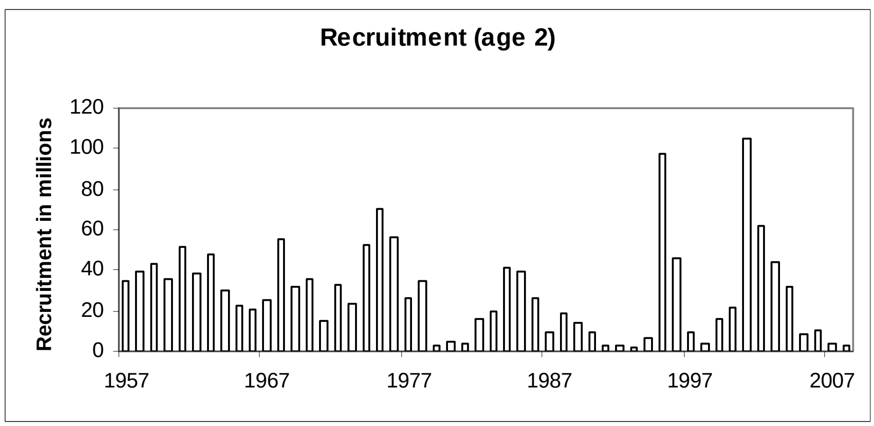


Figure 5.16. Faroe haddock. Retrospective analysis on the 2008 XSA.







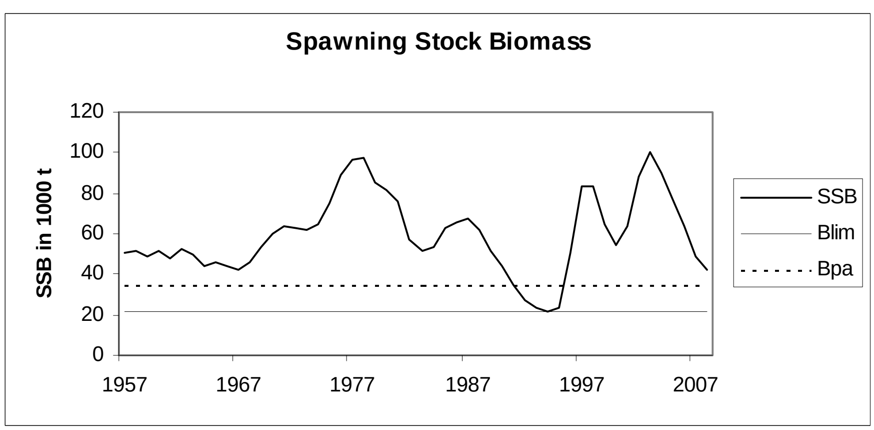


Figure 5.17. Faroe haddock (Division Vb) standard graphs from the 2008 assessment.

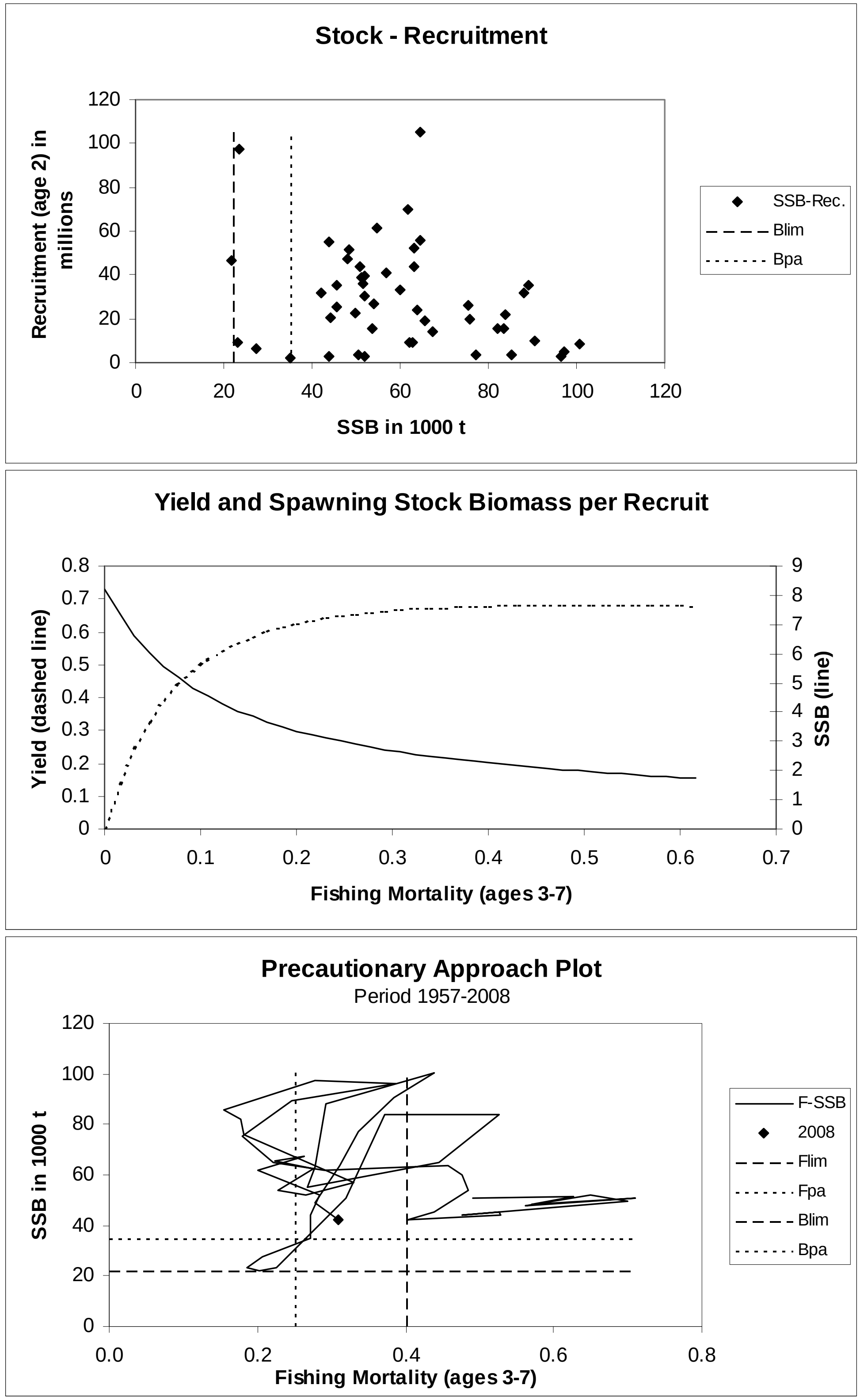


Figure 5.17 (cont.). Faroe haddock (Division Vb) standard graphs from the 2008 assessment.

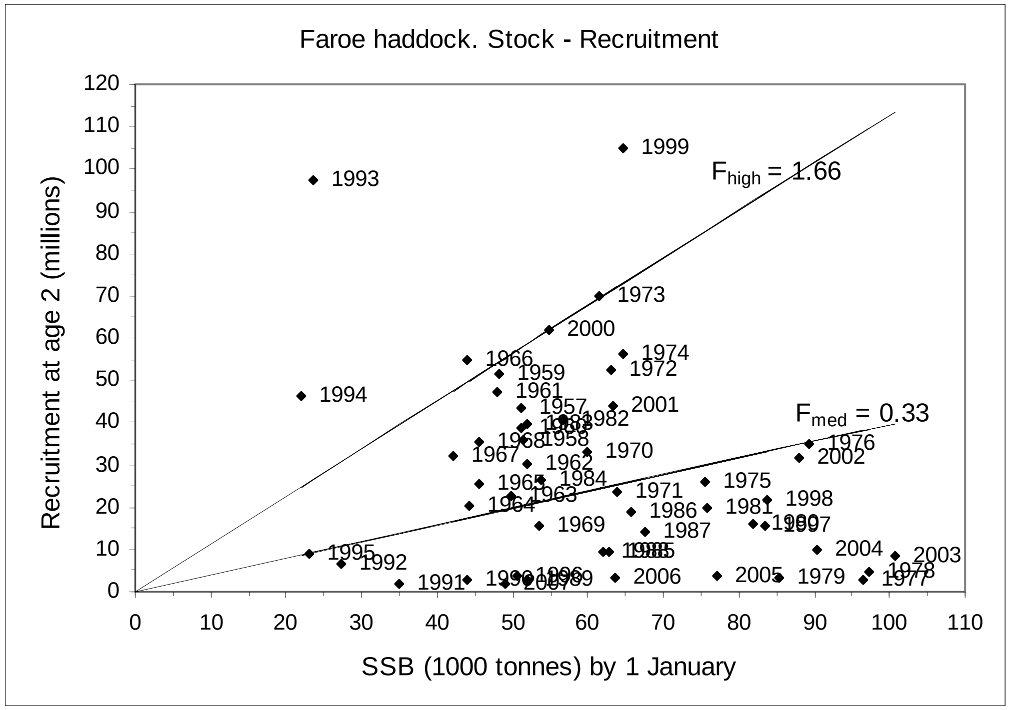
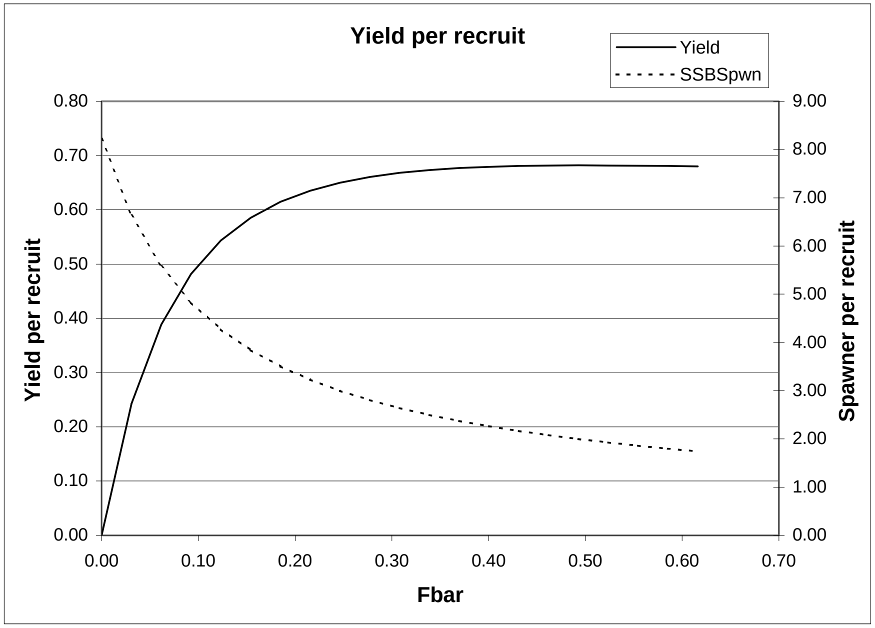
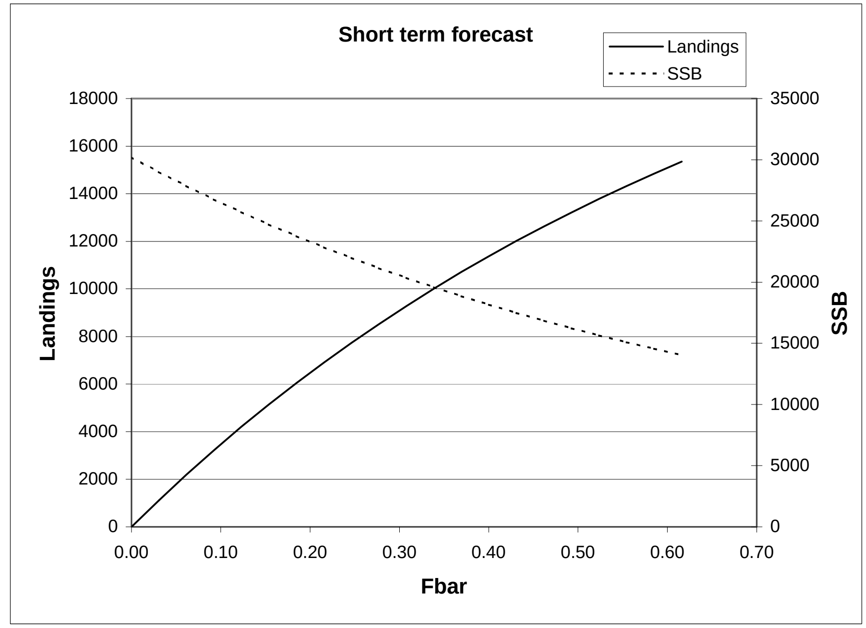


Figure 5.18. Faroe haddock. SSB-R plot.





MFYPR version 1
Run: ypr
Time and date: 19:37 4/19/2008

Reference point	F multiplier	Absolute F
Fbar(3-7)	1	0.3081
FMax	1.6139	0.4972
F0.1	0.5256	0.1619
F35%SPR	0.86	0.2649
Flow	-99	
Fmed	1.0782	0.3322
Fhigh	5.3882	1.66

Weights in kilograms

MFDP version 1
Run: man
Index file 19/04/2008
Time and date: 19:04 4/19/2008
Fbar age range: 3-7

.

Figure 5.19. Faroe haddock. Prediction output.

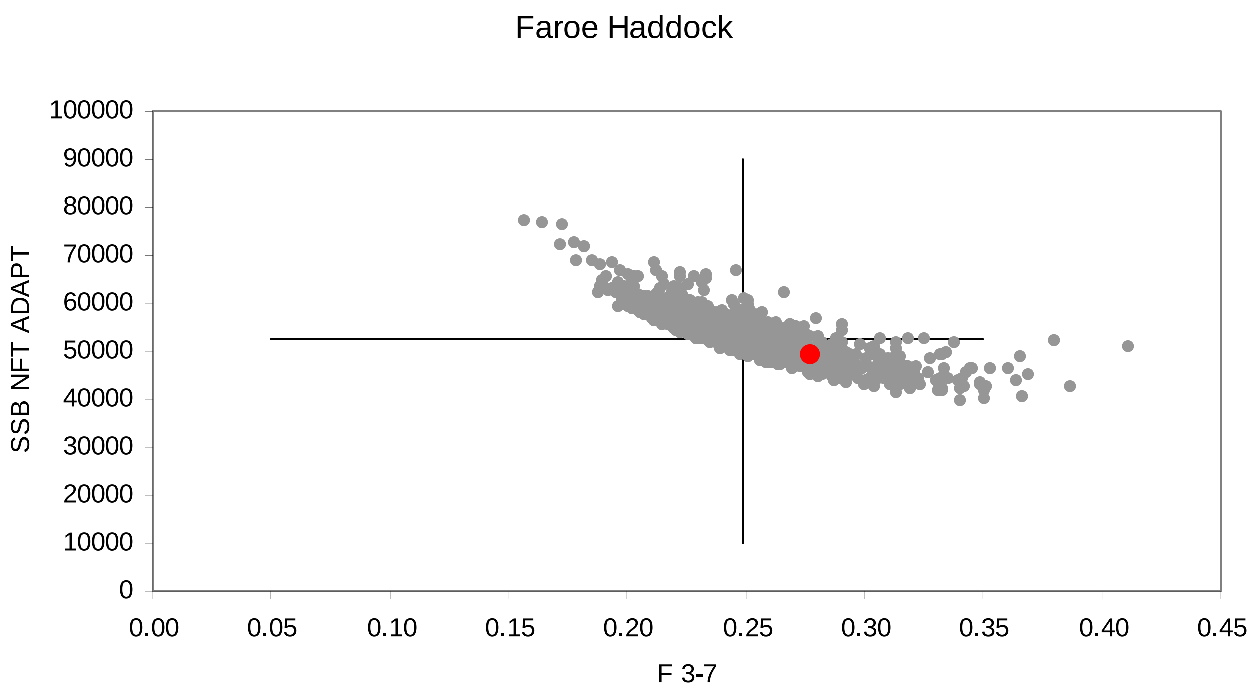
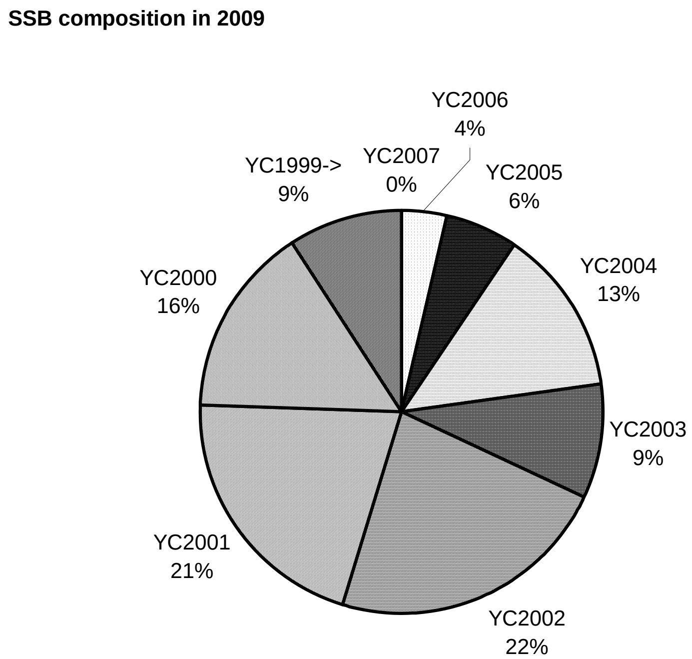


Figure 5.20. The F's and SSB's from a 1000 bootstraps of the ADAPT. Inserted are the point values of F and SSB from the accepted XSA.



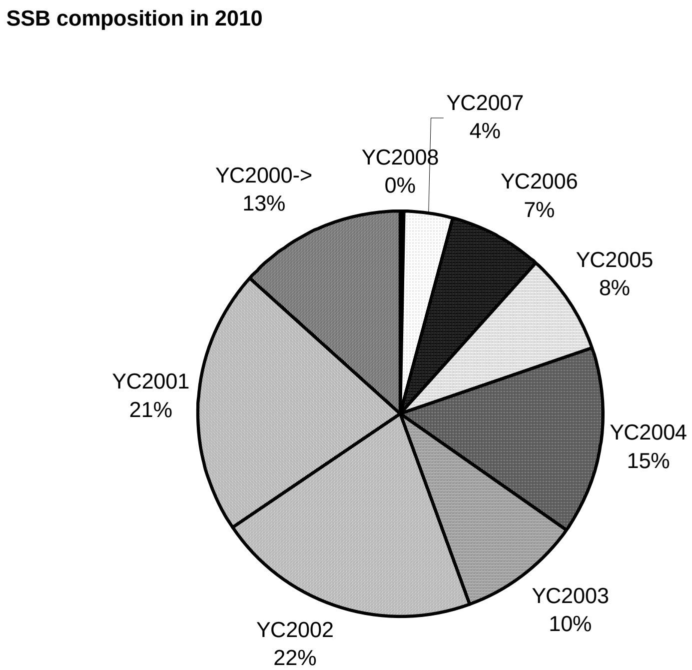


Figure 5.21. Faroe haddock. Projected composition of the number by year-classes in the SSB's in 2009 and 2010.

6 Faroe Saithe

Executive summary

The most recent benchmark assessment was completed in 2005. The 2006 and 2007 assessments have been rejected because of a retrospective pattern believed to be due to decreased size at age. As size at age has not increased markedly, the retrospective pattern, which underestimates stock size and overestimates fishing mortality, is expected to continue to exist. The SPALY (same procedure as last year, which corresponds to the most recent accepted assessment using only the pair trawl CPUE index) XSA is used as a base case and the results are compared with those from an XSA using the pair trawlers and survey results, with those from ADAPT calibrated with the same data as the SPALY XSA and also using surveys, with those from TSA using survey indices and with those from Xcam model (exploratory model setup in excel), and iterative cohort model (also in excel) which do not use tuning fleets

The working group concludes that the XSA assessment is useful to indicate stock trends, but that recent year classes are probably underestimated because of changes in catchability (q) due to slower growth, and fishing mortality is probably overestimated. The Faroe saithe biomass is estimated to be average in 2007. In addition to the SPALY short term forecast, two additional scenarios were explored, assuming lower and higher recruitment at age 3.

For Faroe saithe, the highest recruitment has been observed at or near the lowest SSB. The NWWG in 2007 therefore suggested that Bloss should be used as Bpa, not Blim. The working group recommended that Bpa for saithe be set at Bloss = 60 000t and that Blim be set at an arbitrarily lower value (45-50 000t) until more stock and recruitment data pairs are observed below Bloss. NWWG 2008 re-iterates this recommendation. Fishing mortality reference points need to be further considered.

6.1 Stock description and management units.

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 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 have demonstrated migrations between the Faroes, Iceland, Norway, west of Scotland and the North Sea (Jákupsstovu 1999). The saithe in Sub-division Vb is considered a separate management unit, but limited exchanges are believed to occur with neighbouring stocks.

6.2 Scientific data

6.2.1 Catch at age

Catch at age is based on length, weight and otoliths samples from Faroese landings of small and large single and pair trawlers, and landing statistic by fleet provided by the

Faroese Authorities. Catch at age was calculated for each fleet by four-month periods and the total was raised by the foreign catches. The catch-at-age data for previous years were also revised according to the final catch statistics (Tables 6.2.1.1 and 6.2.1.2). The sampling intensity in 2007 was similar to that in previous years (Table 6.2.1.3).

6.2.2 Weight at age

Mean weights at age have varied by a factor of about 2 during 1961-2007. Mean weights at age were generally high during the early 1980s and they subsequently decreased from the mid 1980s to the early 1990s (Table 6.2.2.1 and Figure 6.2.2.1). The mean weights increased again in the period 1992-96 but have shown a general decrease since. In 2007 the weights at age of some age groups have increased relative to 2006.

The lower weights at age after 2001 are believed to have resulted in lower catchability (q estimated by dividing the pair trawler CPUE at age by the N at age from the SPALY XSA assessment). Decreases in catchability can be seen at age 3 (Figure 6.2.2.2a) during 1995 to 2007 when there is an abrupt decrease in weight-at-age from 2001 to 2002-2007. Decreases can also be seen in Figure 6.2.2.2b which shows the ratio of the pair trawlers cpue at age (mesh size 135 mm) to the spring and summer surveys indices at age (mesh size 40 mm, not expected to show a decreased catchability) and also in Figure 6.2.2.2c which shows that the lower weights at age since 2001 correspond to lower q's. Lower catchabilities will affect the assessment, in that partially recruited ages will be underestimated in the tuning when weights at age are low. These year classes will subsequently show up as stronger than initially estimated as they recruit to the fishery and appear in the catches. The SOP for weight at age in 2007 was 100%.

6.2.3 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. The working group examined various smoothers in previous meetings and decided to use a three years running average to predict the maturity at age; this was repeated for 1983-2007. (Table 6.2.3.1 and Figure 6.2.3.1). 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 recent years. A comparison of XSA SSB output with different maturity input showed little variation of SSB (ICES C.M. 2006/ACFM:26).

6.2.4 Indices of stock size

6.2.4.1 Surveys

Survey indices are available for Faroe saithe from a Spring (since 1994) and a summer (since 1996) surveys. Survey results have not been used in recent assessments because the index showed different values and trends depending on the number of strata used to calculate the stratified estimate. In order to resolve this issue, data-driven post-stratification was applied to the survey series. The analysis suggested that 5 strata should be used in the spring and 7 for the summer survey. This new stratification reduces the variability in the survey estimates and improves year class consistency from one year to the next (Ridao Cruz, L. 2008, WD 5). The NWWG agreed this approach should be explored further. The survey data were not used in the 2008 SPALY (Same Procedure as Last Year) XSA assessment but they were used in an exploratory XSA using FLR, in NFT ADAPT and in TSA.

6.2.4.2 Commercial CPUE

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. All vessels use 135mm mesh size, the catch is stored on ice on board and landed as fresh fish. The data on which the tuning series are based origin from all available logbooks from the above mentioned trawlers since 1995. The data are stored in the database at the Faroese Fisheries Laboratory in Torshavn where their quality is controlled and the logbooks are corrected if necessary. Effort is estimated as the number of fishing (trawling) hours, i.e. 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). The series is based on data from 4-10 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. During 2002-2005 four pairs of these trawlers left the fleet. In 2004 and 2005 two new pairs of trawlers (>1000 HP) were introduced in the tuning series; one pair had been fishing saithe since 1986 and the other since 1995. These two new pairs showed approximately the same trends as the other pair trawlers in the series during 1999-2003. In the CPUE at age series (1995-2007) information for each haul was supplied and only those hauls where saithe contributed to more than 50% of the total catches were used. Figure 6.2.4.2.1 is a map of the distribution of saithe hauls from the pair trawlers tuning fleet during 1995-2007 showing that the fleet used to calculate the index consistently covers .most of the areas.

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 in R using data from each haul was used to standardize the CPUE-data (WD 37, 2005). The fitted CPUE values (Figure 6.2.4.2.2) have been estimated for the period 1995-2007 including year, month, pair, and statistical square as explanatory variables.

6.3 Information from the fishing industry

6.3.1 Landings

Nominal landings of saithe from the Faroese grounds (Division Vb) have varied cyclically between 10 000 t and 68 000 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 to 68 000 tonnes in 2005 (Table 6.3.1.1, Figure 6.3.1.1) but declined slightly in 2006 (67100t) and 2007 (60 800t).

Since the introduction of the 200 miles EEZ in 1977, the saithe fishery has been prosecuted mostly by Faroese vessels. The principal fleet consists of large pair trawlers (>1000 HP), which have a directed fishery for saithe, about 50 - 60% of the reported landings in 1992-2007 (Table 6.3.1.2). The smaller pair trawlers (<1000 HP) and larger single trawlers have a more mixed fishery and they have accounted for about 10-20% of the total landings of saithe in 1997-2006, but the larger single trawlers contributed about 30% in 2007. Jiggers only account for about 2% of the total landings in the last five years.

Catches used in the assessment are presented in Table 6.3.1.1. 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.

6.4 Methods

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). The 2006 and 2007 assessments were not accepted because of the catchability problem discussed above (see section 6.2.2). The 2008 SPALY XSA assessment described below uses the assessment formulation accepted at the last benchmark assessment in 2005 and explores the implications for providing scientific advice.

the 2008 SPALY XSA is calibrated with the GLM Pair Trawlers 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. The tunings series used are shown in table 6.4.1. The diagnostics are in Table 6.4.2 and the output from the are presented in Tables 6.4.3-5. Log catchability residuals are relatively random in recent years (Figure 6.4.1).

Comparisons between different models (Xcam model, TSA, iterative cohort model, ADAPT and XSA using the newly calculated survey indices) suggest that the XSA calibrated with the pair trawlers only continues to underestimate stock size and overestimate fishing mortality (Figure 6.4.2a-b-c-d). The Xcam model and the iterative cohort model do not use tuning data.

The 2008 SPALY XSA assessment indicates that the point estimator of SSB is close to 93 000t and that fishing mortality is close to F=0.64. As indicated above, if the 2008 SPALY XSA assessment continues to underestimate stock size and overestimate fishing mortality, SSB is probably higher and F lower than indicated in the assessment results, but by an unknown amount.

Retrospective analysis of the average fishing mortality from the XSA for age groups 4-8 (Figure 6.4.3 (middle) continues to show a tendency to overestimate F in the last years. This implies that biomass was correspondingly underestimated (Figure 6.4.3 (top). With respect to recruitment, the analysis indicated an underestimate (Figure 6.4.3 bottom). The fishing mortalities for 1961-2007 are presented in Table 6.4.3 and in Figure 6.4.4. The average fishing mortality for age groups 4-8 was 0.64 in 2007.

6.5 Reference points

6.5.1 Biological reference points

Yield per recruit and spawning stock biomass per recruit curves are presented in Figure 6.5.1.1. Compared to the 2007 average fishing mortality of 0.64 in age groups 4-8, $\mathbf{F}_{max}$ is 0.44, $\mathbf{F}_{0.1}$ is 0.13, $\mathbf{F}_{med}$ is 0.36 and $\mathbf{F}_{high}$ is 1.10 (Table 6.5.1.1, Figure 6.5.1.1 and Figure 6.5.1.2).

Yield and spawning biomass per Recruit F-reference points:

	Fish Mort Ages 4-8	Yield/R	SSB/R
Average last 3 years	0.54	1.49	2.60
Fmax	0.44	1.49	3.06
F0.1	0.13	1.29	7.38
Fmed	0.36	1.49	3.55

The history of the stock/fishery in relation to the existing four reference points can be seen in Figure 6.5.1.3.

The pa and lim reference points for saithe in Vb are listed in the table below.

Reference point Type	Value
B_{lim}	60 000 t
B_{pa}	85 000 t
F_{lim}	0.40
F_{pa}	0.28
F_{y}	~ 0.45

For Faroe saithe, the highest recruitment has been observed at or near the lowest SSB. The NWWG in 2007 therefore suggested that Bloss should be used as Bpa, not Blim. The working group recommended that Bpa for saithe be set at Bloss = 60 000t and that Blim be set at an arbitrarily lower value (45-50 000t) until more stock and recruitment data pairs are observed below Bloss. NWWG 2008 reiterates those recommendations. Fishing mortality reference points need to be further considered.

6.6 State of the stock

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 6.6.1.1). The 1998 year class (87 millions) and the 1999 year class (93 millions) are the largest in the available time series. 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 6.4.5 and Figure 6.6.1.2). The SSB has increased since 1996 to above 100 000t in 2005 with the maturation of the 1992, 1994, 1996, 1998 and 1999 yearclasses but since 2005 the SSB has decreased to 93 000 t. The relation between stock and recruitment (Figure 6.6.1.3) shows that the highest recruitment has been observed at or near the lowest SSBs. While the spawning stock biomass graph shows three cycles of decreasing magnitude, that of total biomass (Figure 6.6.1.4) shows three cycles of increasing magnitude. This could be due to higher exploitation rates since the early 1990s.

The 93 000t SSB in 2007 is above both Bpa and Blim. Fishing mortality, however, is higher than Ftarget, Fpa and Flim. Bearing in mind that the 2008 SPALY XSA is likely to underestimate SSB and overestimate F, the stock has full reproductive capacity but, even considering the likely overestimation of F, the stock is likely to be harvested unsustainably.

6.7 Short term forecast

6.7.1 Input data

Input data for prediction with management options are presented in Table 6.7.1.1.

Population numbers for the base short term prediction up to the 2004 year class are from the final 2008 SPALY XSA run whereas values for the 2005-2007 year classes are the geometric mean of the 1977 to 2004 year classes. Two additional scenarios were examined. Firstly the geometric mean of the 1977-2003 year classes was also used for the 2004 year class (32 644 instead of the XSA 60 685), and secondly, assuming that good recruitment will continue, the geometric mean of year classes 1996-2003 was used for the 2004-2007 year classes. The 2007 values were used for 2008-2010 weights (Table 6.7.1.1). The value of natural mortality is 0.2.

The average of 2007-2008 proportion mature values from the spring survey were used for 2008. For 2009 and 2010 the average for 2006-2008 was used. For all three years the average exploitation pattern in the final VPA for 2005-2007, unscaled to Fbar (ages 4-8) in 2007 in view of a retrospective problem (as suggested by ACFM, 2004), was used.

Projection of catch and biomass

Results from predictions with management option are presented in Table 6.5.1.1a-c. Catches at status quo F would be 47 100 t in 2008 and 45 700 t in 2009. The spawning stock biomass would be about 79 600 tonnes in 2008 and about 71 500 in 2009. The additional two scenarios are listed in the table below. In all cases the SSB is above above the Bpa =60 000t suggested by NWWG in 2007, but below the ICES Bpa of 85 000t. With the 2004 year class set at the GM mean of the 1977 to 2003 year classes (32 644) SSB would be 61 500 in 2009, close to the Bpa proposed by the WG and the existing Blim and the landings 38 100. The landings in 2008 are not much altered by changing the recruitment settings. If strong recruitment continues, the 2008 and 2009 SSB are correspondingly higher.

Recruitment Year classes	33 375 2005-2007		32 644 2004-2007		54 880 2004-2007	
Year	2008	2009	2008	2009	2008	2009
Landings	47 100	45 700	43 900	38 100	46 900	47 000
SSB	79 600	71 500	72 000	61 500	78 000	75 300

A projection of catch in number by year classes in 2007 and weight composition in SSB by year classes in 2009 is presented in Figure 6.7.1.1 for the base case. The catch in 2008 is predicted to rely on the four most recent year classes (92%). In 2009 the year classes from 2002 to 2004 are expected to contribute about 70% of the SSB.

6.8 (Medium term forecasts)

No medium term projections were done in 2008.

6.8.1 Input data to yield per recruit

Mean weights for 1961-2006 were used. The value of natural mortality is 0.2. For proportion mature in the long term prediction the average of smoothed values for 1983-2008 was used.

The exploitation pattern was set equal to the average of exploitation patterns for 2002-2007 (as suggested from ACFM, 2004). The input data to long term prediction are shown in Table 6.8.1.1.

Results from the yield per recruit estimates are shown in Table 6.8.1.2 and Figure 6.5.1.1.

6.9 Uncertainties in assessment and forecast

The NMFS NFT software was used to run ADAPT with the pair trawler CPUE, with the spring and summer surveys individually and combined and with the three indices of stock size combined. The scatterplots of the 1000 bootstrapped F and SSB pairs suggest that the pair trawler cpue and the spring survey, when used alone, can provide widely differing results. The summer survey consistently results in higher estimates of stock size. Results seem relatively more stable when the 3 stock size indices are used in the assessment,

As discussed above, SPALY XSA results are likely to continue to underestimate stock size and overestimate fishing mortality.

6.9.1 Assessment quality

The assessment is calibrated exclusively with commercial CPUE data. The WG recognises that these are high quality data, but the problems associated with the use of commercial CPUE data (e.g. increased efficiency due to technological creep etc.) may affect the assessment. The introduction of GLM standardisation could mitigate the problems of vessel replacement if sufficient overlap occurs with other vessels.

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

The 2006 and 2007 assessments have been rejected because of the retrospective pattern which is expected to continue to exist. Given that the survey estimates are now available, a benchmark assessment should be done prior to the next NWWG to provide a firmer basis to the formulation of scientific advice.

6.10 Comparison with previous assessment and forecast

The two previous assessments have not been accepted. This assessment is consistent with previous results in the sense that stock size seem to continue to be underestimated and fishing mortality overestimated presumably because of decreased catchability related to reduced growth.

6.11 Management plans and evaluations

Although the 2008 SPALY XSA is expected to continue to overestimate fishing mortality, the probability that F 4-8 is at or less than the target is low. This implies that current management measures are probably insufficient to meet the stated fishing mortality target of F = 0.45.

6.12 Management considerations

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

The spawning stock biomass is above Bpa and is expected to reduce to 72 000 t at status quo fishing mortality, due to poor recruitment in the short term. However, if the 2008 SPALY XSA continues to underestimate SSB and if recent year-classes are stronger than used in the base case, the 2009 assessment could indicate that the SSB had remained above Bpa.

The XSA suggests that the abundance of the strong year classes of the early 2000s will be considerably decreased in 2008 but there are indications in the alternate assessment techniques (Figure 6.4.2) that this may not be the case. If the alternate assessments are correct, there could good abundance of age 6 saithe in 2008.

6.13 Ecosystem considerations

6.14 Regulations and their effects

6.15 Changes in fishing technology and fishing patterns

6.16 Changes in the environment

The shallow areas on the Faroe Plateau have been coupled to primary production for some years. A possible ecosystem driver in the deeper areas on the Faroe Plateau is the North Atlantic subpolar gyre. When comparing a gyre index (GI), described by Hatun et al., 2005, to saithe in Faroese waters there was a marked positive relationship between annual variations in GI and the total biomass of saithe lagged 4 years. This is further described in section 2 and in WD 20 (Steingrund, P. and Hatun, H., 2008).

6.17 Response to technical minutes

2006

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

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

Bycatch has been mentioned in the latest technical minutes. The results presented in NWWG 2007 indicate that the bycatch issue is a minor problem in the saithe assessment (ICES C.M. 2007/ACFM:17). Mandatory use of sorting grids in the blue whiting fishery was introduced from April 15, 2007 in the areas west and northwest of the Faroe Islands.

2007

Technical minutes pointed out the problem of variability in weight-at-age and suggested the possibility of using different modelling approaches that the WG could explore in the future. It was discussed whether there was possibility for Faroe Saithe to be part of the benchmark workshop in winther 2008; but this session was already closed for additional participants. Alternatively the group discussed the possibility of working intersessionally to explore usable models for next years meeting.

References

ICES C.M. 1993/Assess:18.

ICES C.M. 1998/ACFM:19.

ICES C.M. 2003/ACFM:24.

ICES C.M. 2005/ACFM:21.

ICES C.M. 2006/ACFM:26.

ICES C.M. 2007/ACFM:17

Hatun, H., Sando, A. B., Drange, H., Hansen, B., and Valdimarsson, H. 2005b: Influence of the Atlantic subpolar gyre on the thermohaline circulation. Science, **309**: 1841-1844.

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

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

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

Ridao Cruz, L. 2008. Post-Stratification of the survey indices for Faroese saithe. WD 5, NWWG 2008.

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

Steingrund, P. and Hatun, H., 2008. Relationship between the North Atlantic Subpolar Gyre and fluctuations of the saithe stock in Faroese waters. WD 20, NWWG 2008.

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

Table 6.2.1.1. Saithe in the Faroes (Division Vb). Catch number at age by fleet categories (calculated from gutted weights).

Age	Jiggers	Single trawlers >1000 HP	Pair trawlers <1000 HP	Pair trawlers >1000HP	Others	Total Faroese fleet	Foreign fleet	Total Division Vb
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
2	0	5	1	1	0	14	1	15
3	5	192	19	204	3	804	25	829
4	42	572	199	879	14	3239	75	3315
5	126	1987	725	2913	56	11026	262	11288
6	85	820	596	1815	33	6359	108	6467
7	41	424	445	1034	17	3722	56	3778
8	50	492	448	1215	20	4225	65	4290
9	20	194	140	435	7	1511	26	1536
10	4	61	34	110	2	398	8	406
11	1	14	8	19	0	79	2	81
12	0	4	2	0	0	11	0	11
13	0	3	1	0	0	9	0	9
14	0	1	0	0	0	3	0	3
15	0	0	0	0	0	0	0	0
Total No.	372	4770	2617	8624	152	31399	629	32028
Catch, t.	710	8602	5355	16540	288	59805	1022	60827

Notes: Numbers in 1000'

Catch, round weight in tonnes

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

Table 6.2.1.2. Saithe in the Faroes (Division Vb). Catch number at age (thousands) from the commercial fleet.

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

YEAR	1961	1962	1963	1964	1965	1966	1967
AGE							
3	183	562	614	684	996	488	595
4	379	542	340	1908	850	1540	796
5	483	617	340	1506	1708	1201	1364
6	403	495	415	617	965	1686	792
7	216	286	406	572	510	806	1192
8	129	131	202	424	407	377	473
9	116	129	174	179	306	294	217
10	82	113	158	150	201	205	190
11	45	71	94	100	156	156	97
+gp	82	105	274	174	285	225	140
TOTALNUM	2118	3051	3017	6314	6384	6978	5856
TONSLAND	9592	10454	12693	21893	22181	25563	21319
SOPCOF %	108	93	96	99	92	98	104

YEAR	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
AGE										
3	614	1191	1445	2857	2714	2515	3504	2062	3178	1609
4	1689	2086	6577	3316	1774	6253	4126	3361	3217	2937
5	1116	2294	1558	5585	2588	7075	4011	3801	1720	2034
6	1095	1414	1478	1005	2742	3478	2784	1939	1250	1288
7	548	1118	899	828	1529	1634	1401	1045	877	767
8	655	589	730	469	1305	693	640	714	641	708
9	254	580	316	326	1017	550	368	302	468	498
10	128	239	241	164	743	403	340	192	223	338
11	89	115	86	100	330	215	197	193	141	272
+gp	187	190	132	100	210	186	265	298	287	330
TOTALNUM	6375	9816	13462	14750	14952	23002	17636	13907	12002	10781
TONSLAND	20387	27437	29110	32706	42663	57431	47188	41576	33065	34835
SOPCOF %	102	97	96	109	100	120	113	116	107	104

YEAR	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
AGE										
3	611	287	996	411	387	2483	368	1224	1167	1581
4	1743	933	877	1804	4076	1103	11067	3990	1997	5793
5	1736	1341	720	769	994	5052	2359	5583	4473	3827
6	548	1033	673	932	1114	1343	4093	1182	3730	2785
7	373	584	726	908	380	575	875	1898	953	990
8	479	414	284	734	417	339	273	273	1077	532
9	466	247	212	343	296	273	161	103	245	333
10	473	473	171	192	105	98	52	38	104	81
11	407	368	196	92	88	98	65	26	67	43
+gp	535	691	786	1021	902	540	253	275	158	97
TOTALNUM	7371	6371	5641	7206	8759	11904	19566	14592	13971	16062
TONSLAND	28138	27246	25230	30103	30964	39176	54665	44605	41716	40020
SOPCOF %	100	102	99	96	96	100	100	94	94	96

YEAR	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
AGE										
3	866	451	294	1030	521	1316	690	398	297	344
4	2950	5981	3833	5125	4067	2611	3961	1019	1087	832
5	9555	5300	10120	7452	3667	4689	2663	3468	1146	2440
6	2784	7136	9219	5544	2679	1665	2368	1836	1449	1767
7	1300	793	5070	3487	1373	858	746	1177	1156	1335
8	621	546	477	1630	894	492	500	345	521	624
9	363	185	123	405	613	448	307	241	132	165
10	159	83	61	238	123	245	303	192	77	71
11	27	55	60	128	63	54	150	104	64	29
+gp	60	39	79	118	108	52	49	117	82	100
TOTALNUM	18685	20569	29336	25157	14108	12430	11737	8897	6011	7707
TONSLAND	45285	44477	61628	54858	36487	33543	33182	27209	20029	22306
SOPCOF %	99	97	98	99	105	102	102	102	103	100

YEAR	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
AGE										
3	163	322	811	1125	302	330	76	454	1479	829
4	1689	655	2830	2452	8399	2432	2011	2949	5060	3315
5	1934	3096	1484	8437	5962	11152	8544	9490	7804	11288
6	3475	2551	4369	2155	9786	3994	8762	16613	7735	6467
7	1379	4113	2226	3680	862	4287	2125	7102	10327	3778
8	683	915	2725	1539	1280	417	1807	843	3771	4290
9	368	380	348	1334	465	419	265	810	642	1536
10	77	147	186	293	362	304	293	32	283	406
11	32	24	56	90	33	91	146	102	32	81
+gp	73	69	25	56	45	43	112	30	29	23
TOTALNUM	9873	12272	15060	21161	27496	23469	24141	38425	37162	32013
TONSLAND	26421	33207	39020	51786	53546	46555	46355	68008	67103	60827
SOPCOF %	102	102	102	100	100	100	100	100	100	100

Table 6.2.1.3. Saithe in the Faroes (Division Vb). Sampling intensity in 2000-2007.

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	5.9
	Otoliths	180	180	240	3537	240	4377	
	Weights	180	120	120	3357	1364	5141	
2005	**Lengths**	1048	4266	6183	32046	1564	45107	3.6
	Otoliths	120	413	690	2760	240	4223	
	Weights	340	385	791	3533	1564	6613	
2006	**Lengths**	1059	7979	8115	23082	1139	41374	3.5
	Otoliths	180	598	1138	2096	60	4072	
	Weights	180	60	1620	5678	812	8350	
2007	**Lengths**	683	10525	10593	18045	381	40227	4.1
	Otoliths	120	748	960	1977	0	3805	
	Weights	120	697	5603	9884	120	16424	

Table 6.2.2.1. Saithe in the Faroes (Division Vb). Catch weights at age (kg) from the commercial fleet.

Table 2 Catch weights at age (kg)

YEAR	1961	1962	1963	1964	1965	1966	1967
AGE							
3	1.4300	1.2730	1.2800	1.1750	1.1810	1.3610	1.2730
4	2.3020	2.0450	2.1970	2.0550	2.1250	2.0260	1.7800
5	3.3480	3.2930	3.2120	3.2660	2.9410	3.0550	2.5340
6	4.2870	4.1910	4.5680	4.2550	4.0960	3.6580	3.5720
7	5.1280	5.1460	5.0560	5.0380	4.8780	4.5850	4.3680
8	6.1550	5.6550	5.9320	5.6940	5.9320	5.5200	5.3130
9	7.0600	6.4690	6.2590	6.6620	6.3210	6.8370	5.8120
10	7.2650	6.7060	8.0000	6.8370	7.2880	7.2650	6.5540
11	7.4970	7.1500	7.2650	7.6860	8.0740	7.6620	7.8060
+gp	9.3399	9.0237	8.8589	8.5591	8.9035	9.2233	8.1494
SOPCOFAC	1.0779	.9342	.9590	.9933	.9220	.9769	1.0357

YEAR	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
AGE										
3	1.3020	1.1880	1.2440	1.1010	1.0430	1.0880	1.4300	1.1140	1.0880	1.2230
4	1.7370	1.6670	1.4450	1.3160	1.4850	1.4610	1.5250	1.6580	1.6760	1.6410
5	2.0360	2.3020	2.2490	1.8180	2.0550	1.5820	2.2070	2.2600	2.8780	2.6600
6	3.1200	2.8530	2.8530	2.9780	2.8290	2.2490	2.5000	3.1200	3.0810	3.7900
7	4.0490	3.6730	3.5150	3.7020	3.7910	3.6870	3.1200	3.5570	4.2870	4.2390
8	5.1830	5.0020	4.4180	4.2710	4.1750	4.3850	4.6010	4.0960	4.3520	5.5970
9	6.2380	5.7140	5.4440	5.3880	4.8080	5.1280	5.5590	5.1280	4.7900	5.3500
10	7.5200	6.4050	5.7330	5.9720	5.2940	5.2760	5.7140	6.0940	5.9120	5.9120
11	8.0490	6.5540	6.6620	6.4900	6.9480	6.7270	6.2590	7.1960	6.6190	6.8370
+gp	9.0925	8.0870	8.5844	8.0047	7.5146	8.0307	8.0104	8.5982	7.8941	7.7085
SOPCOFAC	1.0194	.9663	.9634	1.0935	1.0043	1.2006	1.1296	1.1607	1.0680	1.0442

YEAR	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
AGE										
3	1.4930	1.2200	1.2300	1.3100	1.3370	1.2080	1.4310	1.4010	1.7180	1.6090
4	2.3240	1.8800	2.1200	2.1300	1.8510	2.0290	1.9530	2.0320	1.9860	1.8350
5	3.0680	2.6200	3.3200	3.0000	2.9510	2.9650	2.4700	2.9650	2.6180	2.3950
6	3.7460	3.4000	4.2800	3.8100	3.5770	4.1430	3.8500	3.5960	3.2770	3.1820
7	4.9130	4.1800	5.1600	4.7500	4.9270	4.7240	5.1770	5.3360	4.1860	4.0670
8	4.3680	4.9500	6.4200	5.2500	6.2430	5.9010	6.3470	7.2020	5.5890	5.1490
9	5.2760	5.6900	6.8700	5.9500	7.2320	6.8110	7.8250	6.9660	6.0500	5.5010
10	5.8320	6.3800	7.0900	6.4300	7.2390	7.0510	6.7460	9.8620	6.1500	6.6260
11	6.0530	7.0200	7.9300	7.0000	8.3460	7.2480	8.6360	10.6700	9.5360	6.3430
+gp	7.5756	8.6262	9.2153	8.9618	10.0411	10.0547	10.0976	11.9501	10.2181	10.2439
SOPCOFAC	1.0049	1.0248	.9937	.9564	.9632	.9997	.9991	.9415	.9419	.9620

YEAR	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
AGE										
3	1.5000	1.3090	1.2230	1.2400	1.2640	1.4080	1.5030	1.4560	1.4320	1.4760
4	1.9750	1.7350	1.6330	1.5680	1.6020	1.8600	1.9510	2.1770	1.8750	1.7830
5	1.9780	1.9070	1.8300	1.8640	2.0690	2.3230	2.2670	2.4200	2.4960	2.0320
6	2.9370	2.3730	2.0520	2.2110	2.5540	3.1310	2.9360	2.8950	3.2290	2.7780
7	3.7980	3.8100	2.8660	2.6480	3.0570	3.7300	4.2140	3.6510	3.7440	3.5980
8	4.4190	4.6670	4.4740	3.3800	4.0780	4.3940	4.9710	5.0640	4.9640	4.7660
9	5.1150	5.5090	5.4240	4.8160	5.0120	5.2090	5.6570	5.4400	6.3750	5.9820
10	6.7120	5.9720	6.4690	5.5160	6.7680	6.5400	5.9500	6.1670	6.7450	7.6580
11	9.0400	6.9390	6.3430	6.4070	7.7540	8.4030	6.8910	7.0800	7.4660	7.8820
+gp	9.3369	9.9364	8.2869	7.7285	8.2297	8.0501	9.1086	7.5392	7.9806	9.2453
SOPCOFAC	.9928	.9698	.9811	.9938	1.0506	1.0169	1.0240	1.0205	1.0319	.9994

YEAR	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
AGE										
3	1.3880	1.3740	1.4770	1.3300	1.1420	1.1230	1.1430	1.1480	1.1260	1.0580
4	1.7110	1.7120	1.6060	1.5900	1.4600	1.3040	1.3330	1.3250	1.2180	1.3910
5	1.9540	1.9050	2.0770	1.7850	1.6520	1.6140	1.4500	1.5160	1.4620	1.4130
6	2.4050	2.3960	2.3600	2.5860	1.9690	1.9770	1.7890	1.6720	1.7900	1.8240
7	3.3000	2.8450	2.9770	3.0590	3.1300	2.5320	2.5600	2.0870	2.0350	2.3610
8	4.2200	4.1240	3.4800	3.8710	3.5890	3.9700	3.1590	2.9750	2.4360	2.6820
9	4.9990	5.2560	4.8510	4.3740	4.5130	4.8340	4.1540	3.7900	3.8610	3.2780
10	6.3910	5.5260	5.2680	5.5650	5.1380	5.4990	5.1670	6.0870	4.2220	4.1040
11	6.6650	6.9560	6.5230	6.7030	6.4220	6.0990	6.0150	6.1340	5.1490	4.9980
+gp	8.4847	8.5237	5.9024	6.9076	7.5192	6.9154	6.3209	6.7283	6.4458	7.1370
SOPCOFAC	1.0221	1.0182	1.0154	1.0017	1.0004	1.0012	1.0038	.9999	.9969	.9983

Table 6.2.3.1. Saithe in the Faroes (Division Vb). Proportion mature at age from the spring survey.

Table 5 Proportion mature at age

YEAR AGE	1961	1962	1963	1964	1965	1966	1967
3	.0400	.0400	.0400	.0400	.0400	.0400	.0400
4	.2600	.2600	.2600	.2600	.2600	.2600	.2600
5	.5700	.5700	.5700	.5700	.5700	.5700	.5700
6	.8200	.8200	.8200	.8200	.8200	.8200	.8200
7	.9100	.9100	.9100	.9100	.9100	.9100	.9100
8	.9800	.9800	.9800	.9800	.9800	.9800	.9800
9	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
11	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

YEAR AGE	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
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	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
3	.0400	.0400	.0400	.0400	.0400	.0000	.0300	.0400	.1100	.1100
4	.2600	.2600	.2600	.2600	.2600	.2800	.2500	.3700	.3100	.3200
5	.5700	.5700	.5700	.5700	.5700	.6300	.5600	.7100	.5500	.5900
6	.8200	.8200	.8200	.8200	.8200	.9900	.9400	.9200	.8600	.8300
7	.9100	.9100	.9100	.9100	.9100	1.0000	.9800	.9800	.9800	.9700
8	.9800	.9800	.9800	.9800	.9800	1.0000	1.0000	1.0000	1.0000	.9700
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	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
3	.1000	.0300	.0000	.0000	.0000	.0100	.0400	.0400	.0200	.0000
4	.2200	.2000	.2000	.1600	.1700	.1500	.1800	.1400	.1300	.1300
5	.5200	.5700	.5500	.4400	.4700	.5100	.6600	.6500	.5900	.4300
6	.7500	.6700	.6800	.7000	.7800	.8300	.8600	.8600	.8000	.6400
7	.9100	.8300	.8000	.8300	.8900	.9400	.9600	.9500	.9400	.8700
8	.9200	.9200	.9400	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	.9900
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	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
3	.0100	.0300	.0300	.0200	.0000	.0000	.0000	.0000	.0000	.0000
4	.1600	.2000	.2100	.2000	.1800	.1500	.1300	.1700	.2200	.2500
5	.3700	.3500	.3600	.3600	.4100	.3700	.3800	.3500	.4000	.4400
6	.5400	.5200	.6200	.6000	.6000	.5100	.5500	.5600	.6200	.6500
7	.7900	.7400	.7600	.7500	.7300	.6700	.7100	.7100	.7800	.8400
8	.9700	.9200	.9300	.9100	.9400	.8700	.8700	.8500	.8800	.9100
9	.9700	.9700	.9600	.9700	.9700	.9900	.9900	.9700	.9600	.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 6.3.1.1. Saithe in the Faroes (Division Vb). Nominal catches (tonnes round weight) by countries, 1989-2007, as officially reported to ICES.

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

Country	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007 [1]
Denmark	-	-	-	-	-	-	-	-	34	-
Estonia	-	-	-	-	-	-	-	-	-	-
Faroe Islands	25,995	32,439		49,676	55,165	47,933	48,222	71,496	70,696	64,654
France	17	-	273	934	607	370	147	123	315	84
Germany	-	100	230	667	422	281	186	1	49	3
Greenland	-	-	-		125	-				
Irland	-	-	-	5	-	-	-	-	-	-
Norway	53	160	72	60	77	62	82	82	35	81
Portugal	-	-	-	-	-	-	5	-	-	-
Russia	-	-	20	1	10	32	71	210	104	99
UK (E/W/NI)	19	67	32	80	58	89	85	32	88	
UK (Scotland)	337	441	534	708	540	610	748	4,322	1,011	
United Kingdom										412
Total	26,421	33,207	1,161	52,131	57,004	49,377	49,546	76,266	72,332	65,333
Working Group estimate [4,5,6,7]	26,421	33,207	39,020	51,786	53,546	46,555	46,355	68,008	67,103	60,827

[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 2001-2007 catches from Faroe Islands, as stated from Faroese coastal guard service, are corrected in order to be consistent with procedures used previous years.

Table 6.3.1.2. Saithe in the Faroes (Division Vb). Total Faroese landings (rightmost column) and the contribution (%) by each fleet category. Averages for 1985-2007 are given at the bottom.

Year	Open boats	Long-liners <100 GRT	Single trawl <400 HP	Gill-nets	Jiggers	Single trawl 400-1000 HP	Single trawl >1000 HP	Pair trawl <1000 HP	Pair trawl >1000 HP	Long-liners >100 GRT	Indust-rial trawlers	Others	Total round weight (tonnes)
1985	0.2	0.1	0.1	0.0	2.6	6.6	33.7	28.2	28.2	0.1	0.2	0.2	42598
1986	0.3	0.2	0.1	0.1	3.6	2.8	27.3	27.5	36.5	0.1	0.7	0.9	40107
1987	0.7	0.1	0.3	0.4	5.6	4.1	20.4	22.8	44.2	0.1	1.1	0.0	39627
1988	0.4	0.3	0.1	0.3	6.5	6.8	20.8	19.6	43.6	0.1	1.3	0.1	43940
1989	0.9	0.1	0.3	0.2	9.3	5.4	17.7	23.5	41.1	0.1	1.3	0.0	43624
1990	0.6	0.2	0.2	0.2	7.4	3.9	19.6	24.0	42.8	0.2	0.9	0.0	59821
1991	0.6	0.1	0.1	0.6	9.8	1.3	13.9	26.5	46.2	0.1	0.8	0.0	53321
1992	0.4	0.4	0.0	0.0	10.5	0.5	7.1	24.4	55.6	0.1	1.0	0.0	35979
1993	0.6	0.2	0.1	0.0	9.3	0.6	6.5	21.4	60.6	0.1	0.7	0.0	32719
1994	0.4	0.4	0.1	0.0	12.6	1.1	6.8	18.5	59.1	0.2	0.7	0.0	32406
1995	0.2	0.1	0.4	0.0	9.6	0.9	9.9	17.7	60.9	0.3	0.0	0.0	26918
1996	0.0	0.0	0.1	0.0	9.2	1.2	6.8	23.7	58.6	0.2	0.0	0.0	19267
1997	0.0	0.1	0.1	0.0	8.9	2.5	10.7	17.8	58.9	0.4	0.4	0.0	21721
1998	0.1	0.4	0.1	0.0	8.1	2.8	13.8	16.5	57.6	0.3	0.4	0.0	25995
1999	0.0	0.1	0.1	0.0	5.7	1.2	12.6	18.5	60.0	0.2	1.6	0.0	32439
2000	0.1	0.1	0.2	0.0	3.7	0.3	15.0	17.5	62.3	0.1	0.7	0.0	37859
2001	0.1	0.1	0.1	0.0	2.8	0.3	20.2	16.5	58.8	0.2	0.8	0.1	49676
2002	0.1	0.2	0.1	0.0	1.6	0.1	26.5	10.5	60.8	0.1	0.0	0.0	51028
2003	0.0	0.0	1.9	0.0	0.9	0.4	17.4	14.7	64.7	0.1	0.0	0.0	44338
2004	0.1	0.2	3.7	0.0	1.9	0.4	15.1	14.4	63.8	0.2	0.0	0.0	44605
2005	0.2	0.1	4.4	0.0	2.4	0.2	12.7	20.6	59.2	0.2	0.0	0.0	66134
2006	0.2	0.4	0.3	0.0	3.9	0.1	19.8	20.6	54.1	0.6	0.0	0.0	65394
2007	0.2	0.2	0.2	0.0	2.0	0.1	30.4	16.0	50.6	0.3	0.0	0.0	59805
Average	0.3	0.2	0.6	0.1	6.0	1.9	16.7	20.1	53.4	0.2	0.5	0.1	42144

Table 6.4.1. 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 2007

1 1 0 1

3 11

10486	91	349	1118	457	283	95	46	37	27
7128	99	306	262	358	161	90	43	41	22
9615	76	205	571	389	295	128	28	13	4
10555	46	281	492	637	313	139	73	17	5
15112	94	263	840	1090	1094	442	103	45	7
12997	212	765	446	1320	652	784	94	52	15
14100	315	742	2554	602	958	386	319	66	15
12670	58	1741	1736	3016	228	299	108	77	11
8731	50	528	2321	839	800	70	75	44	13
8523	15	428	1818	1828	370	272	40	42	19
9352	73	463	1573	2829	1219	125	113	3	17
7823	52	440	902	967	1384	515	100	32	5
9118	92	397	1317	821	467	549	197	50	8

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Table 6.4.2. Saithe in the Faroes (Division Vb). Diagnostics from XSA with commercial pair trawler (GLM) tuning series.

Lowestoft VPA Version 3.1

16/04/2008 12:40

Extended Survivors Analysis

FAROE SAITHE (ICES Division Vb) SAI_IND

CPUE data from file D:\NWWG\NWWG2008\XSA\backup\allpairGLM3-11.DAT

Catch data for 47 years. 1961 to 2007. Ages 3 to 12.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
All pair (GLM) >1000	1995	2007	3	11	.000	1.000

Time series weights :

Tapered time weighting not applied

Catchability analysis :

Catchability independent of stock size for all ages
Catchability independent of age for ages >= 8

Terminal population estimation :

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

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

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

Prior weighting not applied

Tuning converged after 32 iterations

Regression weights

1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Fishing mortalities

Age	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
3	.014	.006	.026	.014	.003	.007	.002	.009	.041	.015
4	.072	.073	.068	.103	.142	.035	.055	.100	.133	.121
5	.151	.182	.237	.295	.391	.284	.164	.398	.414	.490
6	.241	.305	.422	.642	.665	.496	.379	.550	.668	.733
7	.461	.499	.478	.776	.580	.705	.541	.610	.813	.836
8	.529	.643	.743	.728	.690	.624	.748	.427	.787	1.013
9	.718	.642	.543	1.075	.502	.507	1.118	.941	.684	.906
10	.820	.719	.774	1.356	1.020	.736	.829	.362	1.099	1.417
11	.729	.660	.672	1.171	.505	.786	1.017	.796	.760	1.204

XSA population numbers (Thousands)

	AGE								
YEAR	3	4	5	6	7	8	9	10	11
1998	1.27E+04	2.70E+04	1.52E+04	1.80E+04	4.13E+03	1.84E+03	7.94E+02	1.52E+02	6.83E+01
1999	5.86E+04	1.02E+04	2.06E+04	1.07E+04	1.16E+04	2.13E+03	8.86E+02	3.17E+02	5.49E+01
2000	3.46E+04	4.77E+04	7.78E+03	1.40E+04	6.48E+03	5.75E+03	9.17E+02	3.82E+02	1.26E+02
2001	8.69E+04	2.76E+04	3.65E+04	5.03E+03	7.53E+03	3.29E+03	2.24E+03	4.36E+02	1.44E+02
2002	9.68E+04	7.01E+04	2.04E+04	2.23E+04	2.16E+03	2.84E+03	1.30E+03	6.26E+02	9.21E+01
2003	5.07E+04	7.90E+04	4.98E+04	1.13E+04	9.37E+03	9.92E+02	1.17E+03	6.45E+02	1.85E+02
2004	4.20E+04	4.12E+04	6.25E+04	3.07E+04	5.62E+03	3.79E+03	4.35E+02	5.75E+02	2.53E+02
2005	5.54E+04	3.43E+04	3.19E+04	4.34E+04	1.72E+04	2.68E+03	1.47E+03	1.17E+02	2.05E+02
2006	4.09E+04	4.50E+04	2.54E+04	1.75E+04	2.05E+04	7.65E+03	1.43E+03	4.69E+02	6.65E+01
2007	6.07E+04	3.21E+04	3.22E+04	1.38E+04	7.37E+03	7.44E+03	2.85E+03	5.92E+02	1.28E+02

Table 6.4.2. (Continued)

Estimated population abundance at 1st Jan 2008

0.00E+00	4.89E+04	2.33E+04	1.62E+04	5.41E+03	2.62E+03	2.21E+03	9.43E+02	1.17E+02

Taper weighted geometric mean of the VPA populations:

2.68E+04	2.01E+04	1.35E+04	7.91E+03	4.27E+03	2.26E+03	1.18E+03	6.10E+02	3.19E+02

Standard error of the weighted Log(VPA populations) :

.5795	.6040	.6377	.6271	.6066	.5957	.6486	.8095	.9875

Log catchability residuals.

Fleet : All pair (GLM) >1000

Age	1995	1996	1997
3	.27	1.21	.32
4	.61	-.03	-.25
5	.83	-.22	-.67
6	.00	.08	-.25
7	.32	-.21	-.01
8	.23	.39	-.16
9	.16	.63	-.11
10	-.39	1.46	-.06
11	.01	.09	-.19

Age	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
3	.69	-.49	1.01	.40	-1.30	-.42	-1.42	-.20	-.04	-.03
4	-.34	.20	-.12	.33	.38	-.61	-.14	.05	-.08	.00
5	-.41	-.52	-.01	.14	.48	.21	-.30	.24	.10	.12
6	-.84	-.11	.01	.27	.51	.21	-.04	.03	.09	.05
7	-.17	-.29	-.09	.19	.03	.24	-.07	-.05	.16	-.04
8	-.27	.43	.20	-.04	-.05	-.11	-.02	-.68	.02	.05
9	.00	-.15	-.17	.30	-.37	-.25	.38	.04	.01	-.06
10	.24	.08	.21	.47	.24	-.10	.03	-1.30	.16	.34
11	-.22	-.05	.03	.02	-.01	-.04	.14	.05	.12	-.04

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	-15.4710	-13.3537	-12.1136	-11.5536	-11.3586	-11.2309	-11.2309	-11.2309	-11.2309
S.E(Log q)	.7878	.3252	.4179	.3130	.1835	.2910	.2791	.6140	.1072

Regression statistics :

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
3	6.54	-2.319	42.01	.02	13	4.41	-15.47
4	1.32	-1.617	14.31	.70	13	.40	-13.35
5	1.05	-.228	12.21	.67	13	.46	-12.11
6	1.03	-.172	11.61	.81	13	.33	-11.55
7	1.00	-.031	11.37	.93	13	.19	-11.36
8	1.04	-.334	11.37	.86	13	.31	-11.23
9	1.19	-1.400	12.02	.83	13	.32	-11.20
10	.92	.310	10.69	.56	13	.58	-11.12
11	.91	2.293	10.64	.98	13	.08	-11.24

Terminal year survivor and F summaries :

Age 3 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
All pair (GLM) >1000	47345.	.818	.000	.00	1	.855	.016
F shrinkage mean	59454.	2.00				.145	.013

Table 6.4.2. (Continued)

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
48935.	.76	.09	2	.115	.015

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

Year class = 2003

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
All pair (GLM) >1000	23134.	.312	.014	.05	2	.973	.122
F shrinkage mean	30697.	2.00				.027	.093

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
23310.	.31	.03	3	.111	.121

Age 5 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	15958.	.254	.078	.31	3	.972	.495
F shrinkage mean	25908.	2.00				.028	.332

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
16174.	.25	.08	4	.310	.490

Age 6 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	5357.	.206	.180	.88	4	.974	.738
F shrinkage mean	7863.	2.00				.026	.556

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
5411.	.21	.16	5	.759	.733

Age 7 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	2591.	.185	.061	.33	5	.973	.841
F shrinkage mean	3690.	2.00				.027	.656

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
2615.	.19	.06	6	.317	.836

Table 6.4.2. (Continued)

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

 Year class = 1999

 Fleet                  Estimated     Int        Ext     Var     N  Scaled   Estimated
                        Survivors     s.e        s.e    Ratio       Weights     F
 All pair (GLM) >1000       2168.    .176        .117     .66    6   .969     1.026

   F shrinkage mean         4140.    2.00                             .031      .661

 Weighted prediction :

 Survivors         Int       Ext     N     Var      F
 at end of year    s.e       s.e          Ratio
      2212.        .18       .11     7     .633   1.013

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

 Year class = 1998

 Fleet                  Estimated     Int        Ext     Var     N  Scaled   Estimated
                        Survivors     s.e        s.e    Ratio       Weights     F
 All pair (GLM) >1000        936.    .171        .042     .25    7   .973      .910

   F shrinkage mean         1226.    2.00                             .027      .758

 Weighted prediction :

 Survivors         Int       Ext     N     Var      F
 at end of year    s.e       s.e          Ratio
       943.        .18       .04     8     .241    .906

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

 Year class = 1997

 Fleet                  Estimated     Int        Ext     Var     N  Scaled   Estimated
                        Survivors     s.e        s.e    Ratio       Weights     F
 All pair (GLM) >1000        111.    .166        .141     .85    8   .940     1.462

   F shrinkage mean          290.    2.00                             .060      .818

 Weighted prediction :

 Survivors         Int       Ext     N     Var      F
 at end of year    s.e       s.e          Ratio
       117.        .20       .15     9     .776   1.417

 Age 11   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         31.    .232        .030     .13    9   .946     1.208

   F shrinkage mean           35.    2.00                             .054     1.125

 Weighted prediction :

 Survivors         Int       Ext     N     Var      F
 at end of year    s.e       s.e          Ratio
        31.        .24       .03    10     .118   1.204
```

Table 6.4.3. Saithe in the Faroes (Division Vb). Fishing mortality (F) at age.

Table 8 Fishing mortality (F) at age

YEAR	1961	1962	1963	1964	1965	1966	1967
AGE							
3	.0226	.0465	.0307	.0478	.0495	.0250	.0248
4	.0556	.0863	.0358	.1260	.0772	.1007	.0518
5	.0994	.1208	.0716	.2198	.1588	.1492	.1217
6	.1219	.1401	.1115	.1797	.2137	.2326	.1388
7	.0933	.1192	.1634	.2213	.2216	.2784	.2564
8	.0852	.0752	.1157	.2566	.2424	.2536	.2615
9	.0972	.1150	.1355	.1424	.2983	.2770	.2269
10	.0915	.1295	.2012	.1658	.2355	.3346	.2903
11	.0916	.1069	.1514	.1891	.2601	.2900	.2609
+gp	.0916	.1069	.1514	.1891	.2601	.2900	.2609
FBAR 4- 8	.0911	.1083	.0996	.2007	.1827	.2029	.1660

YEAR	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
AGE										
3	.0320	.0328	.0479	.0885	.0935	.1271	.2293	.1505	.2055	.1478
4	.0910	.1452	.2547	.1480	.0728	.3227	.3170	.3595	.3704	.2977
5	.0954	.1719	.1538	.3579	.1649	.4582	.3543	.5442	.3153	.4251
6	.1357	.1684	.1597	.1404	.2985	.3486	.3276	.2891	.3431	.4140
7	.1345	.2000	.1536	.1262	.3286	.2919	.2297	.1957	.2048	.3664
8	.2183	.2094	.1943	.1118	.2995	.2425	.1770	.1752	.1767	.2537
9	.2182	.3063	.1656	.1244	.3759	.1982	.1960	.1183	.1664	.2026
10	.2027	.3289	.2008	.1213	.4600	.2496	.1809	.1485	.1202	.1740
11	.2141	.2831	.1877	.1196	.3810	.2312	.1854	.1479	.1550	.2111
+gp	.2141	.2831	.1877	.1196	.3810	.2312	.1854	.1479	.1550	.2111
FBAR 4- 8	.1350	.1790	.1832	.1769	.2329	.3328	.2811	.3127	.2821	.3514

YEAR	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
AGE										
3	.0837	.0374	.0926	.0137	.0285	.0693	.0158	.0628	.0211	.0366
4	.2367	.1776	.1536	.2415	.1832	.1061	.4954	.2365	.1384	.1385
5	.2881	.2890	.2023	.1957	.2031	.3628	.3457	.5026	.4548	.4267
6	.1915	.2780	.2299	.4379	.4822	.4647	.5671	.2914	.7610	.5760
7	.2001	.3213	.3217	.5551	.3197	.4953	.6363	.5660	.4051	.4616
8	.4119	.3572	.2549	.6322	.5383	.5283	.4648	.4139	.7498	.4164
9	.2642	.3871	.3127	.5592	.5697	.8445	.5172	.3184	.8256	.5476
10	.3017	.4698	.5104	.5211	.3288	.3717	.3691	.2172	.6205	.7302
11	.3279	.4075	.3617	.5757	.4826	.5865	.4537	.3184	.7391	.5695
+gp	.3279	.4075	.3617	.5757	.4826	.5865	.4537	.3184	.7391	.5695
FBAR 4- 8	.2657	.2846	.2325	.4125	.3453	.3914	.5018	.4021	.5018	.4039

YEAR	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
AGE										
3	.0215	.0176	.0159	.0470	.0299	.0633	.0465	.0114	.0137	.0115
4	.0887	.2022	.2044	.4160	.2639	.2056	.2747	.0898	.0391	.0482
5	.3555	.2277	.6218	.7732	.5993	.5537	.3346	.4126	.1382	.1159
6	.6404	.4934	.7834	.8602	.7180	.6074	.6093	.4073	.3020	.3274
7	.5872	.3742	.8065	.7969	.5318	.5290	.6112	.7122	.4889	.5053
8	.5968	.5274	.4055	.6673	.4806	.3671	.6858	.6462	.8244	.5373
9	.5629	.3525	.2121	.7311	.5725	.4743	.4126	.8678	.5525	.6838
10	.5537	.2371	.1865	.8171	.5102	.4736	.6958	.4944	.7748	.6627
11	.5760	.3747	.2695	.7457	.5253	.4415	.6033	.5473	.3016	.7728
+gp	.5760	.3747	.2695	.7457	.5253	.4415	.6033	.5473	.3016	.7728
FBAR 4- 8	.4537	.3650	.5643	.7027	.5187	.4526	.5031	.4536	.3585	.3068

Table 8 Fishing mortality (F) at age

YEAR	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	FBAR **-**
AGE											
3	.0143	.0061	.0262	.0144	.0035	.0072	.0020	.0091	.0408	.0152	.0217
4	.0717	.0734	.0678	.1034	.1420	.0346	.0554	.0998	.1328	.1210	.1179
5	.1510	.1821	.2368	.2949	.3908	.2844	.1639	.3983	.4143	.4895	.4340
6	.2405	.3047	.4219	.6422	.6654	.4963	.3793	.5499	.6677	.7330	.6502
7	.4608	.4994	.4776	.7763	.5799	.7048	.5406	.6099	.8134	.8360	.7531
8	.5291	.6431	.7426	.7276	.6902	.6243	.7485	.4268	.7873	1.0134	.7425
9	.7182	.6424	.5434	1.0747	.5024	.5066	1.1176	.9411	.6836	.9057	.8435
10	.8196	.7188	.7736	1.3559	1.0200	.7364	.8287	.3616	1.0993	1.4175	.9595
11	.7288	.6604	.6724	1.1711	.5045	.7862	1.0173	.7955	.7596	1.2038	.9196
+gp	.7288	.6604	.6724	1.1711	.5045	.7862	1.0173	.7955	.7596	1.2038	
FBAR 4- 8	.2906	.3406	.3893	.5089	.4937	.4289	.3775	.4169	.5631	.6386	

Table 6.4.4. Saithe in the Faroes (Division Vb). Stock number at age (start of year) (Thousands).

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

YEAR	1961	1962	1963	1964	1965	1966	1967
AGE							
3	9047	13663	22431	16192	22803	21830	26879
4	7739	7241	10678	17809	12638	17769	17432
5	5643	5993	5438	8435	12854	9578	13154
6	3881	4183	4349	4145	5543	8979	6755
7	2680	2813	2977	3185	2835	3665	5826
8	1746	1999	2044	2070	2090	1860	2272
9	1384	1313	1518	1491	1311	1343	1182
10	1036	1028	958	1085	1059	797	833
11	568	774	740	641	753	685	467
+gp	1032	1141	2147	1111	1367	981	670
TOTAL	34757	40149	53279	56164	63254	67486	75468

YEAR	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
AGE										
3	21515	40798	34136	37285	33607	23282	18897	16306	18911	12940
4	21468	17059	32325	26640	27941	25059	16786	12301	11485	12607
5	13552	16048	12079	20514	18811	21271	14859	10010	7030	6492
6	9536	10085	11064	8480	11742	13059	11014	8536	4756	4199
7	4814	6816	6978	7721	6033	7133	7545	6498	5234	2763
8	3691	3445	4569	4899	5572	3556	4361	4910	4375	3492
9	1432	2429	2288	3080	3587	3381	2285	2991	3374	3002
10	771	942	1464	1587	2227	2016	2271	1537	2176	2339
11	510	515	555	981	1151	1151	1286	1551	1085	1580
+gp	1067	846	848	977	727	990	1722	2386	2199	1907
TOTAL	78355	98986	106306	112165	111398	100899	81025	67026	60624	51320

YEAR	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
AGE										
3	8415	8633	12451	33329	15223	40985	25975	22213	61760	48647
4	9138	6337	6808	9293	26916	12113	31309	20934	17079	49509
5	7664	5905	4344	4781	5976	18349	8919	15620	13529	12176
6	3475	4704	3621	2905	3218	3993	10451	5168	7737	7029
7	2273	2349	2917	2356	1535	1627	2054	4853	3162	2959
8	1568	1523	1395	1731	1107	913	812	890	2256	1726
9	2218	850	872	885	753	529	441	418	482	873
10	2007	1395	473	522	414	349	186	215	249	173
11	1609	1215	714	232	254	244	197	105	142	109
+gp	2100	2263	2840	2549	2579	1330	760	1107	330	244
TOTAL	40467	35173	36435	58584	57975	80432	81104	71523	106724	123446

YEAR	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
AGE										
3	45067	28490	20654	24810	19541	23714	16772	38663	24196	33328
4	38398	36114	22918	16644	19381	15528	18225	13108	31294	19541
5	35293	28769	24156	15295	8990	12188	10350	11337	9810	24638
6	6506	20250	18758	10620	5780	4042	5736	6065	6144	6995
7	3235	2808	10122	7016	3679	2308	1803	2553	3304	3719
8	1527	1472	1581	3700	2589	1770	1113	801	1025	1659
9	932	688	711	863	1554	1311	1004	459	344	368
10	413	435	396	471	340	718	668	544	158	162
11	68	194	281	269	170	167	366	273	272	60
+gp	150	137	367	245	289	160	118	304	346	202
TOTAL	131590	119357	99945	79934	62314	61905	56155	74106	76892	90672

YEAR	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	GMST 61-**	AMST 61-**
AGE													
3	12668	58640	34595	86869	96789	50703	41998	55413	40884	60685	0	26061	30690
4	26975	10225	47719	27590	70105	78971	41213	34316	44958	32135	48935	19530	23393
5	15246	20557	7779	36508	20370	49797	62456	31923	25427	32230	23310	13089	16100
6	17964	10733	14029	5026	22256	11283	30680	43403	17549	13757	16174	7679	9531
7	4128	11563	6479	7533	2165	9367	5624	17190	20504	7369	5411	4074	4804
8	1837	2132	5746	3290	2838	992	3790	2682	7648	7443	2615	2142	2476
9	794	886	917	2239	1301	1165	435	1468	1433	2849	2212	1149	1403
10	152	317	382	436	626	645	575	117	469	592	943	614	837
11	68	55	126	144	92	185	253	205	66	128	117	337	513
+gp	154	156	56	88	124	86	190	60	59	36	40		
TOTAL	79987	115263	117827	169723	216666	203194	187214	186777	158998	157224	99758		

Table 6.4.5. Saithe in the Faroes (Division Vb). Summary table.

Table 16 Summary (without SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

	RECRUITS Age 3	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 4- 8
1961	9047	121972	83798	9592	.1145	.0911
1962	13663	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	181652	104635	21319	.2037	.1660
1968	21515	189804	115962	20387	.1758	.1350
1969	40798	215031	123796	27437	.2216	.1790
1970	34136	224448	129143	29110	.2254	.1832
1971	37285	228426	139501	32706	.2344	.1769
1972	33607	237049	147569	42663	.2891	.2329
1973	23282	210528	136683	57431	.4202	.3328
1974	18897	204074	137612	47188	.3429	.2811
1975	16306	187422	137888	41576	.3015	.3127
1976	18911	169752	122019	33065	.2710	.2821
1977	12940	156337	114099	34835	.3053	.3514
1978	8415	137401	96028	28138	.2930	.2657
1979	8633	113051	83559	27246	.3261	.2846
1980	12451	124853	88946	25230	.2837	.2325
1981	33329	142242	76332	30103	.3944	.4125
1982	15223	150258	83378	30964	.3714	.3453
1983	40985	179311	91811	39176	.4267	.3914
1984	25975	190448	96212	54665	.5682	.5018
1985	22213	190246	118136	44605	.3776	.4021
1986	61760	235804	98214	41716	.4247	.5018
1987	48647	250716	102889	40020	.3890	.4039
1988	45067	260946	101021	45285	.4483	.4537
1989	28490	229532	101414	44477	.4386	.3650
1990	20654	192712	99076	61628	.6220	.5643
1991	24810	150309	71454	54858	.7677	.7027
1992	19541	124707	59894	36487	.6092	.5187
1993	23714	133836	59690	33543	.5619	.4526
1994	16772	127452	63456	33182	.5229	.5031
1995	38663	153271	62163	27209	.4377	.4536
1996	24196	163153	63399	20029	.3159	.3585
1997	33328	180601	63746	22306	.3499	.3068
1998	12668	164808	66776	26421	.3957	.2906
1999	58640	212759	73407	33207	.4524	.3406
2000	34595	223896	84661	39020	.4609	.3893
2001	86869	287140	84714	51786	.6113	.5089
2002	96789	317934	83471	53546	.6415	.4937
2003	50703	301153	86722	46555	.5368	.4289
2004	41998	282259	99864	46355	.4642	.3775
2005	55413	281837	105328	68008	.6457	.4169
2006	40884	237975	103349	67103	.6493	.5631
2007	60685	229562	92687	60827	.6563	.6386
Arith. Mean	31545	193632	96918	36676	.3928	.3487
Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

Table 6.5.1.1. a)Saithe in the Faroes (Division Vb). Prediction with management option,

MFDP version 1a
Run: management1
Index file 23/4/2008
Time and date: 13:09 23/04/2008
Fbar age range: 4-8

2008				
Biomass	**SSB**	**FMult**	**FBar**	**Landings**
197603	79628	1	0.5395	47129

2009					2010	
Biomass	**SSB**	**FMult**	**FBar**	**Landings**	**Biomass**	**SSB**
175665	71549	0	0	0	210744	103783
.	71549	0.1	0.054	5787	204287	98785
.	71549	0.2	0.1079	11255	198199	94095
.	71549	0.3	0.1619	16426	192455	89691
.	71549	0.4	0.2158	21316	187034	85554
.	71549	0.5	0.2698	25945	181916	81666
.	71549	0.6	0.3237	30329	177081	78012
.	71549	0.7	0.3777	34481	172511	74576
.	71549	0.8	0.4316	38418	168191	71343
.	71549	0.9	0.4856	42151	164104	68301
.	71549	1	0.5395	45694	160236	65437
.	71549	1.1	0.5935	49057	156573	62739
.	71549	1.2	0.6474	52252	153103	60198
.	71549	1.3	0.7014	55289	149815	57802
.	71549	1.4	0.7553	58176	146696	55542
.	71549	1.5	0.8093	60924	143738	53411
.	71549	1.6	0.8633	63540	140930	51399
.	71549	1.7	0.9172	66032	138263	49499
.	71549	1.8	0.9712	68407	135729	47705
.	71549	1.9	1.0251	70671	133319	46009
.	71549	2	1.0791	72832	131028	44406

Input units are thousands and kg - output in tonnes

recruitment for year classes 2005 to 2007 is geometric mean of 1980 to 2007.

Table 6.5.1.1. b)Saithe in the Faroes (Division Vb). Prediction with management option. Recruitment for year classes 2004 to 2007 is geometric mean of 1980 to 2006.

Short term calculations made in Excel.

2008 Biomass	SSB	FMult	FBar	Landings
165377	71954	1.0000	0.5395	43934

2009 Biomass	SSB	FMult	FBar	Landings	2010 Biomass	SSB
150831	61497	0.0000	0.0000	0	183892	87695
.	61497	0.1000	0.0540	4881	178488	83364
.	61497	0.2000	0.1079	9481	173409	79311
.	61497	0.3000	0.1619	13818	168631	75518
.	61497	0.4000	0.2158	17909	164136	71967
.	61497	0.5000	0.2698	21771	159904	68640
.	61497	0.6000	0.3237	25418	155919	65523
.	61497	0.7000	0.3777	28864	152162	62601
.	61497	0.8000	0.4316	32123	148621	59861
.	61497	0.9000	0.4856	35206	145280	57291
.	61497	1.0000	0.5395	38124	142127	54878
.	61497	1.1000	0.5935	40889	139150	52613
.	61497	1.2000	0.6474	43509	136336	50486
.	61497	1.3000	0.7014	45994	133676	48487
.	61497	1.4000	0.7553	48352	131160	46608
.	61497	1.5000	0.8093	50592	128778	44840
.	61497	1.6000	0.8633	52720	126522	43177
.	61497	1.7000	0.9172	54743	124385	41612
.	61497	1.8000	0.9712	56668	122358	40138
.	61497	1.9000	1.0251	58501	120435	38748
.	61497	2.0000	1.0791	60247	118609	37439

Input units are thousands and kg - output in tonnes

Table 6.5.1.1. c) Saithe in the Faroes (Division Vb). Prediction with management option, recruitment for yearclasses 2004 to 2007 is geometric mean of 1999 to 2006.

Short term calculations made in Excel.

2008 Biomass	SSB	FMult	FBar	Landings
213844	78039	1.0000	0.5395	46913

2009 Biomass	SSB	FMult	FBar	Landings	2010 Biomass	SSB
217571	75260	0.0000	0.0000	0	272833	114882
.	75260	0.1000	0.0540	5901	266305	109910
.	75260	0.2000	0.1079	11488	260140	105240
.	75260	0.3000	0.1619	16781	254313	100852
.	75260	0.4000	0.2158	21799	248804	96727
.	75260	0.5000	0.2698	26559	243591	92848
.	75260	0.6000	0.3237	31077	238658	89198
.	75260	0.7000	0.3777	35368	233984	85763
.	75260	0.8000	0.4316	39445	229556	82528
.	75260	0.9000	0.4856	43322	225356	79480
.	75260	1.0000	0.5395	47011	221372	76607
.	75260	1.1000	0.5935	50524	217590	73898
.	75260	1.2000	0.6474	53870	213997	71341
.	75260	1.3000	0.7014	57060	210582	68928
.	75260	1.4000	0.7553	60104	207335	66650
.	75260	1.5000	0.8093	63008	204244	64496
.	75260	1.6000	0.8633	65783	201301	62461
.	75260	1.7000	0.9172	68435	198497	60535
.	75260	1.8000	0.9712	70972	195824	58713
.	75260	1.9000	1.0251	73400	193274	56988
.	75260	2.0000	1.0791	75725	190840	55354

Input units are thousands and kg - output in tonnes

Table 6.7.1.1 a). Saithe in the Faroes (Division Vb). Input data for prediction with management options. (Recruitment for year classes 2005 to 2007 is geometric mean of 1980 to 2007)

MFDP version 1a
Run: man1
Time and date: 06:14 24/04/2008
Fbar age range: 4-8

2008

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	33375	0.2	0.00	0	0	1.058	0.02	1.058
4	48935	0.2	0.24	0	0	1.391	0.12	1.391
5	23310	0.2	0.44	0	0	1.413	0.43	1.413
6	16174	0.2	0.64	0	0	1.824	0.65	1.824
7	5411	0.2	0.89	0	0	2.361	0.75	2.361
8	2615	0.2	0.93	0	0	2.682	0.74	2.682
9	2212	0.2	0.98	0	0	3.278	0.84	3.278
10	943	0.2	1.00	0	0	4.104	0.96	4.104
11	118	0.2	1.00	0	0	4.998	0.92	4.998
12	40	0.2	1.00	0	0	7.137	0.92	7.137

2009

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	33375	0.2	0.00	0	0	1.058	0.02	1.058
4	.	0.2	0.24	0	0	1.391	0.12	1.391
5	.	0.2	0.42	0	0	1.413	0.43	1.413
6	.	0.2	0.64	0	0	1.824	0.65	1.824
7	.	0.2	0.83	0	0	2.361	0.75	2.361
8	.	0.2	0.91	0	0	2.682	0.74	2.682
9	.	0.2	0.97	0	0	3.278	0.84	3.278
10	.	0.2	1.00	0	0	4.104	0.96	4.104
11	.	0.2	1.00	0	0	4.998	0.92	4.998
12	.	0.2	1.00	0	0	7.137	0.92	7.137

2010

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	33375	0.2	0.00	0	0	1.058	0.02	1.058
4	.	0.2	0.24	0	0	1.391	0.12	1.391
5	.	0.2	0.42	0	0	1.413	0.43	1.413
6	.	0.2	0.64	0	0	1.824	0.65	1.824
7	.	0.2	0.83	0	0	2.361	0.75	2.361
8	.	0.2	0.91	0	0	2.682	0.74	2.682
9	.	0.2	0.97	0	0	3.278	0.84	3.278
10	.	0.2	1.00	0	0	4.104	0.96	4.104
11	.	0.2	1.00	0	0	4.998	0.92	4.998
12	.	0.2	1.00	0	0	7.137	0.92	7.137

Table 6.7.1.1 b-c). Saithe in the Faroes (Division Vb). Input data for prediction with management options. b) (left) Recruitment for year classes 2004 to 2007 is geometric mean of 1980 to 2006 and c) (right) recruitment for year classes 2004 to 2007 is geometric mean of 1999 to 2006.

	N		
Age	*Year*		
	2008	2009	2010
3	32644	32644	32644
4	26324		
5	23310		
6	16174		
7	5411		
8	2615		
9	2212		
10	943		
11	118		
12+	40		

	N		
Age	*Year*		
	2008	2009	2010
3	54880	54880	54880
4	44254		
5	23310		
6	16174		
7	5411		
8	2615		
9	2212		
10	943		
11	118		
12+	40		

Table 6.8.1.1. Saithe in the Faroes (Division Vb). Yield per recruit input data.

MFYPR version 2a
Run: YR1
Index file 23/4/2008
Time and date: 14:28 23/04/2008
Fbar age range: 4-8

Age	M	Mat	PF	PM	SWt	Sel	CWt
3	0.2	0.020	0	0	1.295	0.02	1.295
4	0.2	0.200	0	0	1.768	0.09	1.768
5	0.2	0.490	0	0	2.342	0.35	2.342
6	0.2	0.710	0	0	3.037	0.57	3.037
7	0.2	0.850	0	0	3.856	0.70	3.856
8	0.2	0.950	0	0	4.753	0.72	4.753
9	0.2	0.990	0	0	5.566	0.83	5.566
10	0.2	1.000	0	0	6.311	0.89	6.311
11	0.2	1.000	0	0	7.152	0.91	7.152
12	0.2	1.000	0	0	8.445	0.91	8.445

Weights in kilograms

Table 6.8.1.2. Saithe in the Faroes (Division Vb). Yield per recruit, summary table.

MFYPR version 2a
Run: YR1
Time and date: 14:28 23/04/2008
Yield per results

FMult	Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNosJan	SSBJan	SpwnNosSpwn	SSBSpwn
0.0	0.0000	0.0000	0.0000	5.5167	21.8374	3.2918	17.7621	3.2918	17.7621
0.1	0.0485	0.1717	0.8504	4.6619	15.6390	2.4587	11.6378	2.4587	11.6378
0.2	0.0970	0.2666	1.1873	4.1908	12.5099	2.0078	8.5763	2.0078	8.5763
0.3	0.1455	0.3284	1.3407	3.8852	10.6442	1.7208	6.7727	1.7208	6.7727
0.4	0.1940	0.3726	1.4164	3.6671	9.4122	1.5201	5.5977	1.5201	5.5977
0.5	0.2425	0.4063	1.4552	3.5014	8.5395	1.3707	4.7776	1.3707	4.7776
0.6	0.2910	0.4331	1.4754	3.3699	7.8888	1.2546	4.1756	1.2546	4.1756
0.7	0.3395	0.4551	1.4855	3.2623	7.3842	1.1614	3.7163	1.1614	3.7163
0.8	0.3880	0.4736	1.4899	3.1720	6.9808	1.0846	3.3550	1.0846	3.3550
0.9	0.4365	0.4895	1.4910	3.0947	6.6501	1.0202	3.0638	1.0202	3.0638
1.0	0.4850	0.5033	1.4902	3.0276	6.3736	0.9653	2.8242	0.9653	2.8242
1.1	0.5335	0.5155	1.4883	2.9685	6.1385	0.9178	2.6238	0.9178	2.6238
1.2	0.5820	0.5264	1.4857	2.9159	5.9357	0.8762	2.4537	0.8762	2.4537
1.3	0.6305	0.5362	1.4828	2.8688	5.7587	0.8396	2.3075	0.8396	2.3075
1.4	0.6790	0.5451	1.4796	2.8261	5.6026	0.8069	2.1805	0.8069	2.1805
1.5	0.7275	0.5532	1.4763	2.7872	5.4636	0.7776	2.0692	0.7776	2.0692
1.6	0.7760	0.5607	1.4730	2.7515	5.3390	0.7512	1.9707	0.7512	1.9707
1.7	0.8245	0.5676	1.4698	2.7186	5.2263	0.7271	1.8831	0.7271	1.8831
1.8	0.8730	0.5740	1.4667	2.6882	5.1239	0.7052	1.8045	0.7052	1.8045
1.9	0.9215	0.5799	1.4636	2.6598	5.0303	0.6850	1.7336	0.6850	1.7336
2.0	0.9700	0.5855	1.4606	2.6334	4.9443	0.6665	1.6693	0.6665	1.6693

Reference p	F multiplier	Absolute F
Fbar(4-8)	1.000	0.485
FMax	0.901	0.437
F0.1	0.261	0.127
F35%SPR	0.343	0.166
Flow	0.201	0.098
Fmed	0.742	0.360
Fhigh	2.276	1.104

Weights in kilograms

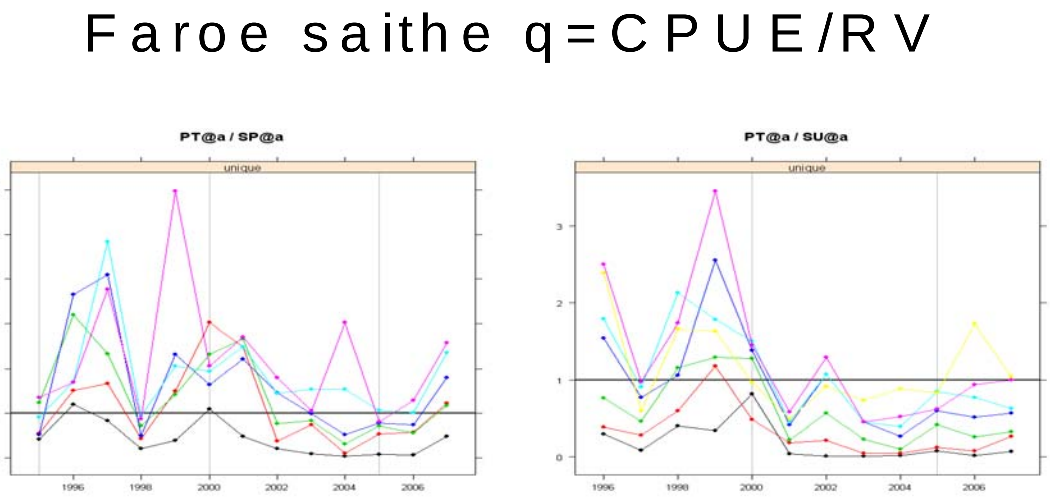


Figure 6.1.1. Saithe in the Faroes (Division Vb). Landings in 1000 tonnes.

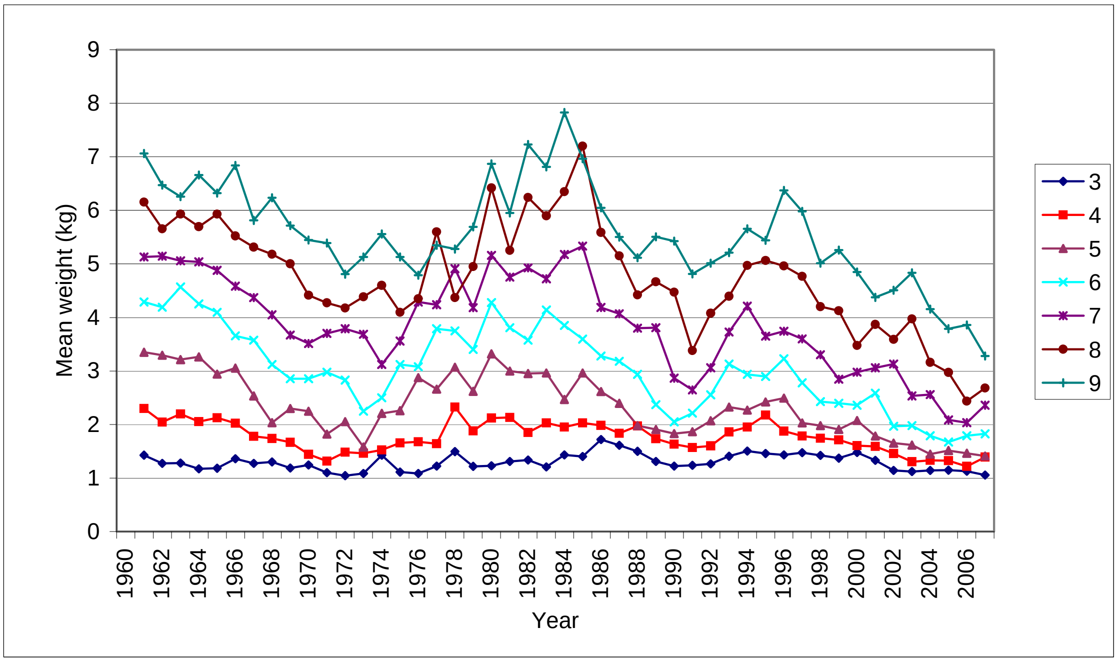


Figure 6.2.2.1. Saithe in the Faroes (Division Vb). Mean weight at age (kg) in the commercial catches for the period 1961-2007.

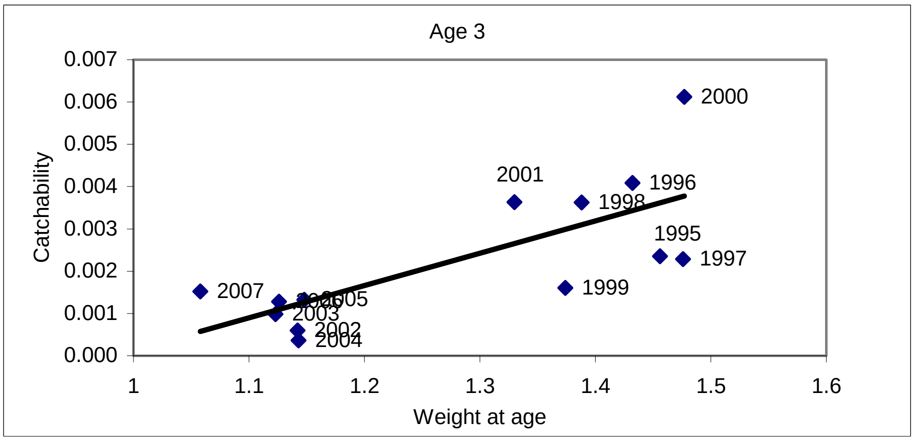


Figure 6.2.2.2 a). Saithe in the Faroes (Division Vb). Relation between weight at age and catchability for age 3.

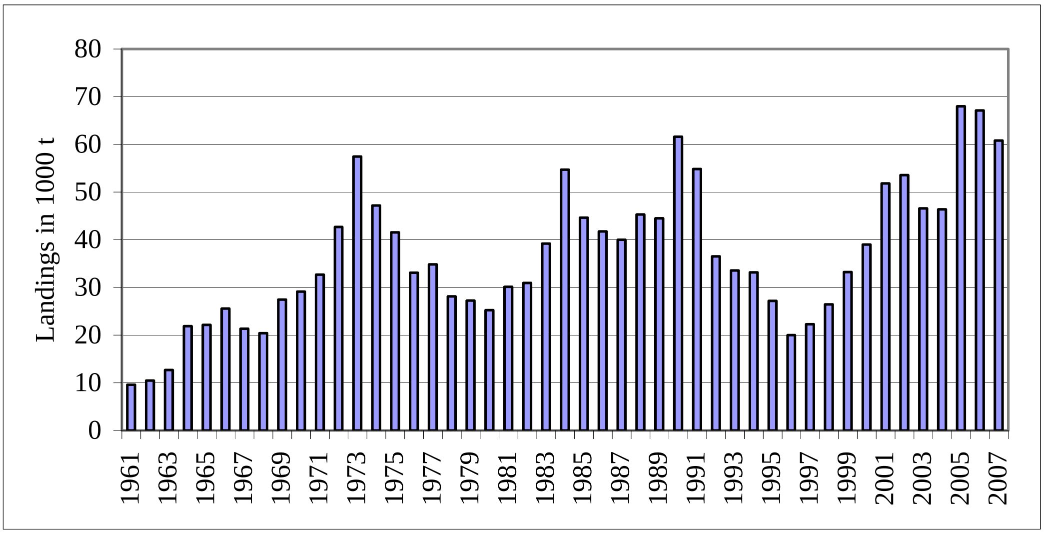


Figure 6.2.2.2 b). Saithe in the Faroes (Division Vb). Ratio of the pair trawlers CPUE (mesh size 135 mm) at age to the spring and summer surveys indices (mesh size of 40 mm) at age indicative of lower catchability in the pair trawlers in recent years.

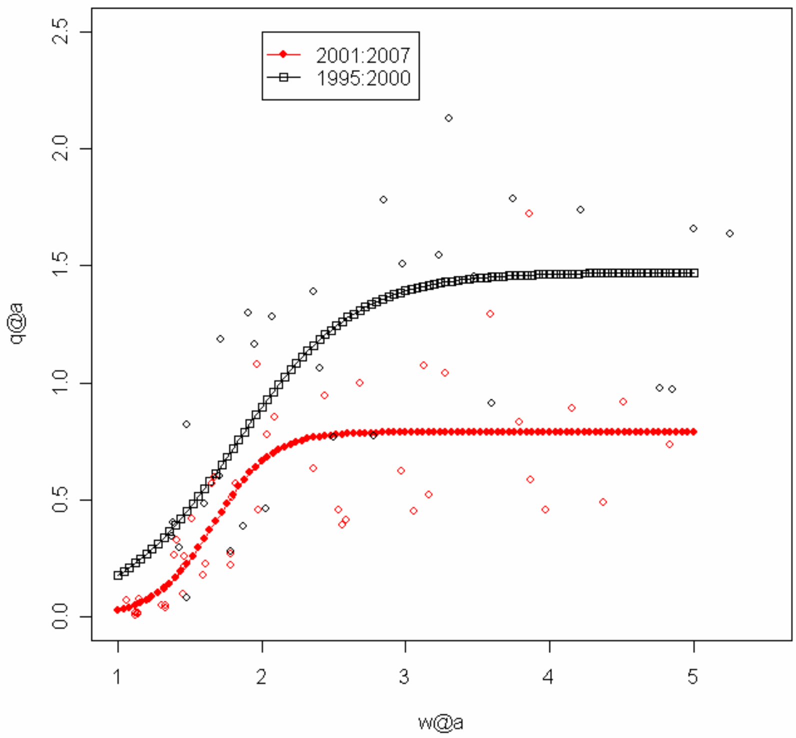
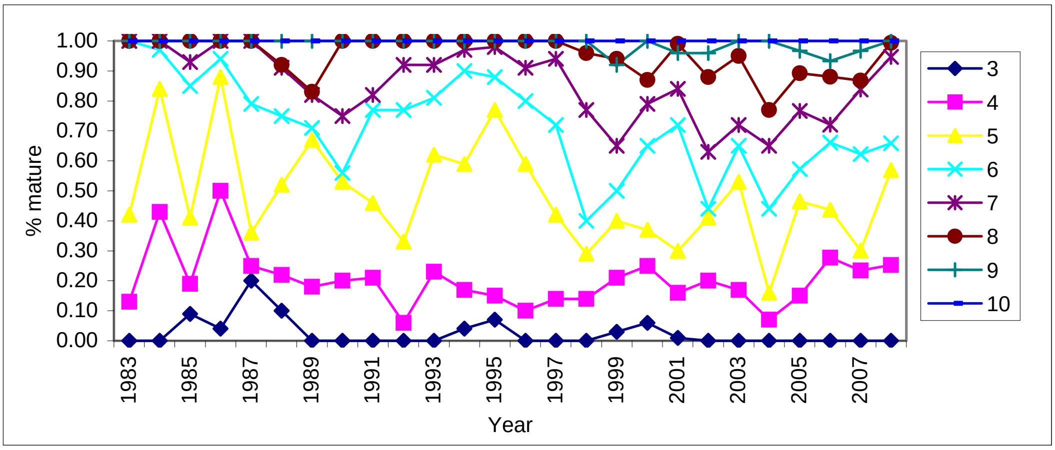


Figure 6.2.2.2 c). Saithe in the Faroes (Division Vb). Catchability at age (pair trawlers CPUE divided by SPALY XSA population numbers) plotted against weight at age showing lower average catchability for 2001-2007 compared to 1995-2000.



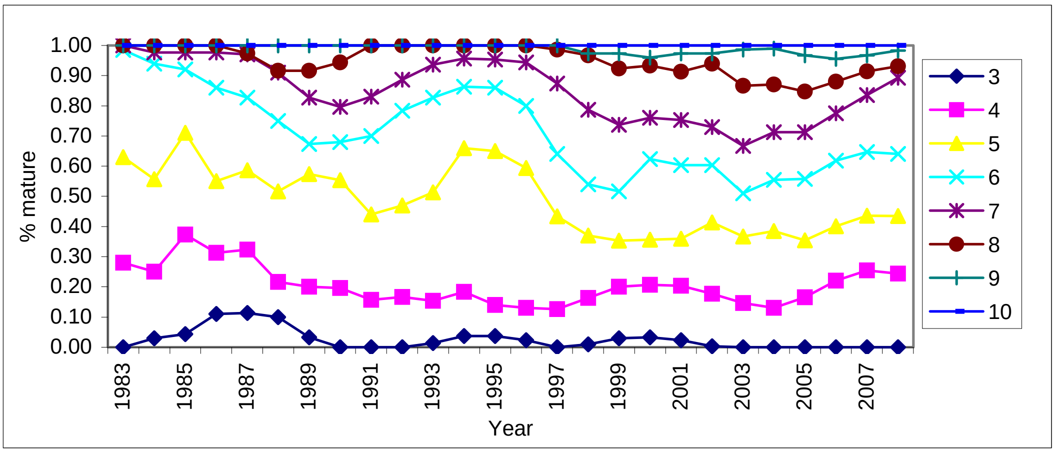


Figure 6.2.3.1. Saithe in the Faroes (Division Vb). Observed (upper figure) and three years running average (lower figure) proportion mature at age from the spring survey for the period 1983-2007. 2008 value is predicted.

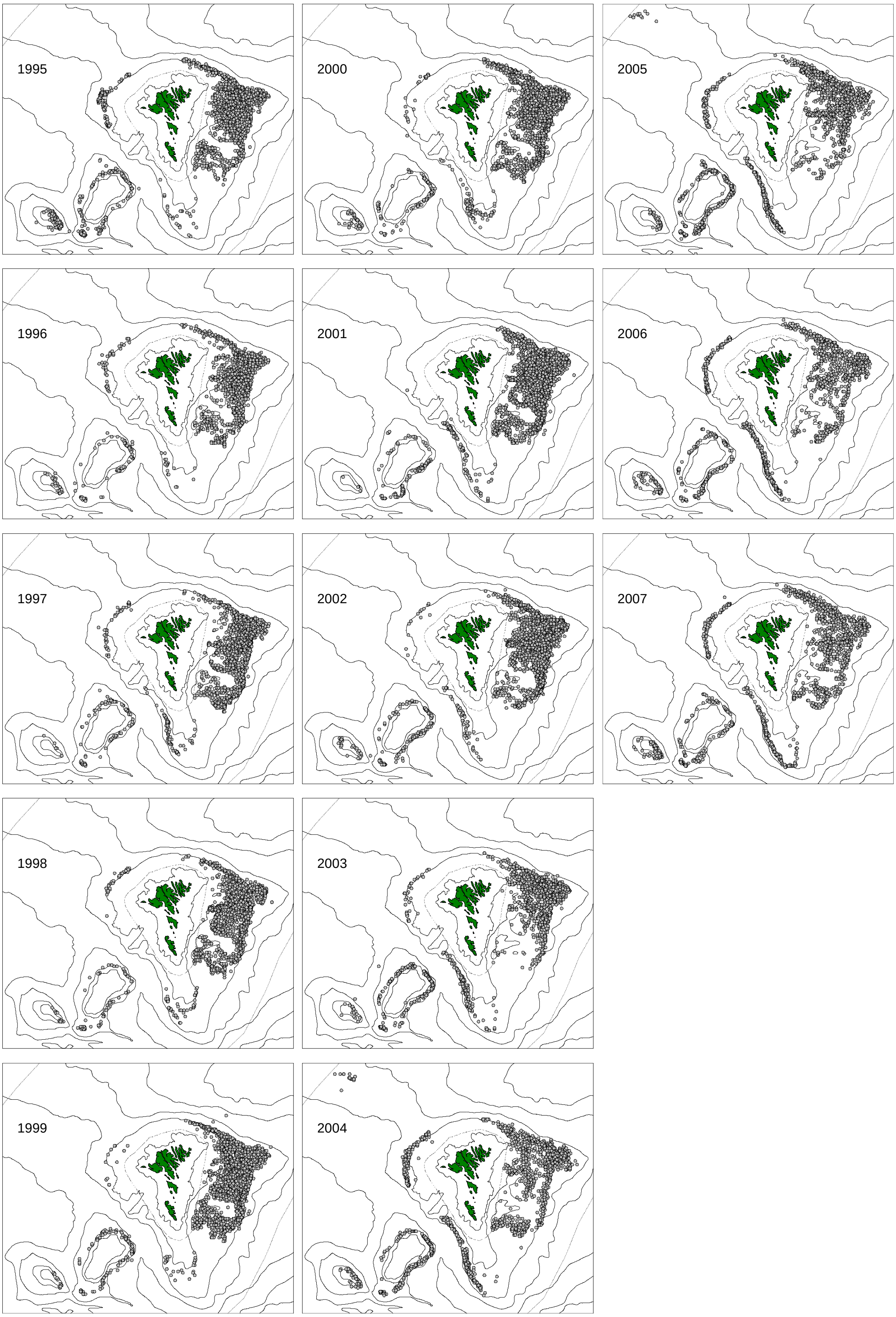


Figure 6.2.4.2.1. Saithe in the Faroes (Div. Vb). Start position of all saithe hauls from the pair trawlers 1995- 2007, which are used in the pair trawler tuning series.

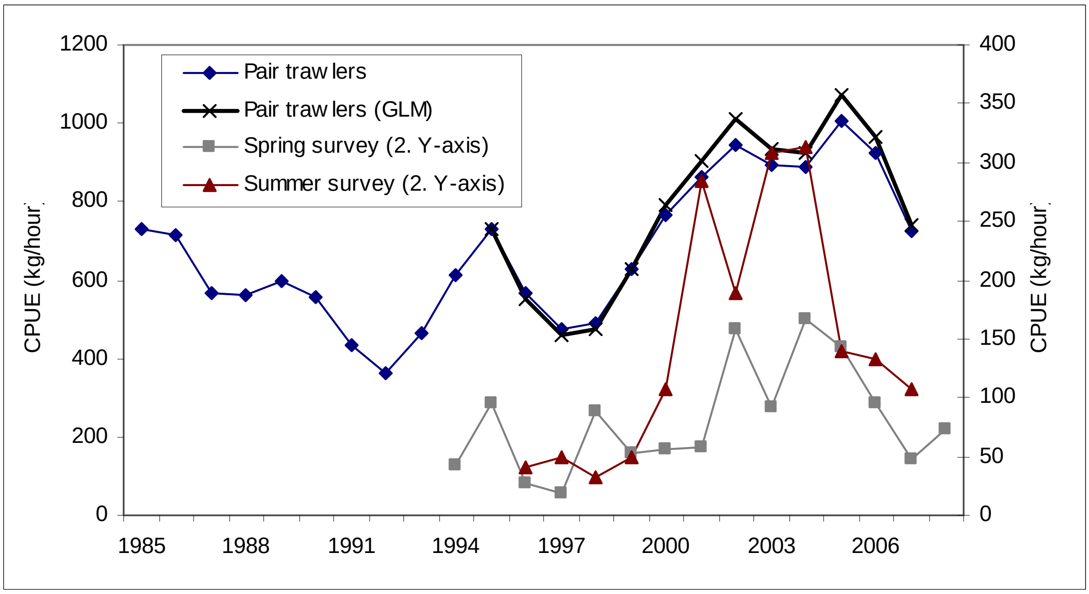


Figure 6.2.4.2.2. CPUE (kg/hour) from the commercial pair trawlers and from the spring- and summer surveys. Pair trawlers (GLM) modelled CPUE from R (used in this years XSA).

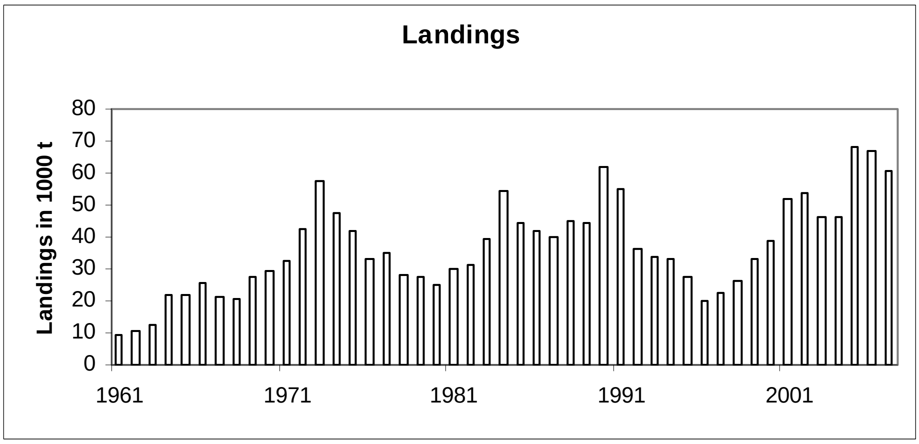


Figure 6.3.1.1. Saithe in the Faroes (Division Vb). Landings in tonnes.

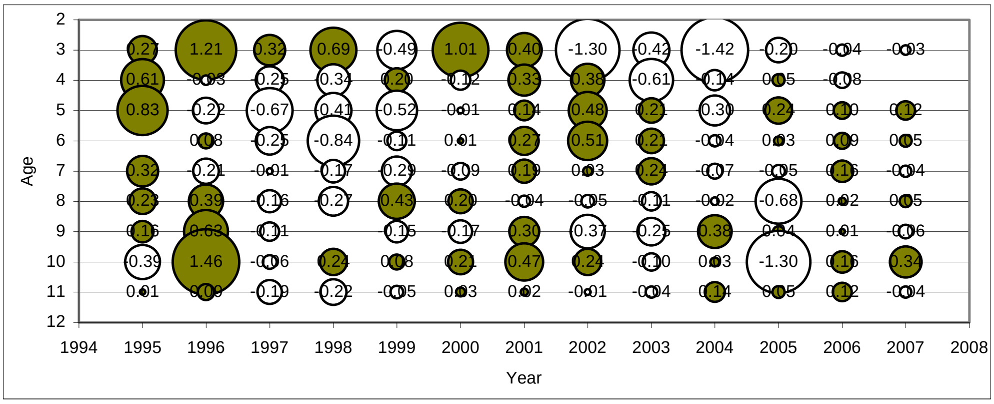


Figure 6.4.1. Saithe in the Faroes (Division Vb). Log catchability residuals for age groups 3 - 11from XSA.

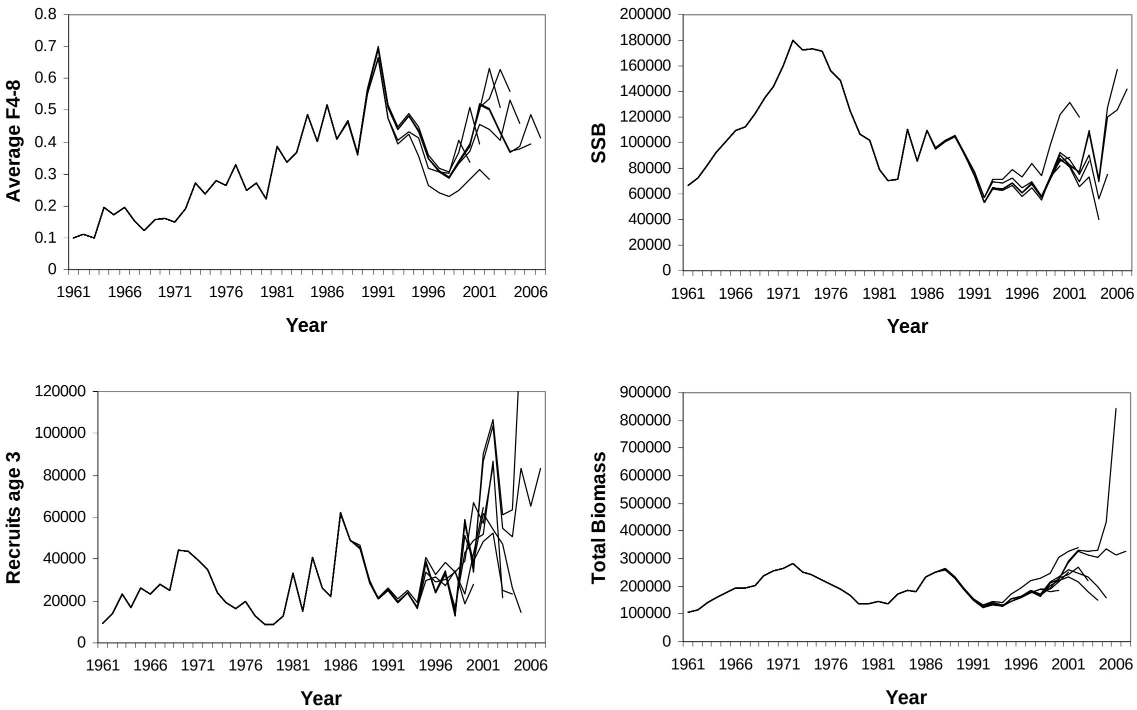


Figure 6.4.2 a). Retrospective analysis using iterative cohort analysis.

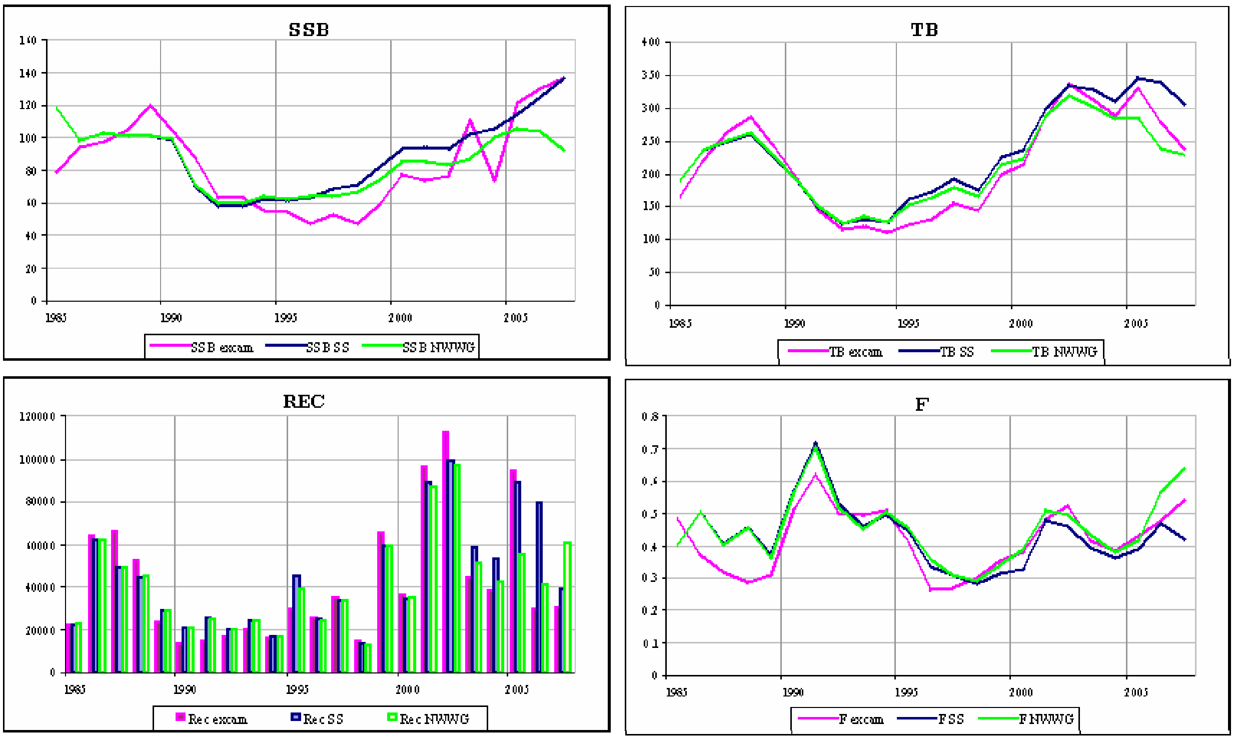


Figure 6.4.2 b). Assessment results, using Xcam (pink), XSA based on survey indices (blue) and the XSA calibrated with the pair trawlers (green).

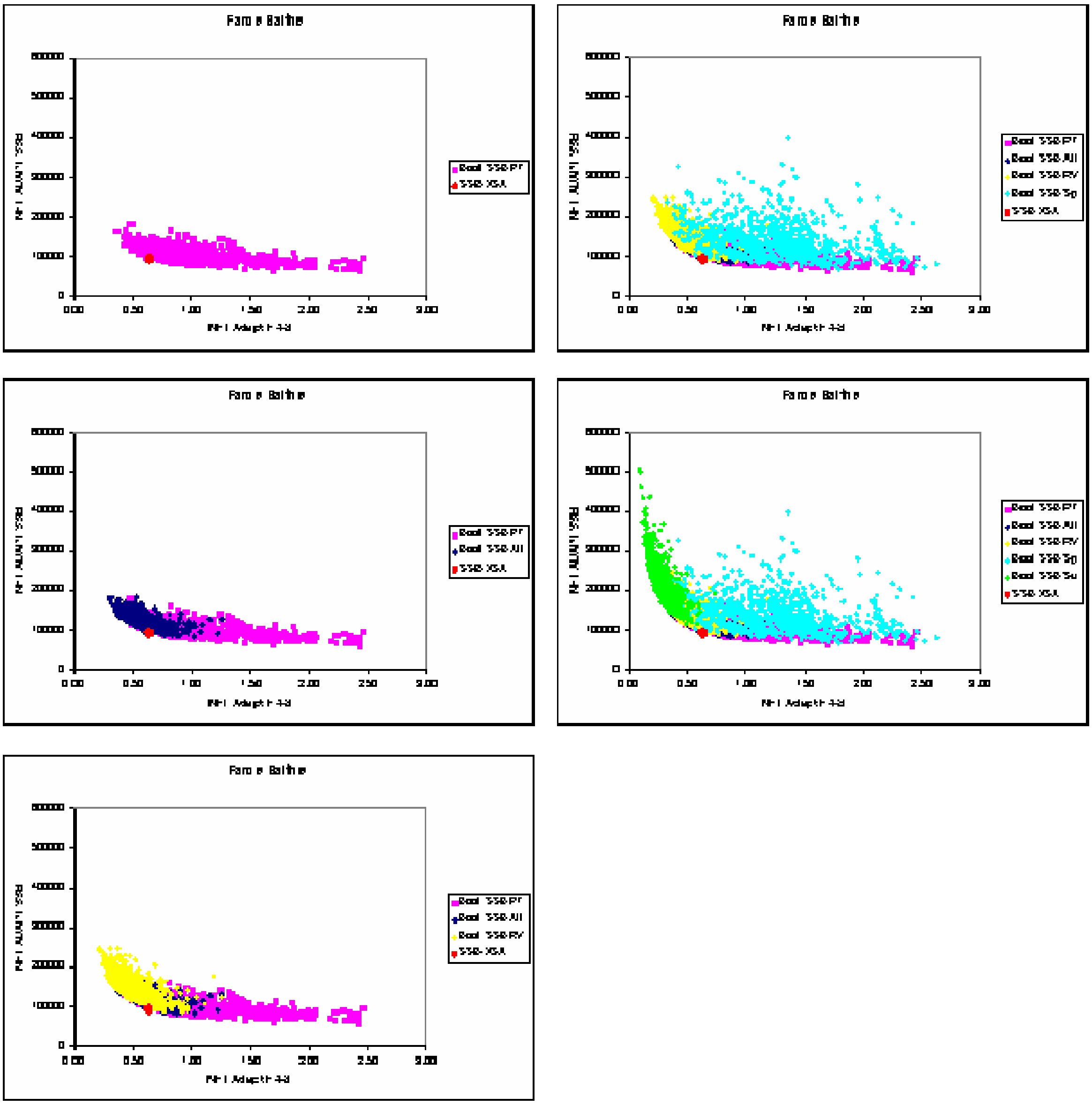
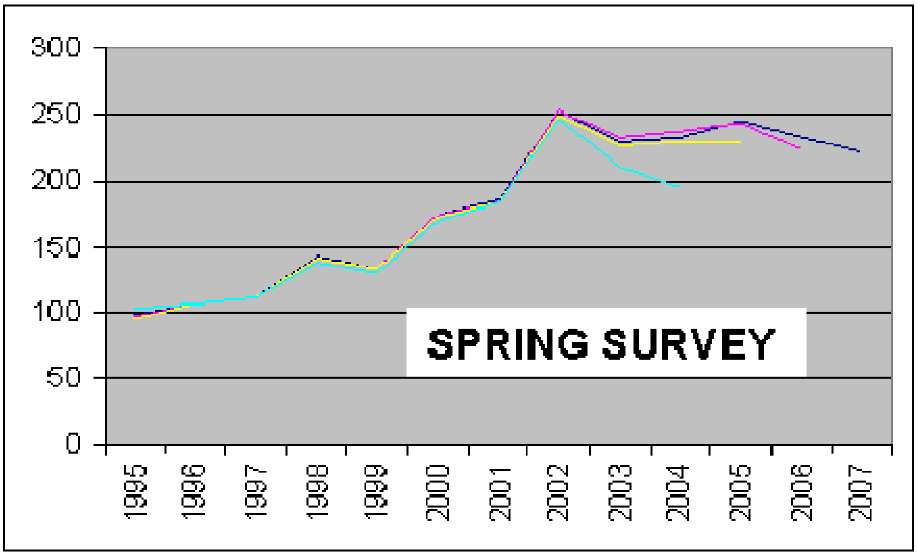


Figure 6.4.2 c). Bootstrapped SSB from Pair Trawler tuning fleet (pink), Pair trawler and survey indices (blue), survey indices (yellow), spring survey indices (turqois), and summer survey indices (green). The red dot is the SSB output from the XSA-assessment.



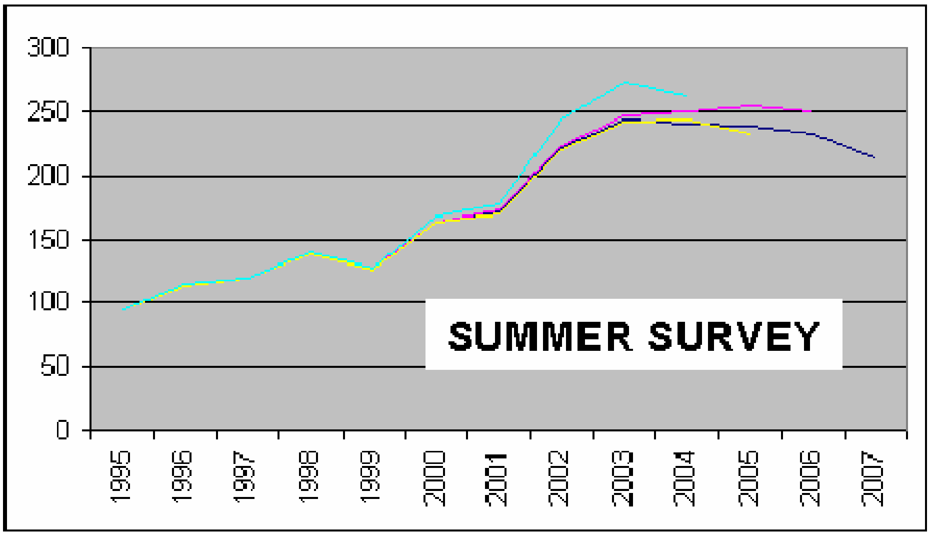


Figure 6.4.2d) TSA analysis of SSB from the survey indices.

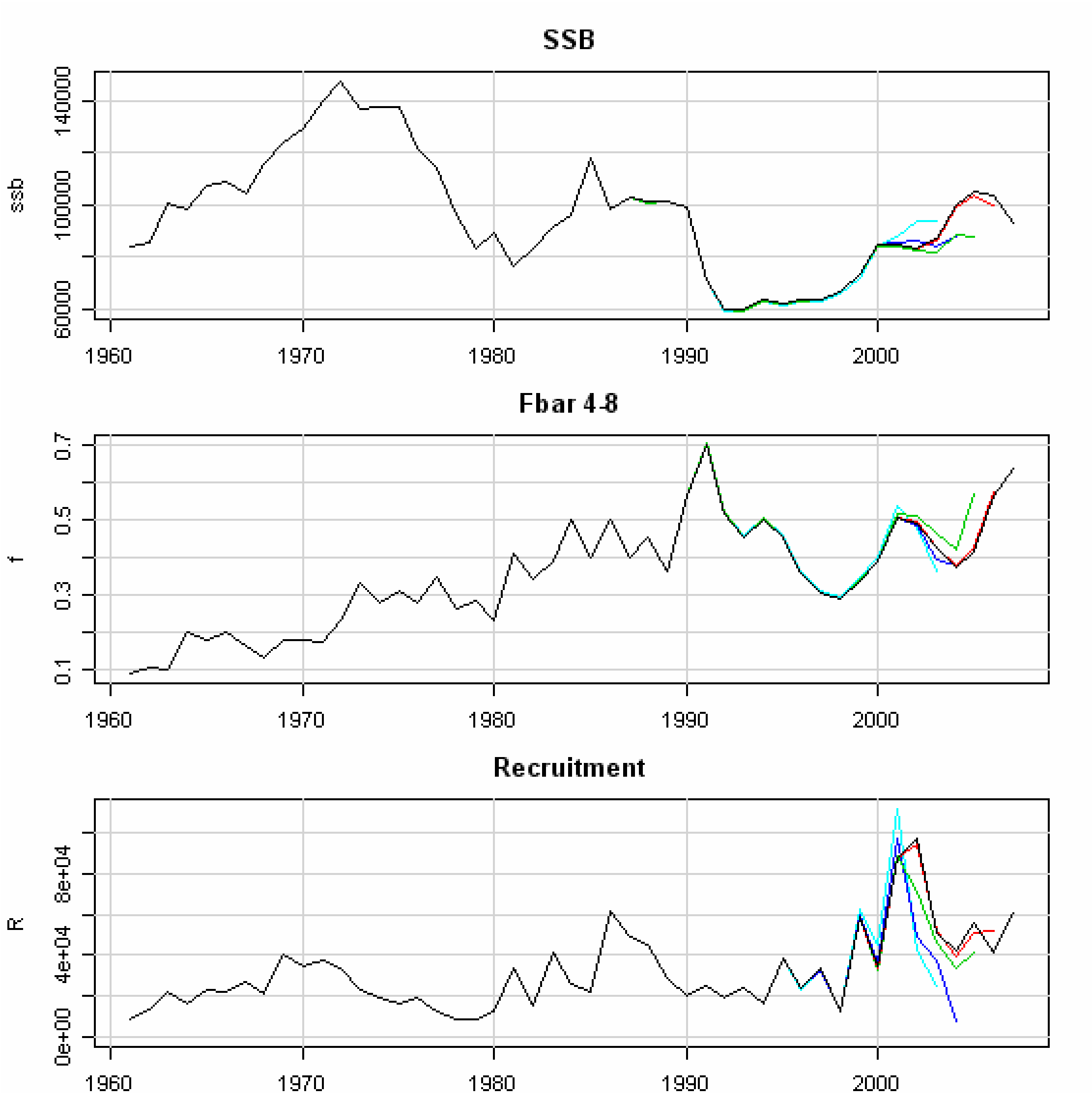


Figure 6.4.3. Saithe in the Faroes (Division Vb). Retrospective analysis of average spawning stock biomass, fishing mortality of age groups 4-8 and recruitment for age 3 from XSA for the years 2002-2007.

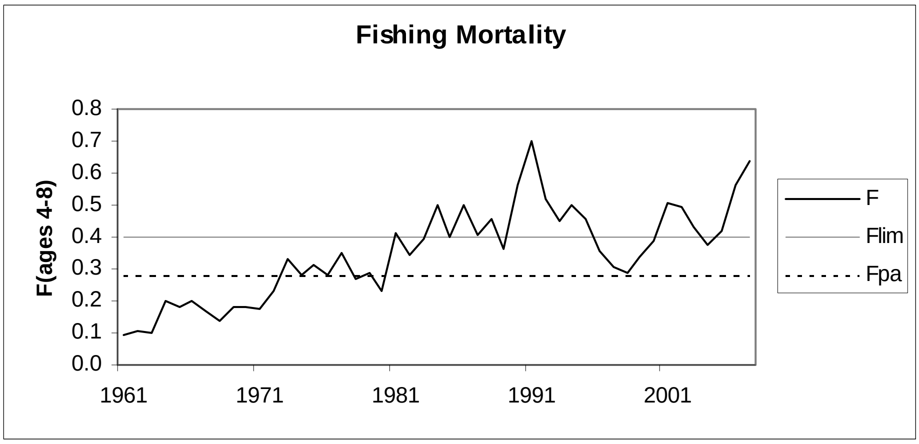


Figure 6.4.4. Saithe in the Faroes (Division Vb). Fishing mortality (average F ages 4-8).

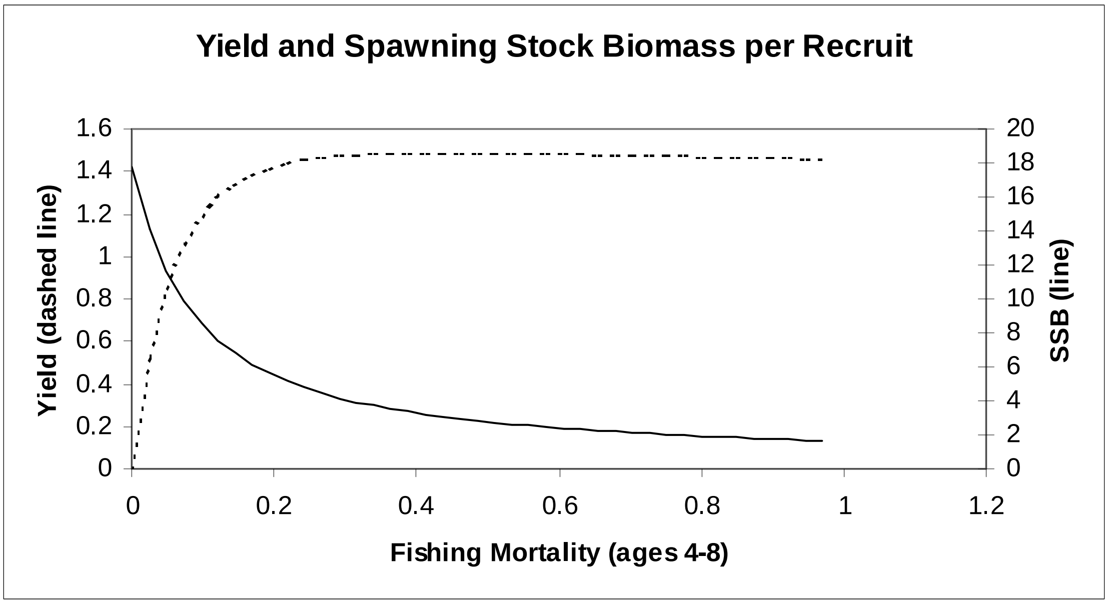


Figure 6.5.1.1. Saithe in the Faroes (Division Vb). Fish stock summary.

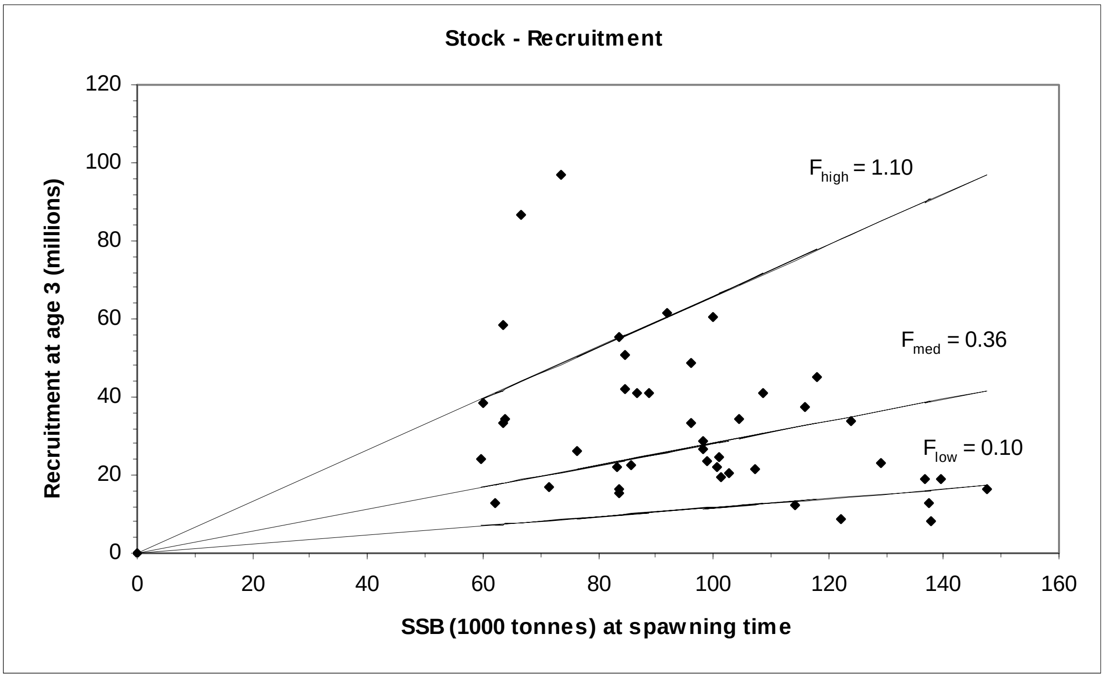


Figure 6.5.1.2. Saithe in the Faroes (Division Vb). Stock-Recruitment plot.

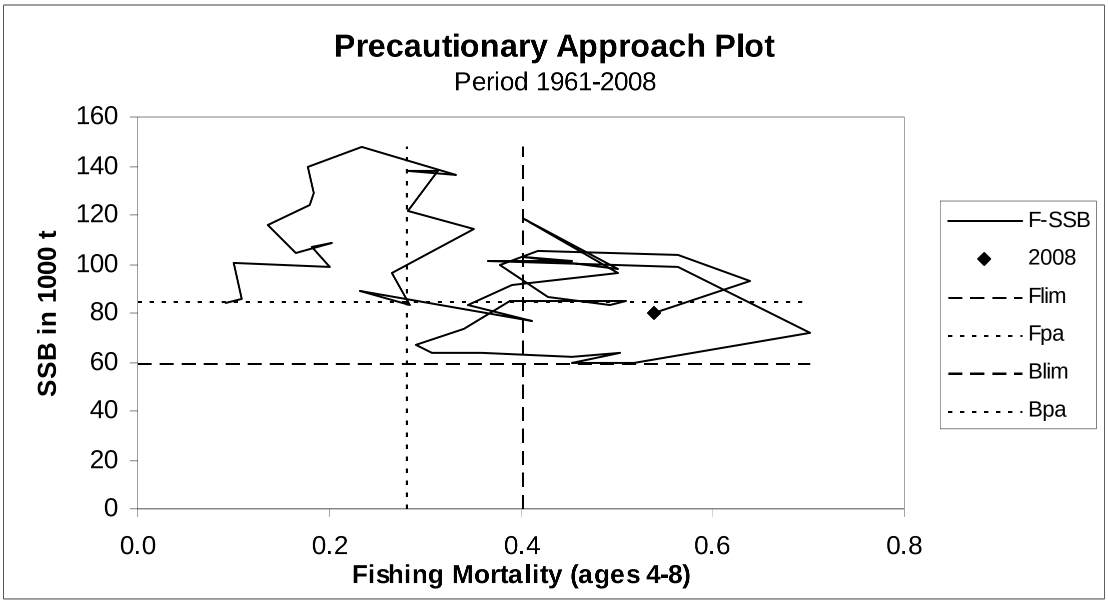


Figure 6.5.1.3. Saithe in the Faroes (Division Vb). Precautionary approach plot, period 1961-2007. The history of the stock/fishery in relation to the four reference points.

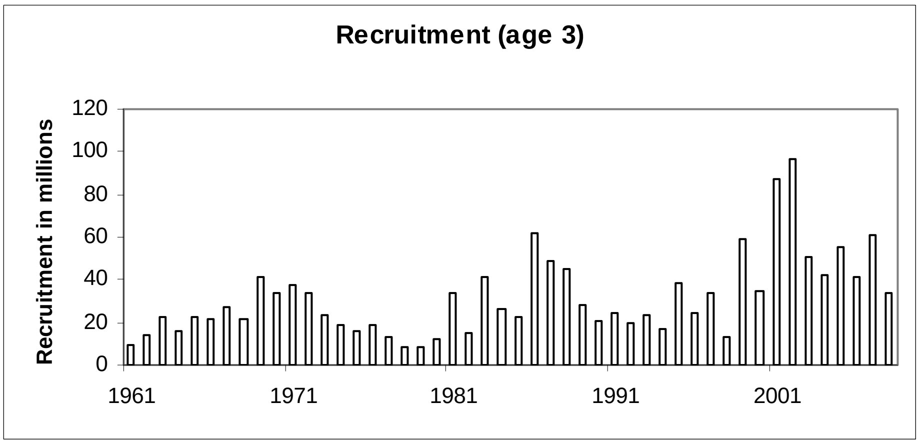


Figure 6.6.1.1. Saithe in the Faroes (Division Vb). Recruitment at age 3 (millions).

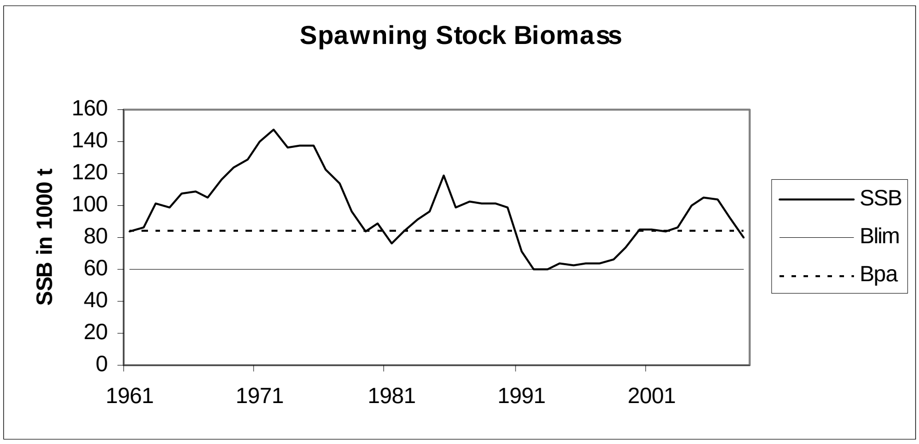


Figure 6.6.1.2. Saithe in the Faroes (Division Vb). Spawning stock biomass (1000 tonnes).

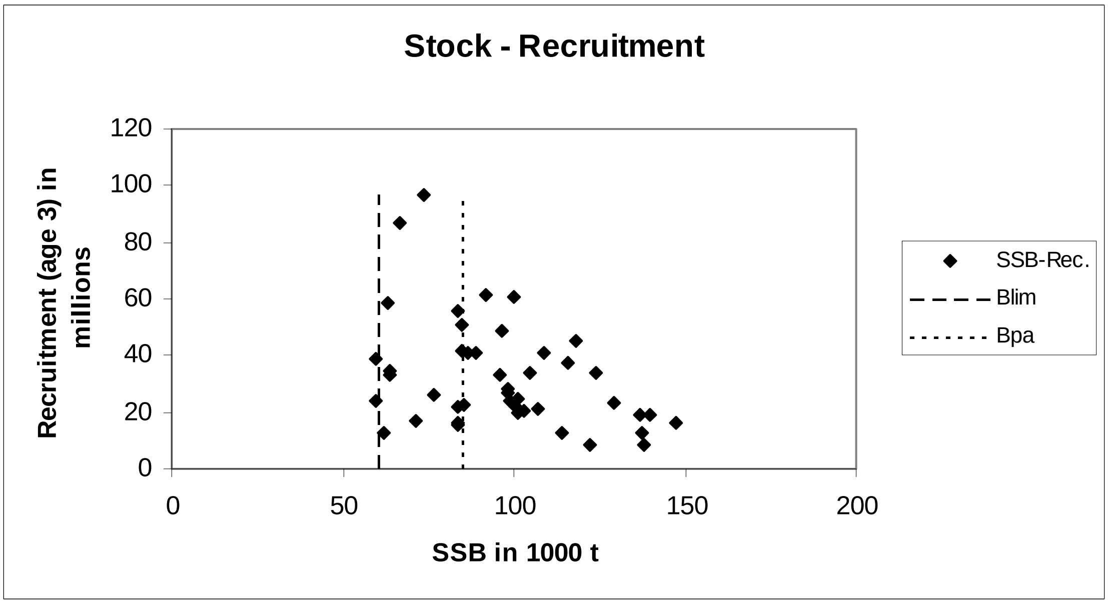


Figure 6.6.1.3. Saithe in the Faroes (Division Vb). Stock-Recruitment plot.

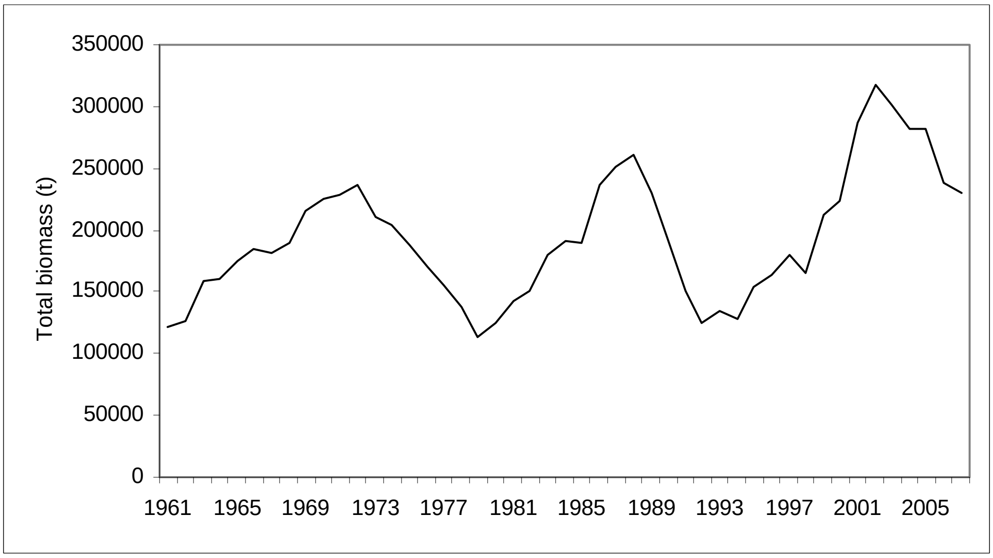
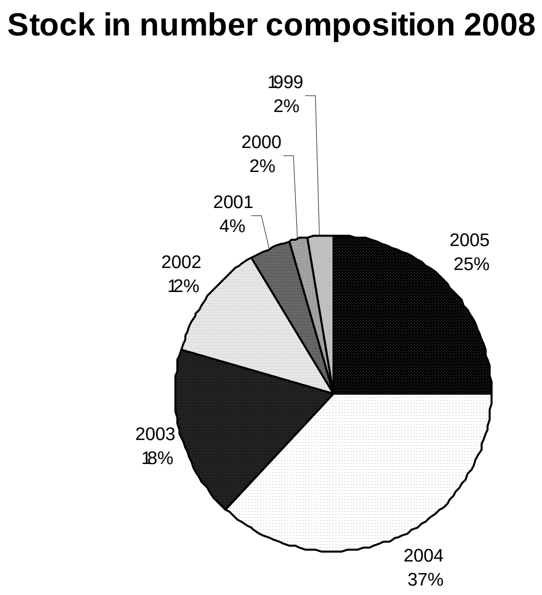


Figure 6.6.1.4. Saithe in the Faroes (Division Vb). Total biomass (1000 tonnes).



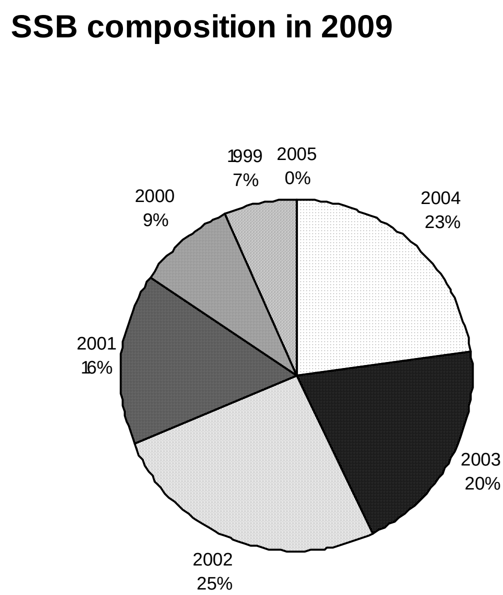


Figure 6.7.1.1. Saithe in the Faroes (Division Vb). Projected composition in number by year classes in the catch in 2008 (left figure) and the composition in SSB in 2009 by year classes (right figure).

7 Overview on ecosystem, fisheries and their management in Icelandic waters

This section gives a very broad and general overview of the ecosystem, 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. 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.

The information on the ecosystem of Icelandic waters is brief but a more detailed description is available in the WGRED report.

7.1 Environmental and ecosystem information

Iceland is located at the junction of the Mid-Atlantic Ridge and the Greenland-Scotland Ridge just south of the Arctic Circle. The bottom topography of this region is generally irregular, with hard rocky bottom prevailing in most areas. The shelf around Iceland is cut by many sub-sea canyons. It is narrowest off the south coast where in places it extends out only a few km. From there, the continental slope falls away to over 1000 m. Off the west, north and east coasts, however, the shelf is relatively broad and extends often over 150 km from the coast.

The Polar Front lies between Greenland and Iceland and separates the cold and relatively low saline south-flowing East Greenland Current from the Irminger Current, the westernmost branch of the warmer and more saline North Atlantic Current. South and east of Iceland the North Atlantic Current flows towards the Norwegian Sea. The Irminger Current flows northwards over and along the Reykjanes Ridge and into the Denmark Strait where it divides. One branch continues northeastward and eastward to the waters north of Iceland and the other branch flows south-westward parallel to the East Greenland Current. In the Iceland Sea north of Iceland a branch out of the cold East Greenland Current flows over the Kolbeinsey Ridge and continues to the southeast along the northeastern shelf brake as the East Icelandic Current. This current is part of a cyclonic gyre in the Iceland Sea.

The Icelandic Shelf is a high (150-300 gC/m2-yr) productivity ecosystem based on SeaWiFS global primary productivity estimates. Productivity is higher in the southwest regions than to the northeast and higher on the shelf areas than in the oceanic regions (Gudmundsson 1998). In terms of numbers of individuals, copepods dominate the mesozooplankton of Icelandic waters with *Calanus finmarchicus* being the most abundant species, often comprising between 60-80% of net-caught zooplankton in the uppermost 50 m (Astthorsson and Vilhjalmsson 2002, Astthorsson et al. 2007).

The underlying features which appear to determine the structures of benthic communities around Iceland are salinity (as indicator of water masses) and sediment types. Accordingly, the distribution of benthic communities is closely related to existing water masses and, on smaller scale, with bottom topography (Weisshappel and Svavarsson 1998). Survey measurements indicate that shrimp biomass in Icelandic waters, both in inshore and offshore waters, has been declining in recent years. Consequently the shrimp fishery has been reduced and is now banned in most inshore areas. The decline in the inshore shrimp biomass is in part considered to be environmentally driven, both due to increasing water temperature north of Iceland and due to increasing biomass of younger cod, haddock and whiting.

Based on information from fishermen, eleven coral areas were known to exist close to the shelf break off northwest and southeast Iceland at around 1970. Since then more coral areas have been found, reflecting the development of the bottom trawling fisheries extending into deeper waters in the 70s and 80s. At present considerably large coral areas exist on the Reykjanes Ridge and off southeast Iceland. Other known coral areas are small (Steingrímsson and Einarsson 2004).

The database of the BIOICE programme provides information on the distribution of soft corals, based on sampling at 579 locations within the territorial waters of Iceland. The results show that gorgonian corals occur all around Iceland. They were relatively uncommon on the shelf (< 500 m depth) but are generally found in relatively high numbers in deep waters (> 500 m) off south, west and north coasts of Iceland. Similar patterns were observed in the distribution of pennatulaceans off Iceland. Pennatulaceans are relatively rare in waters shallower than 500 m but more common in deep waters, especially off South Iceland (Guijarro et al. 2007).

Icelandic waters are comparatively rich in species and contain over 25 commercially exploited stocks of fish and marine invertebrates. Main species include cod, haddock, saithe, redfish, Greenland halibut and various other flatfish, wolffish, tusk *(Brosme brosme)*, ling *(Molva molva)*, herring, capelin and blue whiting. Most fish species spawn in the warm Atlantic water off the south and southwest coasts. Fish larvae and 0-group drift west and then north from the spawning grounds to nursery areas on the shelf off northwest, north and east Iceland, where they grow in a mixture of Atlantic and Arctic water.

Capelin is important in the diet of cod as well as a number of other fish stocks, marine mammals and seabirds. Unlike other commercial stocks, adult capelin undertake extensive feeding migrations north into the cold waters of the Denmark Strait and Iceland Sea during summer. Capelin abundance has been oscillating on roughly a decadal period since the 1970s, producing a yield of up to 1600 Kt at the most recent peak. In recent years the stock size of capelin has decreased from about 2000 Kt in 1996/97 to about 1000 Kt in 2006/07 (Anon. 2007). Herring were very abundant in the early 1960s, collapsed and then have increased since 1970 to a historical high level in the last decade. Abundance of demersal species has been trending downward irregularly since the 1950s, with aggregate catches dropping from over 800 Kt to under 500 Kt in the early 2000s.

A number of species of sharks and skates are known to be taken in the Icelandic fisheries, but information on catches is incomplete, and the status of these species is not known. Information on status and trends of non-commercial species are collected in extensive bottom trawl surveys conducted in early spring and autumn, but information on their catches in fisheries, is not available.

The seabird community in Icelandic waters is composed of relatively few but abundant species, accounting for roughly ¼ of total number and biomass of seabirds within the ICES area (ICES 2002). Auks and petrel are most important groups comprising almost 3/5 and 1/4 of abundance and biomass in the area, respectively. The estimated annual food consumption is on the order of 1.5 million tonnes.

At least 12 species of cetaceans occur regularly in Icelandic waters, and additional 10 species have been recorded more sporadically. In the continental shelf area minke whales (*Balaenoptera acutorostrata*) probably have the largest biomass. According to a

2001 sightings survey, 67 000 minke whales were estimated in the Central North Atlantic stock region, with 44 000 animals in Icelandic coastal waters (NAMMCO 2004, Borchers *et al.* 2003, Gunnlaugsson 2003). Two species of seals, common seal (*Phoca vitulina*) and grey seal (*Halicoerus grypus*) breed in Icelandic waters, while 5 northern vagrant species of pinnipeds are found in the area (Sigurjonsson and Hauksson, 1994; Hauksson, 1993, 2004).

7.2 Environmental drivers of productivity

Mean weight at age of Icelandic cod 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.

No other ecosystem drivers of productivity that may affect the assessment of the Icelandic stocks assessed in this report were presented to the NWWG in 2008.

7.3 Ecosystem considerations (General)

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 7.3.1.). 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 7.3.2)

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. 7.3.3). The most obvious examples of increased abundance of such species in the mixed water area north of Iceland are haddock, whiting, monkfish, lemon sole and witch. The semi-pelagic blue whiting has lately been found and fished in E-Icelandic water in far larger quantities than ever before.

On the other hand, coldwater species like Greenland halibut and northern shrimp have become scarcer. Capelin have both shifted their larval drift and nursing areas far to the west to the colder waters off E-Greenland, the arrival of adults on the overwintering grounds on the outer shelf off N-Iceland has been delayed and migration routes to the spawning grounds off S- and W-Iceland have been located farther off N- and E-Iceland and not reached as far west along the south coast as was the rule in most earlier years (Figure 7.3.4. and 7.3.5.). The change in availability of capelin in the traditional grounds may have had an effect on the growth rate of various predators, as is reflected in low weight of cod in recent years.

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

7.4 Description of fisheries [Fleets]

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

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

The Icelandic fishing fleet can be characterised by the most sophisticated technological equipment available in this field. This applies to navigational techniques and fish-detection instruments as well as the development of more effective fishing gear. The most significant development in recent years is the increasing size of pelagic trawls and with increasing engine power the ability to catch pelagic fishes at greater depths than previously possible. There have also been substantial improvements with respect to technological aspects of other gears such as bottom trawl, longline and handline. Each fishery uses a variety of gears and some vessels frequently shift from one gear to another within each year. The most common demersal fishing gear are otter trawls, longlines, seines, gillnets and jiggers while the pelagic fisheries use pelagic trawls and purse seines. The total recorded landings of the Icelandic fleets in 2005 amounted to 2.0 million tonnes where pelagic fishes amounted to 1.5 million tonnes. Spatial distributions of the catches are shown in figure 7.4.1. Detailed information of landings by species and gear type are given in Table 7.1. Spatial overviews of the removal of the some important species by different gear are given in figures 7.4.2. – 7.4.5.

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

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

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

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

- Large and small trawlers using demersal trawl. This fleet is the most important one fishing cod, haddock, saithe, redfish as well as a number of other species. This fleet is operating year around; mostly outside 12 nautical miles from the shore.
- Boats (< 300 GRT) using gillnet. These boats are mostly targeting cod but haddock and a number of other species are also target. This fleet is mostly operating close to the shore.
- Boats using longlines. These boats are both small boats (< 10 GRT) operating in shallow waters as well as much larger vessels operating in deeper waters. Cod and haddock are the main target species of this fleet but a number other species are also caught, some of them in directed fisheries.
- Boats using jiggers. These are small boats (<10 GRT). Cod is the most important target species of this fleet with saithe of secondary importance.
- Boats using Danish seine. (20-300 GRT) Cod, haddock and variety of flatfishes, e.g. plaice, dab, lemon sole and witch are the target species of this fleet.

Although different fleets may be targeting the main species the spatial distribution of effort may different. In general it can be observed that the bottom trawl fleet is fishing in deeper waters than the long line fleet (Figures 7.4.6. and 7.4.7).

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. Additionaly a significant part of the pelagic fisheries of the Icelandic fleet is caught outside the Icelandic EEZ, both on the Atlanto-Scandian herring and on blue whiting.

7.5 Regulations

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

7.5.1 The ITQ system

A system of transferable boat quotas was introduced in 1984. The agreed quotas were based on the Marine Research Institute's TAC recommendations, taking some socio-economic effects into account, as a rule to increase the quotas. Until 1990, the quota year corresponded to the calendar year but since then the quota, or fishing year, starts on September 1 and ends on August 31 the following year. This was done to meet the needs of the fishing industry. In 1990, an individual transferable quota (ITQ) system was established for the fisheries and they were subject to vessel catch quotas. Since 2006/2007 fishing season, all boats operate under the TAC system.

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

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

7.5.2 Mesh size regulations

With the extension of the fisheries jurisdiction to 200 miles in 1975, Iceland introduced new measures to protect juvenile fish. The mesh size in trawls was increased from 120 mm to 155 mm in 1977. Mesh size of 135 mm was only allowed in the fisheries for redfish in certain areas. Since 1998 a minimum mesh size of 135 is allowed in the codend in all trawl fisheries not using "Polish cover" and in the Danish seine fisheries. For the gillnet fishery both minimum and maximum mesh-sizes are restricted. Since autumn 2004 the maximum allowed mesh-size in the gillnet fishery is 8 inches. The objective of this measure is to decrease the effort directed towards bigger spawners.

7.5.3 Area closures

REAL TIME AREA CLOSURE: A quick closure system has been in force since 1976 with the objective to protect juvenile fish. Fishing is prohibited for at least two weeks in areas where the number of small fish in the catches has been observed by inspectors to exceed certain percentage (25% or more of <55 cm cod and saithe, 25% or more of <40 cm haddock and 20% or more of <33 cm redfish). In 2007 the minimum landing size for haddock was changed from 45cm to 40cm because of slow growth of the 2003 cohort (See section 10.14). If, in a given area, there are several consecutive quick closures the Minister of Fisheries can with regulations close the area for longer time forcing the fleet to operate in other areas. Inspectors from the Directorate of Fisheries supervise these closures in collaboration with the Marine Research Institute. In 2004, 73 such closures took place

PERMANENT AREA CLOSURES: In addition to allocating quotas on each species, there are other measures in place to protect fish stocks. Based on knowledge on the biology of various stocks, many areas have been closed temporarily or permanently aiming at protect juveniles. Figure 7.5.1. shows map of such legislation that was in force in 2004. Some of them are temporarily, but others have been closed for fishery for decades.

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

7.5.4 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 discard rate for cod has been less than 1-2% of the reported landings over the time investigated (Figure 7.5.2.). The discard estimates for haddock are somewhat higher ranging between 2-6% annually. Discarding of saithe and golden redfish has been neglible over time period of investigation. Estimates of discards of cod and haddock in 2006 by individual fleets are given in table 7.2. These relatively low discard rates compared to what is generally assumed to be a side effect of a TAC system may be a result of the various measures, including the flexibility within the Icelandic ITQ system (see above). Since the time series of discards is relatively short it is not included in the assessments.

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

7.6 Mixed fisheries, capacity and effort

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 7.6.1.). Fishermen can however have a relatively good control of the relative catch composition of the different species. E.g. the saithe fishery along the shelf edge is often in the same areas as the redfish fisheries: Fleets are often targeting at redfish during daytime and saithe during nights. Therefore the fishery for one of those species is relatively free of bycatch of the other species even though they take place in the same area. Small differences in the location of setting are also known to affect the catch composition. This has for example been documented in the long line fisheries in Faxabay, where in adjacent areas cod catches and wolfish catches are known 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).

7.7 References

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

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

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

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

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

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

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

Table 7.1 Overview of the 2007 landings of fish and shrimp caught in Icelandic waters by the Icelandic fleet categorized by gear type. 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 trawl	Danish seine	Dredge	Gillnets	Jiggers	Long line	Neprops trawl	Pelagic trawl	Pot	Purse seine	Shrimp trawl	Total
Atlantic mackerel	0	0	0	0	0	0	0	36518	0	0	0	36518
Atlantic wolffish	7819	1551	0	88	6	6645	45	21	0	0	0	16175
Black scabbard fish	1	0	0	0	0	0	0	0	0	0	0	1
Blue whiting	0	0	0	0	0	0	0	237854	0	0	0	237854
Blueling, European ling	1483	44	0	33	0	374	55	6	0	0	0	1995
Capelin	0	0	0	0	0	0	0	50529	0	257176	0	307705
Cod	77080	8633	0	23584	4228	58927	735	829	53	75	141	174285
European/Common whelk	3	0	0	0	0	0	0	0	551	0	0	554
Dab	22	780	0	5	0	7	0	0	0	0	0	814
Deep water prawn	10	0	0	0	0	0	0	0	0	0	2016	2026
Dogfish	2	3	0	4	0	35	0	0	0	0	0	44
Greater argentine	4108	0	0	0	0	0	0	119	0	0	0	4227
Greater forkbeard	0	0	0	0	0	1	0	0	0	0	0	1
Greenland halibut	8985	2	0	166	0	20	0	420	0	0	3	9596
Greenland shark	1	0	0	0	0	1	0	0	0	0	0	2
Haddock	57235	12846	0	1035	45	37192	211	714	2	8	43	109331
Halibut	171	39	0	19	1	187	10	5	0	0	0	432
Herring	0	0	0	0	0	0	0	368	0	142891	0	143259
Herring (Atl.-scand)	5	0	0	0	0	0	0	166813	0	9808	0	176626
Lemon sole	1441	1191	0	8	1	0	14	9	0	0	0	2664
Ling	1396	238	0	671	6	4042	243	5	0	0	0	6601
Long rough dab	82	271	0	2	0	9	1	0	0	0	0	365
Lumpsucker, lumpfish	2	2	0	18	0	0	0	2	0	0	0	24
Megrim	43	120	0	0	0	0	25	0	0	0	0	188
Monkfish	558	385	0	1484	1	52	311	0	0	0	0	2791
Norway haddock	24	0	0	0	0	0	0	0	0	0	0	24
Norway lobster	1	0	0	0	0	0	2006	0	0	0	0	2007
Ocean quahog	0	0	4620	0	0	0	0	0	0	0	0	4620
Other	21	1	0	0	0	0	0	0	0	1	0	23
Other	45	4	0	1	0	1	1	0	0	0	0	52
Plaice	2223	3306	0	140	2	124	1	13	0	1	0	5810
Rabbitfish (rat fish)	1	0	0	0	0	0	0	0	0	0	0	1
Rauðmagi	2	4	0	36	0	0	0	0	0	0	0	42
Redfish (demersal S.mentella)	12823	0	0	0	0	0	0	1735	0	0	0	14558
Redfish (pelagic S.mentella)	3629	0	0	0	0	0	0	16338	0	0	0	19967
Redfish (S. Marinus)	37418	546	0	175	55	1151	362	1203	0	0	0	40910
Roughhead grenadier	2	0	0	0	0	0	0	0	0	0	0	2
Roundnose grenadier,	11	0	0	0	0	0	0	1	0	0	0	12
Sailray	0	0	0	0	0	7	0	0	0	0	0	7
Saithe	54500	1197	0	4029	1736	945	40	1790	0	6	0	64243
Sea urchins	0	0	134	0	0	0	0	0	0	0	0	134
Shagreen ray	1	1	0	0	0	16	0	0	0	0	0	18
Skate	43	21	0	16	0	39	4	0	0	0	0	123
Spotted wolffish, leopardfish	1296	15	0	5	1	1391	1	15	0	0	0	2724
Starry ray, thorny skate	45	113	0	9	0	329	0	2	0	0	0	498
Tusk, torsk, cusk	95	0	0	40	9	5833	9	0	0	0	0	5986
Whiting	741	71	0	22	5	394	22	4	0	0	0	1259
Witch	113	1531	0	2	0	0	159	0	0	0	0	1805
Total	273481	32915	4754	31592	6096	117722	4255	515313	606	409966	2203	1398903

Table 7.2. Estimates of discard of cod and haddock in the Icelandic fisheries in 2006. Source: Ólafur K. Pálsson, Eyþór Björnsson, Guðmundur Jóhannesson, Ari Arason, og Þórhallur Ottesen 2007. Discards in demersal Icelandic fisheries 2006. Marine Research Institute, report series (manuscript for printing). NOT UPDATED

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

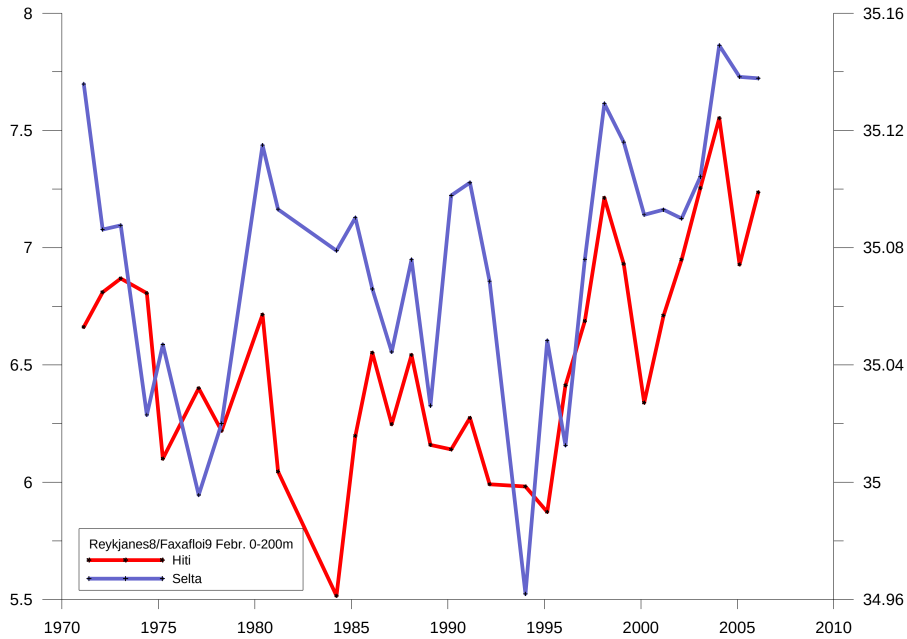


Figure 7.3.1. Changes of temperature and salinity west of Iceland 1970-2006. NOT UPDATED

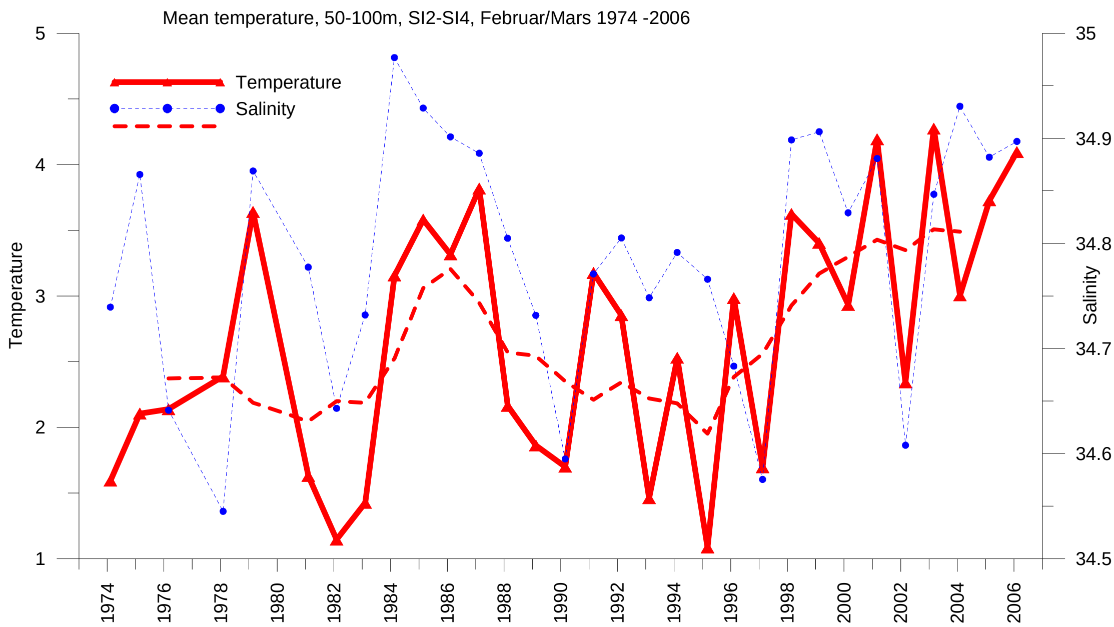


Figure 7.3.2. Changes of temperature and salinity off central North-Iceland 1970-2006. NOT UPDATED

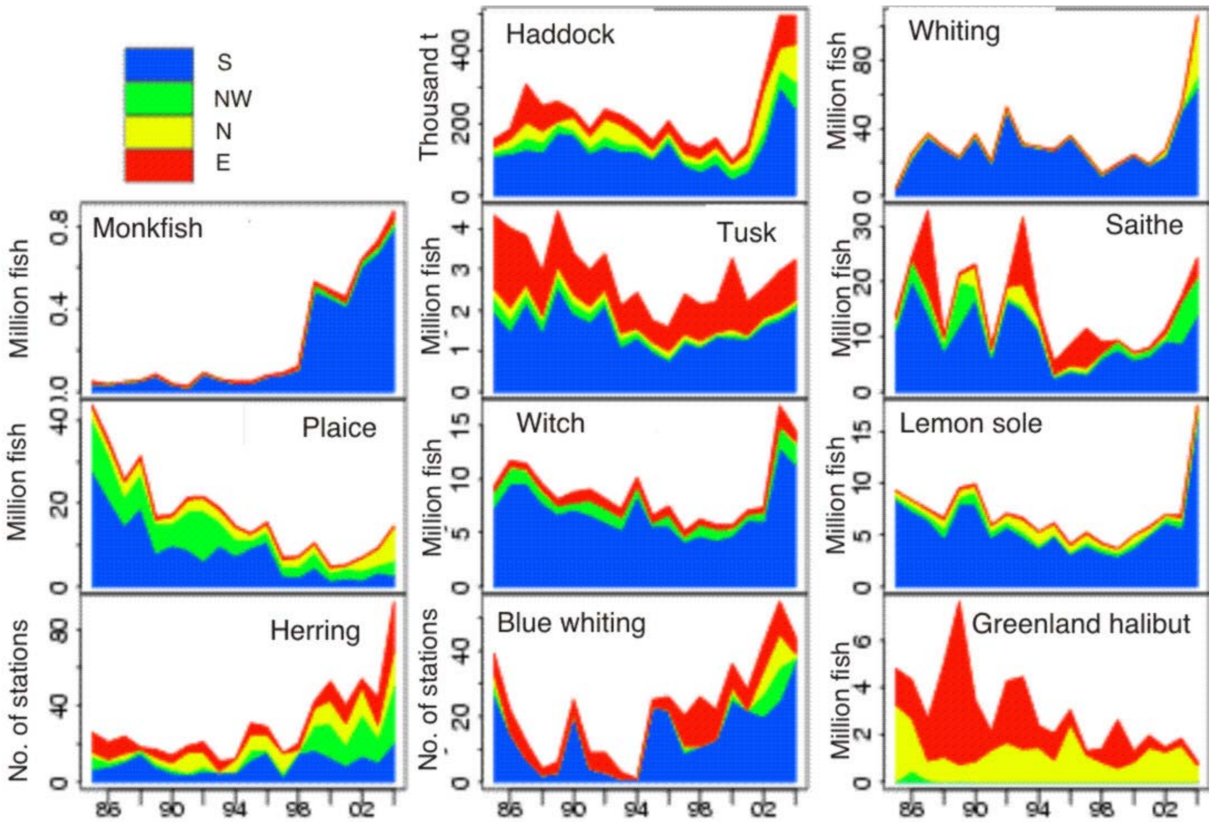


Figure 7.3.3. Changes of indices of abundance and geographical distribution of several fish stocks in Icelandic waters, 1985 – 2005 (based on the spring groundfish survey). The denotations S, NW, N and E beside the color code shown in the top left corner stand for South-, Northwest-, North- and East-Iceland in that order NOT UPDATED.

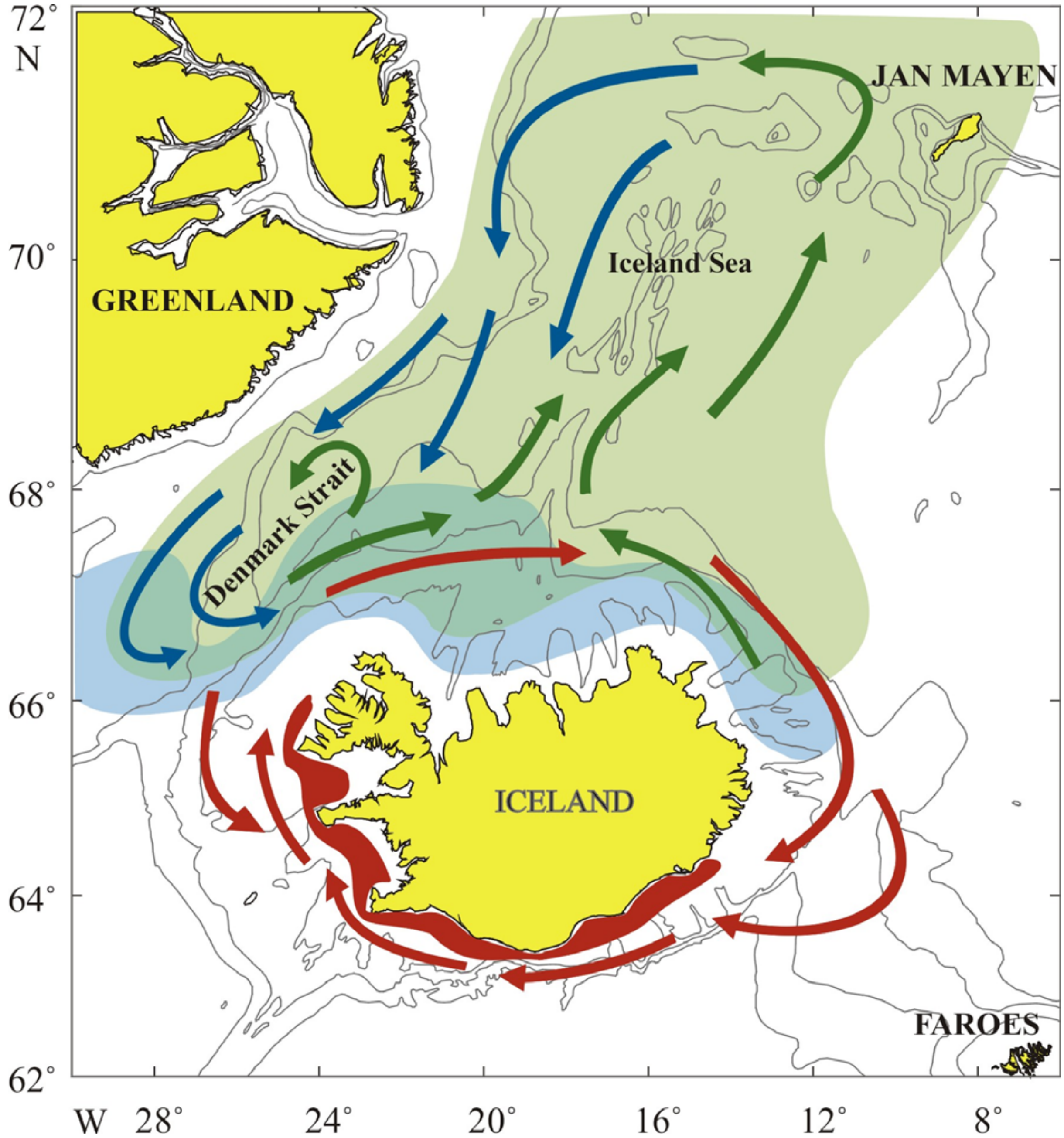


Figure 7.3.4. Distribution and migrations of capelin in the Iceland/East-Greenland/Jan Mayen area before 2001. Red: Spawning grounds; Green: Adult feeding area; Blue: Distribution and feeding area of juveniles; Green arrows: Adult feeding migrations; Blue arrows: Return migrations; Red arrows: Spawning migrations; Depth contours are 200, 500 and 1000 m (Vilhjalmsson 2002)

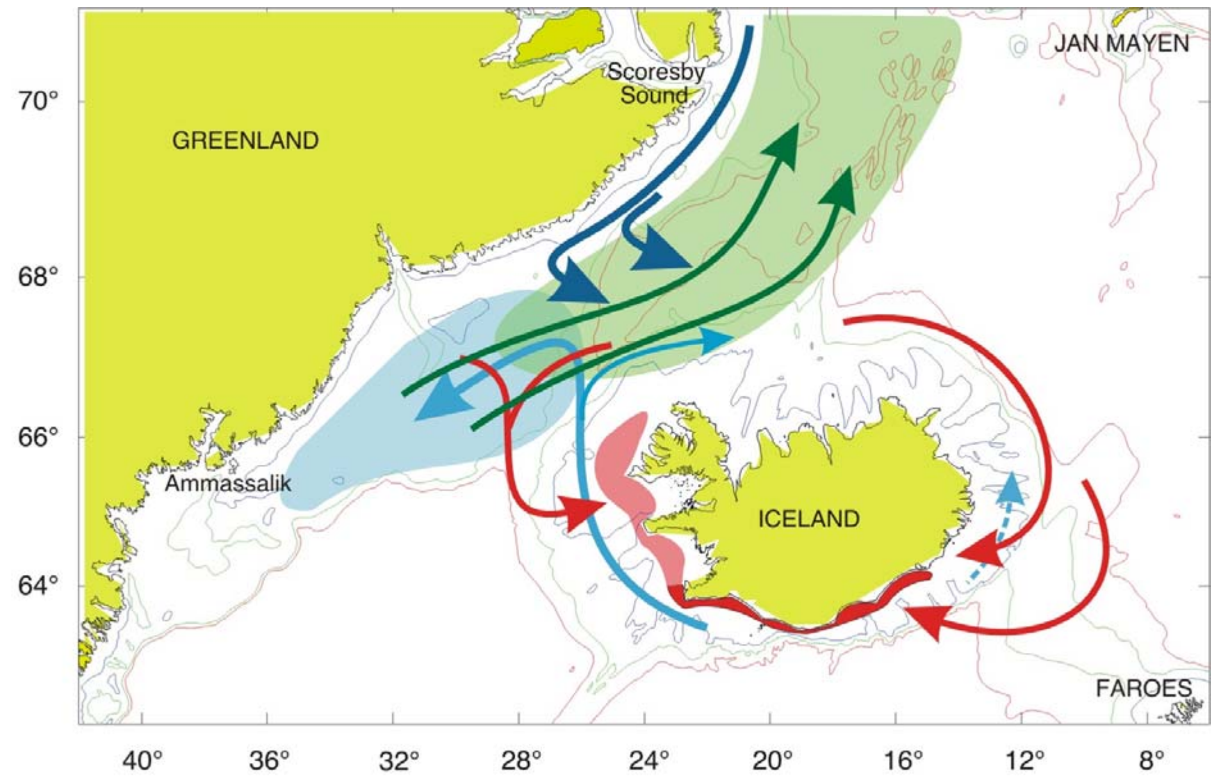


Figure 7.3.5. Likely changes of distribution and migration routes of capelin in the Iceland/Greenland/Jan Mayen area in the last 3-4 years. Green: Feeding area; Light blue: Juvenile area; Red area: Main spawning grounds; Lighter red colour: Lesser importance of W-Iceland spawning areas; Light blue arrows: Larval drift; Dark green arrows: Feeding migrations; Dark blue arrows: Return migrations; Red arrows: Spawning migrations. Depth contours are 200, 500 and 1000 m.

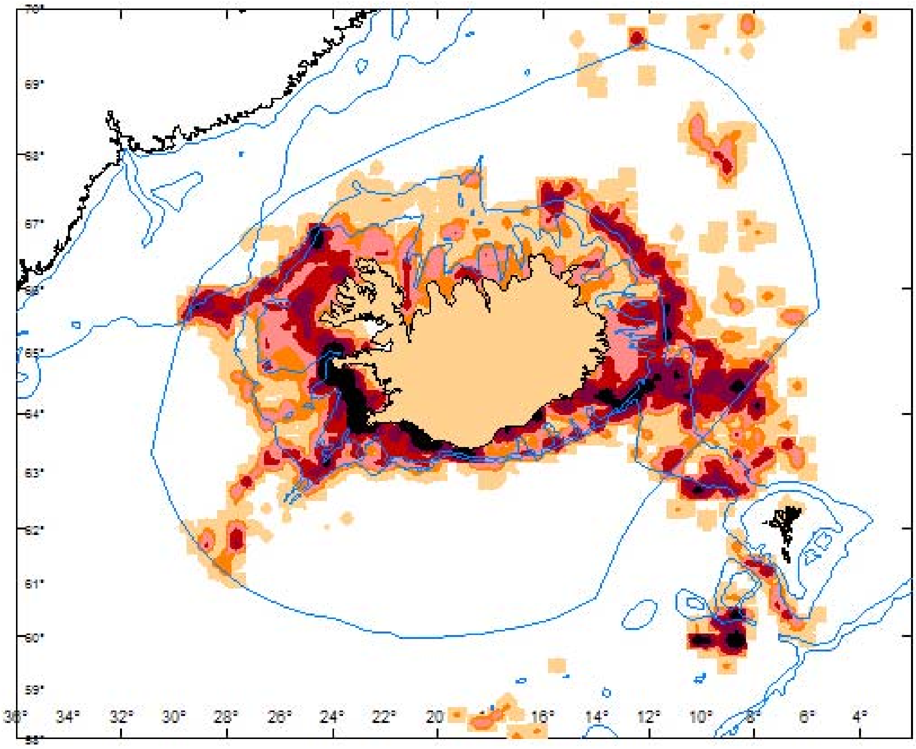


Figure 7.4.1. Distribution of total catch of all species by the Icelandic fishing fleet in Icelandic EEZ and adjacent waters in 2007. The Icelandic EEZ is shown as a blue, contour lines indicate 500 and 1000 m depth.

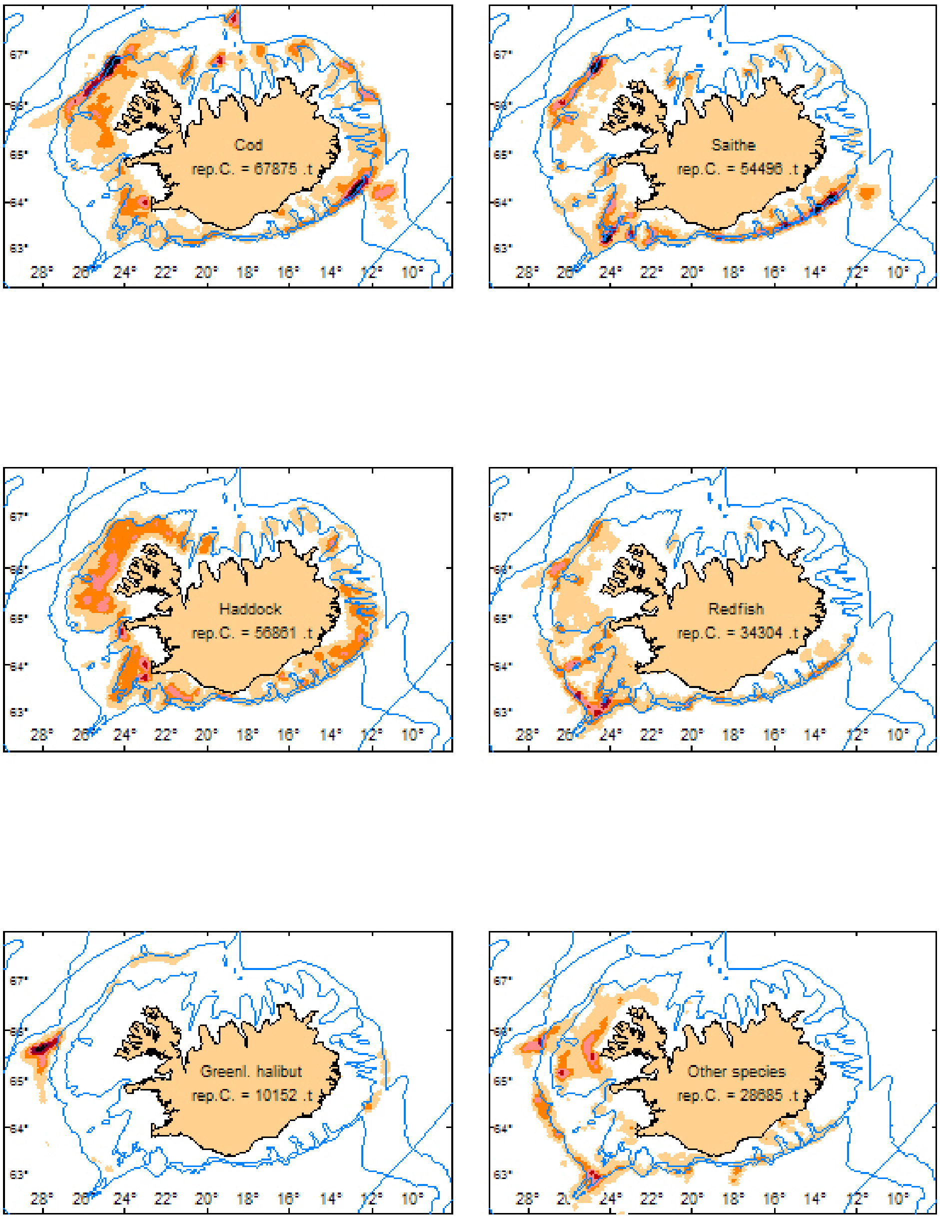


Figure 7.4.2. Location of catches of cod, saithe, haddock, redfish, Greenland halibut and others caught with bottom trawl 2007.

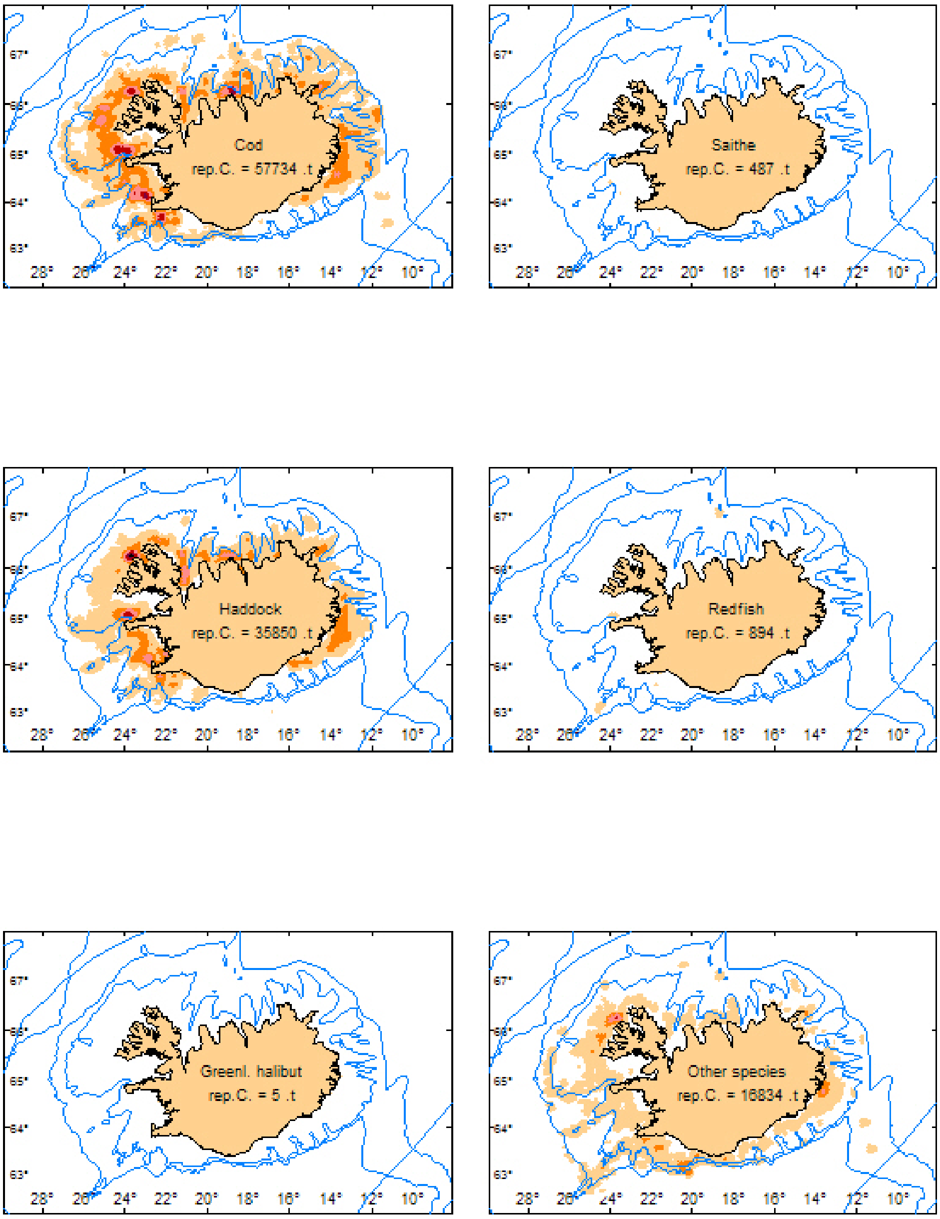


Figure 7.4.3. Location of catches of cod, saithe, haddock, redfish, Greenland halibut and others caught with long-line in 2007.

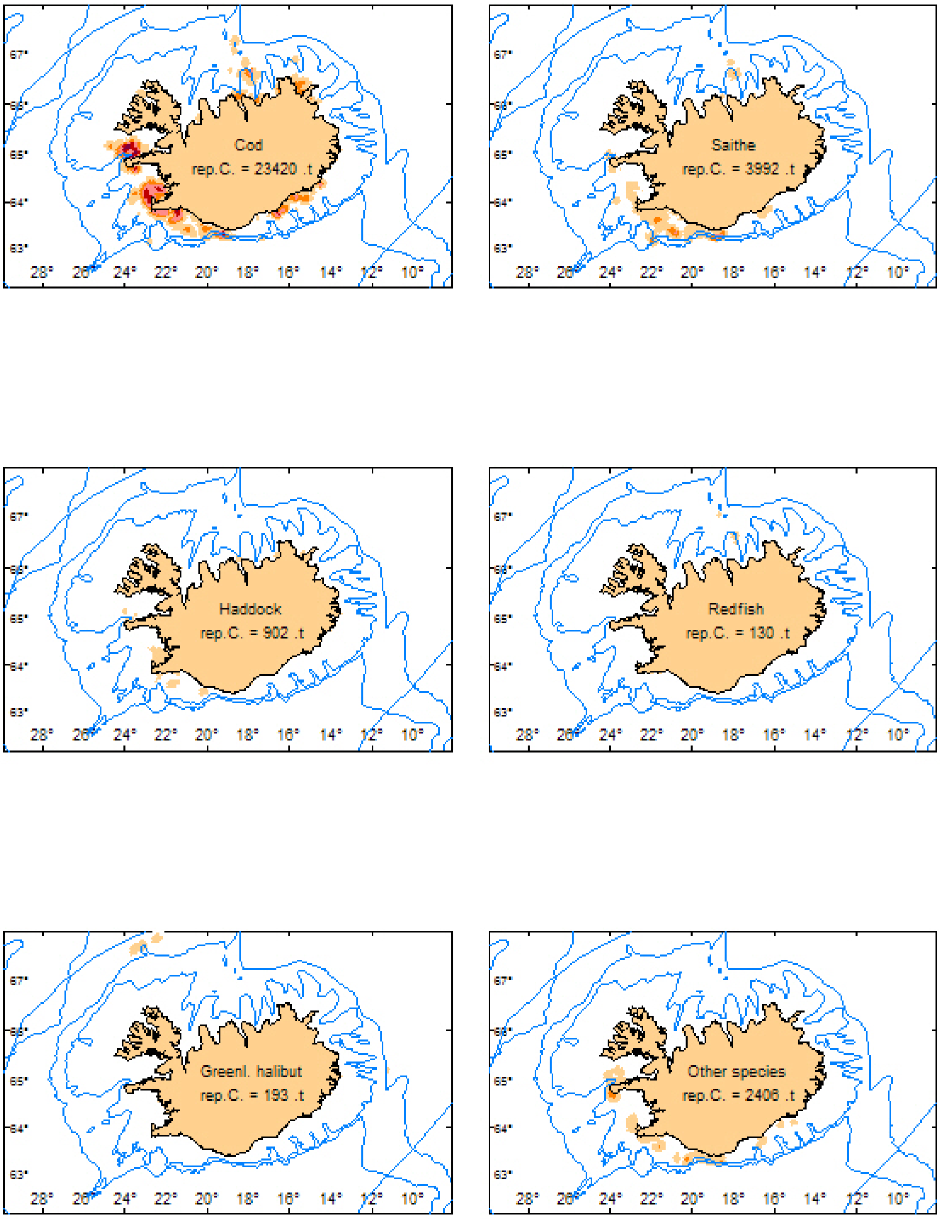


Figure 7.4.4. Location of catches of cod, saithe, haddock, redfish, Greenland halibut and others caught with gillnets in 2007.

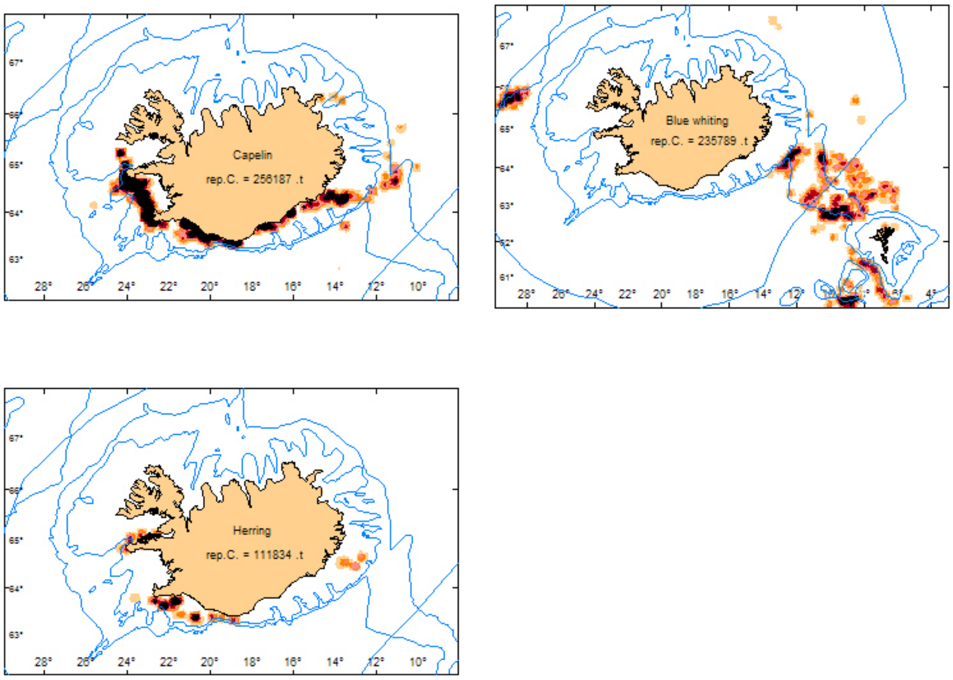


Figure 7.4.5. Location of catches of capelin, Icelandic summer spawning herring and blue whiting with purse seine and pelagic trawls in 2007.

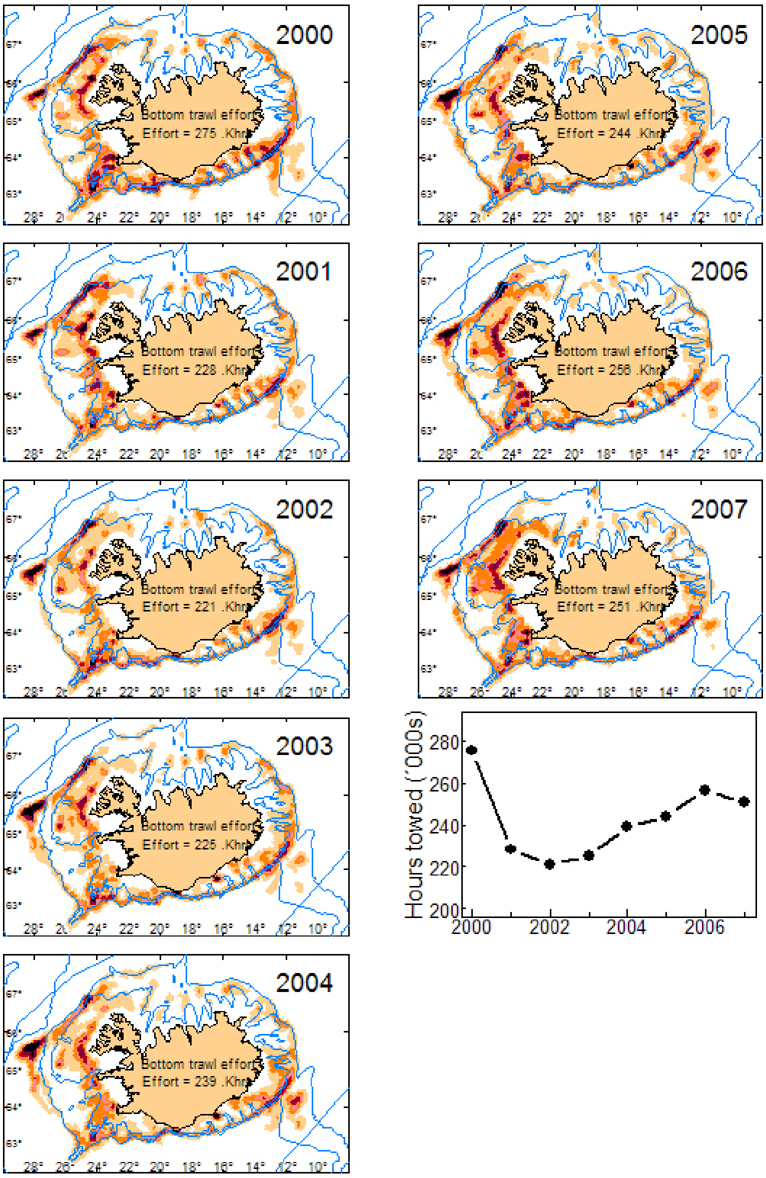


Figure 7.4.6 Spatial distribution of the trawler fleet effort (in hours trawled) in 2000-2007.

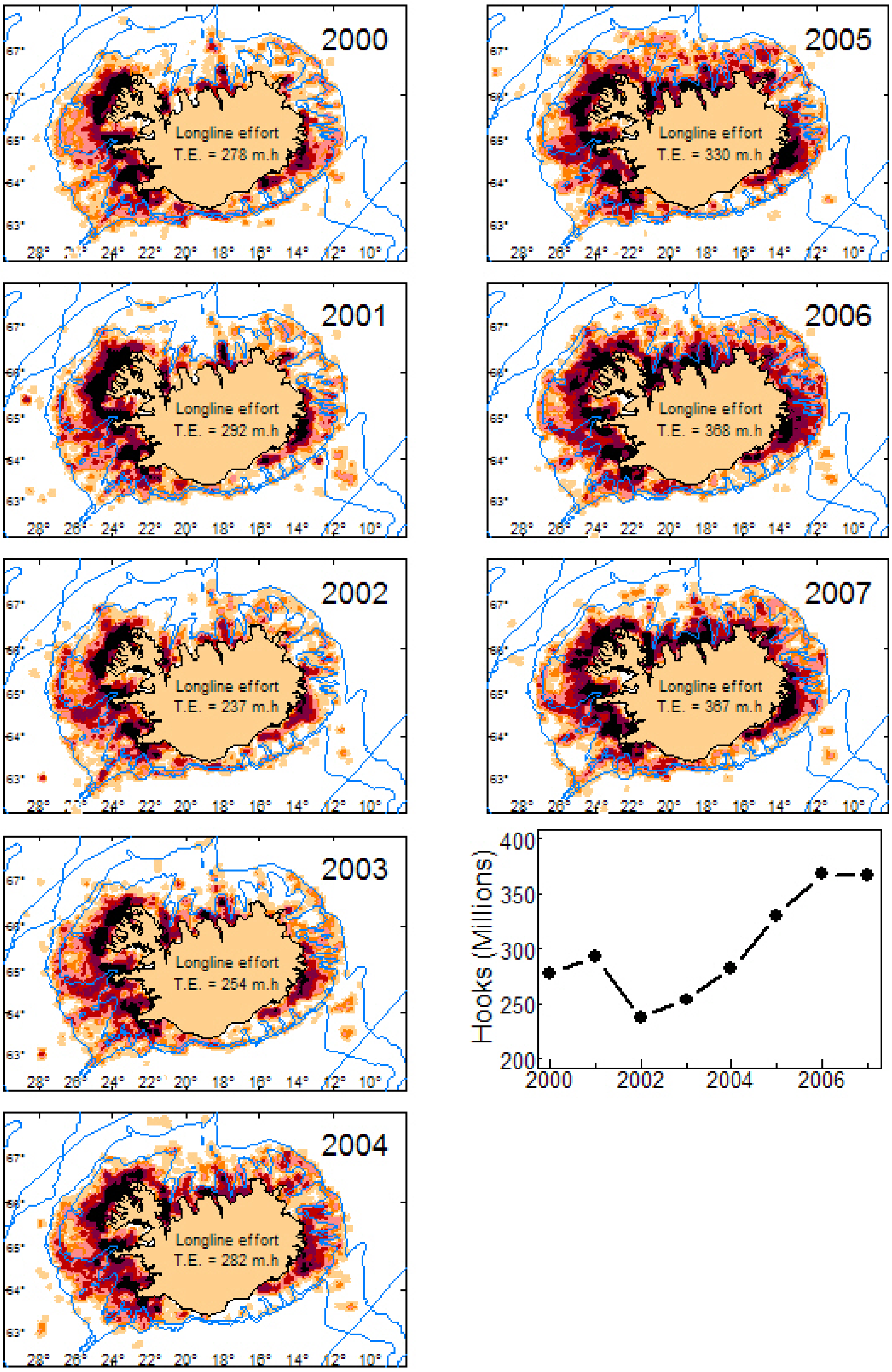


Figure 7.4.7. Spatial distribution of the longlinefleet effort (in number of hooks) in 2000-2007. The main targeted species for longline fishing are cod, haddock, catfish and tusk.

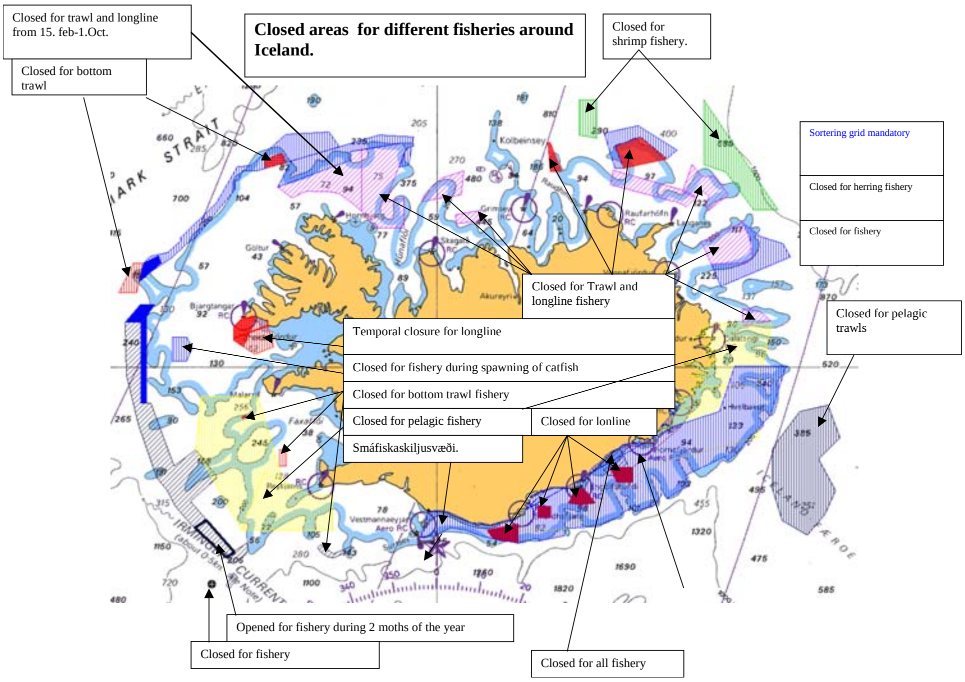


Figure 7.5.1. Overview of closed areas around Iceland. The boxes are of different nature and can be closed for different time period and gear type. NOT UPDATED

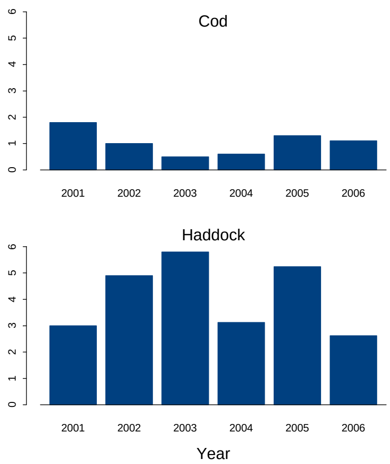


Figure 7.5.2. Estimates of discard percentage by weight, all gears combined for cod and haddock. Source: Ólafur K. Pálsson, Eyþór Björnsson, Guðmundur Jóhannesson, Ari Arason, og Þórhallur Ottesen 2007. Discards in demersal Icelandic fisheries 2006. Marine Research Institute, report series (manuscript for printing). NOT UPDATED

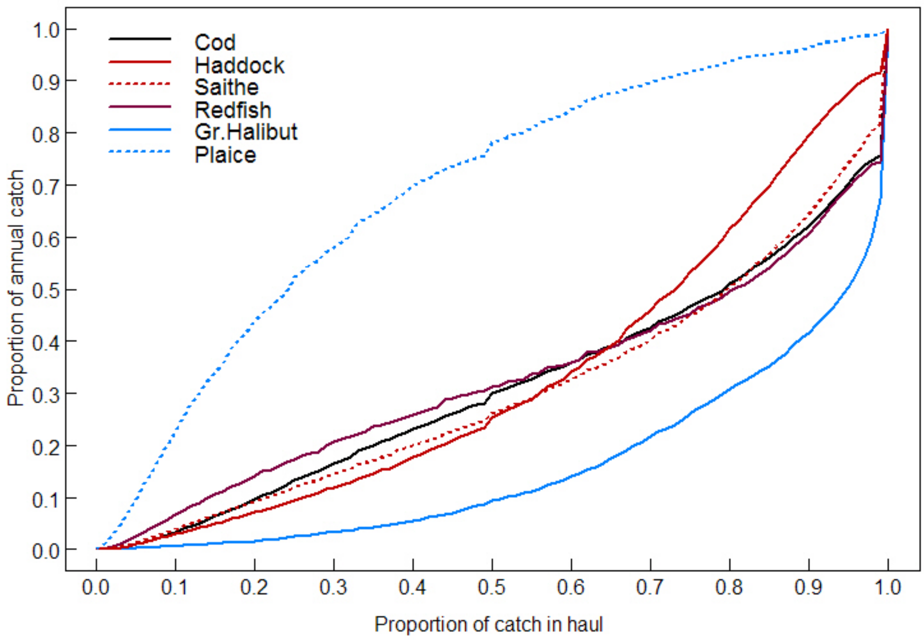


Figure 7.6.1. Cumulative plot for bottom trawl in 2007. An example describes this probably best. Looking at the figure above it can be seen from the dashed lines that 30% of the catch of haddock comes from hauls where haddock is less than 60% of the total catch while only 4% of the catch of greenland 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 10% 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.

8 Saithe in Icelandic waters

The main points in this section are.

- The stock was not assessed by NWWG in 2007. The Assessment method was changed from separable model used in 2006 to ADCAM in the domestic MRI assessment in 2007.
- Reason for the change in method in 2007 was a shift in the fishing pattern which the separable model did not account for. The problem has persisted and therefore the group adopted the ADCAM which can deal with a more flexible fishing pattern.
- Low mean weight at age for most ages, shift in fishing pattern towards younger fish and reduction of survey indices has move resulted in the last assessments being overestimates of the stock.

8.1 Stock description and management units

Saithe in Va have been managed as a single stock, but the possibility of a migration from abroad having an effect on the stock has been considered in the past, with assessments including migration estimating immigration in pre-specified years based on circumstantial evidence. The possibility of emigration from Icelandic waters has not been explicitly accounted for in the assessment.

According to available data approximately 115 thousand saithe were tagged in the NE-Atlantic in the last century, most of them in the Barents Sea with total returns just under 20 thousand (S. T. Jonsson 1996). At Iceland 6 000 saithe were tagged in 1964-65, the recapture rate being 50% (Jones and Jonsson, 1971). Based on recaptures by area approximately 1 in 500 of tagged saithe released outside Icelandic waters were recaptured in Icelandic waters and 1 in 300 released in Icelandic waters were recaptured in distant waters (S. T. Jonsson 1996). For comparison, cod long term average rate of emigration from Icelandic waters is 1 in 2000 tagged fish (J. Jonsson 1996), a rate almost an order of maginitude lower.

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

A tagging program was conducted in Icelandic waters in 2000-2004 from which ~1750 of ~16000 tags released have been returned. The number of returns from areas other than the Icelandic EEZ has now reached 10. Most were tagged at eastern localities. and recaptured in Faroes waters, with a pulse of tags recovered in early 2006 (Figure 1). This coincides with age groups 7+ disapperaring faster from the fishery than projected in 2007 . Other foreign returns have come from areas west of Scotland and east of Greenland. Figure 8.1.1 shows the total returns from this tagging program and

Figure 8.1.2 the returns from the subset of tagging stations from which the eastward migrants originated, after more than 560 days at liberty (the minimum in the returns from the Faroe Islands). In all 10 saithe have been recaptured from Faroe Island or from the Faroe-Iceland Ridge (where 2 have been caught). This is ~2.5% of all recaptures from taggings in the area extending along the south eastern and eastern coast of Iceland to the northeast corner.

8.2 Scientific data

The scientific data used for assessing Icelandic saithe are the same as for most other species in Icelandic waters. The sampling programs i.e log books, surveys, sampling from landings etc. are described in section xx.

8.2.1 Landings

Landings of saithe in Icelandic waters in 2007 are estimated to have been 64,430 tonnes the highest since 1963, see figure 10.2.1 and table 10.2.1 Of the landings 64 005 tonnes are by Iceland but 425 tonnes by other nations.

Domestic landings in the quota year 2006/2007 amounted to 66500, 13500 tonnes short of the 80Kt TAC issued. The domestic advice for the current fishing year ('fish at Fpa=0.3') was 60Kt., but the TAC issued was 75Kt. Putting the stock at increased risk was a part of suite of fisheries management actions intended to ameliorate the effects of the reduction of the cod quota by 1/3 to 130Kt.

The gear used for cathing saithe is mainly bottom trawl (~85% in 2006 and 2007), gillnet, jiggers and Danish seine taking the majority of the rest. The gillnet fleet has in the past taken a considerable part of the total catches especially when large year classes have reached age 5 or 6.

8.2.2 Landings by age

Catch in numbers by age are shown in table 10.2.2. Discards are not included in the total catch in tonnes but partly in the samples used for compiling catch in numbers that are a somewhat variable mixture of harbour and sea samples.

Discarding is not considered to be a problem in the Icelandic saithe fisheries.for which monitoring programmes have been in place (Pálsson 2003). Comparison of sea and harbour samples indicate that discard was small in 2007 (figure 10.2.3) as it has been in most years since 2000. Not including discards with catch in numbers has probably some effects on recruitment estimates as the recruitment in the years with most discards is probably underestimated. It must though be born in mind that length measurments taken at sea have usually been 60-70% of the length measurements used for calculating catch in numbers. Raising of the landings has though not been done and it must also been born in mind that discards might be an index of hidden mortality caused by the fisheries.

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 2007, 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	3914	8	370	20	1900
Jiggers	1733	2	78	11	899
Danish seine	1197	2	100	13	2364
Bottom trawl	54308	125	6198	326	49561
Other gear	2853	-	-	-	-
Foreign landings	425	-	-	-	-
Total	64430	137	6746	370	54724

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 8.2.3.1 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 2003-2005. 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%). The sampling program from the blue whiting catches continued in 2006 for Icelandic vessels within the Icelandic EEZ, but very little saithe have been observed recently (Ólafur K. Pálsson, pers. comm.), so no saithe bycatch estimate has been included in the 2006 or 2007 catch at age.

Compared to predicted landings at age in the 2007 assessment, the numbers at age in landings were considerably lower than predicted for age group 6, the large 2000 year class, but higher for age group 4 (Figure 3.2.3.1). The total number of saithe landed was almost 20% higher than predicted last year.

8.2.3 Surveys

Saithe is among the most difficult demersal fishes to get reliable information on from bottom trawl surveys. In the March survey which has 500-600 stations large proportion of the saithe is caught in relatively few hauls and there seems to be considerable interannual variability in the number of these hauls. This is demonstrated in figures 8.2.6 and 8.2.8 that show saithe abundance in the surveys.

Those large tows lead to large interannual variability in indices from the surveys and estimated CV is also quite high as shown in figure 8.2.8. The figure indicates that from 1995 -2006 the indices in the March survey were relatively stable compared to earlier years but there was a substantial drop between 2006 and 2007. Internal consistency in the surveys measured by the correlation of the indices for the same year class in 2 adjacent surveys is bad with R2 close to 0.3 for the best defined agegroups much much lower for some other.

Small saithe tends to live very close to shore, near piers so survey indices for ages 1 and 2 are nonsurprisingly not good measures of recruitment and the number of those saithe caught in the survey is very low.

8.2.4 Mean Weight and maturity 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 2006 of the 1998-2000 year classes (age groups 6-8) was among the lowest on record (Figure 8.210 and Table 8.2.4). Weight at age in the landings is also used as weight at age in the stock.

Weight at age from the Icelandic ground fish survey (IGFS) show similar trends as catch weight at age (Figures 8.2.10 and 8.2.11, Tables 8.2.4 and 8.2.5). 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.

Instead of using the method of predicting weight at age in the catches and spawning stock from previous weigths and survey weights-at-age (as described in NWWG2006 and earlier) the group used three year averages weigth-at-age for 2008 and in predictions. A comparison of the results of the method used earlier with the simple 3 year averages is shown in Figure 8.2.12, the three year averages . The group rejected the model as it does not pick up reduction in weights-at-age and has.

8.3 Information from the fishing industry

Catch and/or landings in numbers are described in 10.2 and will not be described further here.

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 2007 from all gears combined is shown in Figure 8.2.3, 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 8.3.1. The indices increased sharply from 2000-2004 but have decreased since then, how much varies between indices. The CPUE is though above the level from 1988 to 2000. Indices from the first 3 months of the year are shown in figure 8.3.2 showing increase from 2000 – 2004, drop from 2004 – 2006 but little change from 2006 – 2008.

8.4 Methods

Since 2003 the assessment of Icelandic saithe has been calibrated by age disaggregated indices from the groundfish survey in March in spite of the problems described in section 8.2.3. This started in the period when the survey indices were unusually stable (8.2.4) but there had also been a number of problems with tuning by the commercial fleets. Figures 8.3.1 and 8.3.2 do also show that CPUE of the commercial fleet is nearly as variable as the survey indices and if that is mixed with correlation of age distribution in catch in numbers problems will occur.

Last year this stock was not assessed by the NWWG. In 2006 a run of the separable model ('camera') was the adopted assessment, a 'spaly' of the two previous NWWGs. In the domestic assessment in 2007 the separable model was rejected due to shifts in the age composition of the landings. It was considered unrealistic to assume a fixed selection pattern for the whole assessment period as 'camera' does. Instead the ADCAM model adapted to the Icelandic saithe was adopted as the domestic MRI assessment in 2007. In the 2008 assessment a spaly ADCAM and a 'spaylb' ('same procedure as year before last') camera were run. In addition TSA was run, and XSA and an adapt-type model ('cadapt'), all tuned with IGFS indices at age. In addition to the change in assessment model back home last year a discrepancy in the sumproduct of catch weights- and landings-at-age was discovered for the 1962-1973 period. That part of the series was omitted, and as no revision has taken place, this assessment is based on catch-at-age data 1974-2007, tuned with index-at-age 1-10 from the IGFS 1985-2008.

Assessment in recent years has shown considerable difference between predicted age composition of the catches and that estimated when the fish have been landed. Declining weight-at-age has been observed and maturity is poorly know, and a fixed maturity ogive has been used since 2004

The adopted ADCAM run used this is a SPALY of the domestic assessment in 2007.

AD-CAM

Settings for saithe (Figure 8.6.1)

- Nonparametric fishing mortality. Random walk model of fishing mortality with light weight.
- Catch at age data from 1974 to 2007, survey data 1985 – 2008, age 2-10.
- Ricker SSB-recruitment relationship first recruitment guess. Autocorrelation in residuals modelled.
- Correlation of residuals of age groups in survey estimated.
- CV of residuals in the catch and the survey estimated. The pattern in each set is given but one multiplier estimated.
- Linear relationship for all age groups.
- 5 Migrations estimated (the same as in TSA)

8.5 Reference points

Reference points for Icelandic saithe have been defined.. Blim was defined as Bloss or 100 000 tonnes. . Bpa was set as the low SSB values in 1978 – 1997 or 150 000 tonnes and Fpa as the fishing mortality sustained for 3 decades or 0.3.

The recruitment model used in ADCAM predicts SSB_{max} i.e the spawning stock at which maximum recruitment occurs in the Ricker relationship to be 110 000 tonnes, close to Bloss. This estimate is on the other hand very uncertain, close to nonsense but there are at least not indications that SSB_{max} is very high. The autocorrelation in the residuals is estimated as 0.45 indicating periods with good and bad recruitment.

At the meeting the coherence of Bpa and Fpa were tested by simulating the stock using the observed recruitment pattern since 1974, fishing exactly at Fpa but using different values for weights in the spawning stock, maturity at age and selection pattern. The scenarios tested were.

1. Mean weight, maturity at age and selection pattern mean from 1974 – 2007.
2. Mean weight, maturity at age as in 2008. Selection pattern mean of last 3 years.
3. Mean weight, maturity at age as in 2008. Selection pattern mean from 1974 – 2007.

In scenario 1 probability of SSB going below Bpa was 20%, 80 percent in alternative 2 and 60% in alternative 3. Selecting recruitment randomly from the observed recruitment reduced the risk of going below Bpa , as the autocorrerlation in the recruitment is ignored.

Those results indicate that with current low mean weights Bpa and Fpa are inconsistent. The selection pattern has though changed towards smaller fish in recent years, mostly due to reduction in the gillnet fisheries. This selection leads to increased risk of SSB going below Bpa but other factors like age diversity in the spawning stock are most likely going to increase as the effort towards large saithe decreases.

In summary it seems like the biomass reference points are not in line with fishing mortality reference points because of changes in mean weight at age observed (see section 8.2.4) .

8.6 State of the stock

Th spawning stock in the beginning of 2008 is estimated to be 156, 000 and fishing mortality in 2007 to be 0.33. Year classes 1998-2000 and 2002 is estimated to have been strong but the year classes after 2003 considerably smaller.

The main results of the assessment are shown in figure 8.6.1 and table 8.6.3. Table 8.6.2 shows the number in stock and table 8.6.1 the fishing mortality.

The catch residuals from the assessment are shown in table 8.4.4. In 2007 they show more than predicted of ages 3 to 6 and less of ages 7 to 10. Residuals from the survey are shown in table 8.4.4 and 8.4.6. In 2008 they are positive for ages 3 to 6 but negative for the older age groups i.e the large year classes from 1998-2000. The survey residuals in 2008 and catch residuals in 2007 give the same message, relative lack of older fish compared to younger fish. Residuals are also shown in figures 8.4.1 and 8.4.2.

Figure 8.4.10 shows the selection pattern used in prognosis, CV in the catch, catchability in the survey CV in the survey as function of age. The CV in the survey is quite high, lowest for ages 5 to 7. CV in the catch is estimated to be considerably lower.

8.7 Short term forecast

Results from short term prediction are shown in figure 8.6.1 and table 8.7.2. They indicate that the SSB in 2009 and 2010 will be below 150 000 tons if fished at Bpa fishing mortality in 2009 will have to be reduced to 0.15 if the stock in 2010 is to be above Bpa.

Landings are predicted to decrease in coming years due to the large year classes from 1998-2000 and 2002 disappearing from the fishery. If fished at Fpa the landings in 2003 are predicted to be 50 000 tons but 44 000 tons in 2010.

8.8 Medium term forecasts

No medium term forecasts were done this year.

8.9 Uncertainties in assessment and forecast

The assessment of Icelandic saithe is relatively incertain due to lack of good tuning data. The internal consistency in the survey that is used for the assessment is very low and on top of that quite annual variation in selection pattern are observed. These things are not surprising considering the nature of the species that is partly pelagic, schooling and relatively widely migrating.

Landings in last 2 years have shown more than expected of young fish and less of older fish than expected. Some of it is due changes in selection and some can be due to less than predicted of older age groups or changes in behaviour of the older fish. How much is caused by each of those is on the other hand not known.

All those factors lead to the assessment being relatively incertain and estimated CV in the spawning stock in 2008 is 24 000 tonnes or 15%. This is an underestimate of the real CV due to number in stock and on top of that comes then uncertainity parameters used to calculate SSB.

Estimation of future values of SSB is even more incertain as the recruiting year classes are not well known. The estimated CV of the spawning stock in 2010 is 28% including errors in assessment and weight prognosis, assuming landings at Fpa in 2009. As before this is probably an underestimate of the real Cv.

Figure 8.4.7 shows the retrospective pattern of 3 assessment models indictaing substantial downward revision (23%) of the 2006 spawning stock biomass between the 2006 and 2008 assessment. This downwards revision is mostly caused by the changes in the survey indices seen in figure 8.2.8.

Comparison of the results of different assessment models (figure 8.4.4) shows estimated SSB in 2008 to be between 125 and 175 000 tonnes or 30% difference between the lowest and the highest value.

8.10 Comparison with previous assessment and forecast

Comparison between the assessment this year and last two years is shown in figures 8.4.3 to 8.4.5. The figures shows downwards revision of year classes 1998 but some of the younger year classes are predicted to be stronger than last year.

The estimated SSB in 2008 is estimated to be 15% lower than last year, half due to changed in estimation of numbers, half due to less than predicted weight. Last years assessment was again downwards revision from the 2006 assessment. Looking at figure 8.2.8 substantial reduction in survey indices was observed in 2007 while the 2008 indices are little higher than the 2007 values. The assessment model do not take a change like that occurring from 2006 to 2007 in one step so there is a downward revision of the stock estimate from 2007 – 2008 in spite of some increase in survey indices.

8.11 Management plans and evaluations

None underway

8.12 Management considerations

Nothing submitted

8.13 Ecosystem considerations

Changes in the distribution of the large pelagic stocks (blue whiting, Norwegian spring spawning herring) may affect the propensity of saithe to migrate off shelf and between management units. This is poorly documented but well .known. The evidence from the tagging experiments shows that there is some traffic along the Faroe-Iceland Ridge and also to some extent onto the East Greenland shelf, but to which extent, the larger saithe, some of which went missing in the last 2 assessments (especially the 2000 year class) are out of reach from the fishery is not know. A hypotheses of a decscending right limb on the selection curve for saithe might have some merit, the saithe might thereby show resilience to fishing given that enough saithe 'escape' from the fishery onto the niche where the large pelagic stocks are available.

8.14 Regulations and their effects

Due to the large reductions in the cod quota for the fishing year 2007/2008 there was pressure from the industry to open up areas where the trawler fleet is restricted in its saithe fishing. In light of the fact that the saithe-TAC exeeded the advice by 15 000 tonnes these requests were not met.

8.15 Changes in fishing technology and fishing patterns

The proportion of saithe landings taken in gillnets icreased slightly in recent years (from 5% in 2005 to 6% in 2007) in spite of the fact that in recent years the total effort of gillnetters has gone down around Iceland. This fleet might be able pick up saithe from the large year classes of 2000 and 2002 if they show up again.

8.16 Changes in the environment

Some Narrow fjord tales.

Table 8.2.1. Nominal catch (tonnes) of SAITHE in Division Va by countries, 1997-2006, as officially reported to ICES with working group estimates when data are missing and bycatch estimates are included.

Country	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Faroe Islands	716	997	700	228	128	366	143	214	322	415	392
Germany	-	3	2	1	14	6	56	157	224	33	
Iceland	36,548	30,531	30,583	32,914	31,854	41,687	51,857	62,614	67,283	75,197	64,005*
Norway	-	-	6	1	44	3*	164	1	2	2	3
UK (E/W/NI)	-	-	1	2	23	7	...	105			
UK (Scotland)	-	-	1	-	-	2	...				
United Kingdom							35		312	16	30
Total	37,264	31,531	31,293				52091	63,091	68,143	75,663	64,430*
Bycatch							403	1,700	1,000		
WG estimate				33,146	32,063	42,071	52,494	64,791	69,143		

***Preliminary.**
****WG estimate**

Table 8.2.2. Saithe in division Va. Catch in numbers (thousands) 1962--2006.

	3	4	5	6	7	8	9	10	11	12	13	14
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
2006	1380	10051	2616	5840	4514	1989	667	485	118	112	86	31
2007	1244	6552	8751	2124	2935	1817	964	395	190	43	36	20

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

Table 8.2.3. Saithe in Division Va. IGFS indices of numbers at age 1985-2008 used for tuning in separable model 'camera', TSA, ADCAM (and ADAPT and XSA).

	1	2	3	4	5	6	7	8	9	10
1985	0.05	0.61	0.58	3.06	5.18	1.73	1.03	0.47	1.32	0.13
1986	0.02	2.33	2.44	2.10	2.10	1.41	0.60	0.26	0.16	0.29
1987	0.10	0.39	11.54	12.94	6.31	3.71	2.89	0.74	0.34	0.24
1988	0.69	0.31	0.48	2.69	2.72	1.62	0.88	0.35	0.06	0.06
1989	0.20	1.43	3.96	4.98	6.46	2.42	1.74	0.89	0.39	0.00
1990	0.01	0.35	1.69	4.83	6.20	11.95	3.17	1.13	0.57	0.10
1991	0.01	0.22	1.40	1.69	2.15	1.08	2.38	0.28	0.02	0.02
1992	0.01	0.14	0.89	5.68	5.45	2.76	2.62	1.86	0.26	0.05
1993	0.00	1.27	11.04	2.00	6.79	2.40	2.24	1.02	4.00	0.64
1994	0.04	0.82	0.73	1.89	1.73	1.94	0.52	0.83	1.00	3.59
1995	0.06	0.48	1.97	1.09	0.50	0.28	0.33	0.09	0.14	0.15
1996	0.03	0.13	0.51	3.71	1.11	0.99	0.57	0.94	0.05	0.09
1997	0.23	0.32	0.90	4.66	3.90	0.94	0.39	0.15	0.10	0.05
1998	0.01	0.11	1.64	2.30	2.50	1.23	0.69	0.29	0.08	0.07
1999	0.57	0.75	3.70	0.92	1.23	1.64	0.56	0.16	0.02	0.02
2000	0.00	0.38	2.01	2.51	0.60	0.84	0.52	0.44	0.07	0.03
2001	0.00	0.89	1.90	2.60	1.58	0.20	0.22	0.38	0.13	0.07
2002	0.02	1.05	2.22	2.93	3.04	2.14	0.41	0.46	0.31	0.22
2003	0.01	0.05	9.60	4.99	2.90	1.34	0.75	0.20	0.05	0.10
2004	0.01	0.91	1.38	8.98	5.80	4.19	1.44	0.80	0.17	0.16
2005	0.00	0.23	4.32	2.32	6.85	4.27	2.17	0.85	0.43	0.12
2006	0.01	0.00	2.18	6.62	1.92	8.58	3.37	1.16	0.28	0.25
2007	0.00	0.05	0.30	1.70	3.07	0.74	1.47	0.64	0.27	0.15
2008	0.01	0.08	2.25	1.77	2.73	3.73	0.55	0.70	0.31	0.14

Table 8.2.4. Saithe in Division Va. Mean weight at age in the catches and in the spawning stock 1974-2007 with predicted weights for 2008-2010 (as the average of 2005-2007).

	3	4	5	6	7	8	9	10	11	12	13	14
1974	1120	1760	2730	4290	5540	7270	8420	9410	10000	10560	11870	13120
1975	1120	1760	2730	4290	5540	7270	8420	9410	10000	10560	11870	13120
1976	1120	1760	2730	4290	5540	7270	8420	9410	10000	10560	11870	13120
1977	1120	1760	2730	4290	5540	7270	8420	9410	10000	10560	11870	13120
1978	1120	1760	2730	4290	5540	7270	8420	9410	10000	10560	11870	13120
1979	1116	1760	2731	4294	5539	7268	8415	9410	10001	10563	11873	13115
1980	1428	1983	2667	3689	5409	6321	7213	8565	9147	9617	10066	11041
1981	1585	2037	2696	3525	4541	6247	6991	8202	9537	9089	9351	10225
1982	1547	2194	3015	3183	5114	6202	7256	7922	8924	10134	9447	10535
1983	1530	2221	3171	4270	4107	5984	7565	8673	8801	9039	11138	9818
1984	1653	2432	3330	4681	5466	4973	7407	8179	8770	8831	11010	11127
1985	1609	2172	3169	3922	4697	6411	6492	8346	9401	10335	11027	10644
1986	1450	2190	2959	4402	5488	6406	7570	6487	9616	10462	11747	11902
1987	1516	1715	2670	3839	5081	6185	7330	8025	7974	9615	12246	11656
1988	1261	2017	2513	3476	4719	5932	7523	8439	8748	9559	10824	14099
1989	1403	2021	2194	3047	4505	5889	7172	8852	10170	10392	12522	11923
1990	1647	1983	2566	3021	4077	5744	7038	7564	8854	10645	11674	11431
1991	1224	1939	2432	3160	3634	4967	6629	7704	9061	9117	10922	11342
1992	1269	1909	2578	3288	4150	4865	6168	7926	8349	9029	11574	9466
1993	1381	2143	2742	3636	4398	5421	5319	7006	8070	10048	9106	11591
1994	1444	1836	2649	3512	4906	5539	6818	6374	8341	9770	10528	11257
1995	1370	1977	2769	3722	4621	5854	6416	7356	6815	8312	9119	11910
1996	1229	1755	2670	3802	4902	5681	7182	7734	9256	8322	10501	11894
1997	1325	1936	2409	3906	5032	6171	7202	7883	8856	9649	9621	10877
1998	1347	1972	2943	3419	4850	5962	6933	7781	8695	9564	10164	10379
1999	1279	2106	2752	3497	3831	5819	7072	8078	8865	10550	10823	11300
2000	1367	1929	2751	3274	4171	4447	6790	8216	9369	9817	10932	12204
2001	1280	1882	2599	3697	4420	5538	5639	7985	9059	9942	10632	10988
2002	1308	1946	2569	3266	4872	5365	6830	7067	9240	9659	10088	11632
2003	1310	1908	2545	3336	4069	5792	7156	8131	8051	10186	10948	11780
2004	1467	1847	2181	2918	4017	5135	7125	7732	8420	8927	10420	10622
2005	1287	1888	2307	2619	3516	5080	6060	8052	8292	8342	8567	10256
2006	1164	1722	2369	2808	3235	4361	6007	7166	8459	9324	9902	9636
2007	1140	1578	2122	2719	3495	4114	5402	6995	7792	9331	9970	10738
2008	1197	1729	2266	2715	3415	4518	5823	7404	8181	8999	9480	10210
2009	1197	1729	2266	2715	3415	4518	5823	7404	8181	8999	9480	10210
2010	1197	1729	2266	2715	3415	4518	5823	7404	8181	8999	9480	10210

Predicted for 2008-2010

Table 8.4.5. Saithe in Division Va. Mean weight at age 3-8 in the IGFS 1985-2008.

	3	4	5	6	7	8
1985	973	1690	2147	3100	3992	4984
1986	848	1421	2269	3291	4663	5811
1987	875	1168	1719	3394	4204	5919
1988	784	1443	2008	2770	4261	5133
1989	646	1414	1796	2806	3664	5010
1990	746	1267	2142	2609	4367	5872
1991	797	1370	1876	2652	2920	4571
1992	890	1400	2017	2966	3771	4213
1993	768	1476	2071	2933	3726	4790
1994	853	1607	2771	3387	4721	6200
1995	741	1221	2330	3640	4269	6084
1996	899	1326	1970	2737	5248	5088
1997	740	1303	1781	2732	4227	5745
1998	841	1155	1800	2530	3931	5371
1999	774	1466	2132	2872	3545	5515
2000	821	1352	2227	2712	3612	3869
2001	767	1517	2124	3391	4220	5123
2002	739	1265	2196	3366	4587	5377
2003	602	1182	1888	2678	3674	5298
2004	844	1257	1882	2812	4240	5645
2005	674	1406	1881	2421	3602	5559
2006	638	1165	2052	2557	3136	4103
2007	613	1190	1784	2505	3281	3624
2008	679	1232	1813	2311	3524	4448

Table 8.2.6. Saithe in Division Va. Sexual maturity at age , fixed ogive for 1974-1979, smoothed maturity at age for 1980-2003, fixed ogive for 2004-2010 at predicted values for 2004. The maturity model is based on samples from landings, in recent year insufficient to update model.

	3	4	5	6	7	8	9	10	11	12	13	14
1974	0.00	0.06	0.27	0.63	0.81	0.97	1.00	1.00	1.00	1.00	1.00	1.00
1975	0.00	0.06	0.27	0.63	0.81	0.97	1.00	1.00	1.00	1.00	1.00	1.00
1976	0.00	0.06	0.27	0.63	0.81	0.97	1.00	1.00	1.00	1.00	1.00	1.00
1977	0.00	0.06	0.27	0.63	0.81	0.97	1.00	1.00	1.00	1.00	1.00	1.00
1978	0.00	0.06	0.27	0.63	0.81	0.97	1.00	1.00	1.00	1.00	1.00	1.00
1979	0.00	0.06	0.27	0.63	0.81	0.97	1.00	1.00	1.00	1.00	1.00	1.00
1980	0.15	0.24	0.39	0.65	0.78	0.89	0.95	1.00	1.00	1.00	1.00	1.00
1981	0.16	0.27	0.40	0.58	0.80	0.89	0.95	1.00	1.00	1.00	1.00	1.00
1982	0.16	0.29	0.45	0.59	0.74	0.90	0.94	1.00	1.00	1.00	1.00	1.00
1983	0.14	0.31	0.51	0.64	0.74	0.85	0.96	1.00	1.00	1.00	1.00	1.00
1984	0.11	0.26	0.49	0.69	0.80	0.86	0.92	1.00	1.00	1.00	1.00	1.00
1985	0.14	0.20	0.43	0.68	0.83	0.90	0.93	1.00	1.00	1.00	1.00	1.00
1986	0.08	0.26	0.36	0.63	0.82	0.91	0.95	1.00	1.00	1.00	1.00	1.00
1987	0.04	0.15	0.43	0.55	0.78	0.91	0.96	1.00	1.00	1.00	1.00	1.00
1988	0.10	0.09	0.28	0.62	0.72	0.89	0.96	1.00	1.00	1.00	1.00	1.00
1989	0.14	0.20	0.17	0.46	0.78	0.85	0.94	1.00	1.00	1.00	1.00	1.00
1990	0.17	0.27	0.35	0.31	0.65	0.89	0.93	1.00	1.00	1.00	1.00	1.00
1991	0.14	0.31	0.44	0.54	0.50	0.80	0.94	1.00	1.00	1.00	1.00	1.00
1992	0.19	0.27	0.50	0.63	0.72	0.68	0.90	1.00	1.00	1.00	1.00	1.00
1993	0.18	0.34	0.44	0.68	0.79	0.85	0.82	1.00	1.00	1.00	1.00	1.00
1994	0.19	0.33	0.53	0.63	0.82	0.89	0.92	1.00	1.00	1.00	1.00	1.00
1995	0.14	0.33	0.51	0.71	0.79	0.91	0.95	1.00	1.00	1.00	1.00	1.00
1996	0.16	0.27	0.52	0.70	0.84	0.89	0.96	1.00	1.00	1.00	1.00	1.00
1997	0.19	0.30	0.44	0.70	0.83	0.92	0.95	1.00	1.00	1.00	1.00	1.00
1998	0.22	0.34	0.48	0.63	0.84	0.92	0.96	1.00	1.00	1.00	1.00	1.00
1999	0.16	0.38	0.52	0.66	0.79	0.92	0.96	1.00	1.00	1.00	1.00	1.00
2000	0.15	0.29	0.57	0.71	0.81	0.89	0.96	1.00	1.00	1.00	1.00	1.00
2001	0.13	0.27	0.47	0.74	0.84	0.90	0.95	1.00	1.00	1.00	1.00	1.00
2002	0.11	0.24	0.45	0.66	0.86	0.92	0.95	1.00	1.00	1.00	1.00	1.00
2003	0.04	0.20	0.41	0.64	0.81	0.93	0.96	1.00	1.00	1.00	1.00	1.00
2004	0.08	0.22	0.43	0.65	0.84	0.93	0.96	1.00	1.00	1.00	1.00	1.00
2005	0.08	0.22	0.43	0.65	0.84	0.93	0.96	1.00	1.00	1.00	1.00	1.00
2006	0.08	0.22	0.43	0.65	0.84	0.93	0.96	1.00	1.00	1.00	1.00	1.00
2007	0.08	0.22	0.43	0.65	0.84	0.93	0.96	1.00	1.00	1.00	1.00	1.00
2008	0.08	0.22	0.43	0.65	0.84	0.93	0.96	1.00	1.00	1.00	1.00	1.00
2009	0.08	0.22	0.43	0.65	0.84	0.93	0.96	1.00	1.00	1.00	1.00	1.00
2010	0.08	0.22	0.43	0.65	0.84	0.93	0.96	1.00	1.00	1.00	1.00	1.00

Table 8.4.1. Saithe in Division Va. Output from TSA run tuned with IGFS index for age groups 2-6.

Icelandic saithe
Estimated with catch-at-age 4-11 years 1985-2007,
Bottom trawl survey, spring, 2-6 years, 1985-2008

Stock (million fish)

	biom.	2	3	4	5	6	7	8	9	10	11
1985	292.	51.1	25.2	44.7	21.4	9.03	5.80	4.04	3.58	1.50	0.24
1986	301.	59.8	51.9	25.7	31.2	13.32	5.83	3.42	2.10	2.52	0.77
1987	324.	37.0	60.9	53.5	21.9	19.07	8.73	3.69	1.75	1.22	1.33
1988	375.	25.8	37.7	61.0	40.2	13.93	9.84	4.80	1.99	0.82	0.65
1989	371.	19.0	25.7	39.8	48.7	29.15	7.02	5.75	2.40	0.91	0.44
1990	360.	21.9	18.7	25.5	30.2	34.06	16.95	4.45	3.06	1.16	0.46
1991	315.	11.9	21.9	18.4	19.9	20.24	25.93	8.19	2.15	1.60	0.56
1992	262.	17.2	11.6	22.0	15.0	12.89	10.93	11.43	3.83	1.04	0.73
1993	223.	14.4	17.2	11.4	15.6	8.19	6.51	5.82	9.05	1.94	0.51
1994	183.	20.2	14.1	16.6	8.5	10.23	4.40	3.27	2.90	4.27	0.94
1995	153.	18.9	19.9	14.1	10.8	5.38	6.26	2.30	1.55	1.35	1.93
1996	135.	13.8	18.8	19.6	9.6	6.44	2.80	3.14	1.03	0.73	0.63
1997	139.	8.1	13.6	19.0	13.1	6.26	3.74	1.69	1.42	0.48	0.35
1998	133.	21.1	7.7	13.5	12.5	7.51	3.85	1.99	0.91	0.69	0.26
1999	126.	24.1	21.3	7.3	9.4	9.15	6.75	2.14	1.05	0.46	0.33
2000	138.	37.6	24.1	21.4	5.0	6.41	5.67	5.45	1.12	0.57	0.23
2001	156.	42.7	38.2	24.1	15.3	3.04	4.07	3.30	2.69	0.62	0.31
2002	206.	47.9	43.3	39.3	16.6	11.48	1.86	2.65	1.90	1.35	0.35
2003	257.	16.0	48.6	44.4	31.4	9.97	6.82	1.07	1.50	1.05	0.75
2004	284.	46.7	16.1	48.1	34.3	20.92	5.80	3.78	0.68	0.84	0.60
2005	244.	24.7	47.6	16.2	30.9	23.69	11.97	3.41	2.20	0.41	0.48
2006	255.	11.3	24.8	48.3	10.3	19.08	13.41	6.26	2.01	1.24	0.24
2007	214.	23.6	11.2	24.7	30.2	6.74	9.92	6.52	3.28	1.14	0.66
2008	166.	17.1	23.8	11.3	14.4	17.12	3.66	5.39	3.54	1.78	0.61

Kalman filter estimation of standard deviation of biomass and log-stock

2007	27.	0.412	0.276	0.186	0.153	0.150	0.146	0.154	0.173	0.197	0.223
2008	29.	0.501	0.416	0.274	0.260	0.231	0.240	0.230	0.235	0.254	0.275

Adjusted for errors in parameter estimates

(32)	0.516	0.419	0.305	0.289	0.261	0.259	0.242	0.257	0.280	0.300

Migration

(million fish, standard deviation in parentheses)

7 years	1991	6200	(4000)
9 years	1993	4000	(1400)
7 years	1999	2000	(1000)
8 years	2000	1300	(800)

Fishing mortality rates

	F 4-9	4	5	6	7	8	9	10	11
1985	0.285	0.100	0.187	0.279	0.355	0.402	0.386	0.412	0.407
1986	0.280	0.063	0.157	0.262	0.360	0.423	0.417	0.443	0.424
1987	0.355	0.111	0.243	0.370	0.449	0.477	0.480	0.477	0.476
1988	0.337	0.096	0.201	0.334	0.411	0.479	0.499	0.476	0.488
1989	0.329	0.127	0.210	0.313	0.377	0.462	0.487	0.479	0.487
1990	0.370	0.075	0.219	0.390	0.498	0.528	0.507	0.510	0.511
1991	0.400	0.054	0.221	0.450	0.578	0.563	0.536	0.546	0.536
1992	0.415	0.157	0.314	0.448	0.511	0.532	0.525	0.530	0.527
1993	0.376	0.112	0.228	0.365	0.474	0.533	0.546	0.545	0.545
1994	0.387	0.212	0.262	0.336	0.431	0.521	0.562	0.563	0.559
1995	0.422	0.156	0.306	0.446	0.524	0.553	0.546	0.547	0.543
1996	0.362	0.158	0.240	0.334	0.414	0.505	0.518	0.519	0.517
1997	0.361	0.186	0.264	0.342	0.418	0.470	0.485	0.479	0.485
1998	0.302	0.112	0.175	0.262	0.363	0.433	0.469	0.467	0.467
1999	0.309	0.117	0.203	0.300	0.377	0.423	0.434	0.437	0.432
2000	0.309	0.130	0.218	0.302	0.370	0.417	0.416	0.419	0.417
2001	0.271	0.128	0.175	0.243	0.309	0.371	0.398	0.394	0.394
2002	0.306	0.124	0.231	0.327	0.372	0.392	0.389	0.382	0.387
2003	0.299	0.115	0.232	0.324	0.377	0.371	0.376	0.373	0.372
2004	0.315	0.196	0.262	0.324	0.355	0.372	0.380	0.377	0.378
2005	0.348	0.232	0.306	0.371	0.394	0.393	0.395	0.393	0.396
2006	0.378	0.256	0.333	0.402	0.432	0.424	0.421	0.425	0.425
2007	0.393	0.336	0.378	0.411	0.411	0.409	0.412	0.416	0.412

Kalman filter estimates of standard deviation of F 4-9 and logF

2006	0.044	0.149	0.131	0.131	0.132	0.141	0.149	0.149	0.150
2007	0.055	0.207	0.173	0.175	0.164	0.163	0.169	0.170	0.170

Standardized residuals

Catch-at-age

	4	5	6	7	8	9	10	11
1987	1.61	2.43	0.55	1.10	1.61	0.51	1.72	0.61
1988	-0.05	0.17	-0.03	-1.26	0.64	1.49	-1.57	0.86
1989	1.96	1.71	0.96	-1.98	0.15	-0.32	-1.46	0.92
1990	-1.47	0.99	2.07	1.62	2.64	0.74	-0.50	-0.26
1991	-1.71	0.69	1.42	1.08	0.15	0.37	1.87	0.22
1992	0.80	2.04	0.82	-0.06	-1.11	-0.93	-0.62	-1.47
1993	-0.95	-0.92	-1.60	-0.87	0.66	0.53	1.15	0.84
1994	0.17	0.56	-1.13	-1.93	-1.14	0.24	0.45	0.61
1995	0.33	0.16	0.37	0.29	-0.51	-1.19	-1.14	-2.00
1996	-0.35	-1.06	-1.13	-1.00	0.26	-0.70	-0.48	-0.69
1997	0.77	-1.08	-0.42	-0.08	0.99	-1.28	-1.78	-1.11
1998	-0.67	-2.58	-2.52	-0.38	-0.16	1.15	0.43	1.46
1999	-1.77	-0.82	0.01	-0.30	-0.51	-0.61	-0.72	-1.89
2000	0.69	-1.13	-0.67	-0.29	0.13	-0.54	-0.05	-0.98
2001	0.51	-1.16	-2.09	-1.12	-0.51	-0.83	0.15	0.18
2002	1.36	-0.20	0.97	-0.01	1.13	0.43	-1.53	0.24
2003	0.92	1.69	-0.48	-0.45	-0.76	0.23	0.04	-0.05
2004	0.23	1.37	0.58	-0.20	-0.04	1.75	0.27	0.29
2005	0.96	-0.29	0.89	0.20	0.47	0.79	1.04	0.85
2006	1.21	-0.14	0.06	0.17	-0.24	1.23	1.69	2.34
2007	0.60	0.82	0.59	-1.25	-2.00	-0.91	0.63	-0.42
2008	0.04	0.04	0.02	0.02	-0.01	-0.01	-0.02	-0.02

RA,RT,RS 0.46 0.12 0.10 1st order correlation with age, time and cohort

V3,V4 0.15 -1.17 tests for normality with 3rd and 4th moments

STANDARDISED SURVEY RESIDUALS

	2	3	4	5	6
1987	0.23	1.54	2.06	1.72	0.15
1988	0.06	-1.31	-1.55	-1.31	-0.56
1989	1.16	0.67	1.67	0.66	-0.58
1990	0.15	-0.32	0.34	1.25	2.05
1991	-0.18	-0.35	-1.00	-0.33	-1.56
1992	-0.51	-0.70	1.11	1.69	0.38
1993	1.08	1.93	-0.34	1.34	0.52
1994	0.76	-1.08	-1.31	0.21	-0.18
1995	0.38	-0.26	-1.01	-2.61	-2.11
1996	-0.56	-1.42	0.07	-0.96	-0.23
1997	0.09	-0.71	1.19	0.44	-0.08
1998	-0.68	-0.22	-0.05	-0.33	-0.28
1999	0.70	0.90	-1.97	-0.82	0.24
2000	0.21	0.00	-0.20	-1.41	-0.58
2001	0.82	-0.01	-0.33	-1.19	-1.82
2002	0.94	-0.01	0.05	-0.15	0.51
2003	-1.25	1.45	0.66	-0.16	-0.33
2004	0.84	0.21	0.34	0.77	0.78
2005	-0.15	0.69	0.44	0.23	0.54
2006	-1.91	0.27	0.57	-0.05	1.58
2007	-1.25	-1.37	-1.20	-0.69	-0.52
2008	-0.91	0.41	0.52	0.39	0.66

RA,RT,RS 0.58 -0.13 0.00 1st order correlation with age, time and cohort
V3,V4 -0.54 -0.42 tests for normality with 3rd and 4th moments

Table 8.4.2. Saithe in Division Va. Summary table utput from XSA run on 1962-2008 data with default iSaithe setttings tuned to March IGFS 1995-2008 indices for age groups 2-8, shifted by one age group to the end of the year prior to each survey. Included to document the discrepancy between landings and the sum-product of weight- and catch-at-age in 1962-1973.

Run title : Ufsi - Saithe in Va ,

At 22/04/2008 6:16

Table 17 Summary (with SOP correction)

,	RECRUITS, Age 1	TOTALBIO,	TOTSPBIO,	LANDINGS,	YIELD/SSB,	SOPCOFAC,	FBAR 4- 9,
1962,	82928,	249388,	124036,	50514,	.4073,	.9232,	.2846,
1963,	141554,	275355,	113622,	48011,	.4226,	.8381,	.3015,
1964,	105726,	358763,	130274,	60257,	.4625,	.9508,	.2486,
1965,	102806,	445057,	156256,	60177,	.3851,	.9554,	.2312,
1966,	90101,	531991,	203668,	52003,	.2553,	.9679,	.1782,
1967,	133908,	548324,	233338,	75712,	.3245,	.8466,	.2370,
1968,	100979,	580455,	285995,	77549,	.2712,	.8300,	.2093,
1969,	78044,	616247,	318683,	115853,	.3635,	.8016,	.2935,
1970,	40541,	573646,	301672,	116601,	.3865,	.7528,	.3214,
1971,	39439,	519926,	274681,	136764,	.4979,	.7173,	.4422,
1972,	37811,	466128,	256768,	111301,	.4335,	.7600,	.3582,
1973,	38991,	435564,	263624,	110888,	.4206,	.8252,	.3395,
1974,	46878,	454727,	301769,	97568,	.3233,	1.0214,	.2807,
1975,	32622,	401431,	274581,	87954,	.3203,	1.0094,	.2698,
1976,	74392,	348974,	230831,	82003,	.3553,	.9735,	.3144,
1977,	83066,	305072,	191887,	62026,	.3232,	.9876,	.2697,
1978,	42202,	310975,	169730,	49672,	.2927,	.9839,	.2315,
1979,	29216,	346506,	165259,	63504,	.3843,	.9840,	.2433,
1980,	33219,	358429,	152588,	58347,	.3824,	1.0119,	.3086,
1981,	49180,	342283,	163966,	58986,	.3597,	1.0250,	.3102,
1982,	71754,	322433,	173985,	68615,	.3944,	1.0110,	.3884,
1983,	53823,	319814,	167587,	58266,	.3477,	1.0312,	.3396,
1984,	111458,	368501,	163971,	62719,	.3825,	1.0383,	.3118,
1985,	163992,	368104,	146978,	57102,	.3885,	1.0628,	.2508,
1986,	84455,	416333,	156809,	64868,	.4137,	.9944,	.2692,
1987,	47055,	508314,	164510,	80531,	.4895,	1.0037,	.3725,
1988,	32229,	522589,	173456,	77247,	.4453,	1.0000,	.3478,
1989,	41441,	487142,	205715,	82425,	.4007,	1.0010,	.2817,
1990,	22409,	464414,	249565,	98127,	.3932,	1.0060,	.3179,
1991,	30511,	382110,	233375,	102316,	.4384,	1.0011,	.3586,
1992,	26620,	312106,	200011,	79597,	.3980,	1.0004,	.3709,
1993,	44715,	265603,	164573,	71648,	.4354,	1.0015,	.3938,
1994,	37721,	220527,	130611,	64339,	.4926,	1.0123,	.4050,
1995,	26223,	197398,	94713,	48629,	.5134,	1.0069,	.4389,
1996,	12936,	185409,	83182,	40101,	.4821,	1.0190,	.3801,
1997,	43439,	180581,	77782,	37264,	.4791,	1.0162,	.3623,
1998,	49278,	168533,	82177,	31531,	.3837,	1.0285,	.3202,
1999,	80793,	170821,	80172,	31293,	.3903,	1.0128,	.3114,
2000,	94777,	187539,	75852,	33146,	.4370,	1.0121,	.3366,
2001,	107481,	235318,	76878,	32063,	.4171,	1.0156,	.2914,
2002,	31852,	303635,	88541,	42071,	.4752,	1.0024,	.3011,
2003,	101839,	375945,	109184,	52494,	.4808,	1.0036,	.2750,
2004,	42331,	351245,	131619,	64791,	.4923,	1.0019,	.2803,
2005,	14517,	367968,	151413,	69143,	.4567,	1.0013,	.3095,
2006,	21610,	332670,	157812,	75663,	.4794,	1.0027,	.3226,
2007,	10757,	263769,	148080,	64430,	.4351,	1.0026,	.3496,
Arith. Mean ,	60644,	364088,	173952,	68828,	.4068		.3122,
0 Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),			

1

Table 8.4.3. Saithe in Division Va. Log catch residuals from SPAYBL ('same procedure as year before last') 'camera' run.

	3	4	5	6	7	8	9	10	11	12	13	14
1985	-0.70	0.16	-0.08	-0.15	0.09	-0.11	-0.50	0.47	0.11	-0.59	0.28	-0.06
1986	0.70	-0.66	-0.08	-0.28	-0.11	0.17	-0.13	0.83	0.27	0.34	0.28	-0.76
1987	-1.12	-0.21	0.09	0.10	-0.02	0.05	0.14	0.12	0.19	-0.55	0.19	1.24
1988	0.06	-0.49	0.01	0.20	0.01	0.16	0.46	-0.05	0.40	-0.46	-0.54	-2.22
1989	-0.82	0.03	-0.19	0.20	-0.19	0.06	0.07	-0.03	0.43	0.36	-0.16	-0.77
1990	-1.26	-0.50	-0.09	-0.06	0.23	0.14	0.00	-0.22	-0.10	-0.30	0.30	-0.36
1991	-1.50	-0.87	-0.15	0.06	0.18	-0.11	-0.10	0.25	-0.22	-0.92	-2.00	-1.92
1992	-0.48	0.06	0.50	0.27	-0.02	-0.17	-0.19	-0.16	-0.36	-0.79	0.22	-0.25
1993	0.21	-0.32	-0.28	-0.01	-0.11	-0.12	0.35	-0.01	0.01	0.22	0.20	-0.66
1994	0.23	0.35	-0.15	-0.35	-0.21	-0.27	-0.08	0.39	0.04	0.31	0.87	0.86
1995	0.47	0.01	0.09	0.07	0.04	0.01	-0.18	-0.18	-0.10	-0.56	-0.33	-0.95
1996	0.39	-0.15	-0.07	-0.13	-0.17	0.07	0.05	-0.05	-0.12	-0.01	0.62	1.31
1997	0.23	0.23	-0.22	0.02	0.01	0.12	-0.10	-0.24	-0.25	0.10	-0.28	0.27
1998	-0.04	-0.03	-0.31	-0.49	0.18	0.12	0.48	0.27	0.62	0.49	0.71	0.72
1999	0.42	0.07	-0.12	-0.06	0.01	0.07	0.01	0.16	-0.44	-0.35	0.03	-0.04
2000	0.14	-0.02	-0.05	-0.16	-0.12	0.31	-0.05	-0.05	-0.17	-0.65	-0.17	-0.79
2001	0.14	0.17	-0.22	-0.25	-0.13	-0.07	0.31	0.15	0.13	-0.09	-0.03	0.35
2002	-0.13	0.04	0.01	0.07	-0.16	0.04	-0.03	-0.13	0.08	-0.57	-0.17	-0.42
2003	0.34	-0.08	0.15	-0.16	-0.04	-0.32	0.05	-0.07	0.06	-0.56	0.14	0.47
2004	0.51	0.22	0.08	0.02	-0.38	-0.28	-0.05	-0.04	-0.10	-0.34	0.35	-0.25
2005	0.37	0.41	-0.11	0.11	-0.05	-0.37	-0.09	0.06	0.23	0.01	-0.14	-0.15
2006	0.25	0.39	-0.07	-0.30	-0.01	-0.19	-0.10	0.29	0.71	0.60	0.63	0.13
2007	1.14	0.65	0.12	-0.06	-0.49	-0.27	-0.05	0.24	0.21	0.57	0.33	0.04

Table 8.4.4. Saithe in Division Va. Log catch residuals from adopted ADCAM run.

	3	4	5	6	7	8	9	10	11	12	13	14
1974	0.13	0.00	-0.03	-0.03	-0.03	0.02	0.06	0.04	0.07	-0.08	-0.18	0.00
1975	-0.01	-0.01	0.01	-0.07	0.02	0.00	-0.08	-0.05	-0.05	0.05	-0.02	0.49
1976	0.02	0.02	0.01	0.12	0.06	-0.01	-0.03	0.04	-0.12	0.00	-0.03	0.39
1977	-0.36	-0.02	0.01	0.00	-0.08	-0.09	0.14	0.00	0.08	-0.12	-0.30	-1.21
1978	0.07	-0.02	-0.03	-0.11	0.03	0.10	-0.10	-0.26	-0.04	-0.01	0.25	0.49
1979	-0.01	-0.02	-0.02	0.01	-0.02	-0.13	-0.17	0.32	0.30	0.43	0.08	0.29
1980	-0.01	-0.01	0.04	0.02	0.00	0.10	-0.01	-0.01	-0.10	-0.52	-0.56	-0.61
1981	-0.05	-0.01	-0.05	0.02	-0.05	-0.07	0.02	-0.02	-0.31	0.43	0.20	0.54
1982	0.15	-0.01	0.06	-0.03	0.02	0.03	0.17	0.03	-0.27	-0.31	-0.11	-0.23
1983	-0.14	0.08	-0.02	-0.01	0.03	-0.02	-0.01	-0.34	-0.95	-1.27	-2.78	-1.98
1984	-0.63	-0.17	-0.14	-0.04	-0.07	0.08	-0.01	0.23	0.51	0.81	1.31	2.11
1985	0.02	0.13	0.08	0.00	-0.01	-0.15	-0.20	-0.10	-0.38	-0.95	0.27	1.10
1986	0.13	-0.06	0.00	-0.08	-0.04	0.01	-0.06	0.15	0.02	0.25	-0.52	-0.45
1987	-0.12	0.01	0.02	0.07	0.02	0.03	0.09	0.12	-0.06	-0.12	-0.05	0.59
1988	0.09	-0.03	-0.01	-0.02	0.01	0.00	0.16	-0.19	0.21	-0.33	-0.50	-2.63
1989	-0.03	0.05	-0.01	0.03	-0.13	-0.05	-0.07	-0.08	0.16	0.61	-0.15	-0.84
1990	-0.05	-0.02	0.02	-0.05	0.08	0.02	-0.02	-0.12	-0.07	0.05	0.68	-0.41
1991	-0.07	-0.06	-0.06	0.06	0.00	0.06	-0.01	0.26	0.05	-0.33	-1.54	-1.43
1992	0.01	0.06	0.06	0.04	0.01	-0.07	-0.08	-0.23	-0.25	-0.40	0.30	-0.22
1993	0.01	-0.04	-0.08	-0.03	-0.03	0.06	0.04	0.05	0.05	0.31	0.17	-0.65
1994	-0.01	-0.01	0.01	-0.10	-0.05	-0.06	0.08	0.08	0.24	0.38	0.61	0.74
1995	0.03	0.00	0.03	0.09	0.06	0.03	-0.06	-0.06	-0.19	-0.26	-0.55	-1.05
1996	0.00	-0.04	0.00	-0.03	-0.06	0.01	0.03	-0.01	0.02	-0.18	0.38	0.82
1997	0.02	0.04	0.00	0.08	0.02	0.00	-0.10	-0.23	-0.19	0.14	-0.69	0.06
1998	-0.07	-0.02	-0.05	-0.12	-0.01	-0.03	0.14	0.10	0.43	0.33	0.41	-0.07
1999	0.03	0.00	0.02	0.03	0.04	-0.02	-0.05	0.01	-0.34	-0.26	-0.10	-0.26
2000	0.00	-0.02	0.03	0.02	-0.01	0.08	-0.03	0.03	-0.09	-0.28	-0.14	-0.83
2001	0.01	0.01	-0.04	-0.08	-0.02	-0.07	0.05	0.10	0.12	0.07	-0.04	0.21
2002	-0.04	0.00	-0.01	0.05	0.00	0.09	-0.01	-0.13	0.11	-0.18	-0.20	-0.32
2003	0.00	-0.02	0.04	-0.06	0.03	-0.10	0.01	0.00	-0.05	-0.27	0.15	0.45
2004	0.02	-0.02	0.02	0.03	-0.07	0.00	0.01	-0.02	-0.06	-0.18	0.34	-0.08
2005	-0.01	0.01	-0.04	0.05	0.03	-0.04	-0.03	-0.03	0.06	0.04	-0.31	-0.03
2006	-0.03	-0.03	0.01	-0.10	0.07	0.07	0.04	0.11	0.46	0.35	0.43	0.04
2007	0.04	0.03	0.04	0.04	-0.10	-0.05	-0.05	-0.04	-0.16	0.07	-0.13	-0.12

Table 8.4.5. Saithe in Division Va. Log survey residuals from SPAYBL ('same procedure as year before last') 'camera' run.

	2	3	4	5	6	7	8
1985	-0.23	-1.30	-0.36	0.46	0.19	0.36	-0.21
1986	0.64	-0.55	-0.47	-0.63	-0.42	-0.37	-0.45
1987	-0.48	0.54	0.67	0.75	0.37	0.82	0.44
1988	-0.19	-1.98	-1.37	-0.76	-0.16	-0.51	-0.65
1989	1.76	0.65	-0.10	-0.38	-0.47	0.41	0.07
1990	0.01	0.26	0.39	0.23	0.65	0.30	0.55
1991	0.25	-0.31	-0.19	-0.29	-1.07	-0.42	-1.50
1992	-0.37	-0.04	0.65	1.13	0.43	0.40	0.01
1993	1.87	2.27	0.32	0.96	0.77	0.79	0.11
1994	0.86	-0.34	0.07	0.33	0.20	-0.15	0.51
1995	0.51	0.06	-0.38	-1.09	-0.97	-0.91	-1.14
1996	-0.39	-1.12	0.25	-0.20	0.10	0.38	0.88
1997	1.13	-0.18	0.65	0.45	0.12	-0.23	-0.26
1998	-1.01	1.12	0.31	0.16	-0.25	0.37	0.12
1999	0.80	0.75	0.09	-0.21	0.15	-0.53	-0.51
2000	-0.36	0.10	-0.10	-0.22	-0.16	-0.47	-0.18
2001	0.33	-0.47	-0.10	-0.44	-0.89	-0.97	-0.18
2002	0.32	-0.46	-0.49	0.17	0.28	0.34	0.34
2003	-1.42	0.84	-0.10	-0.38	-0.22	-0.24	0.22
2004	0.25	0.06	0.32	0.18	0.43	0.39	0.44
2005	-0.48	0.11	0.13	0.19	0.34	0.35	0.53
2006	-2.76	0.06	0.10	0.10	0.90	0.71	0.42
2007	-1.07	-0.99	-0.63	-0.51	-0.35	-0.22	-0.22
2008	0.00	0.91	0.34	0.00	0.18	-0.02	-0.25

Table 8.4.6. Saithe in Division Va. Log survey residuals from adopted ADCAM run.

	1	2	3	4	5	6	7	8	9	10
1985	-3.24	-0.59	-1.36	-0.40	0.46	0.12	0.21	-0.24	1.10	-0.30
1986	-2.35	0.43	-0.61	-0.53	-0.70	-0.48	-0.44	-0.58	-0.67	-0.38
1987	0.83	-0.76	0.62	0.64	0.62	0.25	0.75	0.33	0.37	0.39
1988	3.98	-0.46	-1.96	-1.29	-0.85	-0.31	-0.61	-0.73	-1.47	-0.64
1989	1.90	1.47	0.67	-0.05	-0.37	-0.57	0.33	-0.03	0.07	inf
1990	0.89	-0.21	0.23	0.42	0.25	0.61	0.29	0.44	0.16	-0.59
1991	-0.12	-0.02	-0.24	-0.23	-0.33	-1.09	-0.49	-1.45	-2.90	-2.51
1992	0.35	-0.80	-0.03	0.72	1.01	0.37	0.45	0.01	-0.82	-1.30
1993	inf	1.56	2.15	0.34	1.01	0.72	0.85	0.18	1.13	0.78
1994	0.64	0.71	-0.41	-0.01	0.29	0.18	-0.15	0.56	0.90	1.80
1995	2.19	0.22	0.18	-0.41	-1.14	-1.08	-0.97	-1.20	-0.45	-0.21
1996	3.63	-0.71	-1.13	0.43	-0.26	0.03	0.27	0.82	-0.99	-0.13
1997	1.95	0.90	-0.18	0.68	0.60	0.00	-0.30	-0.44	-0.63	-0.23
1998	-1.21	-1.40	1.12	0.33	0.18	-0.14	0.26	0.06	-0.34	-0.24
1999	1.06	0.51	0.70	0.12	-0.21	0.12	-0.42	-0.56	-1.92	-0.98
2000	inf	-0.76	0.08	-0.11	-0.21	-0.22	-0.50	-0.38	-0.70	-0.80
2001	inf	-0.07	-0.56	-0.08	-0.48	-0.92	-1.05	-0.23	-0.88	-0.01
2002	0.30	-0.03	-0.57	-0.56	0.18	0.18	0.30	0.22	0.20	0.33
2003	-3.77	-1.93	0.77	-0.19	-0.48	-0.23	-0.32	0.11	-1.40	-0.28
2004	-1.63	-0.15	-0.02	0.29	0.04	0.30	0.39	0.30	0.50	0.39
2005	inf	-0.81	0.00	0.11	0.16	0.16	0.22	0.40	0.23	0.75
2006	-1.55	inf	0.03	0.03	0.10	0.82	0.53	0.19	-0.16	0.29
2007	inf	-2.31	-1.26	-0.60	-0.53	-0.39	-0.38	-0.52	-0.69	-0.19
2008	-0.47	-1.11	0.09	0.15	0.13	0.15	-0.08	-0.62	-0.70	-0.77

Table 8.4.7. Saithe in Division Va. Selected stock parameters and their standard errrors from TSA, 'camera' and ADCAM run on 1985-2007 landings in numbers, 1985-2008 IGFS used as input. For TSA(N08) standard error on log scale is comparable to the CVs for the other two models.

SSB07&08	tsa			camera			adcam		
year	B4+*	std	cv	ssb	std	cv	ssb	std	cv
2007	214.0	27.0	0.13	141.0	17.1	0.12	159.1	16.8	0.11
2008	166.0	29.0	0.17	131.3	22.3	0.17	156.1	23.3	0.15

*note that TSA B4+ uncertainty is comparable to SSB uncertainty when maturity and weights are kept fixed

Survivors08	tsa		camera			adcam		
age	n08	std(log(n))	n08	std	cv	n08	std	cv
2	17.1	0.50	8.9	9.1	1.02	19.2	22.0	1.14
3	23.8	0.42	15.0	9.5	0.64	32.7	15.5	0.47
4	11.3	0.27	10.6	3.3	0.31	12.8	4.4	0.34
5	14.4	0.26	19.1	4.3	0.23	15.8	4.1	0.26
6	17.1	0.23	22.2	4.7	0.21	20.9	4.1	0.20
7	3.7	0.24	4.1	0.9	0.21	4.0	0.9	0.22
8	5.4	0.23	6.7	1.5	0.23	8.7	1.7	0.19
9	3.5	0.24	2.7	0.7	0.25	4.2	0.8	0.20
10	1.8	0.25	1.1	0.3	0.26	2.1	0.4	0.20
11	0.6	0.28	0.3	0.1	0.27	0.6	0.2	0.24

Table 8.4.8. Saithe in Division Va. Selected parameters and their standard errrors from adopted ADCAM run on 1974-2007 landings in numbers, 1985-2008 IGFS used as input. For parameters estimated on log scale, standard deviations can be interpreted as CVs.

Which ones of the 464 that were estimated this year??????????????????

Table 8.6.1. Saithe in Division Va. Fishing mortality from adopted ADCAM run, a statistical catch at age model calibrated with IGFS survey 1985-2008.

	3	4	5	6	7	8	9	10	11	12	13	14
1974	0.054	0.227	0.183	0.197	0.280	0.437	0.411	0.499	0.455	0.416	0.589	0.589
1975	0.023	0.202	0.253	0.223	0.327	0.402	0.375	0.472	0.420	0.445	0.544	0.544
1976	0.011	0.185	0.316	0.390	0.377	0.399	0.382	0.458	0.402	0.435	0.509	0.509
1977	0.004	0.097	0.248	0.318	0.342	0.388	0.403	0.427	0.423	0.414	0.411	0.411
1978	0.011	0.074	0.157	0.239	0.377	0.487	0.348	0.416	0.410	0.454	0.448	0.448
1979	0.011	0.110	0.179	0.353	0.360	0.456	0.364	0.536	0.463	0.506	0.424	0.424
1980	0.011	0.072	0.206	0.354	0.375	0.513	0.413	0.528	0.366	0.371	0.333	0.333
1981	0.012	0.067	0.140	0.350	0.374	0.491	0.480	0.503	0.311	0.381	0.387	0.387
1982	0.022	0.079	0.182	0.285	0.515	0.556	0.545	0.504	0.289	0.298	0.360	0.360
1983	0.004	0.106	0.104	0.258	0.426	0.623	0.495	0.480	0.306	0.256	0.336	0.336
1984	0.002	0.033	0.082	0.267	0.416	0.694	0.477	0.617	0.464	0.312	0.532	0.532
1985	0.011	0.110	0.177	0.248	0.362	0.457	0.410	0.629	0.477	0.281	0.522	0.522
1986	0.043	0.059	0.184	0.247	0.335	0.480	0.424	0.661	0.558	0.318	0.411	0.411
1987	0.012	0.106	0.242	0.351	0.411	0.496	0.524	0.551	0.605	0.331	0.396	0.396
1988	0.025	0.075	0.197	0.339	0.342	0.492	0.564	0.482	0.594	0.340	0.345	0.345
1989	0.011	0.111	0.169	0.329	0.312	0.437	0.504	0.474	0.598	0.404	0.347	0.347
1990	0.008	0.076	0.208	0.328	0.480	0.497	0.460	0.477	0.530	0.389	0.385	0.385
1991	0.008	0.061	0.241	0.409	0.569	0.516	0.478	0.531	0.473	0.346	0.371	0.371
1992	0.018	0.142	0.356	0.451	0.461	0.474	0.478	0.482	0.408	0.337	0.453	0.453
1993	0.036	0.112	0.234	0.408	0.486	0.523	0.560	0.550	0.452	0.409	0.510	0.510
1994	0.046	0.230	0.257	0.359	0.479	0.570	0.589	0.655	0.515	0.441	0.617	0.617
1995	0.066	0.163	0.319	0.410	0.520	0.608	0.570	0.566	0.486	0.383	0.474	0.474
1996	0.049	0.161	0.246	0.357	0.401	0.610	0.571	0.538	0.467	0.409	0.509	0.509
1997	0.039	0.174	0.246	0.324	0.437	0.522	0.547	0.507	0.464	0.433	0.420	0.420
1998	0.026	0.114	0.166	0.241	0.420	0.499	0.554	0.555	0.507	0.452	0.471	0.471
1999	0.037	0.128	0.189	0.286	0.433	0.491	0.509	0.534	0.479	0.413	0.465	0.465
2000	0.033	0.124	0.220	0.277	0.375	0.522	0.492	0.509	0.491	0.393	0.468	0.468
2001	0.026	0.131	0.164	0.250	0.308	0.422	0.501	0.482	0.514	0.390	0.499	0.499
2002	0.022	0.115	0.234	0.314	0.329	0.401	0.455	0.444	0.519	0.385	0.526	0.526
2003	0.036	0.104	0.231	0.306	0.354	0.338	0.422	0.428	0.506	0.393	0.580	0.580
2004	0.047	0.172	0.238	0.336	0.332	0.346	0.397	0.418	0.480	0.428	0.615	0.615
2005	0.043	0.215	0.248	0.365	0.394	0.347	0.383	0.428	0.489	0.482	0.620	0.620
2006	0.048	0.236	0.283	0.344	0.420	0.379	0.383	0.467	0.508	0.567	0.683	0.683
2007	0.081	0.309	0.309	0.380	0.287	0.343	0.365	0.453	0.464	0.573	0.659	0.659

Table 8.6.2. Saithe in Division Va. Stock in numbers (in thousands) from adopted ADCAM run, a statistical catch at age model calibrated with IGFS survey 1985-2008.

	3	4	5	6	7	8	9	10	11	12	13	14
1974	23463	18392	15886	20032	16021	10249	3984	2207	977	492	127	32
1975	25925	18208	12004	10828	13473	9911	5423	2163	1097	508	266	58
1976	31410	20747	12186	7629	7095	7956	5427	3050	1105	590	266	126
1977	22071	25425	14119	7274	4230	3986	4372	3033	1580	605	313	131
1978	49907	17994	18885	9023	4335	2460	2214	2393	1620	847	327	170
1979	50321	40400	13678	13209	5818	2435	1237	1280	1292	880	440	171
1980	28222	40760	29626	9364	7599	3323	1264	704	613	666	434	236
1981	19754	22856	31048	19747	5381	4277	1629	685	340	348	376	255
1982	21932	15981	17502	22096	11395	3031	2142	825	339	204	195	209
1983	32609	17561	12087	11944	13607	5575	1423	1017	408	208	124	111
1984	45710	26587	12927	8919	7553	7273	2448	710	515	246	132	72
1985	35563	37334	21066	9753	5593	4079	2975	1244	314	265	147	63
1986	71212	28784	27380	14451	6229	3190	2114	3012	543	159	164	72
1987	98286	55851	22223	18656	9239	3648	1617	1133	1273	254	95	89
1988	53808	79492	41129	14280	10750	5013	1819	784	535	569	150	52
1989	31944	42966	60370	27663	8330	6252	2509	847	396	242	332	87
1990	21226	25860	31490	41736	16291	4990	3306	1241	432	178	132	192
1991	28119	17243	19620	20940	27227	8251	2486	1708	631	208	99	74
1992	14502	22831	13277	12624	11386	12622	4033	1262	823	322	120	56
1993	20301	11657	16219	7618	6581	5878	9036	2047	638	448	188	63
1994	17391	16036	8533	10510	4146	3314	2852	4227	967	332	243	92
1995	26140	13597	10435	5403	6009	2101	1535	1296	1798	473	175	108
1996	25085	20029	9454	6213	2937	2925	936	710	602	906	264	89
1997	17133	19546	13956	6055	3561	1609	1302	433	339	309	493	130
1998	8415	13492	13453	8937	3586	1883	782	617	214	175	164	265
1999	28993	6711	9856	9333	5782	1929	936	368	290	105	91	84
2000	29260	22868	4836	6683	5740	4462	967	461	177	147	57	47
2001	52807	23188	16532	3178	4146	3230	2167	484	227	88	81	29
2002	61721	42136	16651	11485	2026	2496	1734	1075	245	111	49	40
2003	70337	49418	30737	10785	6869	1193	1368	901	565	119	62	24
2004	22304	55554	36478	19980	6503	3948	697	735	481	279	66	28
2005	68646	17420	38282	23542	11685	3821	2288	384	396	244	149	29
2006	33634	53825	11504	24460	13385	6453	2211	1278	205	199	123	66
2007	16939	26258	34787	7100	14203	7199	3618	1234	656	101	92	51
2008	32717	12785	15783	20910	3975	8725	4183	2056	643	338	47	39

Table 8.6.3. Saithe in Division Va. Summary table from adopted ADCAM run for 1974-2008.

	Recruits Age 3	Totalbio	TotalSpbio	Landings	Yield/SSB	Fbar 4-9
1974	23463	422419	283158	97568	0.345	0.289
1975	25925	373249	256636	87954	0.343	0.297
1976	31410	331325	216225	82003	0.379	0.341
1977	22071	284595	172807	62026	0.359	0.299
1978	49907	292150	149426	49672	0.332	0.280
1979	50321	323401	145497	63504	0.436	0.304
1980	28222	330918	163137	58347	0.358	0.322
1981	19754	311856	163716	58986	0.360	0.317
1982	21932	300378	171161	68615	0.401	0.360
1983	32609	294997	168073	58266	0.347	0.336
1984	45710	335352	170590	62719	0.368	0.328
1985	35563	333421	160613	57102	0.356	0.294
1986	71212	410752	184928	64868	0.351	0.288
1987	98286	480991	177649	80531	0.453	0.355
1988	53809	494420	176145	77247	0.439	0.335
1989	31944	459966	181646	82425	0.454	0.310
1990	21226	430324	196327	98127	0.500	0.342
1991	28119	360828	192344	102316	0.532	0.379
1992	14502	292949	178387	79597	0.446	0.394
1993	20301	260482	167728	71648	0.427	0.387
1994	17391	214068	142485	64339	0.452	0.414
1995	26140	190207	113979	48629	0.427	0.432
1996	25085	175017	99857.1	40101	0.402	0.391
1997	17133	170597	95486.7	37264	0.390	0.375
1998	8415	154875	92682.7	31531	0.340	0.332
1999	28993	159558	89715.4	31293	0.349	0.339
2000	29260	177720	93341.5	33146	0.355	0.335
2001	52807	222361	100539	32063	0.319	0.296
2002	61721	290012	116518	42071	0.361	0.308
2003	70337	359334	130154	52494	0.403	0.292
2004	22304	337761	156072	64791	0.415	0.303
2005	68646	355553	168214	69143	0.411	0.325
2006	33634	327089	169772	75663	0.446	0.341
2007	16939	268821	159106	64430	0.405	0.332
2008	32717	255526	156086			
Arith. Mean	35366	308093	158863	63249	0.396	0.335
Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

Table 8.7.1. Saithe in Va. Prediction with management option/short term prediction - input data. 3 year average weight s and fishing pattern

Icelandic SAITHE. Division Va.

Prognosis - input parameters

Recruitment in 2009=	15.755
Fpa	0.3
Starting year =	2008

Desired TAC:

	2008	2009	2010
Opt1	60	0	0
Opt2	60	54	46
Opt3	60	6	7
Opt4	60	14	15
Opt5	60	27	27
Opt6	60	39	37
Opt7	60	46	41
Opt8	60	50	44
Opt9	60	54	46
Opt10	60	60	49

F-factor:

	2008	2009	2010
Opt1	1	0	0
Opt2	1	1	1
Opt3	1	0.090	0.090
Opt4	1	0.226	0.226
Opt5	1	0.452	0.452
Opt6	1	0.678	0.678
Opt7	1	0.814	0.814
Opt8	1	0.905	0.905
Opt9	1	0.995	0.995
Opt10	1	1.131	1.131

Mean weight in catches and SBBS:

age/year	2008	2009	2010
3	1.197	1.197	1.197
4	1.729	1.729	1.729
5	2.266	2.266	2.266
6	2.715	2.715	2.715
7	3.415	3.415	3.415
8	4.518	4.518	4.518
9	5.823	5.823	5.823
10	7.404	7.404	7.404
11	8.181	8.181	8.181
12	8.999	8.999	8.999
13	9.480	9.480	9.480
14	10.210	10.210	10.210

Table 8.7.1 (Cont'd)

Sexual maturity:

age/year	2008	2009	2010
3	0.080	0.080	0.080
4	0.220	0.220	0.220
5	0.430	0.430	0.430
6	0.650	0.650	0.650
7	0.840	0.840	0.840
8	0.930	0.930	0.930
9	0.960	0.960	0.960
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	2008	2009	2010
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

Selection pattern:

age/year	2008	2009	2010
3	0.057	0.057	0.057
4	0.252	0.252	0.252
5	0.279	0.279	0.279
6	0.362	0.362	0.362
7	0.366	0.366	0.366
8	0.355	0.355	0.355
9	0.376	0.376	0.376
10	0.448	0.448	0.448
11	0.486	0.486	0.486
12	0.538	0.538	0.538
13	0.651	0.651	0.651
14	0.651	0.651	0.651
F4-9	0.33	0.33	0.33

Table 8.7.1 (Cont'd)

Stock in numbers in starting year (millions):

age/year	2008
3	32.717
4	12.785
5	15.783
6	20.910
7	3.975
8	8.725
9	4.183
10	2.055
11	0.643
12	0.338
13	0.047
14	0.039
Total=	102.200

Table 8.7.2. Saithe in Va. Prediction with management/short term prediction, with some ACFM calculations added.

ADCAM numbers and three year average pattern

Projection of stock and spawning stock biomass (thousand tonnes)
in 2005-2007 for different management strategies.

2008				2009				2010							
Stofn	Hrygn-				Stofn	Hrygn-			Stofn	Hrygn-				Current TAC	
4+	stofn				4+	stofn			4+	stofn				qy07/08	
Stock	*Spawning*	F	Afli	Afli	*Stock*	*Spawn.*	F	Afli	*Stock*	*Spawn.*	F		EffortRed	75	
4+	*stock*		*Catch*	*Catch*	*4+*	*stock*		*Catch*	*4+*	*stock*		Basis	Fmultiplier	%deltaTAC	%deltaSSB
216	156	0.332	60	0	200	139	0.000	0	227	171	0.000	Zero catch	0	-100	23
				54	200	139	0.332	46	166	120	0.332	Fsq	1	-27	-13
				6	200	139	0.030	7	221	165	0.030	Fpa*0.1	0.090	-92	19
				14	200	139	0.075	15	212	158	0.075	Fpa*0.25	0.226	-81	13
				27	200	139	0.150	27	197	146	0.150	Fpa*0.5	0.452	-64	5
				39	200	139	0.225	37	184	134	0.225	Fpa*0.75	0.678	-48	-3
				46	200	139	0.270	41	176	128	0.270	Fpa*0.9	0.814	-39	-8
			Fpa	50	200	139	0.300	44	171	124	0.300	Fpa	0.905	-33	-10
				54	200	139	0.330	46	167	121	0.330	Fpa*1.1	0.995	-28	-13
				60	200	139	0.375	49	160	115	0.375	Fpa*1.25	1.131	-20	-17

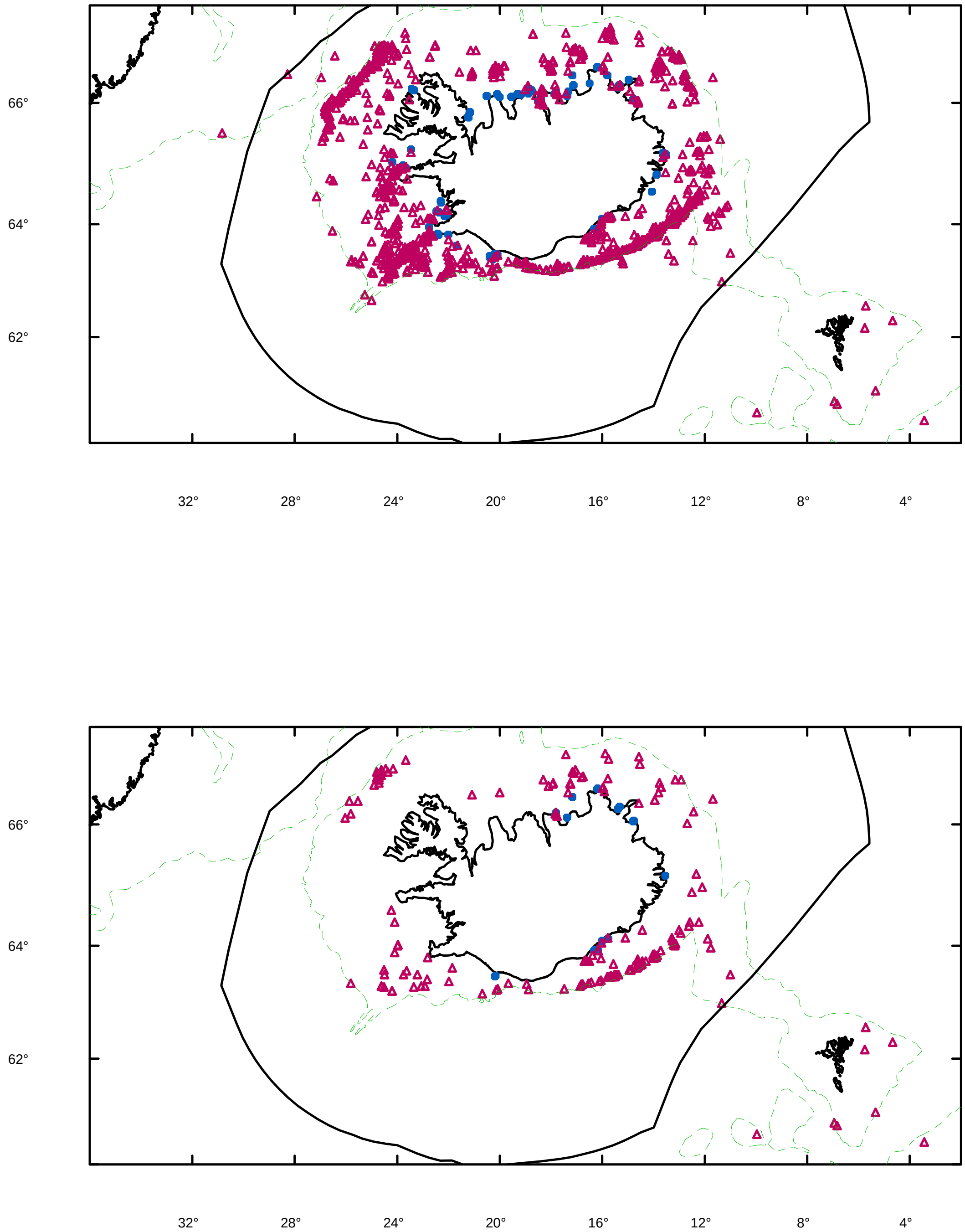


Figure 8.1.1. Saithe in Va. Results from taggings in 2000-2004. Total returns, above; returns after more than 560 days at liberty (the shortest period at liberty in the recaptures from the Faroes) from the set of stations from which tags were recaptured at the Faroes or on the Faroe-Iceland Ridge, below. Blue dots denote tagging locality, violet triangles recapture location, the 500 m isobath and approximate Icelandic EEZ boundary are also shown.

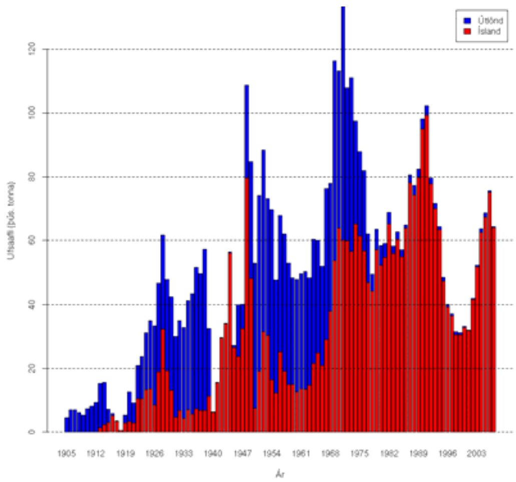


Figure 8.2.1. Saithe in Va. Nominal domestic (red) and foreign (blue) landings 1905-2007. Total landed 5.2 Mt, annual average 50Kt.

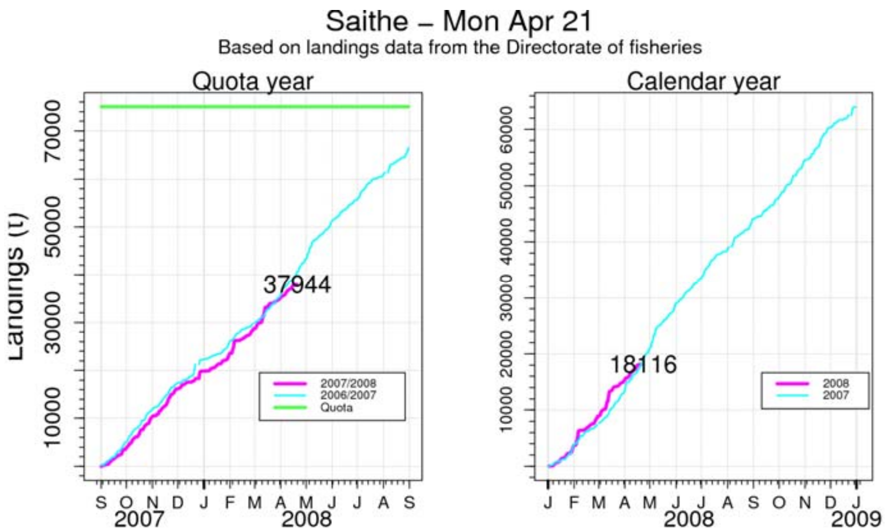


Figure 8.2.2. Saithe in Va. Landings in quota years 2006/2007 (blue) and 2007/2008 (red) and calendar years 2007 (blue) and 2008 (red) (www.hafro.is/~sigurdur/Landings).

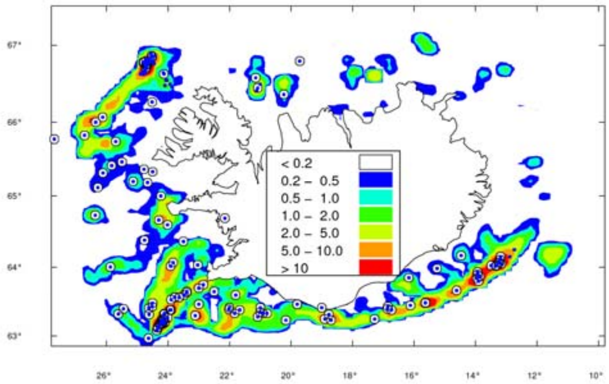


Figure 8.2.3. Saithe in Va. Geographical distribution of the 2007 saithe fishery with all gear, from logbooks, in tonnes per square nautical mile. Sample positions superimposed, white circles indicate an otolith sample, smaller black dots a length sample.

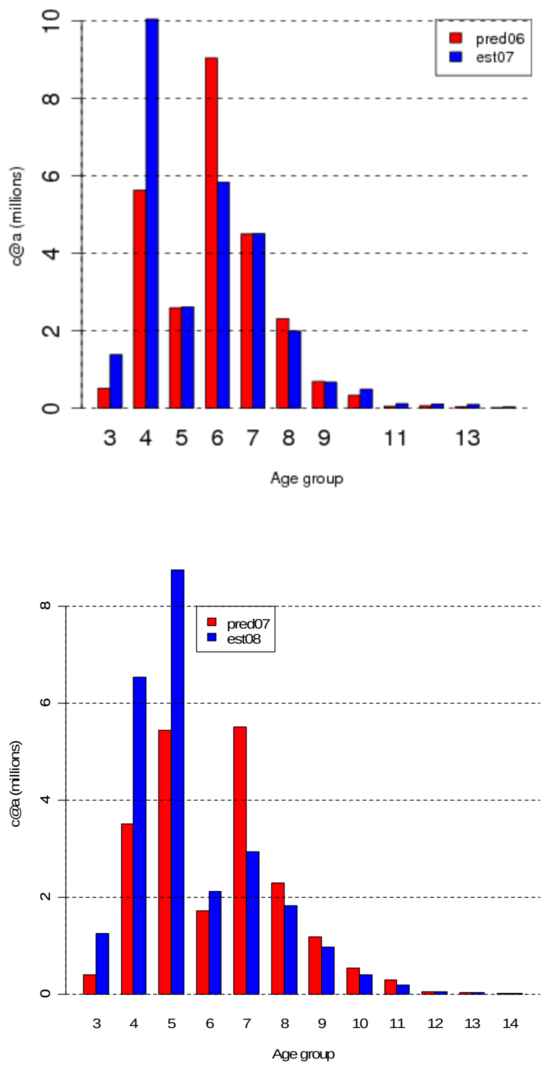


Figure 8.2.4. Saithe in Va. Prognosis in May 2006 and estimate in April 2007 on left and in May 2007 and in April 2008 on right of age composition of landings in numbers at age, in 2006 and 2007, respectively.

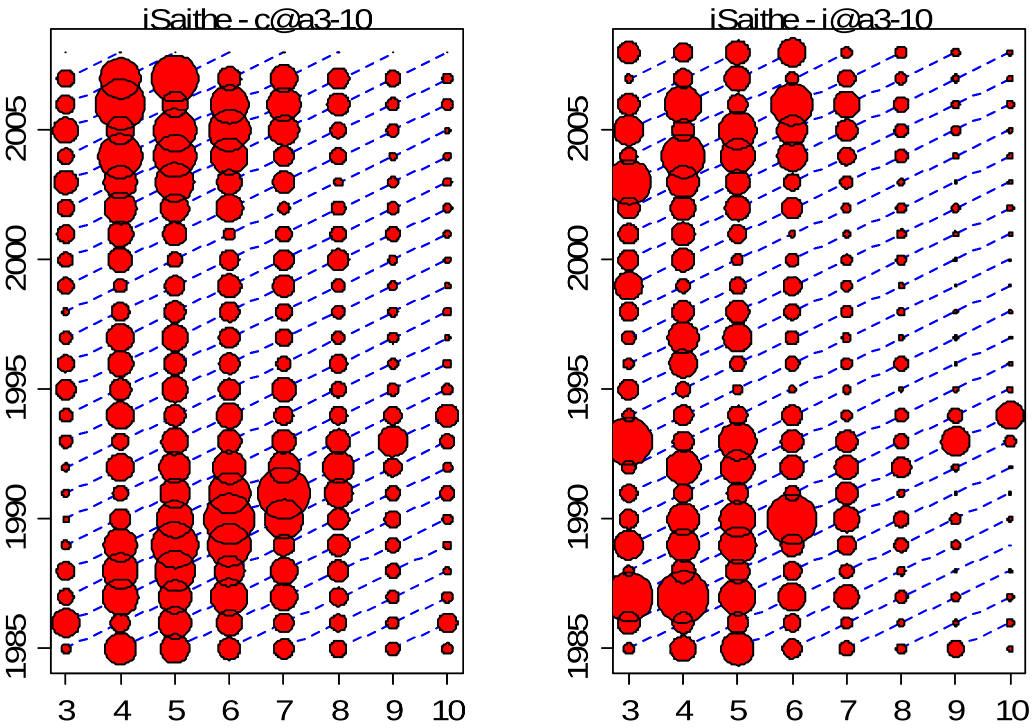


Figure 8.2.5. Saithe in Va. Juxtaposed circles representing landings at age 3-10 in 1985-2007 (right) and of index at age 3-10 in 1985-2008 (left).

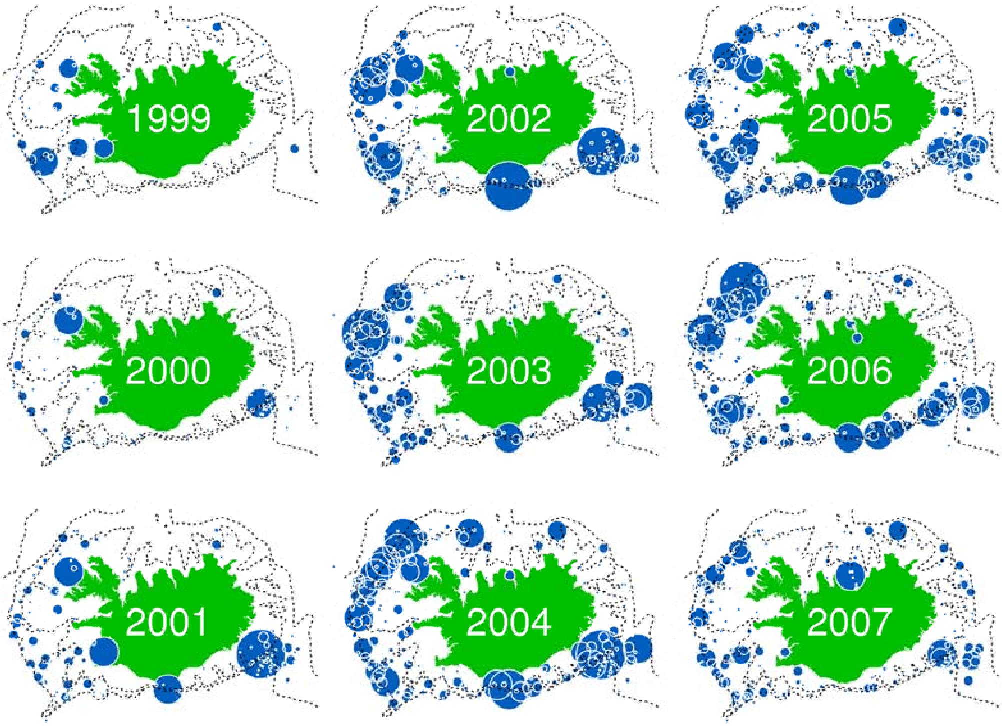


Figure 8.2.6. Saithe in Va. Geographic distribution of abundance in IGFS 1999-2007. Circle area changes for cutpoints 1, 5, 10, 50, 100, 500, 1000, largest circles denote hauls where more than 1000 saithe were caught.

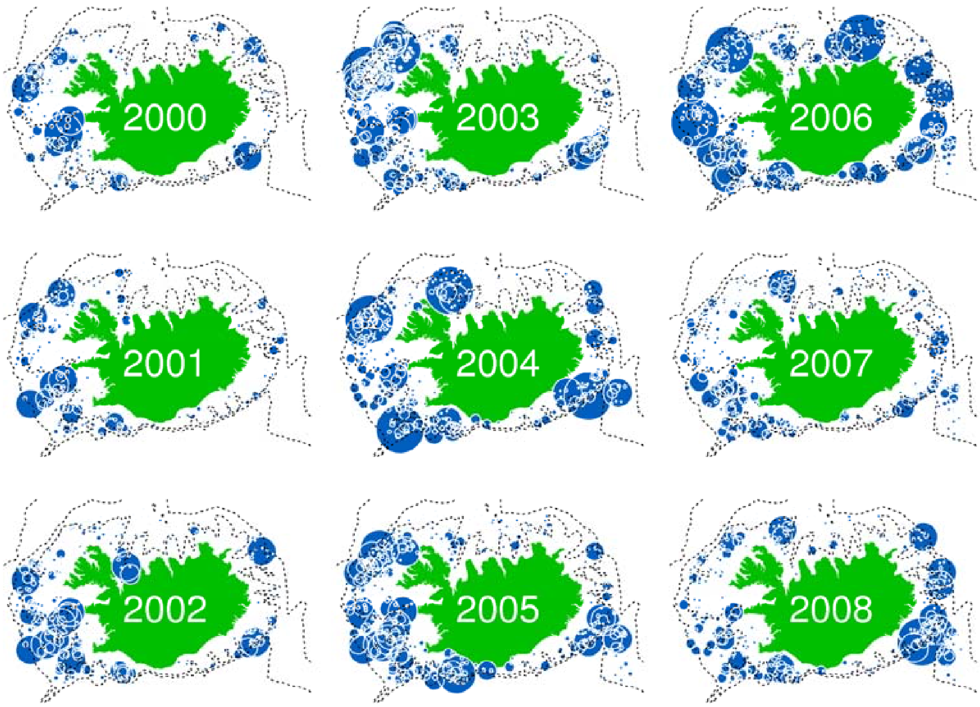


Figure 8.2.7. Saithe in Va. Geographic distribution of abundance in Icelandic autumn survey 1998-2006. Circle area changes for cutpoints 1, 5, 10, 50, 100, 500, 1000, largest circles denote hauls where more than 1000 saithe were caught.

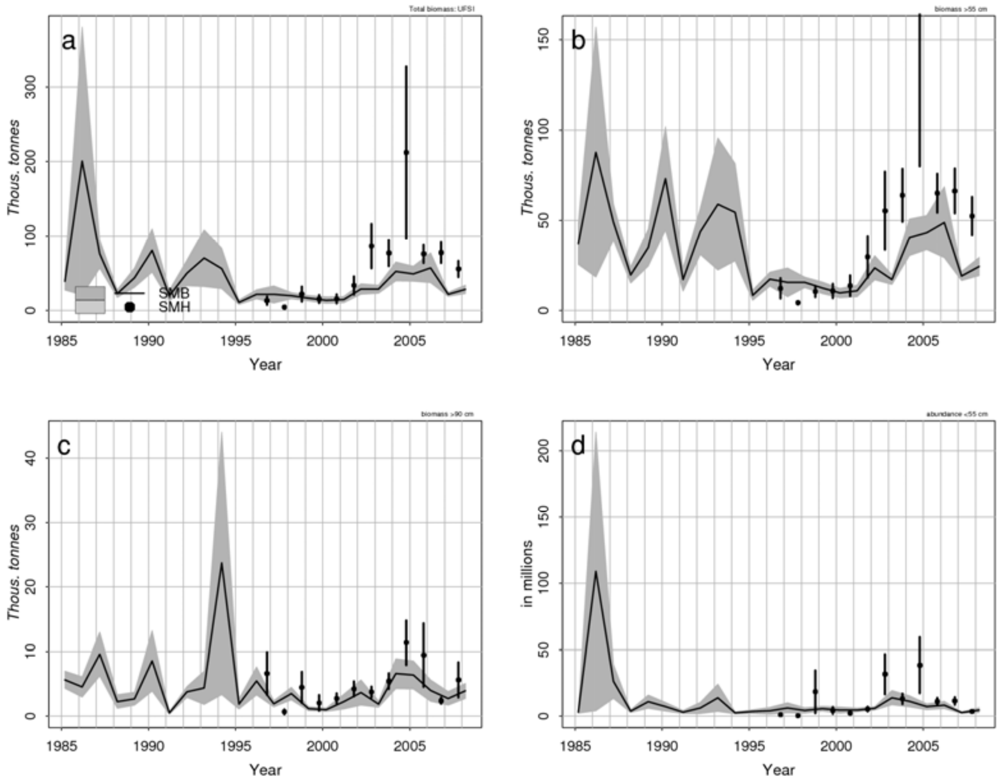


Figure 8.2.8. Saithe in Va. Stratified mean survey indices from IGFS 1985-2008 and the autumn survey 1996-2007. Total biomass (a), fishable biomass (55cm+), large saithe biomass (c) and juvenile abundance (d).

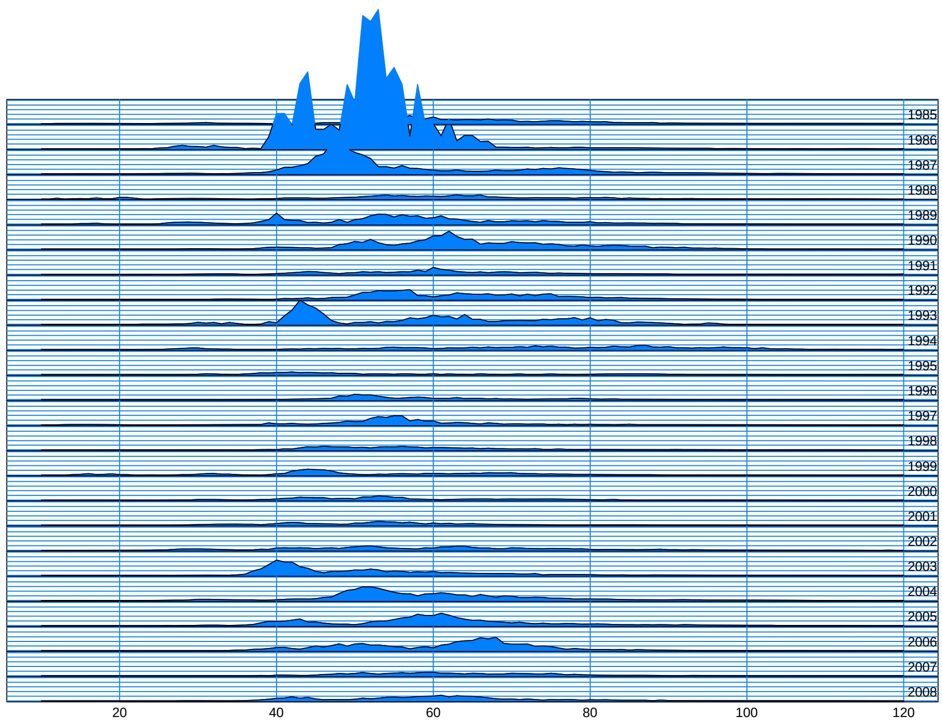


Figure 8.2.9. Saithe in Va. Length distributions in IGFS 1999-2007. Problems with large hauls in the earlier part of the series cause overshadowing of the previous year in 2 cases.

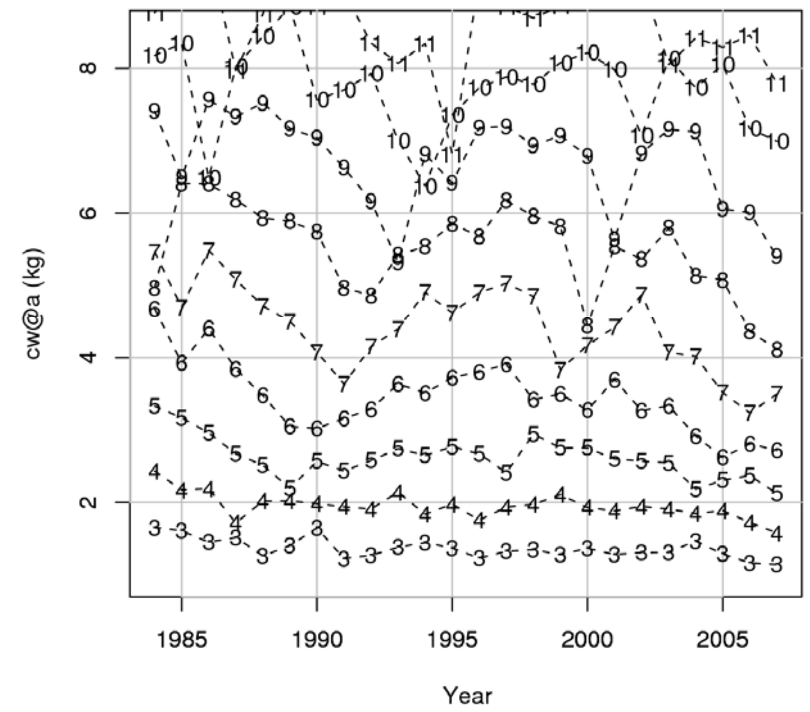


Figure 8.2.10. Saithe in Va. Mean weight at age in the landings and spawning stock in 1984-2007.

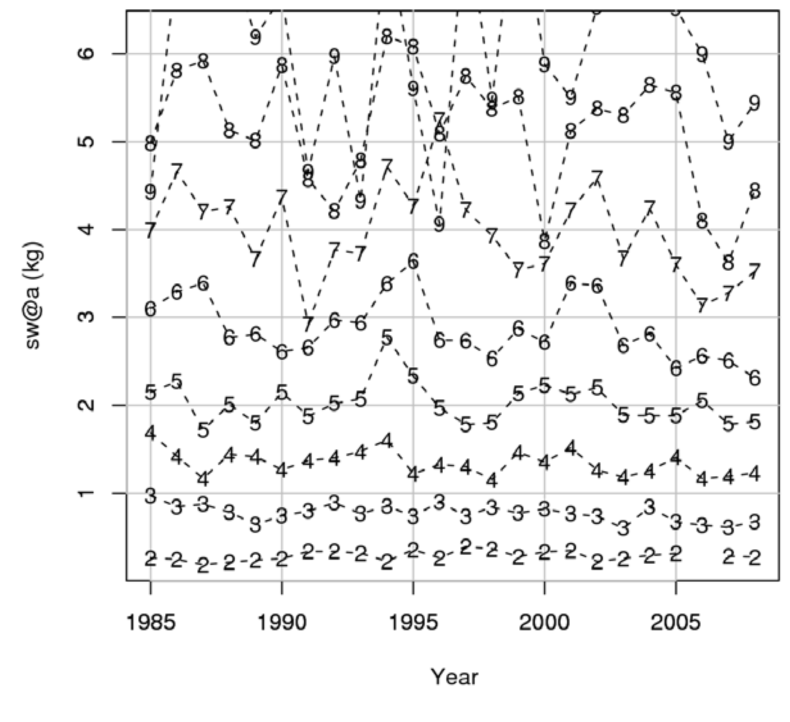


Figure 8.2.11. Saithe in Va. Mean weight at age in the IGFS survey in 1985-2008.

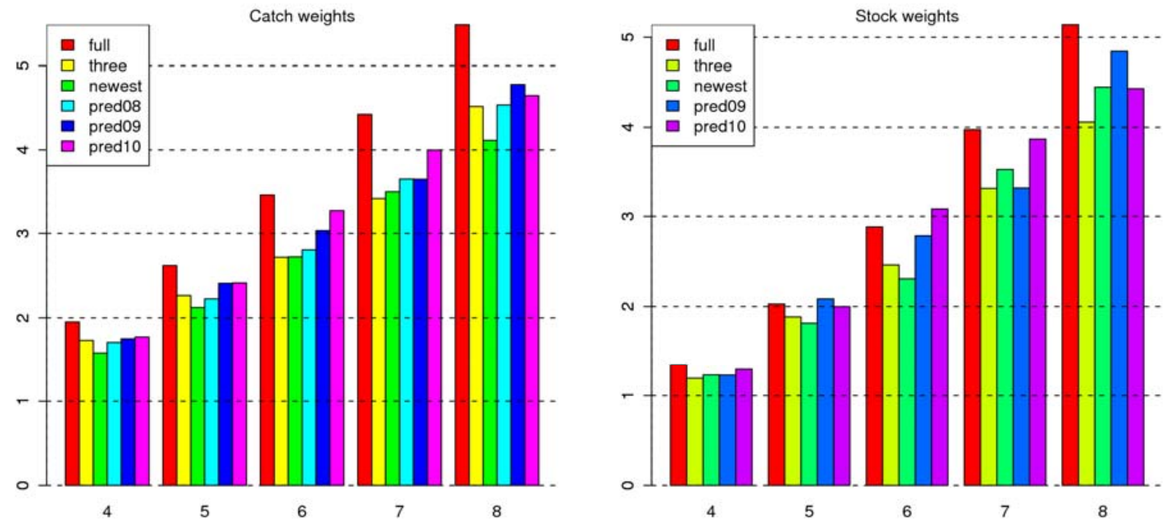


Figure 8.2.12. Saithe in Va. Spaly prediction of stock and catch-weight-at-age compared with the adopted method of using 3 year averages. Legend reads: 'full' is the long term average overt the period shown in Fig. 8.2.?. and 8.2.?. 'three' is the recent average, 'predYY' indicates the prediction for an age group in year 'YY' for the indicated set of weights.

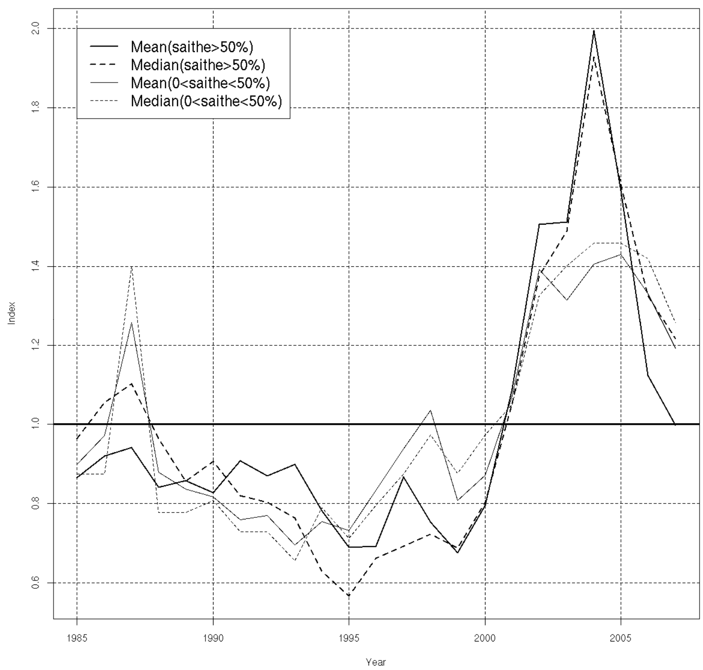


Figure 8.3.1. Saithe in Va. Simple CPUE indices from the trawler fleet for 1985-2007. Mean and median CPUE in trawl hauls where saithe was recorded, as either more or less than 50% of the reported catch.

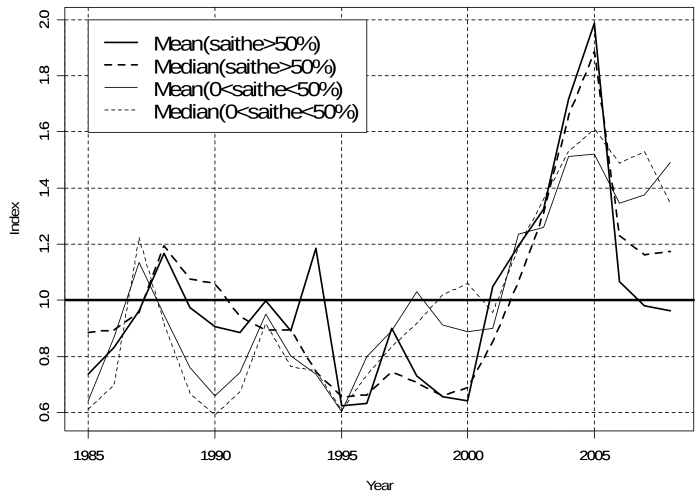


Figure 8.3.2. Saithe in Va. Simple CPUE indices from the trawler fleet in January - March 1985-2008. Mean and median CPUE in trawl hauls where saithe was recorded, as either more or less than 50% of the reported catch.

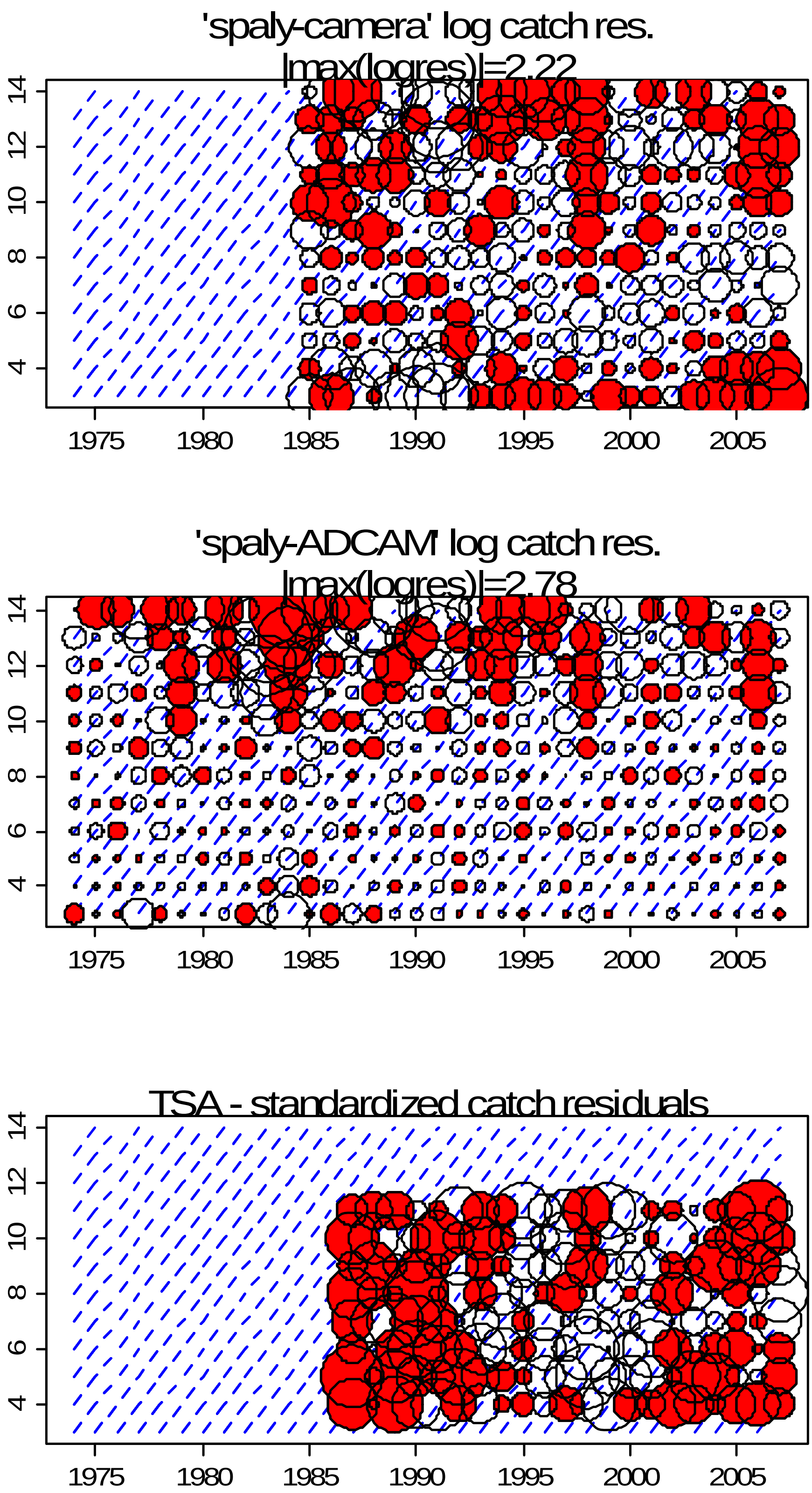


Figure 8.4.1. Saithe in Va. 'SPALY-camera' and ADCAM log-catch residuals and TSA standardized residuals. Note that TSA residuals are on a scale different from that of 'camera' and adcam.

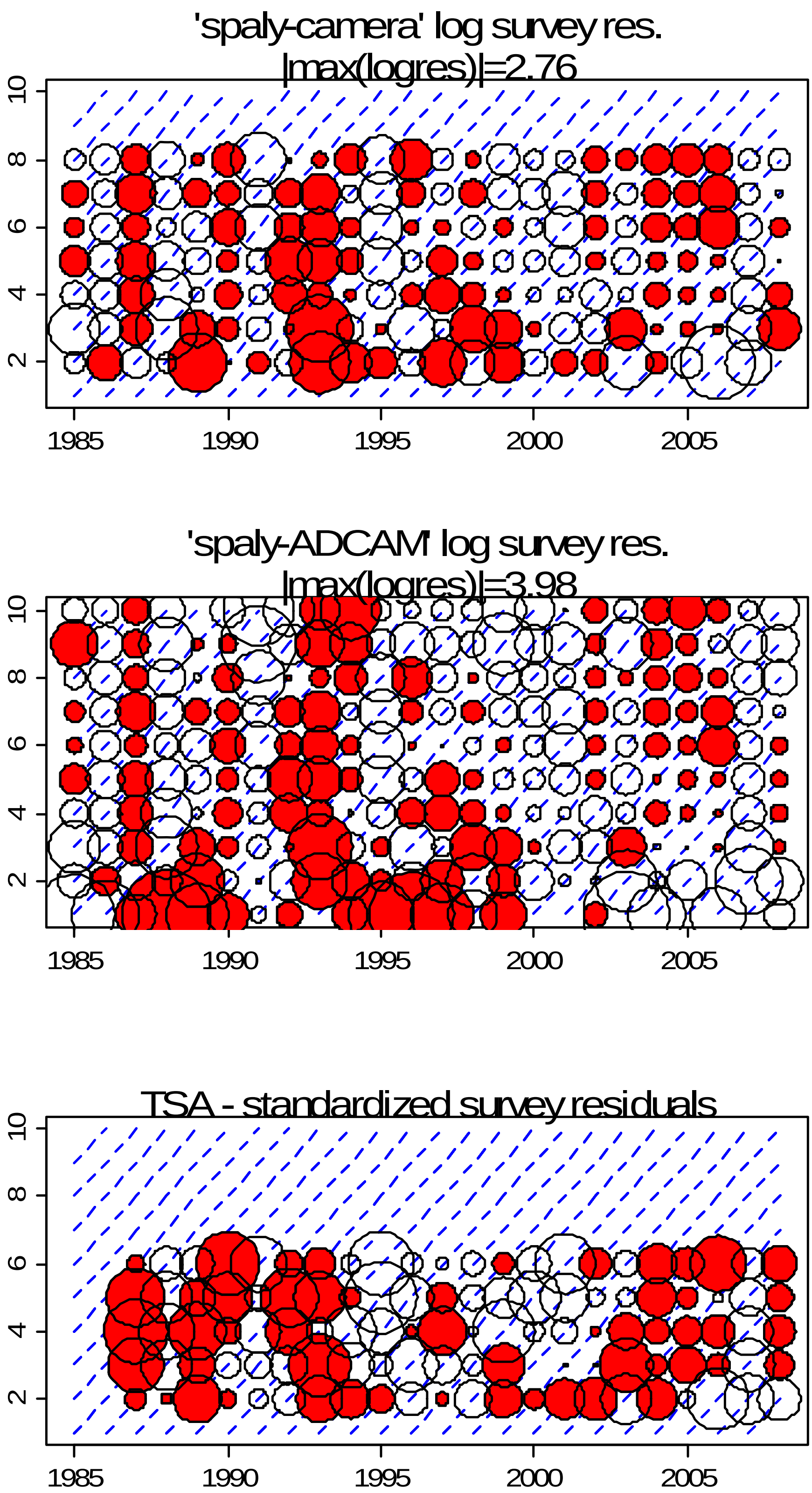


Figure 8.4.2. Saithe in Va. 'SPALY-camera' and ADCAM log-survey residuals and TSA standardized residuals. Note that TSA residuals are on a scale different from that of 'camera' and adcam

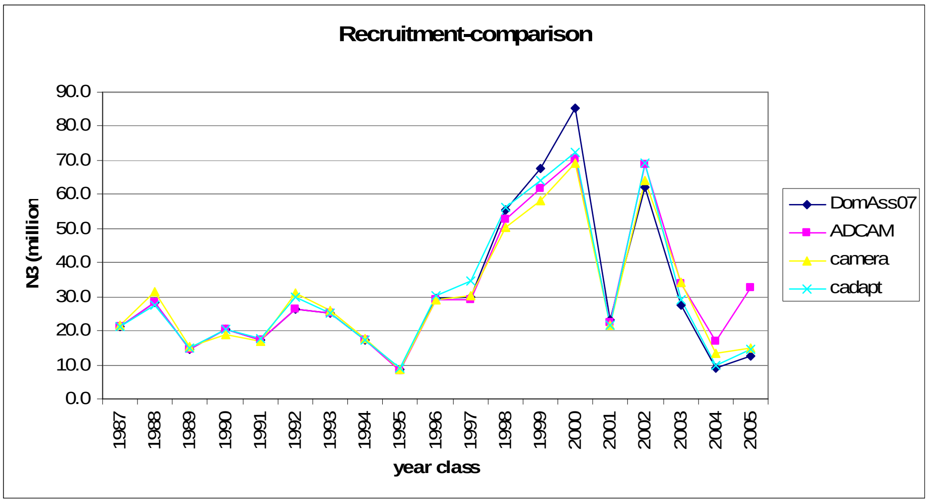


Figure 8.4.3. Saithe in Va. Comparison of R3 from Domestic assessment 2007, ADCAM, 'SPAYBL camera' and 'cadapt' tuned with IGFS survey indices.

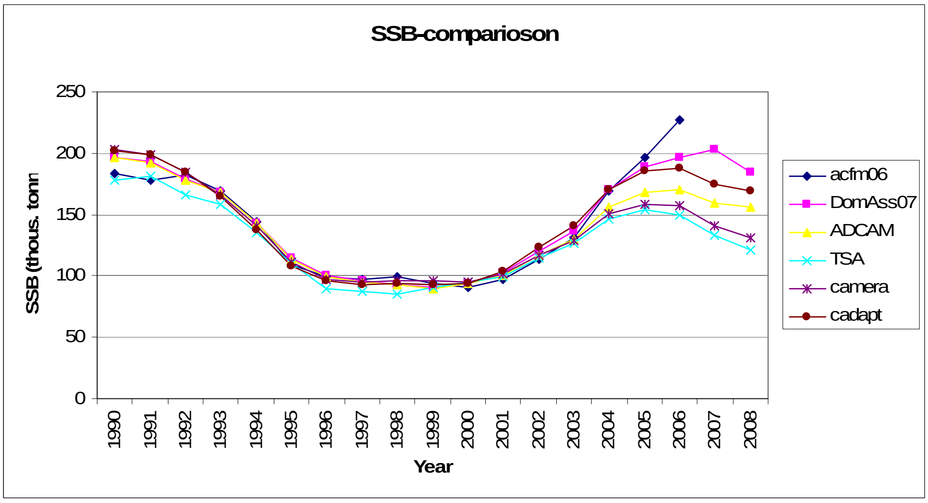


Figure 8.4.4. Saithe in Va. Comparsion of SSB from ACFM2006, Domestic assessment in 2007, ADCAM, TSA, 'SPAYBL camera' and cadapt tuned with IGFS survey indices-at-age.

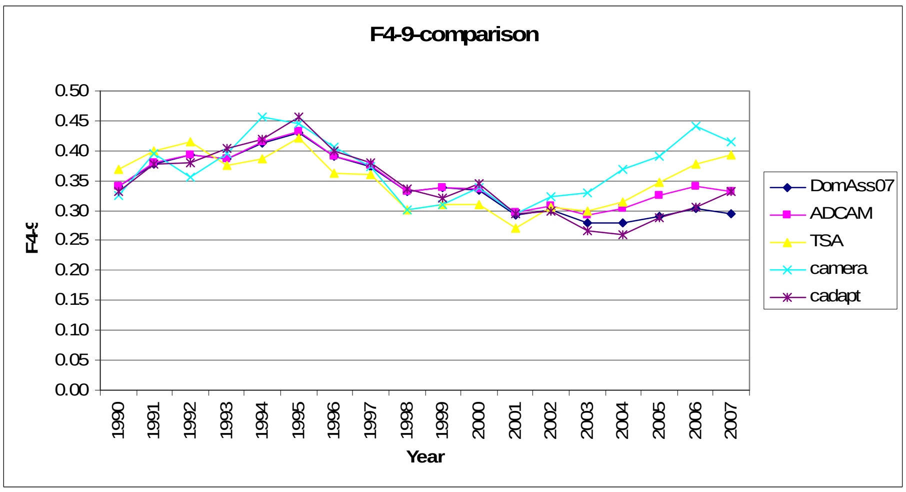


Figure 8.4.5. Saithe in Va.Comparison of F4-9 from Domestic assessment in 2007, ADCAM, TSA, 'SPAYBL camera' and 'cadapt' tuned with IGFS survey indices-at-age..

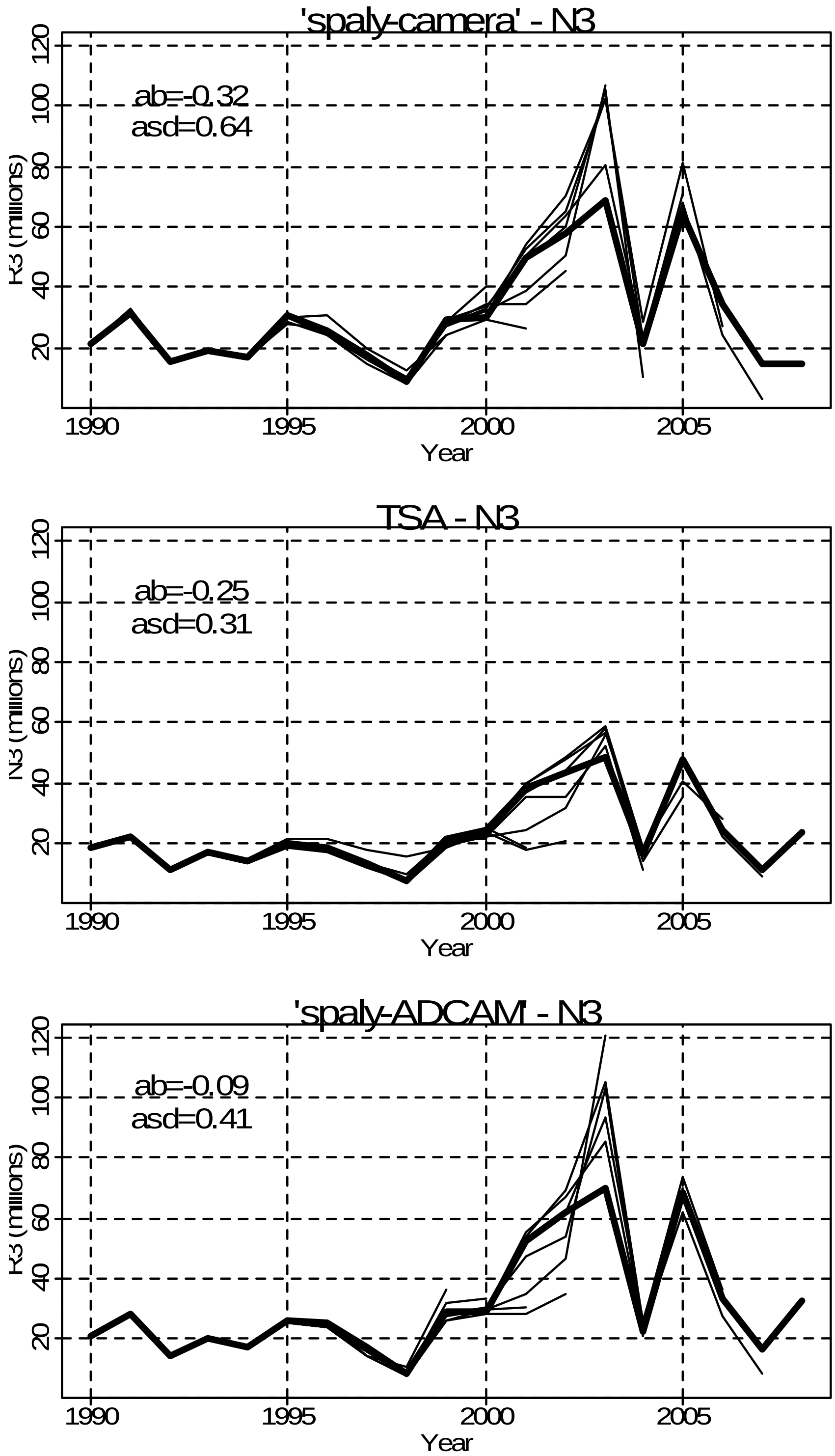


Figure 8.4.6. Saithe in Va. Retrospective analysis of 'camera', TSA and ADCAM recruitment. Note that tsa estimates migration of the 1984 and 1992 year classes and does not include catch at age 3. Retrospective bias (ab) and variation (asd) based on comparison of 9 retro-runs with the current one as in ICES CM2000/X:9 are shown.

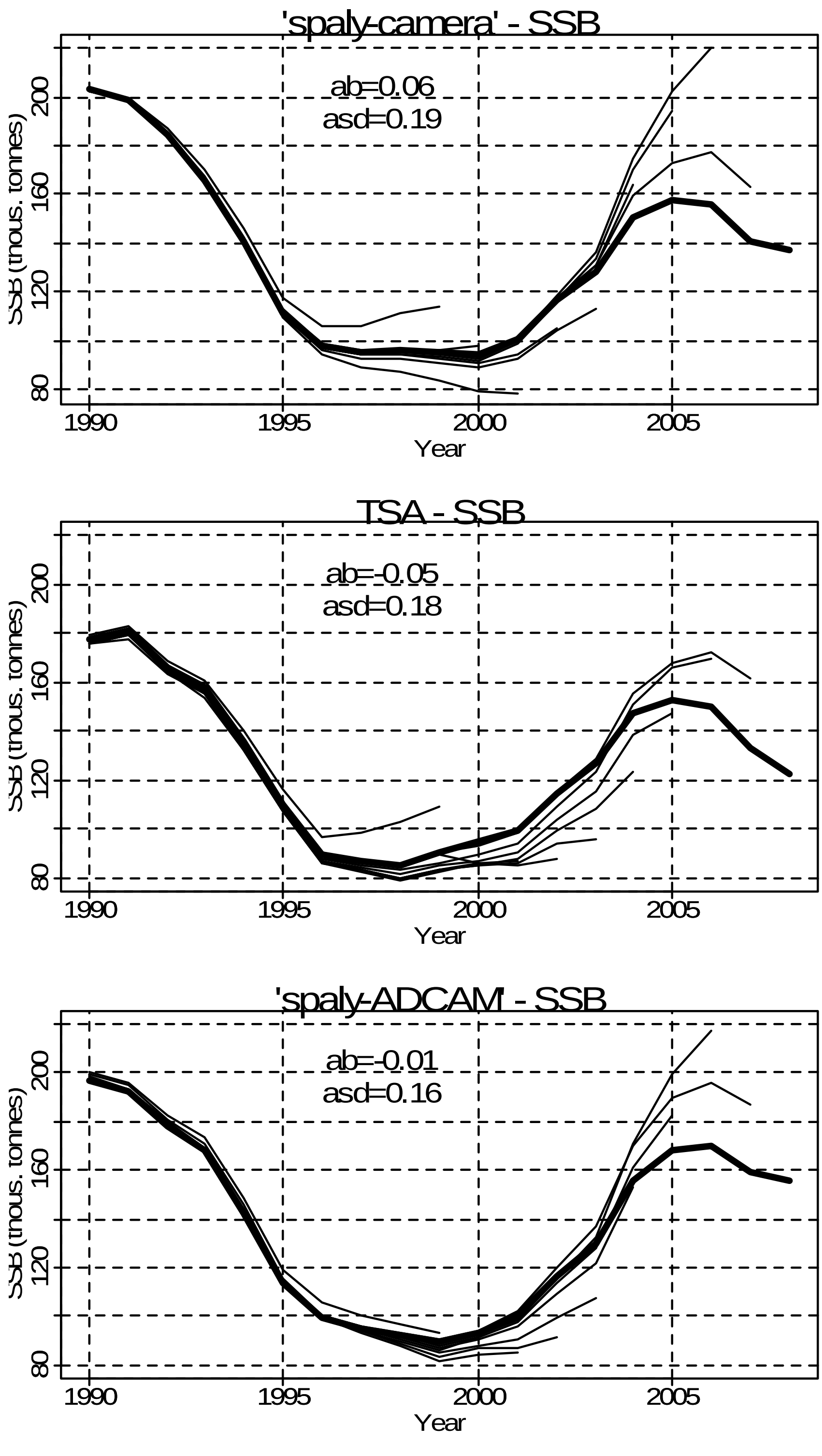


Figure 8.4.7. Saithe in Va. Retrospective analysis of 'camera', TSA and ADCAM SSB. Retrospective bias (ab) and variation (asd) based on comparison of 9 retro-runs with the current one as in ICES CM2000/X:9 are shown.

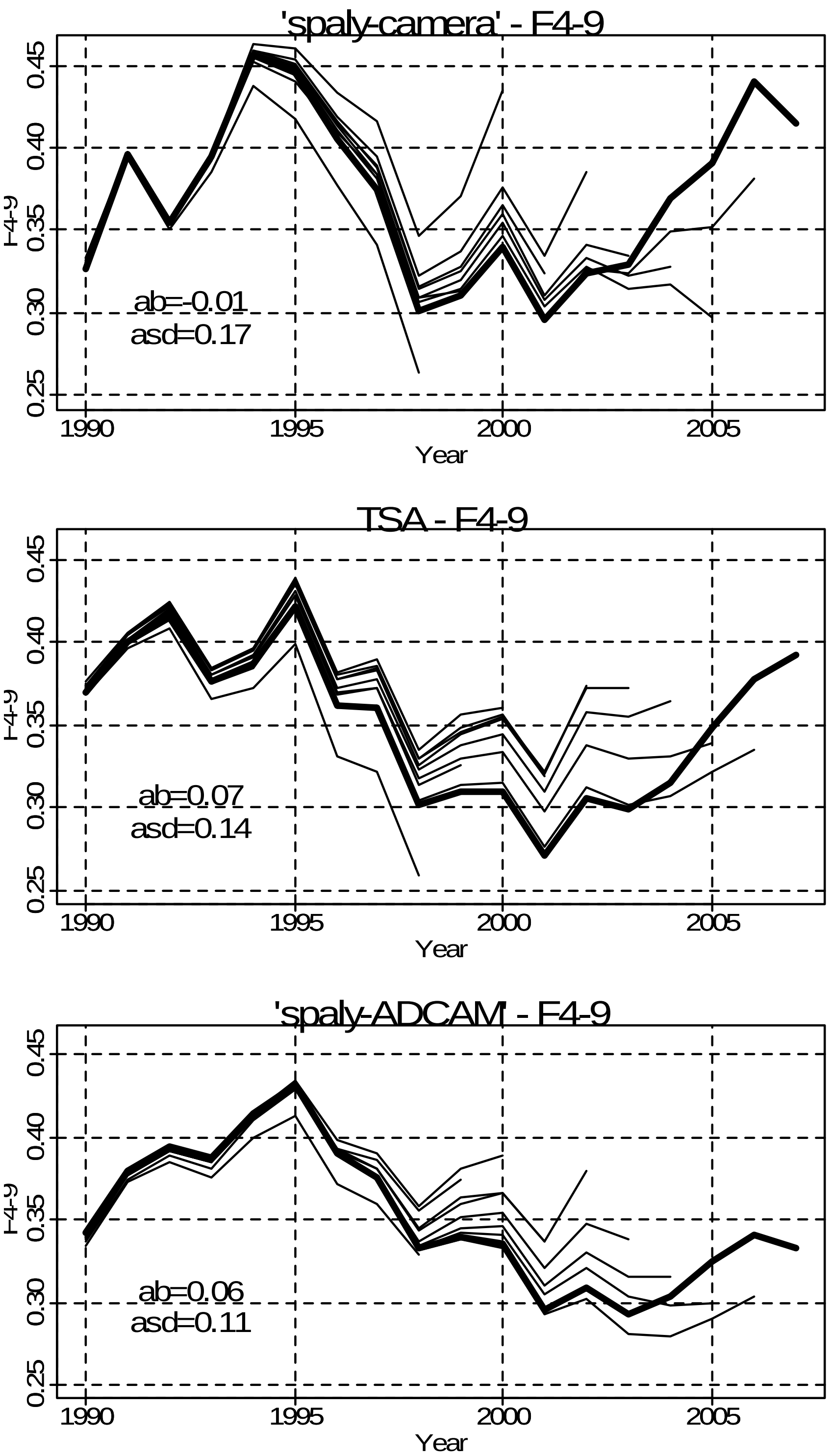
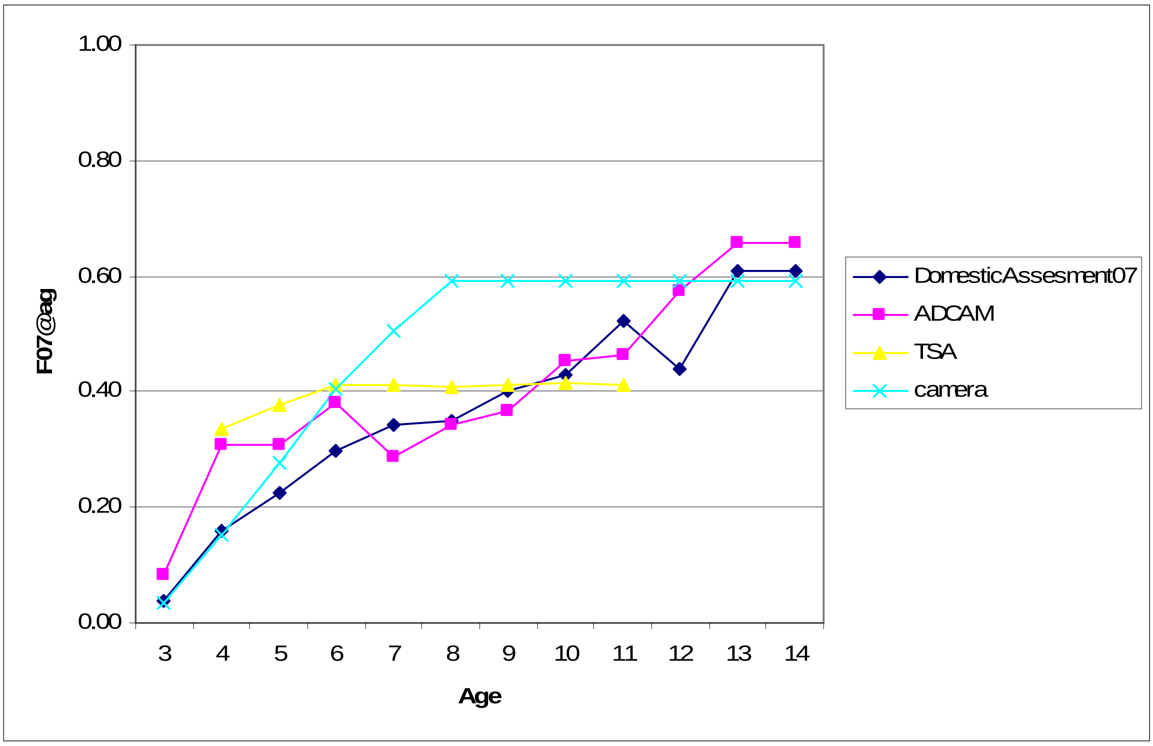


Figure 8.4.8. Saithe in Va. Retrospective analysis of 'camera', TSA and ADCAM F4-9. Retrospective bias (ab) and variation (asd) based on comparison of 9 retro-runs with the current one as in ICES CM2000/X:9 are shown.



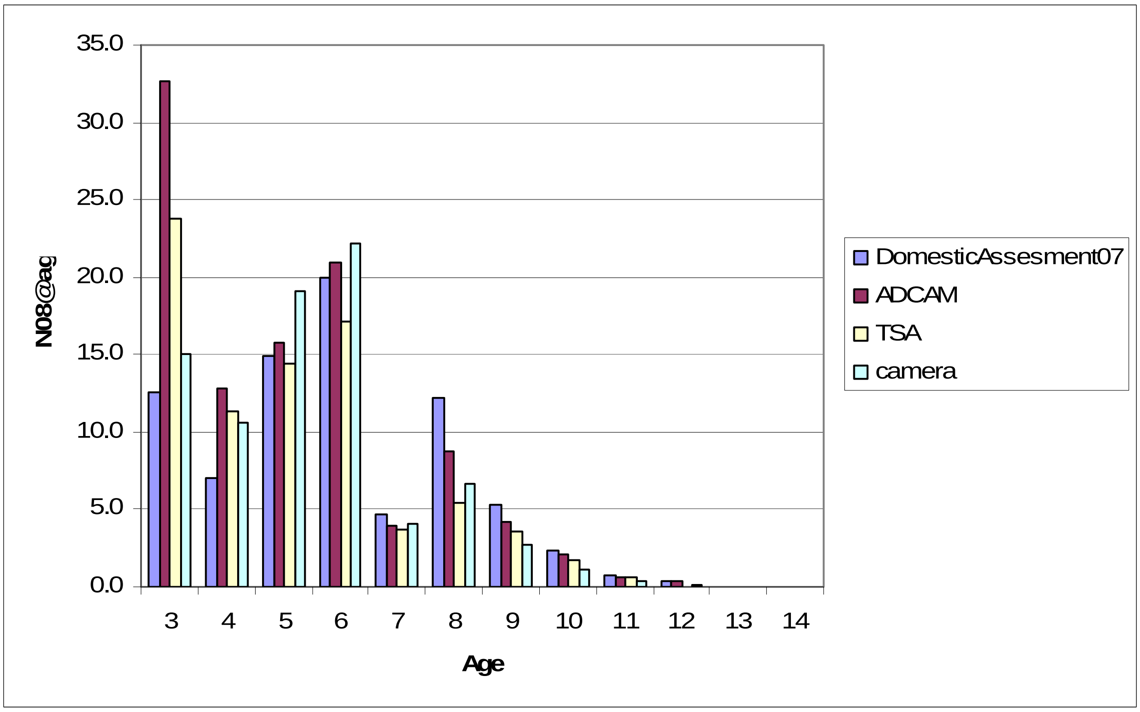


Figure 8.4.9. Saithe in Va. Terminal F-at-age and survivors-at-age from 'camera', TSA and XSA. Note TSA starts fishing mortality estimation at age 4.

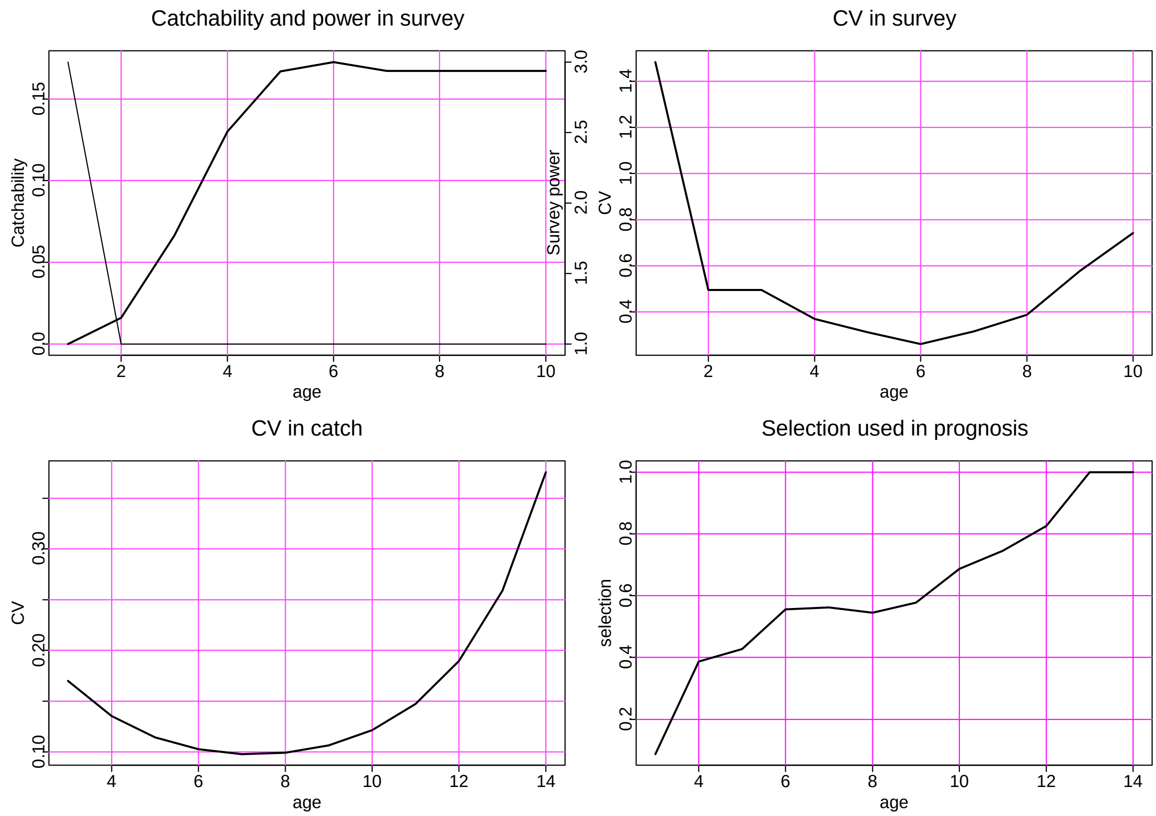
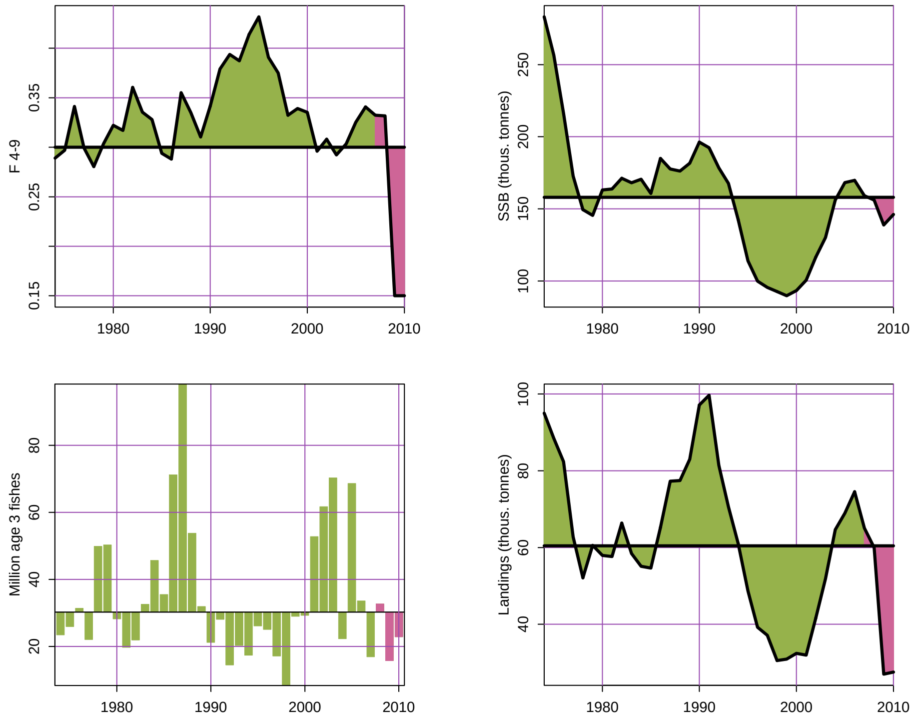


Figure 8.4.10. Saithe in Va. ADCAM settings and parameters by age group.

Adcam projection with F09&10=0.15=Fpa/2



Adcam projection with F09&10=0.3=Fpa

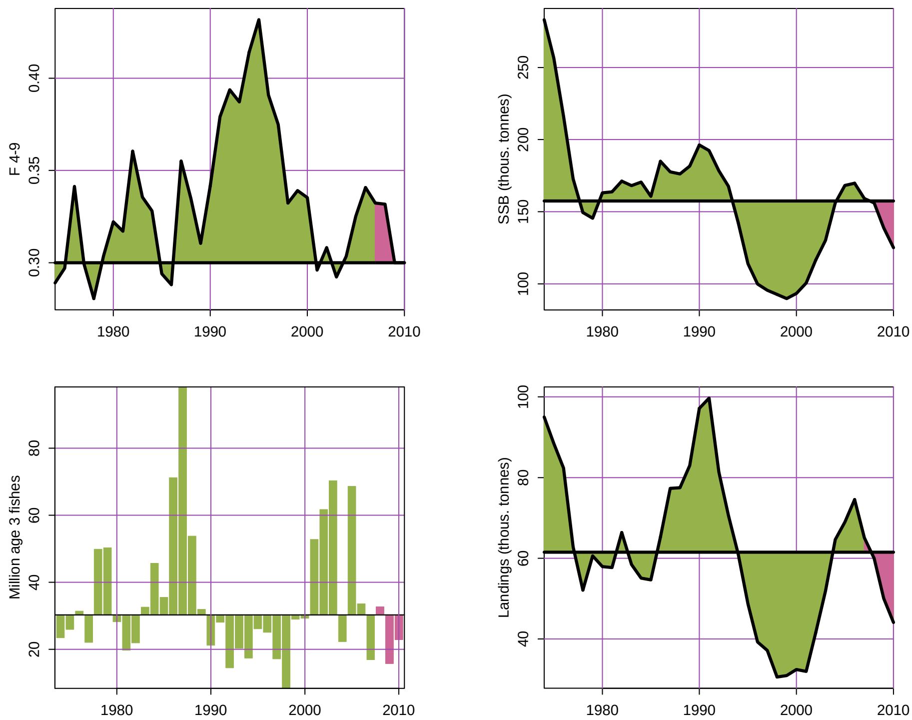


Figure 8.6.1. Saithe in Va. Standard plots with prediction for fishing at Fpa (above) or Fpa/2 (below).

9 Icelandic cod

Summary

INPUT DATA: The total reported landings in 2007 were 170 kt. Total landings in the last 4 fishing year have been relatively close to the set TAC for the Icelandic fleet. The TAC for the current fishing year is set to a historical low of 130 kt with the expectation that this action will result in a significant reduction in fishing mortalities in the current calendar year.

Mean weight at age in landings have been declining in the last 6 years and are in 2007 at historical low in many age groups, being about 11 to 25% below the long term average in age groups 4 to 9. Weights at age in the spring survey have also been declining over the same period, but a slight increase is seen in 2008 compared with the low values obtained in 2007.

Abundance indices by age from the spring and the fall surveys show that the year classes from 2001 onward are on average smaller than the ones from 1997 to 2000.

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) based on the spring survey, was as in previous years, adopted as a point estimate for forward projections. No changes in model configuration were done as no major model misspecifications were identified.

COMPARISON WITH 2007 ASSESSMENT: The estimates of reference fishing mortality in 2006 and the reference stock (B4+) and SSB in 2008 are very similar to that estimated last year. The retrospective pattern of recruitment estimates in recent years, both historical and analytical, indicates a minor but constantly downward revision of year classes 2001 and younger. Since these revisions are on pre-recruits that have not entered the fishery they have minor effect on the estimates of the post-recruit metrics.

STATE OF THE STOCK: The spawning stock has been relatively small in the last 35 year compared with the long term. It reached a historical low in 1993 (120 kt) but has since then increased and is estimated to be about 230 kt at present. Exploitation rate and fishing mortality have been lower after the implementation of the catch rule in 1995 compared with the past. The seven most recent year classes are estimated to be below the long-term average. The low recruitment is addition to historical low weight at age means that the productivity of the stock at present is very low.

9.1 Stock description and management units

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 experiments spanning with some hiatuses over the last 100 year show no indication of significant emigration from Iceland to other areas. In recent years it has been observed that cod tagged in Iceland has been recaptured inside Faroes waters close to the EEZ line separating Iceland and the Faroes islands.

The management unit of the Icelandic cod is limited the native EEZ zone.

9.2 Scientific data

The scientific data used for assessing Icelandic cod are the same as for most other species in Icelandic waters. The sampling programs i.e log books, surveys, sampling from landings etc. have been described in previous reports but have not yet been summarized in a form of a stock annex.

9.2.1 Catch: Landings, discards and misreporting

Landings of Icelandic cod in 2007 are estimated to have been 171 kt which is one of the lowest post-war landings on record (table and figures 9.2.1). Of the landings 167 kt were taken by Icelandic fleet but 4 kt by other nations. The latter includes 1.8 kt of cod taken on the Icelandic Faroe ridge by the Faroese bottom trawl fleet inside the Faroese EEZ. These last allocations are based on analysis of tagging, described in detail in section 4.1.

In recent years 40% of the catches have been taken with bottom trawl (Figure 9.2.2). The share of the long line has doubled in the last 10 years and is now on par with that caught with bottom trawl. The importance of gill net and handline has declined.

The trend in landings in recent years is largely a reflection of the set TAC (figure 9.2.3) that is set for the fishing year (starting 1. September and ending 31 august). The TAC set by the managers has since 1996 been determined by a 25% catch rule based on the reference biomass (TAC being set as 0.25 of the biomass estimates of age 4 and older, B_{4+}), with some amendments made in different years. Overshoot in the landings in the fishing seasons 2001/2002, 2002/2003 and 2003/2004 are a result of too low estimates of what boats smaller than 15 GRT that operated under an effort regime would take. Since 2005 the landings of cod by the Icelandic fleet have been regulated by ITQ's only for all fleet sections. The TAC for the 2007/2008 fishing year is set to 130 kt. This is somewhat lower than the 152 kt point value advice given by ICES last year but in accordance with that advised as a point value in the domestic advice and implied in the management considerations in last years ICES advice (for further elaboration, see section 9.11). The expectation of this action is that the fishing mortalities will be reduced significantly in the current year.

It is estimated that landings for the 2008 calendar year may be on the order of 135 kt.

Estimates of annual cod discards (Pálsson et al 2006) since 2001 are in the range of 0.4-1.8% of the landings. Mean annual discard of cod over the period 2001-2006 was 2192 tons, 1.11% of landings. In 2006 estimates of Cod discards amounted to 2754 metric tons, 1.45% of landings, the second highest value over the period 2001-2006. The method used for deriving these estimates assumes that discarding only occurs as high grading. The justification for applying such an assumption is a combination of larger fish being higher priced and constraints in a mixed fishery under an ITQ regime that is based on single stock allocation.

Misreporting in recent years is not regarded as a major problem in the fishery of this stock but no numerical study is available to support that general perspective. Production figures from processing plants seem to be in "good" agreement with landings figures according to the Fisheries Directorate (personal communication).

9.2.2 Landings and weight by age

SAMPLING INTENSITY: Current sampling protocol for estimating the age composition of the cod has been in effect since 1991 and have been described previous reports. The sampling intensity in 2007 is similar as it has been in previous years.

LANDINGS IN NUMBERS BY AGE: The total landings-at-age (Table 9.2.2) show that in the past two decades age groups 7 and younger have generally accounted for more than 90% of the landings in numbers. The number of 6 year old in 2007 in the catches is somewhat higher than expected relative to earlier catches from this year class. This phenomenon has however been observed before in small year classes, possibly indicating that they enter the fisheries later than larger year classes. The number in catches of year class 2000 at age 7 is relatively low compared with catches at age 6, which again may be considered relatively high compared with the catches at age 5. The reason for this anomaly has not been explored. In general though, the catch at age matrix is reasonably consistent, with CV estimated to be approximately 0.2 for age groups 4-10 based on a Shepherd-Nicholson model (Shepherd and Nicholson 1991).

MEAN WEIGHT AT AGE IN THE LANDINGS: The mean weight in the landings (table 9.2.3) and figure 9.2.4) have been declining in the last 6 years and are in 2007 at historical low in many age groups, being about 11 to 25% below the long term average in age groups 4 to 9. The decline in weight at age in the catches is in part a reflection of the decline in weight in the stock as seen in the measurements from the spring survey (figure 9.2.5) and also by a reduction of gillnet fisheries in the south and increase of the longline fishery in the north (section 9.2.1), because the weights at age of fish in the north are generally smaller than in the south.

Last year the estimates of mean weights in the landings of age groups 3-9 in 2007 were based on a prediction from the spring survey measurements in 2007 using the relationship between survey and landings weights in 2006. The same approach is used this year, i.e. basing the prediction from the spring survey measurements in 2008 using the relationship between survey and landings weight in 2007. Since the survey weights are for some age groups higher in 2008 compared with 2007 (figure 9.2.5), some increase in the weights in the catches for 2008 is predicted compared with that observed in 2007 (figure 9.2.4). These predictions in weights in 2008 are used to calculate the reference biomass of age groups four and older (B4+) in 2008, the latter being the input in the catch rule that determines the TAC in the next fishing year.

9.2.3 Surveys

BIOMASS INDICES: The total biomass indices from the spring and fall survey (figure 9.2.6) indicate that the stock size has declined in the last few years. Biomass of larger fish (> 80 cm) has increased significantly since 2002 but the abundance of small fish (< 55 cm) is declining. The increase in the larger size groups is mostly due to the four year classes from 1997 to 2000 that were close to the long term average, i.e. stronger than other adjacent classes. The decline in the abundance of smaller fish since 2004 is a reflection of poorer recruitment in recent years.

AGE BASED INDICES: Abundance indices by age from the spring and the fall surveys (tables 9.2.6 and 9.2.7) show that the year classes from 2001 onward are significantly smaller than the ones from 1997 to 2000. A residual plot of the spring survey indices by age and year ($U_{a,y}$) from consecutive years based on the model:

$$U_{a+1,y+1} = a + bU_{a,y} + \varepsilon$$

shows that in recent years later observed values (ages 1 vs 2 and ages 2 vs 3) of the incoming year classes are smaller than expected on average (Figure 9.2.7). Although the difference is relatively small it is persistent, resulting in some revision in the size of the incoming recruits to the fishery (age 3) in the assessments in recent year.

9.3 Information from the fishing industry

Unstandardised CPUE and effort indices, based on log book records where cod constitutes more than 50% of the catch, show a marked reduction in effort and increase in CPUE in the early 1990's (figure 9.3.1 and 9.3.2), coinciding with the time of the adoption of the HCR. The largest reduction was by the trawlers who diverted their effort to other species and other areas. The subsequent increase in effort in the late 1990's and beginning of this century is in part attributed the amendment of the HCR in the year 2000, when a 30 kt interannual stabilizer wasintroduced. Effort in recent years has been declining and is at or near a historical low in all fleets except the longliners.

After an increase in the bottom trawl fleet in the early 1990's CPUE it declined temporarily at the end of the decade, but has been relative high since 2003. After declining from 1997 to 2004 gillnet CPUE increased annually. These dynamics are to some extent a reflection of the dynamics in the stock although that is confounded by other factors, including the arbitrary selection criteria applied (cod >50% of catch) that may be affecting the times series if changes in targeting tactics among species occur with time. Since substantial linear trend in catchability in cpue from commercial fleets have been observed (WD-31, NWWG 2002) they are not used for calibration in the analytical assessment models.

9.4 Methods

INTRODUCTION: In recent years "the final assessment" of the Icelandic cod has been based on a statistical catch at age model (ADCAM, developed by Höskuldur Björnsson) tuned with the spring survey indices (SMB). The NWWG 2008 point estimators for the short term predictions as well as for the medium term projections (5 years) are based on the same method with the same settings as used last year (ADCAM), here after sometimes referred to as the SPALY (Same Procedure As Last Year) run.

In addition the cod has annually been assessed using a Time Series Analysis developed by Guðmundur Guðmundsson (199x, model description and details of numerous runs are given in WD 16, NWWG 2008). More conventional approaches, such as VPA type (XSA, ADAPT) and fixed separable CAEGIAN type model (xCAM) are also routinely run. In addition to using the spring survey indices as a tuning fleet, the more recently established fall groundfish survey (SMH), which now covers 12 years, has also been explored in an analytical framework in the last few years.

The WG concluded that there was no basis to change model configuration applied last year. What follows is thus only done for the matter of completeness and includes a description of the method applied as well as the major conclusions from the assessment work carried out this year using the ADCAM (SPALY) framework. Analysis and conclusions using the TSA framework is also presented for comparison, since it contains analysis related to potential model misspecifications..

THE ADCAM (SPALY) MODEL:

Input data: The model used catch data from 1955 to 2007 and spring survey data from 1985 – 2008. Age groups included are 1-10 in the survey and 3 – 14 in the catches.

Parameter estimates and assumptions used:

- Fishing mortality is estimated for every year and age. Fishing mortality of each age group was constrained with a random walk term 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.
- Catchability in the survey was dependent on stock size for ages 1-5.
- CV's of the commercial catch 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.
- Correlation of residuals of different age groups in the survey was estimated as a 1st order AR model. This is to take into account "year effects" in the survey.
- Migrations for specified years (y) in specified ages (a) are estimated (y=c(1958, 1959, 1960, 1962, 1964, 1969, 1970, 1972, 1980, 1981, 1990),a=(9, 9, 10, 9, 10, 8, 8, 9, 7, 8, 6)). The basis for allowing migration in these years and ages are anomalies in the catch and weight matrix.

The recruitment model, weight and maturity model (used for medium term projections):

- Recruitment was assumed to be lognormally distributed around a Ricker curve with the CV of the lognormal distribution estimated. Time trend in Rmax of the Ricker curve was allowed and CV of the residuals in the SSB-recruitment relationship depend on stock size. 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 1955 for the same spawning size of the spawning stock.
- The average weight at age in the catches and the spawning stock was assumed to be of the same as used for deterministic short term prediction. 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. Sexual maturity is fixed to that observed in the short term prediction with no CV modelled.
-

DIAGNOSTIC OF THE SPALY RUN: The diagnostic from the SPALY run are shown in tables and figures 9.4.1 and 9.4.2. The log residuals from the spring survey are generally small but with apparent year effects. Of notice is the largely positive residual blocks for ages 1 and 2 in the most recent years. This is because more recent survey estimates of pre-recruits are smaller than expected (section 9.2.3). The "corrections" of the final year class size are largely between the first, second and third measurements as is apparent in the relatively good diagnostics seen in the retrospective plot on the recruitment at age 3 (Figure 9.4.2b). Retrospective bias in the estimate of the reference biomass (Biomass of age 4 and older, B4+) is in the order of ±10%, with little indication of a persistent pattern in the last decade. The effect of the downward revision in pre-recruits in the recent years is thus not expected to affect the accuracy of the short term prediction and the advice (which is based on the B4+ in the assessment year). It may have a larger effect on the “short medium” term prediction if this pattern will persist, i.e. resulting in downward revision of the current estimates for year classes 2006 and 2007, that are now age 2 and 1. Overall, the addition of one more year of data indicate relatively little changes in the perception of the state of the reference stock and fishing mortalities compared with that estimated last year with the SPALY run (Table 9.4.7).

The relationship between the survey indices and estimated stock in numbers for age groups 1-9 for the SPALY run are shown in figure 9.4.3. The regression line is only fitted to the period 1985-2004, the period were the stock in number estimates are not likely to change with addition of new data. Relatively high correlation is observed for most age groups indicating a good consistency between the catch at age and the survey data. The crosshair shows the SPALY estimates of population numbers in 2008 and the spring survey measurements in 2008. No significant deviation from fitted line is observed except for age 7 (yearclass 2001), where the stock estimates are significantly lower than the most recent survey estimates. The reason for the deviation is that most prior measurements of this year class, both in the catches and in the survey, have indicated that this year class has been extremely small.

The fishing mortalities and stock in numbers by age are from the SPALY run are presented in tables 9.4.3 and 9.4.4.

THE TSA DIAGNOSTIC AND RESULTS (DETAILS IN WORKING DOCUMENT 16): Permanent changes in catchability of the fishing fleet, expressed by a random walk component in a second order polynomial in equation, are significant in estimation with data from 1985, but not from 1995, regardless of which survey is included.

The stock dependence, represented is highly significant for cod, estimated as 2.2 at age 1 and declining towards 1 in the oldest fish.

It is not possible to estimate separately residuals in the measurement equations for catch-at-age- and survey indices, stock equation and model of logF. Specifications including a substantial residual in the stock equation outclass any specifications without a residual in this equation in the likelihood function. The present estimates are obtained with this residual about 0.1 in all ages. When this is included, estimates of residuals of catch-at-age and logF become negligible in the best observed ages and are fixed here at 0.04, but the standard deviation of the catch-at-age residuals increases in the oldest ages and is about 0.2 at 11 years. The survey residuals are considerably higher, especially in the oldest and highest ages. These residuals include irregular variations in catchability which is also expressed by state variables which account for joint transitory variations over all ages and shifts between young and old ages.

There was no indication of a permanent component in the form of random walk in the catchability state variables.

The lowest estimate of the biomass 2008 from 4-11 years was 551 tousand tonnes with an estimated standard deviation about 38, obtained from the analysis including the March survey from 1985 to 2008 and modelling F. This is also the most accurate estimate according to the estimated standard deviation. When linear trend in catchability is included in the estimation it is estimated as -0.011 on a log-scale with a standard deviation of 0.008. The estimated biomass increases to 607 thous. t. with a standard deviation of 75. There is no indication of trend in catchability in the October survey. If only data from 1995 are included in the analysis with the March survey the trend is estimaed as -0.038 with a s.d. of 0.025 and the biomass 690 with a s.d. of 125.

The design and conduct of surveys aims at constant catchability. It is therefore a normal null hypothesis that catchability is constant and the results from the March survey do not provide a strong argument for rejecting it. But catchability can also change with conditions in the sea so that the null hypothesis is not very strong. The negative trend estimates, together with the result from the October survey, suggest that the trend-free estimate with the March survey is more likely to be an underestimate than an overestimate. Notice the big increase in the standard deviation of the estimated biomass when we give up the assumption of no permanent change in catchability of the survey and estimate linear trend.

There is also indication of environmental changes in the recruitment indices in the spring index in last few years. The standardized residuals are consistently negative and predictions have been systematically too high. It is not possible to distinguish variations in natural mortality from catchability variations in the index below catchable ages, but either or both could be the cause of this effect. This effect does not disappear by including trend in survey catchability. It is not apparent in the autumn survey.

There are no serious indications of misspecification in the residual statistics. The discrepancies in the retrospective analyses are of the order indicated by estimated standard deviations in estimates with the March survey but somewhat higher with the October survey.

The standardized residuals and model results for based on the spring survey are presented in table 9.4.5 and figure9.4.1 and the model result for the principal metrics in table 9.4.6. Results of other model runs are presented in working document 16.

COMPARISONS OF PRINCIPAL METRICS FROM MODELS RUN WITH THE SPRING SURVEY: Comparison of the principal assessment metrics for all the models run on the spring survey are given in table 9.4.7. The differences in the results are in most cases relatively small, implying that the assessment is not sensitive to various assumptions in the different models. The most important metric is the estimates of the reference biomass (B4+) in 2008 since that is the input in the catch rule that determines the TAC in the next fishing year. The 2008 stock estimates of the B4+ from the TSA are 551 thousand tonnes with a standard deviation of about 38 kt. The point estimator of the ADCAM SPALY run is somewhat higher or 590 kt with a standard deviation of about 44 kt. Since the estimates of the standard deviation are underestimates the difference between the two point estimates are not significant. Point estimates of other models tuned with the spring survey are somewhat higher, with XSA being the highest giving a point estimate of 663 kt in 2008. The estimates of the exploitation rate in 2007 ($Y_{2007}/B_{4+,2007}$) of the different models range from 25-28%.

9.5 Reference points

No limit reference points have been defined for this stock by ICES, because the harvest rule (see section 9.11) was implemented prior to ICES defining such reference points on a larger scale. ICES considered the 1995 harvest control rule to be consistent with the precautionary approach provided the implementation error is minimal.

The SG on Precautionary Reference Points for Advice on Fishery Management (SGPRP – February 2003) suggested a candidate for Blim "somewhere in the range of 400kt". Due to a change in the method used to calculate the spawning stock biomass (implemented in 2005) from using catch weight and maturity from the catches to using estimated stock weights and stock maturity at age the historical spawning stock estimates presently used are lower than the ones that SGPRP 2003 based their suggestion on.

9.6 State of the stock

The spawning stock has been relatively small in the last 35 year compared with the long term. It reached a historical low in 1993 (120 kt) but has since then increased and is estimated to be about 230 kt at present. Exploitation rate and fishing mortality have been lower after the implementation of the catch rule in 1995 compared with the past. The seven most recent year classes are estimated to be below the long-term average. The low recruitment is addition to historical low weight at age means that the productivity of the stock at present is very low.

9.7 Short term forecast

INPUT: The basis for the prediction for the weight in the catch in 2008, which are also used in the weight of the reference biomass (B_{4+}) were described in section 9.2.2. Weights in the catch and B_{4+} for 2009 onwards were assumed to be the same as those predicted for 2008. Weights and proportion mature in the spawning stock 2009 and onwards were assumed to be the same as measured in the mature fish in the spring survey in 2008 (tables 9.2.4 and 9.2.5). The fishing pattern used is the average of the years 2005-2007. Best estimate of landings of 135 kt for the current calendar year is used as a catch constraint in the year 2008. This is estimate is based on the TAC imposed on Icelandic fleet, with additional estimates of 5 kt catch by foreign fleets. Details of the inputs values used are shown in table 9.7.1.

OUTPUT: The catch in the next fishing year that corresponds to the 20% catch rule is 118 kt (Table 9.7.2). A buffer where the TAC in the current fishing year of 130 kt has a 50% weight results in a TAC of 124 kt. If the proportion landed relative to that caught remains constant, this is expected to result in a significant reduction in fishing mortality, going from a point estimate of 0.55 in 2007, to 0.39 in the assessment year and 0.33 in the advisory year. The catch rule

9.8 Medium term forecasts

The ADCAM framework was used for medium term (5 year ahead) simulation, the assumption and input being described in the method section (section 9.4). The projected landings removed were based on the following scenario:

$$Y_{y/y+1} = \frac{0.2B_{4+,y} + TAC_{y-1/y}}{2}$$

where the Y stands yield in the fishing year (y/y+1), TAC stands for the set TAC in the previous fishing year (y-1/y) and $B_{4+,y}$ is the estimated biomass in the assessment year. This scenario is in accordance with that advised domestically in 2007 as a medium term strategy, with the exception that the TAC stabilizer be not applied in the first year, i.e. in the fishing year 2007/2008. The simulation is only carried forward to the year 2012, since by restricting it to that time frame the spawning stock biomass estimates, in terms of numbers, are mostly determined by year classes where measurements are currently available. Median recruitment estimates (figure 9.8.1) are projected to be low relative to the long term, this being based on the assumptions that Rmax has declined over the time period from 1955 to 1995 (described in the method section 9.4).

The results (figure 9.8.1) indicate that there is a low probability that the spawning stock biomass (SSB) in 2012 will be lower than the medium value estimated in 2008. There is a high probability that the reference biomass (B_{4+}) will not change from the present and catches are most likely expected to remain similar as currently imposed. These latter metrics are more dependent of the Ricker function applied for predicting recruitment than that of the projection of the SSB. The reason that the median catches are not increasing at the same rate as the median reference biomass is because of the stabilizer imposed, since half of the TAC in the prediction year is a function of the TAC in the previous year.

A simulation (WD xxx??), where it is assumed that the downward revision of pre-recruits persist in the most recent year classes (section 9.4. Methods, DIAGNOSTICS OF THE SPALY RUN) show that it is unlikely under this newly amended catch rule that the spawning stock will decline from the present level.

9.9 Uncertainties in assessment and forecast

HISTORICAL ASSESSMENT UNCERTAINTIES: Relative to most southern gadoid stocks assessed by ICES the assessment of the Icelandic cod is likely to be a candidate that could be classified as precise, although the accuracy is unknown. The former is partly because three survey measurements (age 1 to 3) for each year class are available to assess year class strength before they actually enter the reference stock and the fisheries. Compared with last year assessment, the additional measurements have resulted in abundance estimates of incoming year classes being revised downwards, year class 2007 by 14% and year class 2006 by 6%. Since neither of these year classes have yet entered the reference stock (B_{4+}), and since fishing mortality estimates ($F_{5\text{-}10}$) are more or less in line with that predicted last year, those latter metrics are more or less the same as estimated last year.

SHORT TERM FORCAST: Uncertainties in the short term forecast have not been formally quantified, but are by nature larger than assessment uncertainties in the historical part. Given the above observation of having numerous measurements of incoming year classes before they enter the fisheries the short term forecast of numbers in considered reasonable precise. However, in recent years overestimations in prediction of weights, used for estimating reference biomass (B4+) have been on par with that of prediction in numbers. The estimates of the B4+ in the assessment year, which now is the basis for determining TAC in the advisory year, during the assessment period from 1991 to 2005 have on average been 12% higher relative to the current estimates.

9.10 Comparison with previous assessment and forecast

The estimates of reference fishing mortality in 2006 and the reference stock (B4+) and SSB in 2008 are very similar to that estimated last year. The retrospective pattern of recruitment estimates in recent years, both historical and analytical, indicates a minor but constantly downward revision of year classes 2001 and younger. Since these revisions are on pre-recruits that have not entered the fishery they have minor effect on the estimates of the post-recruit metrics.

9.11 Management plans and evaluations

THE 1995 HARVEST CONTROL RULE: A formal Harvest Control Rule was implemented for this stock in 1995. The TAC for a fishing year (y/y+1) was set as a fraction (25%) of the "available biomass" which was computed as average of the biomass of age 4 and older fish B(4+) in the assessment year (y) and advisory year (y+1). In mathematical terms the 1995 catch rule was:

$$TAC_{y/y+1} = 0.25\frac{B_y + B_{y+1}}{2}$$

In the long term, this was considered to correspond to a fishing mortality of about 0.4. ICES has considered the 1995 harvest control rule to be consistent with the precautionary approach provided the implementation error is minimal. This rule has been the basis for ICES advice since 1995 and resulted in a point value ICES advice for the fishing year 2007/2008 of 152 kt.

However, taking into account 1) two amendments in the catch rule that resulted at the time they were set in less stringent action in limiting catches in the next fishing year than would have been the case with the original rule, 2) experienced implementation problems and, 3) the assessment errors and biases in recent 10 years, ICES suggested in 2007 that the original plan should be re-evaluated. Furthermore, ICES advised last year that "Given the relatively high proportions of younger fish in the fishable as well as in the spawning-stock biomass, the relatively weak incoming year classes, and low capelin abundance, lower fishing mortalities than those obtained by the Harvest Control Rule should be considered. In order to ensure a high probability of the SSB increasing in the next 5 years, the exploitation rate must be reduced to no more than 20%."

NATIVE MANAGEMENT PLAN EVALUATIONS: The catch control rule was in a reviewing process in 2001-2004 by a group of experts, appointed by the Ministry of Fisheries. The composition of the group was principally the same as the one that did the risk analysis that resulted in the adoption of the original HCR rule. This group delivered a final report to the Minister in May 2004. It has not been published officially, is only available in Icelandic and the work has not been reviewed by ICES. Based on domestic review of the performance of the original HRC and simulation work the native group recommended a more precautionary HCR, based on using the average of last years TAC and between 18 to 22% of the estimated reference biomass (B4+) in the assessment year. The range in the percentage given was related to the size of the spawning stock, the percent taken being inversely related to the size of the spawning stock. The recommendation of the change in the reference biomass used in the multiplier, from being the average in the assessment year and the prediction year to only that of the assessment year was made to reduce the influence of assessment uncertainties and the influence of incoming recruits.

THE MANAGERS DECISION IN 2007 FOR TAC IN THE FISHING YEAR 2007/2008: The management action for the fishing year 2007/2008 was to reduce the exploitation rate from 25% to 20% with the addition of not taking into account the TAC in the previous fishing year. This resulted in an ITQ for the Icelandic fleet to be no more than 130 kt, compared with 178 kt catch implied by the amended catch rule that was in place the previous fishing year. At present it is unclear what the basis the managers will used to determine the TAC for the next fishing year.

9.12 Management considerations

Prior to allocating the ITQ catches to the Icelandic fishing fleet, the managers should ensure subtracting all expected catches from other sources, including likely catches of the foreign fleets, likely catches of Faroese inside their own EEZ and "research landings". The amount is not known in advance but is likely to be of the similar order of magnitude as last year.

Cod and haddock are often caught in the same fishing operation. The TAC constraint on cod expected to result in significant reduction in fishing mortalities. This reduction is not in line with current fishing mortality trends in haddock. Anecdotal information from the fisheries indicates that the restrictions on the landings of cod are presently changing the behaviour of the fishing fleet, fishermen trying to avoid catching cod but targeting haddock. A lower exploitation rate of the haddock is thus advisable, in particular to avoid potential increase in discarding and misreporting of cod.

9.13 Ecosystem considerations

In Icelandic waters there are a number of areas closed to fishing activities. Although relatively small at present, such no-take zones areas are likely to be important for protection biological communities and species diversity. Findings from a recent study show that closed areas can benefit several fish species such as cod. Recent practices of reducing the size of some of the areas where no fishing activity has taken place for numerous years are counter to prevalent thinking of the importance of no-take zones as well as counter to the ecosystem based approach to fisheries management.

During the last few years the capelin stock has been low. This low abundance as well as anecdotal information about the low abundance of sandeel may 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 on the capelin can not be ruled out.

9.14 Regulations and their effects

Exploitation rate and fishing mortality have been lower after the implementation of the catch rule in 1995 compared with the past.

A quick closure system has been in force since 1976, aimed at protecting juvenile fish. Fishing is prohibited, for at least two weeks, in areas where the number of small cod (< 55 cm) in the catches has been observed by inspectors to exceed 25%. A preliminary evaluation of the effectiveness of the system indicates that the relatively small areas closed for a short time do most likely not contribute much to the protection of juveniles. On the other hand, several consecutive quick closures often lead to closures of larger areas for a longer time and force the fleet to operate in other areas. The effect of these longer closures has not been evaluated analytically.

Since 1995, spawning areas have been closed for 2 3 weeks during the spawning season for all fisheries. The intent of this measure was to protect spawning fish. In 2005, the maximum allowed mesh size in gillnets was decreased to 8 inches in order to protect the largest spawners.

The mesh size in the codend in the trawling fishery was increased from 120 mm to 155 mm in 1977. Since 1998 the minimum codend mesh size allowed is 135 mm, provided that a so-called Polish cover is not used. Numerous areas are closed temporarily or permanently for all fisheries or specific gears for protecting juveniles and habitat, or for socio-political reasons. The effects of these measures have not been evaluated.

9.15 Changes in fishing technology and fishing patterns

Changes in the importance of the various gears used to catch cod are described in section 9.3. The decline in the gill net fishery and the increase in the long line fishery are likely to have resulted in shift in the fishing pattern to smaller age groups. The increase in the long line fishery in the north is partly the reason for the decline in the observed mean weight at age in the catches.

Anecdotal information from the fishing industry in recent months indicate that to minimize cod catches due to the low TAC set, has resulted in the fleet shifting to somewhat shallower water. It has been hypothesised that this may lead to smaller size and age composition in the total catches. This hypothesis has not been confronted with data.

9.16 Changes in the environment

An increased inflow of Atlantic water has been observed in Icelandic waters since 1997, resulting in higher temperature and higher salinity in the Icelandic waters. At present no relationships have been demonstrated between these environmental indicators and cod recruitment. A northward shift in distribution of immature capelin may be linked to these hydrographical changes, resulting in lower availability of capelin as fodder for cod.

In the past, weights-at-age of the cod have been clearly related to the biomass of capelin. The recent reduced mean weights-at-age are likely to be linked to the low abundance of capelin from the feeding areas for cod. These low weights were also used in forecasts, because estimates of the capelin biomass indicate that it will remain low.

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

9.17 References

Gudmundsson, G. 1994. Time series analysis of catch-at-age observations. Applied Statistics, 43: 117-126.

Gudmundsson, G. 2004. Time-series analysis of abundance indices of young fish. ICES Journal of Marine Science: Journal du Conseil 2004 61(2):176-183

Ólafur K. Pálsson, Ari Arason, Eyþór Björnsson, Guðmundur Jóhannesson, Höskuldur Björnsson and Þórhallur Ottesen. 2007. Discards in demersal Icelandic fisheries 2006. Marine Research Institute, report series no. 134

Shepherd, J.G. and M.D. Nicholson. 1991. Multiplicative modelling of catch-at-age data, and its application to catch forecasts. Journal du Conseil international pour l'Exploration de la Mer 47, 284–294.

Table 9.2.1. Icelandic cod in division Va. Nominal catches (tonnes) by countries 1973-2007 as officially reported to ICES and WG best estimates of landings.

Year	Belgium	Faeroe Islands	France	Germany	Germany, Fed. Rep. of	Greenland	Iceland	Norway	Poland	UK - Eng+Wales+N.Irl.	UK - England & Wales	UK - Scotland	UK	Sum	WG estimates	Difference
1973	1110	14207	-	.	6839	-	235184	268	-	.	121320	957		379885	369205	-10680
1974	1128	12125	203	.	5554	-	238066	171	1	.	115395	2144		374787	368133	-6654
1975	1269	9440	23	.	2266	-	264975	144	-	.	91000	1897		371014	364754	-6260
1976	956	8772	-	.	2970	-	280831	514	-	.	53534	786		348363	346253	-2110
1977	1408	7261	-	.	1598	-	329676	108	-	.	-	-		340051	340086	35
1978	1314	7069	-	.	-	-	319648	189	-	.	-	-		328220	329602	1382
1979	1485	6163	-	.	-	-	360077	288	-	.	-	-		368013	366462	-1551
1980	840	4802	-	.	-	-	429044	358	-	.	-	-		435044	432237	-2807
1981	1321	6183	-	.	-	-	461038	559	-	.	-	-		469101	465032	-4069
1982	236	5297	-	.	-	-	382297	557	-	.	-	-		388387	380068	-8319
1983	188	5626	-	.	-	-	293890	109	-	.	-	-		299813	298049	-1764
1984	254	2041	-	.	-	-	281481	90	-	.	2	-		283868	282022	-1846
1985	207	2203	-	.	-	-	322810	46	-	.	1	-		325267	323428	-1839
1986	226	2554	-	.	-	-	365852	1	-	.	-	-		368633	364797	-3836
1987	597	1848	-	.	-	-	389808	4	-	.	-	-		392257	389915	-2342
1988	365	1966	-	.	-	-	375741	4	-	.	-	-		378076	377554	-522
1989	309	2012	-	.	-	-	353985	3	-	-	.	-		356309	363125	6816
1990	260	1782	-	.	-	-	333348	-	-	-	.	-		335390	335316	-74
1991	548	1323	-	-	.	-	306697	-	-	-	.	-		308568	307759	-809
1992	222	883	-	-	.	-	266662	-	-	-	.	-		267767	264834	-2933
1993	145	664	-	-	.	-	251170	-	-	<0.5	.	-		251979	250704	-1275
1994	136	754	-	-	.	-	177919	-	-	-	.	-		178809	178138	-671
1995	-	739	-	-	.	-	168685	-	-	-	.	-		169424	168592	-832
1996	-	599	-	<0.5	.	-	181052	7	-	-	.	-		181658	180701	-957
1997	-	408	-	-	.	-	202745	-	-	-	.	-		203153	203112	-41
1998	-	1078	-	9	.	-	241545	-	-	-	.	-		242632	243987	1355
1999	-	1247	.	21	.	25	258658	85	-	12	.	4		260052	260147	95
2000	-	.	-	15	.	-	234362	60	-	10	.	<0.5		234447	235092	645
2001	-	1143	-	11	.	-	233875	65	-	15	.	5		235114	234229	-885
2002	-	1175	-	15	.	-	206987	73	-	19	.	13		208282	208487	205
2003	-	2118	-	88	.	-	200327	56	-	104	.	42		202735	207543	4808
2004	-	2737	-	113	.	-	220020	90	-	310	.	102		223372	226762	3390
2005	-	2310	.	177	.	.	206343	77	-	224	.	220		209351	213403	4052
2006	-	1665	-	38	.	.	193425	78	-	15	.	5		195226	196276	1050
2007	-	1760	-	-	-	-	-	110	-	-	-	-	11	1880.6	170622	168741

Table 9.2.2. Icelandic cod in Division Va. Observed catch in numbers by year and age in millions of fish in 1955-2007. The 2008 catches are estimates based on a landing estimates of 135 kt, the 2009 estimates are based on prediction from the adopted model applying a 20% catch rule with a buffer.

Year/age	3	4	5	6	7	8	9	10	11	12	13	14
1955	4.790	25.164	46.566	28.287	10.541	5.224	2.467	25.182	2.101	1.202	1.668	0.665
1956	6.709	17.265	31.030	27.793	14.389	4.261	3.429	2.128	16.820	1.552	1.522	1.545
1957	13.240	21.278	17.515	24.569	17.634	12.296	3.568	2.169	1.171	6.822	0.512	1.089
1958	25.237	30.742	14.298	10.859	15.997	15.822	12.021	2.003	2.125	0.771	3.508	0.723
1959	18.394	37.650	23.901	7.682	5.883	8.791	13.003	7.683	0.914	0.990	0.218	1.287
1960	14.830	28.642	27.968	14.120	8.387	6.089	6.393	11.600	3.526	0.692	0.183	0.510
1961	16.507	21.808	19.488	15.034	7.900	6.925	3.969	3.211	6.756	1.202	0.089	0.425
1962	13.514	28.526	18.924	14.650	12.045	4.276	8.809	2.664	1.883	2.988	0.405	0.324
1963	18.507	28.466	19.664	11.314	15.682	7.704	2.724	6.508	1.657	1.030	1.372	0.246
1964	19.287	28.845	18.712	11.620	7.936	18.032	5.040	1.437	2.670	0.655	0.370	1.025
1965	21.658	29.586	24.783	11.706	9.334	6.394	11.122	1.477	0.823	0.489	0.118	0.489
1966	17.910	30.649	20.006	13.872	5.942	7.586	2.320	5.583	0.407	0.363	0.299	0.311
1967	25.945	27.941	24.322	11.320	8.751	2.595	5.490	1.392	1.998	0.109	0.030	0.106
1968	11.933	47.311	22.344	16.277	15.590	7.059	1.571	2.506	0.512	0.659	0.047	0.098
1969	11.149	23.925	45.445	17.397	12.559	14.811	1.590	0.475	0.340	0.064	0.024	0.021
1970	9.876	47.210	23.607	25.451	15.196	12.261	14.469	0.567	0.207	0.147	0.035	0.050
1971	13.060	35.856	45.577	21.135	17.340	10.924	6.001	4.210	0.237	0.069	0.038	0.020
1972	8.973	29.574	30.918	22.855	11.097	9.784	10.538	3.938	1.242	0.119	0.031	0.001
1973	36.538	25.542	27.391	17.045	12.721	3.685	4.718	5.809	1.134	0.282	0.007	0.001
1974	14.846	61.826	21.824	14.413	8.974	6.216	1.647	2.530	1.765	0.334	0.062	0.028
1975	29.301	29.489	44.138	12.088	9.628	3.691	2.051	0.752	0.891	0.416	0.060	0.046
1976	23.578	39.790	21.092	24.395	5.803	5.343	1.297	0.633	0.205	0.155	0.065	0.029
1977	2.614	42.659	32.465	12.162	13.017	2.809	1.773	0.421	0.086	0.024	0.006	0.002
1978	5.999	16.287	43.931	17.626	8.729	4.119	0.978	0.348	0.119	0.048	0.015	0.027
1979	7.186	28.427	13.772	34.443	14.130	4.426	1.432	0.350	0.168	0.043	0.024	0.004
1980	4.348	28.530	32.500	15.119	27.090	7.847	2.228	0.646	0.246	0.099	0.025	0.004
1981	2.118	13.297	39.195	23.247	12.710	26.455	4.804	1.677	0.582	0.228	0.053	0.068
1982	3.285	20.812	24.462	28.351	14.012	7.666	11.517	1.912	0.327	0.094	0.043	0.011
1983	3.554	10.910	24.305	18.944	17.382	8.381	2.054	2.733	0.514	0.215	0.064	0.037
1984	6.750	31.553	19.420	15.326	8.082	7.336	2.680	0.512	0.538	0.195	0.090	0.036
1985	6.457	24.552	35.392	18.267	8.711	4.201	2.264	1.063	0.217	0.233	0.102	0.038
1986	20.642	20.330	26.644	30.839	11.413	4.441	1.771	0.805	0.392	0.103	0.076	0.044
1987	11.002	62.130	27.192	15.127	15.695	4.159	1.463	0.592	0.253	0.142	0.046	0.058
1988	6.713	39.323	55.895	18.663	6.399	5.877	1.345	0.455	0.305	0.157	0.114	0.025
1989	2.605	27.983	50.059	31.455	6.010	1.915	0.881	0.225	0.107	0.086	0.038	0.005
1990	5.785	12.313	27.179	44.534	17.037	2.573	0.609	0.322	0.118	0.050	0.015	0.020
1991	8.554	25.131	15.491	21.514	25.038	6.364	0.903	0.243	0.125	0.063	0.011	0.012
1992	12.217	21.708	26.524	11.413	10.073	8.304	2.006	0.257	0.046	0.032	0.009	0.008
1993	20.500	33.078	15.195	13.281	3.583	2.785	2.707	1.181	0.180	0.034	0.011	0.013
1994	6.160	24.142	19.666	6.968	4.393	1.257	0.599	0.508	0.283	0.049	0.018	0.006
1995	10.770	9.103	16.829	13.066	4.115	1.596	0.313	0.184	0.156	0.141	0.029	0.008
1996	5.356	14.886	7.372	12.307	9.429	2.157	0.837	0.208	0.076	0.065	0.055	0.005
1997	1.722	16.442	17.298	6.711	7.379	5.958	1.147	0.493	0.126	0.028	0.037	0.021
1998	3.458	7.707	25.394	20.167	5.893	3.856	2.951	0.500	0.196	0.055	0.033	0.013
1999	2.525	19.554	15.226	24.622	12.966	2.795	1.489	0.748	0.140	0.046	0.010	0.005
2000	10.493	6.581	29.080	11.227	11.390	5.714	1.104	0.567	0.314	0.074	0.022	0.006
2001	11.338	25.040	9.311	19.471	5.620	3.929	2.017	0.452	0.202	0.118	0.013	0.009
2002	5.934	18.482	24.297	6.874	8.943	2.227	1.353	0.689	0.123	0.040	0.041	0.002
2003	3.950	16.160	21.874	18.145	5.063	4.419	1.124	0.401	0.172	0.034	0.020	0.015
2004	1.778	19.184	25.003	17.384	9.926	2.734	2.023	0.481	0.126	0.062	0.014	0.005
2005	5.102	5.125	26.749	16.980	8.339	4.682	1.292	0.913	0.203	0.089	0.025	0.002
2006	3.258	12.884	8.438	22.041	10.418	4.523	2.194	0.497	0.336	0.067	0.027	0.002
2007	2.074	11.961	15.948	8.280	9.593	5.428	2.205	1.229	0.366	0.198	0.053	0.010
2008	2.625	5.290	11.898	13.141	3.343	4.580	1.913	0.784	0.329	0.048	0.035	0.005
2009	1.915	8.028	6.930	10.295	7.530	1.838	2.348	0.955	0.352	0.150	0.020	0.014

Table 9.2.3. Icelandic cod in Division Va. Observed mean weight at age in the landings (kg) in period the 1955-2007. The weights for age groups 3 to 9 in 2008 are based on predictions from the 2008 survey measurements, weight for 2009 onwards are set equal to those in 2008. The weights in the catches are used to calculate the reference biomass (B4+).

Year/age	3	4	5	6	7	8	9	10	11	12	13	14
1955	0.827	1.307	2.157	3.617	4.638	5.657	6.635	6.168	8.746	8.829	10.086	14.584
1956	1.080	1.600	2.190	3.280	4.650	5.630	6.180	6.970	6.830	9.290	10.965	12.954
1957	1.140	1.710	2.520	3.200	4.560	5.960	7.170	7.260	8.300	8.290	10.350	13.174
1958	1.210	1.810	3.120	4.510	5.000	5.940	6.640	8.290	8.510	8.840	9.360	13.097
1959	1.110	1.950	2.930	4.520	5.520	6.170	6.610	7.130	8.510	8.670	9.980	11.276
1960	1.060	1.720	2.920	4.640	5.660	6.550	6.910	7.140	7.970	10.240	10.100	12.871
1961	1.020	1.670	2.700	4.330	5.530	6.310	6.930	7.310	7.500	8.510	9.840	14.550
1962	0.990	1.610	2.610	3.900	5.720	6.660	6.750	7.060	7.540	8.280	10.900	12.826
1963	1.250	1.650	2.640	3.800	5.110	6.920	7.840	7.610	8.230	9.100	9.920	11.553
1964	1.210	1.750	2.640	4.020	5.450	6.460	8.000	9.940	9.210	10.940	12.670	15.900
1965	1.020	1.530	2.570	4.090	5.410	6.400	7.120	8.600	12.310	10.460	10.190	17.220
1966	1.170	1.680	2.590	4.180	5.730	6.900	7.830	8.580	9.090	14.230	14.090	17.924
1967	1.120	1.820	2.660	4.067	5.560	7.790	7.840	8.430	9.090	10.090	14.240	16.412
1968	1.170	1.590	2.680	3.930	5.040	5.910	7.510	8.480	10.750	11.580	14.640	16.011
1969	1.100	1.810	2.480	3.770	5.040	5.860	7.000	8.350	8.720	10.080	11.430	13.144
1970	0.990	1.450	2.440	3.770	4.860	5.590	6.260	8.370	10.490	12.310	14.590	21.777
1971	1.090	1.570	2.310	2.980	4.930	5.150	5.580	6.300	8.530	11.240	14.740	17.130
1972	0.980	1.460	2.210	3.250	4.330	5.610	6.040	6.100	6.870	8.950	11.720	16.000
1973	1.030	1.420	2.470	3.600	4.900	6.110	6.670	6.750	7.430	7.950	10.170	17.000
1974	1.050	1.710	2.430	3.820	5.240	6.660	7.150	7.760	8.190	9.780	12.380	14.700
1975	1.100	1.770	2.780	3.760	5.450	6.690	7.570	8.580	8.810	9.780	10.090	11.000
1976	1.350	1.780	2.650	4.100	5.070	6.730	8.250	9.610	11.540	11.430	14.060	16.180
1977	1.259	1.911	2.856	4.069	5.777	6.636	7.685	9.730	11.703	14.394	17.456	24.116
1978	1.289	1.833	2.929	3.955	5.726	6.806	9.041	10.865	13.068	11.982	19.062	21.284
1979	1.408	1.956	2.642	3.999	5.548	6.754	8.299	9.312	13.130	13.418	13.540	20.072
1980	1.392	1.862	2.733	3.768	5.259	6.981	8.037	10.731	12.301	17.281	14.893	19.069
1981	1.180	1.651	2.260	3.293	4.483	5.821	7.739	9.422	11.374	12.784	12.514	19.069
1982	1.006	1.550	2.246	3.104	4.258	5.386	6.682	9.141	11.963	14.226	17.287	16.590
1983	1.095	1.599	2.275	3.021	4.096	5.481	7.049	8.128	11.009	13.972	15.882	18.498
1984	1.288	1.725	2.596	3.581	4.371	5.798	7.456	9.851	11.052	14.338	15.273	16.660
1985	1.407	1.971	2.576	3.650	4.976	6.372	8.207	10.320	12.197	14.683	16.175	19.050
1986	1.459	1.961	2.844	3.593	4.635	6.155	7.503	9.084	10.356	15.283	14.540	15.017
1987	1.316	1.956	2.686	3.894	4.716	6.257	7.368	9.243	10.697	10.622	15.894	12.592
1988	1.438	1.805	2.576	3.519	4.930	6.001	7.144	8.822	9.977	11.732	14.156	13.042
1989	1.186	1.813	2.590	3.915	5.210	6.892	8.035	9.831	11.986	10.003	12.611	16.045
1990	1.290	1.704	2.383	3.034	4.624	6.521	8.888	10.592	10.993	14.570	15.732	17.290
1991	1.309	1.899	2.475	3.159	3.792	5.680	7.242	9.804	9.754	14.344	14.172	20.200
1992	1.289	1.768	2.469	3.292	4.394	5.582	6.830	8.127	12.679	13.410	15.715	11.267
1993	1.392	1.887	2.772	3.762	4.930	6.054	7.450	8.641	10.901	12.517	14.742	16.874
1994	1.443	2.063	2.562	3.659	5.117	6.262	7.719	8.896	10.847	12.874	14.742	17.470
1995	1.348	1.959	2.920	3.625	5.176	6.416	7.916	10.273	11.022	11.407	13.098	15.182
1996	1.457	1.930	3.132	4.141	4.922	6.009	7.406	9.772	10.539	13.503	13.689	16.194
1997	1.484	1.877	2.878	4.028	5.402	6.386	7.344	8.537	10.797	11.533	10.428	12.788
1998	1.230	1.750	2.458	3.559	5.213	7.737	7.837	9.304	10.759	14.903	16.651	18.666
1999	1.241	1.716	2.426	3.443	4.720	6.352	8.730	9.946	11.088	12.535	14.995	15.151
2000	1.308	1.782	2.330	3.252	4.690	5.894	7.809	9.203	10.240	11.172	13.172	17.442
2001	1.499	2.050	2.649	3.413	4.766	6.508	7.520	9.055	8.769	9.526	11.210	13.874
2002	1.294	1.926	2.656	3.680	4.720	6.369	7.808	9.002	10.422	13.402	9.008	16.893
2003	1.265	1.790	2.424	3.505	4.455	5.037	5.980	7.819	8.802	10.712	12.152	13.797
2004	1.257	1.771	2.323	3.312	4.269	5.394	5.872	7.397	10.808	11.569	13.767	12.955
2005	1.194	1.712	2.374	3.435	4.392	5.201	6.200	5.495	7.211	9.909	12.944	18.151
2006	1.070	1.614	2.185	3.052	4.347	5.177	5.382	5.769	6.258	5.688	7.301	15.412
2007	1.083	1.556	2.144	2.754	3.920	5.255	6.272	6.481	7.142	6.530	9.724	10.143
2008	1.019	1.522	2.296	3.019	3.901	5.095	6.400	6.481	7.142	6.530	9.724	10.143
2009	1.019	1.522	2.296	3.019	3.901	5.095	6.400	6.481	7.142	6.530	9.724	10.143
2010	1.019	1.522	2.296	3.019	3.901	5.095	6.400	6.481	7.142	6.530	9.724	10.143
2011	1.019	1.522	2.296	3.019	3.901	5.095	6.400	6.481	7.142	6.530	9.724	10.143
2012	1.019	1.522	2.296	3.019	3.901	5.095	6.400	6.481	7.142	6.530	9.724	10.143

Table 9.2.4. Icelandic cod in Division Va. Estimated weight at age in the spawning stock (kg) in period the 1955-2008. The weights for the period 2009 onward are set equal to those in 2008. These weights are used to calculate the spawning stock biomass (SSB).

Year/age	3	4	5	6	7	8	9	10	11	12	13	14
1955	0.645	1.019	1.833	3.183	4.128	5.657	6.635	6.168	8.746	8.829	10.086	14.584
1956	0.645	1.248	1.862	2.886	4.138	5.630	6.180	6.970	6.830	9.290	10.965	12.954
1957	0.645	1.334	2.142	2.816	4.058	5.960	7.170	7.260	8.300	8.290	10.350	13.174
1958	0.645	1.412	2.652	3.969	4.450	5.940	6.640	8.290	8.510	8.840	9.360	13.097
1959	0.645	1.521	2.490	3.978	4.913	6.170	6.610	7.130	8.510	8.670	9.980	11.276
1960	0.645	1.342	2.482	4.083	5.037	6.550	6.910	7.140	7.970	10.240	10.100	12.871
1961	0.645	1.303	2.295	3.810	4.922	6.310	6.930	7.310	0.750	8.510	9.840	14.550
1962	0.645	1.256	2.218	3.432	5.091	6.660	6.750	7.060	7.540	8.280	10.900	12.826
1963	0.645	1.287	2.244	3.344	4.548	6.920	7.840	7.610	8.230	9.100	9.920	11.553
1964	0.645	1.365	2.244	3.538	4.850	6.460	8.000	9.940	9.210	10.940	12.670	15.900
1965	0.645	1.193	2.184	3.599	4.815	6.400	7.120	8.600	12.310	10.460	10.190	17.220
1966	0.645	1.310	2.202	3.678	5.100	6.900	7.830	8.580	9.090	14.230	14.090	17.924
1967	0.645	1.420	2.261	3.579	4.948	7.790	7.840	8.430	9.090	10.090	14.240	16.412
1968	0.645	1.240	2.278	3.458	4.486	5.910	7.510	8.480	10.750	11.580	14.640	16.011
1969	0.645	1.412	2.108	3.318	4.486	5.860	7.000	8.350	8.720	10.080	11.430	13.144
1970	0.645	1.131	2.074	3.318	4.325	5.590	6.260	8.370	10.490	12.310	14.590	21.777
1971	0.645	1.225	1.964	2.622	4.388	5.150	5.580	6.300	8.530	11.240	14.740	17.130
1972	0.645	1.139	1.878	2.860	3.854	5.610	6.040	6.100	6.870	8.950	11.720	16.000
1973	0.645	1.108	2.100	3.168	4.361	6.110	6.670	6.750	7.430	7.950	10.170	17.000
1974	0.645	1.334	2.066	3.362	4.664	6.660	7.150	7.760	8.190	9.780	12.380	14.700
1975	0.645	1.381	2.363	3.309	4.850	6.690	7.570	8.580	8.810	9.780	10.090	11.000
1976	0.645	1.388	2.252	3.608	4.512	6.730	8.250	9.610	11.540	11.430	14.060	16.180
1977	0.645	1.491	2.428	3.581	5.142	6.636	7.685	9.730	11.703	14.394	17.456	24.116
1978	0.645	1.430	2.490	3.480	5.096	6.806	9.041	10.865	13.068	11.982	19.062	21.284
1979	0.645	1.526	2.246	3.519	4.938	6.754	8.299	9.312	13.130	13.418	13.540	20.072
1980	0.645	1.452	2.323	3.316	4.681	6.981	8.037	10.731	12.301	17.281	14.893	19.069
1981	0.645	1.288	1.921	2.898	3.990	5.821	7.739	9.422	11.374	12.784	12.514	19.069
1982	0.645	1.209	1.909	2.732	3.790	5.386	6.682	9.141	11.963	14.226	17.287	16.590
1983	0.645	1.247	1.934	2.658	3.645	5.481	7.049	8.128	11.009	13.972	15.882	18.498
1984	0.645	1.346	2.207	3.151	3.890	5.798	7.456	9.851	11.052	14.338	15.273	16.660
1985	0.485	1.375	1.750	2.709	3.454	6.372	8.207	10.320	12.197	14.683	16.175	19.050
1986	0.758	1.597	2.882	3.246	4.581	6.155	7.503	9.084	10.356	15.283	14.540	15.017
1987	0.576	1.584	2.423	3.522	4.905	6.257	7.368	9.243	10.697	10.622	15.894	12.592
1988	0.610	1.475	2.261	3.277	4.398	6.001	7.144	8.822	9.977	11.732	14.156	13.042
1989	0.673	1.494	2.338	3.429	4.686	6.892	8.035	9.831	11.986	10.003	12.611	16.045
1990	0.563	1.035	2.170	2.798	4.422	6.521	8.888	10.592	10.993	14.570	15.732	17.290
1991	0.686	1.283	2.039	2.747	3.397	5.680	7.242	9.804	9.754	14.344	14.172	20.200
1992	0.619	1.336	2.094	3.029	3.753	5.582	6.830	8.127	12.679	13.410	15.715	11.267
1993	0.708	1.363	2.309	3.235	4.109	6.054	7.450	8.641	10.901	12.517	14.742	16.874
1994	0.847	1.728	2.254	3.340	4.514	6.262	7.719	8.896	10.847	12.874	14.742	17.470
1995	0.745	1.635	2.345	3.186	4.489	6.416	7.916	10.273	11.022	11.407	13.098	15.182
1996	0.678	1.753	2.490	3.531	4.273	6.009	7.406	9.772	10.539	13.503	13.689	16.194
1997	0.670	1.347	2.267	3.746	5.245	6.386	7.344	8.537	10.797	11.533	10.428	12.788
1998	0.599	1.516	2.261	3.263	4.474	7.737	7.837	9.304	10.759	14.903	16.651	18.666
1999	0.711	1.467	1.932	2.996	3.961	6.352	8.730	9.946	11.088	12.535	14.995	15.151
2000	0.600	1.355	1.915	2.881	4.319	5.894	7.809	9.203	10.240	11.172	13.172	17.442
2001	0.661	1.550	2.071	2.694	4.131	6.508	7.520	9.055	8.769	9.526	11.210	13.874
2002	0.630	1.590	2.259	3.120	3.984	6.369	7.808	9.002	10.422	13.402	9.008	16.893
2003	0.900	1.338	2.215	2.988	4.169	5.037	5.980	7.819	8.802	10.712	12.152	13.797
2004	0.900	1.453	2.099	3.057	3.757	5.394	5.872	7.397	10.808	11.569	13.767	12.955
2005	0.900	1.119	1.897	2.963	3.874	5.201	6.200	5.495	7.211	9.909	12.944	18.151
2006	0.900	1.383	1.998	2.905	4.385	5.177	5.382	5.769	6.258	5.688	7.301	15.412
2007	0.900	1.264	2.022	2.580	4.078	5.255	6.272	6.481	7.142	6.530	9.724	10.143
2008	0.912	1.841	2.227	2.924	3.920	5.095	6.400	6.481	7.142	6.530	9.724	10.143
2009	0.912	1.841	2.227	2.924	3.920	5.095	6.400	6.481	7.142	6.530	9.724	10.143
2010	0.912	1.841	2.227	2.924	3.920	5.095	6.400	6.481	7.142	6.530	9.724	10.143
2011	0.912	1.841	2.227	2.924	3.920	5.095	6.400	6.481	7.142	6.530	9.724	10.143
2012	0.912	1.841	2.227	2.924	3.920	5.095	6.400	6.481	7.142	6.530	9.724	10.143

Table 9.2.5. Icelandic cod in Division Va. Estimated maturity at age in period the 1955-2008. The maturity for the period 2009 onward are set equal to those in 2008.

Year/age	3	4	5	6	7	8	9	10	11	12	13	14
1955	0.019	0.022	0.033	0.181	0.577	0.782	0.834	0.960	1.000	1.000	1.000	1.000
1956	0.019	0.025	0.033	0.111	0.577	0.782	0.818	0.980	0.980	1.000	1.000	1.000
1957	0.019	0.026	0.043	0.100	0.549	0.801	0.842	0.990	1.000	1.000	1.000	1.000
1958	0.019	0.028	0.086	0.520	0.682	0.801	0.834	1.000	1.000	1.000	1.000	1.000
1959	0.019	0.029	0.070	0.535	0.772	0.818	0.834	0.990	1.000	1.000	1.000	1.000
1960	0.019	0.026	0.066	0.577	0.782	0.826	0.834	0.990	1.000	1.000	1.000	1.000
1961	0.019	0.025	0.053	0.450	0.772	0.818	0.834	0.990	0.990	1.000	1.000	1.000
1962	0.019	0.025	0.048	0.281	0.791	0.834	0.834	0.990	0.990	1.000	1.000	1.000
1963	0.019	0.025	0.048	0.237	0.706	0.834	0.849	1.000	1.000	1.000	1.000	1.000
1964	0.019	0.026	0.048	0.329	0.762	0.826	0.849	1.000	1.000	1.000	1.000	1.000
1965	0.019	0.025	0.045	0.354	0.751	0.826	0.842	1.000	1.000	1.000	1.000	1.000
1966	0.019	0.026	0.045	0.394	0.791	0.849	0.849	1.000	1.000	1.000	1.000	1.000
1967	0.019	0.028	0.051	0.341	0.772	0.842	0.849	1.000	1.000	1.000	1.000	1.000
1968	0.019	0.025	0.051	0.292	0.682	0.801	0.842	1.000	1.000	1.000	1.000	1.000
1969	0.019	0.028	0.043	0.227	0.682	0.801	0.842	1.000	1.000	1.000	1.000	1.000
1970	0.019	0.023	0.041	0.227	0.644	0.772	0.818	1.000	1.000	1.000	1.000	1.000
1971	0.019	0.025	0.037	0.074	0.657	0.706	0.772	0.979	0.994	0.982	0.993	1.000
1972	0.019	0.023	0.035	0.106	0.450	0.772	0.809	0.979	0.994	0.982	0.993	1.000
1973	0.022	0.028	0.163	0.382	0.697	0.801	0.834	0.996	0.996	1.000	1.000	1.000
1974	0.020	0.031	0.085	0.346	0.636	0.790	0.818	0.989	1.000	1.000	1.000	1.000
1975	0.020	0.035	0.118	0.287	0.715	0.809	0.839	1.000	1.000	1.000	1.000	1.000
1976	0.025	0.026	0.086	0.253	0.406	0.797	0.841	1.000	1.000	1.000	1.000	1.000
1977	0.019	0.024	0.060	0.382	0.742	0.817	0.842	1.000	1.000	1.000	1.000	1.000
1978	0.025	0.025	0.052	0.192	0.737	0.820	0.836	1.000	1.000	1.000	1.000	1.000
1979	0.019	0.021	0.053	0.282	0.635	0.790	0.836	0.919	1.000	1.000	1.000	1.000
1980	0.026	0.021	0.047	0.225	0.653	0.777	0.834	0.977	1.000	0.964	1.000	1.000
1981	0.019	0.022	0.030	0.090	0.448	0.751	0.811	0.962	0.988	1.000	1.000	1.000
1982	0.021	0.025	0.038	0.065	0.297	0.705	0.815	0.967	1.000	1.000	1.000	1.000
1983	0.019	0.030	0.047	0.116	0.264	0.530	0.715	0.979	0.985	1.000	1.000	1.000
1984	0.019	0.024	0.053	0.169	0.444	0.620	0.716	0.949	0.969	0.948	1.000	1.000
1985	0.000	0.021	0.185	0.412	0.495	0.735	0.572	1.000	1.000	1.000	1.000	1.000
1986	0.001	0.023	0.149	0.395	0.682	0.734	0.941	0.962	0.988	1.000	1.000	1.000
1987	0.002	0.033	0.093	0.360	0.490	0.885	0.782	1.000	0.979	1.000	1.000	1.000
1988	0.006	0.029	0.225	0.511	0.448	0.683	0.937	0.946	0.974	0.821	1.000	1.000
1989	0.008	0.025	0.142	0.372	0.645	0.652	0.634	0.991	1.000	0.903	0.859	1.000
1990	0.006	0.012	0.155	0.437	0.581	0.796	0.814	0.986	1.000	1.000	1.000	1.000
1991	0.000	0.055	0.149	0.369	0.637	0.790	0.682	0.842	1.000	1.000	1.000	1.000
1992	0.002	0.062	0.265	0.402	0.813	0.917	0.894	1.000	1.000	1.000	1.000	1.000
1993	0.006	0.085	0.267	0.464	0.693	0.801	0.843	0.968	1.000	1.000	1.000	1.000
1994	0.008	0.110	0.339	0.591	0.702	0.917	0.698	0.852	0.985	1.000	1.000	1.000
1995	0.005	0.109	0.384	0.528	0.752	0.787	0.859	1.000	1.000	1.000	1.000	1.000
1996	0.002	0.031	0.186	0.499	0.650	0.733	0.812	1.000	1.000	0.986	0.971	1.000
1997	0.006	0.037	0.246	0.424	0.685	0.787	0.804	0.932	1.000	0.913	1.000	1.000
1998	0.000	0.061	0.209	0.491	0.782	0.814	0.810	0.925	0.998	1.000	1.000	1.000
1999	0.012	0.044	0.239	0.516	0.649	0.835	0.687	0.988	1.000	1.000	1.000	1.000
2000	0.001	0.065	0.248	0.512	0.611	0.867	0.998	0.980	1.000	1.000	1.000	1.000
2001	0.004	0.043	0.261	0.589	0.750	0.742	0.862	0.987	1.000	1.000	1.000	1.000
2002	0.008	0.086	0.322	0.656	0.759	0.920	0.550	0.979	1.000	1.000	1.000	1.000
2003	0.005	0.046	0.218	0.524	0.870	0.798	0.860	0.998	1.000	1.000	1.000	1.000
2004	0.000	0.038	0.246	0.549	0.626	0.843	0.816	0.990	1.000	1.000	1.000	1.000
2005	0.006	0.109	0.282	0.495	0.791	0.814	0.951	0.990	1.000	1.000	1.000	1.000
2006	0.002	0.023	0.294	0.448	0.751	0.869	0.743	1.000	1.000	1.000	1.000	1.000
2007	0.012	0.032	0.159	0.500	0.693	0.795	0.862	0.960	0.924	1.000	1.000	1.000
2008	0.001	0.041	0.275	0.550	0.730	0.826	0.846	0.954	0.736	1.000	1.000	1.000
2009	0.001	0.041	0.275	0.550	0.730	0.826	0.846	0.954	0.736	1.000	1.000	1.000
2010	0.001	0.041	0.275	0.550	0.730	0.826	0.846	0.954	0.736	1.000	1.000	1.000
2011	0.001	0.041	0.275	0.550	0.730	0.826	0.846	0.954	0.736	1.000	1.000	1.000
2012	0.001	0.041	0.275	0.550	0.730	0.826	0.846	0.954	0.736	1.000	1.000	1.000

Table 9.2.6. Icelandic cod in Division Va. Survey indices of the spring bottom trawl survey (SMB).

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
2007	5.55	18.34	8.50	21.16	27.70	9.10	9.79	5.03	2.05	0.66
2008	6.40	11.77	22.06	9.31	20.43	20.44	8.11	6.58	2.47	0.60

Table 9.2.7 Icelandic cod in Division Va. Survey indices of the fall bottom trawl survey (SMH).

year\age	1	2	3	4	5	6	7	8	9	10
1985										
1986										
1987										
1988										
1989										
1990										
1991										
1992										
1993										
1994										
1995	1.66	16.42	21.86	8.17	17.35	11.36	1.97	0.66	0.19	0.05
1996	5.00	3.29	18.54	13.81	5.68	7.86	6.00	1.44	0.28	0.09
1997	0.56	12.52	5.49	24.75	13.52	3.54	3.02	1.87	0.19	0.12
1998	5.73	2.35	14.39	7.13	14.84	13.17	3.33	1.28	0.67	0.12
1999	7.24	13.64	5.20	21.37	6.97	9.40	3.51	0.46	0.22	0.25
2000	3.89	10.33	13.22	3.43	10.77	3.44	2.29	0.91	0.23	0.19
2001	6.15	10.16	17.84	20.25	3.21	6.23	1.36	0.60	0.13	0.02
2002	0.75	12.21	17.25	28.09	19.42	6.31	5.36	1.13	0.63	0.05
2003	5.23	3.04	30.18	23.23	18.16	10.66	1.95	2.46	0.34	0.10
2004	3.17	15.24	6.55	29.40	19.09	11.74	7.08	1.65	1.49	0.19
2005	1.73	8.36	18.70	6.31	23.57	9.64	3.34	1.58	0.25	0.24
2006	4.03	3.95	14.04	22.11	8.15	14.87	6.18	1.99	0.99	0.15
2007	3.97	9.72	4.71	11.09	15.59	6.35	5.77	2.97	0.71	0.45
2008										

Table 9.4.1. Icelandic cod in Division Va. Catch at age residuals from the ADCAM model tuned with the spring groundfish survey (SMB).

Year/age	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1955			-0.12	-0.21	0.08	0.11	0.21	-0.12	-0.16	0.13	-0.10	-0.45	-0.20	-0.00
1956			-0.03	-0.05	0.03	-0.01	-0.13	-0.20	-0.01	0.01	0.18	0.09	0.23	0.22
1957			0.09	0.02	-0.02	0.17	-0.13	0.09	0.06	-0.15	-0.10	-0.11	-0.38	0.52
1958			0.15	0.18	-0.27	-0.07	0.06	0.08	0.13	-0.23	0.23	0.00	-0.23	0.39
1959			-0.21	0.21	0.26	-0.24	-0.22	-0.06	-0.07	0.28	-0.26	0.38	-0.23	-0.40
1960			0.10	-0.36	0.14	0.19	0.06	0.07	-0.03	-0.11	-0.04	0.03	-0.64	0.91
1961			0.05	0.04	-0.40	0.12	-0.02	0.27	0.20	-0.14	0.09	-0.19	-0.97	0.83
1962			0.09	-0.01	0.13	-0.24	0.12	-0.30	0.09	0.26	-0.06	0.03	-0.40	0.70
1963			-0.06	0.30	-0.17	0.01	-0.03	-0.07	-0.38	0.21	0.35	0.06	0.07	-0.61
1964			-0.13	-0.02	0.13	-0.25	-0.12	0.38	-0.10	-0.46	-0.01	0.27	-0.16	0.01
1965			-0.03	-0.12	0.08	0.16	-0.13	0.05	0.47	-0.48	-0.06	-0.51	-0.36	0.64
1966			-0.04	-0.04	-0.18	0.10	-0.07	0.12	-0.35	0.59	-0.83	0.28	0.01	1.06
1967			0.19	-0.13	0.02	-0.20	0.02	-0.37	0.49	0.05	0.67	-0.73	-0.84	-0.18
1968			0.03	-0.02	-0.27	-0.12	0.23	0.16	-0.42	0.37	-0.12	0.60	-0.66	0.66
1969			-0.09	-0.03	0.15	-0.01	0.05	-0.15	-0.33	-0.25	-0.04	-0.26	-0.81	-0.14
1970			-0.10	0.13	-0.05	-0.14	0.05	-0.16	0.48	-0.58	-0.12	0.24	0.29	0.45
1971			-0.10	0.07	0.09	0.18	-0.18	0.28	-0.17	0.05	-0.45	-0.02	0.12	0.36
1972			-0.17	-0.13	0.07	-0.03	0.12	-0.05	-0.10	0.29	-0.07	0.17	0.52	-2.76
1973			0.27	-0.02	-0.10	0.03	-0.00	-0.24	0.09	0.17	0.16	-0.20	-1.25	-2.09
1974			-0.16	0.21	-0.02	-0.18	-0.01	-0.00	-0.22	0.29	0.01	0.18	-0.44	0.81
1975			0.19	-0.07	0.04	-0.05	0.03	-0.15	-0.21	-0.01	0.41	-0.02	-0.12	0.10
1976			0.10	0.00	-0.17	0.08	-0.09	0.25	-0.16	-0.15	0.06	0.27	-0.23	0.25
1977			-0.40	-0.06	0.05	-0.09	0.13	0.05	0.31	0.03	-0.70	-0.48	-1.22	-2.48
1978			0.08	-0.01	0.04	-0.10	0.04	-0.21	0.12	-0.19	0.02	-0.05	0.53	1.21
1979			0.15	0.10	-0.22	0.10	-0.05	0.03	-0.31	-0.08	0.05	-0.15	0.40	-0.20
1980			0.21	0.01	0.08	0.06	-0.01	-0.09	0.12	-0.49	0.30	0.09	0.15	-1.08
1981			-0.30	-0.21	0.08	-0.13	0.07	0.09	0.02	0.32	-0.08	0.60	-0.03	1.17
1982			0.01	0.15	0.07	-0.06	-0.22	0.19	0.17	0.14	-0.23	-0.87	0.04	-0.85
1983			-0.32	-0.36	0.11	0.14	0.04	0.01	-0.04	-0.03	0.01	0.37	-0.20	0.60
1984			0.35	0.03	-0.06	-0.05	-0.10	-0.01	0.06	-0.13	-0.35	0.17	0.71	0.11
1985			0.05	0.18	-0.10	0.12	-0.10	-0.03	-0.15	0.14	0.03	-0.35	0.47	0.48
1986			0.14	-0.11	0.02	-0.01	0.17	-0.05	0.11	-0.22	0.08	0.05	-0.60	0.19
1987			-0.16	0.11	0.03	-0.16	0.06	0.03	-0.04	0.11	-0.38	-0.12	0.12	-0.29
1988			-0.08	-0.07	-0.06	0.15	-0.09	0.07	0.15	0.02	0.47	0.01	0.54	0.14
1989			-0.20	0.05	0.14	-0.08	0.01	-0.16	-0.33	-0.10	-0.03	0.50	-0.04	-1.40
1990			-0.00	-0.12	-0.09	0.00	0.03	0.10	-0.09	-0.23	0.28	0.09	-0.24	0.08
1991			0.09	0.04	-0.10	-0.06	0.09	-0.08	0.12	-0.09	-0.32	0.38	-0.59	0.12
1992			-0.23	0.10	0.06	0.05	0.10	-0.01	-0.06	-0.06	-0.76	-0.79	-0.59	-0.15
1993			0.25	0.05	-0.17	-0.05	-0.07	-0.13	0.06	0.48	0.51	-0.23	-0.99	0.45
1994			0.05	0.23	-0.12	-0.17	-0.05	0.07	-0.20	-0.14	0.43	0.53	0.52	-0.35
1995			0.27	-0.02	0.08	-0.03	-0.03	-0.13	-0.13	-0.30	-0.21	0.72	1.12	0.65
1996			0.01	-0.06	-0.15	0.07	0.05	0.04	0.11	0.17	-0.39	-0.42	0.60	-0.01
1997			-0.14	0.02	-0.02	-0.10	-0.11	0.22	0.18	0.22	0.40	-0.76	-0.25	0.19
1998			-0.19	-0.15	0.08	0.07	0.04	-0.17	0.23	0.04	0.05	0.25	0.13	-0.70
1999			-0.09	0.02	0.08	0.03	0.09	-0.02	-0.27	-0.17	-0.23	-0.42	-0.46	-0.82
2000			0.15	-0.23	0.12	-0.01	0.01	0.10	0.03	-0.13	0.04	0.19	-0.08	0.08
2001			0.21	0.15	-0.13	-0.02	0.04	-0.20	0.05	0.27	-0.03	0.20	-0.40	0.18
2002			-0.03	0.08	0.02	-0.06	-0.04	0.00	-0.21	0.22	0.26	-0.33	0.49	-0.88
2003			-0.24	-0.02	0.01	-0.06	0.19	-0.00	0.21	-0.39	-0.02	0.10	0.17	0.69
2004			-0.11	0.04	0.07	-0.06	-0.09	0.26	0.00	0.21	-0.58	-0.12	0.23	-0.22
2005			0.17	-0.21	0.11	-0.07	-0.11	-0.10	0.33	0.06	0.31	-0.01	-0.01	-0.71
2006			-0.03	-0.06	-0.03	0.05	0.04	-0.06	-0.12	0.14	-0.06	0.06	-0.24	-1.58
2007			0.01	0.08	-0.13	0.09	-0.15	0.04	-0.06	0.04	0.68	0.26	0.76	-0.28

Table 9.4.2. Icelandic cod in Division Va. Spring survey (SMB) at age residuals from the ADCAM model.

Year/age	1	2	3	4	5	6	7	8	9	10
1985	-0.31	0.09	0.16	0.39	0.17	0.31	0.48	0.28	0.40	0.60
1986	0.42	-0.05	-0.41	-0.26	-0.09	0.03	-0.13	-0.24	-0.21	-0.03
1987	0.39	0.02	0.08	-0.42	-0.03	-0.05	0.08	-0.03	-0.04	0.04
1988	-0.35	0.02	0.44	0.15	-0.10	-0.32	0.11	0.48	-0.10	-0.09
1989	0.18	0.03	0.46	0.51	0.19	0.13	-0.13	-0.10	0.16	0.10
1990	-0.48	0.10	-0.00	-0.01	-0.16	-0.16	0.03	-0.13	-0.00	0.15
1991	-0.33	-0.44	0.03	0.10	0.23	0.07	0.17	-0.14	0.22	0.29
1992	-0.51	-0.01	-0.24	0.06	-0.12	-0.10	-0.13	-0.11	-0.09	0.05
1993	-0.61	-0.07	0.09	-0.07	0.03	-0.03	-0.21	-0.14	-0.23	-0.25
1994	0.48	-0.29	-0.05	0.03	-0.19	-0.28	-0.15	-0.18	-0.14	-0.09
1995	-0.42	0.11	-0.30	-0.13	0.13	0.03	-0.16	-0.04	-0.02	-0.21
1996	-0.71	-0.14	0.03	-0.18	0.17	-0.02	0.30	0.45	0.25	0.07
1997	-0.09	-0.08	0.07	0.24	-0.05	-0.01	-0.01	0.31	-0.27	0.06
1998	-0.19	0.10	-0.25	0.07	0.51	0.31	0.14	0.25	0.51	0.50
1999	-0.07	0.11	-0.11	0.00	-0.06	0.10	0.05	0.04	0.02	0.09
2000	0.77	0.14	0.17	-0.25	-0.10	-0.17	-0.17	0.03	-0.19	-0.22
2001	0.17	-0.10	-0.03	-0.18	-0.50	-0.20	-0.32	-0.51	-0.33	0.05
2002	-0.19	0.22	0.04	0.04	0.00	-0.11	-0.15	-0.22	-0.40	-0.18
2003	0.47	0.03	-0.01	-0.07	-0.01	-0.10	-0.09	0.05	0.25	-0.47
2004	0.33	0.16	0.03	0.21	0.02	0.20	0.18	0.22	0.45	0.31
2005	0.27	0.04	0.15	0.02	0.07	0.09	0.01	0.04	0.09	0.15
2006	0.38	0.07	-0.03	0.06	0.07	0.14	-0.13	-0.30	-0.38	-0.26
2007	0.26	0.04	-0.15	-0.19	-0.11	0.00	-0.28	-0.08	0.01	-0.25
2008	0.06	-0.05	-0.24	-0.24	-0.17	-0.03	0.34	-0.01	0.05	-0.30

Year/age	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1955			0.04	0.17	0.25	0.27	0.30	0.30	0.28	0.33	0.33	0.31	0.33	0.33
1956			0.05	0.18	0.25	0.26	0.29	0.30	0.30	0.34	0.36	0.34	0.34	0.34
1957			0.08	0.21	0.27	0.27	0.30	0.33	0.33	0.36	0.37	0.33	0.30	0.30
1958			0.11	0.25	0.30	0.29	0.32	0.37	0.40	0.44	0.45	0.39	0.33	0.33
1959			0.09	0.23	0.28	0.26	0.30	0.34	0.35	0.40	0.38	0.32	0.23	0.23
1960			0.10	0.23	0.29	0.29	0.34	0.40	0.43	0.48	0.48	0.39	0.27	0.27
1961			0.09	0.23	0.26	0.26	0.33	0.40	0.42	0.46	0.44	0.35	0.23	0.23
1962			0.11	0.25	0.28	0.26	0.35	0.42	0.47	0.51	0.49	0.38	0.24	0.24
1963			0.13	0.28	0.33	0.31	0.38	0.49	0.59	0.65	0.63	0.46	0.29	0.29
1964			0.13	0.29	0.37	0.36	0.43	0.57	0.74	0.81	0.84	0.61	0.39	0.39
1965			0.12	0.28	0.38	0.40	0.47	0.60	0.74	0.85	0.88	0.66	0.43	0.43
1966			0.09	0.25	0.34	0.38	0.49	0.62	0.78	0.92	1.01	0.79	0.54	0.54
1967			0.08	0.23	0.30	0.34	0.48	0.61	0.75	0.88	0.93	0.73	0.46	0.46
1968			0.08	0.25	0.34	0.41	0.58	0.77	1.04	1.20	1.36	1.09	0.74	0.74
1969			0.06	0.23	0.32	0.35	0.50	0.61	0.72	0.84	0.87	0.72	0.45	0.45
1970			0.07	0.27	0.39	0.43	0.55	0.65	0.76	0.89	0.95	0.80	0.52	0.52
1971			0.09	0.31	0.48	0.53	0.62	0.72	0.80	0.96	1.04	0.89	0.59	0.59
1972			0.09	0.30	0.48	0.55	0.65	0.73	0.79	0.96	1.06	0.92	0.61	0.61
1973			0.12	0.32	0.49	0.56	0.67	0.75	0.80	0.95	1.04	0.91	0.60	0.60
1974			0.11	0.32	0.50	0.58	0.70	0.83	0.92	1.06	1.18	1.04	0.71	0.71
1975			0.11	0.31	0.50	0.60	0.72	0.89	1.02	1.13	1.26	1.11	0.79	0.79
1976			0.07	0.26	0.43	0.55	0.70	0.85	0.95	1.01	1.07	0.95	0.67	0.67
1977			0.03	0.20	0.33	0.43	0.61	0.72	0.73	0.74	0.70	0.63	0.42	0.42
1978			0.03	0.17	0.28	0.35	0.53	0.60	0.55	0.55	0.49	0.45	0.29	0.29
1979			0.03	0.17	0.27	0.34	0.50	0.57	0.50	0.49	0.42	0.40	0.25	0.25
1980			0.03	0.17	0.31	0.39	0.54	0.62	0.56	0.55	0.47	0.45	0.30	0.30
1981			0.02	0.18	0.35	0.49	0.65	0.82	0.85	0.82	0.76	0.70	0.53	0.53
1982			0.03	0.19	0.39	0.56	0.70	0.90	0.96	0.87	0.75	0.68	0.52	0.52
1983			0.02	0.18	0.38	0.55	0.71	0.88	0.92	0.86	0.74	0.68	0.54	0.54
1984			0.04	0.20	0.38	0.53	0.67	0.80	0.76	0.71	0.60	0.57	0.45	0.45
1985			0.05	0.23	0.42	0.58	0.71	0.83	0.77	0.70	0.60	0.57	0.45	0.45
1986			0.06	0.26	0.52	0.71	0.82	0.95	0.87	0.77	0.66	0.63	0.50	0.50
1987			0.06	0.27	0.55	0.81	0.91	1.06	0.99	0.85	0.75	0.71	0.59	0.59
1988			0.05	0.26	0.52	0.79	0.92	1.10	1.08	0.94	0.88	0.84	0.74	0.74
1989			0.04	0.24	0.46	0.65	0.79	0.89	0.80	0.72	0.65	0.64	0.53	0.53
1990			0.05	0.25	0.47	0.66	0.79	0.86	0.75	0.69	0.62	0.61	0.51	0.51
1991			0.09	0.30	0.56	0.81	0.88	0.95	0.84	0.77	0.71	0.70	0.60	0.60
1992			0.10	0.32	0.59	0.86	0.92	1.00	0.90	0.81	0.75	0.73	0.64	0.64
1993			0.14	0.31	0.55	0.80	0.89	1.03	1.03	0.94	0.91	0.89	0.81	0.81
1994			0.09	0.24	0.38	0.53	0.68	0.76	0.72	0.70	0.66	0.66	0.58	0.58
1995			0.06	0.20	0.32	0.42	0.57	0.62	0.56	0.57	0.53	0.55	0.47	0.47
1996			0.04	0.16	0.28	0.41	0.56	0.62	0.58	0.60	0.55	0.57	0.50	0.50
1997			0.03	0.15	0.27	0.42	0.58	0.67	0.66	0.69	0.65	0.66	0.60	0.60
1998			0.03	0.15	0.32	0.52	0.66	0.78	0.83	0.85	0.84	0.85	0.81	0.81
1999			0.04	0.18	0.39	0.64	0.74	0.85	0.93	0.92	0.92	0.92	0.91	0.91
2000			0.06	0.18	0.39	0.62	0.74	0.86	0.96	0.97	0.98	1.00	1.00	1.00
2001			0.07	0.19	0.38	0.58	0.69	0.83	0.97	1.00	1.04	1.06	1.08	1.08
2002			0.04	0.17	0.33	0.48	0.59	0.69	0.80	0.86	0.88	0.91	0.92	0.92
2003			0.03	0.15	0.33	0.49	0.57	0.64	0.70	0.76	0.76	0.81	0.80	0.80
2004			0.03	0.15	0.34	0.52	0.57	0.64	0.69	0.75	0.76	0.81	0.80	0.80
2005			0.03	0.14	0.31	0.48	0.54	0.61	0.65	0.72	0.74	0.80	0.79	0.79
2006			0.03	0.14	0.29	0.48	0.54	0.60	0.66	0.74	0.77	0.83	0.84	0.84
2007			0.03	0.13	0.28	0.45	0.52	0.59	0.68	0.78	0.86	0.93	0.97	0.97
2008			0.02	0.10	0.21	0.33	0.37	0.42	0.46	0.51	0.52	0.56	0.56	0.56
2009			0.02	0.08	0.18	0.28	0.32	0.36	0.39	0.43	0.45	0.48	0.48	0.48
2010			0.02	0.08	0.17	0.26	0.30	0.33	0.36	0.40	0.42	0.45	0.45	0.45
2011			0.02	0.07	0.16	0.25	0.28	0.31	0.34	0.38	0.39	0.42	0.42	0.42
2012			0.02	0.08	0.16	0.26	0.29	0.33	0.36	0.40	0.41	0.44	0.44	0.44

Table 9.4.3. Icelandic cod in Division Va. Estimates of fishing mortality 1955-2007 based on ACAM using catch at age and spring bottom survey indices. Estimates for 2008 are based on catch constraint; the prediction for 2009 is based on the 20% catch rule.

Year/age	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1955	255	187	152	218	212	115	36	25	13	87.2	9.2	7.8	8.1	2.6
1956	329	208	153	120	150	135	72	22	15	8.0	51.5	5.4	4.7	4.8
1957	431	270	171	119	82	96	85	44	13	9.0	4.6	29.5	3.2	2.7
1958	230	353	221	129	79	51	60	52	35	7.8	5.1	2.6	17.3	1.9
1959	288	189	289	161	82	48	31	35	52	19.3	4.1	2.7	1.5	10.2
1960	192	236	154	216	105	51	30	19	21	37.5	10.6	2.3	1.6	0.9
1961	265	157	193	114	140	64	31	18	10	11.0	19.0	5.4	1.3	1.0
1962	305	217	129	144	75	89	40	18	24	5.6	5.7	10.0	3.1	0.8
1963	323	249	178	94	92	46	56	23	10	12.1	2.7	2.9	5.6	2.0
1964	342	264	204	128	58	54	28	31	12	4.4	5.2	1.2	1.5	3.4
1965	478	280	216	147	78	33	31	15	14	4.5	1.6	1.8	0.5	0.8
1966	256	391	229	157	91	44	18	16	7	5.6	1.6	0.5	0.8	0.3
1967	369	210	320	171	100	53	24	9	7	2.5	1.8	0.5	0.2	0.4
1968	269	302	172	243	111	60	31	12	4	2.7	0.8	0.6	0.2	0.1
1969	281	220	248	130	155	65	33	41	5	1.2	0.7	0.2	0.2	0.1
1970	208	230	180	192	85	92	37	33	18	1.9	0.4	0.2	0.1	0.1
1971	407	170	189	138	120	47	49	18	14	7.0	0.6	0.1	0.1	0.0
1972	267	334	139	141	83	61	23	22	23	5.2	2.2	0.2	0.0	0.0
1973	389	219	273	104	86	42	29	10	9	8.6	1.6	0.6	0.1	0.0
1974	549	319	179	199	62	43	20	12	4	3.2	2.7	0.5	0.2	0.0
1975	214	449	261	131	118	31	20	8	4	1.2	0.9	0.7	0.1	0.1
1976	339	175	368	192	79	58	14	8	3	1.3	0.3	0.2	0.2	0.1
1977	364	277	143	282	121	42	27	6	3	0.9	0.4	0.1	0.1	0.1
1978	209	298	227	114	190	71	22	12	2	1.1	0.3	0.2	0.0	0.0
1979	210	171	244	181	78	117	41	11	5	1.1	0.5	0.2	0.1	0.0
1980	197	172	140	194	125	49	72	20	5	2.7	0.5	0.3	0.1	0.1
1981	347	161	141	111	134	75	27	47	9	2.4	1.3	0.3	0.1	0.1
1982	207	284	132	113	76	77	38	12	17	3.1	0.8	0.5	0.1	0.1
1983	207	170	232	105	76	42	36	15	4	5.3	1.1	0.3	0.2	0.1
1984	495	169	139	186	72	43	20	15	5	1.3	1.8	0.4	0.1	0.1
1985	392	405	138	109	125	41	21	8	5	2.0	0.5	0.8	0.2	0.1
1986	260	321	332	108	71	67	19	8	3	2.0	0.8	0.2	0.4	0.1
1987	130	213	263	255	68	35	27	7	3	1.0	0.8	0.3	0.1	0.2
1988	194	107	174	203	159	32	13	9	2	0.8	0.4	0.3	0.1	0.0
1989	156	159	87	136	129	77	12	4	2	0.5	0.3	0.1	0.1	0.1
1990	258	128	130	69	87	100	33	4	1	0.9	0.2	0.1	0.1	0.1
1991	204	211	104	101	44	45	43	12	2	0.5	0.4	0.1	0.0	0.0
1992	114	167	173	78	61	20	16	14	4	0.5	0.2	0.1	0.0	0.0
1993	227	93	136	128	47	28	7	5	4	1.3	0.2	0.1	0.1	0.0
1994	247	186	76	97	76	22	10	2	2	1.3	0.4	0.1	0.0	0.0
1995	128	202	152	57	63	43	11	4	1	0.6	0.5	0.2	0.0	0.0
1996	242	105	166	117	38	37	23	5	2	0.4	0.3	0.2	0.1	0.0
1997	104	198	86	131	82	24	20	11	2	0.9	0.2	0.1	0.1	0.0
1998	263	85	163	69	93	51	13	9	4	0.9	0.4	0.1	0.1	0.1
1999	238	216	70	129	48	55	25	5	3	1.6	0.3	0.1	0.0	0.0
2000	242	195	177	55	89	27	24	10	2	1.1	0.5	0.1	0.0	0.0
2001	266	198	160	136	37	49	12	9	3	0.6	0.3	0.2	0.0	0.0
2002	99	218	162	122	92	21	23	5	3	1.0	0.2	0.1	0.0	0.0
2003	219	81	178	127	85	54	11	10	2	1.2	0.4	0.1	0.0	0.0
2004	182	179	66	141	89	50	27	5	4	0.8	0.5	0.1	0.0	0.0
2005	117	149	147	52	99	52	24	12	2	1.8	0.3	0.2	0.1	0.0
2006	204	96	122	116	37	60	26	12	6	0.9	0.7	0.1	0.1	0.0
2007	173	167	79	97	83	23	30	13	5	2.4	0.4	0.3	0.0	0.0
2008	207	142	137	62	69	52	12	15	6	2.2	0.9	0.1	0.1	0.0
2009	207	170	116	110	46	46	30	7	8	3.0	1.1	0.4	0.1	0.0
2010	214	169	139	93	83	32	28	18	4	4.4	1.6	0.6	0.2	0.0
2011	222	175	139	112	71	57	20	17	11	2.2	2.4	0.9	0.3	0.1
2012	229	182	143	112	85	50	37	12	10	6.2	1.2	1.3	0.5	0.2

Table 9.4.4. Icelandic cod in Division Va. Estimates of numbers at age in the stock 1955-2008 based on ACAM using catch at age and spring bottom survey indices. Estimates for 2009 are based on catch constraint for the year 2008; the predictions are based on the 20% catch rule.

STANDARDISED CATCH RESIDUALS

	4	5	6	7	8	9	10	11
1987	0.45	1.22	-0.85	0.82	0.50	0.44	0.43	-0.18
1988	-1.32	0.06	0.73	-0.66	0.27	0.19	0.11	1.55
1989	-1.12	-0.60	-1.00	-0.72	-0.70	-3.55	-2.16	-0.61
1990	-0.39	-2.00	-0.17	0.33	0.64	-0.54	-0.91	0.49
1991	1.78	0.42	-0.10	0.36	-0.56	-0.03	0.11	-0.12
1992	1.27	0.93	0.31	-0.48	-0.85	-0.42	-0.64	-1.54
1993	0.66	-1.35	-0.76	-1.36	-0.81	0.34	2.46	2.18
1994	1.03	-0.18	-0.39	-0.42	1.06	-0.62	-0.33	1.33
1995	0.07	-1.13	-0.50	0.26	-1.27	-1.92	-1.13	-0.76
1996	-0.46	-0.58	-0.39	0.94	0.50	0.52	1.11	-0.51
1997	-1.16	0.44	0.72	0.10	1.41	0.62	1.12	1.12
1998	0.14	0.59	1.83	2.02	0.28	0.88	0.60	0.35
1999	1.44	2.59	0.51	0.40	0.09	-0.77	-1.94	-1.15
2000	-0.40	1.14	0.32	-0.66	0.34	0.09	-0.41	-0.62
2001	-0.21	1.07	-0.60	-0.22	-1.04	-0.07	0.65	-0.12
2002	-0.97	-1.28	0.55	-0.36	0.44	0.27	0.58	0.06
2003	-0.75	-0.41	-0.83	1.53	0.77	1.87	-0.16	-0.50
2004	-0.26	0.60	-0.36	-0.22	1.57	0.98	0.86	-0.73
2005	-0.66	0.20	-1.08	-1.33	-0.12	0.95	0.52	0.21
2006	-0.90	1.29	-0.37	-0.46	0.03	0.22	0.04	-0.15
2007	0.47	-1.22	0.58	-2.18	0.38	0.84	1.47	1.79

RA,RT,RS 0.39 0.11 0.17 1st order correlation with age, time and cohort
V3,V4 -0.20 1.72 Tests for normality by 3rd and 4rth moments

STANDARDISED SURVEY RESIDUALS

	1	2	3	4	5	6	7	8	9
1987	-0.22	-0.49	1.57	-0.47	0.34	-0.42	0.48	-0.16	0.01
1988	-0.29	-1.57	1.94	0.98	0.93	-1.68	0.46	1.42	-1.06
1989	-0.10	1.17	1.43	1.21	0.59	0.31	-0.61	-0.12	-0.29
1990	0.27	-0.17	0.24	-1.70	-2.05	-1.16	0.26	-0.22	0.41
1991	-0.13	-0.15	-0.71	0.42	0.09	-0.46	0.03	-0.84	0.60
1992	-2.09	0.85	0.81	-0.34	-0.99	-0.93	-1.36	-1.07	-0.41
1993	-0.24	0.78	0.60	0.64	-0.16	-0.02	-1.01	-0.43	-0.66
1994	1.36	0.94	0.06	-0.41	-0.19	-0.76	-0.78	-0.85	-0.63
1995	-1.52	-0.20	0.36	-0.55	0.44	1.06	0.25	-0.02	-0.30
1996	-0.20	-0.03	-0.26	0.54	1.86	0.40	2.01	2.36	1.33
1997	-1.49	1.69	0.79	0.97	1.35	1.50	0.17	0.84	-1.79
1998	0.70	0.30	0.02	0.34	2.12	1.61	1.21	0.90	0.57
1999	0.60	1.33	-1.86	1.15	-0.01	-0.83	-0.83	-0.59	-0.72
2000	1.67	1.01	0.91	-1.49	0.28	-0.70	-1.31	-0.32	-1.45
2001	1.17	-1.76	-0.19	-1.04	-1.45	-1.07	-1.29	-2.03	-1.82
2002	-1.81	0.95	0.27	0.34	0.61	1.63	0.48	0.19	-0.40
2003	1.07	0.11	-0.36	-0.40	0.00	-0.64	0.75	1.23	1.87
2004	0.46	-0.46	-0.69	1.05	0.64	0.99	1.46	1.68	2.32
2005	-0.63	-0.99	-0.19	-0.35	0.57	-0.09	0.00	0.75	0.05
2006	0.80	-1.26	-0.77	-0.27	0.90	-0.34	-0.88	-0.88	-1.09
2007	0.27	-0.61	-1.99	-0.84	-0.50	0.28	-1.63	0.08	0.62
2008	0.43	-1.18	-1.48	-1.04	-0.08	0.29	1.09	0.54	0.24

RA,RT,RS 0.45 0.19 0.19 1st order correlation with age, time and cohort
V3,V4 0.68 -1.35 Tests for normality by 3rd and 4rth moments

Table 9.4.5. Icelandic cod in division Va. Standardized catch and survey residuals from the TSA run based on tuning with the spring survey.

Estimation with a time series model of F

Catch-at-age 1985-2007, age 4-11
Spring survey 1985-2008, age 1-9

STOCK

	Biom	1	2	3	4	5	6	7	8	9	10	11
1985	911.	187.6	286.5	113.1	119.9	114.15	44.85	19.49	8.70	4.56	2.12	0.43
1986	825.	154.8	211.3	257.0	102.2	72.89	65.11	20.13	7.46	3.06	1.48	0.72
1987	1014.	77.9	155.4	234.6	253.2	70.46	31.50	27.87	6.83	2.39	1.04	0.47
1988	1080.	89.2	71.9	173.2	237.5	154.02	33.95	11.38	9.20	2.01	0.70	0.33
1989	1112.	82.6	94.5	74.7	160.2	160.08	74.60	12.14	3.76	2.16	0.57	0.22
1990	835.	105.0	82.0	98.7	67.2	87.38	101.43	33.07	4.74	1.23	0.68	0.20
1991	695.	95.9	106.9	78.6	103.0	42.47	44.67	44.75	11.47	1.64	0.41	0.22
1992	543.	45.1	102.0	115.3	77.9	61.48	20.77	16.74	14.16	3.89	0.53	0.12
1993	551.	87.8	46.8	107.0	122.5	41.02	27.63	6.71	4.57	3.82	1.31	0.16
1994	570.	145.9	93.0	46.9	110.8	70.12	19.58	10.07	2.42	1.26	1.05	0.41
1995	544.	56.0	144.3	97.5	48.5	67.33	42.01	10.80	4.27	0.93	0.50	0.42
1996	633.	102.1	57.7	144.6	105.2	32.52	37.33	24.61	5.20	1.95	0.45	0.21
1997	789.	50.9	111.7	59.7	143.9	78.87	21.34	18.34	12.64	2.19	0.87	0.20
1998	727.	135.1	50.0	115.7	59.9	102.33	53.12	12.57	7.94	5.38	0.92	0.37
1999	735.	122.2	146.5	43.2	126.7	47.61	56.18	26.26	5.50	3.13	1.89	0.36
2000	573.	144.4	127.7	151.5	40.8	92.68	26.09	22.35	10.48	2.01	1.08	0.66
2001	692.	144.2	128.9	125.6	149.4	30.82	48.07	11.68	7.42	3.54	0.72	0.37
2002	741.	45.7	149.6	129.2	126.7	96.51	19.96	21.54	4.88	2.58	1.28	0.25
2003	752.	131.9	46.0	148.8	129.3	87.71	50.84	11.80	9.99	2.42	0.97	0.50
2004	835.	102.6	129.2	44.8	154.0	96.45	49.03	24.58	6.05	4.53	1.08	0.39
2005	724.	63.0	95.5	125.1	45.1	115.60	53.25	22.58	11.33	2.76	1.95	0.45
2006	682.	109.4	55.0	89.4	117.8	37.92	65.08	26.69	10.62	5.07	1.23	0.85
2007	606.	95.2	103.8	47.5	89.5	77.75	27.47	27.41	12.92	4.85	2.33	0.57
2008	551.	112.4	90.5	95.7	44.5	62.20	49.39	15.93	13.74	5.85	2.18	1.04

KALMAN FILTER ESTIMATION OF STANDARD DEVIATION OF BIOMASS AND LOG-STOCK

	Biom	1	2	3	4	5	6	7	8	9	10	11
2007	32.	0.089	0.072	0.070	0.073	0.066	0.068	0.073	0.084	0.106	0.137	0.169
2008	37.	0.113	0.084	0.078	0.091	0.100	0.105	0.117	0.129	0.144	0.180	0.204

ADJUSTED FOR ERRORS IN PARAMETER ESTIMATES

	Biom	1	2	3	4	5	6	7	8	9	10	11
2008		0.118	0.086	0.079	0.093	0.101	0.108	0.122	0.133	0.148	0.184	0.210

FISHING MORTALITY RATES

	F 5-10	4	5	6	7	8	9	10	11
1985	0.757	0.265	0.455	0.663	0.791	0.867	0.885	0.881	0.881
1986	0.820	0.247	0.502	0.716	0.890	0.941	0.934	0.938	0.939
1987	0.870	0.308	0.533	0.742	0.913	1.003	1.021	1.005	1.015
1988	0.900	0.201	0.499	0.844	0.964	1.062	1.029	1.005	1.022
1989	0.761	0.218	0.430	0.645	0.811	0.899	0.892	0.891	0.904
1990	0.768	0.230	0.435	0.664	0.823	0.893	0.896	0.898	0.905
1991	0.844	0.308	0.515	0.739	0.904	0.950	0.966	0.987	0.976
1992	0.935	0.353	0.610	0.860	1.014	1.058	1.022	1.044	1.048
1993	0.883	0.357	0.545	0.765	0.899	1.016	1.044	1.028	1.036
1994	0.597	0.268	0.369	0.489	0.609	0.703	0.706	0.706	0.715
1995	0.528	0.229	0.323	0.426	0.546	0.606	0.623	0.643	0.639
1996	0.527	0.168	0.288	0.442	0.544	0.615	0.632	0.638	0.632
1997	0.547	0.137	0.282	0.437	0.579	0.651	0.669	0.666	0.666
1998	0.630	0.154	0.323	0.525	0.676	0.733	0.768	0.755	0.754
1999	0.718	0.182	0.406	0.626	0.769	0.833	0.842	0.834	0.839
2000	0.740	0.194	0.414	0.631	0.800	0.861	0.865	0.867	0.864
2001	0.694	0.201	0.388	0.576	0.725	0.813	0.828	0.831	0.823
2002	0.585	0.176	0.323	0.472	0.606	0.672	0.723	0.716	0.708
2003	0.565	0.148	0.314	0.485	0.604	0.651	0.667	0.671	0.665
2004	0.561	0.146	0.321	0.486	0.594	0.651	0.653	0.659	0.651
2005	0.525	0.135	0.292	0.445	0.554	0.611	0.627	0.623	0.621
2006	0.520	0.128	0.278	0.455	0.556	0.609	0.615	0.609	0.613
2007	0.490	0.159	0.260	0.397	0.495	0.581	0.601	0.604	0.605

ESTIMATED STANDARD DEVIATION OF LOG(F)

	F 5-10	4	5	6	7	8	9	10	11
2006	0.036	0.082	0.070	0.074	0.076	0.082	0.088	0.089	0.090
2007	0.040	0.088	0.081	0.088	0.090	0.095	0.102	0.103	0.102

Table 9.4.6. Icelandic cod in division Va. The estimate of fishing mortality, stock numbers and biomass from the TSA based on tuning with the spring survey. "Biom" refers to biomass of fish 4 years and older. Note that the numbers at age 1, 2 and 3 are unconventional, showing the 1st, 2nd and 3rd estimates of the size of the year class at age 4.

a)

Estimated fishing mortality rate in 2007:

Age	Est 2007	ADCAM SMB	TSA	ADAPT	X-CAM	XSA	ADCAM SMH
3	0.03	0.03		0.03	0.03	0.03	0.03
4	0.13	0.13	0.16	0.15	0.14	0.14	0.12
5	0.30	0.28	0.26	0.22	0.26	0.22	0.26
6	0.47	0.45	0.40	0.42	0.39	0.41	0.41
7	0.56	0.52	0.50	0.42	0.46	0.43	0.47
8	0.63	0.59	0.58	0.61	0.52	0.55	0.56
9	0.73	0.68	0.60	0.72	0.51	0.57	0.61
10	0.85	0.78	0.60	1.04	0.50	0.63	0.61
11	0.84	0.86	0.61	5.70	0.50	0.70	0.62
12	0.88	0.93		0.38		0.82	0.65
13	0.84	0.97		3.79		1.40	0.56
14	0.84	0.97		0.99		0.90	0.56
F(5-10)	**0.59**	**0.55**	**0.49**	**0.57**	**0.44**	**0.47**	**0.49**

b)

Estimated stock in numbers (millions) in 2008:

Age	Est 2007	ADCAM SMB	TSA	ADAPT	X-CAM	XSA	ADCAM SMH
1	185	207	215	219	219	226	191
2	165	142	142	149	143	163	173
3	145	137	123	141	139	147	142
4	64	62	45	62	62	69	64
5	69	69	62	68	68	74	72
6	52	52	49	58	54	59	55
7	11	12	16	14	13	15	13
8	15	15	14	17	18	16	16
9	5.2	5.7	5.9	5.8	7.0	6.7	6.4
10	1.9	2.2	2.2	1.9	3.0	2.6	2.4
11	0.7	0.9	1.0	0.6	2.0	1.3	1.1
12	0.1	0.1		0.0		0.3	0.2
13	0.1	0.1		0.4		0.1	0.2
14	0.0	0.0		0.0		0.0	0.0

c)

Recruitment (N3 abundance):

Yearcl.	Est 2007	ADCAM SMB	TSA	ADAPT	xCAM	XSA	ADCAM SMH
2002	155	147	151	155	153	158	153
2003	123	122	115	121	120	129	126
2004	81	79	57	78	79	86	81
2005	145	137	123	141	139	147	142
2006	135	116	116	122	117	133	142
2007		139	137	147	147	152	128

d)

Estimated stock size (B4+, Thous. tonnes) in 1991-2009

Year	Est 2007	ADCAM SMB	TSA	ADAPT	X-CAM	XSA	ADCAM SMH
1993	589	590	551	588	607	588	610
1994	574	574	570	585	596	585	576
1995	553	553	544	563	574	563	558
1996	668	668	633	688	679	688	686
1997	783	783	789	805	806	805	785
1998	717	718	727	740	743	740	720
1999	730	731	735	755	751	753	737
2000	588	591	573	609	608	609	610
2001	693	698	692	704	709	710	702
2002	729	735	741	734	742	745	728
2003	740	748	752	747	758	764	748
2004	807	805	835	815	836	832	814
2005	703	705	724	719	741	737	722
2006	675	668	682	695	714	714	695
2007	649	629	606	653	673	684	663
2008	570	590	551	623	634	665	632
2009	628	647		685	687		696

Table 9.4.7. Icelandic cod in division Va. Comparison of estimates of key metrics using various methodological approaches. All results shown are based on tuning with the spring survey (SMB) except ADCAM SMH, where the fall survey is used. "Est 2007" refers to the estimates from the NWWG in 2007 using the ADCAM framework.

Year	Landings	F5-10	SSB	N3	B4+	Hratio
1955	538	0.29	938	152	2356	0.24
1956	481	0.29	792	153	2081	0.24
1957	452	0.31	772	171	1878	0.24
1958	509	0.35	873	221	1865	0.28
1959	453	0.32	851	289	1827	0.25
1960	465	0.37	708	154	1753	0.29
1961	375	0.36	467	193	1496	0.25
1962	387	0.38	568	129	1492	0.28
1963	410	0.46	507	178	1315	0.32
1964	434	0.55	451	204	1219	0.39
1965	394	0.58	317	216	1023	0.38
1966	357	0.59	277	229	1031	0.33
1967	345	0.56	256	320	1103	0.30
1968	381	0.72	222	172	1223	0.30
1969	406	0.56	314	248	1326	0.31
1970	471	0.61	331	180	1337	0.39
1971	453	0.68	242	189	1098	0.43
1972	399	0.69	222	139	997	0.43
1973	383	0.70	245	273	843	0.44
1974	375	0.76	187	179	918	0.41
1975	371	0.81	168	261	895	0.40
1976	348	0.75	138	368	955	0.31
1977	340	0.59	198	143	1290	0.26
1978	330	0.48	212	227	1298	0.25
1979	368	0.45	304	244	1396	0.26
1980	434	0.49	356	140	1489	0.32
1981	469	0.66	264	141	1242	0.42
1982	388	0.73	167	132	971	0.44
1983	300	0.72	130	232	792	0.35
1984	284	0.64	141	139	914	0.31
1985	325	0.67	172	138	928	0.37
1986	369	0.78	198	332	852	0.39
1987	392	0.86	149	263	1031	0.38
1988	378	0.89	172	174	1036	0.37
1989	356	0.72	172	87	1004	0.39
1990	335	0.70	214	130	839	0.44
1991	309	0.80	161	104	696	0.50
1992	268	0.85	152	173	546	0.47
1993	252	0.87	124	136	590	0.43
1994	179	0.63	153	76	574	0.32
1995	169	0.51	178	152	553	0.28
1996	182	0.51	159	166	668	0.25
1997	203	0.55	189	86	783	0.27
1998	243	0.66	211	163	718	0.33
1999	260	0.75	185	70	731	0.39
2000	236	0.76	169	177	591	0.37
2001	235	0.74	164	160	698	0.33
2002	209	0.63	199	162	735	0.28
2003	208	0.58	189	178	748	0.27
2004	227	0.59	204	66	805	0.30
2005	214	0.55	232	147	705	0.31
2006	196	0.55	216	122	668	0.30
2007	170	0.55	190	79	629	0.28
2008	134	0.38	230	137	590	0.22
2009	125	0.33	250	116	647	0.19
2010	129	0.30	279	139	701	0.17
2011	137	0.28	313	139	781	0.17
2012	158	0.30	350	143	852	0.19

Table 9.6.1. Icelandic cod in Division Va. Landings (thousand tonnes, average fishing mortality of age groups 5 to 10, recruitment to the fisheries at age 3 (millions), reference fishing biomass (B4+, thousand tonnes), spawning stock biomass (thousand tonnes) at spawning time and harvest ration. Shaded areas are predictions based on 20% harvest strategy.

Mean weights in the stock and the catch

age\year	2007	2008	2009	2010	2011
3	1.083	1.019	1.019	1.019	1.019
4	1.556	1.522	1.522	1.522	1.522
5	2.144	2.296	2.296	2.296	2.296
6	2.754	3.019	3.019	3.019	3.019
7	3.920	3.901	3.901	3.901	3.901
8	5.255	5.095	5.095	5.095	5.095
9	6.272	6.400	6.400	6.400	6.400
10	6.481	6.481	6.481	6.481	6.481
11	7.142	7.142	7.142	7.142	7.142
12	6.530	6.530	6.530	6.530	6.530
13	9.724	9.724	9.724	9.724	9.724
14	10.143	10.143	10.143	10.143	10.143

Mean weights in the SSB

age\year	2007	2008	2009	2010	2011
3	0.900	0.912	0.912	0.912	0.912
4	1.264	1.841	1.841	1.841	1.841
5	2.022	2.227	2.227	2.227	2.227
6	2.580	2.924	2.924	2.924	2.924
7	4.078	3.920	3.920	3.920	3.920
8	5.255	5.255	5.255	5.255	5.255
9	6.272	6.272	6.272	6.272	6.272
10	6.481	6.481	6.481	6.481	6.481
11	7.142	7.142	7.142	7.142	7.142
12	6.530	6.530	6.530	6.530	6.530
13	9.724	9.724	9.724	9.724	9.724
14	10.143	10.143	10.143	10.143	10.143

Sexual maturity at spawning time:

age\year	2007	2008	2009	2010	2011
3	0.01	0.00	0.00	0.00	0.00
4	0.03	0.04	0.04	0.04	0.04
5	0.16	0.28	0.28	0.28	0.28
6	0.50	0.55	0.55	0.55	0.55
7	0.69	0.73	0.73	0.73	0.73
8	0.80	0.83	0.83	0.83	0.83
9	0.86	0.85	0.85	0.85	0.85
10	0.96	0.95	0.95	0.95	0.95
11	0.92	0.74	0.74	0.74	0.74
12	1.00	1.00	1.00	1.00	1.00
13	1.00	1.00	1.00	1.00	1.00
14	1.00	1.00	1.00	1.00	1.00

Selection pattern

age\year	2007	2008	2009	2010	2011
3	0.053	0.056	0.056	0.056	0.056
4	0.245	0.251	0.251	0.251	0.251
5	0.503	0.532	0.532	0.532	0.532
6	0.821	0.856	0.856	0.856	0.856
7	0.941	0.963	0.963	0.963	0.963
8	1.083	1.091	1.091	1.091	1.091
9	1.230	1.203	1.203	1.203	1.203
10	1.422	1.355	1.355	1.355	1.355
11	1.556	1.531	1.531	1.531	1.531
12	1.698	1.531	1.531	1.531	1.531
13	1.761	1.531	1.531	1.531	1.531
14	1.761	1.531	1.531	1.531	1.531

Natural Mortality

age\year	2007	2008	2009	2010	2011
3	0.20	0.20	0.20	0.20	0.20
4	0.20	0.20	0.20	0.20	0.20
5	0.20	0.20	0.20	0.20	0.20
6	0.20	0.20	0.20	0.20	0.20
7	0.20	0.20	0.20	0.20	0.20
8	0.20	0.20	0.20	0.20	0.20
9	0.20	0.20	0.20	0.20	0.20
10	0.20	0.20	0.20	0.20	0.20
11	0.20	0.20	0.20	0.20	0.20
12	0.20	0.20	0.20	0.20	0.20
13	0.20	0.20	0.20	0.20	0.20
14	0.20	0.20	0.20	0.20	0.20

Stock numbers

age\year	2007	2008	2009	2010	2011
3		136.953	116.27	138.99	138.72
4		62.498			
5		69.310			
6		51.560			
7		11.867			
8		14.739			
9		5.732			
10		2.169			
11		0.887			
12		0.123			
13		0.088			
14		0.014			

Prop. mort. before spawning

age\year	F	M
3	0.085	0.250
4	0.180	0.250
5	0.248	0.250
6	0.296	0.250
7	0.382	0.250
8	0.437	0.250
9	0.477	0.250
10	0.477	0.250
11	0.477	0.250
12	0.477	0.250
13	0.477	0.250
14	0.477	0.250

Table 9.7.1. Icelandic cod in Division Va. Inputs in the short term predictions

Prognosis - Summary table

2008				2009				2010				2011			
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)
135	590	231	0.386	100	647	256	0.256	100	730	306	0.217	100	844	366	0.180
				118	647	252	0.309	129	709	285	0.302	142	789	318	0.293
				124	647	250	0.327	127	703	281	0.299	134	785	317	0.277
				155	647	241	0.423	170	668	247	0.454	187	700	248	0.490
				200	647	228	0.581	200	616	206	0.636	200	611	189	0.669

```
Opt 1: Fixed 100 kt landings
Opt 2: 20% of B4+, no buffer
Opt 3: 20% of B4+, buffer
Opt 4: 2006 catch rule
Opt 5: Fixed 200 kt landings
```

Table 9.7.2a. Icelandic cod in Division Va. Output of the short term predictions, domestic format

2008 B4+	SSB	Landings	Fbar
590	231	135	0.386

2009 B4+	Fmult	Fbar	SSB2009	Landings	2010 B4+	2010 SSB
647	0.000	0.000	282	0	844	410
	0.050	0.050	277	21	820	386
	0.100	0.100	272	42	796	363
	0.150	0.150	267	61	774	342
	0.200	0.200	262	80	753	322
	0.250	0.250	257	98	732	304
	0.300	0.300	252	115	713	287
	0.350	0.350	248	132	694	271
	0.400	0.400	243	148	676	256
	0.450	0.450	239	163	658	242
	0.500	0.500	235	177	642	229
	0.550	0.550	230	191	626	217
	0.600	0.600	226	205	610	206
	0.650	0.650	222	218	596	195
	0.700	0.700	218	230	581	185
	0.750	0.750	214	242	568	176
	0.800	0.800	211	254	555	167
	0.850	0.850	207	265	542	159
	0.900	0.900	203	276	530	151
	0.950	0.950	200	286	518	144
	1.000	1.000	196	296	507	137

Table 9.7.2b. Icelandic cod in Division Va. Output of the short term predictions, ICES format

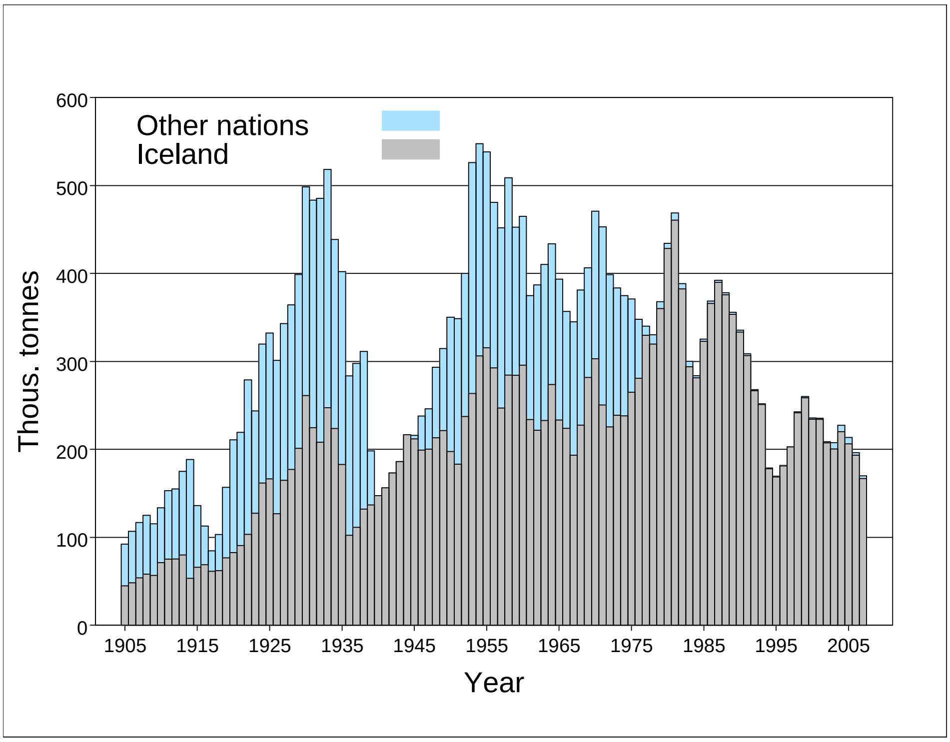


Figure 9.2.1 Icelandic cod division Va. Landings from 1905 to 2007.

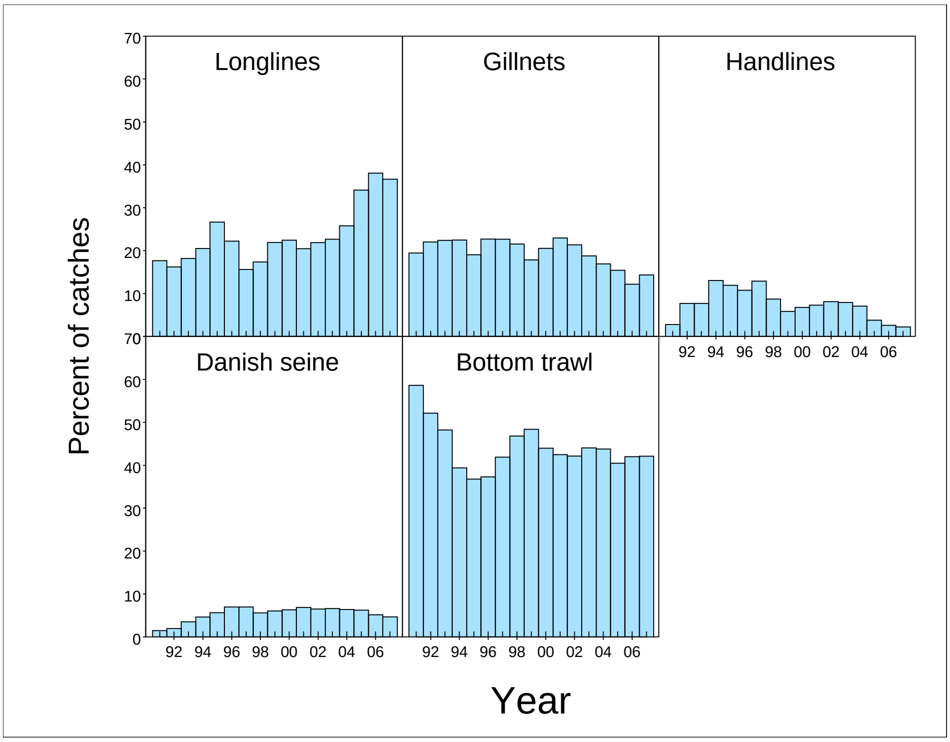


Figure 9.2.2. Icelandic cod division Va. Landings by gear in percentage

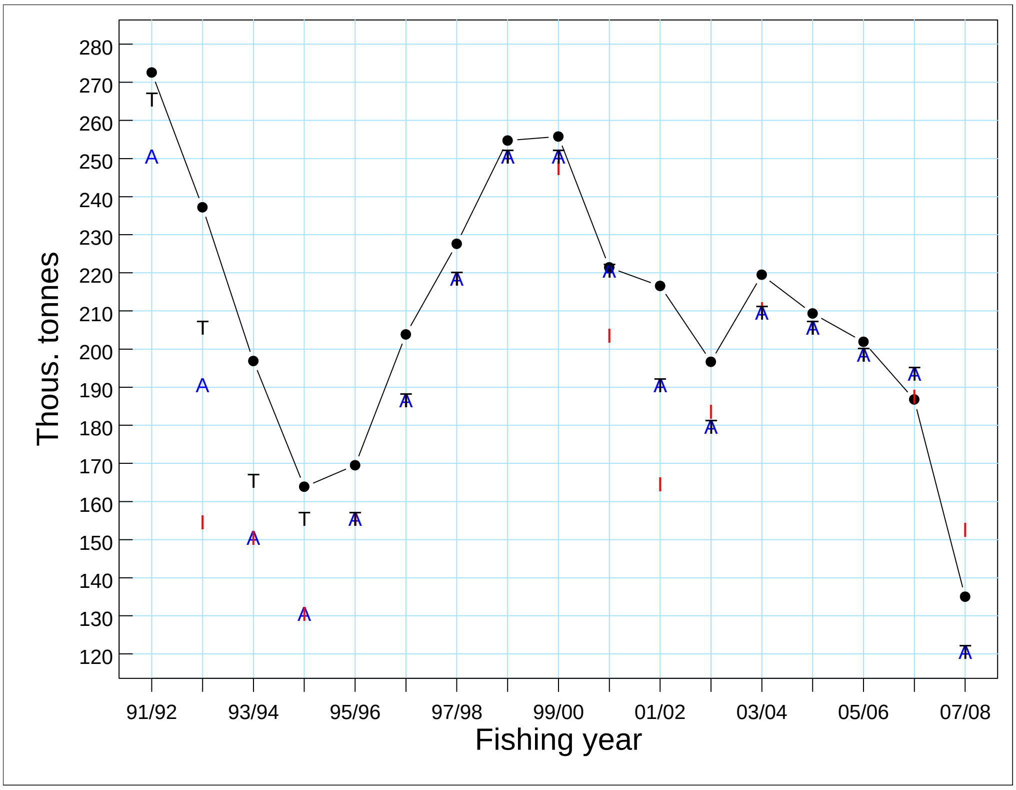


Figure 9.2.3. Icelandic cod division Va. ICES advice (I), domestic advice (A), set TAC (T) and reported landings for the fishing year.

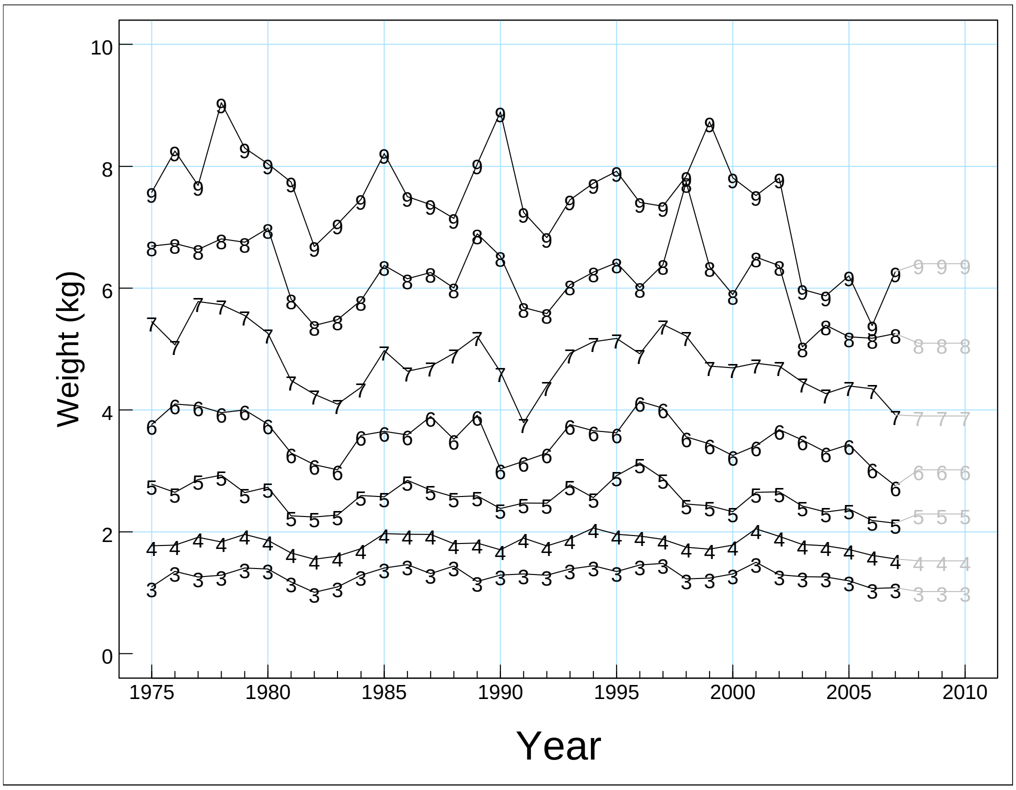


Figure 9.2.4. Icelandic cod division Va. Mean weight at age in the catches.

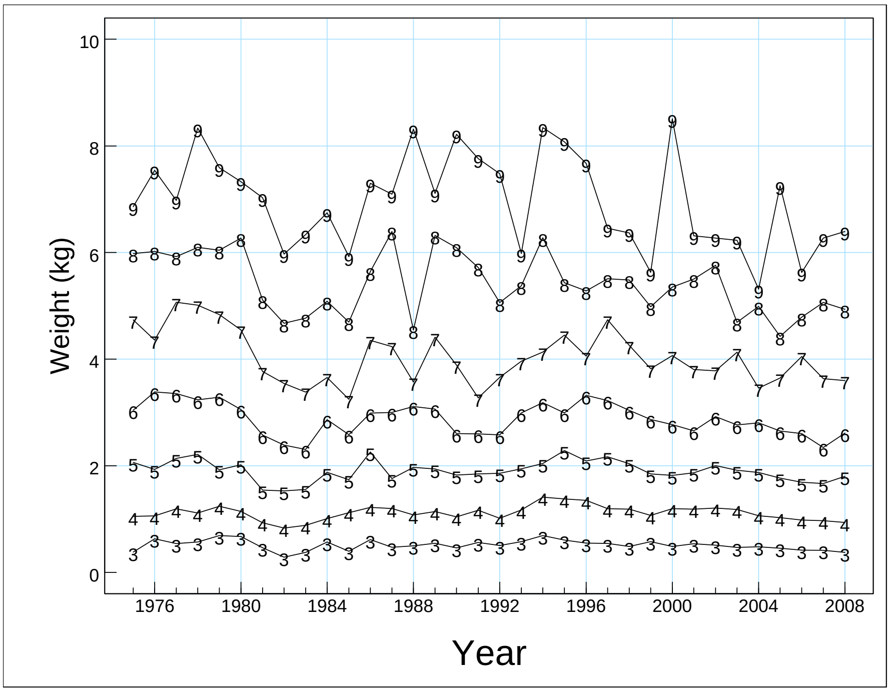


Figure 9.2.5. Icelandic cod division Va. Mean observed weight at age in the March groundfish survey. Note values prior to 1985 are based on predictions.

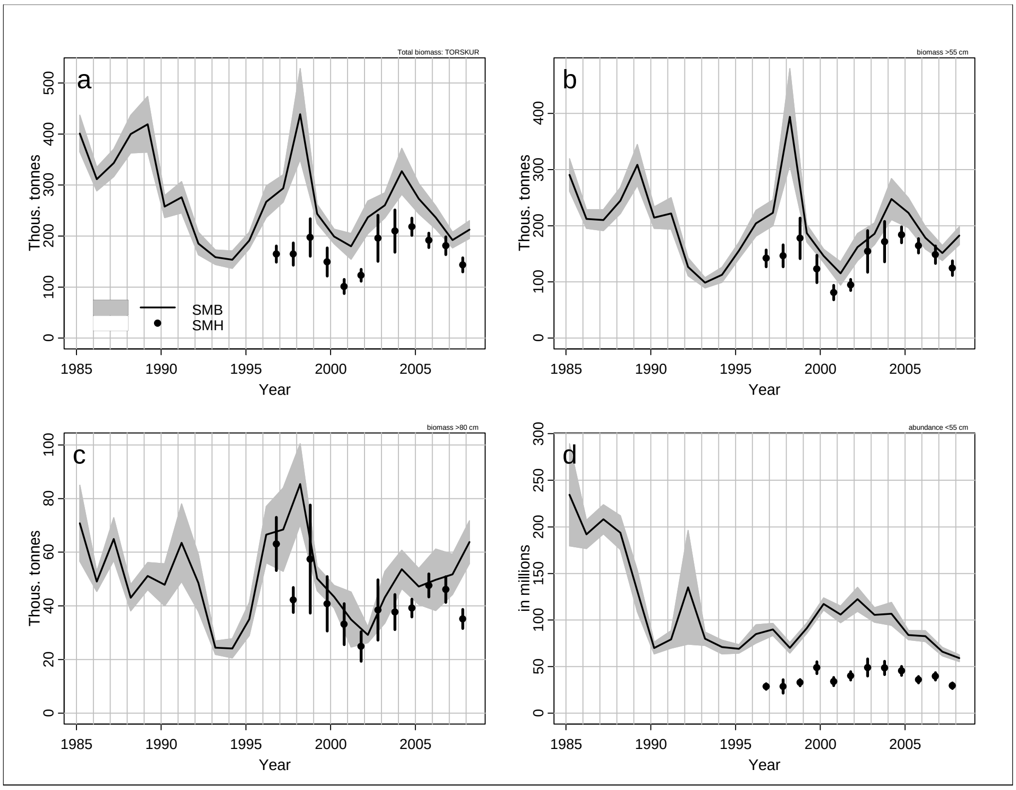


Figure 9.2.6. Icelandic cod division Va. Abundance indices of cod in the groundfish survey in March 1985-2007 (SMB, line, shaded area) and October 1996-2007 (SMH, points, vertical lines). a) Total biomass index, b) Biomass index of 55 cm and larger, c) Biomass index 80 cm and larger, d) Abundance index of < 55 cm. The shaded area and the vertical bar show ±1 standard error of the estimate.

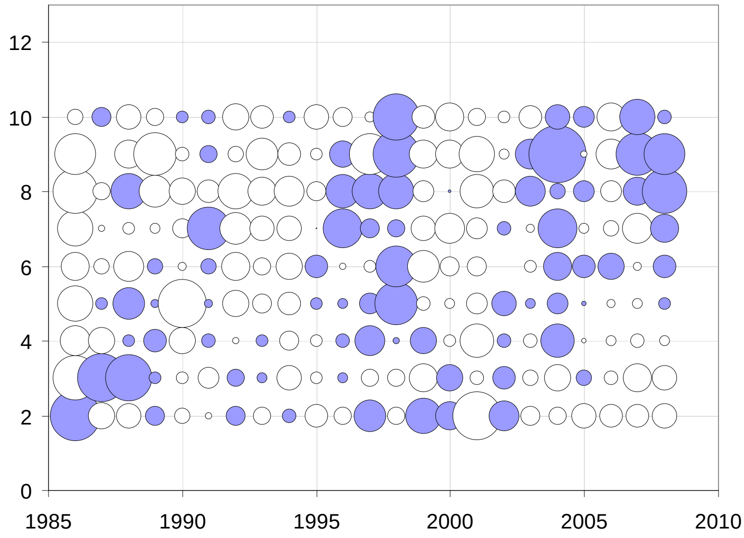


Figure 9.2.7. Icelandic cod division Va. Residual pattern of the observed vs. predicted spring survey indices by age and year from consecutive years. For further explanation see section 9.2.3.

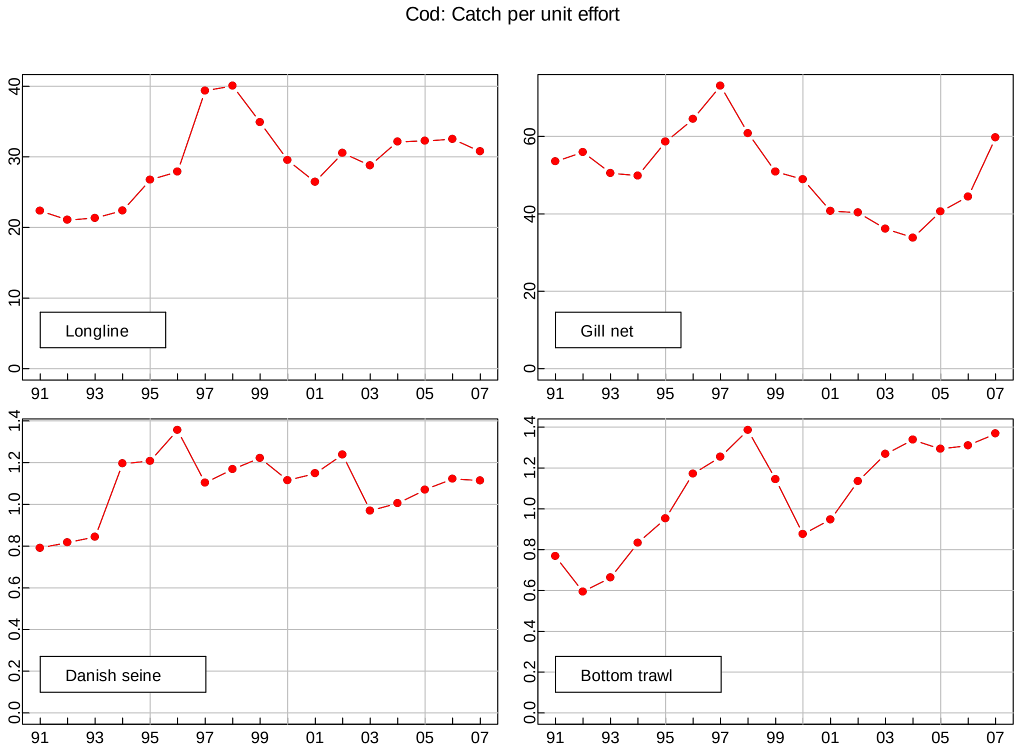


Figure 9.3.1. Icelandic cod division Va. Unstandardized index of catch per unit effort based on log book records where the proportion of cod in the catch is greater than 50%.

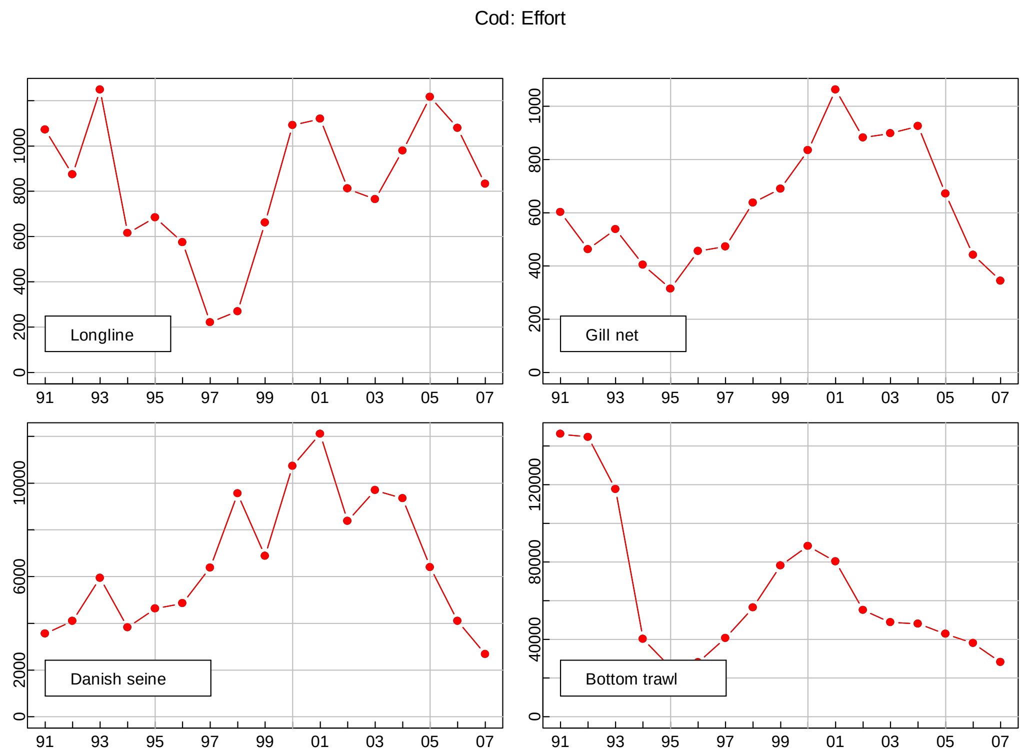


Figure 9.3.2. Icelandic cod division Va. Unstandardized index of effort based on log book records where the proportion of cod in the catch is greater than 50%.

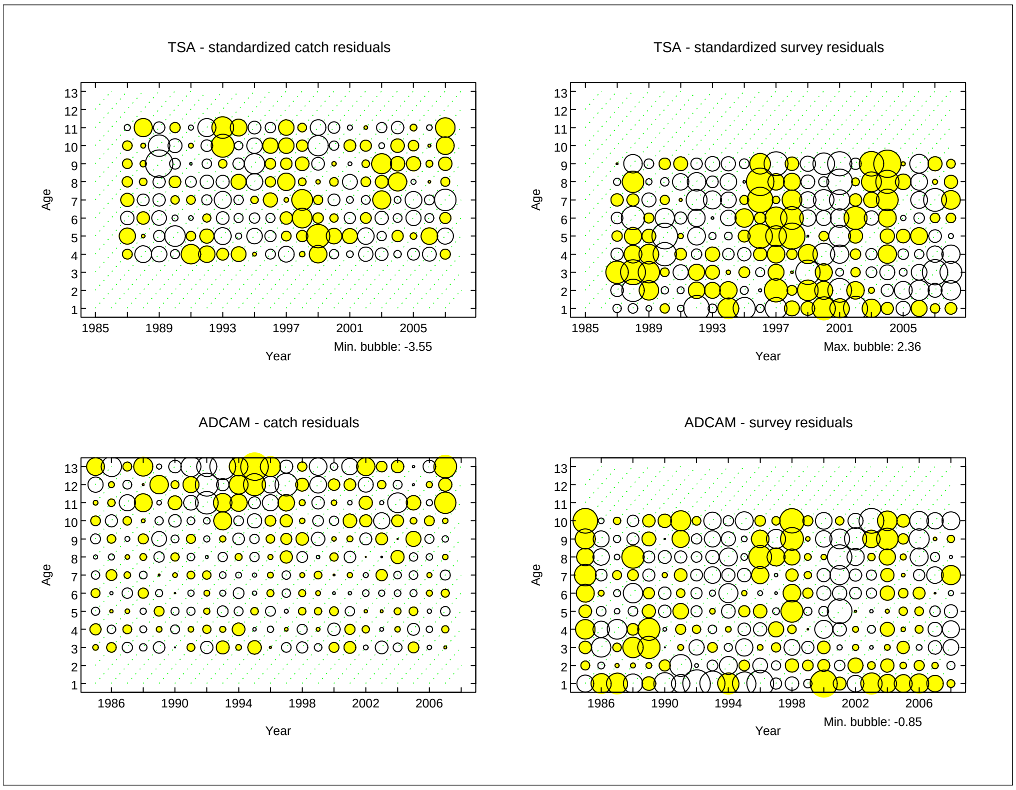
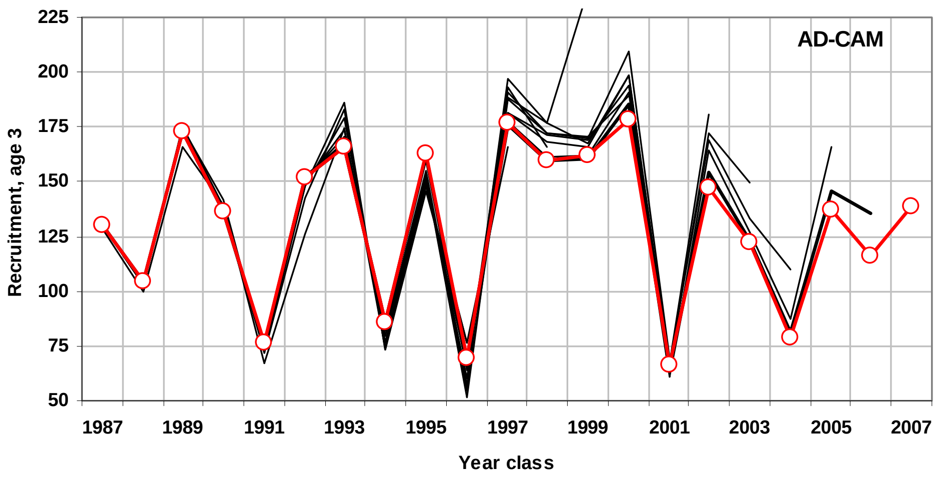
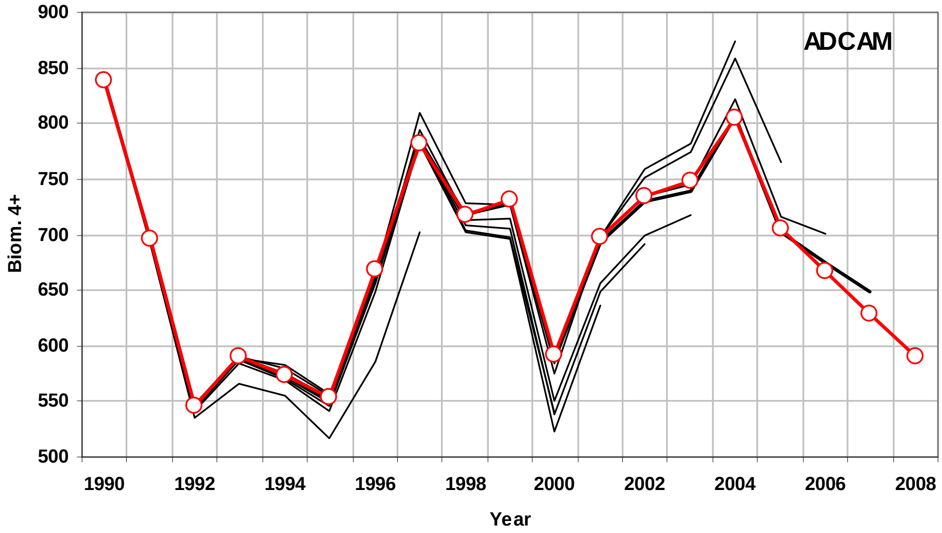


Figure 9.4.1. Residuals by year and age from the various models. Solid symbols indicated positive values, open symbols indicated negative values. Bubble area is proportional to magnitude.





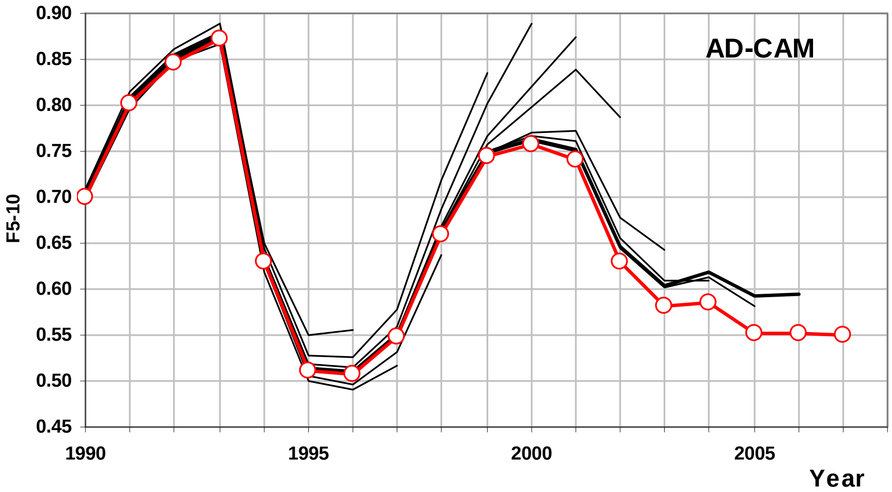


Figure 9.4.2a. Icelandic cod in division Va. Retrospective pattern from the ADCAM SPALY fit with the spring survey. Note that the intercept of the y-axis on the x-axis is not set to zero and that the estimates of B4+ is shown, not the conventional SSB (which constitutes older portion of the stock).

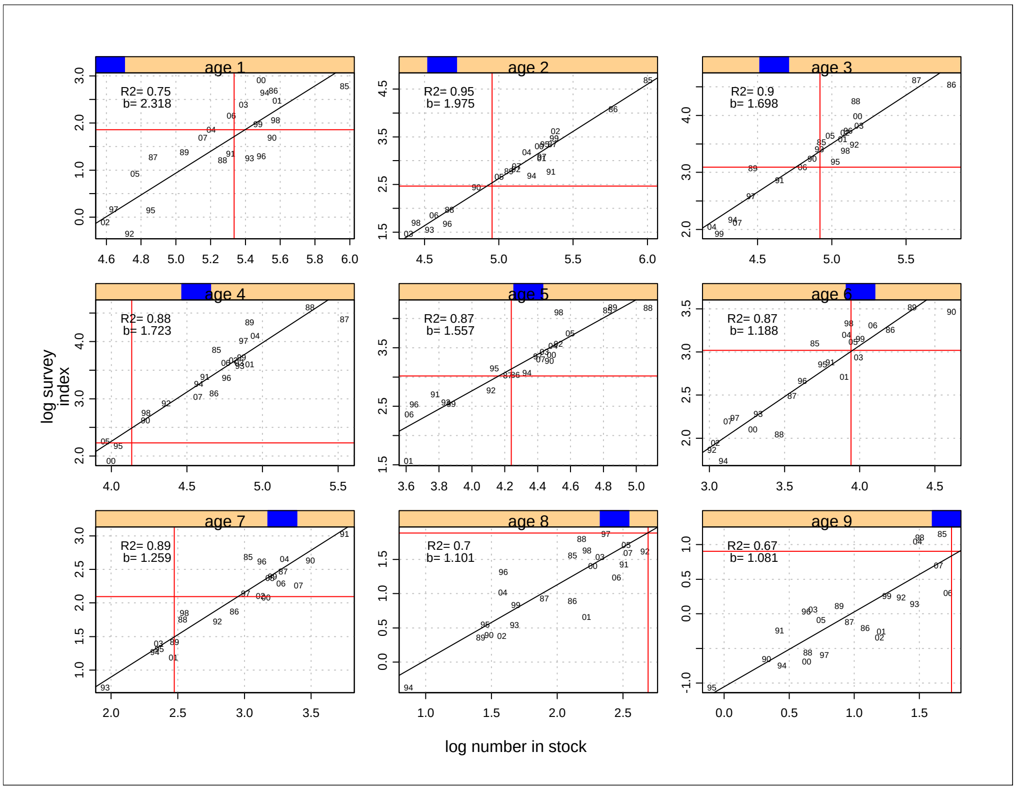


Figure 9.4.3. Icelandic cod in division Va. Log Indices from the spring groundfish survey vs. log number in stock. Line fitted on log scale (power curve) using data from 1985 to 2004. The red lines indicate the stock estimates in 2008 (Na,2008) from the ADCAM SPALY run and the corresponding spring survey measurement (Ua,2008).

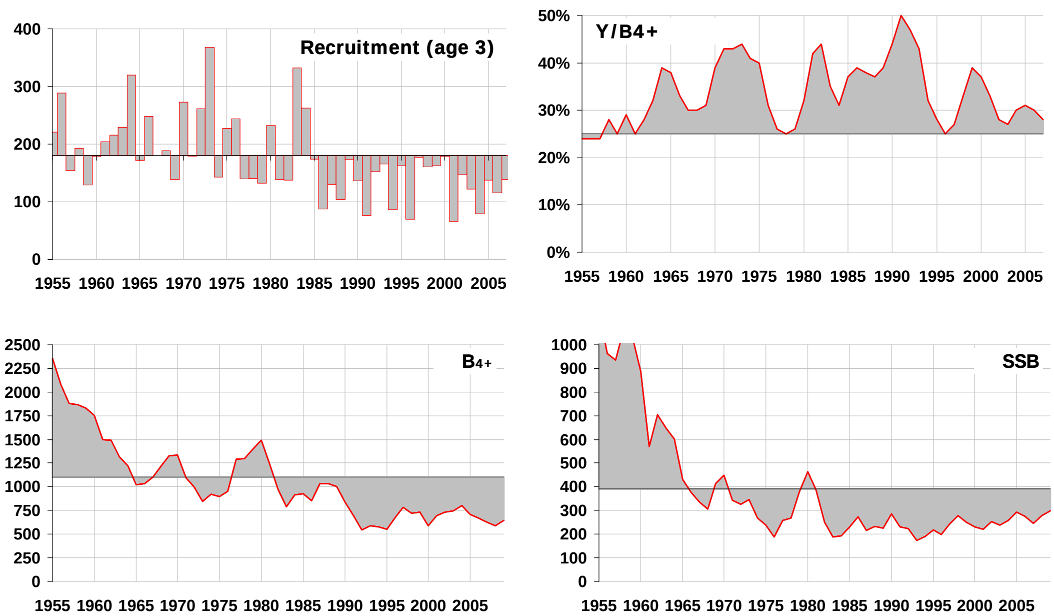


Figure 9.6.1. Icelandic cod in division Va. Summary plot. The x-axis on the recruitment plot refers to year class.

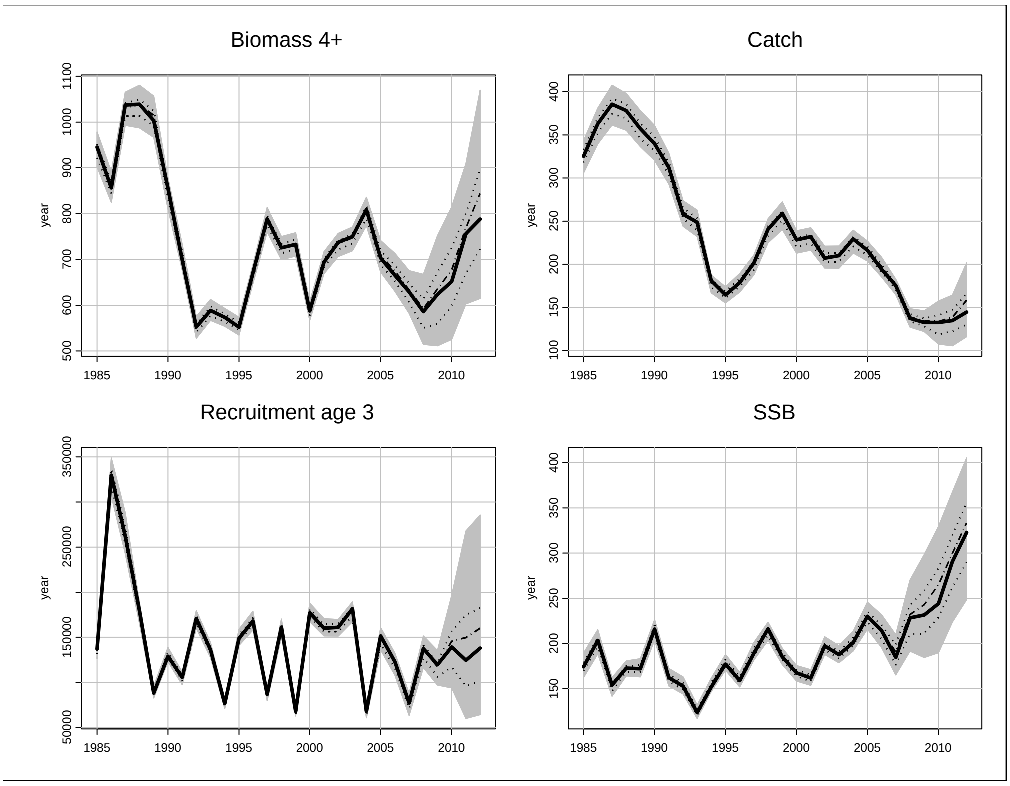


Figure 9.8.1. Icelandic cod in division Va. Medium term projections based showing 95% confidence interval.

10 Icelandic haddock

The main points in this section are.

- Same assessment procedure as last year (SPALY). Adapt type model tuned with both the surveys.
- Slow growth. Selection size based so year classes recruit late to the fishery. Prediction of growth the main problem.
- Low mean weight at age means that same age based fishing mortality means higher fishing effort. Propose lowering the target F from 0.47 to 0.35.
- Problems with to high TAC of haddock compared to cod. Too high effort towards haddock.

10.1 Stock description and management units

Icelandic haddock (Melanogrammus aeglefinus) is mostly limited to the Icelandic continental shelf but 0-group and juveniles from the stock are occasionally found in E Greenland waters. Apart from this larval drifts links with other areas have not been found. 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.

10.2 Scientific data

The scientific data used for assessing Icelandic haddock are the similar as for most other demersal species in Icelandic waters. The sampling programs i.e log books, surveys, sampling from landings etc. are described in the appropriate section.

10.2.1 Landings

Landings of Icelandic haddock in 2007 are estimated to have been 110,000 tonnes the highest since 1963, see figure 10.2.1 and table 10.2.1 Of the landings 108 000 tonnes are by Iceland but 2000 tonnes by other nations. The share of different gear in the haddock catches have been varying with time, with the share of longlines increasing in recent year while the proportion of haddock caught in gillnets is now very small. (figure 10.2.2)

10.2.2 Landings by age

Catch in numbers by age are shown in table 10.2.2 and figure 10.2.4. Discards are not included in the total catch in tonnes but partly in the samples used for compiling catch in numbers that are a somewhat variable mixture of harbour and sea samples.

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 40% of number caught and 22% of landings in 1997 (Pálsson 2003). Comparison of sea and harbour samples indicate that discard was small in 2007 (figure 10.2.6) as it has been in most years since 2000. Not including discards with catch in numbers has probably some effect on recruitment estimates as the recruitment in the years with most discards is probably underestimated. It must though be born in mind that length measurements taken at sea have usually been 60-70% of the length measurements used for calculating catch in numbers. Raising of the landings has though not been done. Discards might also be an index of hidden mortality caused by the fisheries .

Figure 10.2.5 shows the catch in numbers plotted on log scale with lines corresponding to Z=0.6 shown for reference. The line indicates that total mortality of Icelandic haddock has usually been high.

10.2.3 Surveys

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.

The index of total biomass from the groundfish surveys in March and October is shown in figure 10.2.7. Both surveys show much increase between 2002 and 2005 but the most recent surveys show considerable decrease, especially the March survey in 2008.

Age disaggregated indices from the March survey are given in table 10.2 3 and figure 10.2.8 and indices from the autumn survey in table 10.2.4. They indicate that most of year classes 1998 – 2003 are large with the 2003 year class much larger than any other year class. In 2008 the abundance of the 2003 year class is substantially reduced. Later year classes are much smaller but year class 2007 seems to be the largest of those and well above mean. Figure 10.2.9 shows indices from the March survey on log scale indicating that total mortality has usually been high or closed to 1.

Figures 10.2.12 and 10.2.13 show the abundance of the same year class in the surveys two adjcacent years, indicating a reasonably good consistency for the most important age groups. At age 5 the abundance of the large 2003 year class looks normal compared to what it was at age 4 (figure 10.2.13). As the point furthest to the right it can have much effect on the regression line. Skipping it in the regression does not change the line very much so the drop of the year class from age 4 to 5 seems near average. This might indicate average fishing mortality of age 4 in 2007 pointing to relatively high effort as weight at age is low.

10.2.4 Mean Weight and maturity at age

Mean weight at age in the catch is shown in table 10.2.6 and figure 10.2.16.

Mean weight at age in the stock for 1985–2008 is given in Table 10.2.5 and figure 10.2.15. Those data are obtained from the groundfish survey in March. Weights for 1985–1992 were calculated using a length-weight relationship which is the mean from the years 1993–2008. 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. From 1990 to 2004 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 than other year classes. In recent years the weights at age have reduced much and are in 2008 at or near historic low, especially for the large 2003 year class.

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 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 10.2.7 and figure 10.2.17. Those data are obtained from the groundfish survey in March. Maturity at age increased in the nineties compared to the eighties at the same time as mean weight at age decreased.

In recent years maturity at age has been decreasing at the same time as mean weight at age has been decreasing. Maturity by size has though not changed much in recent years.

10.3 Information from the fishing industry

Catch and/or landings in numbers are described in 10.2 and will not be described further here.

Since 2000 all vessels fishing in Icelandic waters have been required to fill out logbooks where they list imformation about the location, catch and a number of other things for each tow (setting). Vessels larger than 12 tonnes have been required to return logbooks since 1991 and some trawlers started returning logbooks in the seventies.

The logbook data have been used to compile catch per unit effort. Interpretation of those data have often been difficult for it is not always clear when haddock is being targeted but haddock has traditionally been caught in mixed fisheries with cod and some other species. Most often "haddock records" have been selected by choosing records where haddock exceeds certain percent of the total catch (often 50%). The effect of this selection criterion with rapidly increasing haddock catch contemporary with rapidly diminishing cod catch is not clear.

Figure 10.3.1 shows the CPUE from the 4 most important fishing gear targeting haddock. The CPUE in longlines, Danish seine and bottom trawl based on settings where haddock exceeds 50 % of the total catch has been reducing in recent years but is still at relatively high level. The CPUE based on all settings where haddock is recorded does not show this decrease. This discrepancy is not unexpected having in mind the increase in haddock landings and expansion of the fisheries (figures 10.2.3 and 10.2.11). CPUE in gillnets is at relatively low level and the share of gillnets in the haddock fisheries is now very small (figure 10.2.2).

10.4 Methods

Last year the final assessment was based on an Adapt type model calibrated with indices from both the groundfish surveys in March and October. Before that statistical catch at age model calibrated with indices from the March survey was used.

In recent years assessment of Icelandic haddock has been done with a number of different age based models, both VPA and statistical catch at age models. This year assessment was done with 4 different models i.e XSA, TSA, Adapt type model and Adcam. In recent years the same models have been used. XSA has always indicated that the stock is somewhat larger than the other models do. Examination of the models has shown that the most important explanation of this difference is that XSA does not model correlation between residuals of different age groups in the surveys in the same year. For Icelandic haddock this correlation is quite high (especially in the March survey) so it can nearly be described as a year factor.

Assessment in recent years has shown some difference between different models but more difference between different data sources i.e the March and the October surveys. Models calibrated with the October survey have indicated smaller stock although both surveys have indicated that the stock is very large. There have been indications that "catchability" of haddock in the March survey might be on the higher side so last year the assessment was based on both the surveys.

The SPALY method used this year was the same as in last year i.e Adapt type model tuned with both the surveys.

10.5 Reference points

In the year 2000 the working group proposed provisional F_{pa} set to the F_{med} value of 0.47 and this value has been used as F_{target} since then. At that time F_{4-7} = 0.47 looked like a reasonable fishing mortality, forgetting the F_{med} approach that does probably not hold water. Since 1984 F_{4-7} has only 3 times been below F_{pa} and 7 times since 1960.

In recent years the mean weight at age has been reducing considerably, especially for the huge 2003 year class and at the moment mean weight at age is one year behind what has been normal. This has affected the selection pattern of the fisheries but also meshed up the reference F as F_{4-7} should now be compared to F_{3-6} in earlier years. Those factors were considered last year and the advice based on F_{4-7} = 0.35 that was considered to lead to similar fishing mortality for the same size of fish as F_{4-7}=0.47 would have done 1985-2000.

The SGPRP proposed B_{loss} as candidate for B_{pa} at its meeting in February 2003. The working group did not discuss this matter further.

10.6 State of the stock

All assessment models run indicate that the stock is large but that younger year classes are much smaller than those that are now in the fisheries so the stock will decrease in coming years. As last year the final assessment was based on an Adapt type model using both the March and the October survey for tuning

Figures 10.6.1 shows the development of recruitment, biomass, survey biomass and fishing mortality but figures 10.6.2 and 10.6.3 residuals from the fit to the survey data. The residuals in the most recent March survey are negative indicating that the model does not follow the drop in survey indices seen in the most recent survey. Figure 10.6.4 shows the estimated "catchability" and CV as function of age for the surveys showing that estimated CV is lower in the autumn survey for ages 2 to 7. Therefore the autumn survey gets more weight for those age groups. The figure also indicates that estimated CV and "catchability" have not changed much since last year.

The table below show estimated fishing mortality in 2007 and biomass in 2008 from a number of models. It shows that models based only on the March survey indicate larger stock than models tuned with the autumn survey or both the surveys. The difference between model results has decreased from assessment in recent years.

MODEL AND DATA	F4-7 2007	BIO 3+ 2008
XSA March survey	0.52	300
Adcam March survey	0.55	273
TSA March survey	0.50	270
Adapt autumn survey	0.61	220
Adapt both surveys	0.55	260

10.7 Short term forecast

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 in 2006. To summarize the findings of working paper #19 the stock weights are predicted forward in time starting with the weights from the March survey 2008. Growth is predicted as a function of weight at age multiplied by a year effect.

$$\log \frac{W_{a+1,t+1}}{W_{a,t}} = \alpha + \beta \log W_{a,t} + \delta_{year}$$

Figure 10.7.1 shows the estimated year effect indicating slow growth in 3 years. Last year the year factor for the year 2006 was used as basis for prediction of growth in 2007 and 2008, leading to overestimation of stock weight at age in 2008 as growth in 2007 was slower than in 2006. The same procedure led on the other hand to underestimation of growth in 2006. This year the procedure is repeated i.e the very slow 2007 growth was used for the years 2008 and later.

Mean weight at age in the catches is predicted from mean weight at age in the stock the same year by an equation of the form

$$\log Wc_{a,t} = \alpha + \beta \log W_{a,t}$$

Figure 10.7.2 shows the data and the fitted relationship. The fitted relationship predicts that catch weights will be below stock weights when the latter are above 3100g but there are no indications in the near future that the mean weight of any age group will reach that value.

Maturity at age was predicted from mean weight at age in the stock by an equation of the form

$$\log it(P_{a,t}) = \alpha + \beta \log W_{a,t}$$

The fitting is done separately for the period 1985 – 2000 and 2001 – 2008 with the latter relationship used for prediction.

Haddock fisheries in Icelandic waters tend to avoid small haddock so when growth is slower the year classes recruit slower to the fisheries. Figure 10.7.2 shows the relationship between mean weight at age in the stock and selection at age of the fisheries with a curve fitted to the data. The selection at age is flat when mean weight at age in the stock exceeds approximately 2 kg.

Stock numbers in the year 2007 and recruitment in 2007 – 2008 were obtained from the Adapt type model calibrated both the surveys and the same model was used for prediction as for assessment.

F_{4-7} = 0.35 was used as basis for advice but as described in working paper #19 2006 and in the section on reference point (section 10.7.2). This value corresponds to F_{4-7} = 0.47 in the period that the reference point was based on.

A TAC constraint of 100 000 tonnes was used for the year 2008. The estimate was the sum of the TAC for the fishing year starting September 1st 2007 that was remaining in the beginning of 2008 and 30% of the estimated TAC for the fishing year 2007-2008

The result of short term prediction is shown in table 10.7.1 and 10.6.1. They show that both stock size and landings will decrease rapidly in coming years when the large year classes disappear, how rapidly depends on fishing mortality and growth.

10.8 Medium term forecasts

No medium term forecasts were done this year.

10.9 Uncertainties in assessment and forecast

The state of the stock today is reasonably well known but there is considerable uncertainty in prediction of growth and therefore in the short term forecast. Currently mean weight of all age groups are at or below historical minimum, well below it for the very large 2003 year class. Growth is predicted to be very slow in coming years but growth is modelled as function of size instead of age so the old relatively small fishes of the 2003 year class are expected to continue to grow at the same rate as 1-2 years younger fish of the same size. This assumption might be correct but growth might also be reduced to age or maturity effects.

10.10 Comparison with previous assessment and forecast

Figure 10.10.1 shows a comparison of this years and last years assessment. The numbers compare reasonably well. The main difference is in mean weight at age that is 8 percent below prediction for the most important year classes (2003 and 2002). Comparison with last years assessment may also be seen in figure 10.6.1 where last years assessment is shown as dashed lines.

Even though the assessment is doing reasonably well in terms of stock in numbers the most recent residuals are negative (figures 10.6.1 and 10.6.2). This indicates that the model does not follow the recent drop in survey indices. Perhaps a signal that numbers might reduce in next years assessment.

Looking at the last 5 years prediction of numbers in stock has succeeded reasonably well but mean weight at age has been overestimated leading to much lower than predicted landings from the large year classes 2002 and 2003. The problem of growth prediction was tackled in 2006 leading to somewhat better prediction of growth since than, some underestimation of 2006 growth but overestimation of 2007 growth.

10.11 Management plans and evaluations

Could just be a reference to the year when the plan was agreed/evaluated. Include proposed/agreed management plan.

10.12 Management considerations

Hidden mortality of young haddock is potentially a major problem (Björnsson and Jónsson 2004). The problem is most pronounced when there is much overlap in the spatial distribution of the recruits and of the fisheries. Also the problem tends to be worse when larger haddock are lacking and when fishing mortality is high. The problem tends to be aliased with the discard problem but also includes fish that escapes from the fishing gear below the surface. In recent years share of longliners have increased, possibly changing the hidden mortality but longlines do not affect fish that does not take the bait.

In 2007 most fishermen claimed that fishing their haddock quotas was difficult because of by catch of cod. This might be an indication that haddock quotas in Icelandic waters might too high and the current assessment confirms that fishing mortality is increasing when fishing mortality of cod is being reduced. **Fishing mortality by age is still not high compared to what it has usually been but fishing mortality by size is relatively higher and that is what matters.** Reasonable balance in fishing mortality of species coexisting in mixed fisheries is very important for management of the fisheries.

10.13 Ecosystem considerations

Known/new impacts of the fisheries on the ecosystem

10.14 Regulations and their effects

For a number of years minimum landing size of haddock has been 45 cm and areas where more then 25% of the catch was below this size were closed temporarily. In 2007 large part of the very large 2003 year class was below minimum landing size but younger year classes are much smaller so nearly all haddock close to the minimum landing size was of the 2003 year class. Keeping the minimum landing size unchanged meant trying to take the largest individuals of the same year class so it was decided to change the minimum landings size to follow the growth of the 2003 year class.

10.15 Changes in fishing technology and fishing patterns

In recent years increased proportion of haddock has been caught by longliners (figure 10.2.2). This might have affected the hidden mortality of haddock.

10.16 Changes in the environment

Some Narrow fjord tales.

Table 10.2.1 Haddock in Division Va Landings by nation.

Table 1.1. Icelandic haddock. Landings by nation.

COUNTRY	1979	1980	1981	1982	1983	1984	1985	1986
Belgium	1010	1144	673	377	268	359	391	257
Faroe Islands	2161	2029	1839	1982	1783	707	987	1289
Iceland	52152	47916	61033	67038	63889	47216	49553	47317
Norway	11	23	15	28	3	3	+	
€UK								
Total	55334	51112	63560	69425	65943	48285	50933	48863

HADDOCK Va

COUNTRY	1987	1988	1989	1990	1991	1992	1993	1994
Belgium	238	352	483	595	485	361	458	248
Faroe Islands	1043	797	606	603	773	757	754	911
Iceland	39479	53085	61792	66004	53516	46098	46932	58408
Norway	1	+						1
UK								
Total	40761	54234	62881	67202	53774	47216	48144	59567

HADDOCK Va

COUNTRY	1995	1996	1997	1998	1999	2000	2001	2002
Belgium								
Faroe Islands	758	664	340	639	624	968	609	878
Iceland	60061	56223	43245	40795	44557	41199	39038	49591
Norway	+	4						
UK								
Total	60819	56891	43585	41434	45481	42167	39647	50469

COUNTRY	2003	2004	2005	2006	2007
Belgium					
Faroe Islands	833	1035	1372	1499	1780
Iceland	59970	83791	95859	96115	108175
Norway	30	9			11
UK	51				
Total	60884	84835	97231	97614	109966

Table 10.2.2 Haddock in division Va. Catch in number by year and age.

Year/age	2	3	4	5	6	7	8	9
1979	161	2066	4074	6559	9769	1887	474	61
1980	595	1384	11476	4296	3796	3730	544	91
1981	10	516	4929	16961	6021	2835	1810	169
1982	50	286	2698	10703	14115	2288	1167	816
1983	10	705	1498	4645	10301	8808	874	241
1984	60	755	4970	1176	4875	3772	4446	171
1985	427	1773	4981	6058	837	1564	2475	2212
1986	196	3681	3822	4933	5761	493	852	898
1987	2237	7559	7500	2696	2249	1194	151	208
1988	133	10068	15927	5598	1260	1009	577	58
1989	78	2603	23077	9703	3118	541	507	144
1990	446	2603	7994	23803	6654	857	167	71
1991	2461	1282	3942	6711	13650	2956	398	52
1992	2726	7343	4181	4158	3989	5936	1314	132
1993	218	11617	12642	3167	1786	1504	2263	379
1994	280	3030	27025	10722	1550	756	404	700
1995	2357	6327	5667	23357	5605	610	263	210
1996	1467	8982	7076	4751	13963	2446	228	87
1997	1375	3690	11127	4885	2540	4981	692	52
1998	207	8109	5984	8390	2420	1502	1884	207
1999	1077	1455	16897	4844	4982	942	588	514
2000	2351	6496	2335	13817	2052	1789	364	197
2001	2212	11298	7124	1497	6212	698	484	104
2002	1020	10603	16192	5128	1126	3126	245	175
2003	279	6396	16355	12695	2866	766	1314	85
2004	1356	4154	17937	19402	8801	1957	539	538
2005	1577	9580	7169	25996	14108	4841	837	250
2006	157	9930	20900	6688	19218	7806	2257	316
2007	745	3730	41648	22995	3445	10445	2902	538

Table 10.2.3 Icelandic haddock. Age disaggregated survey indices from the groundfish survey in March

Year/ age	1	2	3	4	5	6	7	8	9	10
1985	28.15	32.72	18.34	23.65	26.54	3.73	10.98	4.88	5.64	0.51
1986	123.95	108.51	59.07	12.8	16.38	13.2	0.98	2.77	1.26	2.32
1987	22.22	296.28	163.63	57.08	13.17	11.17	8.09	0.58	1.28	0.84
1988	15.77	40.71	184.77	88.86	22.86	1.36	2.25	1.87	0.18	0.28
1989	10.58	23.35	41.53	146.71	44.9	12.74	0.85	0.84	0.41	0.28
1990	70.48	31.86	27.25	39.06	91.79	30.87	3.44	0.9	0.23	0
1991	89.73	145.95	41.55	17.83	20.27	32.55	7.67	0.3	0.1	0.11
1992	18.15	211.43	138.4	35.54	16.56	13.14	15.93	2.21	0.18	0.07
1993	29.99	37.65	245.06	87.3	11.15	3.86	1.66	4.46	0.88	0
1994	58.54	61.34	39.83	142.62	42.41	6.93	2.89	1.42	4.07	0
1995	35.89	82.53	48.09	19.74	68.41	7.66	1.31	0.11	0.34	0
1996	95.25	66.3	121	36.93	19.11	39.77	5.84	0.62	0.13	0.12
1997	8.57	119.13	50.88	52.99	10.86	7.28	10.58	1.37	0.06	0.03
1998	23.12	18.07	108.27	28.25	23.32	4.64	3.47	4.57	0.33	0
1999	80.73	86.21	25.8	98.18	12.9	9.6	1.42	1.7	1.03	0.03
2000	60.58	90.44	45.03	8.54	24.63	2.94	1.62	0.41	0.15	0.45
2001	81.33	148.06	115.04	22.16	4.09	10.56	0.93	0.57	0	0.1
2002	21.14	298.28	201	112.78	23.25	3.52	7	0.31	0.34	0.11
2003	111.96	97.85	282.83	244.83	112.28	18.05	2.58	4.43	0.48	0.85
2004	325.9	291.97	70.85	208.84	109.26	33.86	6.88	1.08	0.86	0
2005	58.37	693.04	288.21	44.97	156.93	57.32	15.75	3.34	0.32	0.27
2006	38.39	90.06	575.79	179.18	18.92	62.94	16.24	6.74	0.7	0.29
2007	34.01	66.06	88.56	436.14	85.73	7.78	21.61	4.74	2.06	34.01
2008	88.53	68.49	71.90	75.17	222.62	29.91	3.53	7.47	1.67	0.27

Table 10.2.4 Icelandic haddock. Age disaggregated survey indices from the groundfish survey in October

Year/age	0	1	2	3	4	5	6	7	8	9
1995	93.95	162.64	184.92	51.4	24.27	42.47	5.74	0.56	0	0.07
1996	12.45	347.52	93.69	77.33	16.52	6.35	15.27	1.28	0	0
1997	49.84	29.63	200.21	59.25	39.34	7.12	5.79	6.35	0.29	0
1998	183.18	79.7	33.41	138.33	19.47	13.6	4.52	4.36	1.68	0
1999	204.63	343.81	57.78	26.55	96.25	10.51	8.97	0.45	1.49	0.31
2000	56.59	157.27	240.32	41.42	7.05	26.77	1.8	2.73	0.07	0.21
2001	50.18	331.24	253.85	155.73	31.35	3.53	12.14	0.64	0.95	0
2002	137.95	76.53	213.48	171.33	84.46	16.88	2.49	2.14	0.85	0.09
2003	313.08	337.83	139.25	223.58	144.16	48.03	8.24	1.89	0.55	0
2004	197.06	716.82	323.19	48.18	142.49	62.11	14.93	3.2	0.67	0.4
2005	98.52	73.87	530.9	171.08	24.38	81.16	23.04	9.29	1.68	0
2006	82.97	109.08	108.39	456.13	96.72	11.78	32.52	8.25	2.91	0.97
2007	197.81	94.74	70.83	85.36	302.15	50.55	7.39	10.39	3.35	0.5

Table 10.2.5 Haddock in division Va Weight at age in the stock. Predicted values are shaded.

Year/ age	1	2	3	4	5	6	7	8	9
1985	35	244	567	1187	1673	2372	2768	3199	3334
1986	35	239	671	1134	1944	2400	3192	3295	3731
1987	31	162	550	1216	1825	2605	3031	3644	3838
1988	37	176	456	974	1831	2697	3104	3483	3321
1989	26	182	440	886	1510	2382	3011	3502	3198
1990	29	184	456	839	1234	1966	2677	3055	3269
1991	31	176	500	1002	1406	1885	2498	3757	3656
1992	28	157	503	894	1365	1892	2326	2938	3684
1993	41	169	384	879	1487	1766	2548	2538	3227
1994	33	179	401	696	1242	1683	1641	2693	1991
1995	37	164	444	763	1071	1856	2667	5312	1313
1996	41	174	447	806	1072	1474	2160	2407	4803
1997	50	173	423	818	1224	1426	1917	2397	3694
1998	41	202	404	742	1232	1738	2015	2333	3081
1999	34	205	479	719	1198	1967	2381	2798	2929
2000	29	179	552	888	1167	1777	2620	2924	3155
2001	36	188	487	1052	1433	1502	2165	2758	
2002	63	172	474	891	1465	1955	2143	1998	3662
2003	40	230	412	801	1268	1873	3139	2343	3301
2004	34	176	556	807	1282	1690	2454	3236	2942
2005	40	153	448	920	1188	1564	2128	2808	2550
2006	33	127	333	736	1145	1512	1944	2232	3272
2007	48	170	350	615	1053	1514	1786	2073	2198
2008	27	179	382	595	868	1295	1828	2201	2340
2009	27	133	399	655	890	1169	1567	2013	2299
2010	27	133	400	656	891	1170	1569	2016	2302

Table 10.2.6 Haddock in division Va Weight at age in the catches. Predicted values are shaded.

Year/age	2	3	4	5	6	7	8	9
1982	330	819	1365	1649	2329	3012	3384	3965
1983	655	958	1436	1827	2355	2834	3569	4308
1984	980	1041	1476	2105	2460	3028	3014	3807
1985	599	1002	1783	2201	2727	3431	3783	4070
1986	867	1187	1755	2377	2710	3591	3760	4135
1987	446	1048	1629	2373	2984	3550	4483	4667
1988	468	808	1474	2230	2934	3545	3769	4574
1989	745	856	1170	2010	2879	4109	4035	4706
1990	357	716	1039	1542	2403	3458	4186	4969
1991	409	868	1111	1546	2035	2849	3464	4642
1992	320	856	1253	1597	2088	2529	3133	4022
1993	420	756	1372	1870	2360	2888	2975	3442
1994	568	720	1058	1742	2380	2785	3447	3156
1995	457	874	1145	1366	2079	2853	3251	3899
1996	387	841	1189	1528	1816	2641	3499	3526
1997	450	829	1192	1663	1934	2360	3059	3010
1998	689	777	1166	1692	2312	2379	2882	3417
1999	616	866	1096	1638	2205	2681	2863	3229
2000	518	951	1314	1461	2096	2679	3181	3438
2001	542	933	1451	1759	1836	2309	2966	3123
2002	573	918	1256	1741	2192	2224	2844	3392
2003	559	908	1266	1700	2297	2699	2626	2897
2004	575	979	1235	1574	2048	2799	3167	3082
2005	398	848	1212	1469	1898	2271	2952	3141
2006	429	723	1087	1496	1754	2167	2591	2923
2007	500	716	970	1326	1815	2048	2361	2572
2008	466	769	1031	1324	1725	2168	2452	2553
2009	383	793	1101	1350	1615	1961	2316	2527
2010	384	793	1102	1351	1617	1964	2318	2530

Table 10.2.7 Haddock in division Va Sexual maturity at age in the stock. (from the March survey). Predicted values are shaded.

YEAR/ AGE	2	3	4	5	6	7	8	9
1985	1.6	14.4	53.6	57.7	76.5	76.6	96.1	93.4
1986	2.1	20.5	41.3	67.3	84.5	88.4	95.2	98.6
1987	2.2	13.7	42.6	53.5	77.8	77.6	100	96.9
1988	1.3	22.1	39.4	76.7	79.3	92.8	91.4	100
1989	4.1	20.2	53.2	72.7	81.8	99.8	100	100
1990	11.4	33.4	63.4	81.4	84.3	91.8	88.2	100
1991	6.3	22.4	59.2	73.9	81.7	89.4	49.5	100
1992	5	22.7	41.9	79.9	90.1	90.1	85.8	100
1993	12.4	36.2	48.1	67	90.4	97.7	90.8	86.7
1994	24.8	31.2	57.3	76.2	84.6	100	90.7	100
1995	12.4	47.9	38.2	75	75.3	60.6	98.5	100
1996	19.1	36.2	59	64.8	78.7	73.9	94.9	90.8
1997	9.3	43.6	58.7	68.3	75	78.3	88	100
1998	2.6	45.4	66.8	77	73.3	84.9	89.9	100
1999	5	39.7	68.3	72.4	74.9	89.2	76.1	92
2000	10.7	26.1	63.2	80.8	86.8	87.3	100	78
2001	9.1	37.7	52.2	75.3	89.5	91.6	91.8	100
2002	4.7	28.6	63.3	80	93.4	92.8	100	100
2003	6.2	34.7	68.5	86.7	92.2	94.6	100	100
2004	3.7	36.1	57	83.1	91	100	100	100
2005	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
2007	7.8	20.8	41.8	68	77	87.5	95.9	100
2008	2.7	26.3	41.8	62.1	82.8	87	90.4	97.5
2009	2.1	21.7	46.9	64.4	77.3	87.1	92.4	94.3
2010	2.1	15.3	48.7	68	78.1	85.1	90.4	93.5

Table 10.6.1 Haddock in division Va. Summary table from the SPALY run using the March survey for tuning.

YEAR	RECRUITMENT MILLION AT AGE 2	BIOMASS 3+ TONS	SSB TONS	LANDINGS 1000 TONS	YIELD/SSB	F_{4-7}
1979	83747	167578	98406	59190	0.601	0.573
1980	36665	197955	119118	50902	0.427	0.384
1981	9758	214309	146537	63491	0.433	0.513
1982	42214	188330	143248	68533	0.478	0.453
1983	30201	154238	117733	64698	0.55	0.477
1984	19949	118839	88032	48121	0.547	0.503
1985	41798	106663	70380	50261	0.714	0.52
1986	89077	94221	57384	47272	0.824	0.787
1987	167335	103846	43116	40132	0.931	0.638
1988	47697	153934	67084	53871	0.803	0.654
1989	26693	170414	100484	62712	0.624	0.656
1990	22368	146847	112274	67038	0.597	0.577
1991	80259	121903	90147	54694	0.607	0.6
1992	170419	105951	67993	47026	0.692	0.695
1993	37566	129981	70863	48737	0.688	0.676
1994	41320	126354	81798	59007	0.721	0.669
1995	70922	121294	82588	60111	0.728	0.653
1996	35111	107764	69555	56716	0.815	0.709
1997	102244	86959	58341	44006	0.754	0.619
1998	18128	97718	64457	41374	0.642	0.654
1999	50320	90813	64059	45231	0.706	0.706
2000	118614	89506	62080	41870	0.674	0.669
2001	157126	114286	69084	39530	0.572	0.504
2002	193859	168329	98733	50294	0.509	0.453
2003	48460	221932	147981	60598	0.409	0.394
2004	166626	255514	182971	84405	0.461	0.482
2005	402312	266621	179781	96655	0.538	0.537
2006	69354	311490	147140	97366	0.662	0.588
2007	51933	307577	170276	109813	0.645	0.554
2008	53749	259554	165708	100066	0.604	0.425
Mean 79-07	83865	156592	99022	59091	0.633	0.583

Table 10.6.2 Haddock in division Va. Number in stock from the SPALY run using both the surveys. Shaded cells are input to prediction

YEAR/AGE	1	2	3	4	5	6	7	8	9
1979	44.8	83.7	123.7	28.1	20.7	21.5	3.3	0.8	0.1
1980	11.9	36.7	68.4	99.4	19.3	11	8.8	1	0.2
1981	51.6	9.8	29.5	54.8	71	11.9	5.6	3.8	0.3
1982	36.9	42.2	8	23.7	40.4	42.8	4.3	2	1.5
1983	24.4	30.2	34.5	6.3	16.9	23.4	22.3	1.5	0.6
1984	51.1	19.9	24.7	27.6	3.8	9.7	9.8	10.3	0.4
1985	108.8	41.8	16.3	19.6	18.1	2	3.5	4.6	4.4
1986	204.4	89.1	33.8	11.7	11.5	9.4	0.9	1.5	1.5
1987	58.3	167.3	72.8	24.4	6.1	5	2.4	0.3	0.4
1988	32.6	47.7	135	52.7	13.2	2.6	2	0.9	0.1
1989	27.3	26.7	38.9	101.4	28.8	5.7	1	0.7	0.2
1990	98	22.4	21.8	29.5	62.1	14.8	1.9	0.3	0.1
1991	208.2	80.3	17.9	15.5	16.9	29.3	6.1	0.7	0.1
1992	45.9	170.4	63.5	13.5	9.1	7.8	11.7	2.3	0.3
1993	50.5	37.6	137.1	45.3	7.3	3.7	2.8	4.2	0.7
1994	86.6	41.3	30.6	101.7	25.7	3.1	1.4	0.9	1.4
1995	42.9	70.9	33.6	22.3	58.8	11.3	1.1	0.5	0.4
1996	124.9	35.1	55.9	21.8	13.1	27	4.2	0.4	0.1
1997	22.1	102.2	27.4	37.7	11.4	6.4	9.5	1.2	0.1
1998	61.5	18.1	82.5	19.1	20.8	4.9	3	3.3	0.4
1999	144.9	50.3	14.7	60.2	10.2	9.4	1.8	1.1	1
2000	191.9	118.6	40.2	10.7	34	4	3.2	0.7	0.3
2001	236.8	157.1	95	27.1	6.6	15.3	1.4	1	0.2
2002	59.2	193.9	126.6	67.5	15.7	4.1	6.9	0.5	0.4
2003	203.5	48.5	157.8	94.1	40.6	8.2	2.3	2.8	0.2
2004	491.4	166.6	39.4	123.4	62.2	21.8	4.1	1.2	1.1
2005	84.7	402.3	135.2	28.5	84.8	33.4	9.9	1.6	0.5
2006	63.4	69.4	328	102	16.9	45.9	14.6	3.7	0.6
2007	65.6	51.9	56.6	259.5	64.6	7.8	20.2	4.9	1
2008	173.7	53.7	41.8	43	174.8	32.1	3.2	7.1	1.4
2009	74.9	142.2	43.5	32	29.6	103.8	15.7	1.3	2.8
2010	74.9	61.3	115.9	33.4	21.9	18.1	56.9	7.6	0.6
2011	74.9	61.3	50	91	22.7	13.1	9.9	28.5	3.4
2012	74.9	61.3	50	39.3	64.1	13.4	7	4.9	13.3

Table 10.6.3 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	0.002	0.019	0.175	0.431	0.698	0.989	1.127	1.013
1980	0.018	0.023	0.136	0.282	0.48	0.636	0.902	0.661
1981	0.001	0.02	0.105	0.306	0.815	0.824	0.749	0.793
1982	0.001	0.04	0.135	0.347	0.453	0.879	1.032	0.925
1983	0	0.023	0.306	0.361	0.668	0.574	1.07	0.599
1984	0.003	0.034	0.222	0.421	0.815	0.553	0.651	0.602
1985	0.011	0.128	0.331	0.461	0.607	0.68	0.895	0.797
1986	0.002	0.128	0.447	0.642	1.142	0.919	1.046	0.995
1987	0.015	0.122	0.416	0.664	0.697	0.776	0.829	0.782
1988	0.003	0.086	0.406	0.635	0.772	0.803	1.18	0.906
1989	0.003	0.077	0.29	0.467	0.924	0.944	1.409	1.119
1990	0.022	0.142	0.356	0.551	0.689	0.713	0.897	0.737
1991	0.034	0.082	0.331	0.576	0.722	0.773	0.892	0.786
1992	0.018	0.137	0.419	0.702	0.834	0.826	1.004	0.853
1993	0.006	0.098	0.368	0.656	0.764	0.916	0.911	0.913
1994	0.008	0.116	0.348	0.619	0.809	0.9	0.678	0.807
1995	0.037	0.234	0.33	0.578	0.792	0.913	0.968	0.929
1996	0.047	0.195	0.445	0.512	0.847	1.033	1.143	1.042
1997	0.015	0.161	0.395	0.64	0.573	0.868	0.982	0.88
1998	0.013	0.115	0.425	0.591	0.783	0.818	1.018	0.917
1999	0.024	0.116	0.372	0.741	0.879	0.831	0.93	0.866
2000	0.022	0.197	0.277	0.597	0.839	0.962	0.945	0.959
2001	0.016	0.141	0.344	0.287	0.594	0.79	0.764	0.779
2002	0.006	0.097	0.308	0.448	0.364	0.691	0.725	0.694
2003	0.006	0.046	0.213	0.423	0.487	0.454	0.716	0.59
2004	0.009	0.124	0.175	0.422	0.591	0.74	0.682	0.727
2005	0.004	0.082	0.325	0.414	0.629	0.78	0.851	0.789
2006	0.003	0.034	0.257	0.577	0.621	0.896	1.116	0.937
2007	0.016	0.076	0.195	0.5	0.675	0.847	1.073	0.887
2008	0.011	0.067	0.173	0.321	0.512	0.693	0.745	0.745
2009	0.005	0.065	0.18	0.289	0.401	0.53	0.647	0.647
2010	0.005	0.041	0.187	0.314	0.406	0.492	0.59	0.641
2011	0.005	0.041	0.15	0.323	0.428	0.498	0.564	0.641
2012	0.005	0.041	0.15	0.323	0.428	0.498	0.564	0.641

Table 10.7.1. Output from short term prediction.

F_{4-7} 2007 = 0.554

2008				
Bio 3+	SSB	Fmult	F4-7	Landings
260	166	0.766	0.425	100

	2009				**2010**	
Fmult	F4-7	Bio 3+	SSB	Landings	Bio 3+	SSB
0.1	0.055	220	155	15	271	185
0.2	0.111	220	155	30	259	175
0.3	0.166	220	155	43	247	166
0.4	0.222	220	155	56	237	157
0.5	0.277	220	155	68	227	149
0.6	0.333	220	155	80	218	141
0.63	0.35	220	155	83	215	139
0.7	0.388	220	155	90	209	134
0.8	0.444	220	155	101	201	127
0.85	0.47	220	155	105	197	124
0.9	0.499	220	155	110	193	121
1	0.554	220	155	119	186	115
1.1	0.61	220	155	128	179	109
1.2	0.665	220	155	136	172	104
1.3	0.721	220	155	143	166	99
1.4	0.776	220	155	150	160	94
1.5	0.832	220	155	157	155	89
1.6	0.887	220	155	163	150	85
1.7	0.943	220	155	170	145	81
1.8	0.998	220	155	175	140	78
1.9	1.053	220	155	181	136	74
2	1.109	220	155	186	132	71

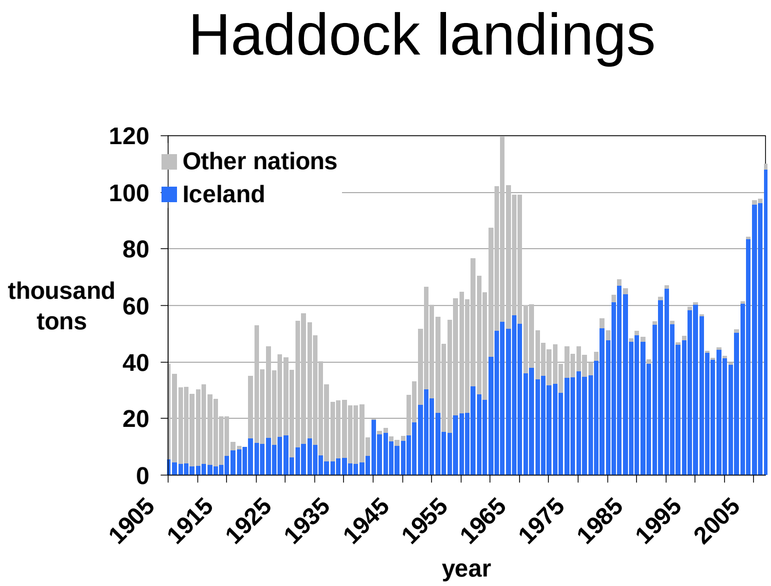


Figure 10.2.1 Haddock in division Va. Landings 1905 – 2005.

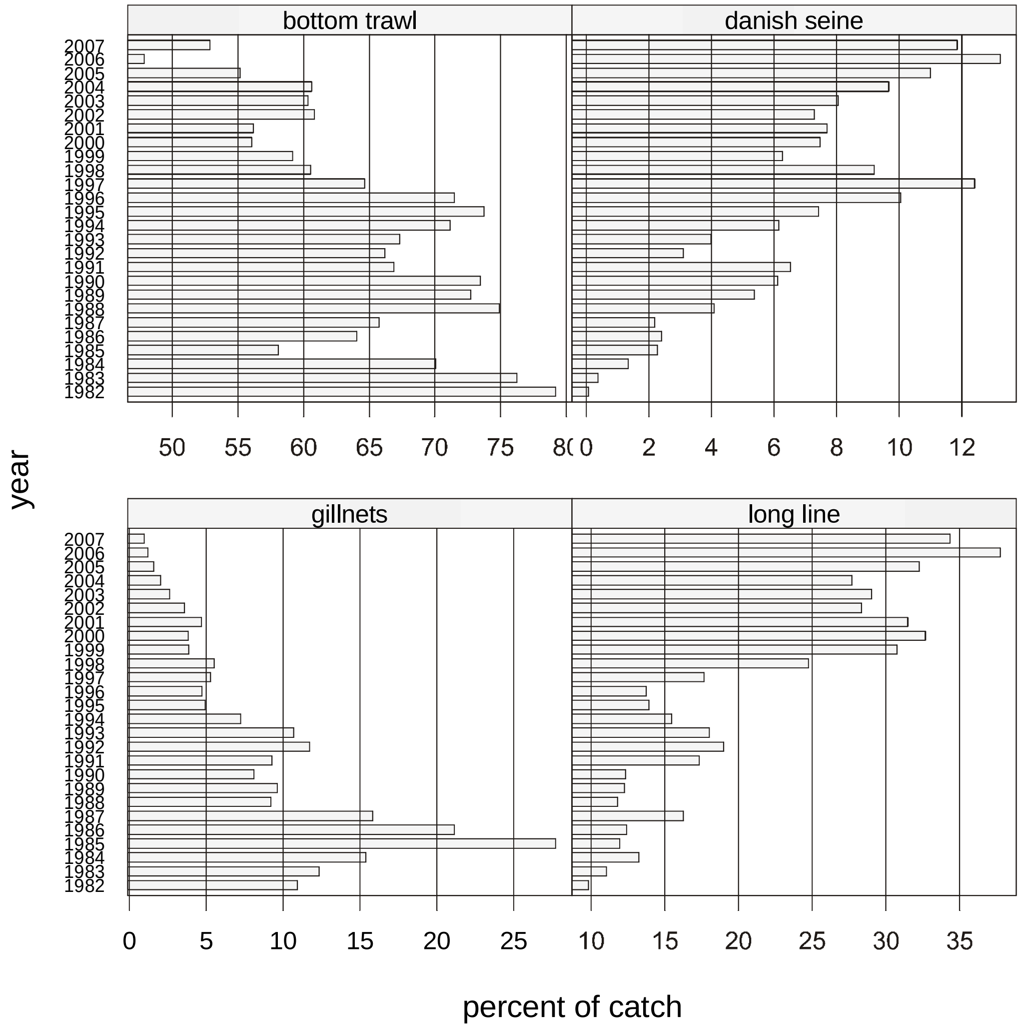


Figure 10.2.2 Haddock Division VA. Landings in percent of total by gear and year.

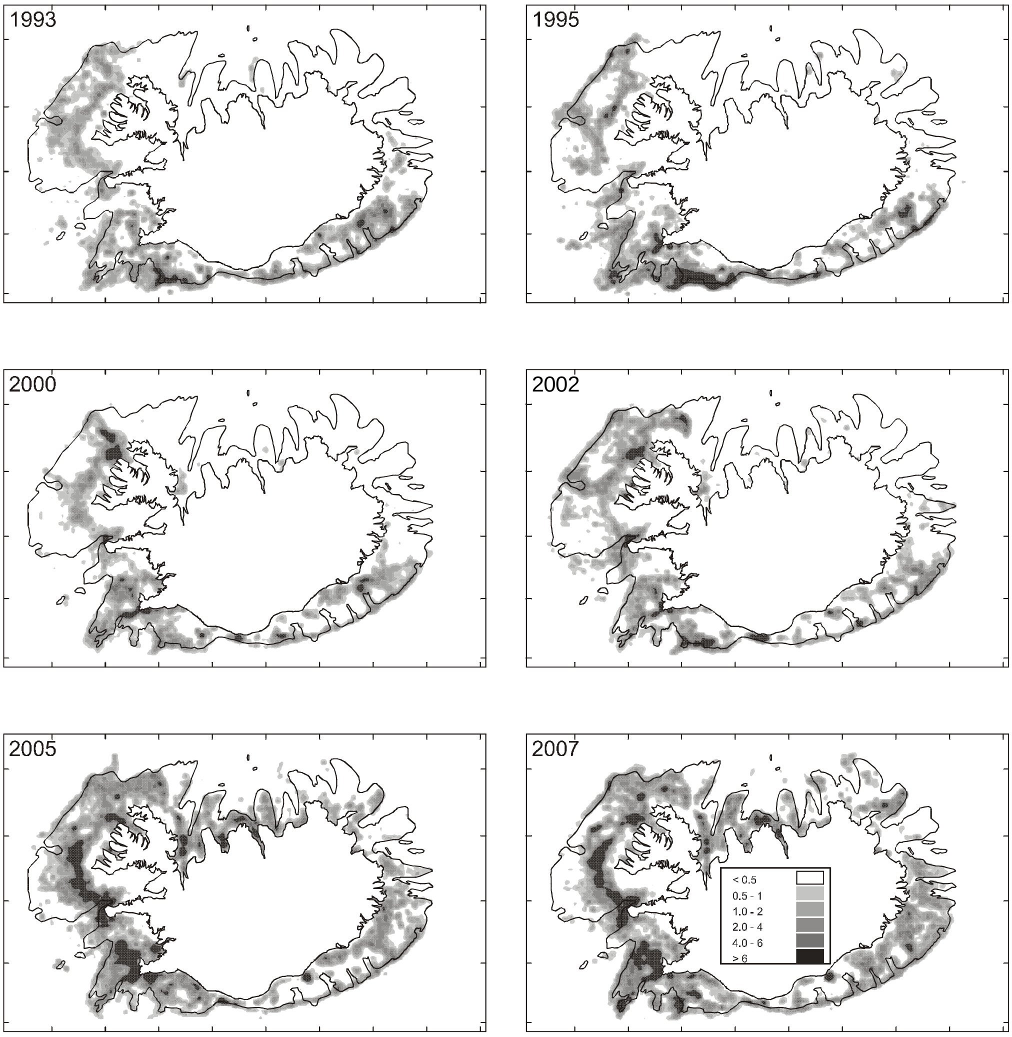


Figure 10.2.3 Haddock Division VA. Spatial distribution af landings. The legend show tonnes per square mile.

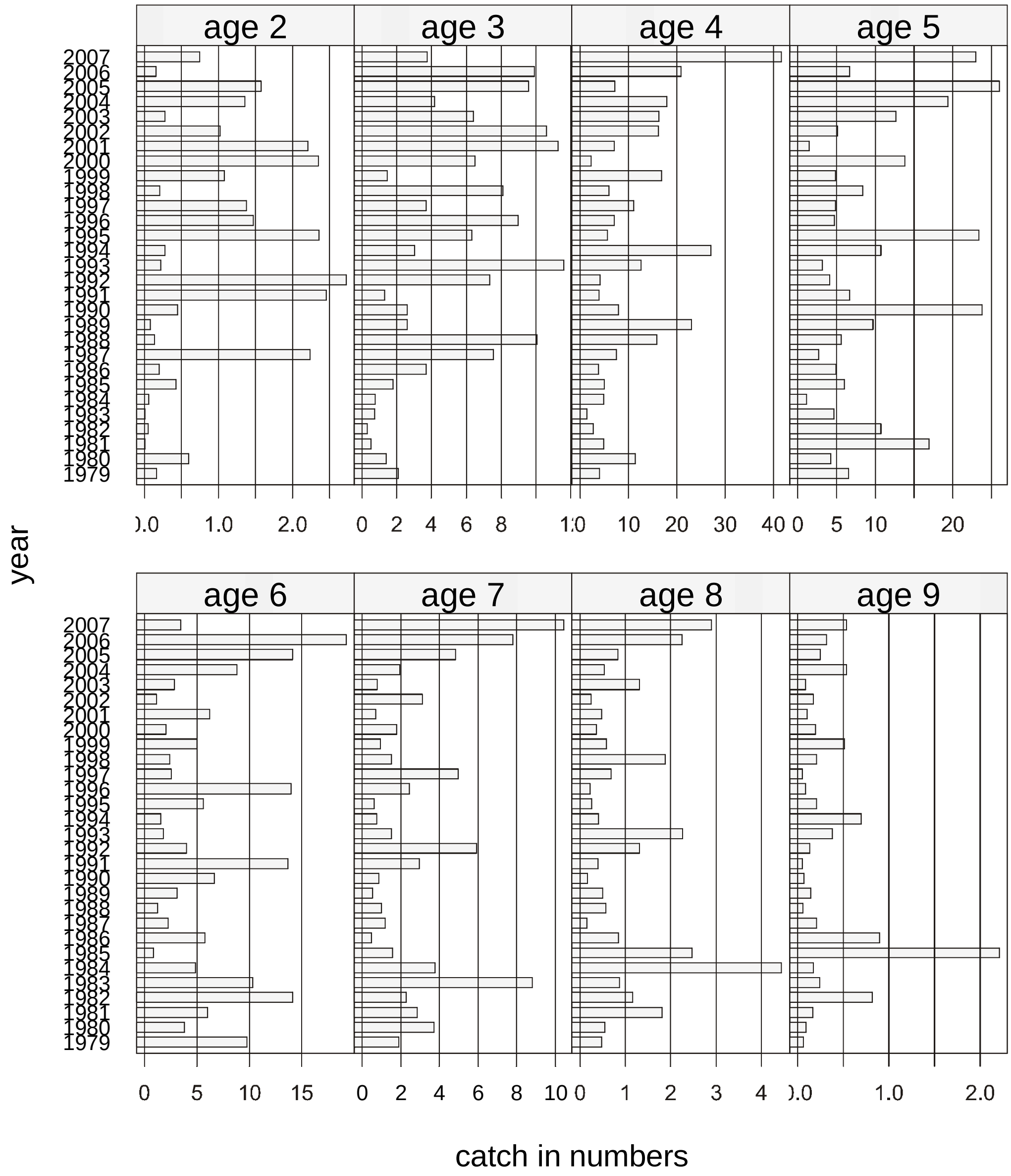


Figure 10.2.4 Haddock in division Va. Age disaggregated catch in numbers.

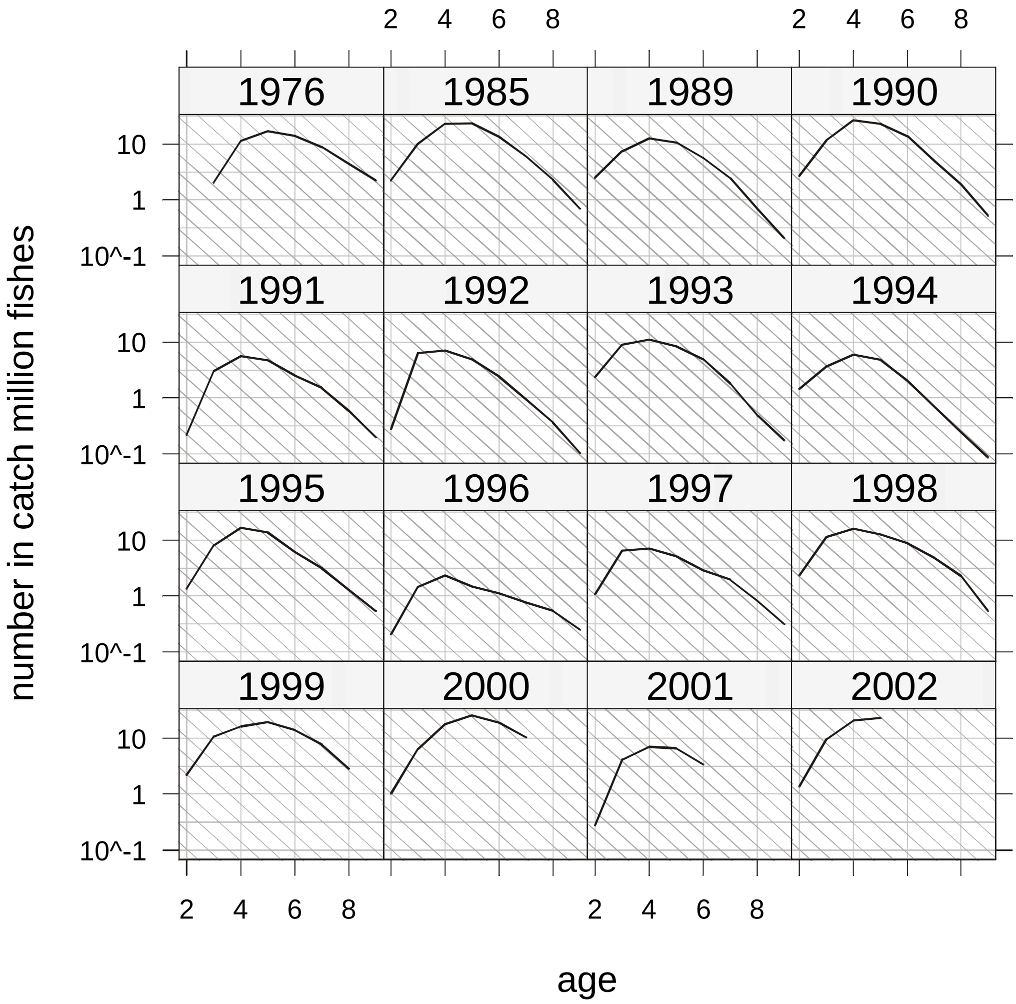


Figure 10.2.5. Haddock in division Va. Age disaggregated catch in numbers plotted on log scale. The grey lines show Z = 1.

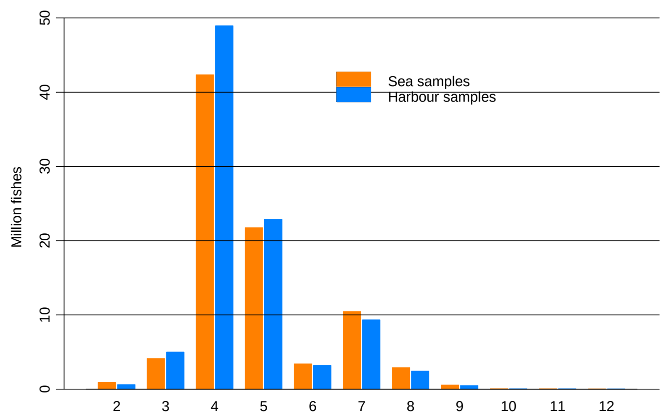


Figure 10.2.6 Comparison of catch in numers in 2007 based on port samples and shore samples.

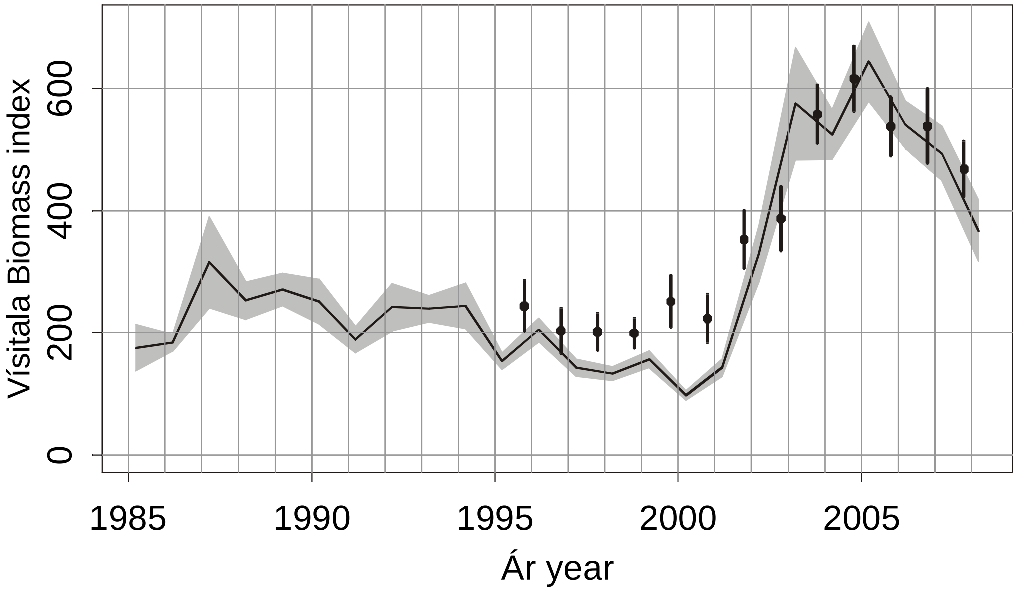


Figure 10.2.7 Icelandic haddock. Total biomass indices from the groundfish surveys in March (lines and shading) and the groundfish survey in October vertical segments. The standard error in the estimate of the indices is shown in the figure.

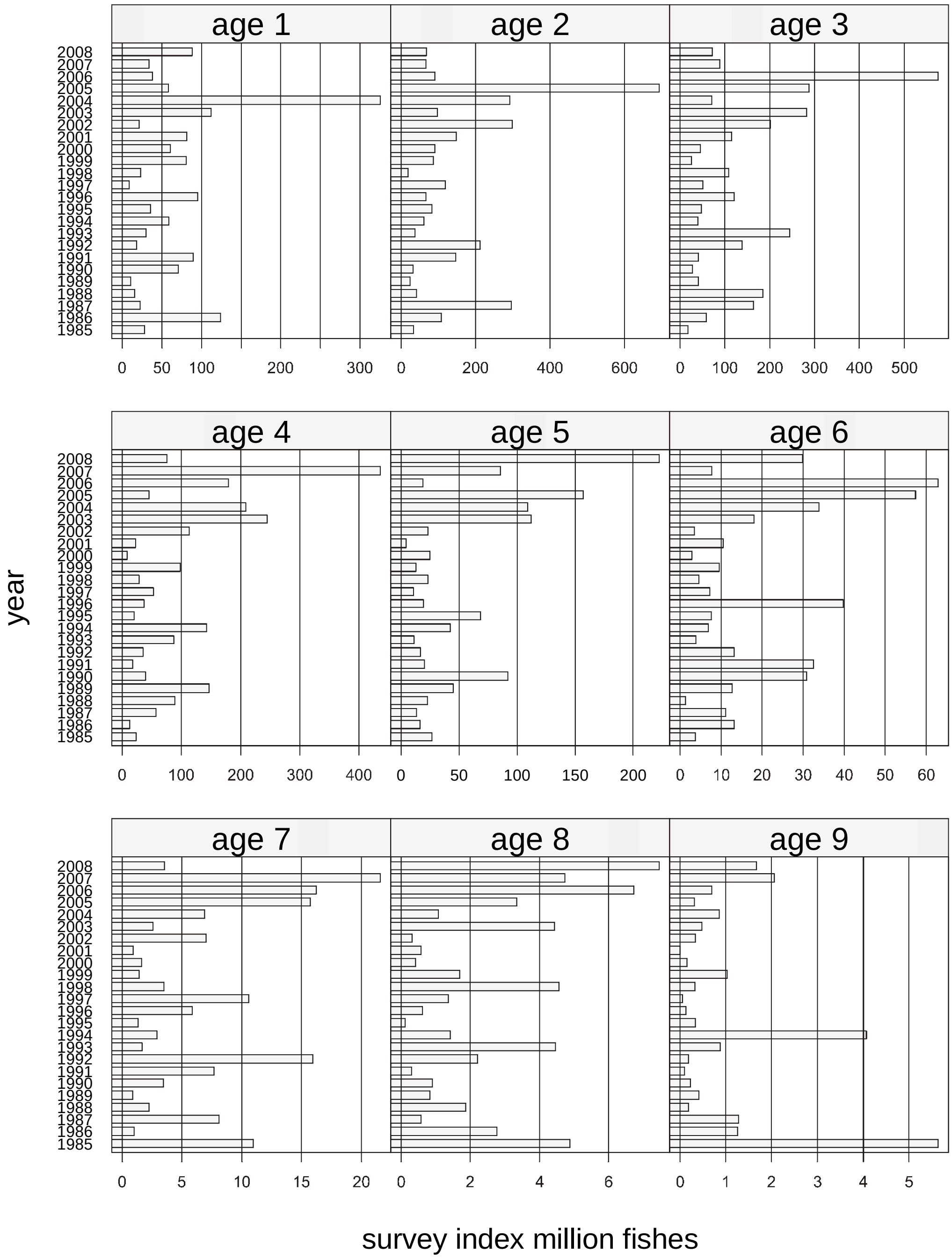


Figure 10.2.8. Age disaggregated indices from the groundfish survey in March. Grey lines show Z=1.

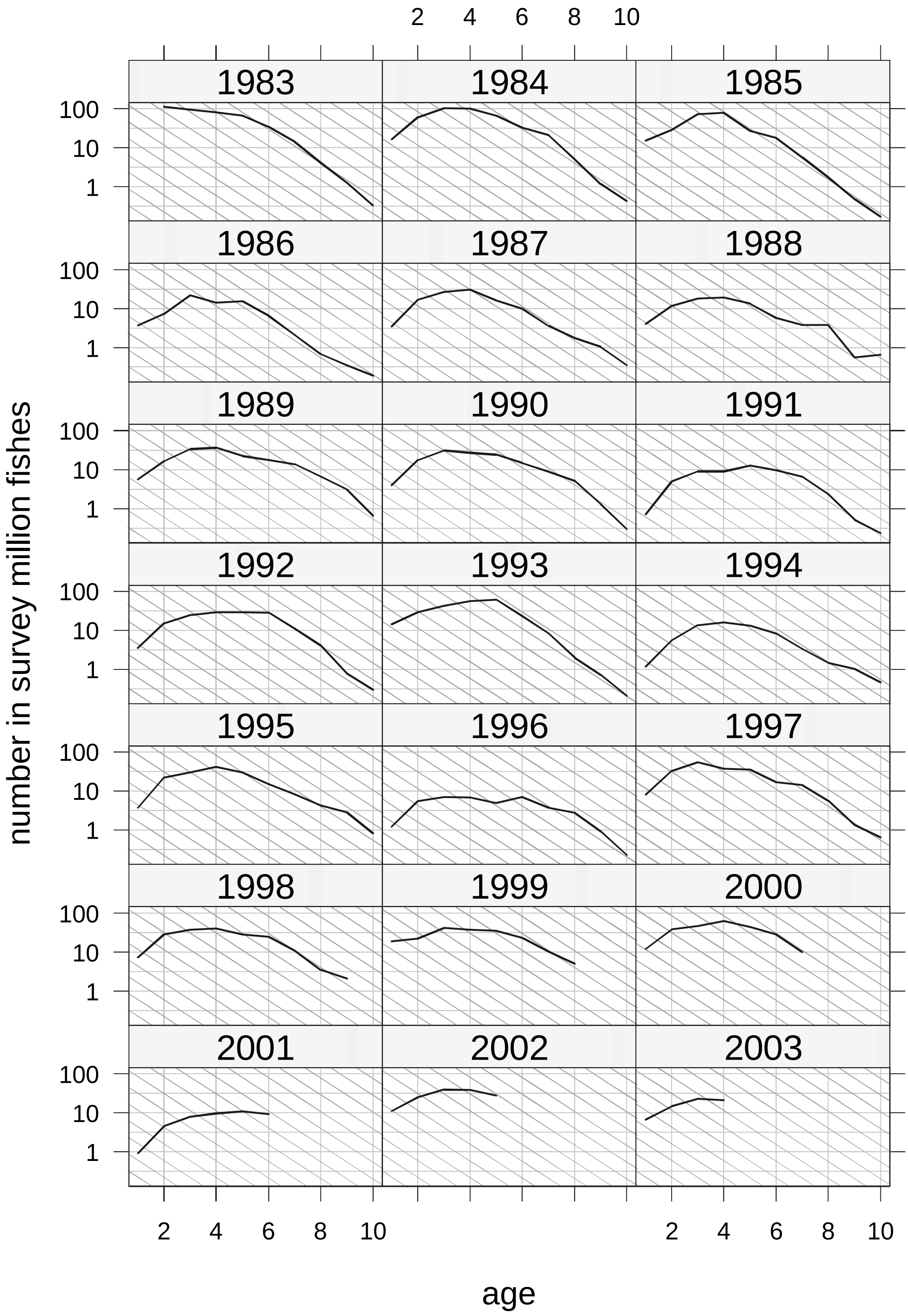


Figure 10.2.9. Age disaggregated indices from the groundfish survey in March plotted on logscale . Grey lines show Z=1.

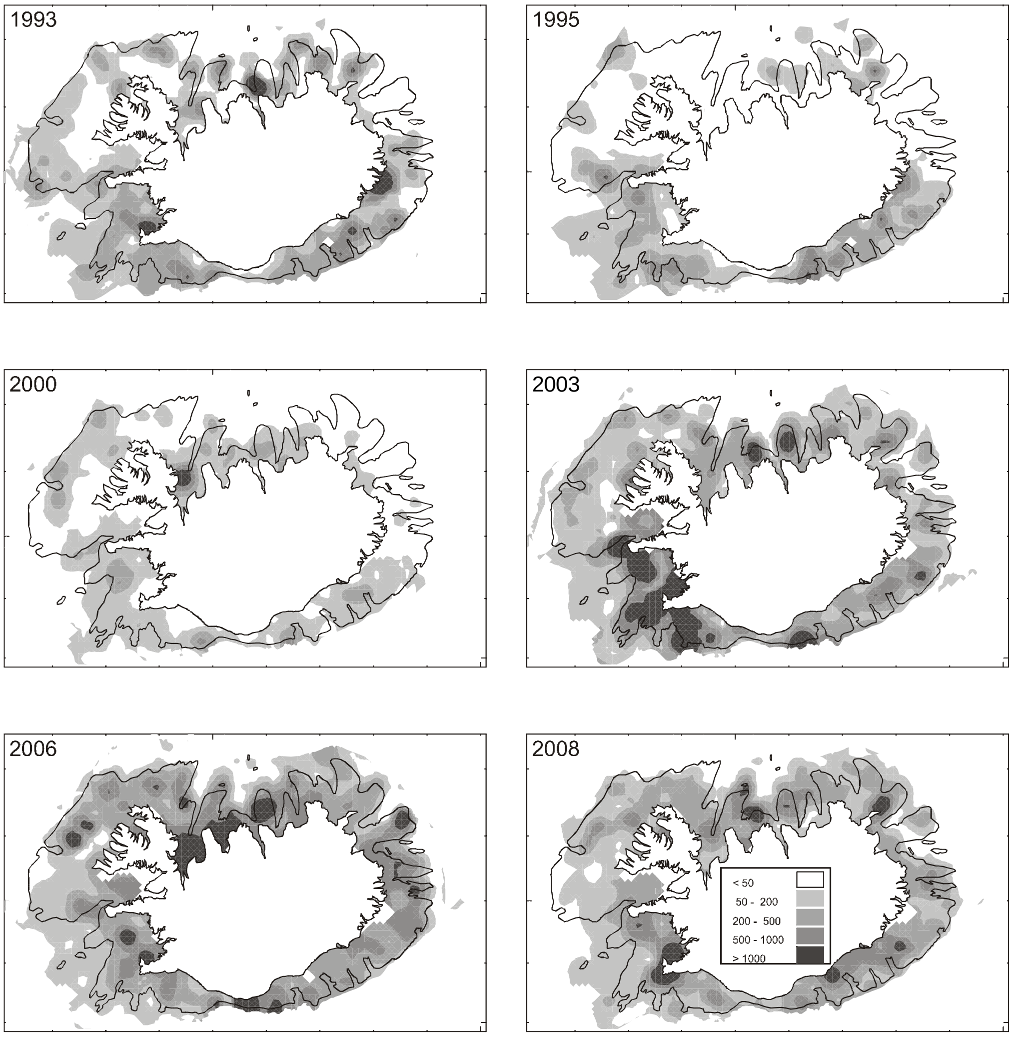


Figure 10.2.10. Spatial distribution of haddock in the groundfish survey in March. The legend show kg per hour towed.

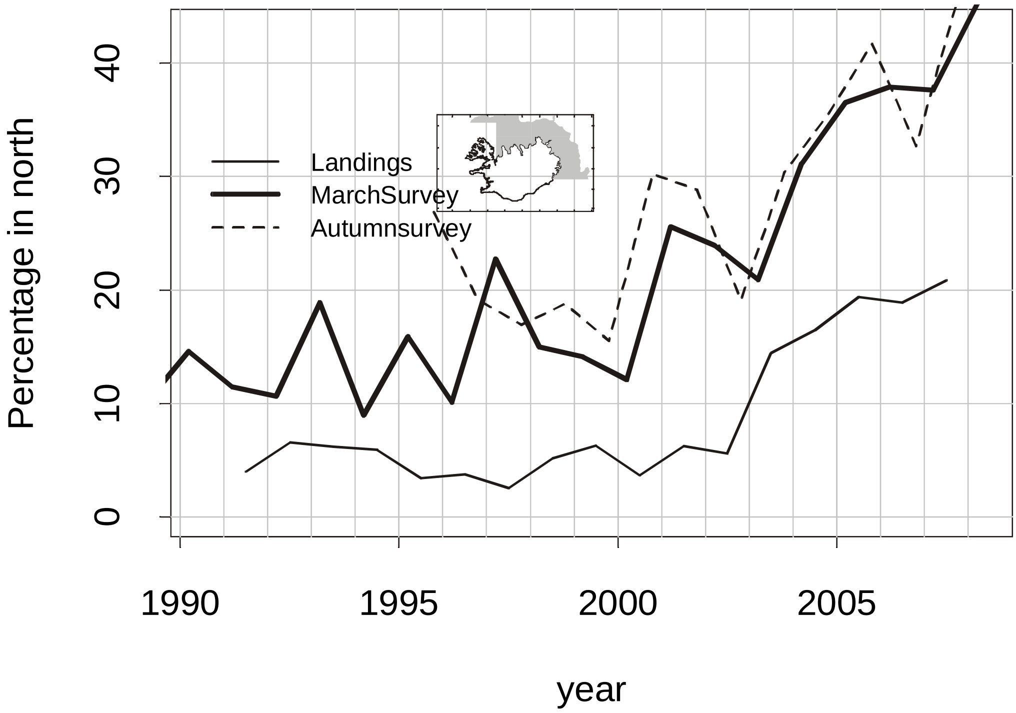


Figure 10.2.11. Proportion of the landings and the biomass of 42cm and older haddock that is in the north area. The small figure shows the northern area

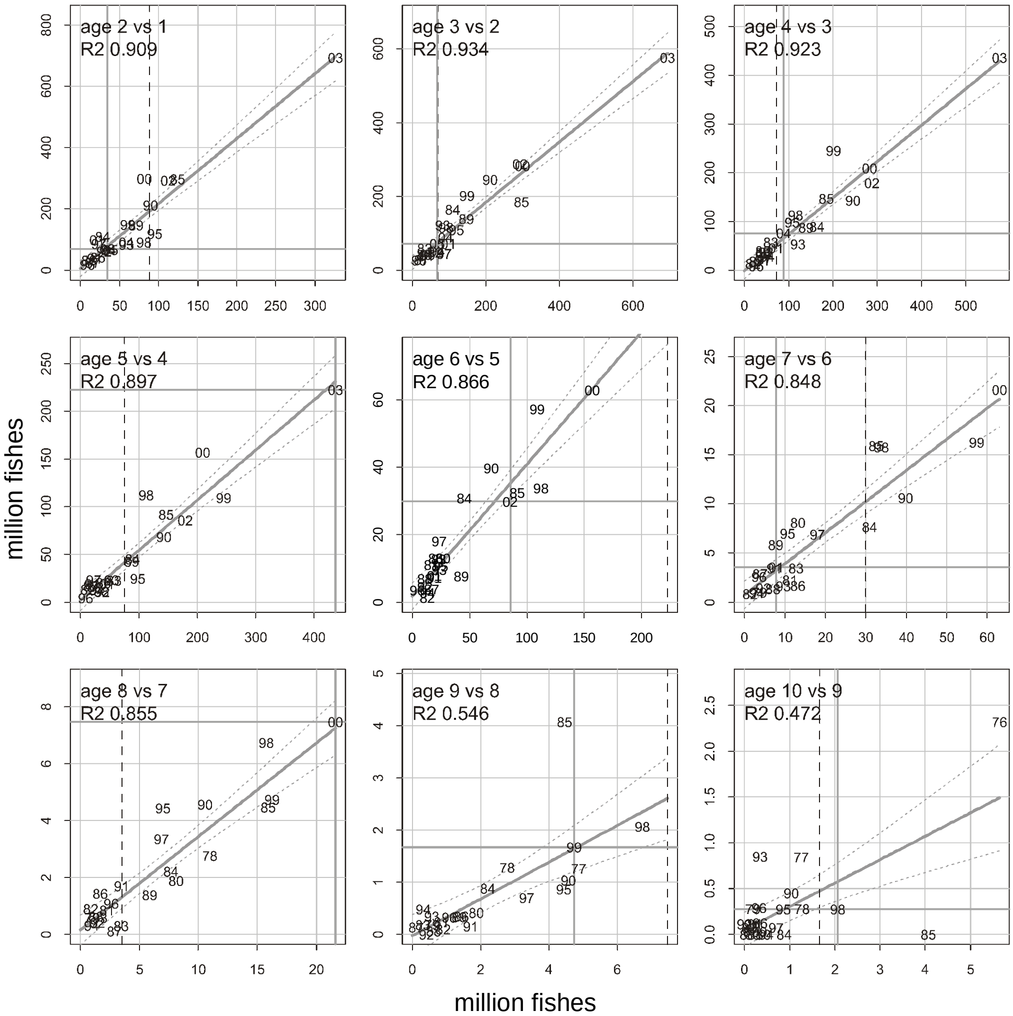


Figure 10.2.12. Haddock in division Va. Indices from March survey plotted against indices of the same year class one year earlier. The letters in the figure are year classes. The dashed vertical lines show the most recent values and the intersection of the gray lines the most recent pair.

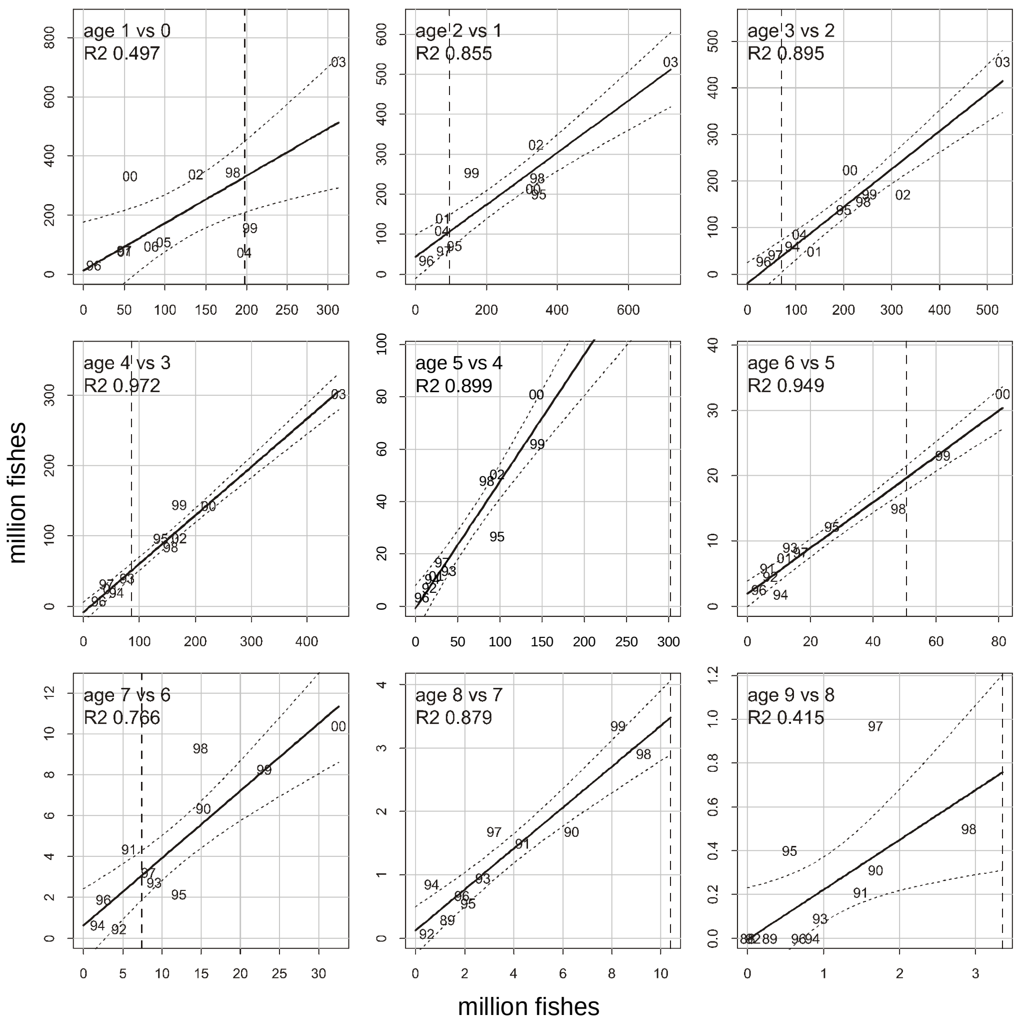


Figure 10.2.13. Indices from October survey plotted against indices of the same year class one year earlier. The letters in the figure are year classes. The dashed vertical lines show the most recent values and the intersection of the gray lines the most recent pair.

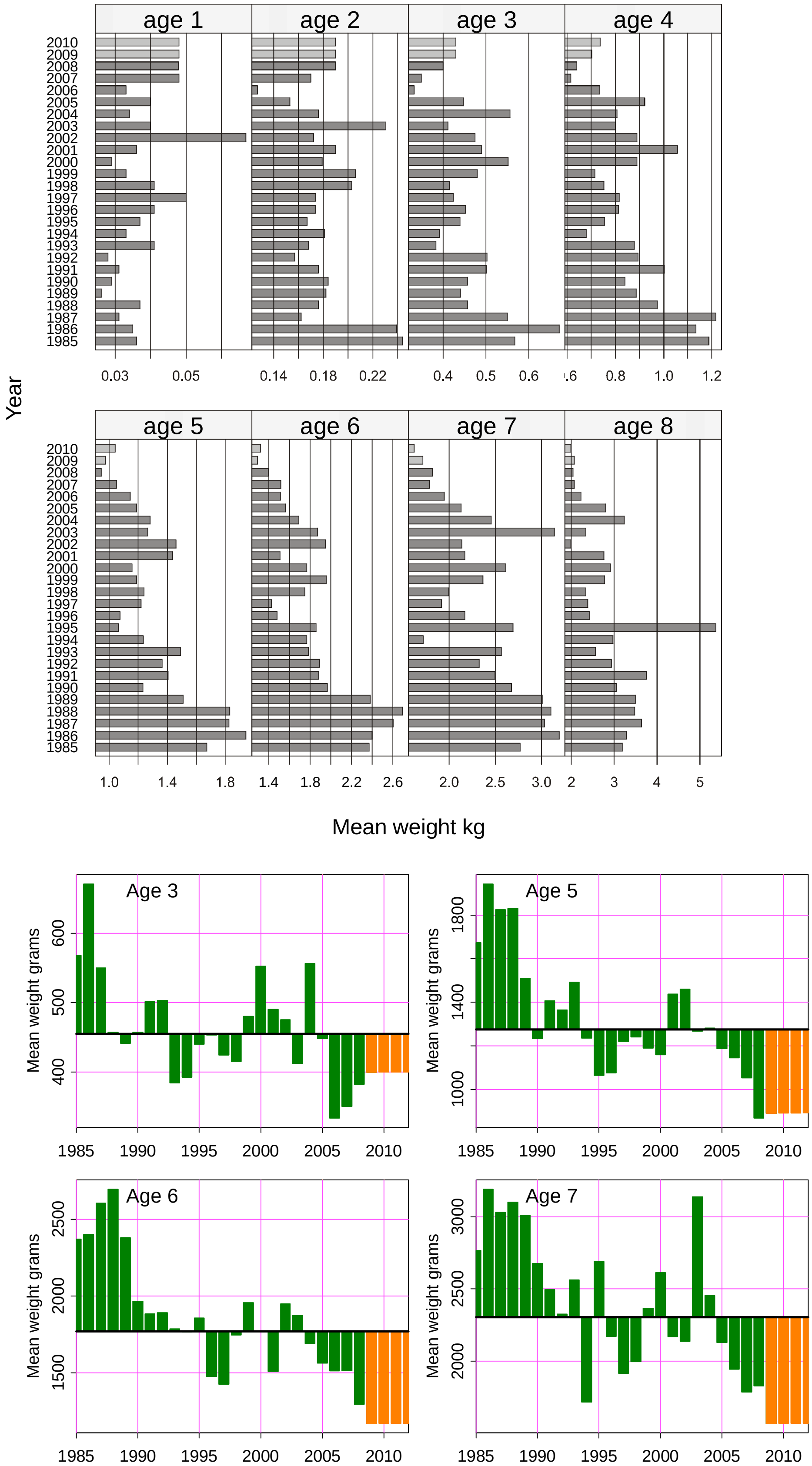


Figure 10.2.15 Haddock in division Va. Mean weight at age in the survey. Predictions are shown as light grey. The values shown are used as weight at age in the stock and spawning stock.

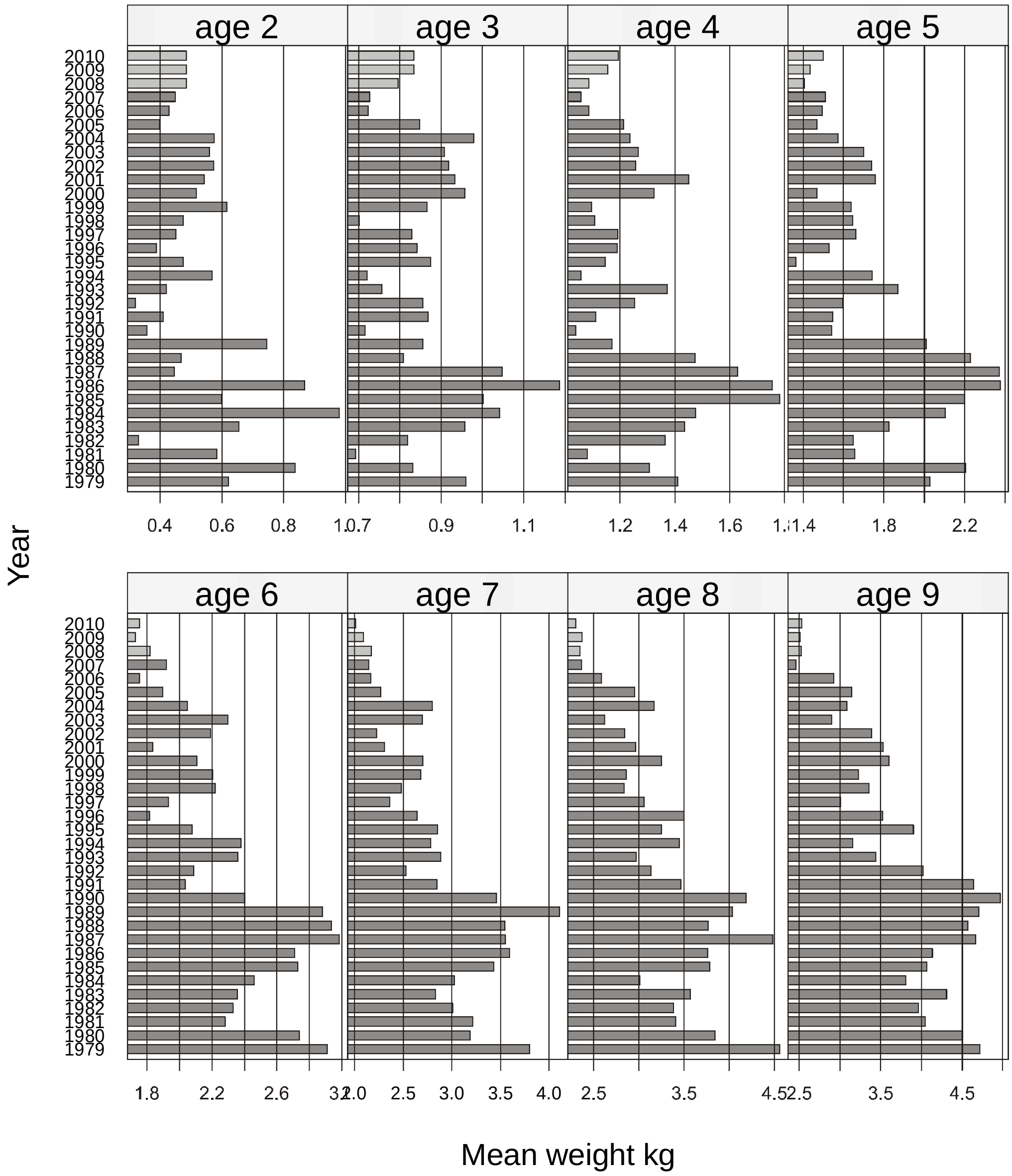


Figure 10.2.16 Haddock in division Va. Mean weight at age in the catches. Perdictions are shown as light grey.

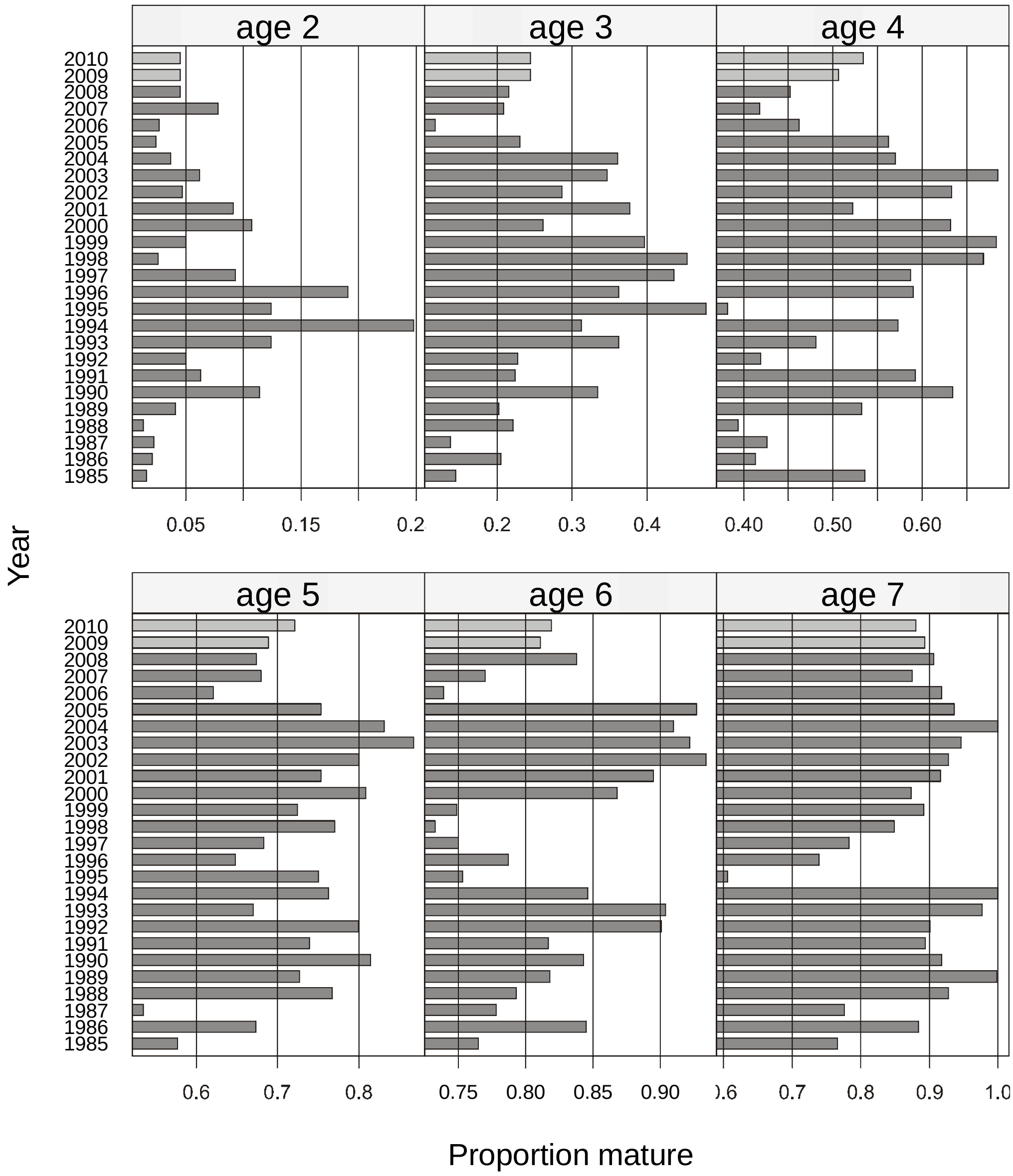


Figure 10.2.17 Haddock in division Va. Maturity at age in the survey. The light grey bars indicate prediction. The values are used to calculate the spawning stock.

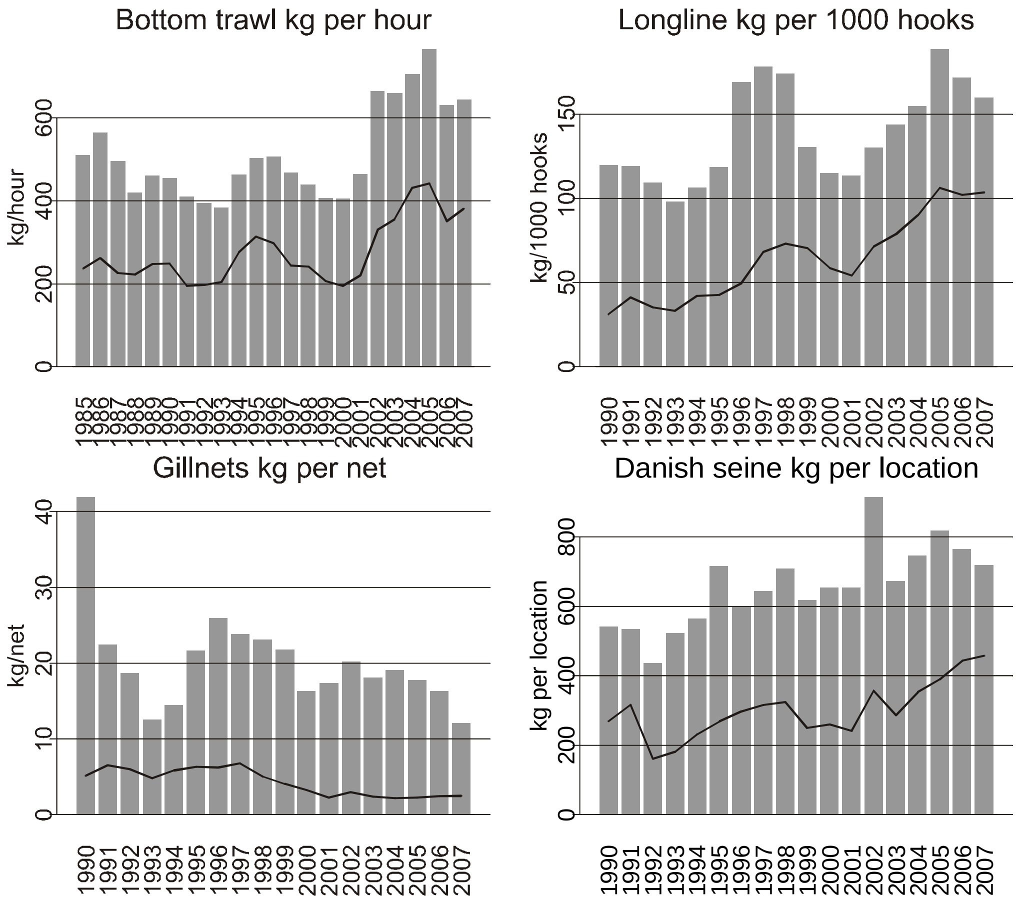


Figure 10.3.1. Catch per unit effort in the most important gear types. The bars are based on locations where more than 50% of the catch is haddock and the lines on all records where haddock is caught. A change occurred in the longline fleet starting September 1999. Earlier only vessels larger than 10 BRT were required to return logbooks but later all vessels were required to return logbooks.

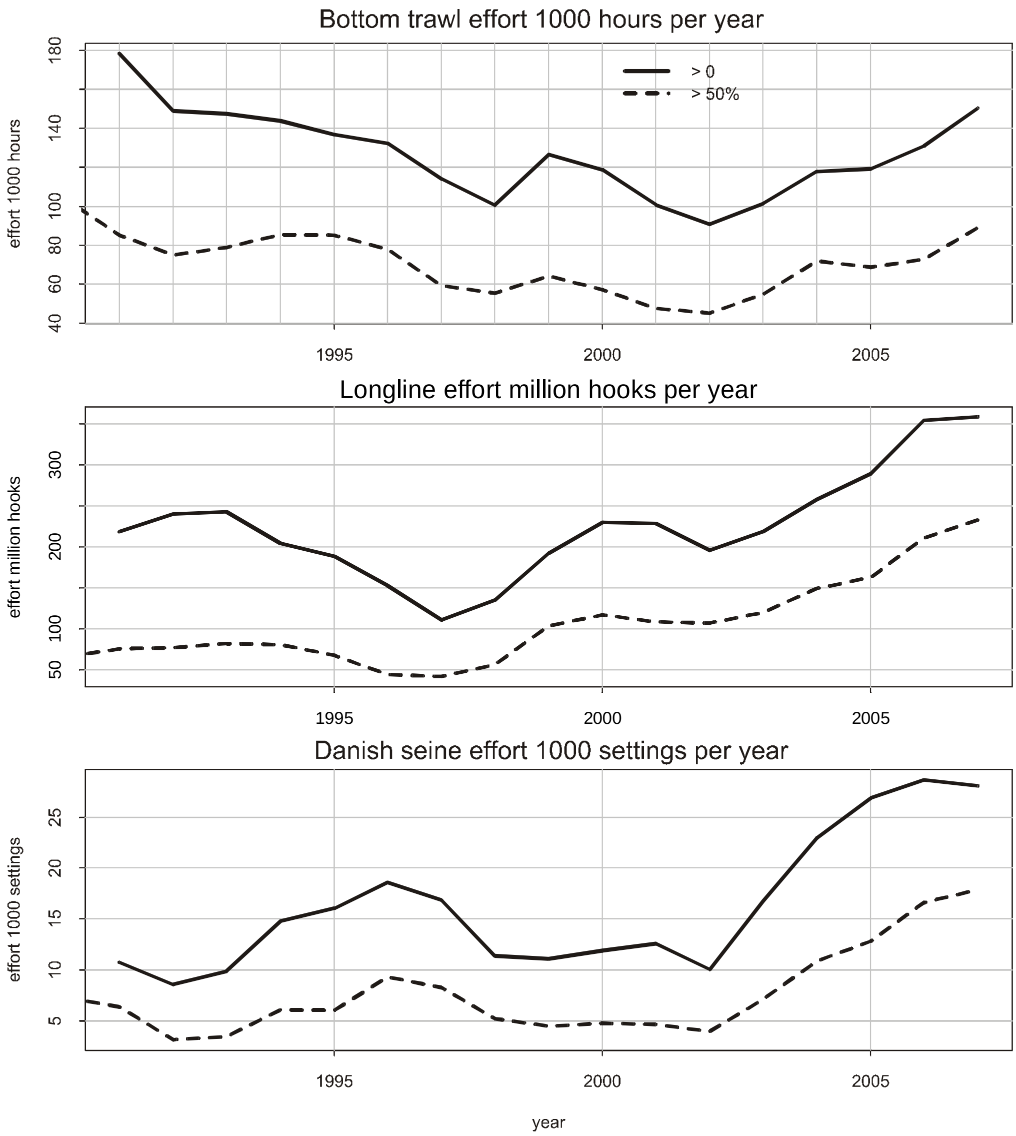


Figure 10.3.2. Effort towards haddock. The effort is calculated as the ratio of the total landings for the gear and the CPUE based on records where haddock was more than 50% of the registered catch

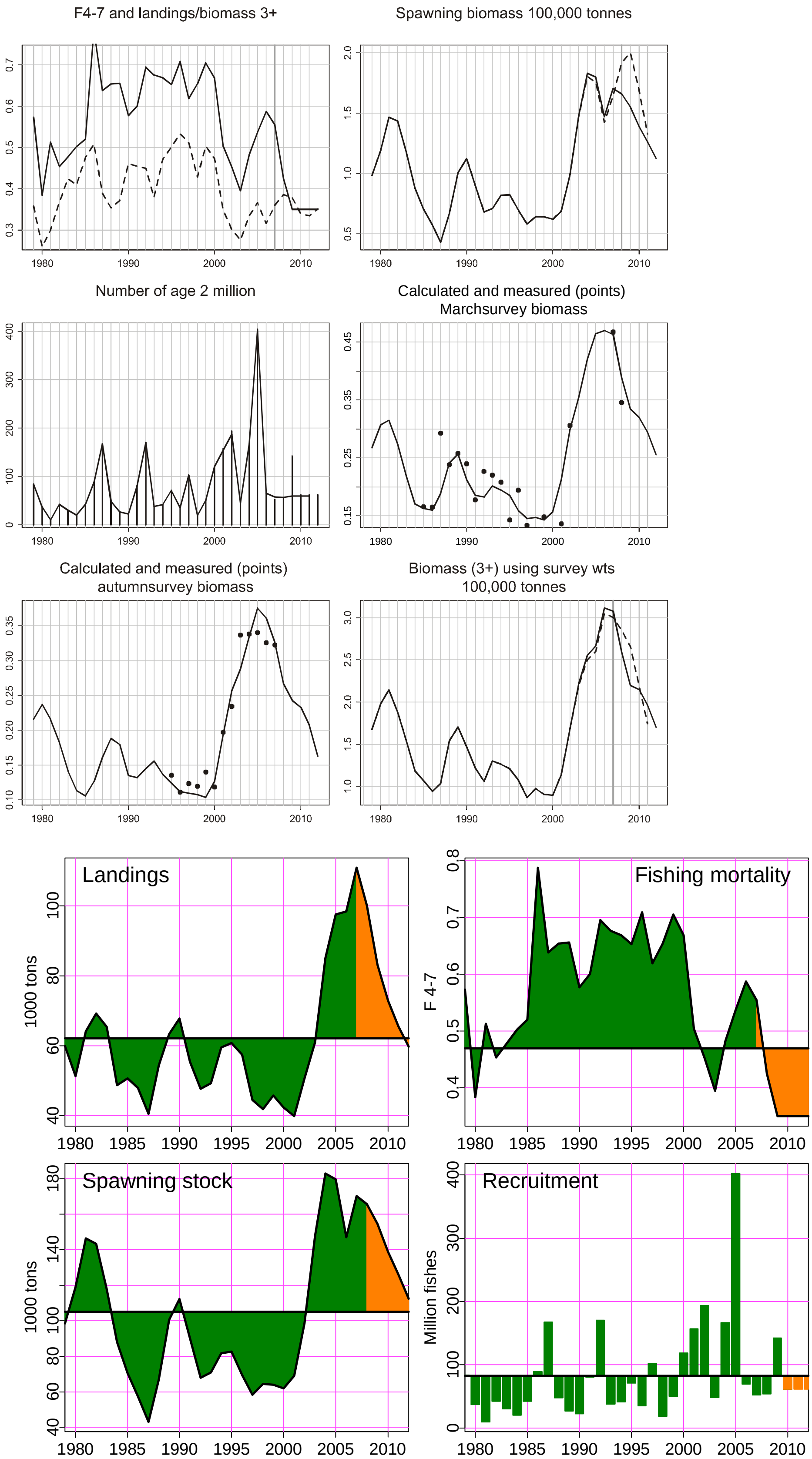


Figure 10.6.1. Haddock in division Va. Summary plots from the SPALY run using the March survey. The dashed lines in the figure of SSB and Biomass(3+) show last years results.

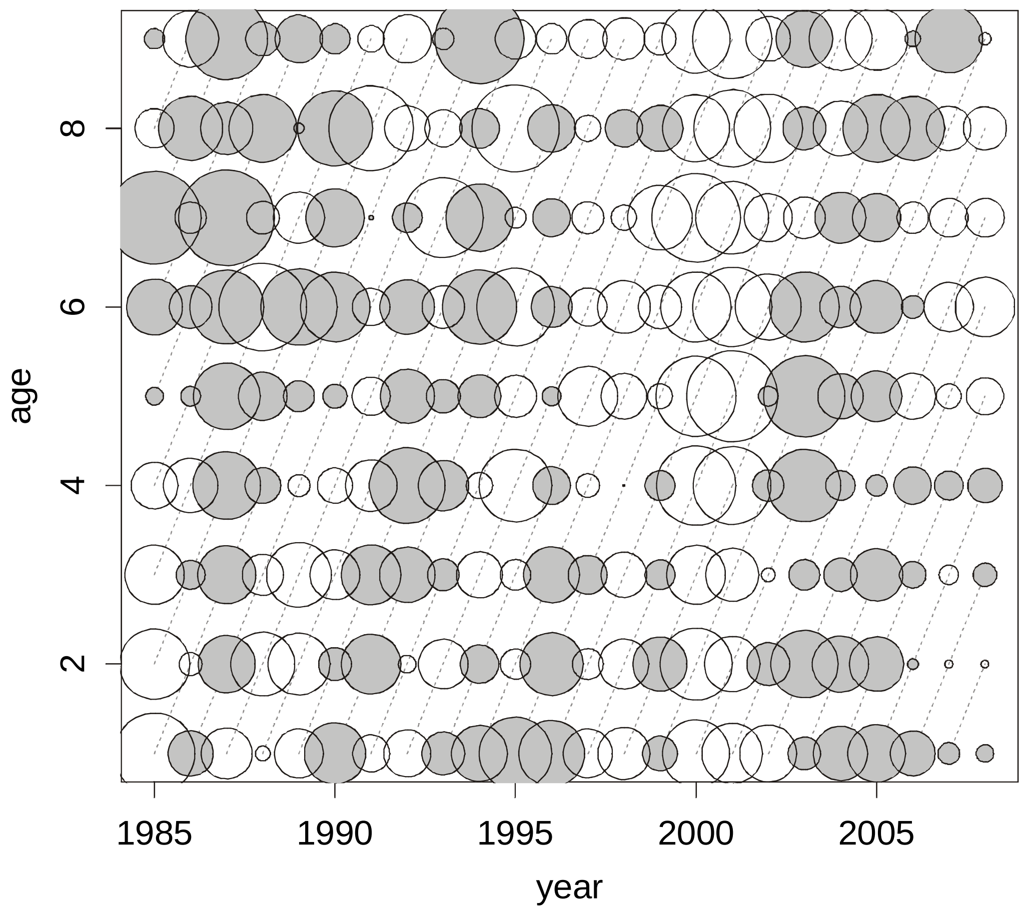


Figure 10.6.2. Haddock in division Va. Residuals from the fit to March survey data . from Adapt run based on the both the surveys. Coloured circles indicate positive residuals (observed > modelled). The largest circle corresponds to a value of 0.87. Residuals are proportional to the area of the circles.

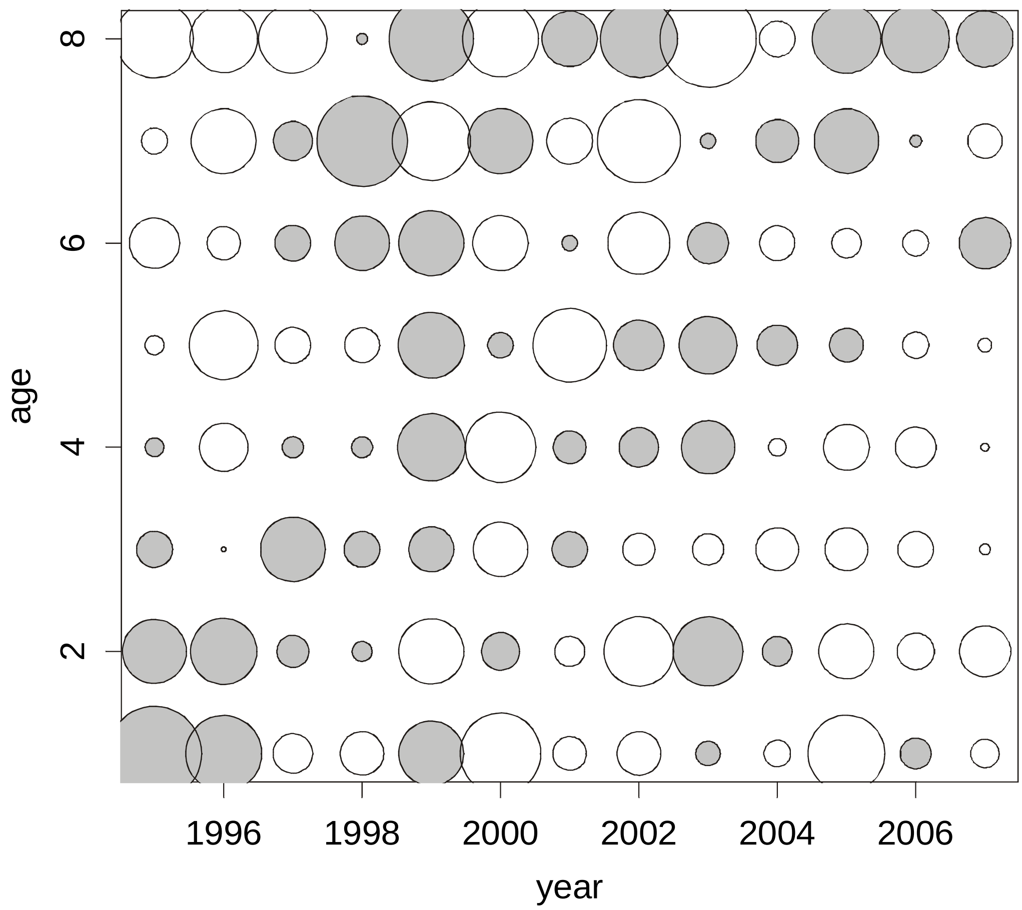


Figure 10.6.3. Haddock in division Va. Residuals from the fit to October survey data from Adapt run based on the both the surveys. Coloured circles indicate positive residuals (observed > modelled). The largest circle for corresponds to a value of 0.89. residuals are proportional to the area of the circles.

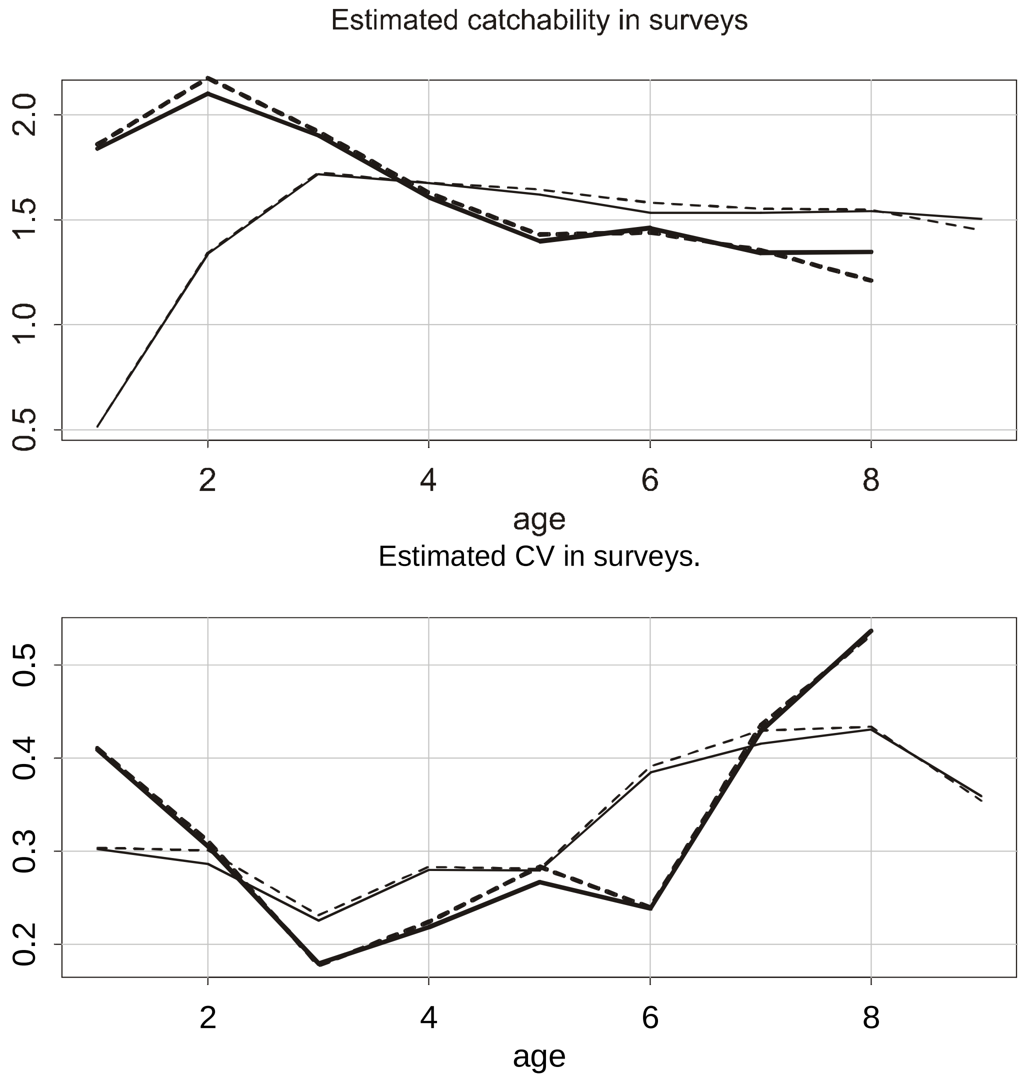


Figure 10.6.4. Haddock in division Va . Results from the spaly run. Catchability and CV from the autumn survey (wide lines) and March survey (thinner lines) . Last years estimates shown dashed.

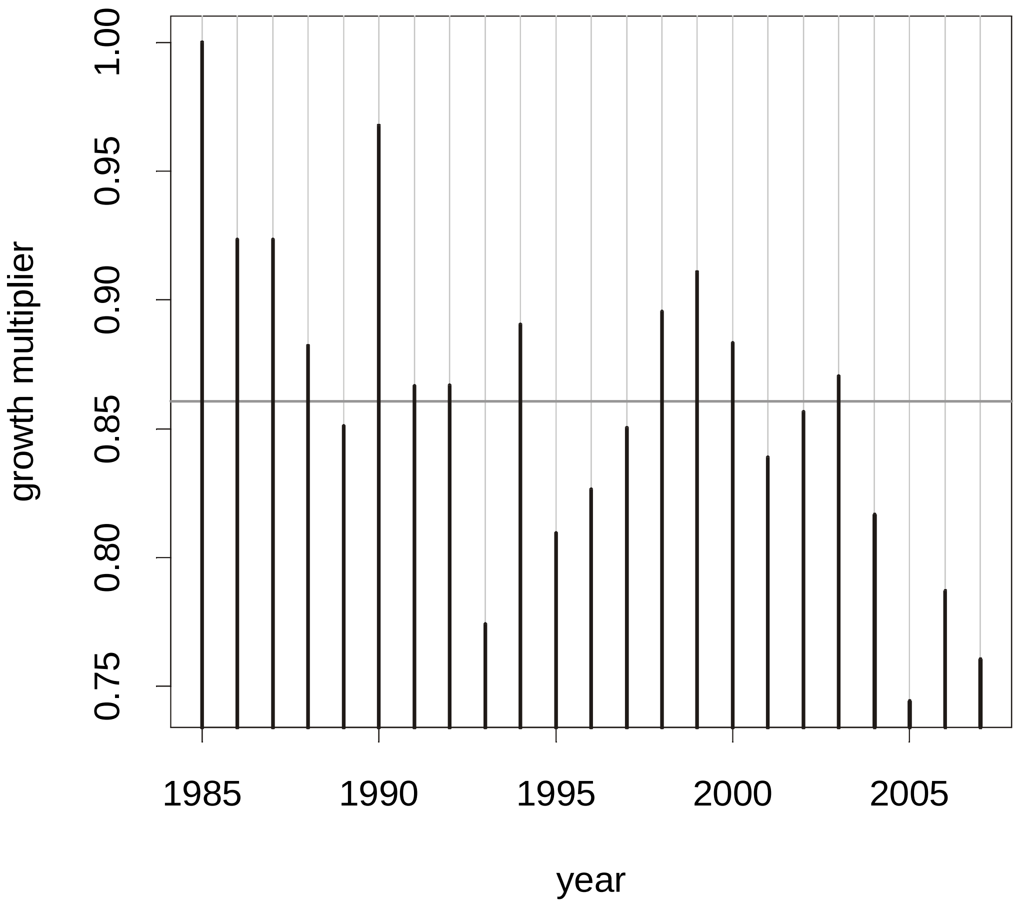


Figure 10.7.1. Haddock in division Va. Exponential of the yearfactor (growth multiplier) in the equation $\log \frac{W_{a+1,t+1}}{W_{a,t}} = \alpha + \beta \log W_{a,t} + \delta_{year}$

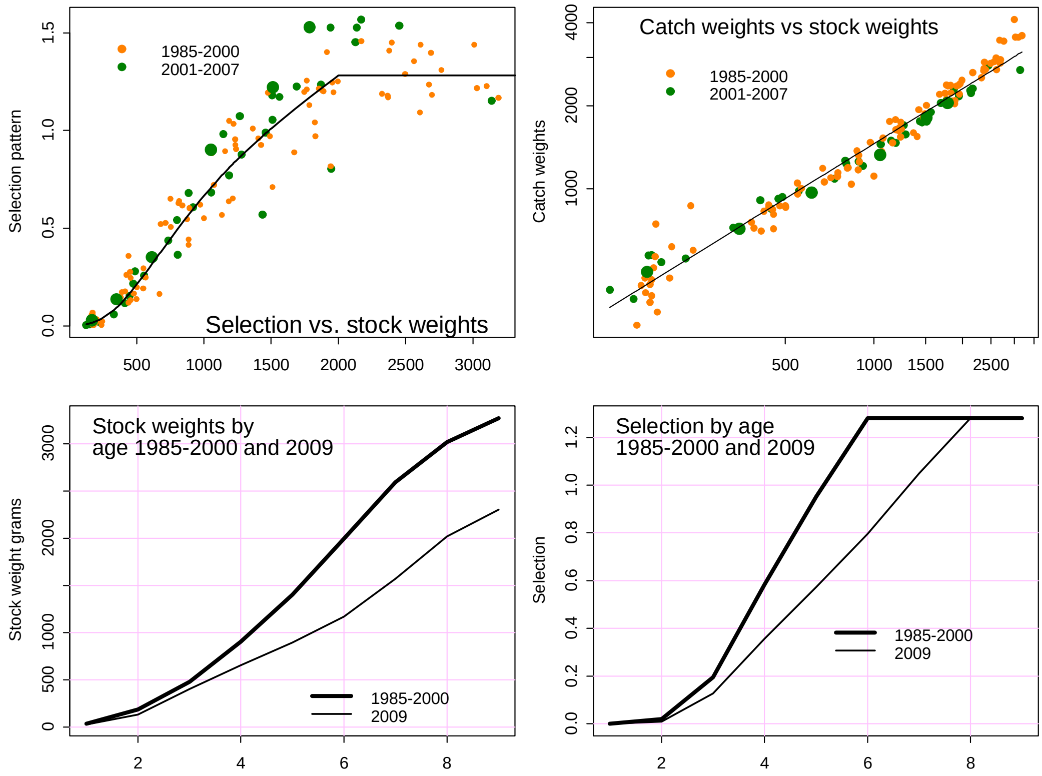
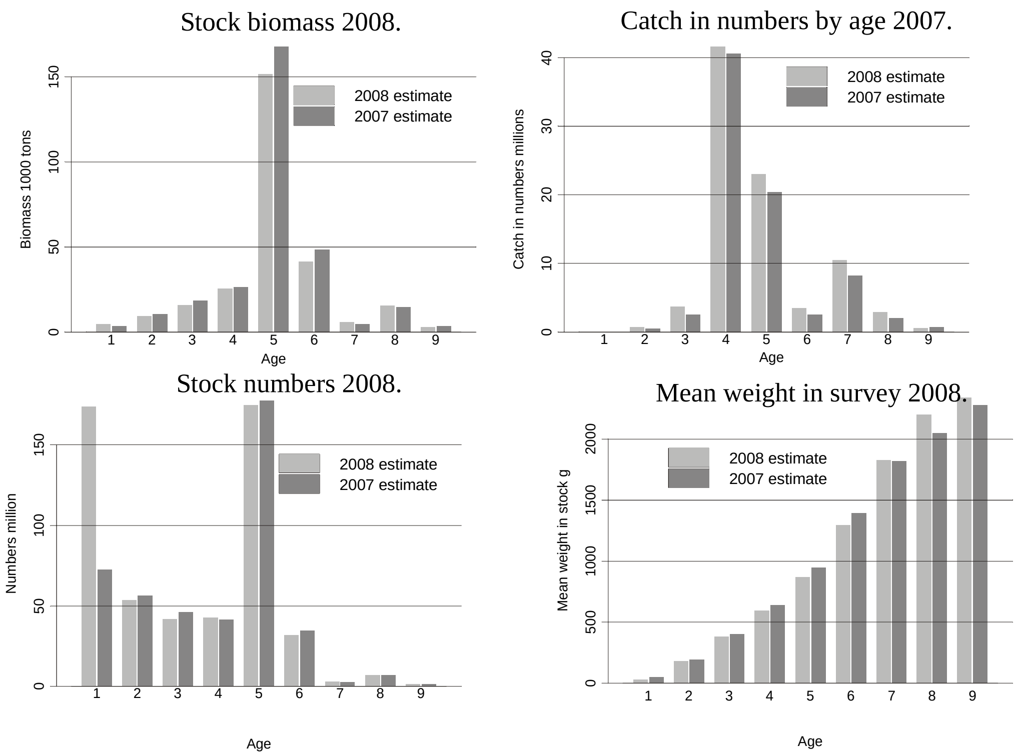


Figure 10.7.2 Haddock in division Va. Input data to prediction.



10.10.1 Haddock in division Va. Comparison of some of the results of the 2008 and 2007 assessment.

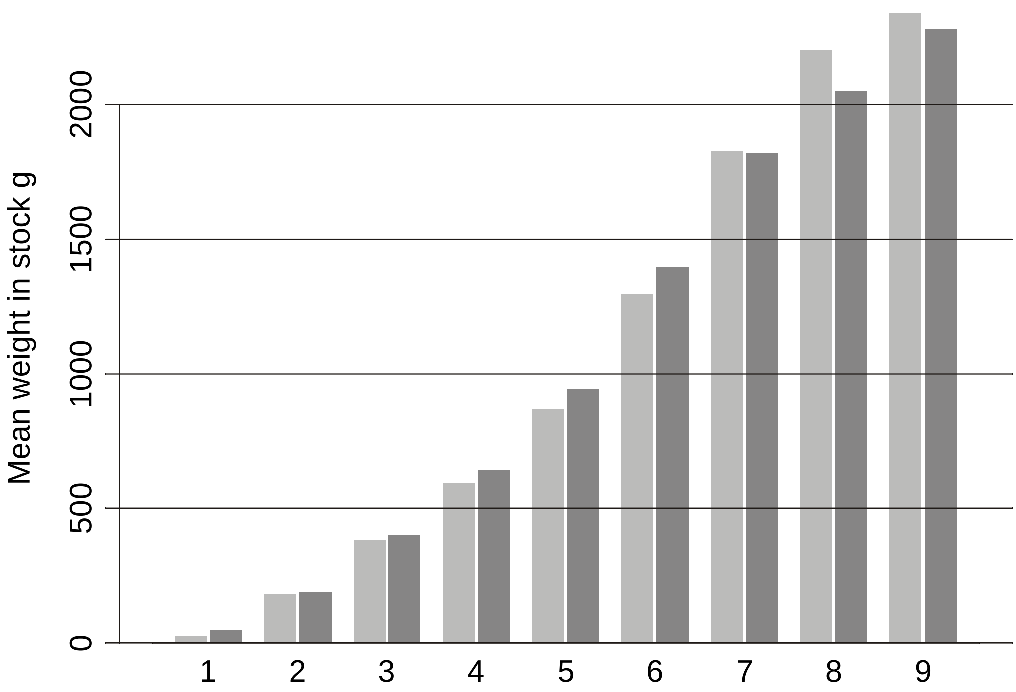


Figure 10.10.2 Mean weight at age in the stock in 2008 as predicted in 2007 and measured in 2008.

11 Icelandic summer spawning herring

Summary

Input data

- The total reported landings in 2007/08 were 159 thous. tons while the TAC was 150 thous. tons.
- Around 141 thous. tons of the catch in 2007/08 was taken in the small fjord Grundarfjörður, and adjoining areas, in W Iceland.
- The total estimate of the adult stock in the herring acoustic surveys in December 2007 was 850 thous. tons, confirming the historically high estimate in the January 2007 survey.
- The acoustic survey in December 2007 took place under good condition and most of the measurements came from a small area. Other areas were herring had been registered by the fleet and research vessels (e.g. of the east coast) provided little to the total amount and the personnel considered that it was rather an underestimation.

Assessment

- The final analytical assessment model, NFT-Adapt, indicate that the biomass of age 3+ is 734 thousands tons and SSB is 686 thousands tons in the end of year 2007.
- Around 26% of the spawning stock consists of the 1999 year class, 19% of the 2000 year class and 20% of the 2002 year class.

Predictions

- Fishing at $\mathbf{F}_{0.1}$= 0.22 in the fishing season 2008/09 will give at catch of 131 thousands tons, where 25% derives from the 1999 year class.

Comments

- The assessment has suffered from a retrospective pattern in recent years, which is now diminishing in the third year in a row, and the last four years in the assessment harmonize in a retrospective sense.
- The stock has been managed at $F_{0.22}$ since the re-opening of the fishery in the 1970s and an approximation of F (F_{proxy}=total catch / survey biomass) indicates that it has been successful from 1993 to present.

11.1 Stock descriptions and management units

The Icelandic summers-spawning herring is constrained to Icelandic waters throughout its lifespan (Figure 11.1.1). The spawning of the stock takes place around July off the SE, S and SW coast (Jakobsson and Stefansson, 1999; Oskarsson 2005). The nursery grounds are mainly in coastal areas off the NW and N coast, but occasionally also in coastal areas off the E, SE, and SW and W Iceland (Gudmundsdottir et al. 2007). The location of the overwintering of the mature and fishable stock has varied during the last 30 years (Óskarsson et al. 2008; manuscript in preparation). Since 1996, the overwintering has been both off the east and west coast, with increasing proportion being in the western part. Moreover, in most recent two winters (2006/07 and 2007/08), most of the stock has been located in, and around, a small fjord off the west coast (Grundarfjörður).

The fishery of the stock in the last four decades has been exclusively a single stock fishery until the fishing season 2004/05, when Norwegian spring spawning herring (NSSH) was found to mixed with the stock off the east coast. This mixing of herring stocks is due to that the summer feeding migration of NSSH has been moving west in recent years and the stock is approaching its former migration route that it had before the stock collapse in the late 1960s (ICES 2007). NSSH is easily distinguishable from the Icelandic herring during this period on the bases of the maturity stage. As most of the fishery of the Icelandic summer spawning herring took place off the west coast in 2007/08, no NSSH were observed in the catch.

The management unit for the stock is Va.

11.2 Scientific data

The scientific data available and applied for assessment of the Icelandic summer-spawning herring stock derives from annual acoustic surveys, which have been ongoing since 1974 (Table 11.2.1). These surveys have been conducted in October-December or January. The survey area varies spatially as the survey is focused on the adult and incoming year classes. The surveyed area is decided based on all available information on the distribution of the stock, including information from the fishery.

The acoustic estimate for 2007/08 is based on four acoustic surveys. In the end of November, the research vessels Bjarni Sæmundsson and Árni Friðriksson searched for herring off the east, south-east and south coast, while in the middle of December Bjarni Sæmundsson searched the area off the west coast. Before the December survey on Bjarni Sæmundsson, acoustic measurements on herring took place in Breiðafjörður (including Grundarfjörður and adjoin areas) onboard a small vessel called Sproti (Figure 11.2.1). The fishery was still ongoing when the surveys took place. The most abundance was in Kiðeyjarsund, around 700 thousands tons, 70 thousands t in Grundarfjörður as well as in Kolluál (off the west coast). Only 12 thousands tons were measured outside these areas (i.e. off the SE coast). The total estimate of the adult stock was therefore 850 thousands tons. Figure 11.2.2 shows the total estimated biomass of 4 year and older herring in the acoustic survey since 1987, and how the eastern part of the stock has been decreasing in size and the western part increasing.

The 1999 and 2002 year classes were most numerous in the survey or 21% and 16%, respectively, of the total number of herring (Table 11.2.1). The results imply that the 2002 year class is above average in size as has been speculated from the results of acoustic surveys in the last two years. The number of fish at age 3 indicates that the 2004 year class is moderate in size (14%) as well as the 2003 year class (9%), which was also suggested from the last years estimate.

The stock composition in terms of age in the acoustic estimation in 2006/07 is based on 6 samples from research vessels (2 in Kolluál and 4 off the SE coast) and 11 catch samples in Grundarfjörður and Kiðeyjarsund (see below) (Table 11.2.2). The total number of aged scales from these samples was 1107.

The vessels used in the acoustic surveys this year, as well as previous years, were equated with EK500 operated at 38 kHz, and all the acoustic data were processed in Echoview software. The threshold of -69 to -72 dB were used in the data processing. 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 the script Echoabundance.sh within Generic Mapping Tools). The TS-length (L) relationship applied was the following: TS=20 log L-72 dB. As normally practiced in acoustic surveys, trawl samples were used to get information about the schools species- and length composition. Furthermore, because of lack of proper fishing gear to use in the small and shallow Grundarfjörður and Kiðeyjarsund, catch samples from purse seiners, taken during the same period as the acoustic measurements, were used instead to obtain information about the length composition.

The annual number of days allocated to measure the adult part of the stock differs but shows a downward trend since its establishment (Figure 11.2.3). In 2007/2008, totally around 14 days were obtained to measure the adult while no days were allocated to measure the juveniles of the stock off NW to NE Iceland, as use to be a standard procedure earlier. As the number of days for the survey has decreased, there is an indication from the fishery of the fleet that the distribution of the stock has increased (Figure 11.2.3). As can be expected from above, the stock's distribution area this winter was much smaller than previous winters.

11.3 Information from the fishing industry

The landings of Icelandic summer-spawning herring by fishing season from 1983 - 2007 are given in Table 11.3.1 and in Figure 11.3.1. The total landings in 2007/2008 season were about 159 thousands tonnes with no discards reported. The quality of the herring landing data regarding discards and misreporting is consider to be adequate as implied in a general summary in section 7. The fishery started in late September and lasted through January, with the most intensity in November and December. The fishery was unusual in the sense that around 77% of the catch was taken in the small and shallow fjord Grundarfjörður in Breiðafjörður off west Iceland, and another 12% in the adjoining area (so called Kiðeyjarsund in Breiðafjörður). Only 1800 tons were taken off the east coast and 16 thous. tons off the south coast (where the main fishery was last year). Overview of geographical distribution of the catches is given in Figure 11.3.2.

The difference between the total catch (159 thousands t) and the TAC for the season (150 thousands t) is due to outstanding quota from the previous fishing season (3 thousands t) and an overshoot (6 thousands t), which will be subtracted from the next season's quota.

Different from previous three fishing seasons (2004/05, 2005/06 and 2006/07) no Norwegian spring spawning herring (NSSH) was found to mixed with the Icelandic summer spawning herring stock in the catch. It is probably because the mixing has been almost exclusively connected to the areas east of Iceland where almost no fishery took place this season.

11.3.1 Fleets and fishing grounds

Until 1990, the herring fishery took place during the last three months of the calendar year. During 1990-2006 the autumn fishery continued until January or early February of the following year, and has started in September since 1994. In 2003 the season was further extended to the end of April and in the summers of 2002 and 2003 an experimental fishery for spawning herring with a catch of about 5 000 t each year was conducted at the south coast. All seasonal restricted landings, catches and recommended TACs since 1984 are given in thous. tonnes in Table 11.3.1.

Almost all of the catch in 2007/08 was taken with purse-seines and only around 3500 tons were taken with pelagic trawls, which is amongst the lowest proportion in pelagic trawls since 1995/96 (see Figure 11.3.1.1). A part of the catches since the fishing season 1998/99 has been taken west off Iceland (opposite to the traditional east coast fishery) or ranging from about 15% (in 2004/05) to 55% (in 2002/03). In the fishing season 2006/07, around 20% and 18% of the catch were taken west and east off Iceland, respectively, while 60% were from the south coast. This season (2007/08) only around 1% were taken of the east coast, 10% off the south coast and the remaining off the west coast. Such large catches have not been taken from the west coast in recent years (Guðmundsdóttir and Sigurðsson 2004; Previous stock's assessment reports) and we need to go back to 1948 to see some similarities (i.e. the fishery in Hvalfjörður in the winter 1947/48 with total catch of 180 thousands tons; Jakobsson 1980).

To protect juveniles herring (27 cm and smaller) in the fishery, area closures are inforced as stated by a regulation about the herring fishery set by the Icelandic Ministry of Fisheries (no. 376, 8. Oktober 1992). In the fishing season 2003/04, area closures were common as small herring was frequently present in the catches, four closures were in the fishing season 2004/05, only one in 2005/06, six closures were inforced in 2006/07 (4 related to small herring and 2 related to high proportion of bycatch), while in 2007/08 there were only two closures (both off the south coast because of small herring).

11.3.2 Catch in numbers, weight at age and maturity

__Procedure for catch at age estimation:__

The annual estimations in the catch at age matrix are based on dividing the annual landings into cells according to the fishing gear, geographical location and month of fishing. The annual number of cells depends then on number of factors, including the spatial and temporal distribution of the fishing and the gear used and the sampling intensity. The number of weight-at-length relationships and length-at-age relationships applied differ between years and are on the range of 1-2 in both cases. Since 1990 to present, all available length measurements are used for the estimations in the cells, while length of aged fish was only used in earlier estimations. Length measurements done by fishery inspectors are though usually omitted as inspectors tend to focus on catches that are suspected to consist of small herring and give therefore often biased length distributions.

The planed re-aging of herring from the catch samples in the fishing seasons 1994/95 through 1997/98 is not finished but is ongoing at the Marine Research Institute. When the re-aging is accomplished the number at age in the catch will be re-estimated. Previous work suggests though that only a small changes can be expected.

__Catch at age in 2008:__

Data from samples taken from purse seiners and pelagic trawlers (at the harbours by the research personnel or at sea by the fishermen) were used to calculate catch in numbers at age for total landings in the fishing season 2007/08 in a traditional manner (Table 11.3.2.1). The calculations were accomplished by dividing the total catch into 7 cells confined by area (three areas), and months, as the catch- and sample sizes allowed. One weight at length relationships was used that was derived from the length and weight measurements of the catch samples and one length-at-age relations. The catches of the Icelandic summer spawners in numbers at age for this fishing season (2007/08) as well as back to 1982 are given in Table 11.3.2.2 (recalculated; see above). The geographical location of the sampling is shown on Figure 11.3.2.1.

Weight at age:

The mean weight at age of the stock is derived from the same catch samples (Table 11.3.2.3) by fitting this equation: ln(whole body weight) = a + b • ln(total length). The total number of fish weighed from the catch in 2007/08 was 2838 and 2561 of them were aged from their fish scales. Even if the samples are less numerous than often, they are considered to be adequate because of the homogeneity of this season fishery (see above).

A comparison of this years weights (2007/08) to previous years (Table 11.3.2.3) evoke concerns because mean weights of age 6 herring, and older, was lower in 2007/08 than for the same year classes a year earlier, in other words the fish did not gain a weight over a period of a year but lost it. A thorough examination of the data (ICES 2008, NWWG, WD 14) indicated that this pattern in the mean weights is related to differences between areas in both mean body weight and total catch among years. Thus, this pattern is not of concern for the assessment.

Proportion mature:

The proportion mature at age has traditionally been estimated annually from the catch data alone for the stock, until in the assessment in 2006 where the proportion mature was fixed (Table 11.3.2.4). The reason for the changes in 2006 was the belief that the large variation of the maturity values over the years was more related to imprecision of the estimations than variation in the stock (Óskarsson and Guðmundsdóttir 2006). In this years assessment we apply the same fixed maturity ogives, where proportion mature at age 3 is set 20% and 85% for fish at age 4, while all older fish is considered mature.

Observed versus predictions of catch composition:

The year class from 2002 dominated in the total catch weight (25%) and total catch number (24%) (Figure 11.3.2.2). The 1999 and 2000 year classes were also abundant in the catch (17% and 15%, respectively, by weight and 14% and 130% by number). The composition of the catch was somewhat different from what proposed in the 2007 assessment (Figure 11.3.2.2). The strong year classes from 1999 and 2000 were less dominant in the catch than expected (27% and 18%, respectively, by weight) while the 2002 year class was underestimated (19% by weight). This is the second season that the 2002 year class dominates the catch and in the both seasons, the total weight of the year class was higher than predicted.

The herring was exceptionally assessable to the purse seiners in Grundarfjörður throughout the fishing season, so the fleet went there again and again, with a limited searching effort in other areas. However, when the fleet tried to fish in a narrow strait (Kiðeyjarsund) further inside of Breiðafjörur in December, they got on average larger herring (proportion of smaller was less). It could indicate that the main fishery in Grundarfjörður was somewhat more concentrated on the younger age classes (including the 2002 year class), as they were relatively more numerous there, in favour of the 1999 and 2000 year classes. It should though be noted that the herring showed some movements within Breiðafjörður, which includes Grundarfjörður, Kiðeyjarsund and other inaccessible places by the fleet.

11.4 Methods

11.4.1 Analysis of input data

Catch curves were plotted by using data from the fishing seasons 1975/76-2007/08 (Figure 11.4.1.1). From them it can be seen that the total mortality signal (Z) in the fully recruited age groups is around 0.4 provided that effort has been the same the whole time. When the catch curves are plotted separately for the year classes from 1971-2002 (Figure 11.4.1.2), it seems that the 1987 year class and those that follows are fully recruited to the fishery at younger ages (around age 4) than the earlier year classes (age 5 to 6). The catch curves for the year classes from 1994 to 2001 show all upward trends in the most recent year (2007) because of the high total catch. The total mortality is therefore poorly readable for the last years.

Because of seemingly higher fishing effort for younger age classes in the fishing season 2006/07 (see assessment report) and general high effort this season, the plot of Ln(catch-ratio) (Figure 11.4.1.3) is probably of little significance in predicting the total mortality for the last year.

Catch curves were also plotted using the age disaggregated survey indices (Figure 11.4.1.4). The lines are zig-zagged, which can be caused by inadequate sampling in the survey (Table 11.2.2). The total mortality sign looks a bit higher than 0.4 but is very noisy. Each of the year classes from 1971-2002 were also explored separately (Figure 11.4.1.5). The curves are again noisy but there is an indication that the fish is fully assessable to the survey at age 3, but could be a year later occasionally, particularly for the year classes. The total mortality seems to vary not far from 0.4. Further exploration of the survey data include a linear fitting of number at age x against number at age x+1 (Figure 11.4.1.6) for different age groups. The slope of the regression lines for the most abundant age classes (age 3 to 9) varied non-systematically from 0.5 to 0.9, which corresponds to 50% and 10%, respectively, mortality between adjoining age classes. The results imply that those age classes (age 3 to 9) are applicable for tuning in the analytical models.

The conclusion from the above is that both the catch- and the survey data are showing similar trend in Z, the survey data being noisier than the catch data.

The year class strength was evaluated independently from the catch data, by sum the total catch of each year class (Figure 11.4.1.7). From Figure 11.4.1.8 it can be estimated that around 85% of the 1999 year class is fished in 2007 and 80% of the 2000 year class. It means that the 1999 year class is probably larger than the large 1983 year class (Figure 11.4.1.7).

11.4.2 Evaluation of F in previous years using yield and survey biomass

To get a historical estimation of the fishing mortality that is independent of F derived from the analytical assessment, an alternative fishing mortality (F_{proxy}) is examined here for the period 1975-2007. F_{proxy} was simply calculated as:

F_{proxy} = Total catch / survey $biomass_{age\ 4+}$

Figure 11.4.2.1 shows the trend in F_{proxy} over the period, with F_{proxy} around 0.22 during 1993 to 2007, but higher values before that. It must be considered that the TS calculations were changed in 1992 for all previous years, which caused on average 25% lower survey indices (ranging from 7-29%; Figure 11.4.2.2). Thus, the estimations of stock size prior to 1992 were based on the premises of around 25% larger stock, which means that F_{proxy} is higher now than it would have been with the old calculations of TS (see the difference between "F_{proxy}" and "Old F_{proxy}" in Figure 11.4.2.1).

Having accounted for these TS changes in the series, the F_{proxy} is still higher in the earlier years. Thus, the total landing, recommended- and agreed- total allowable catch (TAC) were examined for these years (Figure 11.4.2.3; From Jakobsson and Stefánsson, 1999). During the period 1975 to 1988, the agreed and recommended TAC was at similar levels while the landings exceeded the TAC in some years. The most likely explanation for this over shoot in the catch is difficulties in keeping tracks of the landings where many small vessels with small quota were involved in the fishery. During 1989 to 1996, the agreed TAC was, however, always higher than the recommended TAC. From 1996 to present, the agreed- and recommended TAC have again been equal (excluded 2007/08; Figure 11.4.2.4), while the fleet has not always succeeded to get the TAC.

The main conclusion from this examination is that since the agreed TAC started to follow the recommended TAC (in 1996/97), F_{proxy} has been fairly close to 0.22.

Further examination of the survey- and the catch data included plotting of age specific survey indices against corresponding number in the catch (Figure 11.4.2.5). For the age groups that the analytical assessment is based on (age 3-12), the relationships are strong (coefficient of variation ranging from 0.50 to 0.93). However, the large 1999 year class seems to be below expectation in the catch in many years (i.e. in 2002 at age 3, 2005 at age 6, 2006 at age 7 and 2007 at age 8).

11.4.3 Exploration of different assessment models

In order to explore the data this year, three assessments tools were used, namely NFT-ADAPT (VPA/ADPAT version 2.3.2 NOAA Fisheries Toolbox), XSA (Version 3.1, Lowestoft) and a new version of TSA (older version see Gudmundsson, G. 1994). Both NFT-Adapt and XSA used catch data from 1986/87-2007/08 and survey data from 1987/88-2007/08. TSA used three years less catch data, 1989/90-2007/08. Natural mortality is M=0.1 for all age groups, proportion of M before spawning is set to 0.5 and proportion of F before spawning is set to 0.

NFT-Adapt:

In NFT Adapt the estimated parameters are the stock in numbers. The parameters are output by the Levenburg-Marquardt Non-Linear Least Squares minimization algorithm (see VPA/ADAPT Version 2.0, Reference Manual). Corresponding to previous assessment, the estimated parameters were stock numbers for ages 4 to 10 in 2008, but stock numbers at age 3 were set to the geometric mean from 1986-2004.

In NFT Adapt there are three options (classic, average and Heincke) to calculate the value of fully-recruited fishing mortality in the terminal year. It was decided to set the *input partial recruitment* to 1 for ages 4 and older and after testing different options the classic one was chosen on the basis of residuals of sum of squeares (RSS). It must be noted though, that RSS was at a similar level in all cases.

The catchability at age in the survey, as estimated by the NFT adapt, and the CV is shown in Figure 11.4.3.1. Like in the two last year assessments (2006 and 2007) the final Adapt run was without the years 1997 and 2001 in the tuning series.

The output and model settings of the NFT-Adapt run (the adopted final assessment model; see below) are shown in Table 11.4.3.1. Stock numbers and fishing mortalities derived from the run are shown in Table 11.4.3.2 and Table 11.4.3.3, respectively, and summarized in Table 11.4.3.4 and Figure 11.4.3.2.

Residuals of the model fit are shown in Figure 11.4.3.3 and Table 11.4.3.5. The highest values are in the years 1997 to 2003. In this period both the year classes from 1994 and 1996 are seen greater in the survey each year than estimated in the model (i.e. positive residuals). Another cohort effect seen is for the year class 1984, where the model estimates it greater than seen in the survey, but the residuals are not very big. This 1984 year class has always been considered small, while the 1983 year class was strong. Year effects are also observed where 1988 was a negative year (smaller in the survey than estimated in the model) and 1997 was a positive year.

Retrospective analysis (Figure 11.4.3.4) shows that the estimates for the last four years are in harmony, particularly for SSB, and the pattern shows improvements from the last assessment. Before that, the bias is consistent in overestimating the spawning stock and underestimating the fishing mortalities. Thus, there is an indication that this bias is becoming weaker in the last years but only the future can tell if it is going to remain.

XSA:

The final XSA run in 2008 was tuned with age 3-9 (corresponding to NFT-Adapt). The results indicate strong 1999 and 2000 year classes (as NFT-Adapt) and a SSB of 790 thousands tons in the end of year 2007 (Figure 11.4.3.2). The residuals of the surveys and the model fit were worse behaved than in NFT-Adapt and the retrospective pattern showed a little consistency in the patterns for the last years.

TSA:

One TSA run was made in 2008 (Figure 11.4.3.2), with a fixed natural mortality (M=0.1) and allowing the catchability of surveys to change (ICES 2008, NWWG, WD 16). Estimated standard deviations and the retrospective analysis indicate poor accuracy and the specification was rather uncertain. There was little evidence of permanent variations in catchability. This year TSA run differs from the last years analyses by leaving out 1987-1988, which is considered to be the main reason for now little indication of variations in survey catchability.

Comparisons of models:

The estimations of recruitment, spawning stock biomass, and N weighed average $F_{5\text{-}10}$ from the three models (NFT-Adapt, XSA and TSA) were compared (Figure 11.4.4.2). Generally, there is a little difference between NFT Adapt and XSA estimates, except that the XSA is giving bigger stock size, particularly in the most recent years. Comparison between NFT Adapt and TSA indicates that the stock estimates of TSA are lower from around 2003. The difference is mainly because TSA estimate the 1999 and 2000 year classes weaker than NFT Adapt (and XSA) does (Figure 11.4.3.2 and Figure 11.4.3.5).

As in previous years there is a retrospective pattern in the results from all the models. The retrospective analysis from TSA indicates poor accuracy in the most recent year compared with that observed in the NFT-Adapt retrospective pattern. Based on this in addition to that the NFT-Adapt approach is a more familiar framework for the principal assessor of this stock, the WG adopted the results from that method as point estimator for the prediction and thus the basis for the advice.

11.4.4 Final assessment

The model settings and outputs of the adopted final model (NFT-Adapt run in 2008) are shown in Table 11.4.3.1 to Table 11.4.3.4 and Figure 11.4.3.2.

The assessment (Table 11.4.3.4 and Figure 11.4.3.2) indicates that the fishing mortality has been fluctuating between 0.235 and 0.4 time until 2003, which is above F_{pa}. During 2004-2006 F declined but was above F_{pa} in 2007, which is related to higher agreed TAC (150 thousands tons) than recommended by MRI (130 thousands tons). F_{lim} is not defined for the stock. The spawning stock reached maximum in 2006 but is decreasing. The 1999 year class (age 3 in 2002) is the largest one in the whole series and the 2000 and 2002 year class are also large, but the 2002 year class had the highest value ever in the acoustic surveys as 2 years old. Strength of year class 2003 and later is relatively unknown as no estimates are available. Figure 11.4.4.1 shows the relationships between the number at age from the final model and the acoustic measurements.

11.5 Reference points

The Working Group points out that managing this stock at an exploitation rate at or above $\mathbf{F}_{0.1}$ has been successful in the past, despite biased assessments. Thus the Northern Pelagic and Blue Whiting Fisheries Working Group agreed in 1998 with the SGPAFM on using $\mathbf{F}_{pa}$= $\mathbf{F}_{0.1}$= 0.22, $\mathbf{B}_{pa}$= $\mathbf{B}_{lim}$ * $e^{1.645\sigma}$= 300 000 t where $\mathbf{B}_{lim}$= 200 000 t. The Study Group on Precautionary Reference Points for Advice on Fishery Management met in February 2003 and concluded that it was not considered relevant to change the $\mathbf{B}_{lim}$ from 200 000 t. The WG have not dealt with this issue.

The fishing mortality has since 1990 been on the average 0.304 or approximately 40% higher than the intended target of $F_{0.1}$=0.22. This is despite the fact that the managers have followed the scientific advice and restricted quotas with the aim of fishing at the intended target. During this time period the SSB has remained above B_{lim}. As there is an agreed management strategy that have been applied since the fishery was reopened after it collapsed in late 1960's, it is proposed to use $F_{0.1}$ **=** $\mathbf{F}_{pa}$ as F_{target}.

11.6 State of the stock

The state of the stock can be considered healthy despite some uncertainty in the assessment because the stock level is above known any historical level reaching back to 1948 (Jakobsson and Stefansson, 1999; Table 11.4.3.4). The healthy of the stock is both manifested from the acoustic surveys (section 11.4.3) and the analytical assessment (section 11.4.4).

11.7 Short term forecast

11.7.1 The input data

A prognosis was done both for the final adopted model, NFT-Adapt, and TSA for a comparison. The weights estimates used in the prognoses were the same while the number at age differed. The selection pattern used in the prognosis was determined from the fishing mortality at age ($F_{age\ i}/F_{age5\ to\ 10}$), averaged over 2001 to 2006 from the final run. All input values for the prognosis are given in Table 11.7.1.1

The 2003 year class: The estimated number of the 2003 year class in 2008 (age 5) from TSA Adapt (256 and 275, respectively) indicate that it is not strong, which is supported by the acoustic measurements in 2007 (Table 11.2.1). These estimates were used unchanged in the prognoses.

The 2004 year class: The estimated number of the 2004 year class in 2008 (age 4) from TSA Adapt (256 and 275, respectively) indicate that it rather weak. There is a large uncertainty in these estimations but since the acoustic measurements in 2006 and

2007 (Table 11.2.1) support these estimates, they were used unchanged in the prognoses.

The 2005 year class: There is no estimate available for the 2005 year class so its number was set as the geometrical mean for age-3 over 1986-2006, which give 567 millions for NFT-Adapt and 398 millions for TSA.

Inspection of different approaches to select the weights at age in the prognosis (Figure 11.7.1.1) resulted in using the last years weights, as they are most conservative. The selection was based on several features, which included that (a) average of three years is normal procedure in the stock's assessment, (b) high weights in 2005 and 2006 compare to adjoining years, and (c) the location of the fishery in the season 2008/09 is uncertain (i.e. if it will be mainly off the west coast as in 2007/08).

11.7.2 Prognosis results

The results of the prognosis from the final NFT-Adapt run are shown in Table 11.7.2.1a and for TSA in Table 11.7.2.1b with five different options. Fishing at 0.22 (= $F_{0.1}$; the stock is managed at F=0.22) would correspond to a catch of 131 thousand tons in 2008/09 season according to NFT Adapt but 100 thousands tons according to TSA. The proposed composition of the catch differs between NFT-Adapt and TSA (Figure 11.7.2.1), where the main difference lies in the 1999 and 2000 year classes.

11.8 Medium term predictions

No medium term predictions were performed.

11.9 Uncertainties in assessment and forecast

There are several things that could lead to uncertainty in the assessment, both related to the survey and the analytical assessment. Uncertainty related to the survey includes these two aspects (1-2):

1. The results from the acoustic measurements in December 2007 in the densest area Kiðeyjarsund, relied on the day measurements but the night measurements were ignored. The night measurements gave much lower acoustic values but were considered unreliable because the herring was very dense in the surface, above the echo receiver, and the herring was distributed all the way towards the shores where the vessel could not reach it. In other words, it was not possible to cover the stock during the night. The lack of another day measurement, for a comparison, was therefore considered a sort of setback by the personnel, even if they were comfortable about the day measurements. This adds some uncertainty to the results.

2. The coverage of the acoustic survey off the east and south coast was poor, and considering both the observations of herring there from research vessels in capelin surveys, and their small contribution to the acoustic measurements, it was thought that those results were rather an underestimation.

Regarding the analytical assessment, it is mainly the strength of the 1999 and 2000 year classes that distinct between the results of the NFT-Adapt and TSA. The 1999 year class has been observed stronger in the surveys than it appears in the catch for most years, which has been explained by different spatial distribution of the fleet and the year class in previous assessment reports. This fishing season (2007/08), the accessibility of the 1999 year class was again poor as the older part of the stock was in the area of Kiðeyjarsund (section 11.3.2) where the fleet had problems to access because of shallowness and rocks in the sea. This difference between the surveys and the catch creates some uncertainty in the assessment.

It is not dealt directly with these above uncertainties in the forecast for next years fishing season, but stock prognosis from both NFT-Adapt and TSA are provided (section 11.7). In that sense it is dealt with the uncertainty about the 1999 year class indirectly.

It must be noted that strength of the year classes that are recruiting to the spawning stock from 2004 and on, is very poorly determined as there are no recruitment indices available for the stock and the acoustic survey cover them poorly. A special designed juveniles survey has not taken place since 2003 (Figure 11.2.3).

11.9.1 Assessment quality

In previous years there has been concerns regarding the assessment because of retrospective patterns of the models. No assessment was provided in the 2005 due to data and model problems and in the two next consecutive years, ACFM rejected the assessment due to the retrospective pattern. In the last two year assessments (2006 and 2007) there was observed an improvement in the pattern from NFT-Adapt, which has continued in this year assessment for the last four years in the series. Considering this improved behavior, stock estimations from the assessment models and the acoustic surveys in 2006 to 2008, the WG consider that the state of the stock is good, and the assessment quality acceptable.

11.10 Comparison with previous assessment and forecast

This year assessment is in line with the last year assessment, which was though not approved by ACFM mainly because of retrospective pattern. The retrospective pattern of the analytical assessment has improved from last year. The ACFM advice of TAC in 2007 was 117 thousands tons, which was based on average of the preceding 3 years. In the prognosis from this year assessment, $F_{0.22}$ gives 130 thousands tons.

11.11 Management plans and evaluations

It was agreed in 1998 in the Northern Pelagic and Blue Whiting Fisheries Working Group to use $\mathbf{F}_{pa}= \mathbf{F}_{0.1}= 0.22$, $\mathbf{B}_{pa}= \mathbf{B}_{lim} * e^{1.645\sigma}= 300\ 000$ t where $\mathbf{B}_{lim}= 200\ 000$ tons for the Icelandic summer-spawning herring. That is the main management plan in action. As there is an agreed management strategy that have been applied since the fishery was reopened after it collapsed in late 1960's, it is proposed to use $F_{0.1} = \mathbf{F}_{pa}$ as F_{target}. Evaluation of the management plan has not taken place.

11.12 Management consideration

There are several points to address:

The assessment has suffered from a retrospective pattern in recent years, which is now diminishing in the third year in a row, and the last four years in the assessment harmonize in a retrospective sense.

The stock has been managed at $F_{0.22}$ since the re-opening of the fishery in the 1970s and an approximation of F (F_{proxy}=total catch / survey biomass) indicates that it has been successful from 1993 to present (section 11.4.2; Figure 11.4.2.1).

The acoustic survey in December 2007 took place under good condition and most of the measurements came from a small area. Other areas where herring had been registered by the fleet and research vessels (e.g. of the east coast) provided little to the total amount and the personnel considered that it was rather an underestimation.

RG of NWWG expressed concerns in last year report about a year effect in the acoustic surveys and suggested that the survey design should be reconsidered. The WG emphasize that the basically unvarying survey design is not different from acoustic surveys on other pelagic fish species and this observed year effect is inherent in the methodology. This inherent effect could be minimized by keeping the survey time in balance with the size if the distribution area (section 11.2). The main concern of the WG regarding herring surveys is the lack of juvenile surveys in recent years in the nursery areas.

11.13 Ecosystem considerations

The WG does not have any information of direct evidence of environmental effects of the stock but emphasize that increased sea temperature is considered to have generally positive effects on the stock (Jakobsson and Stefansson, 1999). It is manifest in higher number of recruits per SSB during warm years (Jakobsson and Stefansson, 1999; Óskarsson, 2005). Furthermore, the stock occupies colder water around Iceland than other herring stocks in the N-Atlantic and is therefore on edge of the distribution towards cold water, where warming will generally have a positive impacts on the stock development. The increased temperature in Icelandic waters since 1998, with a maximum in 2002 (section 7.3; MRI, 2007), had therefore probably positive effects on the stock.

11.14 Regulations and their effects

The fishery of the Icelandic summer-spawning herring is limited to the period 1 September to 1 May each season, according to regulations set by the Icelandic Fishery Ministry (no. 770, 8. September 2006). Several other regulations are enforced by the Ministry that effect the herring fishery. They involve protections of juveniles herring (27 cm and smaller) in the fishery where area closures are enforced if the proportion of juveniles exceeds 25% in number (no. 376, 8. Oktober 1992). Another regulation deals with the quantity of bycatch allowed. Then there are regulations that prohibit use of pelagic trawls within the 12 nm fishing zone (no. 770, 8. September 2006), which are enforced to limit bycatch of juveniles of other fish species.

11.15 Changes in fishing technology and fishing patterns

The catches of Icelandic summer-spawning herring increased rapidly in the early 1960s due to the development of the purse seine fishery off the south coast of Iceland. This resulted in a rapidly increasing exploitation rate until the stock collapsed in the late 1960s. A fishing ban was enforced during 1972–1975. The catches have since increased gradually to over 100 000 t. Formerly, the fleet consisted of multi-purpose vessels, mostly under 300 GRT, operating purse-seines and driftnets. In recent years, larger vessels (up to 1500 GRT) have entered the fishery. These are a combination of purse-seiners and pelagic trawlers operating in the herring, capelin, and blue whiting fisheries. Since the 1997/1998 fishing season, there has been a fishery for herring both to the west and east of Iceland, which is unusual compared to earlier years when the fishable stock was only found south and east of Iceland. Pelagic trawl fisheries were introduced in 1997/98 and have since then contributed approximately 40–60% of the catches.

There are no recent changes in fishing technology which may lead to different catch compositions. The fishing pattern in 2007/08 was different from previous season because most of the catch was taken from a single fjord of the west coast. It is emphasized that the fishing pattern does varies annually as noted in section 11.3 and is related to variation in distribution and catchability of the different age classes of the stock. This variation in distribution and catchability can have consequences for the catch composition but it is impossible to forecast anything about this variation.

11.16 Comments on the PA reference points

The WG have not dealt with this issue recently.

11.17 Comments on the assessment

In 2005 there was a large uncertainty regarding the assessment of the stock and no assessment was considered reliable enough by ACFM. The same happened in the 2006 and 2007 assessments. Assessments use to be consistently biased in overestimating the spawning stock for some years. Several reasons have been mentioned to account for this overestimation problem, including: (1) discrepancies in the catch and survey; (2) a possible higher natural mortality because of much more widespread spatial distribution of the stock since 1997, which means more accessibility for predators; (3) higher mortality related to the fishery with the pelagic trawl, but since 1997 around 20-60% of the catch is taken by the pelagic trawl; (4) the reduction of the part of the stock that was acoustically measured east of Iceland.

The retrospective pattern that persisted for years, and seems to appear regularly, is of some concerns. The retrospective pattern is now diminishing in the third year in a row, and the last four years in the assessment harmonize in a retrospective sense.

The cautious allowed TAC, that is based on $F_{0.22}$, in recent years has probably facilitated continuous increase in stock size in the last decade.

11.18 References

Guðmundsdottir, A. and Th. Sigurðsson 2004. The autumn and winter fishery distribution of the Icelandic summer spawning herring during 1978-2003. Marine Research Institute, Reykjavik, Iceland. Report, no. 104.

Guðmundsdóttir, Á., G.J. Óskarsson, and S. Sveinbjörnsson 2007. Estimating year-class strength of Icelandic summer-spawning herring on the basis of two survey methods. ICES Journal of Marine Science, **64**: 1182–1190.

Gudmundsson, G. 1994.Time series analysis of catch-at-age observations. Applied Statistics, 43: 117-126.

ICES, 2007. ICES WGNPBW Report 2007. 229 pp.

Jakobsson, J. 1980. Exploitation of the Icelandic spring- and summer-spawning herring in relation to fisheries management, 1947-1977. Rapp. P.-v. Réun. Cons. Int. Explor. Mer, 177: 23-42.

Jakobsson J. and G. Stefánsson 1999. Management of summer-spawning herring off Iceland. ICES J. Mar. Sci. **56**: 827-833.

MRI, 2007. Environmental conditions in Icelandic waters 2006. Marine Research Institute, Iceland, Report No. 130. 39 pp.

Óskarsson, G.J. 2005. Pre-spawning factors and recruitment variation in Atlantic herring (Clupeidae; *Clupea harengus*, L.): A comparative approach. PhD thesis, Oceanography Department, Dalhousie University, Halifax, N.S., Canada. 250 pp.

Óskarsson, G.J. and Guðmundsdóttir, Á. 2006. Maturity estimations of the Icelandic summer spawning herring. ICES, NWWG, No 18.

Óskarsson, G.J., Á. Guðmundsdóttir and Th. Sigurðsson 2008.Variation in spatial distribution and migration of Icelandic summer spawning herring. Manuscript in preparation.

Table 11.2.1. Icelandic summer-spawning herring. Acoustic estimates (in millions) in the seasons 1973/74-2007/08 (age refers to the former year, i.e. autumns).

Year\age	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1973/74	154.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1974/75	5.000	137.000	19.000	21.000	2.000	2.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1975/76	136.000	20.000	133.000	17.000	10.000	3.000	3.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1976/77**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1977/78	212.000	424.000	46.000	19.000	139.000	18.000	18.000	10.000	0.000	0.000	0.000	0.000	0.000	0.000
1978/79	158.000	334.000	215.000	49.000	20.000	111.000	30.000	30.000	20.000	0.000	0.000	0.000	0.000	0.000
1979/80	19.000	177.000	360.000	253.000	51.000	41.000	93.000	10.000	0.000	0.000	0.000	0.000	0.000	0.000
1980/81	361.000	462.000	85.000	170.000	182.000	33.000	29.000	58.000	10.000	0.000	0.000	0.000	0.000	0.000
1981/82	17.000	75.000	159.000	42.000	123.000	162.000	24.000	8.000	46.000	10.000	0.000	0.000	0.000	0.000
1982/83**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1983/84	171.000	310.000	724.000	80.000	39.000	15.000	27.000	26.000	10.000	5.000	12.000	0.000	0.000	0.000
1984/85	28.000	67.000	56.000	360.000	65.000	32.000	16.000	17.000	18.000	9.000	7.000	4.000	5.000	5.000
1985/86	652.000	208.000	110.000	86.000	425.000	67.000	41.000	17.000	27.000	26.000	16.000	6.000	6.000	1.000
1986/87**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1987/88	115.544	401.246	858.012	308.065	57.103	32.532	70.426	36.713	23.586	18.401	24.278	10.127	3.926	4.858
1988/89	635.675	201.284	232.808	381.417	188.456	46.448	25.798	32.819	17.439	10.373	9.081	5.419	3.128	5.007
1989/90	138.780	655.361	179.364	278.836	592.982	179.665	22.182	21.768	13.080	9.941	1.989	0.000	0.000	0.000
1990/91	403.661	132.235	258.591	94.373	191.054	514.403	79.353	37.618	9.394	12.636	0.000	0.000	0.000	0.000
1991/92	598.157	1049.990	354.521	319.866	89.825	138.333	256.921	21.290	9.866	0.000	9.327	0.000	0.000	1.494
1992/93	267.862	830.608	729.556	158.778	130.781	54.156	96.330	96.649	24.542	1.130	1.130	3.390	0.000	0.000
1993/94	302.075	505.279	882.868	496.297	66.963	58.295	106.172	48.874	36.201	0.000	4.224	18.080	0.000	0.000
1994/95**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1995/96	216.991	133.810	761.581	277.893	385.027	176.906	98.150	48.503	16.226	29.390	47.945	4.476	0.000	0.000
1996/97	33.363	270.706	133.667	468.678	269.888	325.664	217.421	92.979	55.494	39.048	30.028	53.216	18.838	12.612
1997/98*	291.884	601.783	81.055	57.366	287.046	155.998	203.382	105.730	35.469	27.373	14.234	36.500	14.235	11.570
1998/99	100.426	255.937	1081.504	103.344	51.786	135.246	70.514	101.626	53.935	17.414	13.636	2.642	4.209	8.775
1999/00	516.153	839.491	239.064	605.858	88.214	43.353	165.716	89.916	121.345	77.600	21.542	3.740	11.149	0.000
2000/01	190.281	966.960	1316.413	191.001	482.418	34.377	15.727	37.940	14.320	15.413	14.668	1.705	3.259	0.000
2001/02*	1047.643	287.004	217.441	260.497	161.049	345.852	62.451	57.105	38.405	46.044	38.114	21.062	3.663	0.000
2002/03	1731.809	1919.368	553.149	205.656	262.362	153.037	276.199	99.206	47.621	55.126	18.798	24.419	24.112	1.377
2003/04	1115.255	1434.976	2058.222	330.800	109.146	100.785	38.693	45.582	7.039	6.362	7.509	10.894	0.000	2.289
2004/05	2417.128	713.730	1022.326	1046.657	171.326	62.429	44.313	10.947	23.942	12.669	0.000	1.948	11.088	0.000
2005/06	469.532	443.877	344.983	818.738	1220.902	281.448	122.183	129.588	73.339	65.287	10.115	9.205	3.548	12.417
2006/07	109.959	608.205	1059.597	410.145	424.525	693.423	95.997	123.748	48.773	0.955	0.000	0.000	0.000	0.480
2007/08	90.231	456.773	289.260	541.585	309.443	402.889	702.708	221.626	244.772	13.997	22.113	68.105	10.136	2.800

*** The estimates from the fishing season 1997/98 and 2001/02 were omitted from the tuning procedure in the assessment 2007 because of incomplete coverage of the surveys due to weather condition and time limitations. ** No survey**

Table 11.2.2. Icelandic summers-spawning herring. Number of scales by ages and number of samples taken in the annual acoustic surveys in the seasons 1987/88-2007/08 (age refers to the former year, i.e. autumns). In 2000 seven samples were used from the fishery. No survey was conducted in 1994/95.

															No. of samples		
Year\Age	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total	Total	West	East
1987/88	11	59	246	156	37	28	58	33	22	16	23	10	5	8	712	8	1	7
1988/89	229	78	181	424	178	69	50	77	42	29	23	13	7	12	1412	18	5	10
1989/90	38	245	96	132	225	35	2	2	3	3	2	0	0	0	783	8		8
1990/91	418	229	303	90	131	257	28	6	3	8	0	0	0	0	1473	15		15
1991/92	414	439	127	127	33	48	84	5	3	0	2	0	0	1	1283	15		15
1992/93	122	513	289	68	73	28	38	34	6	2	2	6	0	0	1181	12		12
1993/94	63	285	343	129	13	15	7	14	11	0	1	3	0	0	884	9		9
1994/95*																		
1995/96	183	90	471	162	209	107	38	18	8	14	18	2	0	0	1320	14	9	5
1996/97	24	150	88	351	141	137	87	32	15	10	7	14	4	2	1062	11	4	7
1997/98	101	249	50	36	159	95	122	62	21	13	8	15	8	5	944	14	7	7
1998/99	130	216	777	72	31	65	59	86	37	22	17	5	6	11	1534	17	10	7
1999/00	116	227	72	144	17	13	26	26	27	10	8	2	1	0	689	7	3	4
2000/01	116	249	332	87	166	10	7	21	8	14	11	3	1	0	1025	14	10	4
2001/02	61	56	130	114	62	136	25	24	17	21	17	10	3	0	676	9	4	5
2002/03	520	705	258	104	130	74	128	46	26	25	13	15	10	1	2055	22	12	10
2003/04	126	301	415	88	35	32	15	17	3	4	4	6	1	1	1048	13	8	5
2004/05	304	159	284	326	70	29	17	5	8	4	0	3	3	0	1212	13	4	9
2005/06	217	312	190	420	501	110	40	38	26	18	5	5	5	7	1894	22	14	8
2006/07	19	77	134	64	71	88	22	4	2	2	0	0	0	1	484	6	4	2
2007/08	58	288	180	264	85	80	104	19	15	2	2	6	1	3	1107	17	13	4

Table 11.3.1. Icelandic summer spawners. Landings, catches and recommended TACs in thousand tonnes.

Year	Landings	Catches	Recommended TACs
1972	0.31	0.31	
1973	0.254	0.254	
1974	1.275	1.275	
1975	13.28	13.28	
1976	17.168	17.168	
1977	28.925	28.925	
1978	37.333	37.333	
1979	45.072	45.072	
1980	53.268	53.268	
1981	39.544	39.544	
1982	56.528	56.528	
1983	58.867	58.867	
1984	50.304	50.304	
1985	49.368	49.368	
1986	65.5	65.5	65
1987	73	73	70
1988	92.8	92.8	100
1989	97.3	101	90
1990/1991	101.6	105.1	90
1991/1992	98.5	109.5	79
1992/1993	106.7	108.5	86
1993/1994	101.5	102.7	90
1994/1995	132	134	120
1995/1996	125	125.9	110
1996/1997	95.9	95.9	100
1997/1998	64.7	64.7	100
1998/1999	87	87	90
1999/2000	92.9	92.9	100
2000/2001	100.3	100.3	110
2001/2002	95.7	95.7	125
2002/2003*	96.1	96.1	105
2003/2004*	130.7	130.7	110
2004/2005	114.2	114.2	110
2005/2006	103	103	110
2006/2007	135	135	130
2007/2008	158.9	158.9	130

***Summer fishery in 2002 and 2003 included**

Table 11.3.2.1. Overview of the catch data for Icelandic summer-spawning herring 2007/08.

	West of 15°W	east of 15°W	Total
Total catch (thousands tonnes)	157.3	1.6	158.9
Number of samplings for ageing	30	2	50
Number of aged fish	2450	111	2561
Number of weighed fish	2527	3184	2640
Number of samplings for length determinations	100	3	103
Number of fish length measured	14075	346	14421

Table 11.3.2.2. Icelandic summer-spawning herring. Catch in numbers (millions) and total catch in weight (thous. tonnes) (1981 refers to season 1981/1982 etc).

YEAR\AGE	2	3	4	5	6	7	8	9	10	11	12	13	14	15	CATCH
1975	1.518	2.049	31.975	6.493	7.905	0.863	0.442	0.345	0.114	0.004	0.001	0.001	0.001	0.001	13.280
1976	0.614	9.848	3.908	34.144	7.009	5.481	1.045	0.438	0.296	0.134	0.092	0.001	0.001	0.001	17.168
1977	0.705	18.853	24.152	10.404	46.357	6.735	5.421	1.395	0.524	0.362	0.027	0.128	0.001	0.001	28.925
1978	2.634	22.551	50.995	13.846	8.738	39.492	7.253	6.354	1.616	0.926	0.4	0.017	0.025	0.051	37.333
1979	0.929	15.098	47.561	69.735	16.451	8.003	26.04	3.05	1.869	0.494	0.439	0.032	0.054	0.006	45.072
1980	3.147	14.347	20.761	60.727	65.328	11.541	9.285	19.442	1.796	1.464	0.698	0.001	0.11	0.079	53.268
1981	2.283	4.629	16.771	12.126	36.871	41.917	7.299	4.863	13.416	1.032	0.884	0.760	0.101	0.062	39.544
1982	0.454	19.187	28.109	38.280	16.623	38.308	43.770	6.813	6.633	10.457	2.354	0.594	0.075	0.211	56.528
1983	1.475	22.499	151.718	30.285	21.599	8.667	14.065	13.713	3.728	2.381	3.436	0.554	0.100	0.003	58.867
1984	0.421	18.015	32.244	141.354	17.043	7.113	3.916	4.113	4.517	1.828	0.202	0.255	0.260	0.003	50.304
1985	0.112	12.872	24.659	21.656	85.210	11.903	5.740	2.336	4.363	4.053	2.773	0.975	0.480	0.581	49.368
1986	0.100	8.172	33.938	23.452	20.681	77.629	18.252	10.986	8.594	9.675	7.183	3.682	2.918	1.788	65.500
1987	0.029	3.144	44.590	60.285	20.622	19.751	46.240	15.232	13.963	10.179	13.216	6.224	4.723	2.280	75.439
1988	0.879	4.757	41.331	99.366	69.331	22.955	20.131	32.201	12.349	10.250	7.378	7.284	4.807	1.957	92.828
1989	3.974	22.628	26.649	77.824	188.654	43.114	8.116	5.897	7.292	4.780	3.449	1.410	0.844	0.348	101.000
1990	12.567	14.884	56.995	35.593	79.757	157.225	30.248	8.187	4.372	3.379	1.786	0.715	0.446	0.565	105.097
1991	37.085	88.683	49.081	86.292	34.793	55.228	110.132	10.079	4.155	2.735	2.003	0.519	0.339	0.416	109.489
1992	16.144	94.86	122.626	38.381	58.605	27.921	38.42	53.114	11.592	1.727	1.757	0.153	0.376	0.001	108.504
1993	2.467	51.153	177.78	92.68	20.791	28.56	13.313	19.617	15.266	4.254	0.797	0.254	0.001	0.001	102.741
1994	5.738	134.616	113.29	142.876	87.207	24.913	20.303	16.301	15.695	14.68	2.936	1.435	0.244	0.195	134.003
1995	4.555	20.991	137.232	86.864	109.14	76.78	21.361	15.225	8.541	9.617	7.034	2.291	0.621	0.235	125.851
1996	0.717	15.969	40.311	86.187	68.927	84.66	39.664	14.746	8.419	5.836	3.152	5.18	1.996	0.574	95.882
1997	2.008	39.24	30.141	26.307	36.738	33.705	31.022	22.277	8.531	3.383	1.141	10.296	0.947	2.524	64.682
1998	23.655	45.39	175.529	22.691	8.613	40.898	25.944	32.046	14.647	2.122	2.754	2.15	1.07	1.011	86.998
1999	5.306	56.315	54.779	140.913	16.093	13.506	31.467	19.845	22.031	12.609	2.673	2.746	1.416	2.514	92.896
2000	17.286	57.282	136.278	49.289	76.614	11.546	8.294	16.367	9.874	11.332	6.744	2.975	1.539	1.104	100.332
2001	27.486	42.304	86.422	93.597	30.336	54.491	10.375	8.762	12.244	9.907	8.259	6.088	1.491	1.259	95.675
2002	11.698	80.863	70.801	45.607	54.202	21.211	42.199	9.888	4.707	6.52	9.108	9.355	3.994	5.697	96.128
2003	24.477	211.495	286.017	58.120	27.979	25.592	14.203	10.944	2.230	3.424	4.225	2.562	1.575	1.370	130.741
2004	23.144	63.355	139.543	182.45	40.489	13.727	9.342	5.769	7.021	3.136	1.861	3.871	0.994	1.855	114.237
2005	6.088	26.091	42.116	117.91	133.437	27.565	12.074	9.203	5.172	5.116	1.045	1.706	2.11	0.757	103.043
2006	52.567	118.526	217.672	54.800	48.312	57.241	13.603	5.994	4.299	0.898	1.626	1.213	0.849	0.933	135.303
2007	10.817	94.250	83.631	163.294	61.207	87.541	92.126	23.238	11.728	7.319	2.593	4.961	2.302	1.420	158.917

Table 11.3.2.3. Icelandic summer-spawning herring. The mean weight (g) at age from the commercial catch (1981 refers to season 1981/1982 etc).

YEAR\AGE	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1975	110	179	241	291	319	339	365	364	407	389	430	416	416	416
1976	103	189	243	281	305	335	351	355	395	363	396	396	396	396
1977	84	157	217	261	285	313	326	347	364	362	358	355	400	420
1978	73	128	196	247	295	314	339	359	360	376	380	425	425	425
1979	75	145	182	231	285	316	334	350	367	368	371	350	350	450
1980	69	115	202	232	269	317	352	360	380	383	393	390	390	390
1981	61	141	190	246	269	298	330	356	368	405	382	400	400	400
1982	65	141	186	217	274	293	323	354	385	389	400	394	390	420
1983	59	132	180	218	260	309	329	356	370	407	437	459	430	472
1984	49	131	189	217	245	277	315	322	351	334	362	446	417	392
1985	53	146	219	266	285	315	335	365	388	400	453	469	433	447
1986	60	140	200	252	282	298	320	334	373	380	394	408	405	439
1987	60	168	200	240	278	304	325	339	356	378	400	404	424	430
1988	75	157	221	239	271	298	319	334	354	352	371	390	408	437
1989	63	130	206	246	261	290	331	338	352	369	389	380	434	409
1990	80	127	197	245	272	285	305	324	336	362	370	382	375	378
1991	74	135	188	232	267	289	304	323	340	352	369	402	406	388
1992	68	148	190	235	273	312	329	339	355	382	405	377	398	398
1993	66	145	211	246	292	324	350	362	376	386	419	389	389	389
1994	66	134	201	247	272	303	333	366	378	389	390	412	418	383
1995	68	130	183	240	277	298	325	358	378	397	409	431	430	467
1996	75	139	168	212	258	289	308	325	353	353	377	404	395	410
1997	63	131	191	233	269	300	324	341	355	362	367	393	398	411
1998	52	134	185	238	264	288	324	340	348	375	406	391	426	456
1999	74	137	204	233	268	294	311	339	353	362	378	385	411	422
2000	62	159	217	268	289	325	342	363	378	393	407	425	436	430
2001	74	139	214	244	286	296	324	347	354	385	403	421	421	433
2002	85	161	211	258	280	319	332	354	405	396	416	433	463	460
2003	72	156	189	229	260	283	309	336	336	369	394	378	412	423
2004	84	149	213	248	280	315	331	349	355	379	388	412	419	425
2005	106	170	224	262	275	298	324	335	335	356	372	394	405	413
2006	107	189	234	263	290	304	339	349	369	416	402	413	413	467
2007	93	158	221	245	261	277	287	311	339	334	346	356	384	390

Table 11.3.2.4. Icelandic summer-spawning herring. Proportion mature at age (1981 refers to season 1981/1982 etc).

YEAR\AGE	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1975	0	0.27	0.97	1	1	1	1	1	1	1	1	1	1	1
1976	0	0.13	0.9	1	1	1	1	1	1	1	1	1	1	1
1977	0	0.02	0.87	1	1	1	1	1	1	1	1	1	1	1
1978	0	0.04	0.78	1	1	1	1	1	1	1	1	1	1	1
1979	0	0.07	0.65	0.98	1	1	1	1	1	1	1	1	1	1
1980	0	0.05	0.92	1	1	1	1	1	1	1	1	1	1	1
1981	0	0.03	0.65	0.99	1	1	1	1	1	1	1	1	1	1
1982	0.02	0.05	0.85	1	1	1	1	1	1	1	1	1	1	1
1983	0	0	0.64	1	1	1	1	1	1	1	1	1	1	1
1984	0	0.01	0.82	1	1	1	1	1	1	1	1	1	1	1
1985	0	0	0.9	1	1	1	1	1	1	1	1	1	1	1
1986	0	0.2	0.85	1	1	1	1	1	1	1	1	1	1	1
1987	0	0.2	0.85	1	1	1	1	1	1	1	1	1	1	1
1988	0	0.2	0.85	1	1	1	1	1	1	1	1	1	1	1
1989	0	0.2	0.85	1	1	1	1	1	1	1	1	1	1	1
1990	0	0.2	0.85	1	1	1	1	1	1	1	1	1	1	1
1991	0	0.2	0.85	1	1	1	1	1	1	1	1	1	1	1
1992	0	0.2	0.85	1	1	1	1	1	1	1	1	1	1	1
1993	0	0.2	0.85	1	1	1	1	1	1	1	1	1	1	1
1994	0	0.2	0.85	1	1	1	1	1	1	1	1	1	1	1
1995	0	0.2	0.85	1	1	1	1	1	1	1	1	1	1	1
1996	0	0.2	0.85	1	1	1	1	1	1	1	1	1	1	1
1997	0	0.2	0.85	1	1	1	1	1	1	1	1	1	1	1
1998	0	0.2	0.85	1	1	1	1	1	1	1	1	1	1	1
1999	0	0.2	0.85	1	1	1	1	1	1	1	1	1	1	1
2000	0	0.2	0.85	1	1	1	1	1	1	1	1	1	1	1
2001	0	0.2	0.85	1	1	1	1	1	1	1	1	1	1	1
2002	0	0.2	0.85	1	1	1	1	1	1	1	1	1	1	1
2003	0	0.2	0.85	1	1	1	1	1	1	1	1	1	1	1
2004	0	0.2	0.85	1	1	1	1	1	1	1	1	1	1	1
2005	0	0.2	0.85	1	1	1	1	1	1	1	1	1	1	1
2006	0	0.2	0.85	1	1	1	1	1	1	1	1	1	1	1
2007	0	0.2	0.85	1	1	1	1	1	1	1	1	1	1	1

Table 11.4.3.1. Model settings and results of model parameters from the NFT-Adapt run in 2008 for Icelandic summer spawning herring.

VPA Version 2.3.2002

Model ID: Run 1 in 2008 Same as run8 (final) in 2007

Input File: C:\NFT\VPA\2008\RUN1\RUN1_2008.DAT

Date of Run: 10.apr.08 Time of Run: 16:35

Levenburg-Marquardt Algorithm Completed 5 Iterations

Residual Sum of Squares = 26.701

Number of Residuals = 126

Number of Parameters = 7
Degrees of Freedom = 119
Mean Squared Residual = 0.224378
Standard Deviation = 0.473686

Number of Years = 22
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 -2008

Age	Stock Predicted	Std. Error	CV
4	396629.792	1.94E+05	4.88E-01
5	275246.124	1.04E+05	3.79E-01
6	365144.256	1.31E+05	3.58E-01
7	223332.928	6.94E+04	3.11E-01
8	331188.207	9.73E+04	2.94E-01
9	508250.801	1.35E+05	2.66E-01
10	94342.497	2.62E+04	2.77E-01

Catchability Values for Each Survey Used in Estimate

INDEX	Catchability	Std. Error	CV
1	1.15E+00	1.21E-01	1.05E-01
2	1.40E+00	1.56E-01	1.11E-01
3	1.28E+00	1.12E-01	8.74E-02
4	1.23E+00	1.05E-01	8.58E-02
5	1.27E+00	1.33E-01	1.05E-01
6	1.51E+00	2.08E-01	1.37E-01
7	1.75E+00	2.42E-01	1.38E-01

-- Non-Linear Least Squares Fit --
Default Tolerances Used
Scaled Gradient Tolerance = 6.06E-06
Scaled Step Tolerance = 3.67E-11
Relative Function Tolerance = 3.67E-11
Absolute Function Tolerance = 4.93E-32

VPA Method Options

- Catchability Values Estimated as an Analytic Function of N
- Pope Approximation Used in Cohort Solution
- Plus Group Forward Calculation Method Used
- Arithmetic Average Used in F-Oldest Calculation

- F-Oldest Calculation in Years Prior to Terminal Year
Uses Fishing Mortality in Ages 8 to 10
- Calculation of Population of Age 3 In Year 2008
= Geometric Mean of First Age Populations

Year Range Applied = 1986 to 2004

Stock Estimates
Age 4
Age 5
Age 6
Age 7
Age 8
Age 9
Age 10

Full F in Terminal Year = 0.24
F in Oldest TRUE Age in Terminal Year = 0.2044

Full F Calculated Using Classic Method

F in Oldest TRUE Age in Terminal Year has been Calculated in Same Manner as in All Other Years

Age	Input Partial Recruitment	Calc Partial Recruitment	Fishing Mortality	Used In Full F	Comments
3	0.7	0.582	0.2027	NO	Stock Estimate in T+1
4	1	0.718	0.2501	YES	Stock Estimate in T+1
5	1	1	0.3484	YES	Stock Estimate in T+1
6	1	0.688	0.2396	YES	Stock Estimate in T+1
7	1	0.657	0.229	YES	Stock Estimate in T+1
8	1	0.463	0.1612	YES	Stock Estimate in T+1
9	1	0.609	0.212	YES	Stock Estimate in T+1
10	1	0.689	0.24	NO	Input PR * Full F
11	1	0.587	0.2044	F-Oldest	

Table 11.4.3.2. Icelandic summer spawners stock estimates (from NFT-Adapt in 2008) in numbers (thousands) during 1986-2008.

AGE	1986	1987	1988	1989	1990	1991	1992	1993
3	1124713	549094	282697	435421	293213	837702	1051371	631363
4	378936	1009909	493850	251270	372461	251152	673626	861087
5	118148	310592	871388	407539	202009	282801	180564	492877
6	97895	84597	223691	693944	294728	148928	173805	126872
7	200213	68907	56930	136454	448454	190813	101660	101519
8	72153	107317	43562	29677	82457	256221	120121	65426
9	52357	47925	53119	20267	19133	45838	127077	72143
10	38700	36925	28875	17434	12729	9524	31888	64461
11	42224	26843	20129	14380	8838	7359	4666	17827
12+	67956	75745	58139	40844	39695	37379	34777	31881
Total	2193295	2317854	2132380	2047230	1773717	2067717	2499555	2465456

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AGE	1994	1995	1996	1997	1998	1999	2000	2001
3	685814	211187	201851	786918	320873	590554	429214	560472
4	522622	492500	171123	167452	674707	247161	480787	333880
5	610034	365123	315093	116493	122846	443531	171534	305402
6	357813	416074	247750	203124	80384	89571	267283	108325
7	95022	240809	272662	158608	148848	64541	65739	168970
8	64691	62281	144858	166183	111453	95780	45552	48500
9	46536	39222	36035	93343	120860	76168	56733	33328
10	46618	26602	21007	18579	63270	78876	50043	35765
11	43805	27252	15946	11000	8696	43316	50413	35888
12+	39941	57300	57733	50793	38574	34129	49258	67711
Total	2512896	1938350	1484058	1772493	1690511	1763627	1666556	1698241

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AGE	2002	2003	2004	2005	2006	2007	2008
3	2018751	1290978	609276	978626	556298	536845	566768
4	466896	1749723	966945	491031	860679	390614	396630
5	219900	355117	1311147	742191	404241	571719	275246
6	187307	155591	266037	1012823	559402	313645	365144
7	69160	117924	114170	202206	789511	460212	223333
8	101057	42402	82358	90248	156743	659930	331188
9	34016	51299	24857	65634	70175	128887	508251
10	21821	21373	36007	17003	50634	57795	94342
11	20715	15267	17218	25902	10466	41726	41136
12+	68132	47569	44373	44610	53612	52734	94342
Total	3207755	3847243	3472388	3670274	3511761	3214107	2896380

Table 11.4.3.3. Estimated fishing mortality at age of Icelandic summer-spawning herring (from NFT-Adapt in 2008) during 1986-2007.

AGE	1986	1987	1988	1989	1990	1991	1992	1993
3	0.008	0.006	0.018	0.056	0.055	0.118	0.100	0.089
4	0.099	0.048	0.092	0.118	0.175	0.230	0.212	0.245
5	0.234	0.228	0.128	0.224	0.205	0.387	0.253	0.220
6	0.251	0.296	0.394	0.337	0.335	0.282	0.438	0.189
7	0.524	0.359	0.552	0.404	0.460	0.363	0.341	0.351
8	0.309	0.603	0.665	0.339	0.487	0.601	0.410	0.241
9	0.249	0.407	1.014	0.365	0.598	0.263	0.579	0.337
10	0.266	0.507	0.597	0.579	0.448	0.614	0.482	0.286
11	0.275	0.506	0.759	0.428	0.511	0.493	0.490	0.288
12+	0.275	0.455	0.487	0.169	0.098	0.097	0.072	0.035
WF 5-10	0.388	0.387	0.414	0.325	0.405	0.448	0.425	0.255
WF 4-8	0.347	0.298	0.276	0.303	0.364	0.419	0.303	0.243
AGE	1994	1995	1996	1997	1998	1999	2000	2001
3	0.231	0.110	0.087	0.054	0.161	0.106	0.151	0.083
4	0.259	0.347	0.285	0.210	0.320	0.265	0.354	0.318
5	0.283	0.288	0.339	0.271	0.216	0.407	0.360	0.389
6	0.296	0.323	0.346	0.211	0.120	0.209	0.359	0.349
7	0.322	0.408	0.395	0.253	0.341	0.249	0.204	0.414
8	0.400	0.447	0.340	0.219	0.281	0.424	0.213	0.255
9	0.459	0.524	0.563	0.289	0.327	0.320	0.361	0.324
10	0.437	0.412	0.547	0.659	0.279	0.348	0.233	0.446
11	0.432	0.461	0.483	0.389	0.295	0.364	0.269	0.342
12+	0.135	0.206	0.221	0.367	0.211	0.338	0.305	0.307
WF 5-10	0.315	0.354	0.373	0.266	0.288	0.375	0.335	0.384
WF 4-8	0.287	0.345	0.349	0.231	0.304	0.358	0.346	0.362
AGE	2002	2003	2004	2005	2006	2007		
3	0.043	0.189	0.116	0.028	0.254	0.203		
4	0.174	0.189	0.165	0.095	0.309	0.250		
5	0.246	0.189	0.158	0.183	0.154	0.348		
6	0.363	0.210	0.174	0.149	0.095	0.240		
7	0.389	0.259	0.135	0.155	0.079	0.229		
8	0.578	0.434	0.127	0.152	0.096	0.161		
9	0.365	0.254	0.280	0.160	0.094	0.212		
10	0.257	0.116	0.229	0.385	0.094	0.240		
11	0.400	0.268	0.212	0.232	0.094	0.204		
12+	0.566	0.242	0.227	0.142	0.095	0.254		
WF 5-10	0.384	0.235	0.163	0.167	0.108	0.259		
WF 4-8	0.324	0.203	0.161	0.155	0.220	0.260		

Table 11.4.3.4. Summary table from NFT-Adapt run in 2008 for Icelandic summer spawning herring.

	Recruits age 3	Totalbiom. (age 3+)	TotalSpbio.	Landings (age 3+)	Yield/SSB	WF 5-10
YEAR	(MLLIONS)	(THOUS. T)	(THOUS. T)	(THOUS. T)		
1986	1125	449	296	66	0.221	0.388
1987	549	519	394	75	0.191	0.387
1988	283	511	437	93	0.212	0.414
1989	435	474	400	101	0.252	0.325
1990	293	422	362	104	0.288	0.405
1991	838	434	320	107	0.334	0.448
1992	1051	515	353	107	0.304	0.425
1993	631	558	435	103	0.236	0.255
1994	686	563	451	134	0.297	0.315
1995	211	471	415	125	0.303	0.354
1996	202	359	316	96	0.304	0.373
1997	787	381	279	65	0.232	0.266
1998	321	380	310	86	0.277	0.288
1999	591	390	303	93	0.306	0.375
2000	429	413	326	100	0.307	0.335
2001	560	387	298	94	0.314	0.384
2002	2019	647	354	96	0.271	0.384
2003	1291	749	512	129	0.251	0.235
2004	609	806	668	112	0.168	0.163
2005	979	893	708	102	0.145	0.167
2006	556	938	784	130	0.166	0.108
2007	537	802	686	158	0.230	0.259
2008	567	734	650			

Table 11.4.3.5. The residuals from survey observations and NFT-Adapt 2008 results for Icelandic summer spawning herring (no surveys in 1994, 1997, and 2001).

Year\age	4	5	6	7	8	9	10
1987	-0.35	-0.35	0.07	-0.20	-0.53	-0.13	-0.32
1988	-0.36	-0.90	-0.84	0.12	0.21	-0.17	0.07
1989	0.42	-0.46	-0.30	0.08	0.54	-0.27	-0.02
1990	-0.78	-0.43	-0.70	-0.20	0.46	0.14	0.81
1991	0.30	0.34	0.36	-0.33	-0.10	0.29	-0.96
1992	-0.18	0.05	-0.02	0.05	-0.43	-0.12	-0.15
1993	-0.17	0.03	0.08	-0.55	-0.34	0.41	-0.51
1994							
1995	-0.39	0.54	-0.13	0.14	-0.04	0.59	0.28
1996	0.34	-0.20	0.59	0.33	0.44	0.43	1.05
1997							
1998	-0.11	0.55	-0.10	-0.42	0.11	-0.49	-0.31
1999	0.42	-0.01	0.57	0.09	-0.29	0.66	0.03
2000	0.92	1.12	0.32	0.85	-0.58	-1.16	-0.50
2001							
2002	-0.05	0.11	0.03	0.60	1.05	1.27	0.98
2003	0.25	0.11	-0.03	-0.25	-0.03	0.03	-0.32
2004	0.23	-0.02	-0.21	-0.37	-0.60	-0.81	-1.00
2005	-0.80	-0.50	0.14	0.23	0.35	0.14	0.38
2006	0.30	0.28	0.02	-0.28	-0.19	-0.71	0.20
2007	0.00	-0.29	0.15	0.12	-0.04	-0.09	0.30

Table 11.7.1.1. The input data used for prognosis of the Icelandic summer-spawning herring. The geometric mean of number at age 3 on Jan. 1st was used as the recruits for the following years while number at age on Jan 1st 2008 are from NFT-Adapt 2008 and TSA.

Age	Mean weights (kg)	M	Maturity ogive	Selection pattern	Mortality prop. Before spawning F	M	NFT-adapt Number at age	TSA Number at age
3	0.158	0.1	0.20	0.60	0	0.5	567	398
4	0.221	0.1	0.85	0.90	0	0.5	397	398
5	0.245	0.1	1.00	1.00	0	0.5	275	256
6	0.261	0.1	1.00	1.00	0	0.5	365	381
7	0.277	0.1	1.00	1.00	0	0.5	223	171
8	0.287	0.1	1.00	1.00	0	0.5	331	235
9	0.311	0.1	1.00	1.00	0	0.5	508	294
10	0.339	0.1	1.00	1.00	0	0.5	94	66
11	0.334	0.1	1.00	1.00	0	0.5	41	32
12+	0.364	0.1	1.00	1.00	0	0.5	94	26

Table 11.7.2.1. The prognosis of the Icelandic summer spawning herring for two fishing seasons under five different options (1-5) from (a) the final NFT-Adapt run and (b) TSA run. The biomasses of 3+ and the spawning stock are in the beginning of the season.

(a) NFT-adapt

	2008/2009				2009/2010			
Option	TAC	3+ stock	Sp. Stock	F (5-10)	TAC	3+ stock	Sp. Stock	F (5-10)
1. $F_{0.22}$	131	735	618	0.220	123	703	586	0.220
2. TAC= 120	120	735	618	0.200	120	706	589	0.211
3. TAC=130	130	735	618	0.219	130	695	579	0.234
4. TAC=140	140	735	618	0.238	140	685	569	0.259
5. TAC=150	150	735	618	0.257	150	674	559	0.286

(b) TSA run

	2008/2009				2009/2010			
Option	TAC	3+ stock	Sp. Stock	F (5-10)	TAC	3+ stock	Sp. Stock	F (5-10)
1. $F_{0.22}$	100	562	474	0.220	93	530	446	0.220
2. TAC= 120	120	562	474	0.271	120	502	420	0.309
3. TAC=130	130	562	474	0.297	130	492	410	0.348
4. TAC=140	140	562	474	0.323	140	481	401	0.390
5. TAC=150	150	562	474	0.351	150	471	391	0.437

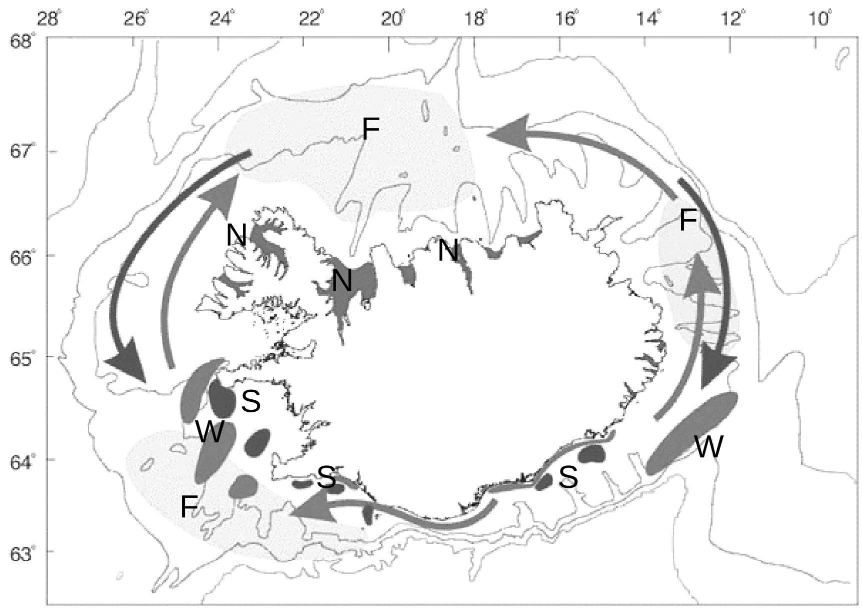


Figure 11.1.1. Chart indicating the major life-history aspects of Icelandic summer-spawning herring, including the feeding- (F), wintering- (W), spawning- (S), and nursery (N) grounds, and the main migration routes off coastal Iceland (Adopted from Jakobsson and Stefansson 1999).

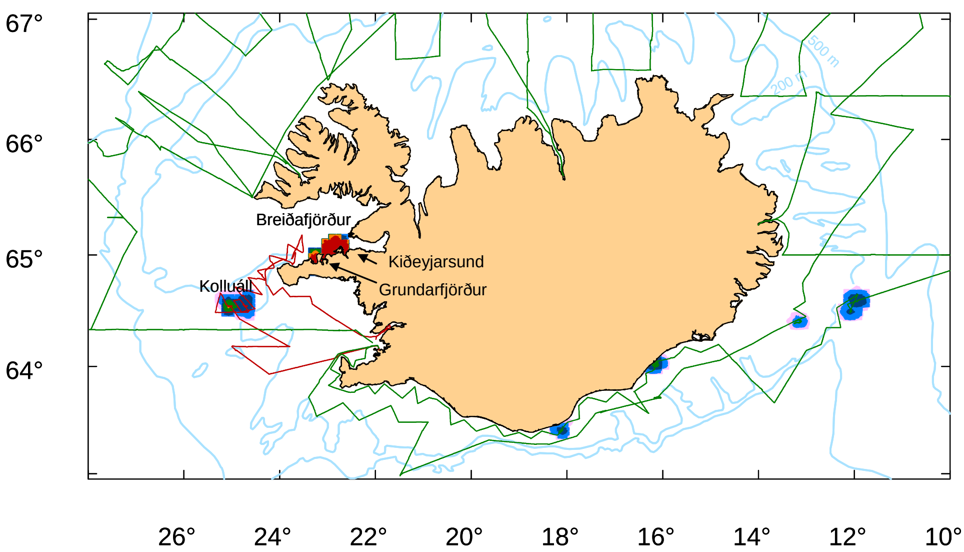


Figure 11.2.1. Distribution of Icelandic summer-spawning herring according to acoustic surveys in Nov.-December 2007 (total 825 thousands tonnes). The green cruise tracks represent combined capelin (off the N and E coast) and herring (off the NW, SE and S coast) surveys.

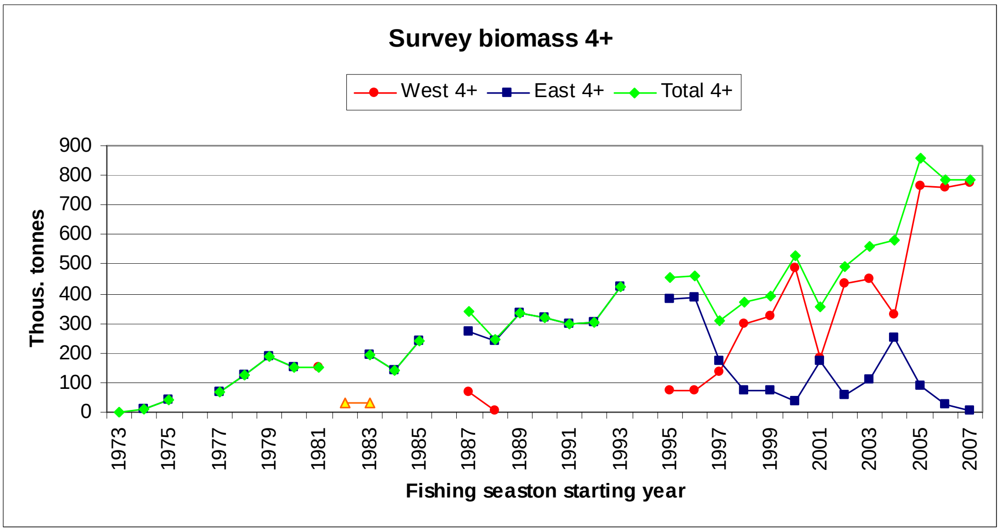


Figure 11.2.2 Total biomass index for Icelandic summer-spawning herring from the acoustic surveys for ages 4+ in the areas east and west of 18°W and then combined. The years in the plot refer to the autumn of the fishing seasons.

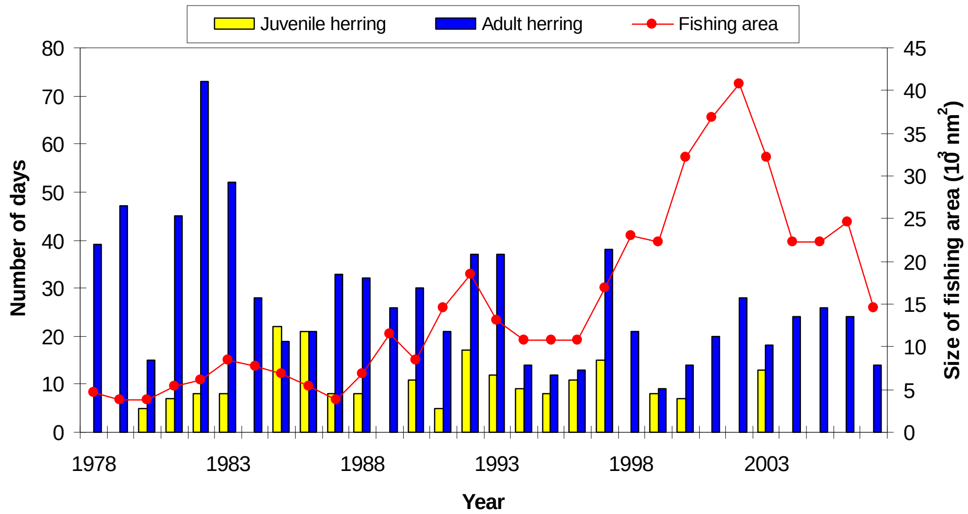


Figure 11.2.3. Number of days assigned for acoustic measurements of Icelandic summer-spawning herring for both juveniles and adults (bars) and estimated size of the area (nm²) that the commercial fleet is fishing herring during each season from 1978/79 through 2007/08 according to fishing reports (based on number of squares where catch was recorded).

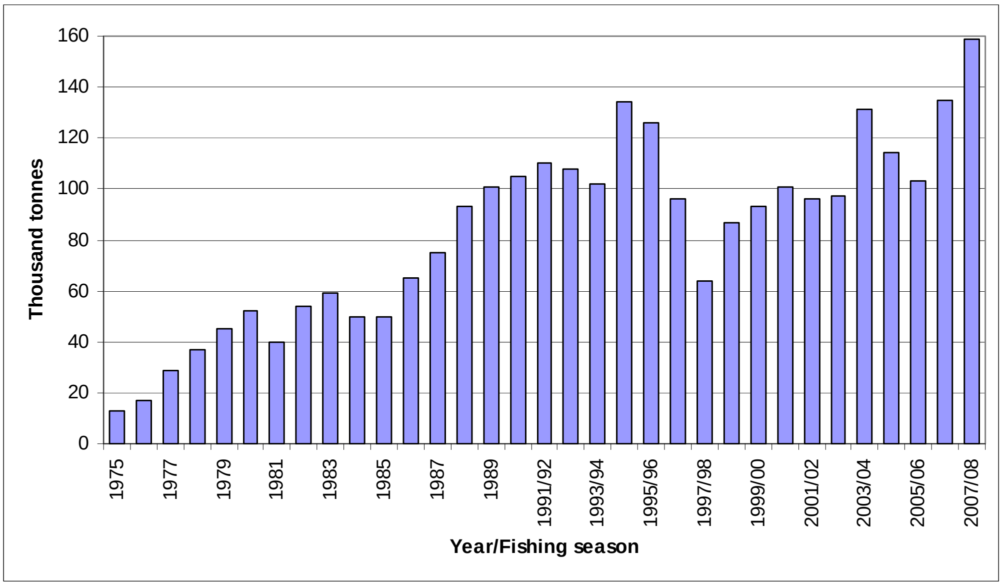


Figure 11.3.1. Icelandic summer spawning herring. Total catch (in thousand tonnes) in 1975/76-2007/08.

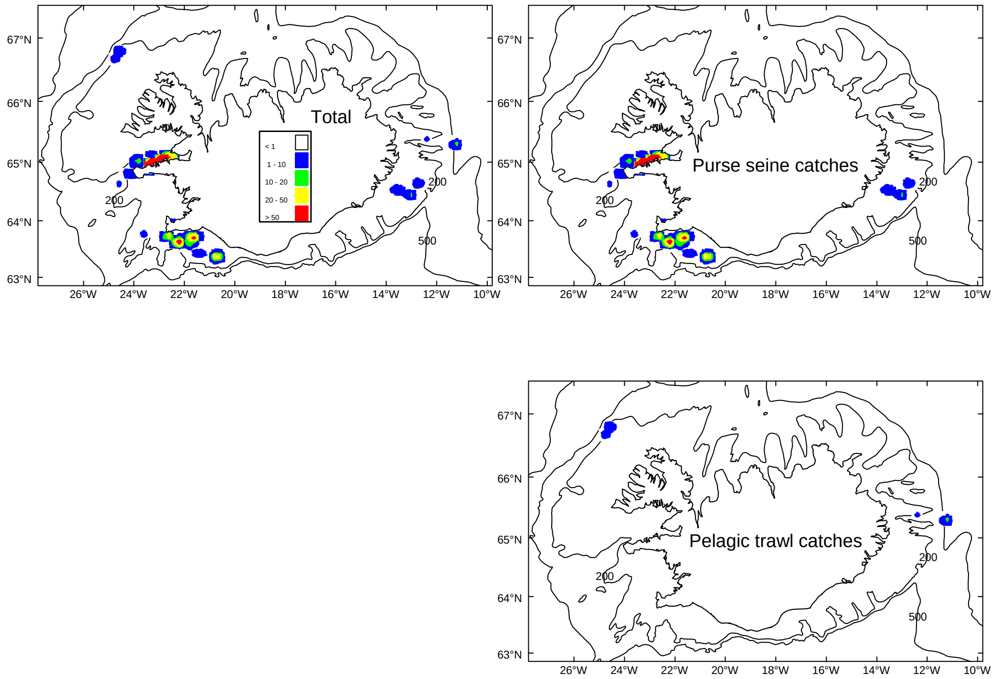


Figure 11.3.2. Icelandic summer spawning herring. Distribution of the total catches and by gears in the fishing season 2007/08 based on data from logbooks.

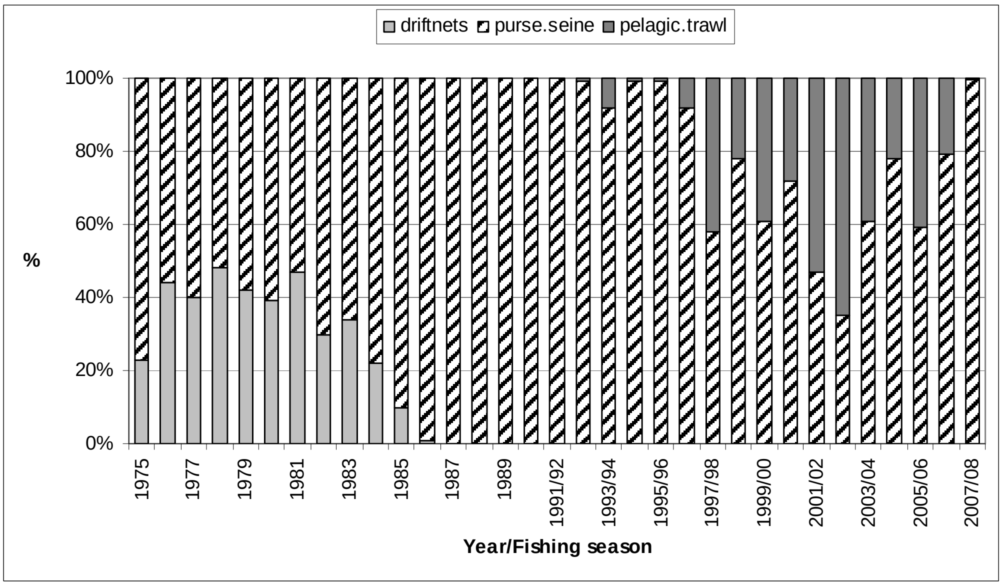


Figure 11.3.1.1. Icelandic summer spawning herring. Proportion of the catches of the Icelandic summer-spawning herring in 1975/76-2007/08 taken by different gears.

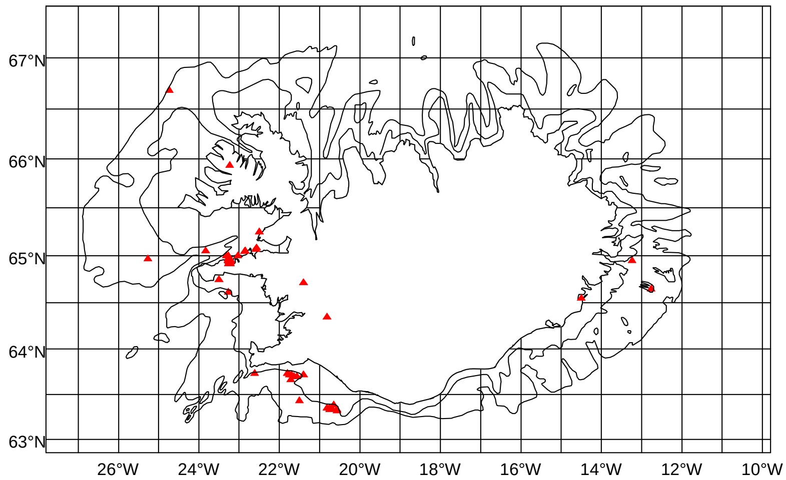


Figure 11.3.2.1. The locations of the Icelandic summer-spawning herring catch samples in 2007/08.

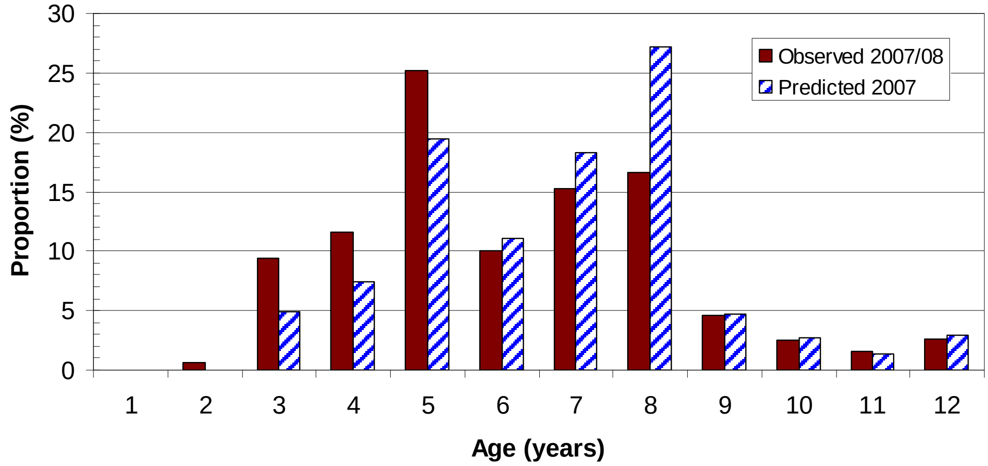


Figure 11.3.2.2. Icelandic summer spawning herring. Predicted catch in weight (%) in the assessment 2007 and observed catch in the season 2007/08.

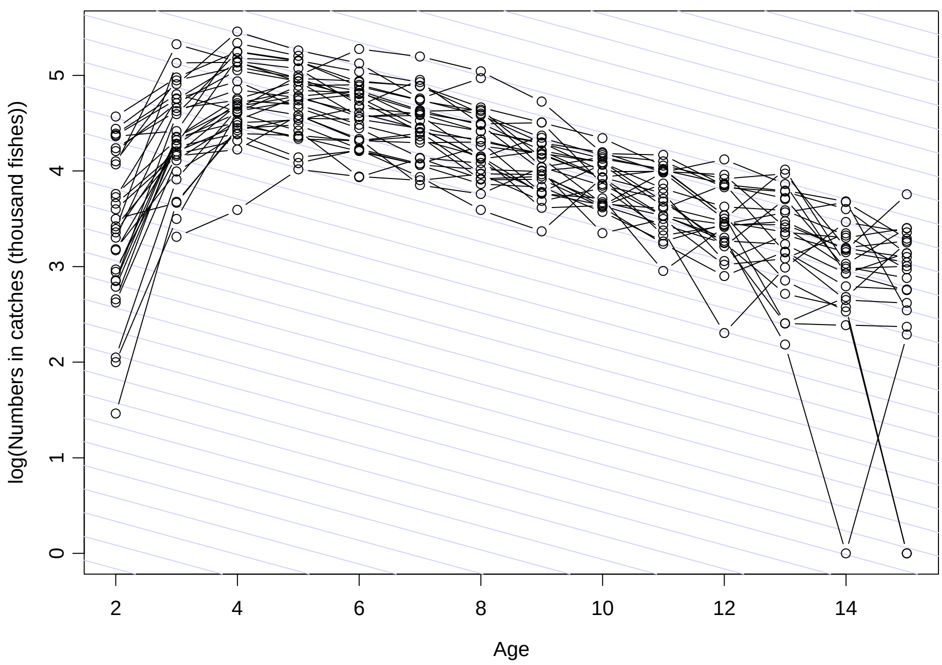


Figure 11.4.1.1. Icelandic summer-spawning herring. Catch curves by yearclasses 1971-2002. Grey lines correspond to Z=0.4.

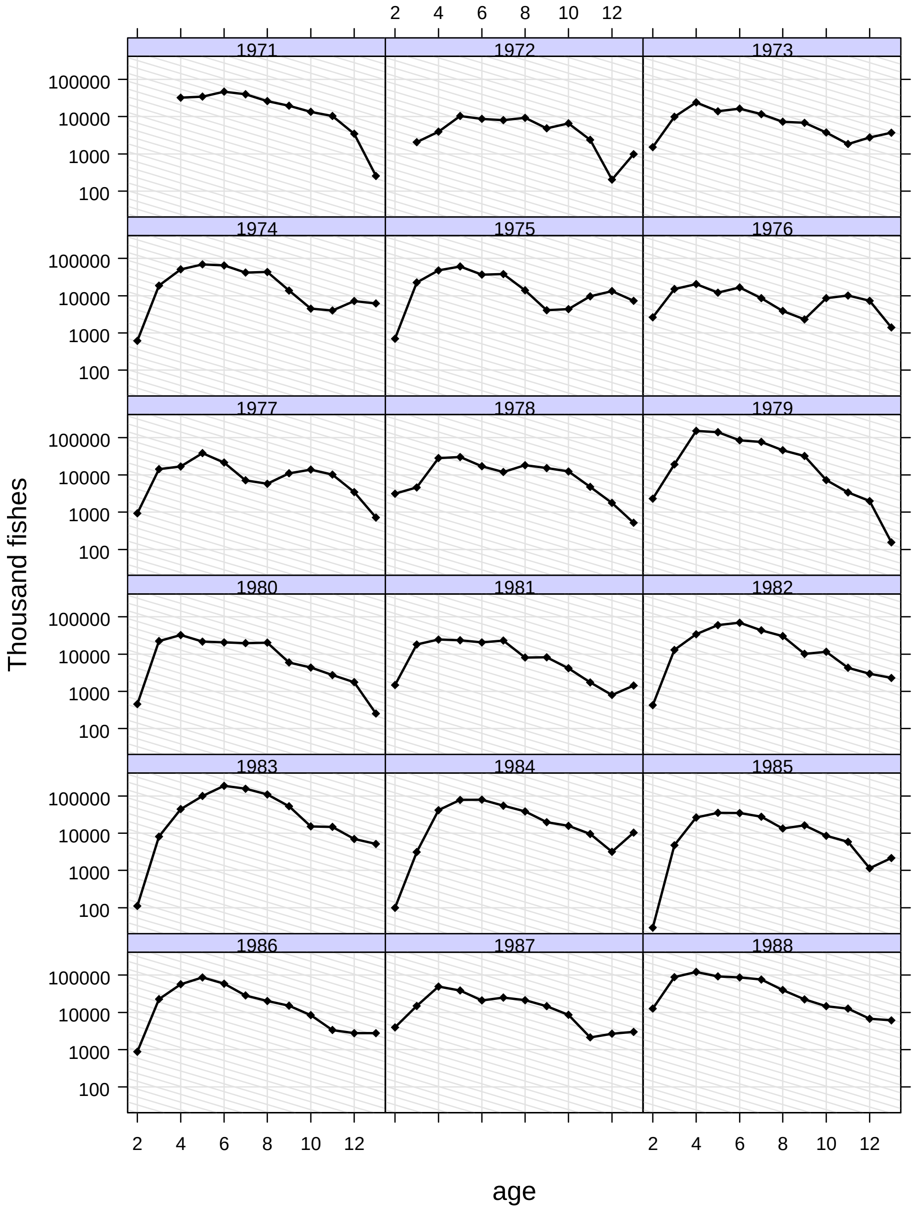


Figure 11.4.1.2. Icelandic summer-spawning herring. Catch curves by year classes 1971-2004. Grey lines correspond to Z=0.4.

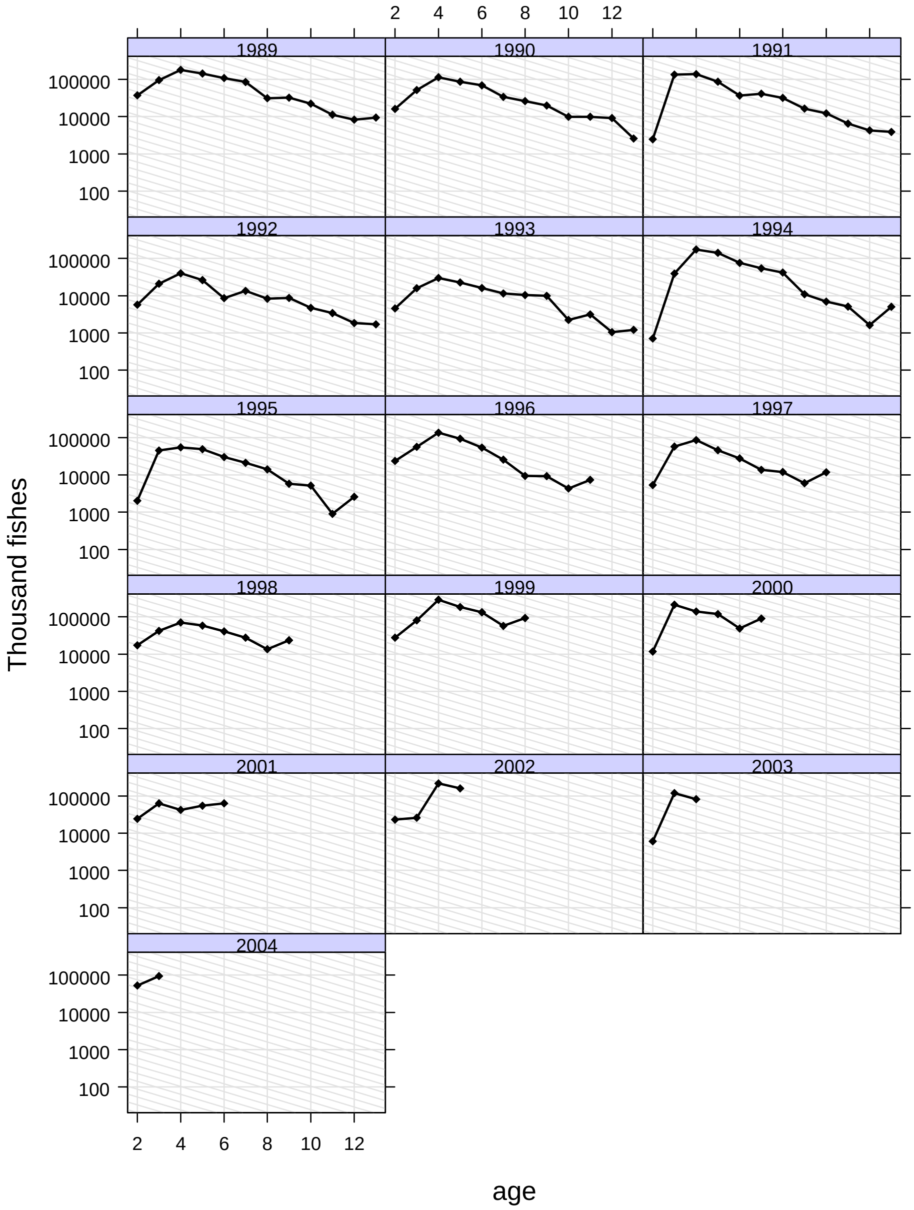
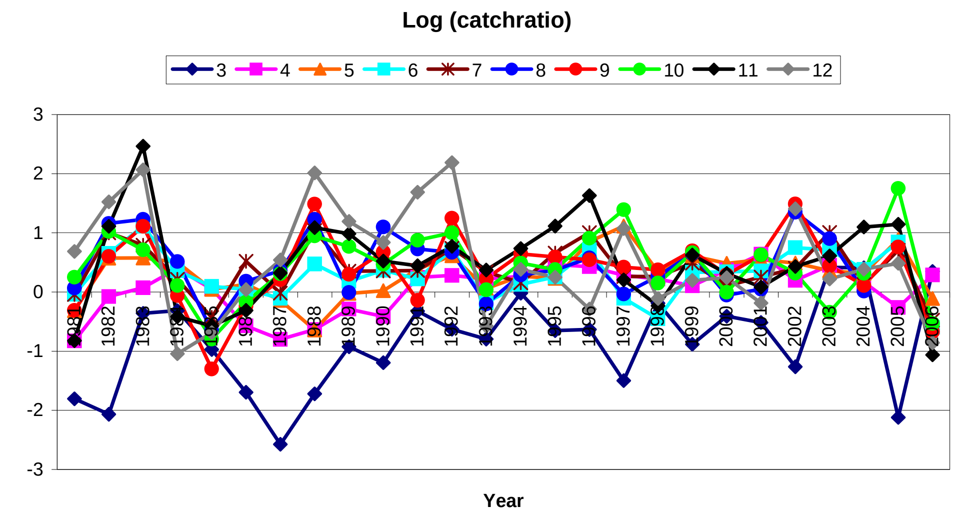


Figure 11.4.1.2, cont. Catch curves by year classes 1971-2004. Grey lines correspond to Z=0.4.



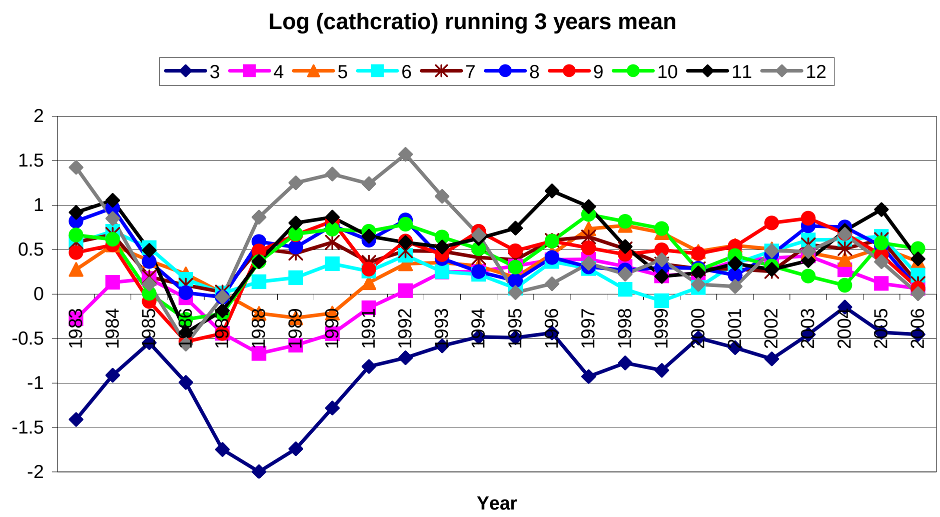


Figure 11.4.1.3. Icelandic summer spawning herring. Ln catch ratio by year and age.

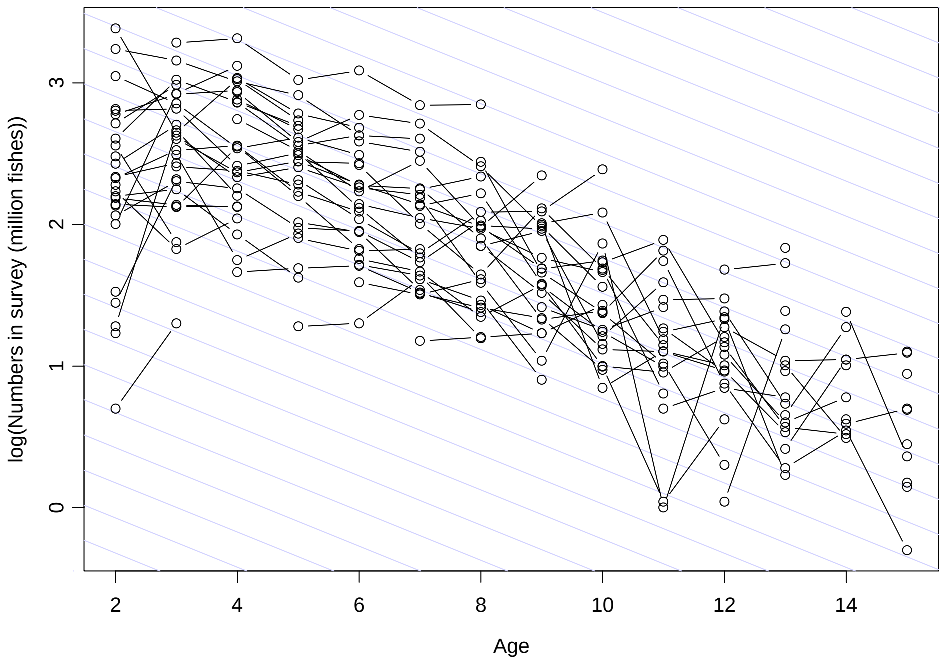


Figure 11.4.1.4. Icelandic summer spawning herring. Catch curves from survey data in the seasons 1973/74-2007/08. Grey lines correspond to Z=0.4.

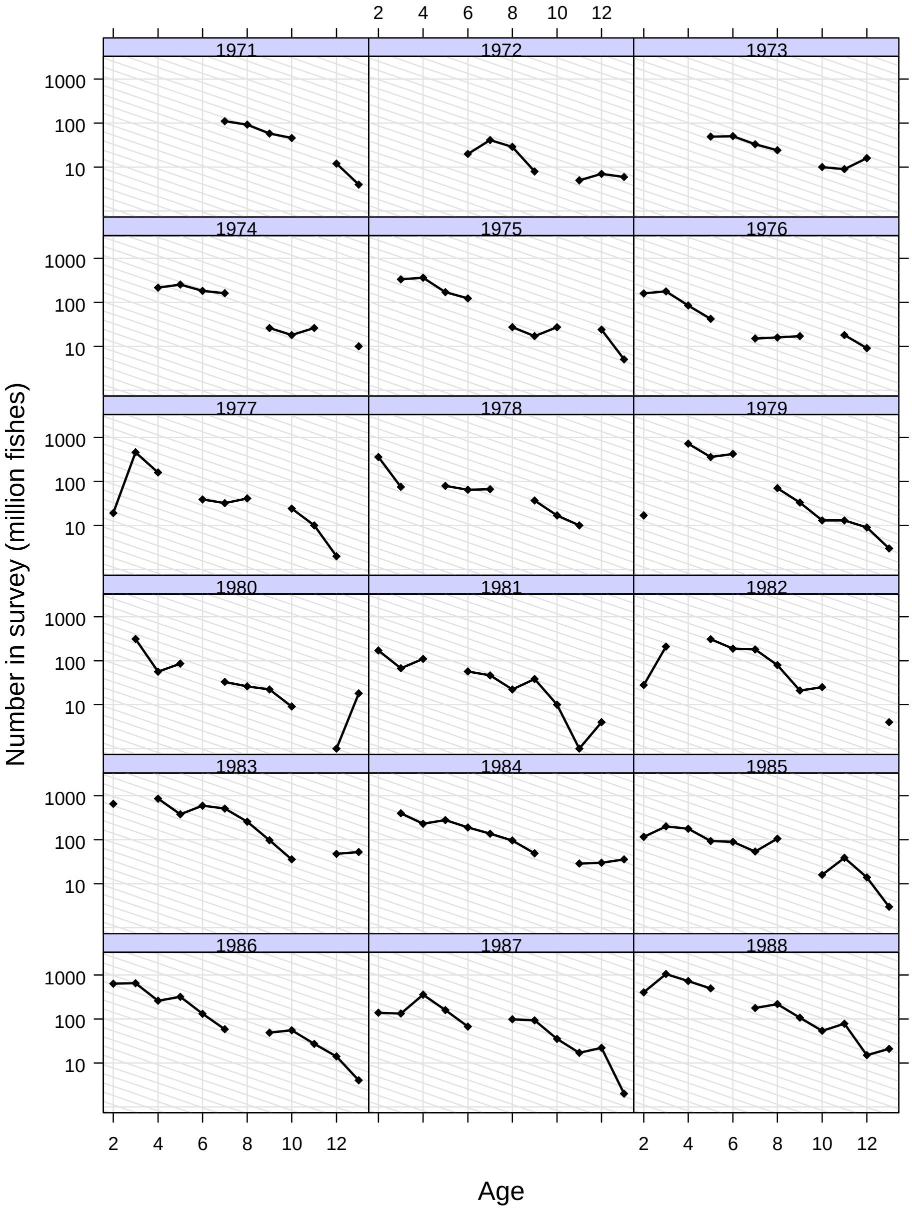


Figure 11.4.1.5. Icelandic summer spawning herring. Catch curves from survey data by year classes 1971-2002. Grey lines correspond to Z=0.4.

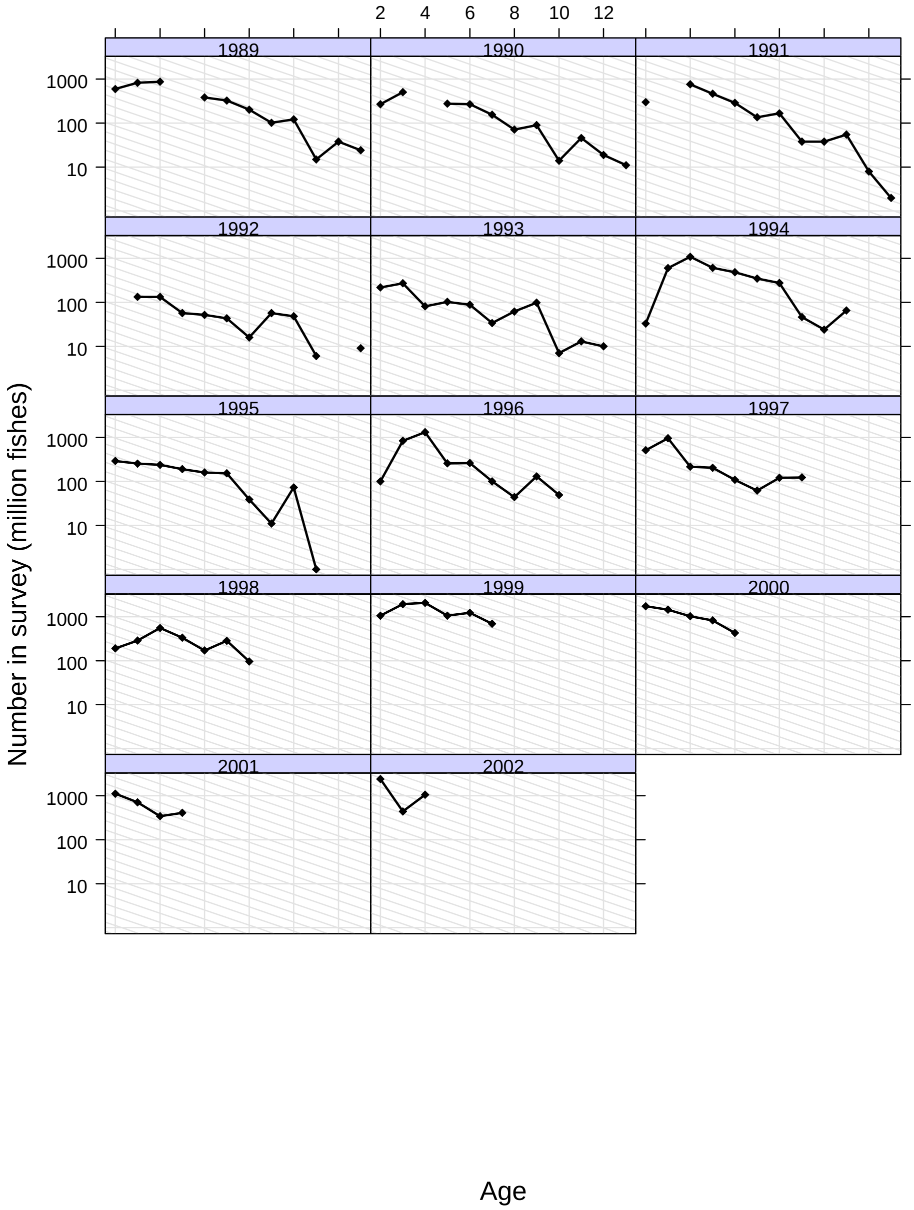


Figure 11.4.1.5, cont. Icelandic summer spawning herring. Catch curves from survey data by year classes 1971-2002. Grey lines correspond to Z=0.4.

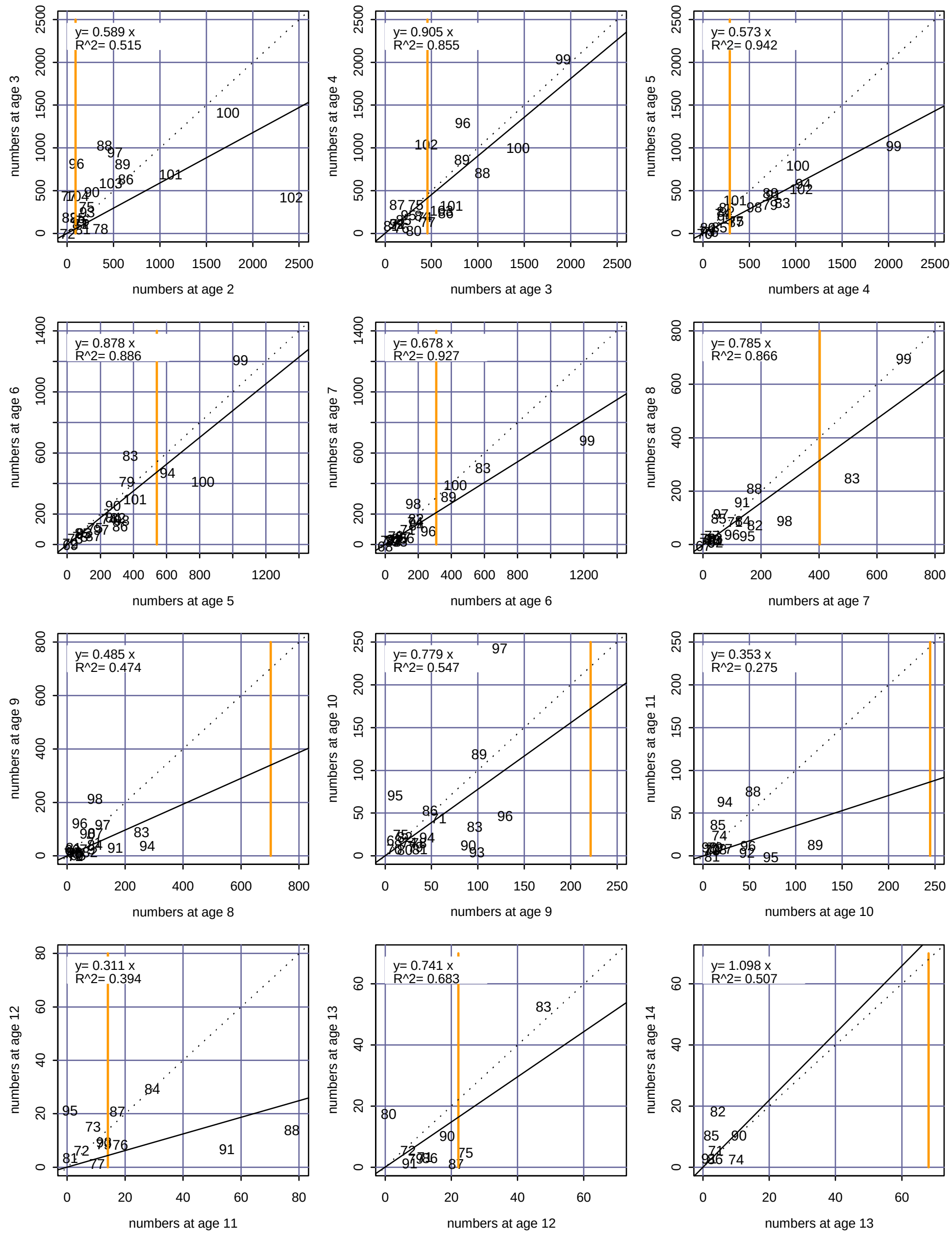


Figure 11.4.1.6. The relationship between acoustic survey indices for age groups 2 to 13 and the same year classes (indicate on graphs) a year later for Icelandic summer-spawning herring. The bolded vertical line represent the acoustic indices in December 2007.

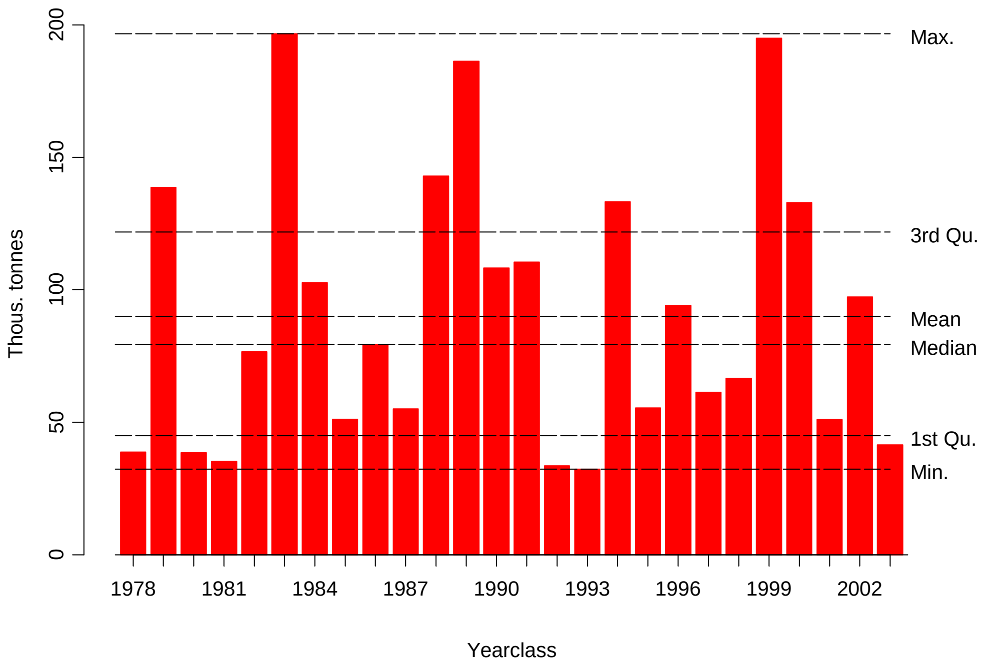


Figure 11.4.1.7. The sum of total catch of each year class of Icelandic summer-spawning herring during 1971 to 2007/08. The provided summary statistic is based on yearclasses upon the 1996 yearclass.

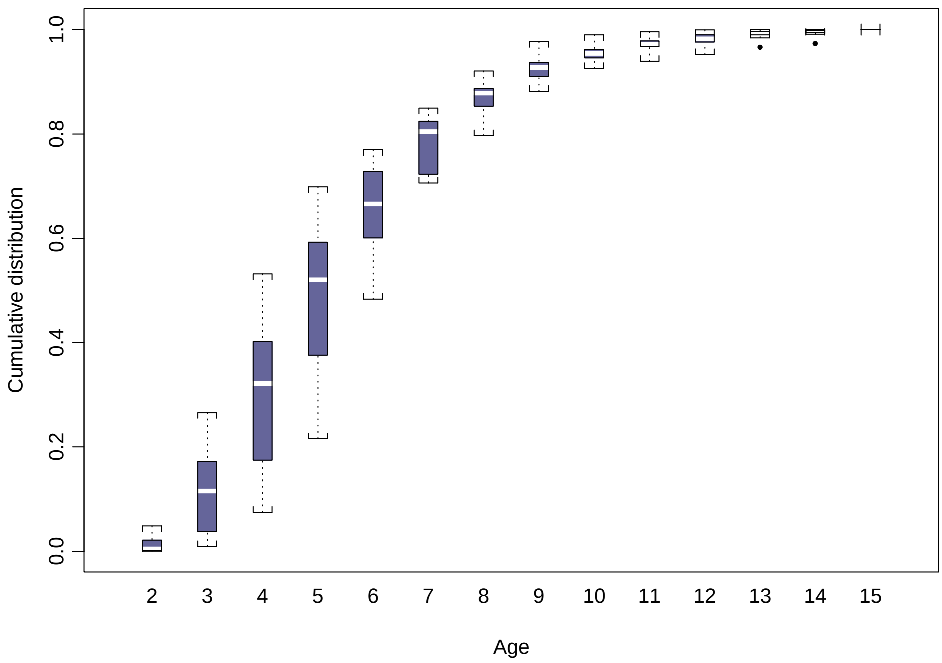


Figure 11.4.1.8. The cumulative total biomass in the catch (in proportion) of Icelandic summer-spawning herring for different age group for the year classes 1978 to 1996.

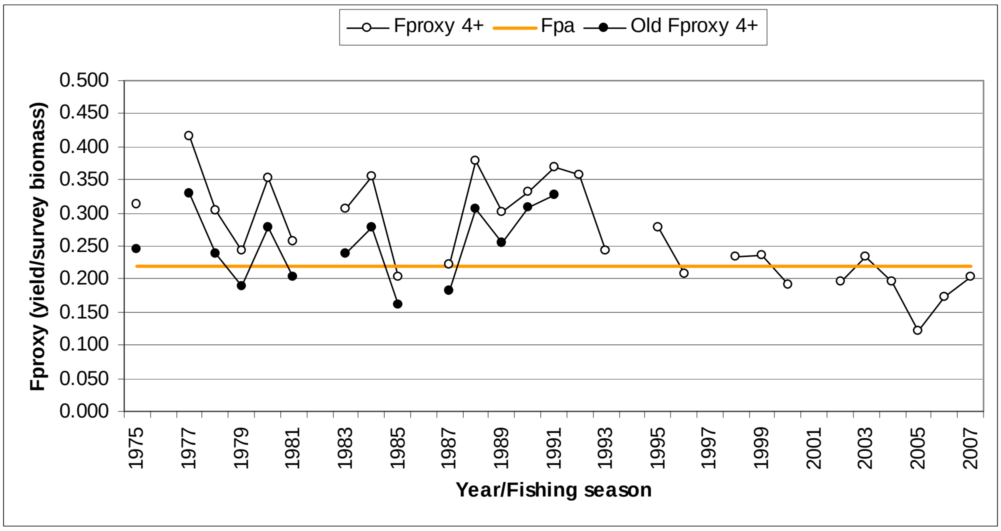


Figure 11.4.2.1. Icelandic summer-spawning herring. The variation in unconventional fishing mortality, i.e. F_{proxy} (yield/survey biomass; open dots), over the fishing seasons 1975-2007 (refers to the autumns). The F_{proxy} from "older" survey biomass estimations (prior to re-estimation in 1992) are also shown (Old Fproxy 4+; filled dots). Fpa at 0.22 is shown with bold horizontal line.

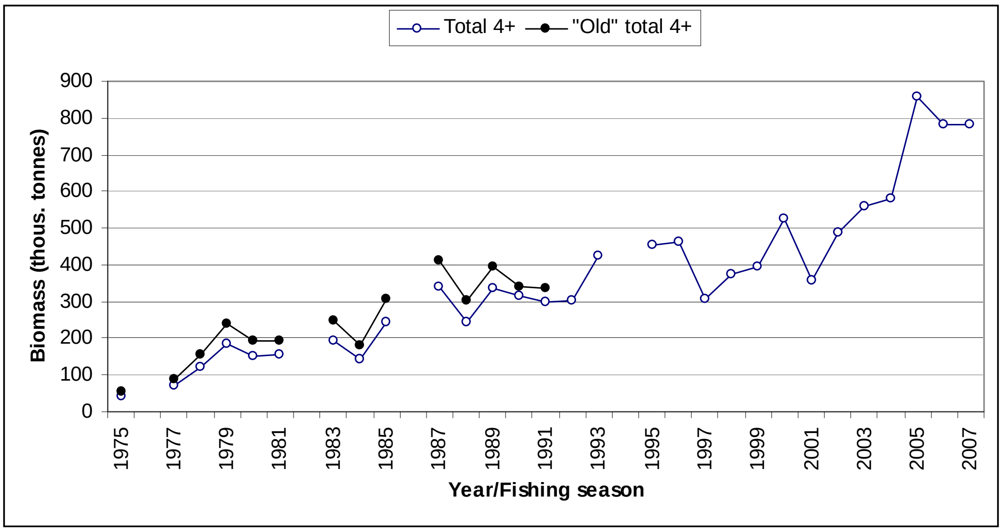


Figure 11.4.2.2. Icelandic summer-spawning herring. Total biomass for 4 years and older herring in the acoustic surveys with old and new TS values.

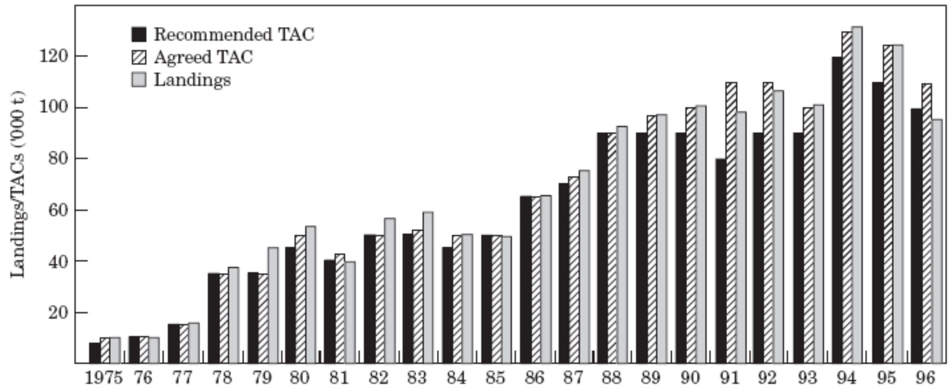


Figure 11.4.2.3. Comparison of landings, recommended- and agreed total allowable catch (TAC) of Icelandic summer-spawning herring during 1975-1996 (derived from Jakobsson and Stefánsson 1999).

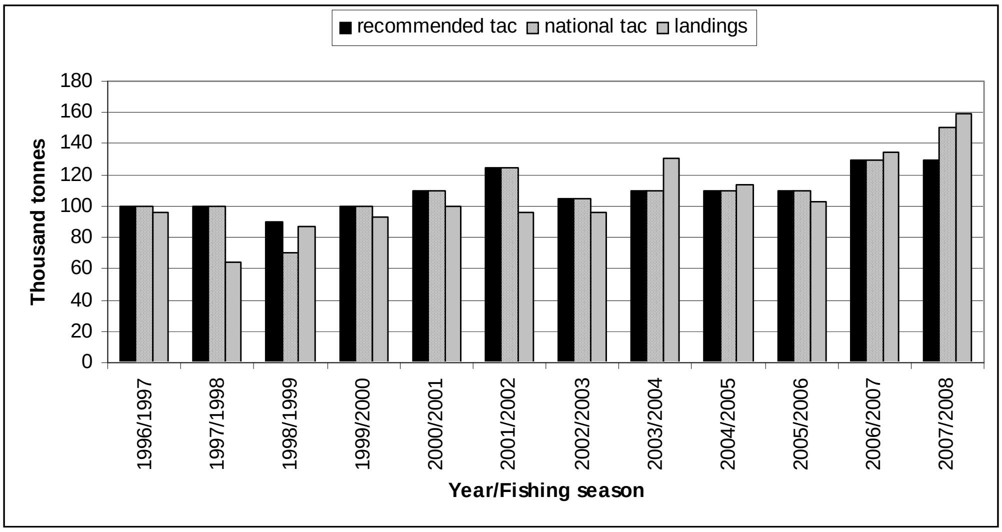


Figure 11.4.2.4. Comparison of landings, recommended- and agreed total allowable catch (TAC) of Icelandic summer-spawning herring during the fishing seasons 1996/97 to 2007/08.

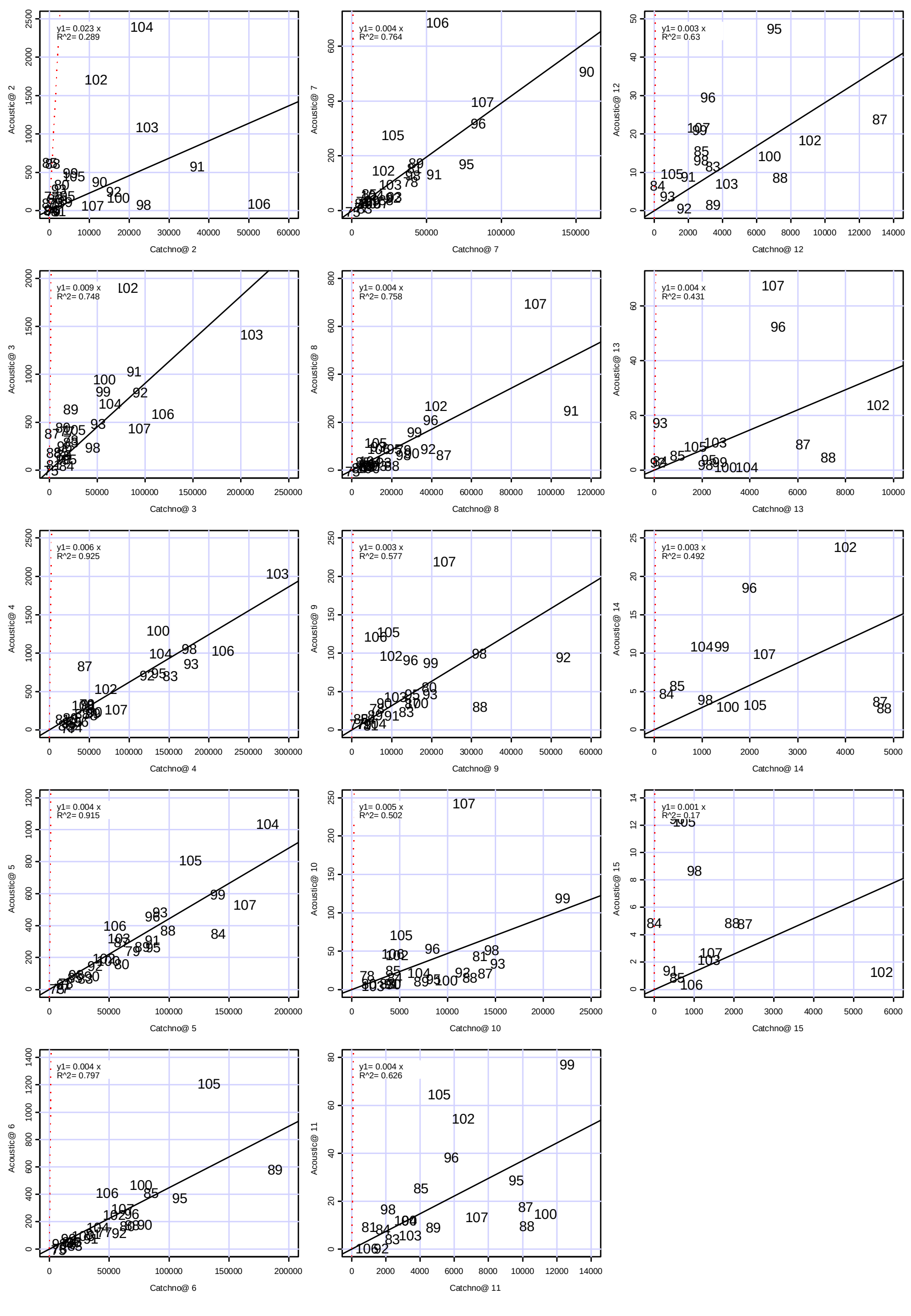


Figure 11.4.2.5. The relationships between number at age in the acoustic survey and number at age in the catch for age groups 2 to 15 years of Icelandic summer-spawning herring over the years 1975-2007.

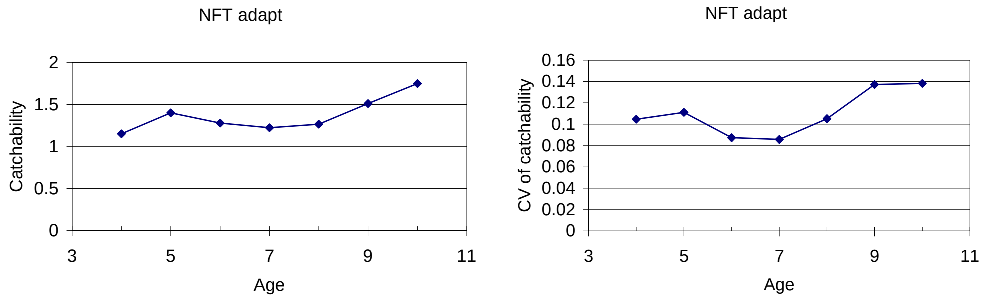


Figure 11.4.3.1. Icelandic summer-spawning herring. The catchablity and its CV for the acoustic surveys used in the Adapt run in 2008.

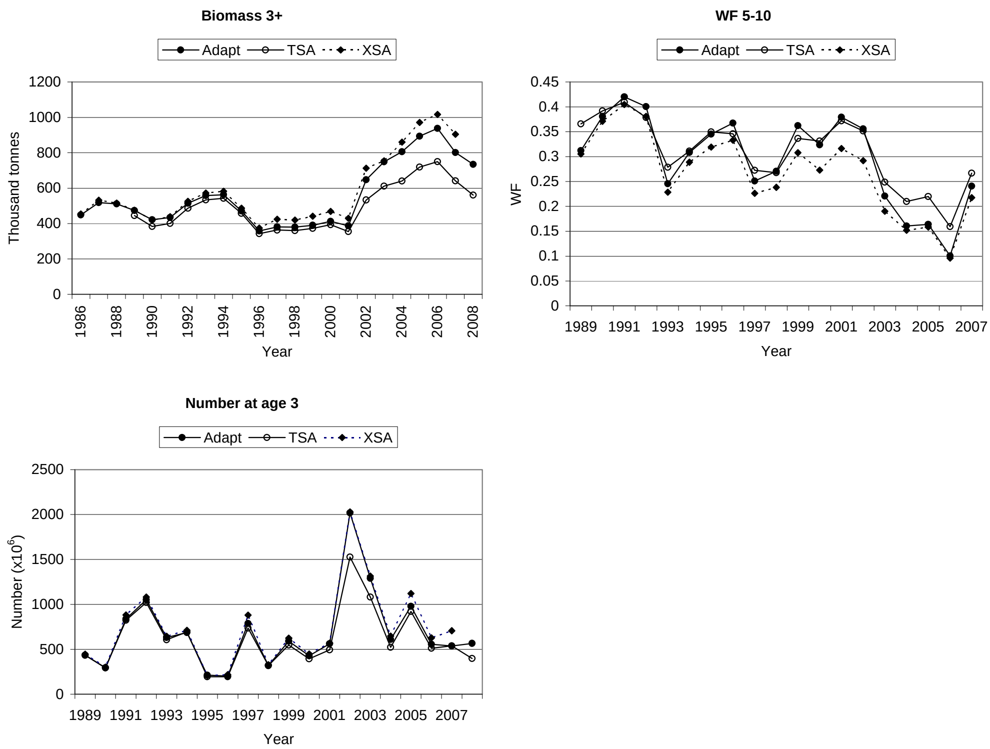


Figure 11.4.3.2. Icelandic summer-spawning herring. Comparisons of NFT-Adapt, TSA and XSA runs in 2008.

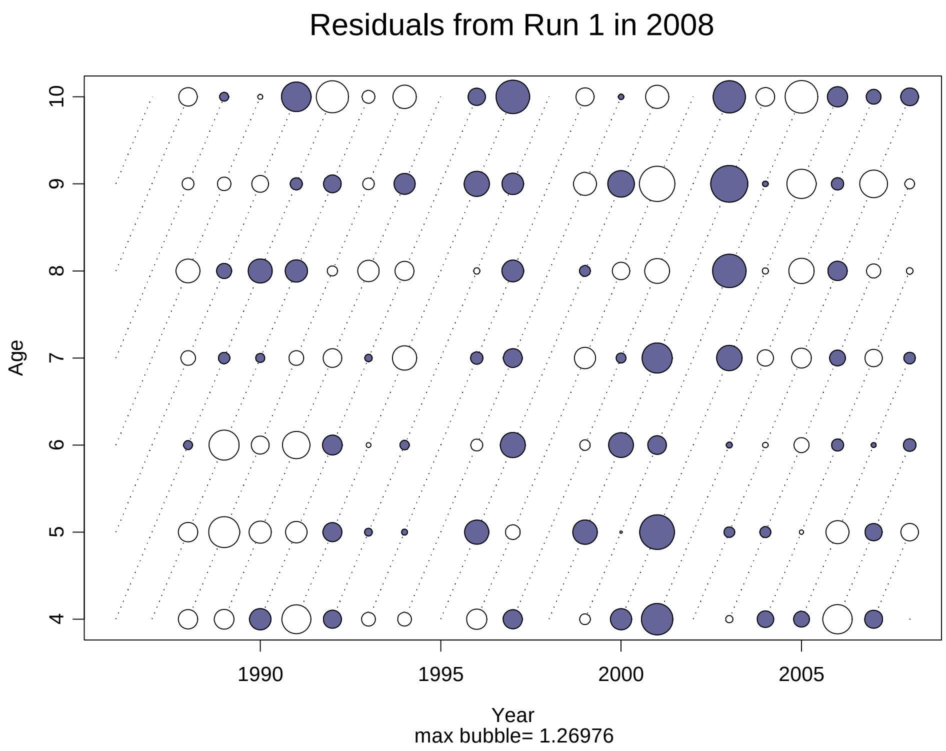


Figure 11.4.3.3. Icelandic summer spawning herring. Residuals of NFT-Adapt run in 2008 from survey observations. Filled bubbles are positive and open negative. Max bubble = 1.27

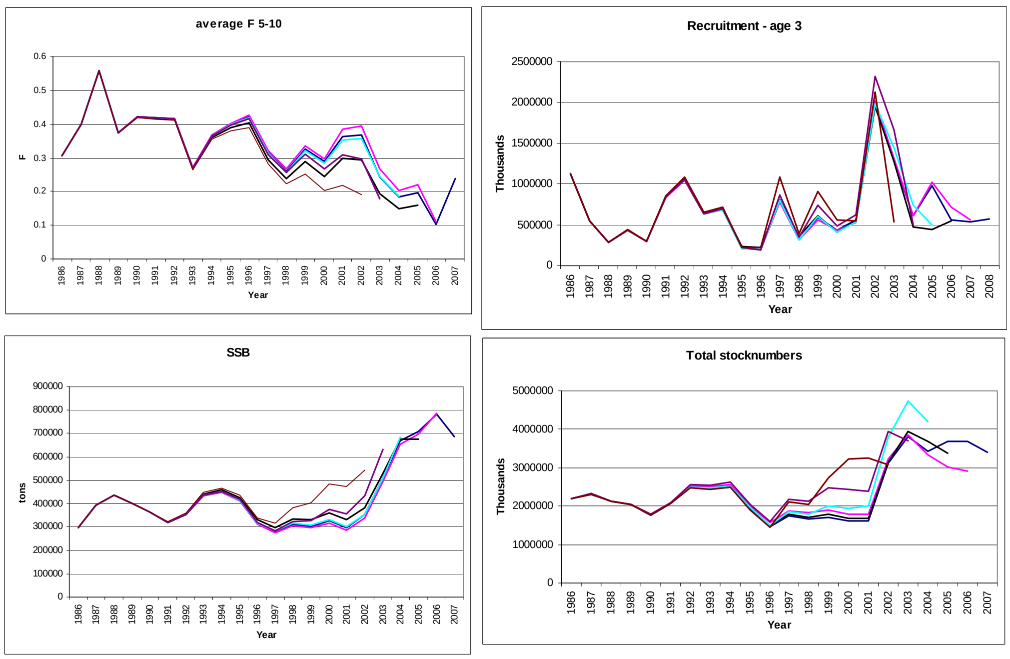


Figure 11.4.3.4. Icelandic summer spawning herring. Retrospective pattern in N weighted F, spawning stock biomass and recruitment from NFT-Adapt in 2008.

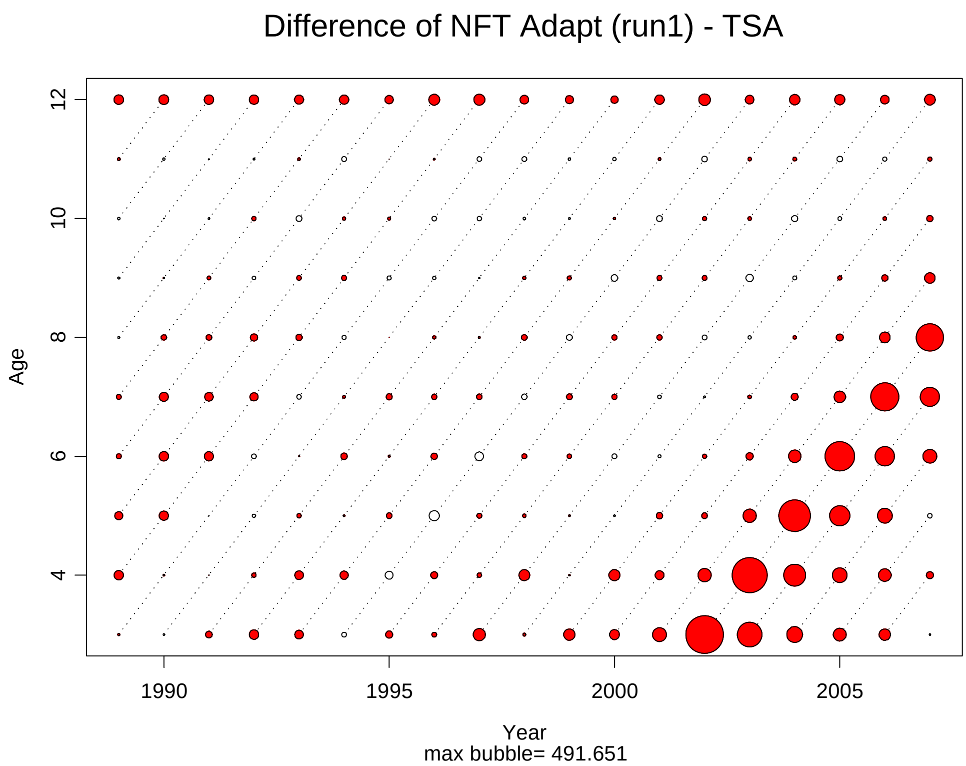


Figure 11.4.3.5. The difference in number at age of Icelandic summer-spawning herring between estimations from NFT adapt and TSA, where positive residuals (filled dots) represent higher NFT-adapt estimates.

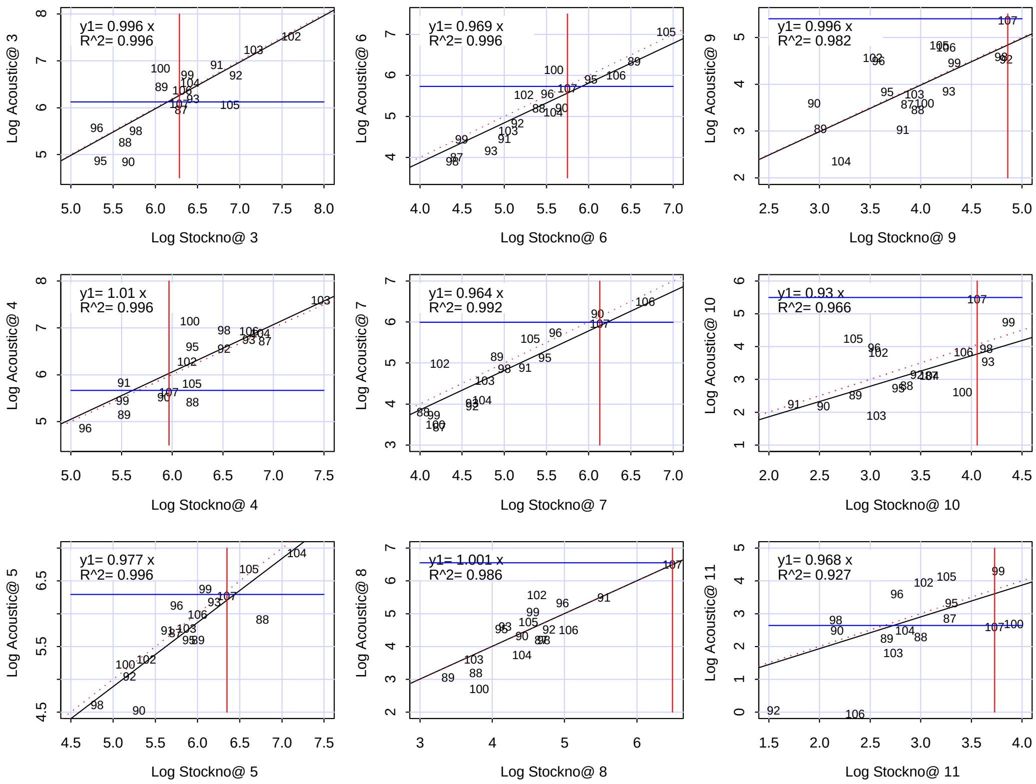


Figure 11.4.4.1. Icelandic summer spawning herring. The relationship between number at age (ln-transformed) from NFT-Adapt in 2008 and the acoustic surveys. The years are indicated on the graphs and the horizontal and the vertical lines cross in the most recent year (2007).

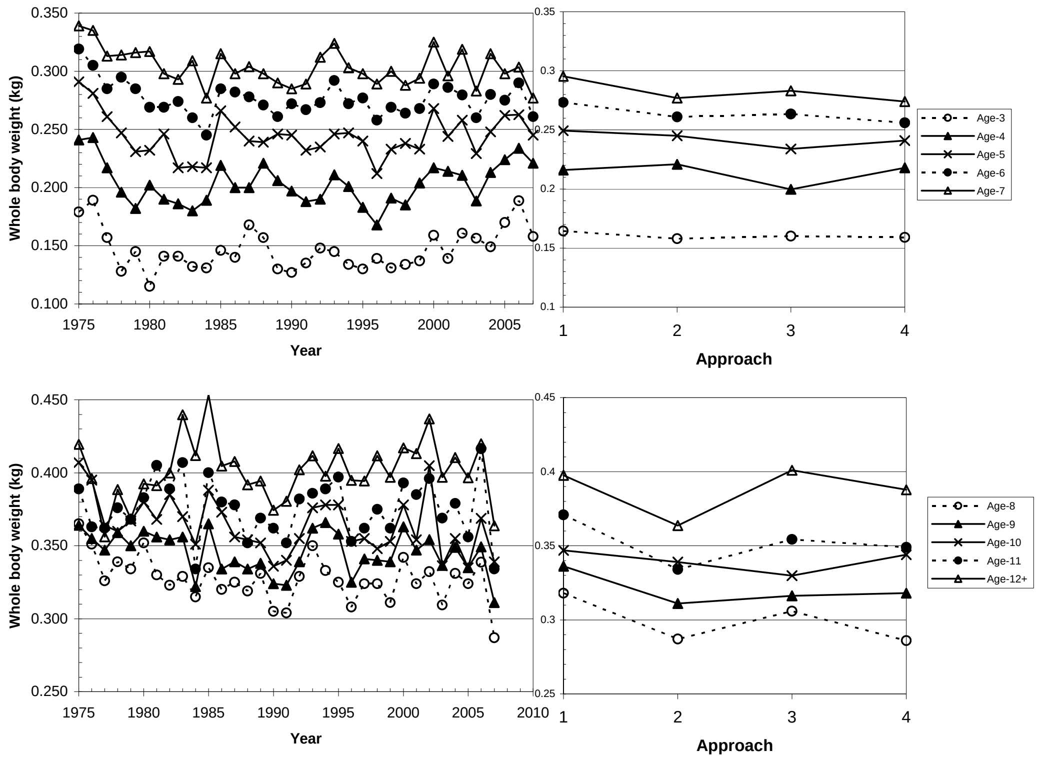
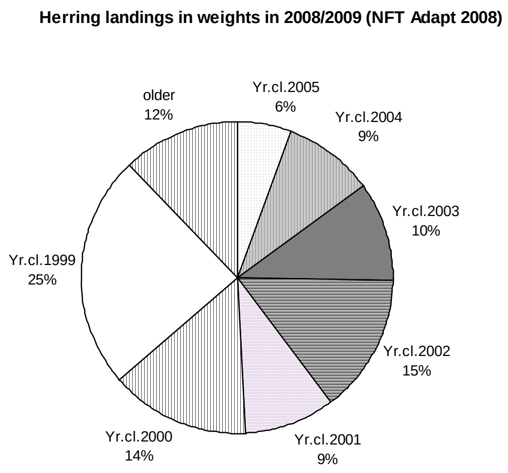


Figure 11.7.1.1. Mean weight at age estimates over 1975 through 2007 from the catch at age estimations of Icelandic summer-spawning herring (to left) and the mean weights at age for four different approaches (to right), where the weights represent: (1) last 5 years average; (2) last years weights, i.e. 2007; (3) last 5 years average off the west coast; (5) last years weights off the west coast.

(a)



(b)

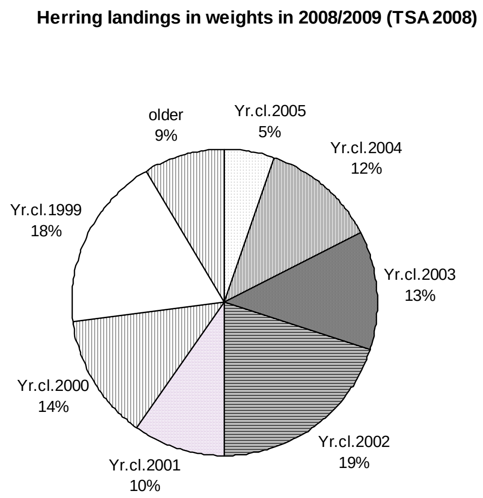


Figure 11.7.2.1. The expected catch composition (biomass in %) of different year classes of Icelandic summer spawning herring in the fishing season 2008/09 as estimated from (a) NFT adapt and (b) TSA.

12 Capelin in the Iceland-East Greenland-Jan Mayen area

Summary

Last year (2007) the starting quota was 205 000 t.

The fishery started in January 2008, but was closed 20-27 February, when it was reopened.

The stock has been at low levels the last 3 year.

Only very low abundance of 1 year old capelin was measured in November 2007.

The advice is therefore not to open the fishery in the season 2008/09 until acoustic assessment surveys have verified that a catch can be allowed with the usual prerequisite of a remaining spawning stock of 400 000 t after taking account of natural mortality.

12.1 Stock description and management units

The capelin is a small pelagic shooling fish. It is considered to be a cold water species that occurs widely in the northern hemisphere. The capelin in the Iceland-East Greenland-Jan Mayen area is considered to be a separate stock. The spawning grounds are in shallow waters (10-150 m) off the south and west coast of Iceland. Spawning peaks in March. Capelin spawn at the age 3-4 years and the males and most of the females die after spawning. Capelin is a migratory fish. Distribution and migrations of capelin before 2001 are shown in figure 7.3.4. The migration pattern and the distribution are of juvenile capelin is considered to have changed in 2002, figure 7.3.5. Capelin is a very important forage species for several commercial fish species amidst the Icelandic cod.

The fishing is shared between Iceland, Norway, Faroe Islands and Greenland by a special agreement, but by far the largest quantities are fished by Iceland.

12.2 Scientific data

Surveys

Several surveys aimed at different age groups of capelin have been conducted through the years. The purpose of the surveys on young capelin is to locate and estimate the abundance of young capelin. The results from these surveys are used to predict a starting quota for the fishing season starting in the year after the surveys are conducted. The surveys aimed at the fishable part of the stock are conducted in the fishing season, either in autumn or in winter. The purpose of these surveys is to measure the size of the stock and on its basis to set a final TAC for the season.

0-group and 1-group surveys in August

The distribution and abundance of 0-group capelin in the Iceland-East Greenland-Jan Mayen area has not been recorded in August since 2003 as the survey was dismissed in 2004. The abundance indices for the 0-group in the years 1970-2003 are given in Table 12.2.1. Age 1 capelin was recorded during these 0-group surveys in the years 1983-2001. The estimated numbers, mean length and weight of age 1 capelin are given in Table 12.2.2. The results from these surveys did not prove to be useful for predicting starting quota.

Surveys on immature 1 and 2 capelin in autumn

The surveys, aimed at young capelin in October or November, have been the basis for the starting quota in many years. But in the years 2001 to 2005 these surveys failed to locate the juveniles and therefore a starting quota could not be set on the basis of their results.

In November 2006 survey recorded immature capelin, mostly in the Denmark Strait and north of the Vestfirdir peninsula but also in more scattered condition off the Icelandic north coast. The total estimate came to about 45 billion age 1 capelin, which is roughly half that indicating a good-to-large year class. The numbers of age 2 immature capelin were very low, which is in tune with the low contribution of age group to the spawning stock in the last few years. Although juvenile capelin were not registered in large numbers, their distribution pattern had become quite similar to that experienced before 2002.

In November 2007 the survey failed to locate the young capelin (Figure 12.2.1). Only very low abundance of 1 year old capelin was measured (< 5 billions) which corresponds to less than 100 000 t of biomass, so preliminary quota can not be set.

Oceanography/ecology survey in summer

In July 2006 a multidisciplinary project began (oceanography/ecology) covering the area from Ammassalik in the west to about 10°W east of Iceland as well as the Iceland Sea north to 71°N. One of the main purposes of this project is to study the distribution, behaviour and feeding habits of all age groups of capelin in spring and summer.

With regard to capelin, the survey in 2006 was not very successful since ice still covered large parts of the area next to Greenland, in places quite wide. Capelin were encountered in fairly wide parts of the survey area but their abundance was low.

In 2007 two year old capelin was found at fairly wide area at the continental slope at East Greenland but the abundance was very low.

Surveys on the adult fishable stock

The acoustic surveys on the maturing, fishable stock have been carried out in October-November and/or in January/February in the fishing season. In the last 8 years it has not succeeded to acoustically measure the fishable stock before new year and final catch quotas have therefore often been set late in the fishing season. This fishing season 2007/08 was no exception, a survey in November only measured very few adult capelin.

In January and in the first 2 weeks of February 4 attempts were made to acoustically measure the capelin stock. The predicted quota for the season was 308 000 t (starting quota 205 000 t), but the highest measurement from these 4 surveys was 280 000 t.

As a consequences of low abundance in all the surveys in January and until mid February, the Marine Research Institute (MRI) recommended to the Ministry of fishery on the 18 February to close all capelin fishery and the fishery was closed from 12:00 on February 20.

At 25-27 February a survey succeeded to measure the adult, fishable stock south off Iceland. A total of 470 000 t were measured in relatively small area 15-30 nautical miles east of Vestmannaeyjar. Therefore, the MRI recommended a reopening of the fishery on the 27 February. The next week, until 3 March research vessel measured capelin east of that area and additional 56 000 t were estimated in that area, whereof 50 000 t of mature capelin. In total 530 000 t were measured (Table 12.2.3, Figures 12.2.2 and 12.2.3). On the basis of these measurements a final TAC of 207 000 t could be set for this fishing season.

Although there were indications of capelin off the NW coast in the bottom trawl survey in March, acoustic surveys conducted in the area only located few thousand tonnes there. Therefore it was considered as no western migration took place during the fishing season 2007/08.

12.3 Information from the fishing industry

The fishery is based on maturing capelin, i.e. that part of each year class which spawns at age 3 as well as those fish at age 4, that did not mature and spawn at age 3.

The starting quota for the fishing season 2007/08 was 205 000 t. It was allocated to Iceland, Norway, Faroe Islands and Greenland by an existing agreement between the nations. The fishery started in the first week of January 2008 north east off Iceland, then following the migration of the capelin south off the east coast of Iceland (Figure 12.3.1). Usually the first spawning migration enter the warm Atlantic water off the southeast coast at the beginning of the second week of February, from there they then migrate fairly fast westward in near-shore areas. This was not the case this winter, the fishery still took place east off Iceland and the catch rates were low. At this time about 90 000 t had been caught. As a consequence of failing to a set a final TAC and it was so late in the fishing season the fishery was closed 20 February. It was reopened 27 February after a TAC could be set. Then the fishery took place south off Iceland and in Faxaflói. The fishery was over 15 March. The total catch during the 2008 winter season was 202 000 t (preliminary numbers) (Table 12.3.1 and Figure 12.3.2). A large proportion of the 2008 winter catch was processed for human consumption.

The total annual catch of capelin in the Iceland-East Greenland-Jan Mayen area since 1964 is given by weight, season, and fleet in Table 12.3.1.

No summer fishery took place in 2006 and 2007, but the total catches in numbers by age during the summer/autumn 1985–2005 are given in Table 12.3.2.

The catch in number by length groups at age for the winter season 2008 are given in Table 12.3.3. and the total catches in numbers by age during the winter seasons 1986–2008 are in Table 12.3.4.

Preliminary and recommended TAC as well as landings for the fishing seasons 1994/95 – 2007/08 are given in Table 12.3.5.

12.4 Methods

Stock projections

To calculate the stock numbers at age the 1-January one has to take into account both the results from the final acoustic survey and how much has been taken by the fishery. Let us assume that the final assessment survey was in winter and only winter fishery took place. The calculations are simple back-projections of stocknumbers. Let I_a=abundance at age a (a=2 and 3) in the survey and C_a=the total number caught at age a until the survey took place. We also assume that there is no survival of spawners, so we are practically calculating the number of mature capelin at age 2 and 3.

The stock number N_a at age a the 1-January is $N_a = I_a e^{iM} + C_a$, where i=the number of months between 1-January and the acoustic survey and M=0.035 (a monthly natural mortality).

We now have the number of mature capelin at age 2 and 3 each year. To get the number of immature capelin at age 2 the abundance of the 3 years old have to be back-projected one more year. By adding the number of the 2 years old immature ones to the measured 2 years old mature one (the right year class) one has the total number of 2 years old the corresponding year.

Further details can be found in Gudmundsdottir, A., and Vilhjálmsson, H. 2002.

Stock prognosis

The fishable stock consists of only two year classes, i.e. age classes 2 and 3 in autumn, spawning at age 3 and 4 at the end of the fishing season. Therefore one needs to know how many mature capelin will be at age 2 and 3 in autumn, to be able to predict a quota.

There exists a linear relationship between the abundance of 1 year old capelin in year y and the number of 2 years old mature capelin in year y+1. A similar relationship exists between the total number of 2 years old in year y and 3 years old mature ones in year y+1. Therefore one can for example predict the number of 2 and 3 years old in autumn 2008 if one has the abundance of 1 and 2 year old in autumn 2007.

There is taken account for some things in the stock prognosis, such as the mean weight being inversely related to the total adult stock in numbers, weight gain from autumn to winter and that 400 000 t that have to be left for spawning. Detailed description is given in Gudmundsdottir, A., and Vilhjálmsson, H. 2002.

12.5 Reference points

Reference points have not been defined for this stock. The proposal is to use B_{lim}=400 000 t, which is the targeted remaining spawning stock for capelin in the Iceland-East Greenland-Jan Mayen area since 1979.

The definition of other precautionary reference points is more problematic. Care has to be taken if the predicted fishable stock biomass is < 500 000 t, then the fishery should not be opened until after the within-season acoustic survey in autumn/winter and the starting quota should never exceed 1 million tonnes.

12.6 State of the stock

The state of the stock is very uncertain. The SSB is highly variable because it is dependent on only two age groups. It is estimated that 406 000 t were left for spawning in spring 2008 (Table 12.6.1). It is clear that the stock has been at low level the last 3 fishing seasons. Only very few 1 year old capelin were measured in autumn 2007 and immature 2 year old were not seen, both of which should be in the SSB in spring 2009.

The number of 4 years old capelin in the catches have been very low in the last 3 years and have been declining since the fishing season 1986/87. This seams to follow the year class size at age 3 in the stock, so it might indicate that the stock has been at low levels in the last 3 years.

The historical estimates of stock abundance are based on the "best" acoustic estimates of the abundance of maturing capelin in autumn and/or winter surveys, the "best" in each case being defined as that estimate on which the final decision of TAC was based. Taking account of the catch in number and a monthly natural mortality rate of M = 0.035 (ICES 1991/Assess:17), abundance estimates of each age group are then projected to the appropriate point in time. Since natural mortality rates of juvenile capelin are not known, their abundance by number has been projected using the same natural mortality rate.

The annual abundance by number and weight at age for mature and immature capelin in the Iceland-East Greenland-Jan Mayen area has been calculated with reference to 1 January of the following year for the 1978/79–2007/08 seasons. The results are shown in Table 12.6.1 and also the remaining spawning stock by number and biomass in March/April 1979–2008. An overview of stock developments during 1978–2008 is given in Table 12.6.2.

12.7 Short term forecast

To predict the abundance of the fishable stock in the 2008/09 season a knowledge of the amount of immature capelin at age 1 and 2 from the autumn 2007 are needed. As the measurement of 1 year old capelin is so low (corresponding to a SSB of less than 100 000 t) and there is no information about the size of immature capelin at age 2 then a starting quota can not be given for the fishing season 2008/09. There should be no fishery until new information on stock size becomes available and it shows a predicted SSB of at least 400 000 t in March 2009 in addition to a sizeable amount for fishing.

12.8 (Medium term forecasts)

12.9 Uncertainties in assessment and forecast

Usually the stock is acoustically measured in deep waters east off Iceland. This year the acoustic survey was conducted in shallow water south off Iceland. Comparisons between acoustic measurements in deep and shallow water do not exist. It is known that it is more difficult to separate bottom from the targeted species in shallow water when the shoal is dense.

12.10 Comparison with previous assessment and forecast

Last year the predicted quota was 308 000 t (for 1-November) meaning that the biomass should have been about 700 000 t 1-January 2008. This assessment gives a biomass of about 620 000 t and the final TAC was only 207 000 t.

12.11 Management plans and evaluations

The fishery is managed according to a two-step management plan which requires a minimum spawning-stock biomass of 400 000 t by the end of the fishing season. The first step in this plan is to set a preliminary TAC based on the results of an acoustic survey carried out to evaluate the immature (age 1 and most of age 2) part of the capelin stock about a year before it enters the fishable stock. The initial quota is set at 2/3 of the preliminary TAC, calculated on the condition that 400 000 t of the SSB should be left for spawning. The second step is based on the results of another survey conducted during the fishing season for the same year classes. This result is used to revise the TAC, still based on the condition that 400 000 t should be left for spawning.

ICES has not evaluated the management plan with respect to its conformity to the precautionary approach.

12.12 Management considerations

In recent years, the fishery has changed from being mostly an industrial fishery to being mostly for human consumption.

12.13 Ecosystem considerations

Capelin is an important forage fish and declines in stock may be expected to have implications for the productivity of their predators, see further in section 7.3.

12.14 Regulations and their effects

Over the years the fishery has been closed during April - late June and the season has started in July/August or later, depending on the state of the stock. Due to very low stock abundance there was a fishing ban lasting from December 1981 to November 1983. There was also a ban on capelin fishing during the summer/autumn seasons in 2005, 2006 and 2007 due to lack of information on the state of the stock. In addition, areas with high abundances of juvenile age 1 and 2 capelin (on the shelf region off NW-, N- and NE-Iceland) have usually been closed to the summer and autumn fishery.

Discards are allowed when catches are beyond the carrying capacity of the vessel. Methods of transferring catches from the purse seine of one vessel to another vessel were invented long ago, and since skippers of purse-seine vessels prefer to operate in groups, discards are practically zero. In the pelagic trawl fishery, such large catches of capelin rarely occur. A regulation calling for immediate, temporary area closures when high abundance of juveniles are measured in the catch (more than 20% of the catch composed of fish less than 13 cm) is enforced, using on-board observers.

12.15 Changes in fishing technology and fishing patterns

Until 1975 only winter fishery took place (January-March), even only in February-March the first 8 years. Summer fishery began in 1976 in deep water north of Iceland. The fishery then soon became multinational. When the fishery started in mid 1960 it was exclusively purse seine fishery, but in mid 1990s the pelagic trawl was introduced to the capelin fishery. Variable amount of the catches have been taken with pelagic trawl through the fishing seasons. Only small part was taken with the pelagic trawl in the fishing season 2007/08. Since 2005 only winter fishery has taken place.

12.16 Changes in the environment

Icelandic waters are characterized by highly variable hydrographical conditions, with temperatures and salinities depending on the strength of Atlantic inflow through the Denmark strait and the variable flow of polar water from the north. Since 1996 the quarterly monitoring of environmental conditions of Icelandic waters shows a rise in sea temperatures north and east of Iceland, which probably also reaches farther north and northwest. The temperature increase is so great that it may have led to displacements of the juvenile part of the capelin stock. More detailed description is in section 7.3.

References

Gudmundsdottir, A., and Vilhjálmsson, H. 2002. Predicting total allowable catches for Icelandic capelin, 1978–2001. – ICES Journal of Marine Science, 59: 1105–1115.

Table 12.2.1 Abundance indices of 0-group capelin 1970-2003 and their division by areas. No surveys after 2003.

Year	NW-Irminger Sea	West Iceland	North Iceland	East Iceland	Total
1970	1	8	2	-	11
1971	+	7	12	+	19
1972	+	30	52	7	89
1973	14	39	46	17	116
1974	26	44	57	7	134
1975	3	37	46	3	89
1976	2	5	10	15	32
1977	2	19	19	3	43
1978	+	2	29	+	31
1979	4	19	25	1	49
1980	3	18	19	+	40
1981	10	13	6	-	29
1982	+	8	5	+	13
1983	+	3	18	1	22
1984	+	2	17	9	28
1985	1	8	19	3	31
1986	+	16	17	4	37
1987	1	6	6	1	14
1988	3	22	26	1	52
1989	1	13	24	2	40
1990	+	7	12	2	21
1991	8	2	43	1	54
1992	3	11	20	+	34
1993	2	21	13	15	51
1994	3	12	69	10	94
1995	+	6	10	8	24
1996	2	17	57	6	82
1997	5	14	30	12	61
1998	+	7	34	5	46
1999	NA	25	51	7	83
2000	NA	1	7	4	12
2001	NA	25	53	4	82
2002	NA	17	8	1	26
2003*	+	+	4	+	5

*** No surveys after 2003**

Table 12.2.2 Estimated numbers, mean length and weight of age 1 capelin in the August surveys for 1983–2001.

Year	Number (10^9)	Mean length (cm)	Mean weight (g)
1983	155	10.4	4.2
1984	286	9.7	3.6
1985	31	10.2	3.8
1986	71	9.5	3.3
1987	101	9.1	3
1988	147	8.8	2.6
1989	111	10.1	3.4
1990	36	10.4	4
1991	50	10.7	5.1
1992	87	9.7	3.4
1993	33	9.4	3
1994	85	9	2.8
1995	189	9.8	3.4
1996	138	9.3	2.9
1997	143	9.3	2.8
1998	87	9	2.9
1999	55	9.5	3.2
2000	94	9.5	3.1
2001	99	10	3.7

*** No surveys after 2001**

Table 12.2.3 Assessment of adult capelin in the Iceland/Greenland/Jan Mayen area, 25/02-2/03 2008. (Numbers in billions, biomass in thousand tonnes)

Length (cm)	average weight (g)	age 2	age 3	age 4	Numbers	Biomass
13	9.6	0.062	0.116	0.000	0.179	1.716
13.5	10.6	0.187	0.291	0.000	0.478	5.067
14	12.2	0.125	0.815	0.000	0.939	11.442
14.5	13.8	0.249	3.666	0.000	3.916	53.995
15	15.7	0.147	5.237	0.116	5.501	86.311
15.5	17.7	0.105	6.750	0.000	6.855	121.200
16	20.6	0.062	5.354	0.058	5.474	112.660
16.5	22.2	0.000	3.142	0.233	3.375	74.861
17	24.6	0.000	1.571	0.175	1.746	42.998
17.5	27.3	0.000	0.582	0.000	0.582	15.904
18	30.9	0.000	0.058	0.000	0.058	1.798
18.5	37.0	0.000	0.058	0.002	0.060	2.229
Total numbers		0.938	27.641	0.584	29.163	530.180
Total biomass ('000 t)		12.989	504.630	12.562		
Average weight (g)		13.8	18.3	21.5		
Average length (cm)		12.0	13.9	14.6		
Percentage by number		3.2	94.8	2.0		

Table 12.3.1 The international capelin catch 1964–2008 (thousand tonnes).

	Winter season					Summer and autumn season						
Year		Nor-		Green-	Season		Nor-		Green-		Season	Total
1964	8.6	-	-		8.6	-	-	-		-	-	8.6
1965	49.7	-	-		49.7	-	-	-		-	-	49.7
1966	124.5	-	-		124.5	-	-	-		-	-	124.5
1967	97.2	-	-		97.2	-	-	-		-	-	97.2
1968	78.1	-	-		78.1	-	-	-		-	-	78.1
1969	170.6	-	-		170.6	-	-	-		-	-	170.6
1970	190.8	-	-		190.8	-	-	-		-	-	190.8
1971	182.9	-	-		182.9	-	-	-		-	-	182.9
1972	276.5	-	-		276.5		-	-		-	-	276.5
1973	440.9	-	-		440.9	-	-	-		-	-	440.9
1974	461.9	-	-		461.9	-	-	-		-	-	461.9
1975	457.1	-	-		457.1	3.1	-	-		-	3.1	460.2
1976	338.7	-	-		338.7	114.4	-	-		-	114.4	453.1
1977	549.2	-	24.3		573.5	259.7	-	-		-	259.7	833.2
1978	468.4	-	36.2		504.6	497.5	154.1	3.4		-	655.0	1,159.6
1979	521.7	-	18.2		539.9	442.0	124.0	22.0		-	588.0	1,127.9
1980	392.1	-	-		392.1	367.4	118.7	24.2		17.3	527.6	919.7
1981	156.0	-	-		156.0	484.6	91.4	16.2		20.8	613.0	769.0
1982	13.2	-	-		13.2	-	-	-		-	-	13.2
1983	-	-	-		-	133.4	-	-		-	133.4	133.4
1984	439.6	-	-		439.6	425.2	104.6	10.2		8.5	548.5	988.1
1985	348.5	-	-		348.5	644.8	193.0	65.9		16.0	919.7	1,268.2
1986	341.8	50.0	-		391.8	552.5	149.7	65.4		5.3	772.9	1,164.7
1987	500.6	59.9	-		560.5	311.3	82.1	65.2		-	458.6	1,019.1
1988	600.6	56.6	-		657.2	311.4	11.5	48.5		-	371.4	1,028.6
1989	609.1	56.0	-		665.1	53.9	52.7	14.4		-	121.0	786,1
1990	612.0	62.5	12.3		686,8	83.7	21.9	5.6		-	111.2	798.0
1991	202.4	-	-		202.4	56.0	-	-		-	56.0	258.4
1992	573.5	47.6	-		621.1	213.4	65.3	18.9	0.5	-	298.1	919.2
1993	489.1	-	-	0.5	489.6	450.0	127.5	23.9	10.2	-	611.6	1,101.2
1994	550.3	15.0	-	1.8	567.1	210.7	99.0	12.3	2.1	-	324.1	891.2
1995	539.4	-	-	0.4	539.8	175.5	28.0	-	2.2	-	205.7	745.5
1996	707.9	-	10.0	5.7	723.6	474.3	206.0	17.6	15.0	60.9	773.8	1,497.4
1997	774.9	-	16.1	6.1	797.1	536.0	153.6	20.5	6.5	47.1	763.6	1,561.5
1998	457.0	-	14.7	9.6	481.3	290.8	72.9	26.9	8.0	41.9	440.5	921.8
1999	607.8	14.8	13.8	22.5	658.9	83.0	11.4	6.0	2.0	-	102.4	761.3
2000	761.4	14.9	32.0	22.0	830.3	126.5	80.1	30.0	7.5	21.0	265.1	1,095.4
2001	767.2	-	10.0	29.0	806.2	150.0	106.0	12.0	9.0	17.0	294.0	1,061.2
2002	901.0	-	28.0	26.0	955.0	180.0	118.7	-	13.0	28.0	339.7	1,294.7
2003	585.0	-	40.0	23.0	648.0	96.5	78.0	3.5	2.5	18.0	198.5	846.5
2004	478.8	15.8	30.8	17.5	542.9	46.0	34.0	-	12.0		92.0	634.9
2005	594.1	69.0	19.0	10.0	692.0	9.0	-	-	-	-	9.0	701.1
2006	193.0	8.0	30.0	7.0	238.0	-	-	-	-		-	238.0
2007	307.0	38.0	19.0	12.8	376.8	-	-	-	-	-	-	376.8
2008*	148.8	37.6	9.9	6.1	202.4							

*** preliminary**

Table 12.3.2 The total international catch of capelin in the Iceland-East Greenland-Jan Mayen area by age group in numbers (billions) and the total catch by numbers and weight (thousand tonnes) in the autumn season (August-December) 1985–2005.

Year	age 1	age 2	age 3	age 4	Total number	Total weight
1985	0.8	25.6	15.4	0.2	42	919.7
1986	+	10	23.3	0.5	33.8	772.9
1987	+	27.7	6.7	+	34.4	458.6
1988	0.3	13.6	5.4	+	19.3	371.4
1989	1.7	6	1.5	+	9.2	121
1990	0.8	5.9	1	+	7.7	111.2
1991	0.3	2.7	0.4	+	3.4	56
1992	1.7	14	2.1	+	17.8	298.1
1993	0.2	24.9	5.4	0.2	30.7	611.6
1994	0.6	15	2.8	+	18.4	324.1
1995	1.5	9.7	1.1	+	12.3	205.7
1996	0.2	25.2	12.7	0.2	38.4	773.7
1997	1.8	33.4	10.2	0.4	45.8	763.6
1998	0.9	25.1	2.9	+	28.9	440.5
1999	0.3	4.7	0.7	+	5.7	102.4
2000	0.2	12.9	3.3	0.1	16.5	265.1
2001	+	17.6	1.2	+	18.8	294
2002	+	18.3	2.5	+	20.8	339.7
2003	0.3	11.8	1	+	14.3	199.5
2004	+	5.3	0.5	-	5.8	92
2005*	-	0.4	+	-	0.4	9

*** No catch in summer 2006 and 2007.**

Table 12.3.3 The total international catch in numbers (billions) of capelin in the Iceland-East Greenland-Jan Mayen area in the winter season of 2008 by age and length, and the catch in weight (thousand tonnes) by age group.

Total length (cm)	Age 2	Age 3	Age 4	Total	Percentage
11	0.004	0.000	0.000	0.004	0.0
11.5	0.007	0.000	0.000	0.007	0.1
12	0.018	0.011	0.000	0.029	0.2
12.5	0.021	0.022	0.000	0.043	0.4
13	0.081	0.085	0.000	0.165	1.4
13.5	0.100	0.308	0.000	0.407	3.5
14	0.074	0.683	0.004	0.761	6.6
14.5	0.097	1.516	0.000	1.614	14.0
15	0.038	2.072	0.049	2.158	18.7
15.5	0.054	2.441	0.075	2.571	22.3
16	0.007	1.860	0.069	1.935	16.8
16.5	0.000	1.075	0.108	1.183	10.2
17	0.000	0.440	0.043	0.482	4.2
17.5	0.000	0.111	0.049	0.160	1.4
18	0.000	0.015	0.000	0.015	0.1
18.5	0.000	0.007	0.000	0.007	0.1
Total number	0.500	10.644	0.396	11.540	100.0
Percentage	4.3	92.2	3.4	100.0	
Total weight	6.1	187.8	8.5	202.4	

Table 12.3.4 The total international catch of capelin in the Iceland-East Greenland-Jan Mayen area by age group in numbers (billions) and the total catch by numbers and weight (thousand tonnes) in the winter season (January-March) 1986–2008.

Year	age 2	age 3	age 4	age 5	Total number	Total weight
1986	0.1	9.8	6.9	0.2	17	391.8
1987	+	6.9	15.5	-	22.4	560.5
1988	+	23.4	7.2	0.3	30.9	657.2
1989	0.1	22.9	7.8	+	30.8	665.1
1990	1.4	24.8	9.6	0.1	35.9	686.8
1991	0.5	7.4	1.5	+	9.4	202.4
1992	2.7	29.4	2.8	+	34.9	621.1
1993	0.2	20.1	2.5	+	22.8	489.6
1994	0.6	22.7	3.9	+	27.2	567.1
1995	1.3	17.6	5.9	+	24.8	539.8
1996	0.6	27.4	7.7	+	35.7	723.6
1997	0.9	29.1	11	+	41	797.6
1998	0.3	20.4	5.4	+	26.1	481.3
1999	0.5	31.2	7.5	+	39.2	658.9
2000	0.3	36.3	5.4	+	42	830.3
2001	0.4	27.9	6.7	+	35	787.2
2002	0.1	33.1	4.2	+	37.4	955.0
2003	0.1	32.2	1.9	+	34.4	648.0
2004	0.6	24.6	3	+	28.3	542.9
2005	0.1	31.5	3.1	-	34.7	692.0
2006	0.1	10.4	0.3	-	10.8	230.0
2007	0.3	19.5	0.5	-	20.3	376.8
2008	0.5	10.6	0.4	-	11.5	202.4

Table 12.3.5 Preliminary TACs for the summer/autumn fishery, recommended TACs for the entire season and landings (000 tonnes) in the 1994/95–2007/08 seasons.

Season	Preliminary TAC	Recommended TAC	Landings
1994/95	950	850	842
1995/96	800	1390	930
1996/97	1100	1600	1571
1997/98	850	1265	1245
1998/99	950	1200	1100
1999/00	866	1000	934
2000/01	975	1090	1065
2001/02	1050	1325	1249
2002/03	1040	1000	988
2003/04	835	875	741
2004/05	335	987	783
2005/06	235	235	238
2006/07	180	385	377
2007/08*	205	207	202

*** landings preliminary**

Table 12.6.1 The estimated number (billions) of capelin on 1 January 1979–2008 by age and maturity groups. The total number (billions) and weight (thousand tonnes) of the immature and maturing (fishable) stock components and the remaining spawning stock by number and weight are also given.

	age 2	age 3	age 3	age 4	age 5	Number		weight		Number	Weight
YEAR	JUVEN-ILE	IMMAT	MATURE	MATURE	MATURE	IMMAT.	MATURE	IMMAT.	MATURE	SPAWN. STOCK	SPAWN. STOCK
1979	137.6	12.8	51.8	14.8	0.3	150.4	66.9	1028	1358	29	600
1980	50.6	13.8	53.4	3.6	0.2	64.4	57.2	502	980	17.5	300
1981	55.3	3.5	16.3	4.9	+	58.8	21.2	527	471	7.7	170
1982	41.2	3	8	0.5	+	44.2	8.5	292	171	6.8	140
1983	123.7	12.6	14.3	2	+	136.3	16.3	685	315	13.5	260
1984	105	35.7	39.8	7.6	0.1	140.7	47.5	984	966	21.6	440
1985	211.6	34.3	25.2	15.6	0.3	245.9	41.1	1467	913	20.7	460
1986	83.2	83.9	34.5	10.5	0.2	167.1	45.2	1414	1059	19.6	460
1987	131.9	25.6	22.1	37	0.2	157.5	59.1	1003	1355	18.3	420
1988	120.5	31.2	34.1	11.7	+	151.3	45.8	1083	993	18.5	400
1989	67.8	20.1	48.8	16	0.3	87.9	64.8	434	1298	22	440
1990	53.9	8.6	31.2	12.1	+	62.5	43.3	291	904	5.5	115
1991	98.9	8.6	22.3	4.5	+	107.5	26.8	501	544	16.3	330
1992	111.6	8.1	54.8	5.3	+	119.7	60.1	487	1106	25.8	475
1993	124.6	13.9	46.5	3.5	+	138.5	50	622	1017	23.6	499
1994	121.3	16.9	50.5	4.6	+	138.2	55.1	573	1063	24.8	460
1995	188.1	29.5	35.1	8.7	+	217.6	43.8	696	914	19.2	420
1996	165.2	37.9	75.5	20.1	+	203.1	95.6	800	1820	42.8	830
1997	160	24.1	72.4	24.8	+	184.1	97.2	672	1881	21.8	430
1998	138.8	29.5	50.1	7.9	+	168.3	58	621	1106	27.6	492
1999	140.9	16.1	53.2	16	+	157	69.3	585	1171	29.5	500
2000	115.8	20.5	68.2	10	+	136.3	78.2	535	1485	34.2	650
2001	122.2	21	46.3	10.5	+	161.2	56.8	655	1197	21.3	450
2002	117.3	7.6	59.3	10.5	+	126.6	69.8	510	1445	22.9	475
2003	109.4	9.4	58.4	2.9		105.1	61.3	487	1214	20.7	410
2004	134.6	11.4	54.2	6.2	+	143.5*	60.4	597*	1204	28.2	535
2005	48	2.9	86.6	7.5	+	50.9	72.5	214	1450	36.3	602
2006	79.8*	2.2	29.4	1.9	-	82.0*	31.3	336*	639	18.8	400
2007	43.2*	1.4	52.5	1.4	-	43.2*	53.9	180*	997	19.1	410
2008	NA	NA	32.5	0.7	-	NA	33.2	NA	619	22.2	406

*** preliminary**

NA: not available

Table 12.6.2 Capelin in the Iceland-East Greenland-Jan Mayen area 1978-2008. Recruitment of 1 year old fish (unit 10^9) are given for 1 August Spawning stock biomass ('000 t) is given at the time of spawning (March next year). Landings ('000 t) are the sum of the total landings in the season starting in the summer/autumn of the year indicated and ending in March of the following year.

Season Summer/winter	Recruitment	Landings	Spawning stock biomass
1978/79	164	1195	600
1979/80	60	980	300
1980/81	66	684	170
1981/82	49	626	140
1982/83	146	0	260
1983/84	124	573	440
1984/85	251	897	460
1985/86	99	1312	460
1986/87	156	1333	420
1987/88	144	1116	400
1988/89	81	1037	440
1989/90	64	808	115
1990/91	118	314	330
1991/92	133	677	475
1992/93	163	788	499
1993/94	144	1179	460
1994/95	224	864	420
1995/96	197	929	830
1996/97	191	1571	430
1997/98	165	1245	492
1998/99	168	1100	500
1999/00	138	933	650
2000/01	146	1071	450
2001/02	140	1249	475
2002/03	142	988	410
2003/04	132	741	535
2004/05	57	783	602
2005/06	95*	238	400
2006/07	51*	377	410
2007/08*	NA	202	406

*** preliminary**

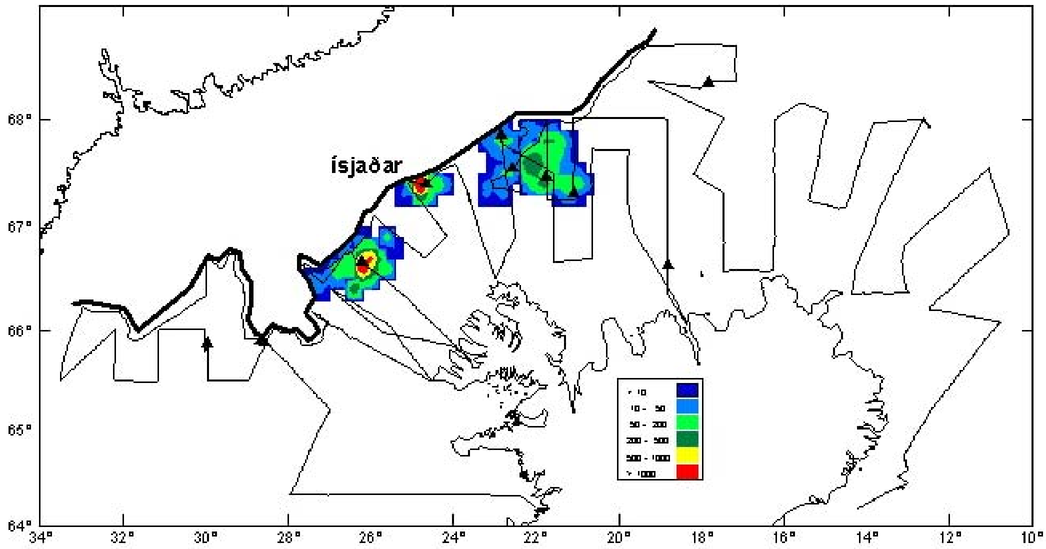


Figure 12.2.1. Cruise tracks, relative densities (as SA values) and the ice edge during an acoustic survey by r/v Arni Fridriksson in November 2007.

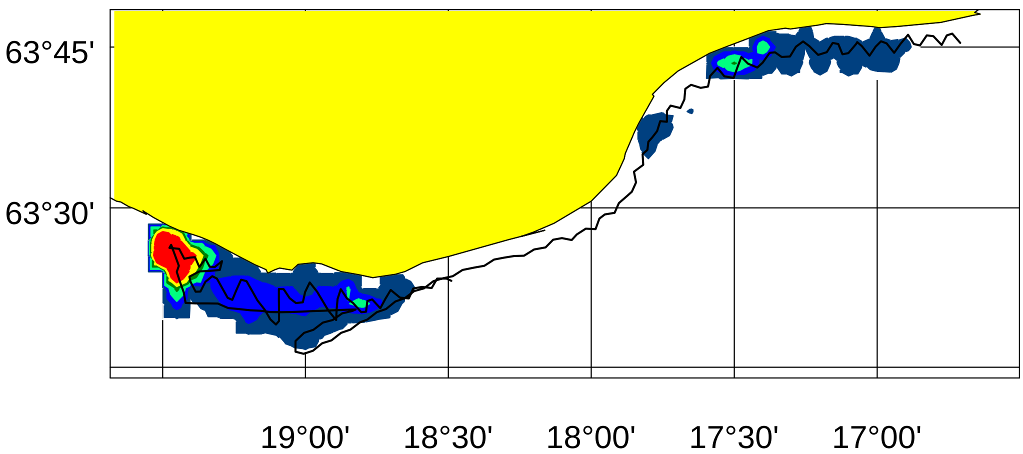


Figure 12.2.2. The main capelin assessment survey carried out with the r/v Arni Fridriksson in February 26-27, 2008.

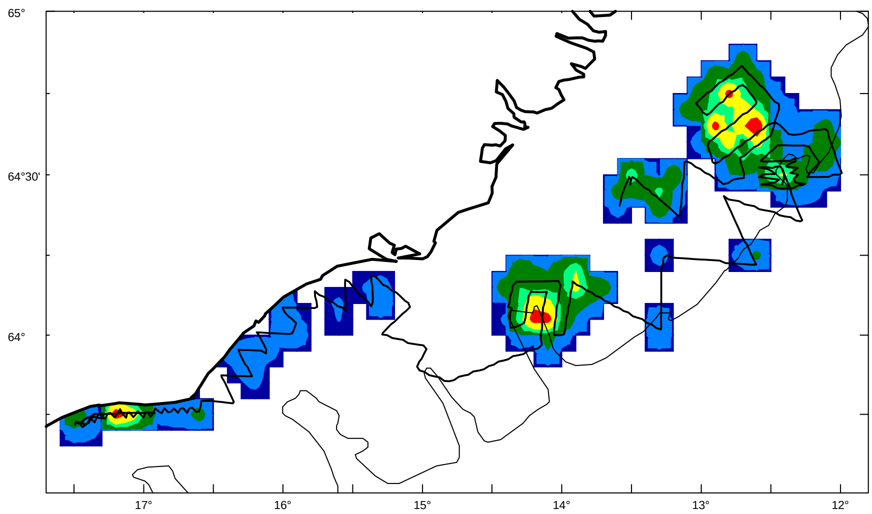


Figure 12.2.3. The second part of the main capelin assessment survey carried out with the r/v Arni Fridriksson in March 2-3, 2008.

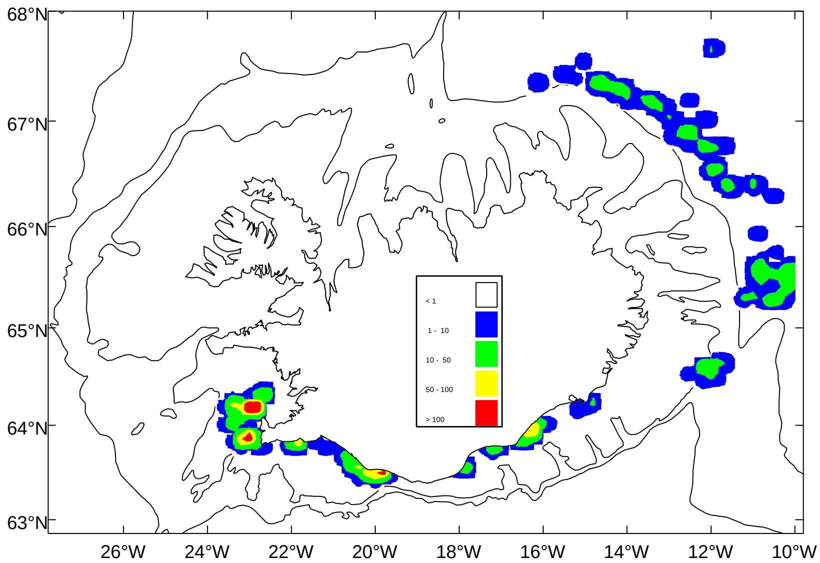


Figure 12.3.1. Distribution of the catches of the Icelandic capelin in the fishing season 2007/08 based on data from logbooks.

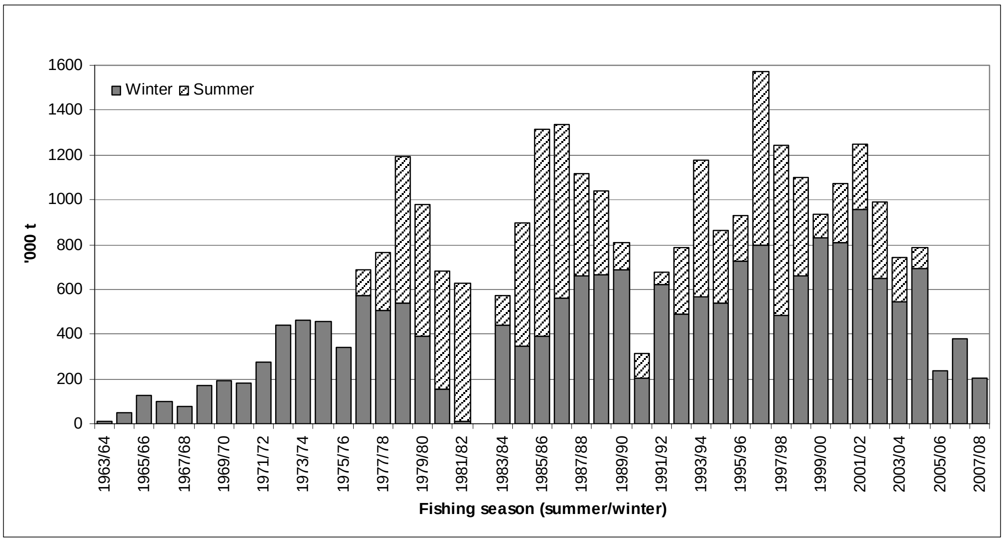


Figure 12.3.2. Total catch (in thousand tonnes) of the Icelandic capelin in 1963/64-2007/08.

13 Overview on ecosystem, fisheries and their management in Greenland waters.

13.1 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. In recent years spawning cod has been observed on the banks of East Greenland, eggs and larvae from these cod are also being transported with the current to West Greenland. The spawning takes place in spring (april-may) and shortly after a peak in primary production occurs (fig. 1).

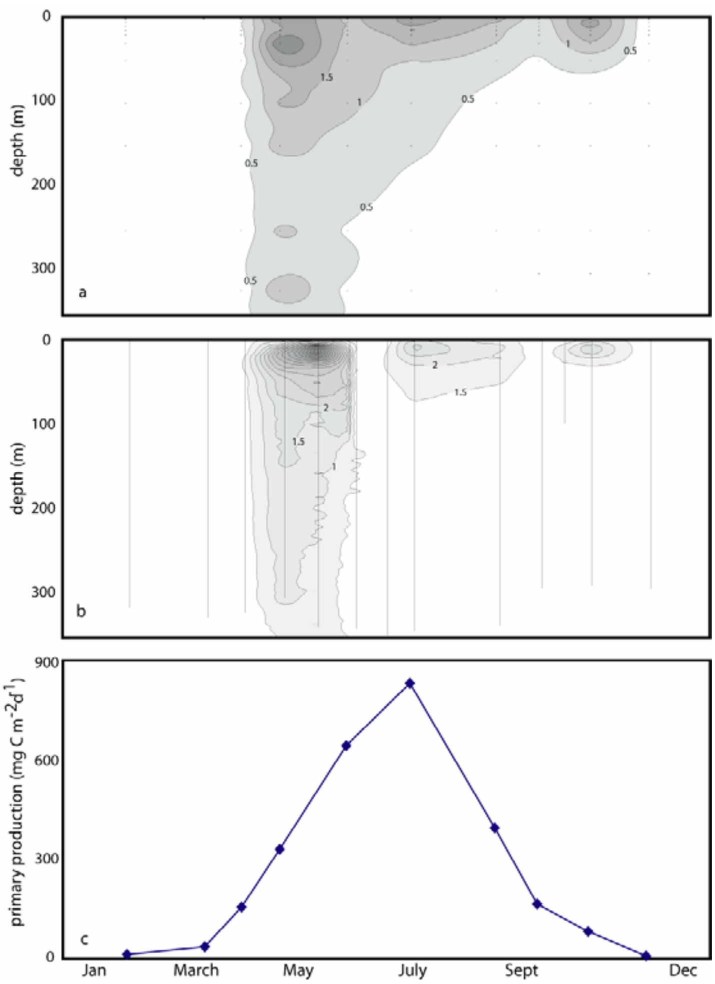


Figure 1. Annual variation in algal biomass and productivity at the inlet of Nuuk Fjord. a: chlorophyll (μg l^{-1}), b: fluorescence, c: primary production (mg C m^{-2} d^{-1}). Dots represent sampling points. From Mikkelsen et al. (2008).

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 recent years temperature have increased significant in Greenland water to about 2°C above the average for the historic average, with historic high temperatures registered in 2005 (50 years time series, fig. 2). 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 exist and with a historic large shrimp biomass in West Greenland water in present time feeding conditions would be optimal for fish predators such as cod (Hvingel & Kingsley 2006).

In recent years more southerly distributed species such as monk fish, lemon sole, saithe and whiting has been observed on surveys in offshore West and East Greenland and inshore West Greenland.

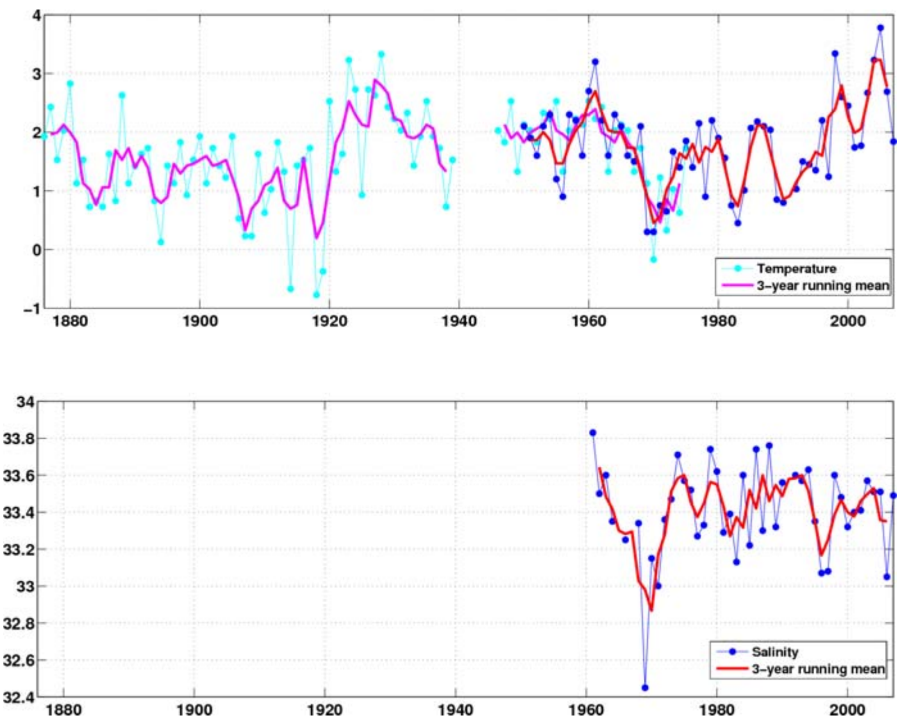


Figure 2. Timeseries of mean temperature (top) and mean salinity (bottom) on top of Fylla Bank (located outside Nuuk Fjord) (0–40 m) in the middle of June for the period 1950–2007. The red curve is the 3 year running mean value. From Ribergaard et al. (2008).

13.2 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.

13.2.1 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 fourth 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.

13.2.2 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 targetet using demersal otter board trawls with a minimum mesh size of 140 mm since 1985.

Cod fishing has ceased since 1992 in the West Greenland offshore waters. In East Greenland the fishery has been increasing in recent years due to a small longline fishery and limited commercial "experimental fisheries" using trawl. The Greenland offshore shrimp fleet consist of 15 freezer trawlers. They exclusively target shrimp stocks off West and East Greenland landing around 135 000 and 12 500 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 (22 mm) to avoid by-catch of juvenile fish. The 3 most economically interesting species, redfish, cod and Greenland halibut are only found in relatively small proportions of the by-catch.

The longliners are operating on the East coast with Greenland halibut and cod as targeted species. By-catches for the longliners fishing for Greenland halibut 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.

13.3 Overview of resources

In the last century the main target species of the various fisheries in Greenland waters have changed. A large international fleet landed in the 50s and 60s, large catches of cod reaching historic high in 1962 with about 450 000t. The offshore stock collapsed in the late 60s early 70s due to heavy exploitation and possible due to environmental condition. Since then the stock remained depended on occasional Icelandic larval cod transported. From 1992 to 2004 the biomass of offshore cod at West Greenland have been negligible. In 1969 the offshore shrimp fishery started and has been increasing ever since reaching a historic high of close to 150 000 t in 2003. Recent catches however indicate a decline in the shrimp fishery.

13.3.1 Shrimp

The shrimp *Pandalus borealis* stock in Greenland waters is considered in moderately good condition although a decrease in estimated biomass of the West Greenland has been observed over the last four 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, 2005; 550 000 tonnes and in 2007; 400 200 tonnes) but biomass-levels are still regarded as moderately high.

13.3.2 Snow crab

The biomass of snow crab in West 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 3 305t in 2006 down from 15 139t in 2001. After several years of decreasing CPUE it now appears to have stabilized at low levels in the majority of areas.

13.3.3 Scallops

The status of scallops in Greenland is unknown. From the mid 80s to the start 90s landings were between 4-600 t yearly. Since then landings have increased to around 2000 t. The fishery is based on license and is exclusively at the west coast between 20-60m. The growth rate is considered very low reaching the minimum landing size on 65mm on 10 years.

13.3.4 Squids

The status of squids in Greenland water is unknown.

13.3.5 Cod

In 2007, total landings of cod was reported as 16500 t where 4800 t were reported from the offshore areas. Although the landings are the highest in a 10-years period it is still only a fraction (16%) of the landings caught in 1990. Recruitment has been negible since the 1984 and 1985 year-class was observed, but the 2003 year-class is estimated to be 25% of the strength of the 1984 year-class in 2007. The information on spawning offshore is limited as the survey takes place well after the spawning period. However offshore spawning has been inferred of East Greenland since 2004 and in spring 2007 dense concentrations of unusual large cod were actively spawning off East Greenland. The inshore fishery is not regulated and the offshore fishery is managed with license and minimum size. As a response to the favourable environmental conditions (large shrimp stock, high temperatures and spawning cod in East Greenland) cod could re-colonise the offshore areas and therefore a recovery plan is urgently required to rebuild the stock.

13.3.6 Redfish

Advice on demersal stocks under mixed fisheries consideration.

13.3.7 Greenland halibut

Greenland halibut in the Greenland area consist of at least two stocks and more components; the status of the inshore component is not known but the components 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 long time perspective the stock is at a low level.

13.3.8 Lump sucker

The status of the lumpfish is unknown. The landing of lumpfish has increased the last couple of years reaching close to 9 000 t in 2003. Catches have remained at that level since. Local depletion will likely occur due to a heavy exploitation.

13.3.9 Capelin

Advice on demersal stocks under mixed fisheries consideration.

13.4 Advice on demersal fisheries

ICES recommends a zero catch for cod in Greenland for all offshore areas. It is especially important to give the spawning stock of East Greenland the maximum protection to secure the spawning potential that may be able to utilize the favourable environmental conditions (large shrimp stock and high temperatures). A recovery plan is recommended to ensure a sustainable increase in SSB and recruitment. Such plan must include appropriate measures to avoid any cod by-catch in other fisheries deploying mobile gears capable of catching cod. Observers must monitor functionalism of measures.

References

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.

Hvingel, C., Kingsley, M.C.S. 2006. A framework to model shrimp (Pandalus borealis) stock dynamics and quantity risk associated with alternative management options, using Bayesian methods, ICES J. Mar. Sci. 63; 68-82.

Mikkelsen, D.M., Rysgaard, S., Mortensen, J., Retzel, A., Nygaard, R., Juul-Pedersen, T., Sejr, M., Blicher, M., Krause-Jensen, D., Christensen, P.B., Labansen, A., Egevang, C., Witting, L., Boye, T. K., Simen, M. 2008. Nuuk Basic: The Marine Basic programme 2007. GN Report 2008.

Ribergaard, M.H., Mortensen, J., Olsen, S.M. 2008. Oceanographic Investigations off West Greenland 2007. NAFO SCR 08-003 GN Report 2007.

14 Cod Stocks in the Greenland Area (NAFO Area 1 and ICES Subdivision XIVb)

14.1 Stock definition

The cod found in Greenland is derived from three separate "stocks" that each is labelled by their spawning areas: I) offshore cod spawning of East and West Greenland waters; II) cod spawning in West Greenland fiords cod and III) Icelandic spawning where the offspring occasionally are transported in significant quantities with the Irminger current to Greenland water (Figure. 14.1.1).

Offshore, the offspring is carried pelagically over vast distances: the Icelandic offspring generally settles off East and South Greenland, the offspring from the Greenland offshore spawning is believed mainly to settle off the West Greenland coast (Wieland and Hovgård, 2002). Significant larval drifts from Iceland occur irregularly; e.g. in 1973 and 1984 (Buch et al, 1994, Schopka, 1994). Spawning cod is documented in many fjords between 64 and 67°N in West Greenland (Hansen 1949, Smidt 1979, Buch *et al.*, 1994). Recent summaries of the stock structure and developments, that provide references to the more detailed studies includes: Wieland and Storr-Paulsen, 2005, Storr-Paulsen et al. 2004, ICES 2005, Wieland and Hovgård, 2002, Buch et al. 1994).

Tagging information show that cod tagged in the fiords are predominately recaptured in the same fiord as tagged or in the adjacent coastal areas (Storr-Paulsen et al, 2004, Hovgård and Christensen, 1990, Hansen, 1949). Bank tagged cod are predominately recaptured on the Banks and to a lesser extent in the coastal area. The returns of the cod tagged in the coastal areas are in contrast found distributed over all the three habitats. The tagging experiments thus indicate that the offshore and inshore cod are generally separated but that the coastal area is a zone of mixing. A considerable number of tags are returned from Icelandic waters, especially from tagging in the coastal areas and the banks in East and Southwest Greenland (ICES XIV, NAFO Div. 1EF).

14.2 Information from the fisheries

14.2.1 The history of the Greenland cod fisheries

The inshore Greenland commercial cod fishery in West Greenland started in 1911 by opening the cod trading at localities where cod seemed to occur regularly. The fishery expanded over the next decades through a development of a number of new trading places. Annual catches above 20 000t have been taken inshore during the period 1955-1969 and in 1980 and 1989 catches of approximately 40 000t were landed, partly driven by a few strong year classes entering from the offshore stock (Horsted 2000). From 1993 to 2001 the inshore catches were low – in the range 500-2 000t. Inshore catches have since increased.

The offshore fishery took off in 1924 when Norwegian fishers discovered dense concentrations of cod on Fylla Bank. The West Greenland offshore fishery rapidly expanded to reach 120 000 t in 1931 – a level that remained for a decade (Horsted 2000). During World War II landings decreased by 1/3 as only Greenland and Portugal participated in the fishery. Less is known about the offshore cod fisheries off East Greenland waters, but since 1954 landing statistics have been available. In the next 15 years the East Greenland landings were only contributing between 2-10 % of the total offshore landings (Figure 14.2.1.). During a period from the mid 1950s to

1960 the total annual landings taken offshore averaged about 270 000 t. In 1962 the offshore landings culminated with landings of 440 000 t. After this historic high, landings decreased sharply by 90 % to 46 000 t in 1974 and even further down in 1977. Annual catch level of 40 000 t was only exceeded during short periods due to the occurrence of the strong year classes 1973 and 1984. During 1989–92 the fishery, which almost exclusively depended on the 1984 year class shifted from West to East Greenland. The offshore fishery completely collapsed in 1993. From 1994 to 2001 no directed offshore cod fishery has taken place. From 2002 limited quotas have been allotted to Faeroese and Norwegian vessels and in 2005-2006 Greenland trawlers were allowed limited quotas for experimental cod fishery. Offshore catches of cod increased from 400 t in 2004 to 850 t in 2005 and to 2,400 t in 2006. In 2007 the annual quota was ca. 5000 tons distributed between Greenland, EU, Norway and the Faroe Islands. Catches is dominated by trawl but some long-lining takes place.

14.2.2 The 2007 fishery

Cod is fished by a coastal and an offshore fleet. The ***coastal fleet*** consist of vessels below 75BT/120BT .The catches is not constrained by catch quotas. Catches are reported through sale slips information only. The gear used is pound-net, jig, gill-net and trawl (trawl however restricted to offshore area 3nm off the baseline). The ***offshore fleet*** consists of vessels above 75BT/120BT that are only allowed fishing in the offshore area. The fisheries are requiring a license that stipulates the vessel quota. The catch in weight is provided by logbook information.

The catches from the coastal fleet were estimated at 11,693 tons including 42 tons taken in East Greenland (Table 14.3). Compared to 2006 catches has increased by ca. 4300 t (58%), caused mainly by a very significant increase in Div. 1F where catches almost quadrupled from 1,461 t in 2006 to 4,988 t in 2007 (Table 14.4). The increase in catches in Div. 1F is contributed both to the 2003 YC being now in commercial size and to an increase in effort, as it is known that a number of small trawlers started fishing offshore in the summer. The most important fishery is the pound net fishery that takes place during summer as reflected by the fact that 78% of the total catches are taken in May-August. The pound net fishery target small cod as only the shallowest depths are fished (0-20m).

The offshore fleet catches doubled from 2389 t in 2006 to 4841 tons in 2007. The trawlers caught 2780 t in east Greenland and 1589t in West Greenland, the west Greenland catches being mainly taken in the southernmost area (NAFO Div. 1F). Long-liners caught 479 t, almost exclusively in East Greenland. The increase in catches is caused by an increase in the quotas including a Greenland experimental quota of 3000 tons and a quota of 1000 t to EU. The catch rates in the Greenland experimental cod fisheries during 2006 and 2007 have been very high, especially in East Greenland.

14.2.3 Length and age distributions, catch and weight at age in 2007

There is an overall lack of landing sample information from the 1990's were the cod fishery was very low. Length frequency information is generally lacking for the offshore fisheries where cod was mainly taken as a by-catch. For the inshore fisheries length frequency information is lacking for several years.

In 2007 the Greenland sampling level was considerable. In the inshore fisheries length frequencies was measured from 70 harbour samples (ca. 19,600 cod) covering all NAFO divisions. Size and age distribution and catch at age are aggregated in div. 1ABCD and 1EF. The age and length distributions are provided in fig. 14.2.2 and

14.2.3. In the offshore fisheries length information has been sampled by scientific observers, fisheries control officers and by arrangement with the vessel owners. Overall 116 hauls/line settings were measured (ca. 19,500 cod). Catches are aggregated on trawlers (east and west separated) and long-line. The areas fished by the offshore fleet are shown in Figure 14.2.4.

14.2.4 Documentation on spawning off East Greenland in 2007

The German and Greenland trawl surveys takes place well after the spawning period and reliable maturity information can therefore not be sampled on the regular surveys. The recent years offshore fisheries has however documented (skippers reports and photos, cod roe production figures) dense concentrations of large spawning cod off East Greenland at least since 2004. To rigidly document the spawning the Greenland Institute of Natural resources dispatched an observer on two trawlers fishing within the experimental cod fisheries framework.

The fishery took place April –June and the vessels were targeting dense concentrations of mature cod. Cod was maturity staged according to Tomkiewicz et al, (2002). The average length was 70 cm and 66% was classified as mature (fig. 14.2.5). The 50% maturity was found at 58 cm and at age 4.5 (Figures 14.2.6 and 14.2.7).

Inshore spawning is known to occur in many Greenland fiords but a thorough evaluation of its magnitude and distribution is lacking. Therefore, GINR in 2008 initiated a comprehensive surveys to define spawning areas, estimate maturity ogives and describe the maturity cycle over time. Conditions have been difficult due to extended ice coverage and a technical breakdown by R/V Adolf Jensen. Samplings have however been carried out the fiord areas around Qaqortoq (div.1F), Paamiut (Division 1E), Nuuk (Division 1D), Aasiat (Division 1A) and Illulisat (Division 1A), with spawning being confirmed in the tree last mentioned areas. The maturity information is not fully sampled or analysed but the preliminary information from the Nuuk fjord indicate that inshore cod may become mature at a size considerable smaller than seen off shore (L50% maturity found at ca. 45 cm – Figure 14.2.7).

14.2.5 Quota settings for 2008

The quota for the total international offshore fishery is sat at 15,000 tons for 2008, with fishery not being allowed north of 63^{o} northern latitude in both East and West Greenland. The quota in 2007 was 4,875 tons. The inshore cod fisheries are not quota constrained but industry expect 2008 catches in the range 10,000 to 15,000 t.

14.3 Surveys

14.3.1 Results of the German groundfish survey off West and East Greenland

Annual abundance and biomass indices have been derived from stratified random groundfish surveys covering shelf areas and the continental slope off West and East Greenland. Surveys commenced in 1982 and were primarily designed for the assessment of cod (*Gadus morhua* L.). A detailed description of the survey design and determination of these estimates was given in ICES, 1993. Survey strata were limited at the 3 mile line offshore except for some inshore regions off East Greenland where there is a lack of adequate bathymetric measurements. In 1984, 1992, 1994 and 2006 the survey coverage was incomplete off East Greenland and in 1995 and 2002 in West Greenland partly due to technical problems. In the work up of the survey information strata with less than five valid sets were rejected from the calculations. In 2006, strata

5.1. and 5.2 in East Greenland were not sampled completely. In 2007, strata 5.1 were not sampled completely (only 4 hauls made). Including this strata increases the survey abundance with ca. 6 mill fish.

14.3.1.1 Cod stock abundance indices

Table 14.7 lists abundance and biomass indices for West and East Greenland, respectively, and combined for the years 1982–2006. Trends of the estimated biomass and SSB index for West and East Greenland are shown in Figure 14.3.1, In 2005, the spawning stock biomass index was revised and based on survey biomass index 1982-2006, and historical maturity data presented by Horsted et al. (1983). The figure illustrates the pronounced increase in stock abundance and biomass indices from 1984 to 1987 due to good recruitment of the predominating year classes 1984 and 1985. Since 1988, stock abundance and biomass indices decreased dramatically by 99% to only 5 million fish and 6 000t in 1993. Biomass and abundance remained at very lo levels during the next decade but increase considerable by 2005. The stock size is however still at a low level as compared to the late 1980's.

The 2007 survey results confirmed previous findings indicating a strong year class of 2003. The year class 2003 is estimated as the strongest year class since year class 1984. The 2007 survey indicates that year class strength of 2003 is about 25 % of that of 1984, which is consistent with the ratio of 32 % between year classes at age 3. The highest abundances are found in Strata 4.1 (south west Greenland). The second most abundant year class is that of 2005 witch is found almost exclusively on West Greenland. The size of the 2005 year class, measured at age 2, is estimated at 36% of the 2003 year class. Older cod (year classes 1999-2002) are almost exclusively taken in Southwest Greenland (strata 4.1-4.2) and at East Greenland. The index of SSB has remained approximately constant since 2005 and is still at low level compared to historical data (Fig. 14.3.1).

14.3.1.2 Cod mean length at age

The trends of the mean length of the age groups 1–10 years for West and East Greenland are illustrated in Figure 14.3.2 and 14.3.3 respectively for the period 1982–2007. Age groups 3–10 years off East Greenland were found to be in average 15% larger than those off West Greenland. Off West Greenland mean length for the age groups 1–5 declined in 1986–87 and remained at low levels until 1991. Since then a slight increase have occurred notably for the older ages in the most recent years. At East Greenland length at age have been more constant, although fluctuating somewhat between years. In the last two years, the trend for age groups 2 to 6 was reversed and a slight decline occurred. Mean weight at age can be obtained from regression: weight= $0.00895\text{Length}^{3.00589}$ (weight in kg, length in cm) the equation has been determined on the basis of historic measurements.

14.3.2 Results of the Greenland surveys in West and East Greenland

14.3.2.1 Greenland shrimp survey off West Greenland

Since 1988, the Greenland Institute of Natural Resources has conducted an annual stratified random trawl survey at West Greenland. The focus of the survey is to evaluate the biomass and abundance of the Northern shrimp (*Pandalus borealis*) but fish catches have been recorded since 1992.

The survey covers the offshore areas at West Greenland between ca. 59º15'N and 72º30'N and the inshore area of Disko Bay from the 3 mile limit down to the 600 m. The stratification is based on designated 'Shrimp Areas' that is divided into depth zones of: 151-200, 201-300, 301-400 and 401-600 m, as based on depth contour lines. 95% of the annual trawl stations are allocated to shrimp strata's and are being allocated with the objective of minimising the variances of the shrimp biomass. More shallow areas have been rather unsystematically covered but from 2004 two extra depth zones ("fish stratas") have been formally defined: 50-100m, and 100-150m. The annual number of hauls is high, in 2007 262 hauls were made off West Greenland.

The survey is conducted by R/V Paamiut that until 2004 was equipped with a 3000/20-mesh Skjervøy with a twin cod end. In 2005 the Skjervøy trawl were replaced with a Cosmos trawl (Wieland and Bergström, 2005). Calibration experiments with the two the trawls were conducted in the main shrimp areas in 2004 and 2005 and a formal analysis of conversion factors were established for shrimp (Rosing and Wieland, 2005). The catch of cod in the calibration experiments was very low (a mean of 6 cod caught per calibration tow) and the experiments are considered insufficient for providing reliable estimates of the difference in catch efficiency towards cod.

In previous survey evaluations cod abundance have been analysed after a de-facto restratification to NAFO divisions. It was recognised that this may imply potential bias's as the haul density in the shrimp strata's is not proportional to survey areas. A comparison of the estimates from the two stratifications showed limited differences for 2006 and 2007 but considerable differences from 2005. The differences observed for 2005 is caused by two trawl hauls with high leverage.

The survey estimation based on the actual stratification on 'shrimp areas, is applied for the years since 2005 when the Cosmos trawl was introduced. Earlier years survey estimates are kept in the Skærvod units and have not been recalculated according to the shrimp strata.

Until 2001 the survey biomass was below 1,000 t but increased to ca 2,300t by 2004. The increase in abundance and biomass in 2005 coincides with the change in gear but also reflects that the cod of the relative large 2003 year class attained sizes that made them efficiently available to the gear. The 2005 survey catches were, however, significantly influence by a high leverage haul that contributed about ½ the total survey biomass and including almost ½ the individuals of age 5 and about all older fish. In 2007 biomass and abundance indices were estimated at 28,488 tons and 52.5 mill. individuals, corresponding to +16% and -23% when compared to the 2006 values. Abundance and weigh per km2 are shown in fig 14.3.4.

Since 2005 then the biomass and abundance has been dominated by the 2003 and the 2005 year classes, the latter being efficiently available to the gear in 2007. The 2005 year class size is measured at 33% of the 2003 year class, measured at age 2. The two dominating year classes differ with respect to distribution. The 2003 YC was almost exclusively found in the most southern area of Division 1F (Figure 14.3.5) whereas the 2005 year class appears rather evenly distributed (Figure 14.3.5). The very southern distribution of the 2003 year class is similarly reflected in the commercial fisheries that almost entirely took place in Division 1F.

Tables 14.11, 14.12 and 14.13 list biomass and abundance indices of cod by year, division and age.

14.3.2.2 Greenland pilot trawl survey off East Greenland

Due to the current cod distribution it was decided to cover the East Greenland area by a pilot survey in 2007. The survey was scheduled to 22 days but due to a vessel break down only 9 days was available in the area. In is difficult to locate good trawling bottom off east Greenland and as the vessel time resources became limited it was not attempted to fish at random sites – instead fishing was carried out on known trawl positions. No attempts were made to raise survey abundance/biomass to strata levels. 24 valid hauls were made north of 63^{O} and 11 hauls south of 63^{O}.

The catches taken in East Greenland (measured in abundance per km2) are contrasted to the West Greenland survey catches in Figure 14.3.4. The catch composition in East Greenland south of 63^{O} resembles that of NAFO div. 1F, with a clear dominance of the 2003 year class although also containing more old fish. Densities in East Greenland north of 63^{O} was found lower. The 2005 year class is not abundant in East Greenland.

14.3.2.3 Offshore Survey information on haddock occurrence useful for stock identification

Haddock is rarely seen in the west Greenland area and the species is not known to spawn in Greenland waters. For this reason the occurrence of small haddock has been used as an indicator for current conditions that have allowed haddock-and hence also cod- to be carried from Iceland to Greenland waters (Hovgård and Messtorf, 1987; Dickson and Brander, 1993). In the German survey haddock was seen abundant in association with the large 1984 year class. High abundance was seen again in 2003

Based on age readings undertaken from 2004 to 2006 and length-frequency distributions (LFDs), the major component in 2003 was 0-group haddock with a length of about 13.5 cm 0-groups also appeared in the surveys in 2004-2006. LFDs indicate that the haddock off West Greenland grew from age 0 in 2003 to age 3 in 2006 at a length of 35-40 cm. The numbers of haddock caught in the Greenlandic surveys has been very low until 2002 but haddock occurred more frequent in 2003-2005 (notably in 2004.). The Haddock catches has not been aged but the length distribution characterized by modes around 22 cm in 2004 and 30 cm in 2005 suggest an inflow from year class 2003. Haddock catches decreased again in 2006 and was very low in the 2007 survey (only 18 haddock caught). ICES (2007) provide a detailed presentation of the haddock information.

14.3.2.4 West Greenland young cod survey

A survey using gangs of gill nets with different mesh-sizes has been developed and used since 1985 with the objective of assessing the abundance of age 2 and age 3 cod in the inshore areas. Selectivity and fishing power estimates are documented in Hovgård (1996) and Hovgård and Lassen (2000). The fishing power dependents on the net material. It has been impossible to substitute damaged net section with the original net materials and substitution with alternative net materials were therefore made in 2004 and in 2006. Comparative fisheries indicate that the change in net materials has resulted in increased fishing power but no rigid analysis has yet been carried out. The survey was originally designed to cover Div 1BDF but for budgetary reasons the survey have in later years been limited to cover only two areas annually. In 2007 Div. 1B and 1F was covered.

In Div. 1B the gill-net abundance indices for age groups 2 and 3 were slightly above last years levels. Both indices are considerable above the low levels seen in the 1990s (table 14.14).

The experience from previous years surveys in NAFO Div. 1F (Qaqortoq) has been that high juvenile cod indices are only found for year classes being abundant in the offshore areas, i.e. the previous important 1984 and 1985 year classes. The coverage of Div. 1F was halted in 1995 after successive years of very low catches (table 14.14) being only infrequently covered since then. The survey in 2007 found high inshore densities dominated by the 2003 and 2005 year classes, thus in accordance with the historical pattern. The relative size of the two year classes cannot be estimated from the survey, as the mesh sizes used do not adequately catch the 2003 year class (the size is to large for being gilled properly; instead the fish are “snagged” around their maxillae cf. Hovgård, 1996 for selectivity technicalities).

14.3.3 Stock assessment

The poor sampling coverage in the recent years where cod was almost not fished commercially impedes a formal analytical assessment. The NWWG in 2006,instead, conducted an XSA covering the 1965-1995 period tuned with the German survey information 1982-1995. Catchabilities coefficients were then calculated for each age group by regressing VPA estimates on Survey abundances. Applying these catchabilities coefficients to the estimated abundance in the 2007 survey and using the observed mean weights leads to a rough estimate of the biomass and SSB at 169,000t, and 27,000, respectively (table 14.16 and fig 14.3.6).

14.3.4 State of the stock

The two survey abundance indices both indicate that the cod stock is presently significantly above the very depressed state that was experienced in the 1990’s. The up scaling of the German survey estimates however also suggests that the total biomass and SSB is still low compared to the 1965-1990 historical levels.

The increase in abundance experienced since the very depressed stock status found in late 1990’s appear to be affecting all stock components found in Greenland

Off East Greenland a small offshore spawning stock has been building up in the most recent years and spawning has been inferred since 2004. The spawning area is historical well known being the area of highest cod egg concentration in the Northwestlant programme in 1963 (Wieland and Hovgård, 2002).

Both surveys indicate that all year classes since 2002 are larger than any of the year class since the 1985 year class. The increase is mainly attributed to occurrence of the 2003 year class that is estimated at ca. 25% of the size of the very large 1984 year class. The southern distribution of the 2003 year class and the concurrent occurrence of haddock of the same year class suggest that this 2003 year class is dominated by cod that have drifted from Iceland. The second most important year class is that of 2005, found almost exclusively off West Greenland, and not associated with a major occurrence of haddock and may hence be of Greenland origin Both surveys estimates the 2005 year class as about a third of the 2003 YC size

The knowledge on the various local fiord spawning cod population is limited but it is noted that the abundance indices in the inshore gill-net survey show higher recruitment in recent years than were experienced in the 1990’s. The recent increase in catches took off in the early years of the present decade in NAFO div. 1AB where the surveys showed no cod offshore. The 2007 increase in catches in NAFO div. 1F is presumably due to an inshore migration of the 2003 year class that is found abundantly in the offshore area. The overall catch from the coastal fleet segment has increased gradually from les than 1,000t in 2000 to 11,700 in 2007.

14.4 Management considerations

Management considerations

Cod in Greenland derives from three stock components, labeled by their spawning areas: I) an offshore Greenland spawning stock, II) inshore West Greenland fiords spawning populations, and III) Icelandic spawned cod that drift to Greenland with the Irminger current.

The offshore Greenland spawning stock has not been fished during the last 15 years. Surveys and exploratory fishery now suggest limited but dense concentrations of large spawning cod in East Greenland north of 63°N. The SSB is, however, estimated to be low compared to the levels before the stock collapse and the spawning area is limited in distribution compared to the extension of spawning grounds observed historically. The offspring of these fish drifts with the Irminger/West Greenland current to settle off West Greenland The spawning stock should be given the maximum protection to secure the spawning potential that may be able to utilize the favourable environmental conditions, especially the recent temperature increase, that have developed over the last decade.

Offshore recruitments have improved since the end of the 1990s. The size of the 2003 year class is now estimated at approximately 25% of the 1984 year class, which is the last strong year class. The 2003 year class shows the characteristics usually associated with cod that have drifted from Iceland (associations with haddock of the same age and a southern distribution). In the past, cod of Icelandic origin have often migrated back to Iceland when mature. The 2005 year class, found off West Greenland and not associated with haddock is estimated at a third of the 2003 year class size. Recruitment levels is still low compared to the recruitments before the stock became depleted.

Inshore recruitment has increased in recent years and is now well above the low levels observed in the late 1990's. The catch taken by the coastal fleet components, that is not quota regulated, has increased by a factor of ten over the last decade. The stock dynamics of the inshore stocks are, however, not known

A multi-annual management plan should be developed to ensure that the quotas are sat at low levels until a substantial increase in biomass and recruitment is evident. The management plan may incorporate the knowledge on the stock structure, *inter alia*. by differentiating management objectives for the inshore and offshore stock components.

14.4.1 Comments on the assessment

A new survey trawl was introduced in the Greenland offshore survey in 2005. The very low catches of cod in the trawl calibration experiments implies that tit is not possible to reliable relate the difference in catch efficiency between the two gears. Irrespectively of this uncertainty there is no doubt that abundance was low prior to 2005.

Sampling levels of the commercial fisheries has been low in the years with little fisheries. However, since 2006, the number of samples as well as the number of fish measured has been increased very considerable.

The historical information on maturity at age is limited as the two available abundance surveys are conducted well after the spawning period. An ongoing

Greenland program is expected to produce considerable maturity information in the coming year.

14.5 References

Buch, E., Horsted, S.A., and Hovgård, H. 1994. Fluctuations in the occurrence of cod in Greenland waters and their possible causes. ICES Mar. Sci. Symp. 198: 158-174.

Dickson, R. R., and Brander, K. M. 1993. Effects of a changing windfield on cod stocks of the North Atlantic. Fisheries Oceanography, 2: 124-153.

ICES, 1992. Report of the North Western Working Group. ICES CM 1992/Assess: 14.

ICES 1993 Report of the North Western Working Group. ICES CM 1993/Assess:18.

ICES 2005. Spawning and life history information for North Atlantic cod stocks ICES Cooperative Research Report 274,

Hansen, P.M. 1949. Studies on the biology of the cod in Greenland waters. Rapp. P.-v. Réun. Cons. int. Explor. Mer 123: 1-77.

Horsted, S.A. 2000. A review of the cod fisheries at Greenland, 1910-1995. J.Northw.Atl.Fish.Sci. 28: 1-112.

Hovgård, H., and Messtorf, J. 1987. Is the West Greenland cod mainly recruited from Icelandic waters? NAFO Scientific Council Research Documents, 31.

Hovgård, H. and Christensen, S. 1990. Population structure and migration patterns of Atlantic cod at West Greenland waters based on tagging experiments from 1946 to 1964. NAFO Sci. Coun. Studies 14: 45-50.

Hovgård, H., 1996. A two step approach to estimating selectivity and fishing power of experimental gill-nets used in Greenland Waters. Can. J. Fish. Aquat. Sci. 53: 1014-1017.

Hovgård H., and Lassen, H., 2000. Manual on estimation of selectivity for gill-net and long-line gears in abundance surveys. FAO Fish. Tech. P., 397.

.Rosing, M. & K. Wieland (2005): Preliminary results from shrimp trawl calibration experiments off West Greenland (2004, 2005) with notes on encountered design/analyses problems. NAFO SCR Doc. 05/92.

Schopka, S. A.. 1994: Fluctuations in the cod stock off Iceland during the twentieth century in relation to changes in the fisheries and the environment. ICES mar. Sci. Symp. 198: 175-193.

Smidt, E. 1979. Annual cycles of primary production and of zooplankton at Southwest Greenland. Meddelser om Grønland, Bioscience 1: 1-53.

Storr-Paulsen, M., Wieland K., Hovgård H. and Rätz H-J. 2004. Stock structure of Atlantic cod (*Gadus morhua*) in West Greenland waters: implications of transport and migration ICES Journal of Marine Science. 61: 972-982.

Tomkiewicz, J, Tybjerg,L, Hom, N, Hansen, A, Broberg, C and Hansen E. 2002. manual to determined gonadal maturity of Baltic cod. DFU rapport 116-02, Charlottenlund. Danish Institute of Fisheries Research. 49 p.

Wieland, K. & B. Bergström (2005): Results of the Greenland bottom trawl survey for northern shrimp (*pandalus borealis*) off West Greenland (NAFO subarea 1 and Division 0A); 1988-2005. NAFO SCR Doc. 05/74.

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).

Wieland, K. and Storr-Paulsen, M., 2005. In: ICES. Spawning and life history information for North Atlantic cod stocks ICES Cooperative Research Report 274.

Table 14.1 Nominal catch (t) of Cod in NAFO Sub-area 1, 1988-2007 as officially reported to ICES.

Country	1988	1989	1990	1991	1992	1993
Faroe Islands	-	-	51	1	-	-
Germany	6.574	12.892	7.515	96	-	-
Greenland	52.135	92.152	58.816	20.238	5.723	1.924
Japan	10	-	-	-	-	-
Norway	7	2	948	-	-	-
UK	927	3780	1.631	-	-	-
Total	59.653	108.826	68.961	20.335	5.723	1.924
WG estimate	62.653 [2]	111.567 [3]	98.474 [4]	-	-	-

Country	1994	1995	1996	1997	1998	1999
Faroe Islands	-	-	-	-		
Germany	-	-	-	-		
Greenland	2.115	1.710	948	904	319	622
Japan	-	-	-	-		
Norway	-	-	-	-		
UK	-	-	-	-		
Togo	2.115	1.710				
Total	-	-	948	904	319	622
WG estimate			-	-	-	-

Country	2000	2001	2002[1]	2003[1]	2004[1]	2005
Faroe Islands						
Germany						
Greenland	764	1680	3698	3989	4948	
Japan						
Norway				693 [5]		
UK						
Togo				533 [5]		
Total	764	1680	3698	5215		
WG estimate	-	-				6118

Country	2006	2007
Faroe Islands		
Germany		
Greenland		
Japan		
Norway		
UK		
Togo		
Total		
WG estimate	7769	13313

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 14.2 Nominal catch (t) of cod in ICES Sub-area XIV, 1988-2007 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 14.2 Cont. Nominal catch (t) of cod in ICES Sub-area XIV.

COUNTRY	2006	2007
Faroe Islands		305
Germany		772
Greenland		
Iceland		
Norway	479	613
Portugal		
UK (E/W/NI)		
United Kingdom		180
Total		
WG estimate	1981	3221

Table 14.3 Cod off Greenland (inshore and offshore components). Catches (t) from 1924 – 2007 as used by the Working Group, inshore and offshore, offshore divided into East and West Greenland. Until 1995, based on Horsted (1994, 2000). * indicates preliminary results.

COD	INSHORE	OFFSHORE			TOTAL
Year	Total	East	West	Total	Greenland
1924	843		200	200	1043
1925	1024		1871	1871	2895
1926	2224		4452	4452	6676
1927	3570		4427	4427	7997
1928	4163		5871	5871	10034
1929	7080		22304	22304	29384
1930	9658		94722	94722	104380
1931	9054		120858	120858	129912
1932	9232		87273	87273	96505
1933	8238		54351	54351	62589
1934	9468		88122	88122	97590
1935	7526		65846	65846	73372
1936	7174		125972	125972	133146
1937	6961		90296	90296	97257
1938	5492		90042	90042	95534
1939	7161		89807	89807	96968
1940	8026		43122	43122	51148
1941	8622		35000	35000	43622
1942	12027		40814	40814	52841
1943	13026		47400	47400	60426
1944	13385		51627	51627	65012
1945	14289		45800	45800	60089
1946	15262		44395	44395	59657
1947	18029		63458	63458	81487
1948	18675		109058	109058	127733
1949	17050		156015	156015	173065
1950	21173		179398	179398	200571
1951	18200		222340	222340	240540
1952	16726		317545	317545	334271
1953	22651		225017	225017	247668
1954	18698	4321	286120	290441	309139
1955	19787	5135	247931	253066	272853
1956	21028	12887	302617	315504	336532
1957	24593	10453	246042	256495	281088
1958	25802	10915	294119	305034	330836
1959	27577	19178	207665	226843	254420
1960	27099	23914	215737	239651	266750
1961	33965	19690	313626	333316	367281
1962	35380	17315	425278	442593	477973
1963	23269	23057	405441	428498	451767
1964	21986	35577	327752	363329	385315
1965	24322	17497	342395	359892	384214
1966	29076	12870	339130	352000	381076
1967	27524	24732	401955	426687	454211
1968	20587	15701	373013	388714	409301
1969	21492	17771	193163	210934	232426

Table 14.3 Cont. Cod off Greenland (inshore and offshore component). * indicates preliminary results.

COD	INSHORE	OFFSHORE			TOTAL
Year	Total inshore	East	West	Total offshore	Greenland
1970	15613	20907	97891	118798	134411
1971	13506	32616	107674	140290	153796
1972	14645	26629	95974	122603	137248
1973	9622	11752	53320	65072	74694
1974	8638	6553	39396	45949	54587
1975	6557	5925	41352	47277	53834
1976	5174	13027	28114	41141	46315
1977	13999	8775	23997	32772	46771
1978	19679	7827	18852	26679	46358
1979	35590	8974	12315	21289	56879
1980	38571	11244	8291	19535	58106
1981	39703	10381	13753	24134	63837
1982	26664	20929	30342	51271	77935
1983	28652	13378	27825	41203	69855
1984	19958	8914	13458	22372	42330
1985	8441	2112	6437	8549	16990
1986	5302	4755	1301	6056	11358
1987	18486	6909	3937	10846	29332
1988	18791	12457	36824	49281	68072
1989	38529	15910	70295	86205	124734
1990	28799	33508	40162	73670	102469
1991	18311	21596	2024	23620	41931
1992	5723	11349	4	11353	17076
1993	1924	1135	0	1135	3059
1994	2115	437	0	437	2552
1995	1710	284	0	284	1994
1996	948	192	0	192	1140
1997	1186	370	0	370	1556
1998	323	346	0	346	669
1999	622	112	0	112	734
2000	764	100	0	100	864
2001	1680	221	0	221	1901
2002	3698*	448	0	448	4146*
2003	5215*	286	7	293	5515*
2004	4948*	369	27	396*	5344*
2005	6043	773	75	847*	6890*
2006	7388*	1981	408	2389	9777*
2007	11693	3221	1620	4841	16534

Table 14.4 Cod catches (t) divided to NAFO –divisions, caught inshore from vessels 50 GRT (Horsted 2000, Statistic Greenland 2007, Greenland Fisheries License Control). [1]Including 1258t ranshipped 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	ICES XIV	TOTAL
1984	175	3908	1889	5414	1149	1333		19958
1985	149	2936	957	1976	1178	1245		8441
1986	76	1038	255	1209	1456	1268		5302
1987	97	2995	536	8110	4560	1678		8402
1988	333	6294	1342	2992	3346	4484		22829
1989	634	8491	5671	8212	10845	4676		28529
1990	476	9857	1482	9826	1917	5241		29026
1991	876	8641	917	2782	1089	4007		18311
1992	695	2710	563	1070	239	450		5723
1993	333	323	173	968	18	109		1924
1994	209	332	589	914	11	62		2115
1995	53	521	710	332	4	81		1710
1996	41	211	471	164	11	46		948
1997	18	446	198	99	13	130		1186
1998	9	118	79	78	0	38		319
1999	68	142	55	336	8	4		622
2000	154	266	0	332	0	12		764
2001	117	1183	245	54	0	81		1680
2002	263	1803	505	214	24	813		3622
2003	1109	1522	334	274	3	479		5215 [1]
2004	535	1316	242	116	47	84		4948[2]
2005	650	2351	1137	1162	278	382		6043[2]
2006	922	1682	577	943	630	1461		7388[2]
2007	417	2547	1197	1843	660	4988	42	11694

Table 14.5 Catch at age (abundance in millions) 1985-2007, missing values in 1997, 1998, 2000 and 2001.

Year\Age	1	2	3	4	5	6	7	8	9	10
1985				0.742	0.588	2.464	0.154	0.604	0.016	
1986				0.172	0.170	1.245	0.117	0.565	0.014	
1987		0.043	0.594	7.638	4.153	0.320	0.877	0.229	0.415	
1988		0.052	0.214	7.533	6.446	0.421	0.452	0.088	0.184	
1989		0.006	0.218	11.813	12.619	1.318	1.369	0.172	0.276	
1990		0.002	0.154	10.169	9.340	2.632	0.742	0.137	0.116	
1991		0.004	0.125	7.177	8.562	2.499	0.288	0.012	0.003	
1992		0.001	0.051	1.767	2.634	0.730	0.126	0.008	0.005	
1993		0.000	0.029	0.647	0.706	0.208	0.044	0.006	0.006	
1994		0.001	0.053	1.152	0.727	0.079	0.053	0.012	0.003	
1995			0.008	0.593	0.729	0.140	0.036	0.001	0.001	
1996			0.002	0.148	0.262	0.119	0.056	0.009	0.007	
1997										
1998										
1999			0.082	0.396	0.238	0.037	0.004			
2000										
2001										
2002		0.001	0.565	1.952	1.282	0.333	0.091	0.000	0.000	
2003			0.0665	0.2871	0.4081	0.1068	0.0496	0.0069	0.0073	
2004			0.417	1.093	1.241	1.018	0.065	0.010	0.002	
2005		0.045	2.018	2.472	0.544	0.159	0.054	0.054		
2006		0.035	3.196	2.628	0.769	0.024	0.000	0.001		

Table 14.6 Weight at age in landing 1985-2007, missing values in 1997, 1998, 2000 and 2001.

YEAR\AG	1	2	3	4	5	6	7	8	9	10
1985				0.84	1.29	1.82	2.25	2.97	3.55	
1986				0.86	1.44	2.05	2.39	2.94	3.30	
1987		0.46	0.69	0.88	1.17	2.30	2.91	4.37	4.15	
1988		0.32	0.65	1.05	1.17	1.66	2.51	4.35	4.14	
1989		0.57	0.75	1.19	1.34	1.80	2.21	3.61	3.63	
1990		0.72	0.64	1.08	1.28	1.33	1.78	3.26	3.34	
1991		0.72	0.60	0.84	1.07	1.04	1.42	1.77	2.75	
1992		0.71	0.54	0.84	1.17	1.16	1.61	2.39	4.03	
1993		0.72	0.53	0.76	1.25	1.23	1.97	3.57	3.97	
1994		0.72	0.43	0.83	1.13	1.64	2.32	3.35	3.68	
1995			0.45	0.87	1.28	1.67	1.78	3.17	6.18	
1996			0.39	0.94	1.39	2.03	2.71	3.40	(1.97)	
1997										
1998										
1999		0.31	0.56	0.71	1.02	1.25	1.58			
2000										
2001										
2002		0.32	0.52	0.69	1.09	1.51	1.70	3.36	0.31	
2003			0.98	1.26	2.01	2.77	3.18	5.02	6.14	
2004			0.83	1.01	1.24	1.72	2.51	3.77	(3.6)	
2005		0.51	0.78	1.16	1.85	2.55	2.78	3.45		
2006		0.42	0.82	0.99	1.29	2.97		6.37		

Table 14.7 Cod off Greenland (offshore component), German survey. Abundance (1000) and biomass indices (t) for West, East Greenland and total by stratum, 1982-2007. Confidence intervals (CI) are given in per cent of the stratified mean at 95% level of significance. () incorrect due to incomplete sampling. Spawning stock numbers (SSN, x1000) and biomass indices (SSB, tons) based on survey indices, 1982-2007, and historical maturity data.

	Abundance					Biomass				
YEAR	WEST	EAST	TOTAL	CI	SSN.	WEST	EAST	TOTAL	CI	SSB.
1982	92276	8090	100366	28	16661	128491	23617	152107	25	47868
1983	50204	7991	58195	25	14392	82374	34157	116531	25	48114
1984	16684	(6603)	(23286)	32	6255	25566	(19744)	(45309)	34	21463
1985	59343	12404	71747	33	9404	35672	33565	69236	39	29168
1986	145682	15234	160915	32	11291	86719	41185	127902	26	40878
1987	786392	41635	828026	59	24127	638588	51592	690181	63	55727
1988	626493	23588	650080	48	28940	607988	52946	660935	46	48997
1989	358725	91732	450459	59	63159	333850	239546	573395	46	127083
1990	34525	25254	59777	43	16669	34431	65964	100395	34	35871
1991	4805	10407	15213	29	6992	5150	32751	37901	36	19400
1992	2043	(658)	(2700)	50	238	607	(1216)	(1823)	69	752
1993	1437	3301	4738	36	636	359	5600	5959	41	2560
1994	574	(801)	(1375)	36	224	140	(2792)	(2930)	68	1009
1995	278	7187	7463	93	1415	57	15525	15581	155	7932
1996	811	1447	2257	38	308	373	3599	3973	56	1237
1997	315	4153	4469	75	910	284	13722	14007	90	3663
1998	1723	1671	3394	54	439	130	4348	4479	91	1674
1999	912	2769	3681	34	358	240	3917	4157	62	1747
2000	1926	4816	6742	36	550	570	4778	5349	40	2208
2001	8160	7604	15764	39	1120	2666	15271	17937	42	3955
2002	4121	9691	13812	41	2413	2110	19726	21836	51	8299
2003	5632	19904	25537	45	6060	2264	50867	53131	73	23879
2004	31607	17540	49147	58	4406	6284	32392	38676	38	15585
2005	62774	79455	142230	35	6409	25217	109739	134955	39	33287
2006	219856	(62933)	282789	109	8773	146496	(83287)	229783	78	30811
2007	156022	(28188)	184210	92	10555	158985	69682	228667	74	33048

Table 14.8 Cod off West Greenland (offshore component), German survey. Age disaggregate abundance indices (1000), 1982-2007. *) calculated proportionally using age compositions reported by the ICES Working Group on Cod Stocks off East Greenland (ICES 1984/Assess:5).

YEAR	0	1	2	3	4	5	6	7	8	9	10	11+	TOTAL
1982	0	176	884	33470	11368	32504	9528	2622	578	939	91	90	92250
*1983	0	0	1469	2815	26619	4960	10969	1882	992	317	168	13	50204
1984	159	5	38	2070	1531	9848	842	1873	87	186	27	0	16666
1985	831	38016	1481	948	6403	2833	7682	467	646	27	35	0	59369
1986	0	14148	112532	4089	903	6823	2095	4271	133	616	34	39	145683
1987	0	317	45473	692567	24230	5929	11813	1637	4006	0	366	30	786368
1988	0	257	3332	102767	510980	5425	613	1122	654	1274	32	35	626491
1989	12	204	2461	3565	93687	254002	3934	0	535	114	228	0	358742
1990	159	47	1007	3005	1244	21724	7221	47	0	0	0	19	34473
1991	0	293	224	476	1397	164	1894	317	6	0	0	0	4771
1992	0	263	1427	220	36	77	0	28	0	0	0	0	2051
1993	0	10	832	544	20	28	6	0	0	0	0	0	1440
1994	0	283	45	199	38	5	0	5	0	0	0	0	575
1995	0	0	241	16	22	0	0	0	0	0	0	0	279
1996	0	147	11	638	10	0	10	0	0	0	0	0	816
1997	0	12	27	15	263	0	0	0	0	0	0	0	317
1998	48	1642	0	0	5	25	0	0	0	0	0	0	1720
1999	29	401	392	87	7	0	6	0	0	0	0	0	922
2000	0	165	1015	615	116	0	0	0	0	0	0	0	1911
2001	0	620	6202	1100	159	51	0	0	0	0	0	0	8132
2002	12	13	1061	2972	64	0	0	0	0	0	0	0	4122
2003	68	3225	392	1090	743	93	25	0	0	0	0	0	5636
2004	31	24115	5316	803	588	584	142	9	0	0	0	0	31588
2005	217	1028	53779	6099	410	569	460	37	23	0	0	0	62622
2006	420	4043	16294	181859	12697	598	2337	1263	113	0	0	0	219624
2007	318	488	19366	11284	115077	8765	513	148	62	0	0	0	156021

Table 14.9 Cod off <u>East</u> Greenland (offshore component), German survey. Age disaggregate abundance indices (1000), 1982-2007. *) calculated proportionally using age compositions reported by the ICES Working Group on Cod Stocks off East Greenland (ICES 1984/Assess:5). () incomplete sampling.

YEAR	0	1	2	3	4	5	6	7	8	9	10	11+	TOTAL
1982	0	0	239	841	1764	1999	1227	379	130	1392	73	72	8116
*1983	0	0	411	605	1008	1187	2125	1287	302	265	703	101	7994
(1984)	0	18	74	1342	657	1397	855	1617	407	103	36	95	6601
1985	230	1932	556	118	2494	2034	1852	785	2000	295	56	36	12388
1986	0	1397	3351	1693	551	2417	1120	2191	566	1627	116	139	15168
1987	0	13	13785	17788	3890	1027	1770	457	1571	187	1093	36	41617
1988	11	25	163	6982	11094	2016	480	1435	152	674	98	469	23599
1989	0	7	179	489	17396	63216	3021	294	4870	406	1795	42	91715
1990	0	38	80	551	462	5128	18012	265	72	251	0	349	25208
1991	0	106	377	394	685	147	3512	5035	81	37	11	9	10394
(1992)	15	44	77	74	69	54	47	143	52	0	0	6	581
1993	0	17	44	1857	370	279	278	88	272	95	0	0	3300
(1994)	0	87	0	29	261	143	87	145	0	29	0	0	781
1995	0	7	2523	1125	370	1730	450	141	460	36	217	125	7184
1996	0	0	0	502	258	295	255	60	77	0	0	0	1447
1997	0	0	37	28	1508	1611	566	236	140	0	0	19	4145
1998	63	240	192	21	45	462	435	156	43	0	0	0	1657
1999	191	632	665	417	138	302	179	200	0	35	24	0	2783
2000	0	808	1074	1341	787	157	291	75	141	115	31	0	4820
2001	0	309	944	1468	2244	1349	705	211	191	73	36	9	7539
2002	96	8	415	1824	2026	2080	1952	889	235	83	36	30	9674
2003	1102	585	141	1067	4530	4285	4486	2374	1074	188	0	25	19857
2004	190	4227	2008	712	1019	3975	2559	1933	738	130	44	0	17535
2005	188	3125	45849	12962	2508	6051	5785	2008	534	98	0	0	79108
(2006)	0	77	1469	45301	8850	2147	2978	1702	257	71	22	0	62874
(2007)	101	103	403	661	17065	7250	908	1055	1042	107	0	0	28694

Table 14.10 Cod off Greenland (total offshore component), German survey. Age disaggregate abundance indices (1000), 1982-2007. *) calculated proportionally using age compositions reported by the ICES Working Group on Cod Stocks off East Greenland (ICES 1984/Assess:5). () incomplete sampling.

YEAR	0	1	2	3	4	5	6	7	8	9	10	11+	TOTAL
1982	0	176	1123	34311	13132	34503	10755	3001	708	2331	164	162	100366
*1983	0	0	1880	3420	27627	6147	13094	3169	1294	582	871	1140	58198
(1984)	159	23	112	3412	2188	11245	1697	3490	494	289	63	95	23267
1985	1061	39948	2037	1066	8897	4867	9534	1252	2646	322	91	36	71757
1986	0	15545	115883	5782	1454	9240	3215	6462	699	2243	150	178	160851
1987	0	330	59258	710355	28120	6956	13583	2094	5577	187	1459	66	827985
1988	11	282	3495	109749	522074	7441	1093	2557	806	1948	130	504	650090
1989	12	211	2640	4054	111083	317218	6955	294	5405	520	2023	42	450457
1990	159	85	1087	3556	1706	26852	25233	312	72	251	0	368	59681
1991	0	399	601	870	2082	311	5406	5352	87	37	11	9	15165
(1992)	15	307	1504	294	105	131	47	171	52	0	0	6	2632
1993	0	27	876	2401	390	307	284	88	272	95	0	0	4740
(1994)	0	370	45	228	299	148	87	150	0	29	0	0	1356
1995	0	7	2764	1141	392	1730	450	141	460	36	217	125	7463
1996	0	147	11	1140	268	295	265	60	77	0	0	0	2263
1997	0	12	64	43	1771	1611	566	236	140	0	0	19	4462
1998	111	1882	192	21	50	487	435	156	43	0	0	0	3377
1999	220	1033	1057	504	145	302	185	200	0	35	24	0	3705
2000	0	973	2089	1956	903	157	291	75	141	115	31	0	6731
2001	0	929	7146	2568	2403	1400	705	211	191	73	36	9	15671
2002	108	21	1476	4796	2090	2080	1952	889	235	83	36	30	13796
2003	1170	3810	533	2157	5273	4378	4511	2374	1074	188	0	25	25493
2004	221	28342	7324	1515	1607	4559	2701	1942	738	130	44	0	49123
2005	405	4135	99628	19061	2918	6620	6245	2045	557	98	0	0	141730
(2006)	420	4120	17763	227160	21547	2745	5315	2965	370	71	22	0	282498
(2007)	419	591	19769	11945	132142	16015	1421	1203	1104	107	0	0	184715

Table 14.11 Cod off Greenland (offshore component), Greenland survey. Abundance indices (1000) for West Greenland by division, 1992-2007. Confidence intervals (CI) are given in percent of the stratified mean at 95% level of significance. Since 2005 there has been a change in survey gear.

YEAR	0A	1A	1B	1C	1D	1E	1F	TOTAL	CI
1992		4	53	243	345	0	8	653	49
1993		2	16	54	135	286	18	512	68
1994		10	41	87	0	6	0	144	47
1995		0	51	380	44	62	39	578	55
1996		0	0	46	68	87	107	308	55
1997		0	7	31	0	0	0	38	68
1998		0	4	0	26	26	3	59	54
1999		32	136	16	23	6	0	213	29
2000		585	437	71	58	9	189	1349	23
2001		26	305	110	448	305	313	1508	26
2002		13	203	78	3294	114	457	4158	50
2003		492	1395	351	727	214	211	3391	22
2004		197	152	379	2630	1538	1610	6507	29
				New Survey Gear Introduced					
2005	145	205	820	1846	4643	7051	93608	108317	52
2006	454	429	4091	2702	11039	8792	40261	67769	29
2007	737	1267	3179	7424	3798	2857	33256	52517	37

Table 14.12 Cod off Greenland (offshore component), Greenland survey. Biomass indices (t) for West Greenland by division, 1992-2007. Confidence intervals (CI) are given in per cent of the stratified mean at 95% level of significance. Since 2005 there has been a change in survey gear.

YEAR	0A	1A	1B	1C	1D	1E	1F	TOTAL	CI
1992		23	54	75	118	0	2	251	45
1993		2	5	25	39	124	5	200	70
1994		3	9	38	0	1	0	51	46
1995		5	6	120	23	3	4	155	63
1996		0	0	15	23	27	49	113	51
1997		0	2	53	0	0	0	55	76
1998		1	1	0	47	50	3	101	56
1999		29	28	1	17	1	0	53	47
2000		226	130	21	9	2	46	357	23
2001		140	155	56	178	98	100	603	23
2002		67	128	41	1489	42	150	1863	46
2003		444	323	264	453	118	46	1332	26
2004		542	53	176	680	685	305	2394	28
				New Survey Gear Introduced					
2005	38	71	349	406	1226	1316	60546	63952	70
2006	114	77	640	481	3148	2855	17197	24514	33
2007	247	386	826	1554	620	899	23957	28488	45

Table 14.13 Cod off Greenland (offshore component), Greenland survey. Age disaggregate abundance indices (1000) for West Greenland, 1992-2007. Since 2005 there has been a change in survey gear.

YEAR	0	1	2	3	4	5	6	7	8+	TOTAL
1992	-	0	221	126	123	63	10	3	1	547
1993	-	0	39	170	73	16	7	1	2	308
1994	-	0	10	126	22	8	1	0	0	167
1995	-	19	345	101	157	40	0	0	0	662
1996	-	0	14	203	78	3	0	0	0	298
1997	-	0	0	10	3	24	8	1	0	46
1998	-	0	17	25	20	0	0	0	0	62
1999	-	7	144	66	23	6	1	1	1	249
2000	-	90	711	363	92	13	52	0	0	1321
2001	-	97	540	546	376	0	0	0	0	1559
2002	-	0	603	2323	1078	245	0	4	0	4253
2003	-	81	1416	1037	433	135	18	0	0	3120
2004	-	1215	2812	1205	786	382	71	33	4	6508
New Survey Gear Introduced										
2005	3284	1348	38177	44685	10490	5595	4596	113	30	108318
2006	244	6804	5826	42612	9722	1956	532	72	0	67768
2007	224	295	12835	6348	29856	2708	166	69	16	52537

Table 14.14: Cod abundance indices (numbers of cod caught per 100 hours net settings) by age as found in NAFO division 1B in the West Greenland inshore gill-net survey 1987 to 2007.

Years																						
Age	1985*	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
1	25,6	4,1	0,2	0,2	0,71	0	0,3	0	0	4,2	1,5	0	0	2,1				30,5	1,3	32,0	47,2	31,9	7
2	22,6	245,4	121,8	32,6	109,8	108,5	3,4	42,7	21,8	7,8	114,6	28,4	14,4	7				206,5	68,2	27,5	122,6	147,8	170
3	0	16	232,6	129,5	82,9	107,7	131,2	9,7	22,4	18,5	18,5	40,4	7,7	4,3				72,1	68,9	28,6	35,0	59,7	82
4	5,8	8	24,5	111,4	56,8	62,4	53,3	18,4	1,6	11,7	6,7	6,8	3,2	6,2				20,7	21,2	8,9	7,1	24,4	15
5	0	2,2	1,1	1,9	32	53	11,3	2,7	0,8	0,4	1,2	0,7	0,7	3,3				9,0	2,9	4,7	4,6	1,3	1
6	0	2	0,1	0,1	0,7	11,9	2,5	0,2	0,2	0,3	0,2	0,2	0	0,3				0,6	0,1	0,4	1,2	0,7	0
7	0	0,3	0,2	0	0	0	0,3	0,1	0,1	0	0	0	0	0				0,3	0		3	0	0
8	0	0	0,1	0	0	0	0	0	0	0	0	0	0	0				0	0	0	0	0	0
CPUE	54	278	380,6	275,7	282,9	343,5	202,3	73,8	46,9	42,9	142,7	76,5	26	23,2	**	**	**	339,7	162,5	102,1	221,1	170,1	275

* incomplete survey coverage

** no survey coverage

Table 14.14 (cont.): Cod abundance indices (numbers of cod caught per 100 hours net settings) by age as found in NAFO division 1D in the West Greenland inshore gill-net survey 1987 to 2007.

Years																						
Age	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
1	68	0	0,6	0	0	0	123,9	0,2	0	0	0	0	2,5	0	0	0,2		0,2	0,2	2,9	9,0	1,8	
2	76,9	95,5	15,7	19,6	78,3	14,4	2,7	60,6	3,9	0,4	2,6	1,1	3,3	10,3	0,4	2,4		6,8	5,6	43,2	26,8	114,0	
3	0,4	14,8	67,6	48	47,2	34,5	17,3	22	57	6	1,8	1,2	1,2	17	1,2	1,9		3,7	4,0	6,2	6,9	36,6	
4	2,7	0	5,3	30,1	12,8	4	6,4	9,5	19,7	4,5	4,2	0,1	0,1	0,5	2,7	0,6		2,7	2,3	2,8	1,9	12,9	
5	2,9	0,4	0,1	0,9	13,2	3,7	2,3	7	1,8	0,5	3,6	1,7	0,2	0,1	0,4	0,6		0,3	1,0	1,1	0	4,3	
6	3,2	0,5	0,1	0,2	0,1	2,8	0,8	0,6	0,3	0,1	0,2	0,1	0,5	0,1	0,1	0,3		0	0,1	0,5	0	0,2	
7	0,2	2,3	0,1	0,1	0	0,1	0,1	0,3	0,1	0	0	0	0	0	0	0,2		0	0	0	0	0	
8	0,8	0	0,4	0,2	0	0	0	0,1	0	0	0	0	0	0	0	0		0	0	0,1	0	0,3	
CPUE	155,1	113,5	89,9	99,1	151,6	59,5	153,5	100,3	82,8	11,5	12,4	4,2	7,8	28	4,8	6,2	**	13,7	13,2	56,8	44,6	170,1	**

* incomplete survey coverage

** no survey coverage

Table 14.14 (cont.): Cod abundance indices (numbers of cod caught per 100 hours net settings) by age as found in NAFO division 1F in the West Greenland inshore gill-net survey 1987 to 2007.

Year:																							
Age	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
1	204	16,5	0	0	0	0	2	0	0	0	0			0		0							6
2	8,4	111,7	142,8	0,9	5,4	0,4	1,5	2,6	4,6	0	0			4		13,8							90
3	0,5	5,3	146,9	82,8	1,8	2,6	0,1	1,4	2,4	1,4	0			12,3		7,5							9
4	0,8	0,1	0,8	5,6	19	1,7	2,1	0,1	0,6	0,7	0			0,2		0,1							21
5	0,7	1,6	0,1	0,1	2,3	12,5	0,2	0,9	0,1	0,2	0			0		1,8							1
6	1,3	0,2	0	0	0	1,3	1,3	0,1	0,3	0,2	0,3			0		0,3							0
7	0,6	0,2	0	0	0	0	0,1	1	0,1	0	0			0		0,6							0
8	0,2	0	0,1	0	0	0	0	0	0	0	0			0		0							0
C	216,5	135,6	290,7	89,4	28,5	18,44	7,3	6,1	8,1	2,5	0,3	**	**	16,5	**	24,1	**	**	**	**	**		108

* incomplete survey cove

** no survey coverage

Table 14.15 Mean weight at age (kg) in the Greenland Survyof offshore cod at West Greenland.

Year	0	1	2	3	4	5	6	7	8
2004		0.040	0.220	0.450	0.820	1.200	1.600	2.800	7.110
2005	0.004	0.032	0.176	0.636	1.030	1.560	1.789	3.177	2.620
2006	0.005	0.023	0.154	0.348	0.531	0.925	1.633	3.428	
2007	0.002	0.027	0.128	0.283	0.648	1.220	2.376	6.704	7.940

Table 14.16. 2007 cod stock estimates for cod off Greenland. The survey abundance is raised by conversion factors derived by regressing VPA abundances on Survey abundance. The data window used for the regression is the decade 1982-1991. See ICES 2007 for the calculation procedure.

Age	Survey Abund.	Conversion Factors	Converted stock Abun.	Mean weight	Maturity ogive	Biomass tons	Spawners tons
1	743	12.34	9,169	0.132	0	1,210	0
2	20152	3.28	66,099	0.237	0	15,665	0
3	12471	0.50	6,236	0.570	0.01	3,554	36
4	135721	0.54	73,289	1.354	0.03	99,234	2,977
5	16959	0.59	10,006	3.002	0.11	30,037	3,304
6	1532	1.93	2,957	4.297	0.32	12,705	4,066
7	1280	1.71	2,189	6.794	0.61	14,871	9,071
8	1135	0.85	965	8.110	0.83	7,824	6,494
9	109	0.85	93	8.799	0.94	815	766
10	0	0.85	0	0	0.98	0	0
Sum	190102				B1+	185,916	
					B3+	169,041	
					SSB		26,714

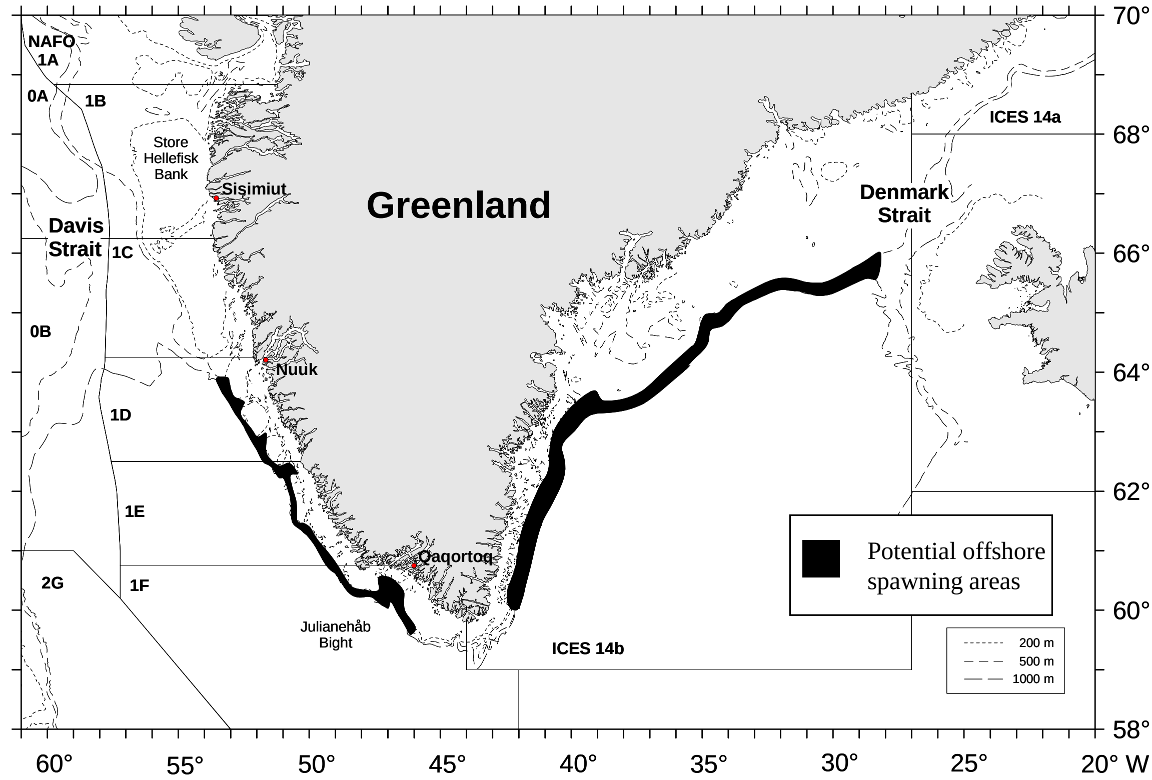


Figure 14.1.1. Historical offshore spawning areas of cod in Greenland.

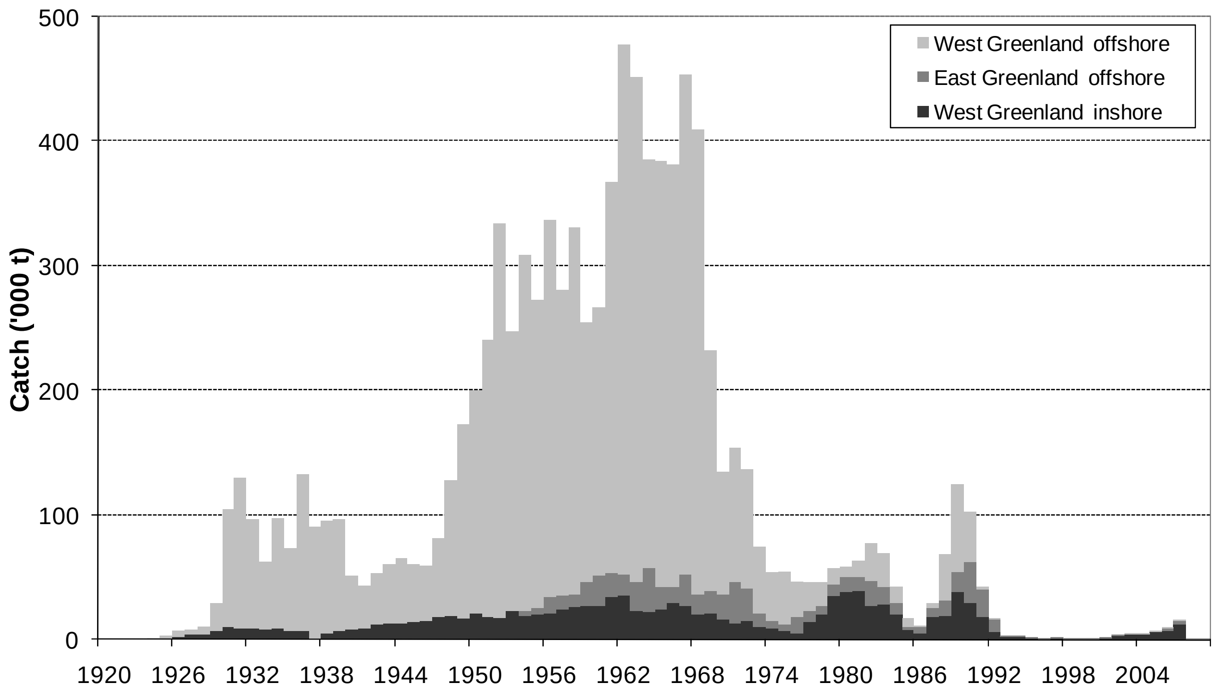
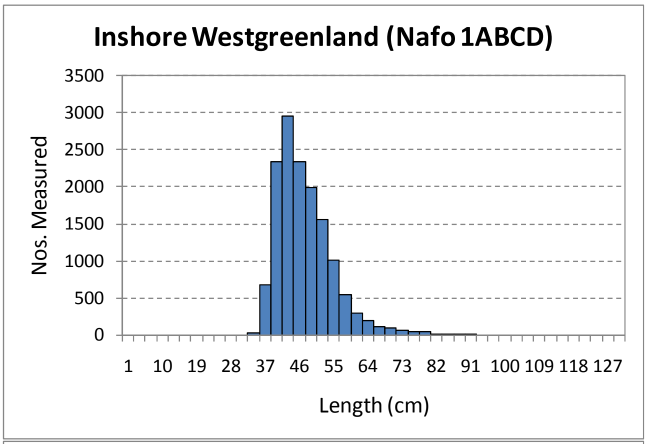
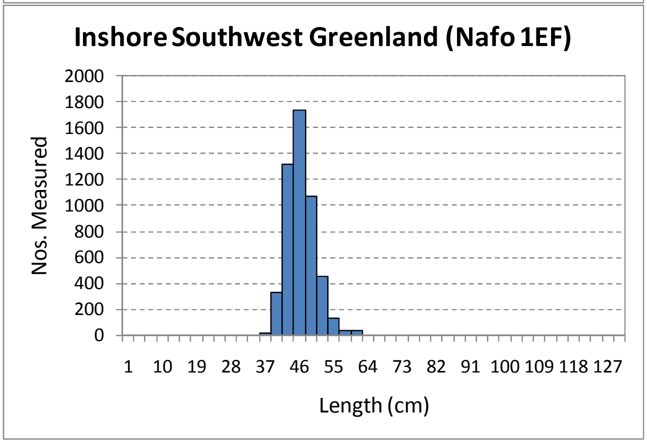
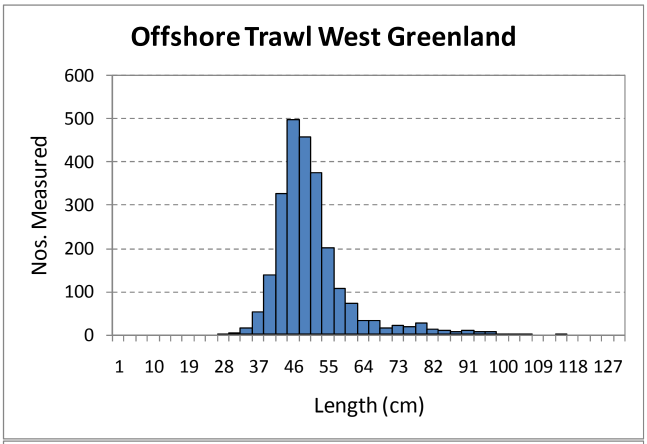
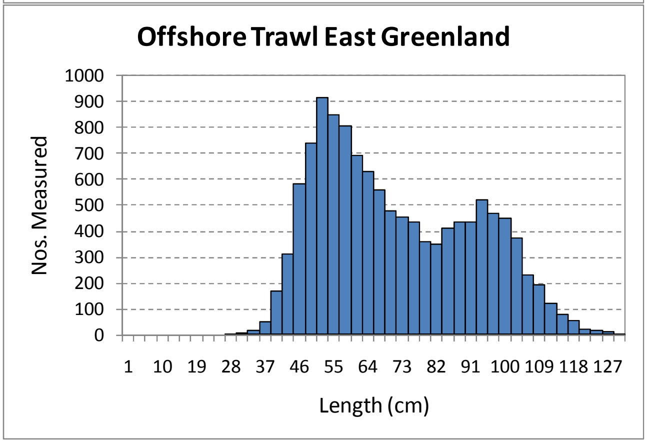


Figure 14.2.1. Cod off Greenland. Catches 1920-2006 as used by the Working Group, inshore and offshore by West and offshore by East Greenland (Horsted 1994,2000). Columns are stacked.


Inshore Westgreenland (Nafo 1ABCD)
Nos. Measured
3500
3000
2500
2000
1500
1000
500
0
1 10 19 28 37 46 55 64 73 82 91 100 109 118 127
Length (cm)


Inshore Southwest Greenland (Nafo 1EF)
Nos. Measured
2000
1800
1600
1400
1200
1000
800
600
400
200
0
1 10 19 28 37 46 55 64 73 82 91 100 109 118 127
Length (cm)


Offshore Trawl West Greenland
Nos. Measured
600
500
400
300
200
100
0
1 10 19 28 37 46 55 64 73 82 91 100 109 118 127
Length (cm)


Offshore Trawl East Greenland
Nos. Measured
1000
900
800
700
600
500
400
300
200
100
0
1 10 19 28 37 46 55 64 73 82 91 100 109 118 127
Length (cm)

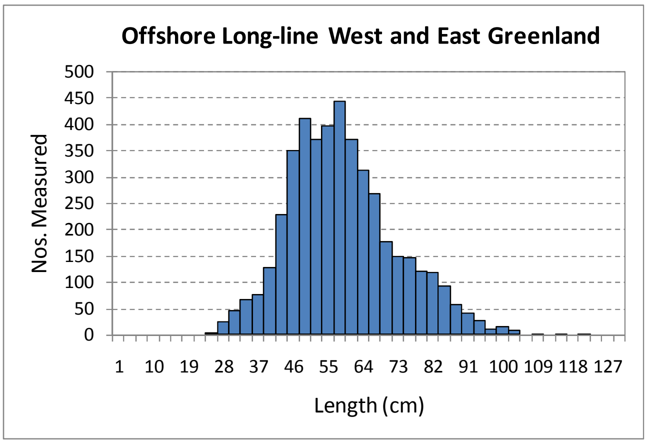


Figure 14.2.2 Length distribution of inshore cod landings in West Greenland (NAFO area 1ABCD), Southwest Greenland (NAFO area 1EF) and offshore cod catches by trawl in West and East Greenland and long-lines in 2007. The long-line catches are predominantly taken off East Greenland.

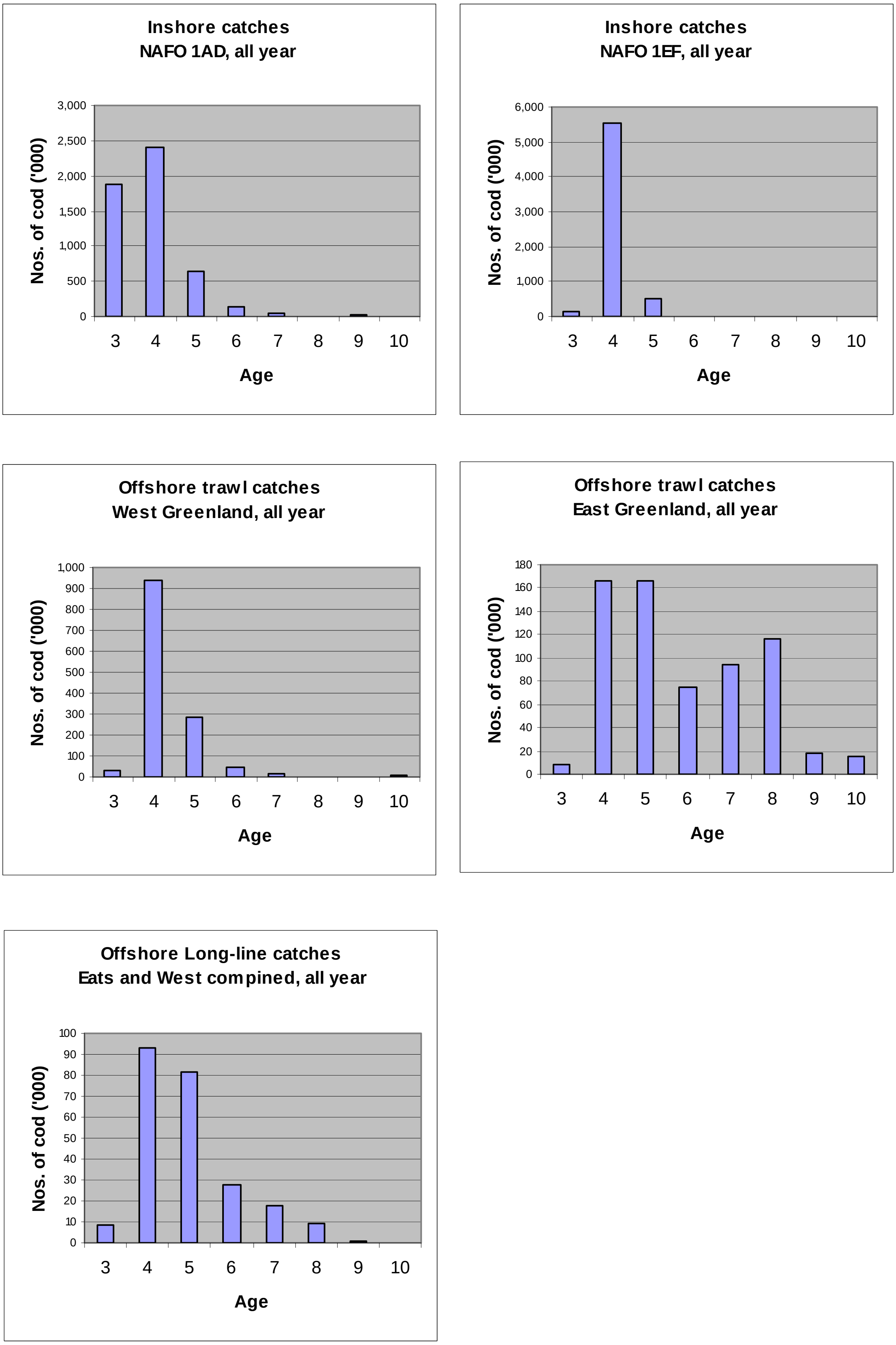


Figure 14.2.3. Age distribution of inshore cod landings in West Greenland (NAFO area 1AD), Southwest Greenland (NAFO area 1EF) and offshore cod catches by trawl in West and East Greenland and long-lines in 2007. The long-line catches are predominantly taken off East Greenland.

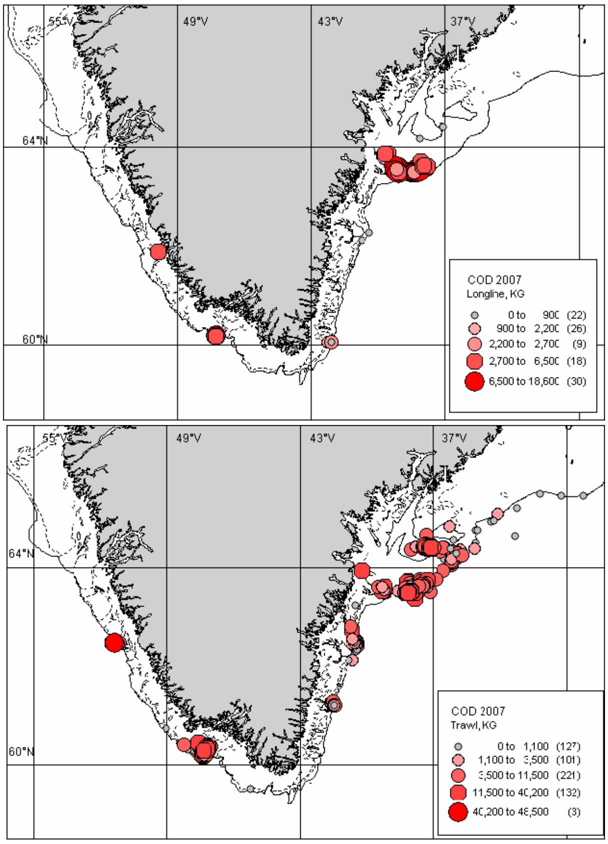


Figure 14.2.4. Fishing areas for offshore trawl and longliners, 2007. Catches are in kg/haul.

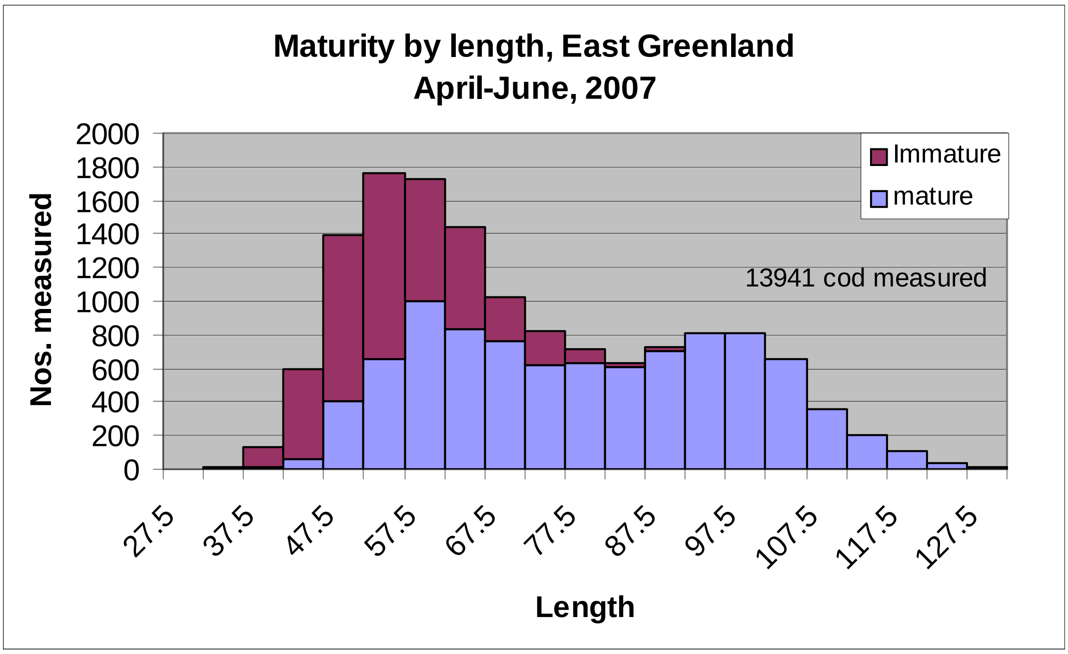


Figure 14.2.5. Maturity information from East Greenland, april-june 2007. Length distribution of catches separated into mature and immature (mature defined as stages III-VII (Tomkiewicz, 2002) immature as stages I-II plus VIII-X). The majority of the matures were actively spawning (stages V-VI).

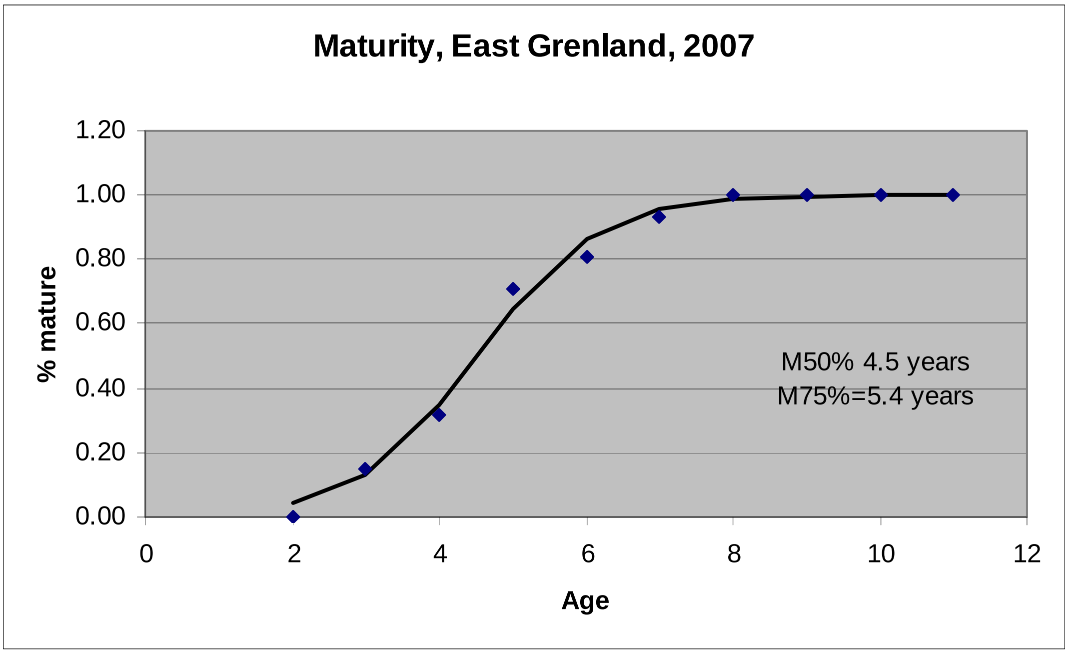
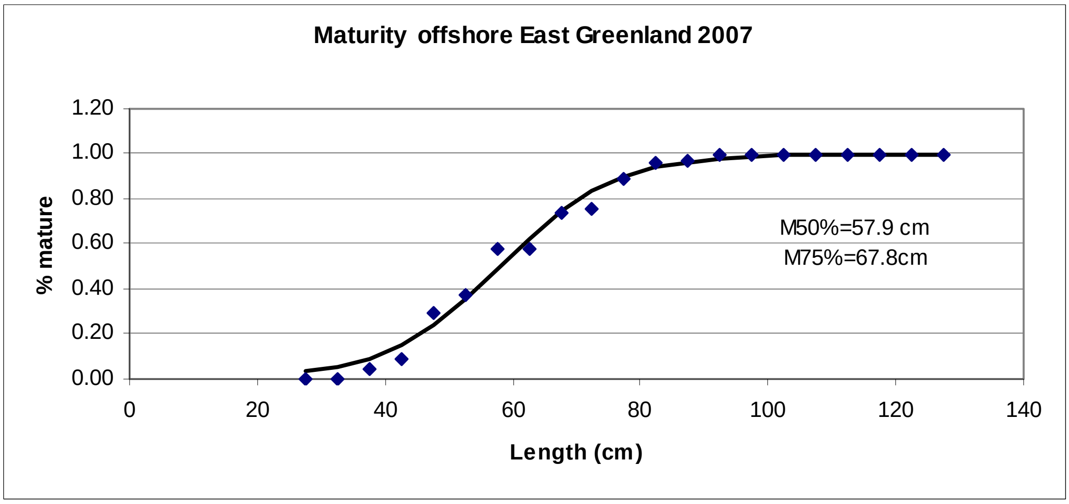


Figure14.2.6. Maturity ogive at age offshore East Greenland 2007. 50% and 75% maturity at age are indicated. (Mature defined as stages III-VII (Tomkiewicz, 2002), immature as stages I-II plus VIII-X).



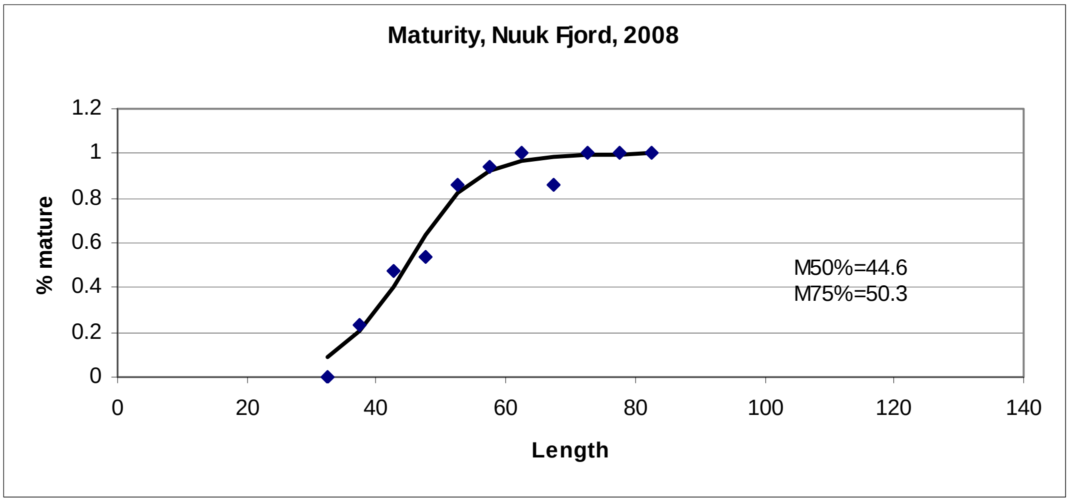


Figure 14.2.7. Maturity at length, Offshore East Greenland and inshore West Greenland.

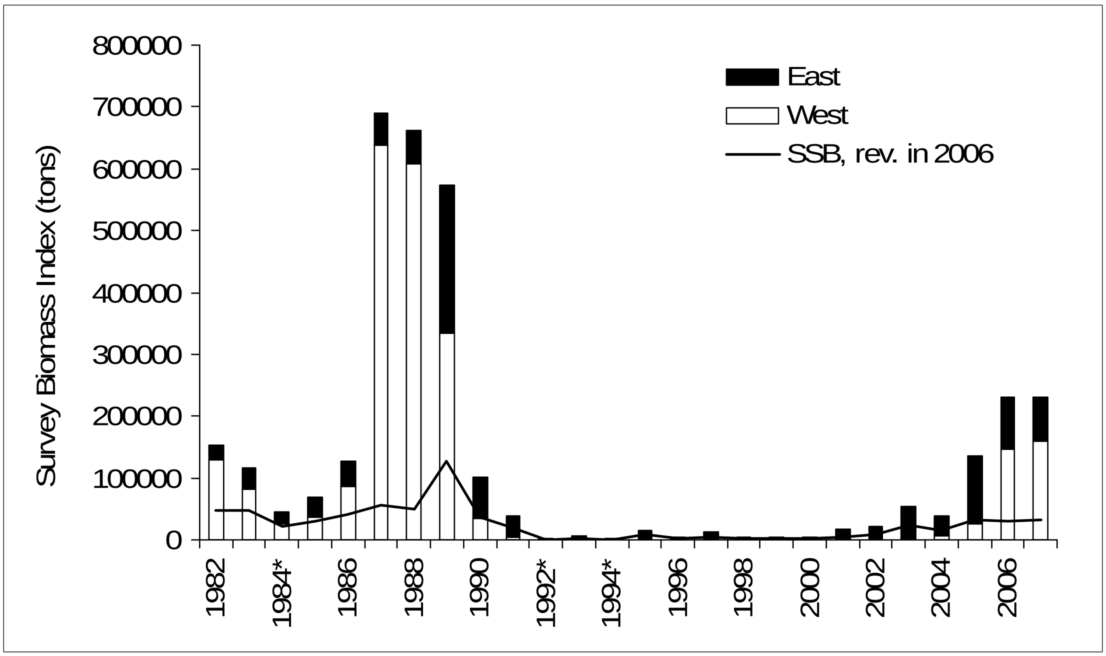


Figure 14.3.1. Cod off Greenland (offshore component), German survey. Aggregated survey biomass indices for West and East Greenland and revised spawning stock biomass, 1982-2005. Incomplete survey coverage in 1984, 1992, 1994, 2006 and 2007.

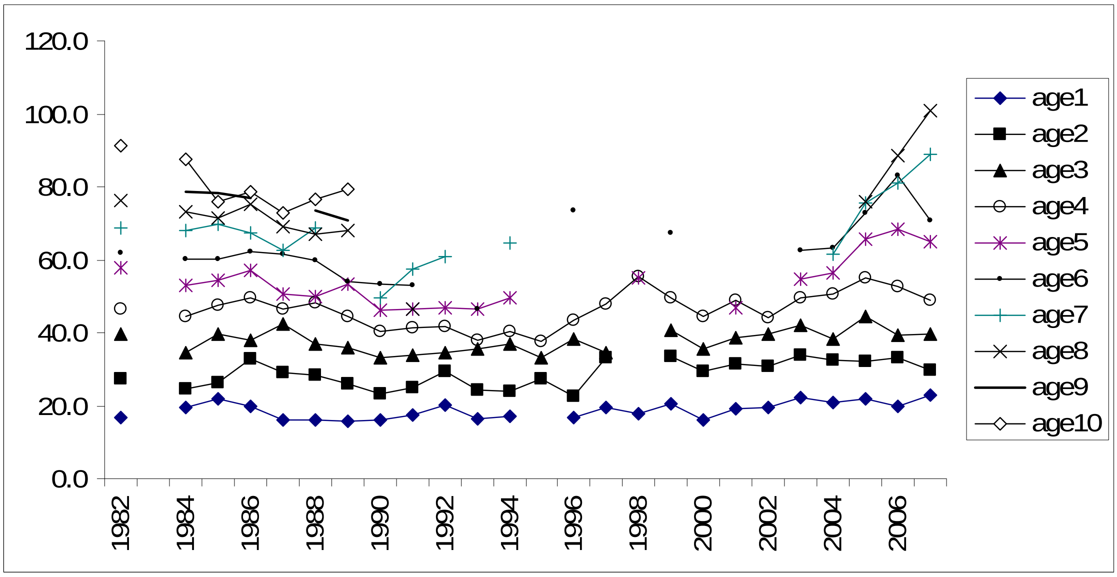


Figure 14.3.2: Weighted mean length at age 1-10 years 1982, 1984-2007 sampled in West Greenland. Data derived from German survey.

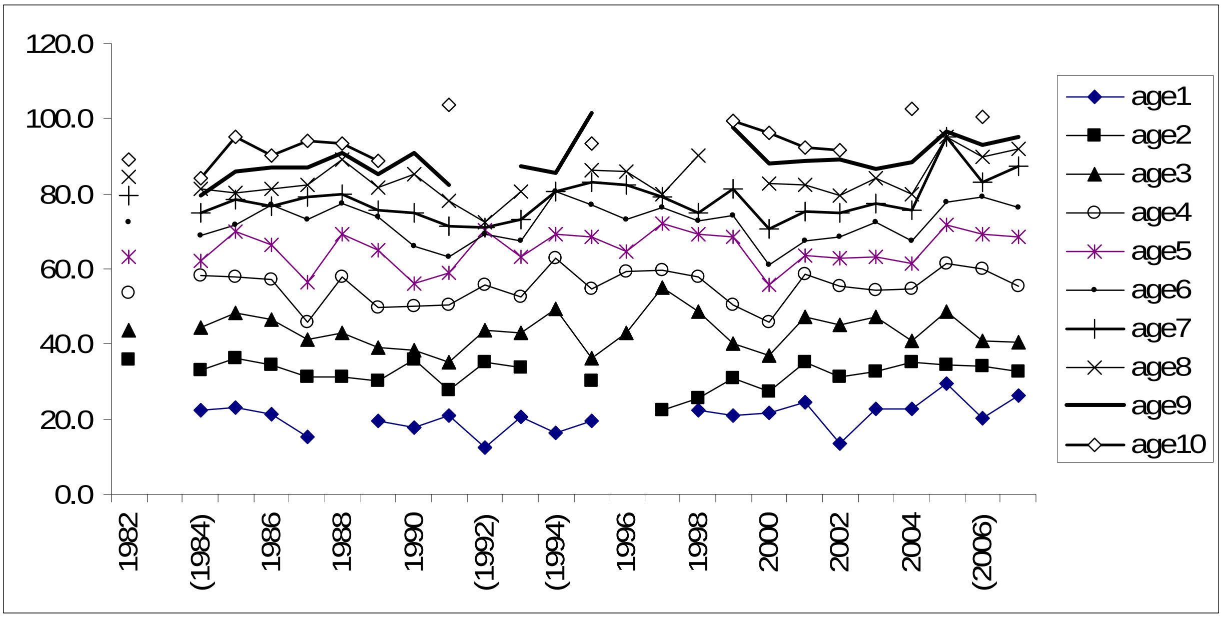


Figure 14.3.3.: Weighted mean length at age 1-10 years 1982, 1984-2007 sampled in East Greenland. Data derived from German survey.

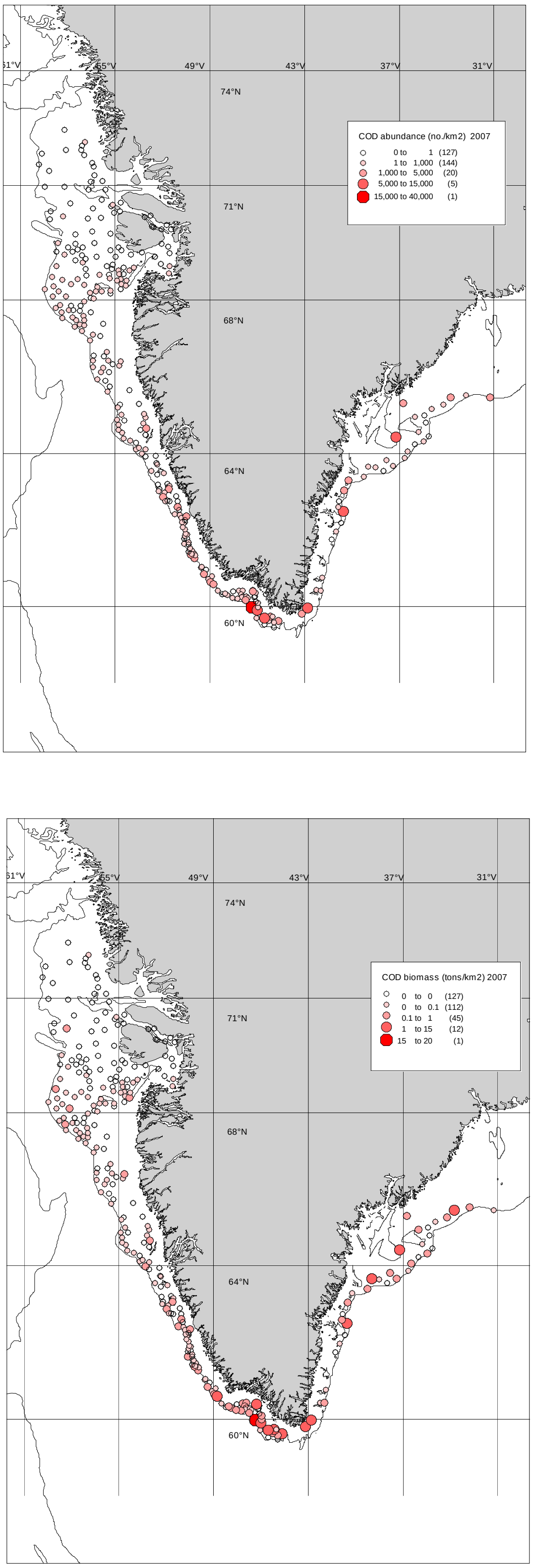
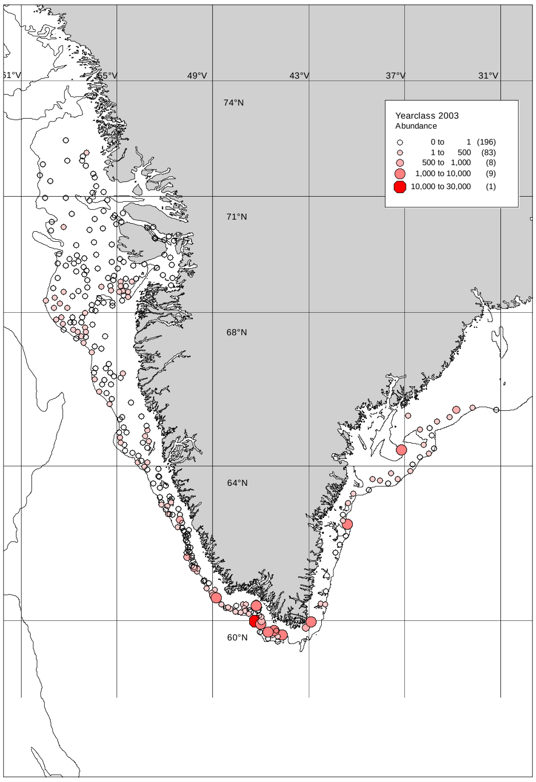


Figure 14.3.4. Number of cod /km^2 and biomass off Greenland (offshore component), Greenland survey (R/V Paamiut). Survey area, stratification and position of hauls carried out in 2007.



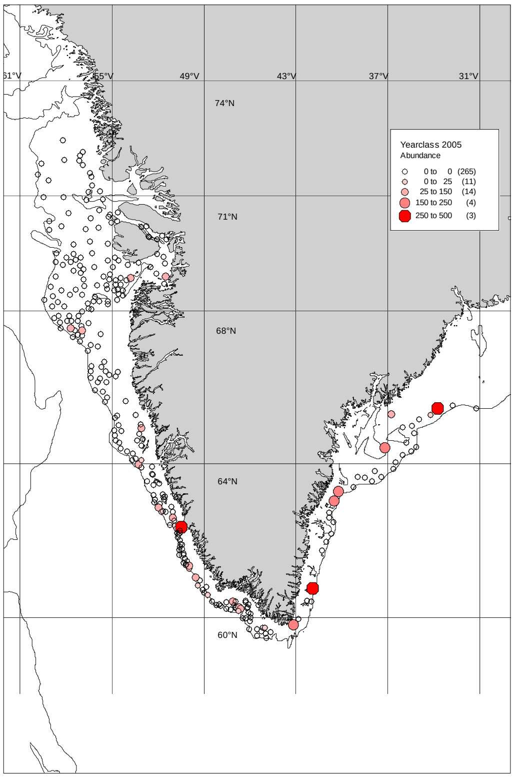
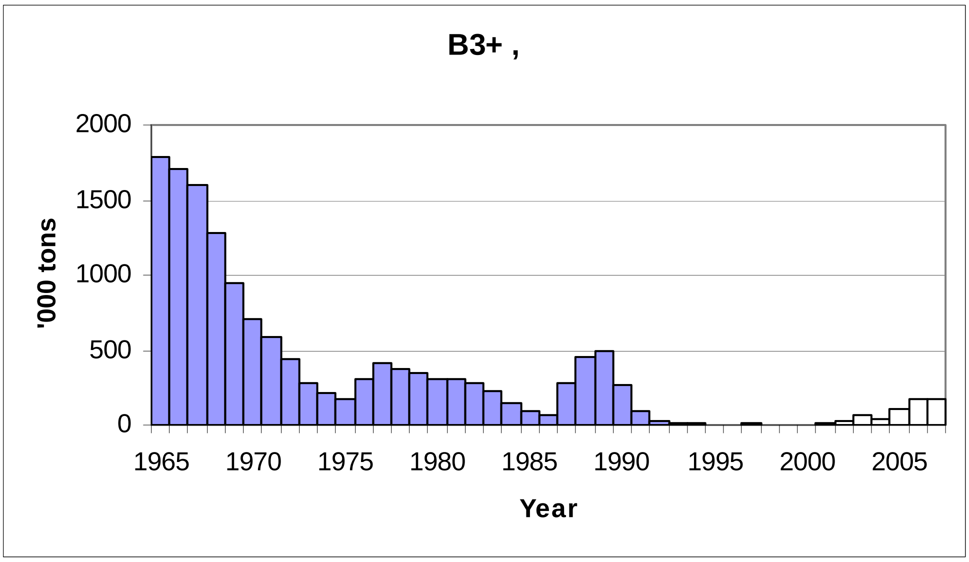


Figure 14.3.5. R/V "Paamiut" Survey 2007. Abundance of year-class 2003 and year class 2005.



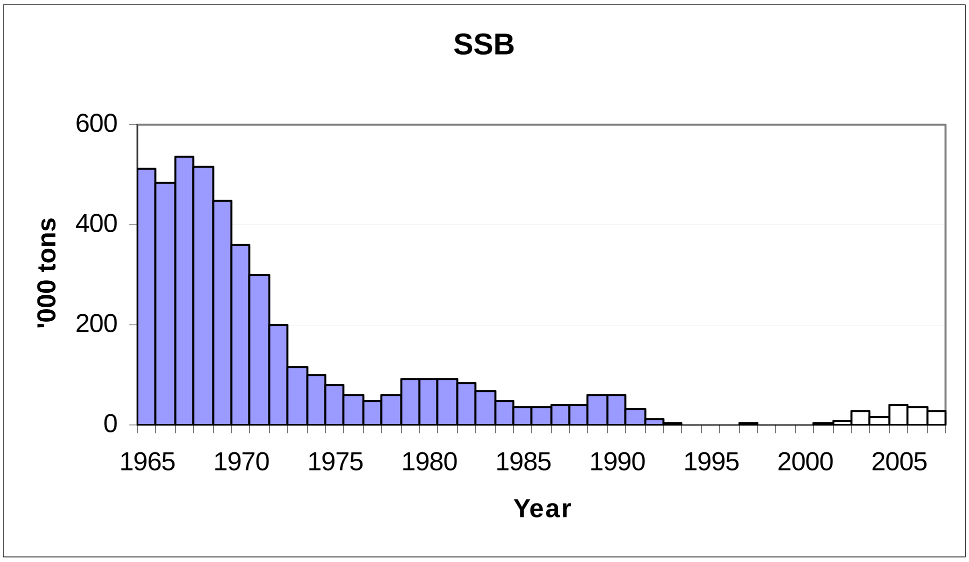


Figure 14.3.6 . Historical Biomass 3+ and SSB of the cod in Greenland waters, 1965-2007. Data until 1995 based on XSA. Data since 1996 derived by applying survey-VPA conversion factors to the observed survey abundance in the German survey.

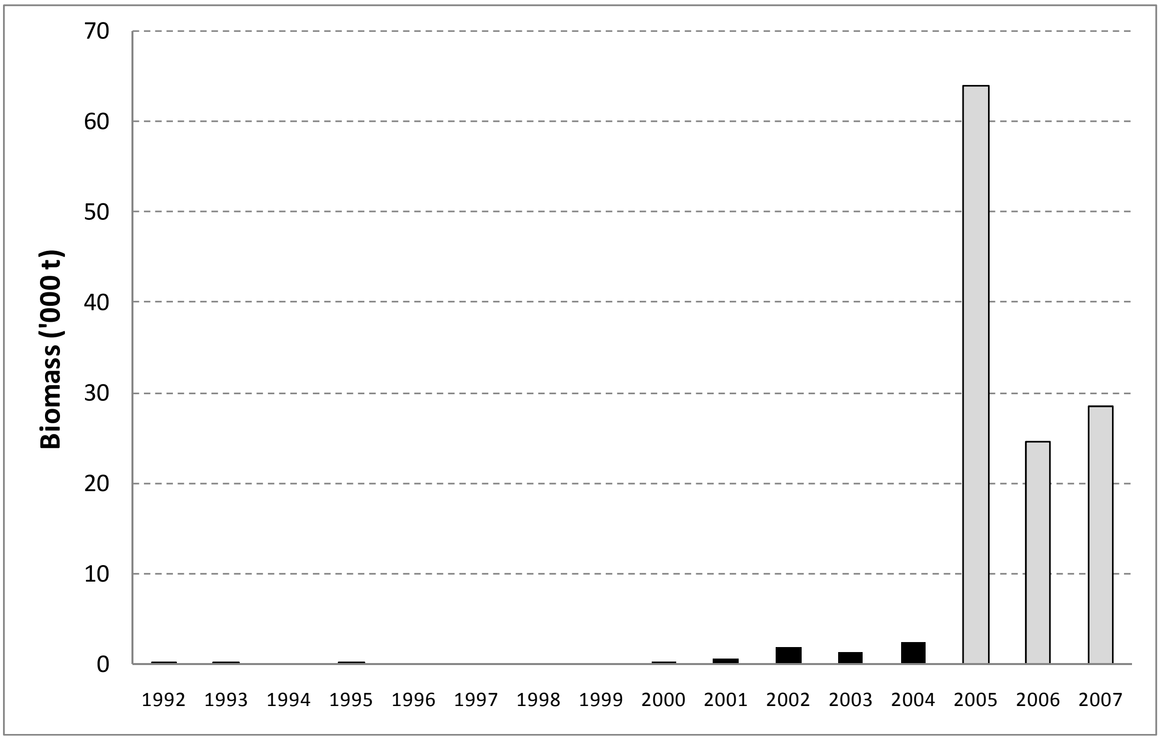


Figure 14.3.7. Cod off Greenland (offshore component), Greenland survey. Aggregated survey biomass indices for West Greenland, 1992-2007. A new survey gear was introduced in 2005.

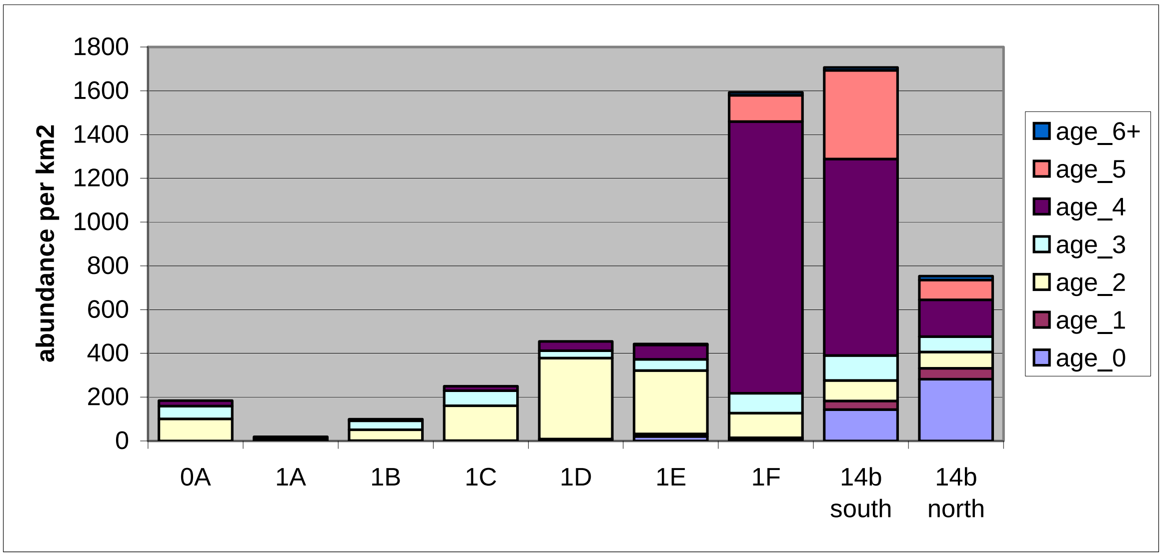
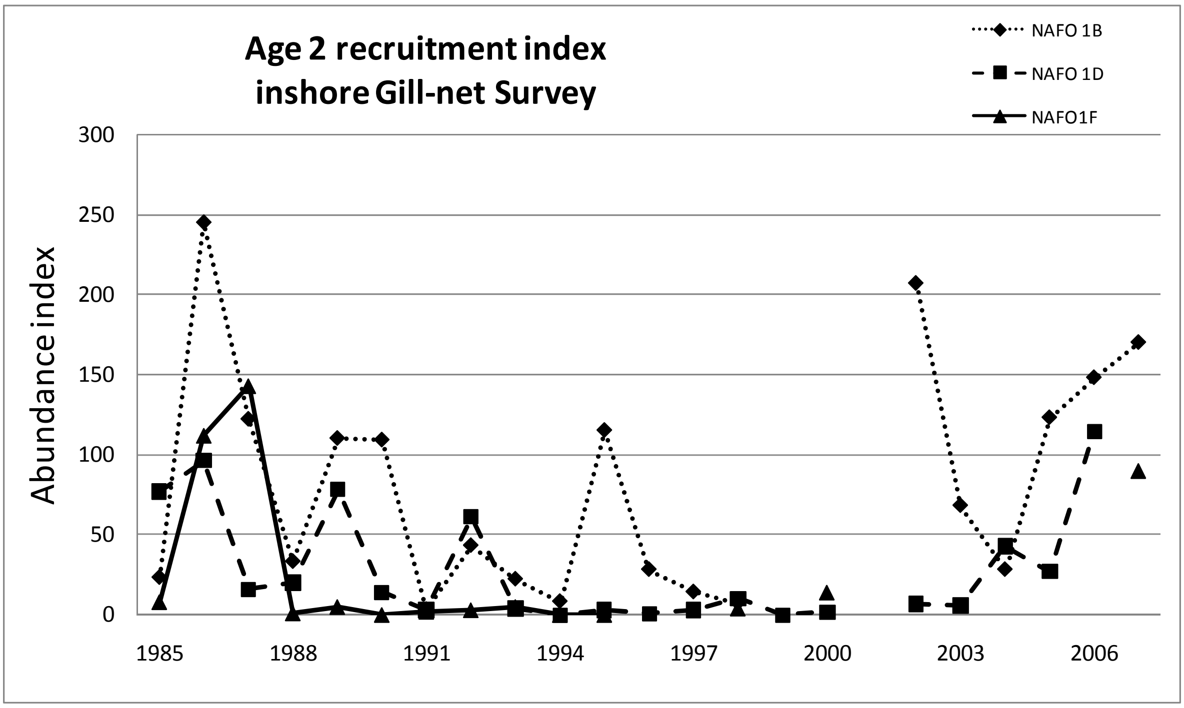


Figure 14.3.8. Cod density by age group and NAFO/ICES areas (14b south is East Greenland south of 63^{o} N. lat.; 14b north is East Greenland north of 63^{o} N. lat.;



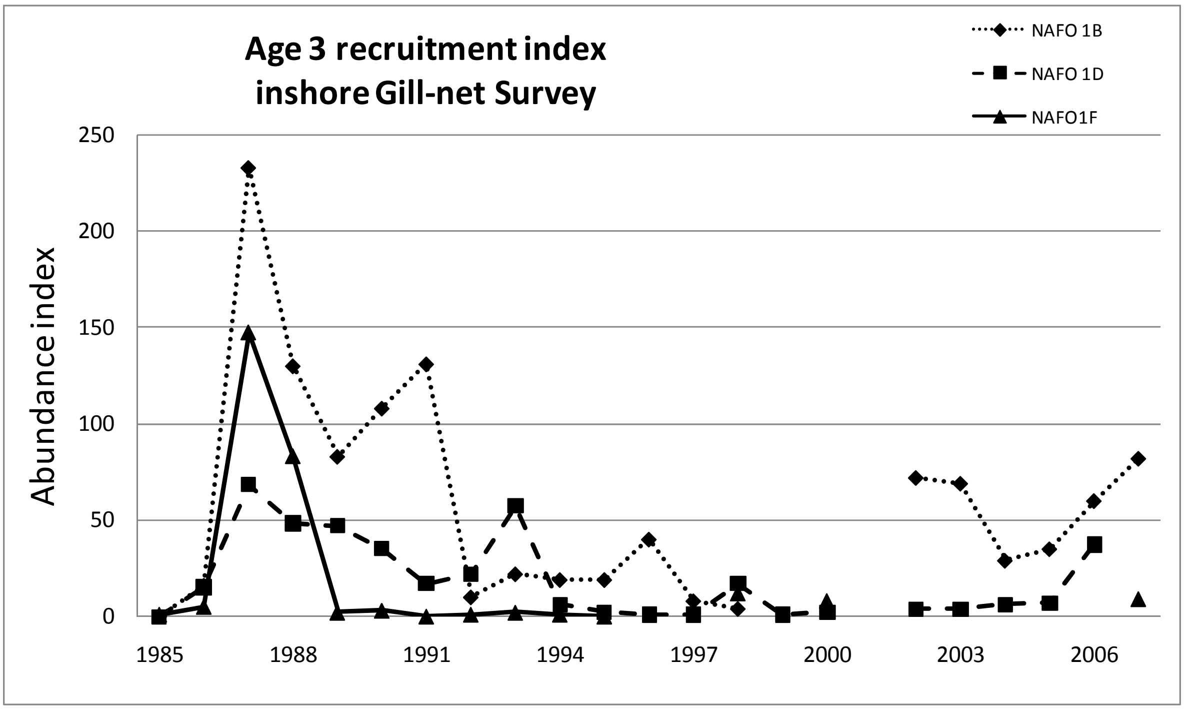


Figure 14.3.9. Recruitment index of age 2 and 3 cod in the inshore gillnet survey in NAFO division 1B, 1D and 1F between 1985 and 2007.

15 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.

15.1 Executive summary

Input data to the assessment this year is unchanged from recent years, except from the catch series that has been prolonged back to the beginning of this fishery. Current surveys have continued and sampling intensity and coverage remains also unchanged. Logbooks from the fishery are still available as haul by haul data. Since 2001 no age readings of otoliths were available from the main fishing areas.

As in 2007 a logistic production model in a Bayesian framework was used to assess stock status and for making predictions. The model for this year included an extended catch series going back to the beginning of the fishery in 1961.

Estimated stock biomass showed an overall decline throughout most of the time series. Since 2004 the stock has been stable at relative low levels well below Bmsy and mortality by fishery exceeds the value that maximizes yield (F_{MSY}).

Stock status 2007-2008

- Stock size:
  - Stock biomass 0.4B_{msy} (median)
  - 100% probability of being below B_{msy}
  - 6-20% risk of being below B_{lim}
- Stock production:
  - MSY = 20 – 35 ktons (inter-quartile range)
  - Actual ≈ 0.6MSY (median)
- Exploitation:
  - -21-20 ktons
  - 2F_{msy} (median)
  - ≈60% risk of exceeding F_{lim}

Predictions

- Risk of exceeding Blim
  - As the stock is estimated to be near B_{lim} and slow growing, the projected risk of exceeding this reference point will be relatively high at any catch level due to the inherent uncertainty in making projections.
- Catch option of 15 ktons/yr
  - Stock biomass is projected to remain near the current low level. There is a high risk going below Blim. F is not projected to decrease towards Fmsy.
- Catch option of 10 ktons/yr
  - Median fishing mortality is projected to decrease towards F_{msy}.
  - Even at this catch level there is still a relative high risk of exceeding Blim due to the low stock size

15.2 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 1981–2007 in Tables 15.1–15.6 and since 1961 in Figureure 15.1. Catches taken within the Icelandic EEZ in Division XIVb have historically been registrated in Division Va. Landings during the decade prior to the extension of the EEZ to 200 nm by coastal nations in 1976 were in the order of 20-35 000 t. From 1976 landings increased from a low of 5 000 t to a record high of about 61 000 t in 1989. Since then landings have decreased markedly to a low of 20 000 t in 1998-99, followed by an increase to about 30 000 t in 2003. From 2003 landings have continually decreased to about 22 000 t in 2007.

Landings in Icelandic waters have historically predominated the total landings in areas V+XIV. In the year 1989 with record high total landings Iceland took 97%. Since then fisheries have developed in Div. XIVb and Vb and these areas have gradually increased their share of the total landings to about 30% - 50% in the past decade. In 2007 landings in Va fell to 10 000 t., while landings in XIV remained increased to about 10 000 t in XIV. Divison Vb has in later years experienced low levels of landings at about 1000 t.

Fisheries and fleets

In 2007 quotas in Greenland EEZ were almost fully utilised by the principal fleets (88%). Anecdotal information from the Greenland fishery justifies the missing utilisation of the Greenland quota due to allocation of effort into a range of other potential fisheries, e.g. exploratory quotas on cod in East Greenland, Barents Sea cod and quotas of Greenland halibut in northwest Greenland (Baffin Bay). Within the Iceland EEZ, quotas in the fishing year 2006/2007 were almost fully utilized (82%) as in the fishing year 2005/2006 (85%) and 2004/2005 (87%). In the Faroe EEZ the fishery is regulated by a fixed numbers of licenses and technical measures like by-catch regulations for the trawlers and depth and gear restrictions for the gillnetters. Total catch has decreased mainly due to less effort in the gillnet fleet.

Most of the fishery for Greenland halibut in Divisions Va, Vb and XIVb is a directed trawl fishery only minor catches in Va by Iceland, and in XIVb by Germany and the UK comes partly from a redfish fishery.

Spatial distribution of 2007 and historic effort and catch in the trawl fishery in XIV and V is provided in Figureures 15.2.-5. Fishery in the entire area had previously occurred in a more or less continuous belt on the continental slope from the slope of the Faroe plateau to southeast of Iceland extending north and west of Iceland and further south to southeast Greenland. Fishing depth ranges from 350-500 m southeast, east and north of Iceland to about 1500 m at East Greenland. In 2007 the distribution of the fishery is limited mostly to western Icelandic fishing grounds and along the east Greenland slopes. A gillnet fishery developed in 2002 north of Iceland with approx. 10% of the catches in Div. Va. This fishery has now ceased.

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 Division VIb in Table 15.5-15.6 derive from the Hatton Bank area. This fishery still contributes insignificant to the total catches in V,VI, XII and XIV.

By-catch and discard

The Greenland halibut trawl fishery is generally a clean fishery with respect to by-catches. By-catches are mainly redfish, sharks and cod. Southeast of Iceland the cod fishery and the minor Greenland halibut fishery are coinciding spatially.

The mandatory use of sorting grids in Va and XIVb in the shrimp fishery operated since November 2002 are observed to have reduced by-catches considerably. Based on sampling from three trips (93 hauls) in 2006 and 2007, scientific staff observed by-catches of Greenland halibut to be less than 1% by weight (2 g or 0.04 specimens per 1 kg shrimp) compared to about 50% by weight (0.48 kg and 0.81 individuals of Greenland halibut were caught per 1 kg shrimp) observed before the implementation of sorting grids (in 2002) (Sünksen 2007, WD # 18).

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.

15.3 Trends in Effort and CPUE

Division Va

Indices of CPUE for the Icelandic trawl fleet directed at Greenland halibut for the period 1985–2007 (Table 6.7, Figure. 15.6-8.) 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 15.7).

Catch rates of Icelandic bottom trawlers decreased for all fishing grounds during 1990–1996 (Figure. 15.6.). Since 1996 catch rates peaked in 2000-2001 and has in recent years been record low. The tendency over time is the same for all fishing grounds in Va (Figure, 15.7.), although the less important fishing grounds in north, east and southeast show a more optimistic view in 2006 and 2007. The derived effort has decreased from a high in 2003-2004 to a level similar to that in 1999-2000. The observed effort from logbook information, suggest an effort pattern with a more pronounced maximum in 1996. (Figure. 15.8.).

Division Vb

Information from logbooks from the Faroese otterboard trawl fleet (>1000 hp) was available for the years 1991-2007 (Table 15.7, Figure. 15.9.-10.). The location of the bulk of fishery has changed from the eastern side of the islands in 1995-1998, to the southwestern side since 2000. Only hauls where Greenland halibut consisted of more than 50% of the catches and conducted on depths more than 450 meters were selected for the analyses. The standardisation procedure for the logbooks were similar to that of 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.

Division XIVb

For Division XIVb, logbook data was available from both Greenland and foreign fleets. In the time series a variable proportion of all logbooks have been available for analysis (on average 40%, since 2006 more than 90%). 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 1991–2007 were standardised in the same way as described for fleets in Va and so was effort (Table 6.7, Figure.15.11.). Since 2005 catch rates have maintained a high level above the average. 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 (Figure. 6.12.). Derived effort increased by approx 50% in 2007.

The trend in CPUE series from Divisions Va, Vb and XIVb do not cohere in the period where time series are comparable. This might indicate different population developments in the areas, but could also be artefacts, i.e. due to different behaviour of the fleets, fish migration between areas or difference in availability to the fishery.

Divisions VI and XIIb

Since 2001 a fishery developed in divisions VIb and XIIb in the Hatton Bank area but catches in recent years are insignificant. Limited fleet information is available (ICES WGDEEP). Norway has been targeting Greenland halibut in the Hatton Bank area using longlines since 2000 (Hareide et al 2002). Catches are reported in both VIb and XIIb. Unstandardised catch rates (kg/1000 hooks) based on available logbooks do not show any consistent patterns. Average catch per 1000 hooks has varied between 33 (1999) and 234 (2003) (Fossen 2004). Greenland halibut has been reported as by-catch from the Spanish fleet since 1998. Unstandardised CPUE series indicate that Greenland halibut catches are low compared to V and XIV; between 10 and 90 kg / h in VIb and below 14 kg/h in XIIb. In addition to the fishery in the Hatton bank area Greenland halibut has also previously been caught in the Reykjanes Ridge area of area XII. (Table 6.5-6.6).

15.4 Catch composition

Otoliths have been sampled from the Icelandic fishery in 2006 but as ageing have not been conducted in Iceland since 2001, no readings were available for the WG. Thus, the only available aged otoliths in the entire area were from the Greenland survey in East Greenland. As this survey mainly catches younger fish than the commercial fishery, i.e. below age 8-9 and as length composition by age in the survey is expected to differ from the commercial fishery, attempts were not made to establish catch-at-age for the total catches. Since 2000 no age-disaggregated assessment has been conducted for Greenland halibut and the lack of a catch-at-age matrix do thus prevent an update of any analytical stock assessment approaches.

Length compositions of catches from the commercial trawl fishery in Div. Va are rather stable from year to year. In Figure 15.13. is shown length distributions since 2000 and compared to average 1985-2006 from the western area of Iceland, comprising the most important fishing grounds. In most years catches are composed of fish smaller than long-term average, while 1985 consist of larger fish than the long-term average. Figure 15.14. show a comparison of length compositions of 2007 catches in XIVb, Va and Vb. Fish size from Va and XIV are somewhat larger than in Vb.

15.5 Survey information

The total surveyed area in 2007 for Greenland halibut in Divisions Va, Vb and XIVb is provided in Figureure 15.15. Most of the areas where commercial fishing takes place (Figure 15.14) are covered by the surveys, although a few areas are not that intensively surveyed.

Division Va

Since 2001 the fishable biomass of Greenland halibut (fish of length equal to or greater than 50 cm) has decreased significantly in Icelandic waters (Figure. 15.15.-16.), but stabilised at a low level since 2004 (Figureure 15.17-18.).

Division Vb

The catch rates from the exploratory fisheries survey (Figure. 15.) shows a continuous downward trend since the beginning of the survey in 1995 (Figure. 15.19).

Division XIVb

Total biomass in the Greenlandic survey (Figure 15.20) in 2007 was estimated at 12000 tons which is a 50% reduction from 2006 (Figure 15.21) and a record low. A GLM analysis performed on the survey catch rates, taking into account area and depth did show a less pessimistic development in catch rates in 2007 (Figure. 15.22.).

SURVEY /DIVISION	NO HAULS IN 2007 (PLANNED HAULS)	DEPTH RANGE (M)	COVERAGE (KM^2)
Va	150 (150)	500-1300	130 000
XIVb	46 (70)	400-1500	29 000

See the stock annex for more extensive descriptions of the surveys and trends.

15.6 Stock Assessment

15.6.1 Summary of the various observation data

A number of indices from surveys and from the commercial fishery are available as indicators for the biomass development.

The surveys in Va and XIV are considered to cover the adult stock distribution in the two divisions adequately, while the survey/exploratory fishery in Vb is not considered a good biomass indicator due to its 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 second principal fleet, gill netters, that covers other areas within Vb. The fleet behaviour is likely influenced by a number of factors, such as weather conditions and sea ice especially in the north-western areas. Over the years also technological development of the fishing gear has probably increased catchability. Therefore CPUE series is considered less qualified as biomass indicators than surveys.

- Div. Va: Fishery and survey indices from Va show similar trends. The fall groundfish survey in Va (1996-2007) indicate a slow recovery from a low level in the last four years for all sizes of fish and in all surveyed areas. Within the same period as the Greenland survey in XIVb is conducted (1998-2007) the Icelandic survey increased catch rates until 2001 followed by a decline until 2004. Icelandic trawl CPUE in 1993-2007 are less than half that observed in 1985-1989. CPUE declined since 2001 but has stabilised in 2005-2007. In the last two years CPUE are currently 1/4 of that in 1985. Effort has increased since the late 1980s, and had a recent low in 1998-00. Effort lowered again from 2004 to 2007 and is now about the low 1998-00 effort.

- Div. Vb: Faroese trawl CPUE (1991-2007) show a slight but continuous decrease in catch rates since 1994, following a significant decrease in the early years 1992-94. The Faroese survey/exploratory fishery decreases within the entire time series 1994-2007.
- Div. XIVb: The Greenland survey in XIV has stable biomass index (GLM) in the early period 1998-2000, but since 2002 index decreased to 2007 . Trawl CPUE's from the various fleets in XIVb have maintained three distinct periods, a period from 1994-1998 with high and stable CPUE following a decrease in 1998-2000, to a stable period with lower CPUE in 2000-2004. In 2005 to 2007 CPUEs was markedly higher but below the high 1994-98 CPUE.

15.6.2 A model based assessment

Assessment and management advice was derived using a stochastic version of the logistic production model and Bayesian inference (Hvingel et al. WD #22). The biomass dynamic process equation of this model was similar to the one used in previous assessments (within the ASPIC framework) and a continuation of that work.

15.6.2.1 Modelling framework

The model was built in a state-space framework (Hvingel and Kingsley 2006, Schnute 1994) with a set of parameters (θ) defining the dynamics of the stock. The posterior distribution for the parameters of the model, $p(\theta | data)$, given a joint prior distribution, $p(\theta)$, and the likelihood of the data, $p(data | \theta)$, was determined using Bayes' (1763) theorem:

(1) $$p(\theta \mid data) \propto p(data \mid \theta)\, p(\theta)$$

The posterior was derived by Monte-Carlo-Markov-Chain (MCMC) sampling methods using WinBUGS v.1.4.3 (Spiegelhalter et al. 2004).

The equation describing the state transition from time t to t+1 was a discrete form of the logistic model of population growth including fishing mortality (e.g. Schaefer (1954), and parameterised in terms of *MSY* (Maximum Sustainable Yield) rather than *r* (intrinsic growth rate) (cf. Fletcher 1978):

(2) $$B_{t+1} = B_t - C_t + 4MSY \frac{B_t}{K}\left(1 - \frac{B_t}{K}\right)$$

K is the carrying capacity, or the equilibrium stock size in the absence of fishing; B_t is the stock biomass; C_t is the catch taken by the fishery.

To reduce the uncertainty introduced by the "catchabilities" (the parameters that scales biomass indices to real biomass) equation (2) was divided throughout by B_{MSY} (Hvingel and Kingsley 2006). Finally a term for the process error was applied and the state equation took the form:

(3) $$P_{t+1} = \left(P_t - \frac{C_t}{B_{MSY}} + \frac{2\,MSY\,P_t}{B_{MSY}}\left(1 - \frac{P_t}{2}\right)\right) \cdot \exp(\nu_t)$$

where P_t is the stock biomass relative to biomass at MSY ($P_t = B_t/B_{MSY}$) in year t. This frames the range of stock biomass (*P*) on a relative scale where $P_{MSY}=1$ and $K=2$. The 'process errors', v, are normally, independently and identically distributed with mean 0 and variance σ_v^2 .

15.6.2.2 Input data

The model synthesized information from input priors and three independent series of Greenland halibut biomasses and one series of catches by the fishery (Table 15.8). The three series of biomass indices were: a standardised series of annual commercial-vessel catch rates for 1985–2007, $CPUE_t$,; and two trawl-survey biomass index for 1996–2007, Ice_t, and 1998-2007, $Green_t$. These indices were scaled to true biomass by catchability parameters, q_{cpue}, q_{Ice} and q_{Green} and lognormal observation errors , ω, κ and ε were applied, giving:

$$CPUE_t = q_{cpue} B_{MSY} P_t \exp(\omega_t)$$

(4)
$$Ice_t = q_{Ice} B_{MSY} P_t \exp(\kappa_t)$$

$$Green_t = q_{Green} B_{MSY} P_t \exp(\varepsilon_t)$$

The error terms, ω, κ and ε are normally, independently and identically distributed with mean 0 and variance σ_{cpue}^2 , σ_{Ice}^2 and σ_{Green}^2 .

Total reported catch in ICES Subareas V, VI, XII and XI 1985-2007 was used as yield data (Table 15.8, Figure. 15.1). The fishery being without major discarding problems or variable misreporting, reported catches were entered into the model as error-free.

Two additional biomass series were available. However, for unknown reasons the Greenland CPUE series showed trends conflicting with those of the other biomass indices – even if restricted to data just opposite the midline next to the Icelandic fishery and were therefore not included. The Faeroese survey covered areas contributing less than 4% of the total catches and was due to design not considered to reflect stock dynamics. This survey it was therefore not included either.

15.6.2.3 Input priors

The distributions of priors are given in Table 15.9. Initial stock size: We did not have any information on the size of the stock in 1985 when the stock index series start and an informative prior for the biomass in that year could not be constructed. However, the fishery started i 1961 (Table 15.1) and it was therefore likely that the stock was close to K in 1960. To provide this information to the model we made it simulate stock development from 1960 and on giving P1960 a normal prior with a mean of 2 (K=2) and a standard error of 0.071 (Figure. 15.23). As we had no observations on stock size until 1985 we ran the model for the 1960-1984 period without the process error in order not to blow up the uncertainty and avoid unrealistically large values of the P1985-estimate due to the long period of 'prediction' (1960 to 1985 = 25 years). The resulting effective prior for P1985 had a median of 1.58 and an inter-quartile range of 1.43 to 1.74 (Table 15.11, Figure. 15.23)

The prior distributions for the error terms associated with the biomass indices (the observation errors) were assigned inverse gamma distributions (the gamma distribution, G(r,μ), is defined by: μrxr-1e-μx/Γ(r); x>0) as error standard deviations typically follow this kind of distribution. Their standard deviations were given inverse gamma distributions with 95% of their values between 0.06 and 0.26, corresponding to CVs ranging from 7 to 26% , which is considered to represent a typical range for such data.

The catchabilities qIce , qGreen and qcpue was given reference priors uniform on a log scale (cf. Gelman et al. 1995, Punt and Hilborn 1997, McAllister and Kirkwood 1998, Hvingel and Kingsley 2006). For all these catchabilities the distributions were truncated at -10 and 1 (log scale) – the range chosen large enough as not to interfere with the posteriors.

To provide the model with information on the order of magnitude of K, its prior was constructed as follows: mean biomass densities recorded by the two surveys are around 0.5 tons/km2. If we assume that the surveys 'sees' around 1/3 of the biomass and that K is in the area of 3-4 times larger than this 1996-2007 level we end up around 5 tons/km2 corresponding to 750 ktons in the total area. The prior for K was therefore given a normal prior with a mean of 750 ktons and standard error of 300 supposed to account for our prior uncertainty and provide a reasonable range of what K might be (WD #22). The sensitivity of model results to changes in this prior was investigated (see section 6.6.2.4).

Low-information or reference priors were given to *MSY*, and σ_v as we had little or no information on what their probability distributions might look like. *MSY* was given a uniform prior between 0 and 300 ktons. The upper limit was chosen high enough not to truncate the posterior distribution (Figure. 15.23).

15.6.2.4 Model performance

Inference were made from samples from the converged part of the MCMC samples as identified by appropriate statistics (Hvingel et al. WD #22). The model was able to produce a reasonable simulation of the observed data (Figure. 15.24). The probabilities of getting more extreme observations than the realised ones given in the data series on stock size were in the range of 0.05 to 0.95 i.e. the observations did not lie in the extreme tails of their posterior distributions (Table 15.10). The CPUE series was generally better estimated than the survey series. No major problems in capturing the variability of the data were detected.

The data could not be expected to carry much information on the parameter P_{1960} – the stock size 25 years prior to when the series of stock biomass series start – and the posterior resembled the prior (Figure.15.23). The prior for K was somewhat updated to slightly higher values. However, the posterior still had a wide distribution. If the information in the prior for K was relaxed or restricted to lower values changes in the central parameters MSY and P_{2007} was small. Overall, the model was robust to changes in the priors for the process and observation errors. Further, the model estimates of stock sizes were relatively insensitive to additions of new data points (Figure. 15.25).

The priors for *MSY* was significantly updated (Figure. 15.23). The posterior for *MSY* was positively skewed with upper and lower quartiles at 22 ktons and 40 ktons (Table 15.11). As mentioned above *MSY* was relatively insensitive to changes in prior distributions. The posterior *K* had an inter-quartile range of 794-1127 ktons (Table 15.11).

15.6.2.5 Assessment results

The time series of estimated median biomass-ratios starts in 1960 as a virgin stock at K (Figure. 15.24). The fishery starts in 1961. While experiencing increasing fishing mortality the stock then declined until the mid 1990s to levels below the optimum, B_{msy}. Some rebuilding towards B_{msy} was then seen but in 2001 the stock started to decline again reaching its lowest level in 2004. Since then the stock has been stable at relative low levels. The risk of the biomass being below Bmsy in 2007 is 100% and 6% of being below Blim (Table 15.12). The prediction for 2008 the risc of going below is 20%.

The median fishing mortality ratio (*F-ratio*) has exceeded F_{msy} since the 1990s (Figure. 15.26). This parameter can only be estimated with relatively large uncertainty and the posteriors therefore also include values below F_{msy}. However, the probability that the F has exceeded F_{msy} is high for most of the series.

The posterior for *MSY* was positively skewed with upper and lower quartiles at 12 ktons and 35 ktons (Table 15.11). As mentioned above MSY was relatively insensitive to changes in prior distributions.

Within a one-year perspective the sensitivity of the stock biomass to alternative catch options seems rather low. This is due to the inertia of the model used (see WD #22) and the low growth rate of the population. Risk associated with five optional catch levels for 2009 are given in Table 15.12.

The risk trajectory associated with ten-year projections of stock development assuming annual catch ranging from 0 to 30 ktons were investigated (Figure. 15.29). The calculated risk is a result of the projected development of the stock and the increase in uncertainty as projections are carried forward.

Catches around 15 ktons are likely to maintain stock size around its current level, while larger catches have a higher probability of causing further reductions in stock size.

A catch of 10 ktons will likely result in stock increase. Taking 20 and higher ktons/yr will increase risk of going below Blim to more than 35% within a 3-year period.

The length distributions from the Icelandic survey are in agreement with the model predictions, i.e. there is no sign of above 1996-2006 average recruitment entering the fishable stock in the near future (Figure. 15.30).

15.6.2.6 Conclusions

Stock status 2007-2008

- Stock size:
  - Stock biomass $0.4B_{msy}$ (median)
  - 100% probability of being below B_{msy}
  - 6-20% risk of being below B_{lim}
- Stock production:
  - MSY = 20 – 35 ktons (inter-quartile range)
  - Actual ≈ 0.6MSY (median)

- Exploitation:
  - 21-20 ktons
  - 2F_{msy} (median)
  - ≈60% risk of exceeding F_{lim}

Predictions

- Risk of exceeding Blim
  - As the stock is estimated to be near B_{lim} and slow growing, the projected risk of exceeding this reference point will be relatively high at any catch level due to the inherent uncertainty in making projections.
- Catch option of 15 ktons/yr
  - Stock biomass is projected to remain near the current low level. There is a high risk going below Blim. F is not projected to decrease towards Fmsy.
- Catch option of 10 ktons/yr
  - Median fishing mortality is projected to decrease towards F_{msy}.
  - Even at this catch level there is still a relative high risk of exceeding Blim due to the low stock size

15.6.3 Precautionary reference points

In 2001-2003 when the stock was assessed by a model of similar structure (ASPIC-framework, (Prager 1994) a F_{pa} reference point (precautionary fishing mortality supposed to act as a buffer for F_{lim} by taking into account uncertainties in the point estimates of F) was introduced in the advice (ACFM 2001). The F_{pa} was set to 0.67F_{msy}.

Other reference points were not explicitly defined. However, this Fpa corresponds to a Bpa = 1.33Bmsy (see calculations at the end of this section). By the standard ICES approach $B_{lim} = B_{pa} \cdot \exp(-1.645\sigma)$, where $\sigma = 0.3$. The set Fpa thus infer the following set of references:

$B_{lim} = 0.81B_{msy}$; $B_{pa} = 1.33B_{msy}$; $F_{lim} = 1.19F_{msy}$; $F_{pa} = 0.67F_{msy}$

Setting reference points that imply a B_{lim} close to B_{msy} does in any circumstances not seem appropriate. Further, as the probability of transgressing reference points is calculated directly in this assessment and uncertainty in model estimates therefore explicitly accounted for "buffer reference points" are no longer needed. We therefore propose to introduce a new set of limit reference points as B_{lim}=0.3B_{msy} and F_{lim}=1.7Fmsy based on the following considerations:

Blim

The Schaefer production curve fitted by the assessment model is the estimated stock-recruitment relation of the stock. The slope of this curve is decreasing linearly (Figure. 6.30) i.e. there is not a distinct "change-point" where recruitment starts to decline rapidly as the stock is reduced, which could provide a candidate for a Blim reference.

A Blim could instead be set in relation to the time it takes for the stock to recover from this point (cf. Cadrin 1999). The time needed to rebuild an overfished stock from Blim back to Bmsy depends on the stock size at Blim, the rate of growth and fishing mortality.

At 30%Bmsy production is reduced to 50% of its maximum (Figure. 15.31). This is equivalent to the SSB-level (spawning stock biomass) at 50% Rmax (maximum recruitment). Greenland halibut is believed to be a slow growing species i.e. with relative low r (intrinsic rate of increase) (Figure. 15.32 left). This means that even without fishery it would take some 10 years to rebuild the stock from 30%Bmsy to Bmsy (calculated by setting r=0.21, the 75th percentile) – but likely longer (Figure. 15.32 right).

Once fished down to low levels the stock will, due to the predicted slow recovery potential, spend proportionally longer time at low levels once a recovery plan is implemented and fishing pressure is relaxed. Longer time at low levels means higher risk of “bad things” happening which could destabilise the stock. We therefore propose that the Blim be set no lower than 30% Bmsy.

Once fished down to low levels the stock will, due to the predicted slow recovery potential, spend proportionally longer time at low levels once a recovery plan is implemented and fishing pressure is relaxed. Longer time at low levels means higher risk of “bad things” happening which could destabilise the stock. We therefore propose that the Blim be set no lower than 30% Bmsy.

Flim

An F-ratio (F/Fmsy) corresponding to a yield of 50%MSY (50%Rmax) at a stock biomass of 30%Bmsy (suggested Blim) may be derived from equation 3 as follows:

$$\frac{production}{B_{MSY}} = \frac{2\,MSY\,P_t}{B_{MSY}}\left(1-\frac{P_t}{2}\right),$$

at equilibrium: $C = production$ and

$$F = \frac{C}{B} = \frac{C}{B_{MSY}}\frac{B_{MSY}}{B} \Rightarrow$$

$$F = \frac{2\,MSY\,P_t}{B_{MSY}}\left(1-\frac{P_t}{2}\right)\frac{1}{P}, \quad \text{as } F_{MSY} = \frac{MSY}{B_{MSY}} \Rightarrow$$

$$\frac{F}{F_{MSY}} = Fratio = 2 - P$$

if Blim is 30%Bmsy (P=0.3) then the corresponding Fratio is 1.7 (Figure. 15.31). The proposed Flim at 1.7Fmsy is the fishing mortality that will drive the stock biomass to Blim.

15.7 Management Considerations

Available biological information and information on distribution of the fisheries suggest that Greenland halibut in XIV and V belong to the same entity and do mix. Historic information on tag-recapture experiments in Iceland have shown that Greenland halibut migrate around Iceland. Similar information from Greenland suggests some mix, both between West Greenland and Iceland but also between East Greenland and Iceland. Therefore, management of the stock needs to be in accordance for the present three distinct management areas, XIV, Va and Vb. At present no formal agreement on the management of the Greenland halibut exists among the three coastal states, Greenland, Iceland, and the Faroe Islands. The regulation schemes of those states have previously resulted in catches well in excess of TAC’s advised by ICES.

15.8 Data consideration

The Icelandic CPUE series has for a decade in the 1990s been used as a biomass indicator in the assessment of the stock. However, with the appearance of the new fisheries and surveys in XIV and Vb, indices for those areas were compiled. The commercial CPUE indices are based on haul by haul data from logbooks, and the fisheries for Greenland halibut in the entire area are clean fishery with minor by-catches indices. Thus the quality of these sources is considered good. Despite these qualities, it cannot be out ruled that they are poor biomass indicators due to an assumed scattered distribution of Greenland halibut. Also poor knowledge of stock structure and distribution of the life stages in the area prevent interpretation of the indices and also their use in any model framework. Thus, for the present model framework, a stock production model, that requires cpue indices, it was necessary to reject the Greenland survey due to a contrasting signal to the other indices, although the quality of the Greenland survey data is considered similar to the series included in the model.

15.8.1 Assessment quality

The assessment relies on a number of indices from surveys and the commercial fishery in absence of material to age-disaggregate the catches. As the stock dynamics as well as stock structure in the entire distribution area is not fully understood, any stock index are not easily selected to describe the entire stock development. Among many, one possibility to improve the quality of the assessment of the stock, age-disaggregation of catches must therefore be recommenced. This will require that the main labs must continue sampling otoliths from Greenland halibut and put higher priority to age-reading work. Work is ongoing on age interpretation from otoliths. Preliminary results suggests that Greenland halibut grow slower than previously thought,

The precision of the survey estimates in XIVb and in Va is equal with cv's within the range 15-20%.

15.8.2 Communication with ACFM, Technical Minutes

The ACFM review group in its 2007 technical minutes rejected the assessment based mainly on feelings: '*the RG did not consider the results convincing*'. The WG found it difficult to respond to this rather unspecific objection. However, the WG noted that the applied assessment framework has gone through a scientific peer-review (Hvingel and Kingsley 2006; Hvingel 2006), it is already in use (and accepted) for one ICES stock (Pandalus in the Barents Sea) and that it have been used in NAFO since 2002.

The RG also noted that '*estimates of model parameters are conditional on the assumptions made about the virgin stock*'. The WG suspects that some information might have escaped the RG. WD25 says about the virgin stock that "*changing this prior to make it convey less information by giving $P_{initial}$ a uniform prior between 0 and 2.5 resulted in a slightly more pessimistic interpretation of stock status. This was in particular due to larger uncertainties in estimated stock sizes. However, the estimated posterior for MSY was only marginally affected*'. This observation is expected and in accordance with a general behavior of productions models (eg. Prager 1994). Nevertheless, the WG in this year's model-run followed the advice of the RG to use an extended catch series going back to the beginning of the fishery and start model simulations when the stock could be considered near virgin biomass.

Table 15.1 GREENLAND HALIBUT. Nominal landings (tonnes) by countries, in Sub-areas V, VI, XII and XIV 1981-2005, as officially reported to ICES and estimated by WG

Country	1981	1982	1983	1984	1985	1986	1987	1988	1989
Denmark	-	-	-	-	-	-	6	+	-
Faroe Islands	767	1 532	1 146	2 502	1 052	853	1 096	1 378	2 319
France	8	27	236	489	845	52	19	25	-
Germany	3 007	2 581	1 142	936	863	858	565	637	493
Greenland	+	1	5	15	81	177	154	37	11
Iceland	15 457	28 300	28 360	30 080	29 231	31 044	44 780	49 040	58 330
Norway	-	-	2	2	3	+	2	1	3
Russia	-	-	-	-	-	-	-	-	-
UK (Engl. and Wales)	-	-	-	-	-	-	-	-	-
UK (Scotland)	-	-	-	-	-	-	-	-	-
United Kingdom	-	-	-	-	-	-	-	-	-
Total	19 239	32 441	30 891	34 024	32 075	32 984	46 622	51 118	61 156
Working Group estimate	-	-	-	-	-	-	-	-	61 396

Country	1990	1991	1992	1993	1994	1995	1996	1997	1998
Denmark	-	-	-	-	-	-	1	-	
Faroe Islands	1 803	1 566	2 128	4 405	6 241	3 763	6 148	4 971	3 817
France	-	-	3	2	-	-	29	11	8
Germany	336	303	382	415	648	811	3 368	3 342	3 056
Greenland	40	66	437	288	867	533	1 162	1 129	747
Iceland	36 557	34 883	31 955	33 987	27 778	27 383	22 055	18 569	10 728
Norway	50	34	221	846	1 173 [1]	1 810	2 164	1 939	1 367
Russia	-	-	5	-	-	10	424	37	52
Spain									89
UK (Engl. and Wales)	27	38	109	811	513	1 436	386	218	190
UK (Scotland)	-	-	19	26	84	232	25	26	43
United Kingdom									
Total	38 813	36 890	35 259	40 780	37 305	36 006	35 762	30 242	20 360
Working Group estimate	39 326	37 950	35 423	40 817	36 958	36 300	35 825	30 309	20 382

Country	1999	2000	2001	2002	2003 [1]	2004 [1]	2005 [1]	2006 [1]	2007 [1]
Denmark		-	-	-	-	-	-	-	-
Estonia		-	-	8	-	-	5	3	-
Faroe Islands	3 884	-	121	334	458	338	1 150	855	1 141
France	-	2	32	290	177	157	-	62	17
Germany	3 082	3 265	2 800	2 050	2 948	5 169	5 150	4 299	4 930
Greenland	200	1 740	1 553	1 887	1 459	-	-	-	-
Iceland	11 180	14 537	16 590	19 224	20 366	15 478	13 023	11 798	-
Ireland		-	56	-	-	-	-	-	-
Lithuania		-	-	-	2	1	-	2	3
Norway	1 187	1 750	2 243	1 998	1 074	1 233	1 124	1 097	692
Poland		-	2	16	93	207	-	-	-
Portugal		-	6	130	-	-	-	1 094	-
Russia	138	183	187	44	-	262	-	552	501
Spain		779	1 698	1 395	3 075	4 721	506	33	-
UK (Engl. and Wales)	261	370	227	71	40	49	10	1	-
UK (Scotland)	69	121	130	181	367	367	391	1	-
United Kingdom	-	166	252	255	841	1 304	220	93	17
Total	20 001	22 913	25 897	27 883	30 900	29 286	21 579	19 890	7 301
Working Group estimate	20 371	26 644	27 291	29 158	30 891	27 102	24 978	21 466	21 873

1) Provisional data

Table 15.2 GREENLAND HALIBUT. Nominal landings (tonnes) by countries, in Division Va 1981-2005, as officially reported to ICES and estimated by WG.

Country	1981	1982	1983	1984	1985	1986	1987	1988	1989
Faroe Islands	325	669	33	46			15	379	719
Germany									
Greenland									
Iceland	15 455	28 300	28 359	30 078	29 195	31 027	44 644	49 000	58 330
Norway			+	+	2				
Total	15 780	28 969	28 392	30 124	29 197	31 027	44 659	49 379	59 049
Working Group estimate									59 272 [2]

Country	1990	1991	1992	1993	1994	1995	1996	1997	1998
Faroe Islands	739	273	23	166	910	13	14	26	6
Germany					1	2	4		9
Greenland					1				[1]
Iceland	36 557	34 883	31 955	33 968	27 696	27 376	22 055	16 766	10 580
Norway								[1]	[1]
Total	37 296	35 156	31 978	34 134	28 608	27 391	22 073	16 792	10 595
Working Group estimate	37 308 [2]	35 413 [2]							

Country	1999	2000	2001	2002	2003 [1]	2004 [1]	2005 [1]	2006 [1]	2 007
Faroe Islands	9		15	7	34	29	77	16	25
Germany	13	22	50	31	23	10	6	1	228
Greenland									
Iceland	11 087	14 507	2 310 [4]	2 277 [4]	20 360	15 478	13 023	11 798	
Norway							100		691
Russia									
UK (E/W/I)	26	73	50	21	16	8	8	1	
UK Scottland	3	5	12	16	5	2	27	1	
UK									1
Total	11 138	14 607	2 437	2 352	20 438	15 527	13 241	11 817	945
Working Group estimate		14 607	16 752	19 714	20 415	15 477	13 172	11 817	10 525

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 15.3 GREENLAND HALIBUT. Nominal landings (tonnes) by countries, in Division Vb 1981-2005 as officially reported to ICES and estimated by WG.

Country	1981	1982	1983	1984	1985	1986	1987	1988	1989
Denmark	-	-	-	-	-	-	6	+	-
Faroe Islands	442	863	1 112	2 456	1 052	775	907	901	1 513
France	8	27	236	489	845	52	19	25	...
Germany	114	142	86	118	227	113	109	42	73
Greenland	-	-	-	-	-	-	-	-	-
Norway	2	+	2	2	2	+	2	1	3
UK (Engl. and Wales)	-	-	-	-	-	-	-	-	-
UK (Scotland)	-	-	-	-	-	-	-	-	-
United Kingdom	-	-	-	-	-	-	-	-	-
Total	566	1 032	1 436	3 065	2 126	940	1 043	969	1 589
Working Group estimate	-	-	-	-	-	-	-	-	1 606 [2]

Country	1990	1991	1992	1993	1994	1995	1996	1997	1998
Denmark	-	-	-	-	-	-	-	-	
Faroe Islands	1 064	1 293	2 105	4 058	5 163	3 603	6 004	4750	3660
France [6]	...	...	3 [1]	2	1	28	29	11	8 [1]
Germany	43	24	71	24	8	1	21	41	
Greenland	-	-	-	-	-	-	-	-	
Norway	42	16	25	335	53	142	281	42 [1]	114 [1]
UK (Engl. and Wales)	-	-	1	15	-	31	122		
UK (Scotland)	-	-	1	-	-	27	12	26	43
United Kingdom	-	-	-	-	-				
Total	1 149	1 333	2 206	4 434	5 225	3 832	6 469	4 870	3825
Working Group estimate	1 282 [2]	1 662 [2]	2 269 [2]	-	-		-	-	-58

Country	1999	2000 [1]	2001 [1]	2002 [1]	2003 [1]	2004 [1]	2005 [1]	2006 [1]	2007 [1]
Denmark									
Faroe Islands	3873		106	13	58	35	887	817	1116
France		1	32	4	8	17		40	9
Germany	22								
Iceland									
Ireland									
Norway	87	1	2	1	1		1		1
UK (Engl. and Wales)	9	35	77	50	24	41	2		
UK (Scotland)	66	116	118	141	174	87	204		
United Kingdom								19	1
Total	4057	153	335	209	265	180	1 094	876	1 127
Working Group estimate	2694 [2]	5079	3 951	2 694	2 459	1 771	892	873	1060

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 15.4 GREENLAND HALIBUT. Nominal landings (tonnes) by countries, in Sub-area XIV 1981-2005, as officially reported to ICES and estimated by WG.

Country	1981	1982	1983	1984	1985	1986	1987	1988	1989
Faroe Islands	-	-	-	-	-	78	74	98	87
Germany	2 893	2 439	1 054	818	636	745	456	595	420
Greenland	+	1	5	15	81	177	154	37	11
Iceland	-	-	1	2	36	17	136	40	+
Norway	-	-	-	+	-	-	-	-	-
Russia	-	-	-	-	-	-	-	-	+
UK (Engl. and Wales)	-	-	-	-	-	-	-	-	-
UK (Scotland)	-	-	-	-	-	-	-	-	-
United Kingdom	-	-	-	-	-	-	-	-	-
Total	2 893	2 440	1 060	835	753	1 017	820	770	518
Working Group estimate	-	-	-	-	-	-	-	-	-

Country	1990	1991	1992	1993	1994	1995	1996	1997	1998
Denmark	-	-	-	-	-	-	1	+	+
Faroe Islands	-	-	-	181	168	147	130	148	151
Germany	293	279	311	391	639	808	3 343	3 301	3 399
Greenland	40	66	437	288	866	533	1 162	1 129	747 [1,7]
Iceland	-	-	-	19	82	7	-	1 803	148
Norway	8	18	196	511	1 120	1 668	1 881	1 897 [1]	1 253 [1]
Russia	-	-	5	-	-	10	424	37	52
UK (Engl. and Wales)	27	38	108	796	513	1405	264	218	190
UK (Scotland)	-	-	18	26	84	205	13		
United Kingdom	-	-	-	-	-	-	-		
Total	368	401	1 075	2 212	3 472	4 783	7 218	8 533	5940
Working Group estimate	736 [2]	875 [3]	1 176 [4]	2 249 [5]	3 125 [6]	5 077 [7]	7 283 [8]	8 558 [9]	

Country	1999	2000	2001 [1]	2002 [1]	2003 [1]	2004 [1]	2005 [1]	2006 [1]	2007 [1]
Denmark									
Faroe Islands	2			274	366	274	186	22	
Germany	3047	3243	2 750	2 019	2 925	5 159	5 144	4 298	4 702
Greenland	200 [1,4]	1740	1 553	1 887	1 459				
Iceland	93	30	14 280	16 947	6				
Ireland			7						
Norway	1100	1161	1 424	1 660	846	1 114	1 023	1 094	
Poland						205			
Portugal			6	130				1 094	
Russia	138	183	186	44		261		505	500
Spain		8	10		2 131	3 406	2		
UK (Engl. and Wales)	226	262	100						
UK (Scotland)				24	188	278	160		
United Kingdom				178	799	1 294			
Total	4806	6627	20 316	23 163	8 720	11 991	6 515	7 013	5 202
Working Group estimate	5376 [11]	6958	6 588 [6]	6 750 [6]	8 017	9 854	10 185	8 589	10 261

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 15.5 GREENLAND HALIBUT. Nominal landings (tonnes) by countries in Sub-area XII, as officially reported to the ICES and estimated by WG

Country	1996	1997	1998	1999	2000	2001	2002	2003 [1]	2004 [1]	2005 [1]	2006 [1]	2007 [1]
Faroe Islands		47					40					
France					1			4	30			
Ireland						49						
Lithuania								2	1		2	3
Poland						2		2	1			
Spain [2]	2	42	67	137	751	1338	28	730	1145	501		
UK					7	5				3		
Russia											46	1
Norway	2				553	500	316	201	119			
Estonia											2	
Total	4	89	67	137	1 312	1 894	384	939	1 296	504	50	4
WG estimate												

[1] Provisional data

[2] Based on estimates by observers onboard vessels

Table 15.6 GREENLAND HALIBUT. Nominal landings (tonnes) by countries in Sub-area VI, as officially reported to the ICES and estimated by WG.

Country	1996	1997	1998	1999	2000	2001	2002	2003 [1]	2004 [1]	2005 [1]	2006 [1]	2007 [1]
Estonia							8			5	1	
Faroe Islands												
France							286	165	110		22	8
Poland							16	91	1			
Spain [2]			22	88	20	350	1367	214	170	3	33	
UK					159	247	77	42	10	217	74	15
Russia						1			1		1	
Norway					35	317	21	26			3	
Total	0	0	22	88	214	915	1775	538	292	225	134	23
WG estimate												

[1] Provisional data

[2] Based on estimates by observers onboard vessels

Table 15.7. CPUE indices of trawl fleets in Div Va, Vb and XIVb as derived from GLM multiplicative models.

area	year	cpue	% change in CPUE between years	landings	relative derived effort	% change in effort between years
Iceland Va	1985	1.00		29.197	100	
	1986	1.01	1	31.027	105	5
	1987	1.08	6	44.659	135	29
	1988	1.08	1	49.379	110	-19
	1989	1.04	-4	59.049	125	14
	1990	0.71	-32	37.308	93	-26
	1991	0.68	-4	35.413	98	6
	1992	0.60	-12	31.978	103	5
	1993	0.47	-21	34.134	136	32
	1994	0.39	-18	28.608	102	-25
	1995	0.31	-20	27.391	120	18
	1996	0.26	-16	22.073	96	-20
	1997	0.28	7	16.792	71	-26
	1998	0.43	57	10.595	40	-44
	1999	0.50	15	11.138	91	127
	2000	0.57	14	14.607	115	26
	2001	0.59	4	16.755	111	-4
	2002	0.49	-18	19.714	143	29
	2003	0.32	-34	20.415	157	10
	2004	0.22	-31	15.477	110	-30
	2005	0.24	8	13.015	78	-29
	2006	0.24	2	11.817	89	14
	2007	0.28	15	10.525	78	-13
Greenland, XIVb	1991	1.00		875	100	0
	1992	0.90	-10	1.176	150	50
	1993	2.51	181	2.249	68	-55
	1994	3.26	30	3.125	107	57
	1995	3.53	8	5.077	150	40
	1996	3.81	8	7.283	133	-11
	1997	4.02	6	8.558	111	-16
	1998	3.82	-5	5.940	73	-34
	1999	3.02	-21	5.376	114	56
	2000	2.36	-22	6.958	166	45
	2001	2.43	3	7.216	101	-39
	2002	2.54	5	6.750	89	-12
	2003	2.53	0	8.017	119	34
	2004	2.42	-5	9.854	129	8
	2005	3.29	36	10.185	76	-41
	2006	3.40	3	8589	81	7
	2007	3.24	-5	10261	125	54
Faroe Islands, Vb	1991	1.00		1.662	100	32
	1992	1.09	9	2.269	125	25
	1993	0.83	-24	4.434	258	107
	1994	0.54	-35	5.225	180	-30
	1995	0.56	4	3.832	70	-61
	1996	0.58	3	6.469	163	132
	1997	0.55	-5	4.870	80	-51
	1998	0.45	-19	3.825	97	22
	1999	0.46	4	4.265	108	11
	2000	0.54	17	5.079	102	-5
	2001	0.48	-11	3.245	72	-29
	2002	0.44	-8	2.694	90	25
	2003	0.54	23	2.426	73	-19
	2004	0.40	-26	1.771	98	34
	2005	0.37	-8	892	55	-44
	2006	0.50	35	873	73	32
	2007	0.41	-18	1.060	148	103

Table 15.8. Model input data series: Catch by the fishery; three indices of stock biomass – a standardized catch rate index based on fishery data (CPUE) from the Iceland EEZ, a Icelandic (Ice) and a Greenlandic (Green) research survey index.

Year	Catch (ktons)	CPUE (index)	Survey Ice (ktons)	Survey Green (ktons)
1960	0	-	-	-
1961	0.029	-	-	-
1962	3.071	-	-	-
1963	4.275	-	-	-
1964	4.748	-	-	-
1965	7.421	-	-	-
1966	8.03	-	-	-
1967	9.597	-	-	-
1968	8.337	-	-	-
1969	26.2	-	-	-
1970	33.823	-	-	-
1971	28.973	-	-	-
1972	26.473	-	-	-
1973	20.463	-	-	-
1974	36.28	-	-	-
1975	23.494	-	-	-
1976	6.045	-	-	-
1977	16.578	-	-	-
1978	14.349	-	-	-
1979	23.622	-	-	-
1980	31.157	-	-	-
1981	19.239	-	-	-
1982	32.441	-	-	-
1983	30.891	-	-	-
1984	34.024	-	-	-
1985	32.075	1.76	-	-
1986	32.984	1.78	-	-
1987	46.622	1.9	-	-
1988	51.118	1.91	-	-
1989	61.396	1.82	-	-
1990	39.326	1.24	-	-
1991	37.95	1.2	-	-
1992	35.487	1.05	-	-
1993	41.247	0.83	-	-
1994	37.19	0.68	-	-
1995	36.288	0.54	-	-
1996	35.932	0.46	34.44	-
1997	30.309	0.49	42.01	-
1998	20.382	0.76	42.01	50.43
1999	20.371	0.88	52.37	39.45
2000	26.644	1	39.63	50.50
2001	27.291	1.04	55.73	-
2002	29.158	0.86	47.15	60.11
2003	30.891	0.56	24.41	40.74
2004	27.102	0.39	16.01	26.40
2005	24.978	0.42	22.31	36.23
2006	21.466	0.42	18.46	42.80
2007	21.873	0.49	21.05	27.89
2008	*20.000	-	-	-

*estimated

Table 15.9. Priors used in the model. ~ means "distributed as..", dunif = uniform-, dlnorm = lognormal-, dnorm= normal- and dgamma = gammadistributed. Symbols as in text.

Parameter		Prior	
Name	Symbol	Type	Distribution
Maximal Suatainable Yield	MSY	reference	dunif(1,300)
Carrying capacity	K	low informative	dnorm(750,300)
Catchability Iceland survey	q_{Ice}	reference	$\ln(q_{Ice})$~dunif(-3,1)
Catchability Greenland survey	q_{Green}	reference	$\ln(q_{Green})$~dunif(-3,1)
Catchability Iceland CPUE	q_{cpue}	reference	$\ln(q_{cpue})$~dunif(-10,1)
Initial biomass ratio	P_1	informative	dnorm(2,0.071)
Precision Iceland survey	$1/\sigma_{Ice}^2$	low informative	dgamma(2.5,0.03)
Precision Greenland survey	$1/\sigma_{Green}^2$	low informative	dgamma(2.5,0.03)
Precision Iceland CPUE	$1/\sigma_{cpue}^2$	low informative	dgamma(2.5,0.03)
Precision model	$1/\sigma_P^2$	reference	dgamma(0.01,0.01)

Table 15.10. Model diagnostics: residuals (% of observed value), probability of getting a more extreme observation (p.extreame; see text for explanation).

	CPUE		Survey Ice		Survey Green	
Year	resid (%)	Pr	resid (%)	Pr	resid (%)	Pr
1985	-0.15	0.51	-	-	-	-
1986	0.73	0.48	-	-	-	-
1987	-0.95	0.53	-	-	-	-
1988	-2.09	0.56	-	-	-	-
1989	-5.27	0.65	-	-	-	-
1990	4.20	0.38	-	-	-	-
1991	-1.48	0.54	-	-	-	-
1992	-1.91	0.56	-	-	-	-
1993	0.79	0.48	-	-	-	-
1994	0.42	0.49	-	-	-	-
1995	4.38	0.38	-	-	-	-
1996	13.39	0.17	-22.28	0.85	-	-
1997	15.59	0.13	-33.71	0.94	-	-
1998	-2.64	0.58	-7.92	0.65	0.35	0.49
1999	-5.97	0.67	-18.45	0.81	36.35	0.05
2000	-10.91	0.79	17.33	0.20	19.43	0.18
2001	-5.01	0.65	-7.11	0.63	0.08	-
2002	-2.86	0.58	-7.12	0.64	-5.03	0.59
2003	-1.09	0.53	17.73	0.20	-7.40	0.63
2004	2.41	0.42	26.92	0.09	3.32	0.44
2005	3.19	0.40	1.85	0.47	-20.15	0.82
2006	4.01	0.38	21.92	0.14	-36.38	0.95
2007	-8.66	0.73	11.44	0.29	9.77	0.32

Table 15.11. Summary of parameter estimates: mean, standard deviation (sd) and 25, 50, and 75 percentiles of the posterior distribution of selected parameters (symbols as in the text).

	Mean	sd	25 %	Median	75 %
MSY (ktons)	28	12	20	28	35
K (ktons)	967	241	794	960	1127
r	0.13	0.07	0.08	0.12	0.17
q_{cpue}	3.E-03	9.E-04	2.E-03	2.E-03	3.E-03
q_{Ice}	0.14	0.05	0.10	0.13	0.16
q_{Green}	0.18	0.06	0.13	0.17	0.21
P_{1985}	1.56	0.23	1.41	1.55	1.70
P_{2007}	0.39	0.06	0.35	0.39	0.43
σ_{Ice}	0.20	0.05	0.16	0.19	0.23
σ_{cpue}	0.11	0.03	0.09	0.10	0.12
σ_{Green}	0.19	0.04	0.16	0.19	0.22
σ_{P}	0.21	0.04	0.18	0.20	0.23

Table 15.12. Upper: stock status for 2007 and predicted to the end of 2008. Lower: predictions for 2009 given catch options ranging from 0 to 30 ktons.

Status	2007	2008*
Risk of falling below B_{lim} ($0.3B_{MSY}$)	6 %	20 %
Risk of falling below B_{MSY}	100 %	100 %
Risk of exceeding F_{MSY}	94 %	90 %
Risk of exceeding F_{lim} ($1.7F_{MSY}$)	63 %	60 %
Stock size (B/Bmsy), median	0.39	0.38
Fishing mortality (F/Fmsy),	2.01	1.98
Productivity (% of MSY)	63 %	61 %

*Predicted catch = 20ktons

Catch option 2009 (ktons)	0	5	10	15	20	30
Risk of falling below B_{lim} ($0.3B_{MSY}$)	18 %	20 %	22 %	25 %	32 %	24 %
Risk of falling below B_{MSY}	100 %	100 %	100 %	100 %	100 %	100 %
Risk of exceeding F_{MSY}	-	16 %	46 %	71 %	86 %	97 %
Risk of exceeding F_{lim} ($1.7F_{MSY}$)	-	7 %	22 %	42 %	60 %	83 %
Stock size (B/Bmsy), median	0.42	0.40	0.40	0.39	0.37	0.36
Fishing mortality (F/Fmsy),	0.00	0.45	0.93	1.46	2.07	3.03
Productivity (% of MSY)	66 %	64 %	64 %	63 %	60 %	59 %

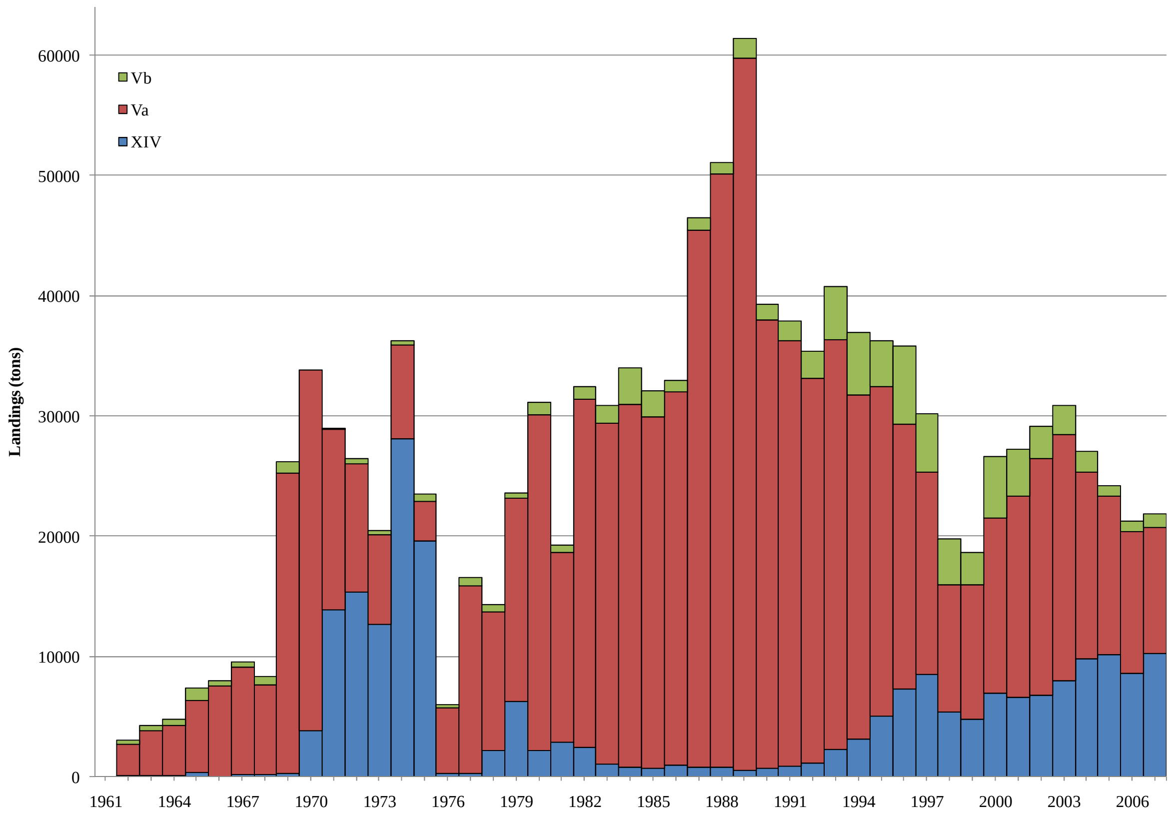


Figure 15.1. Landings of Greenland halibut in Divisions V, XI and XIV. As the landings within Icelandic waters, since 1976, have not officially been separated and reported according to the defined ICES statistical areas, they are set under area Va by the North Western Working Group.

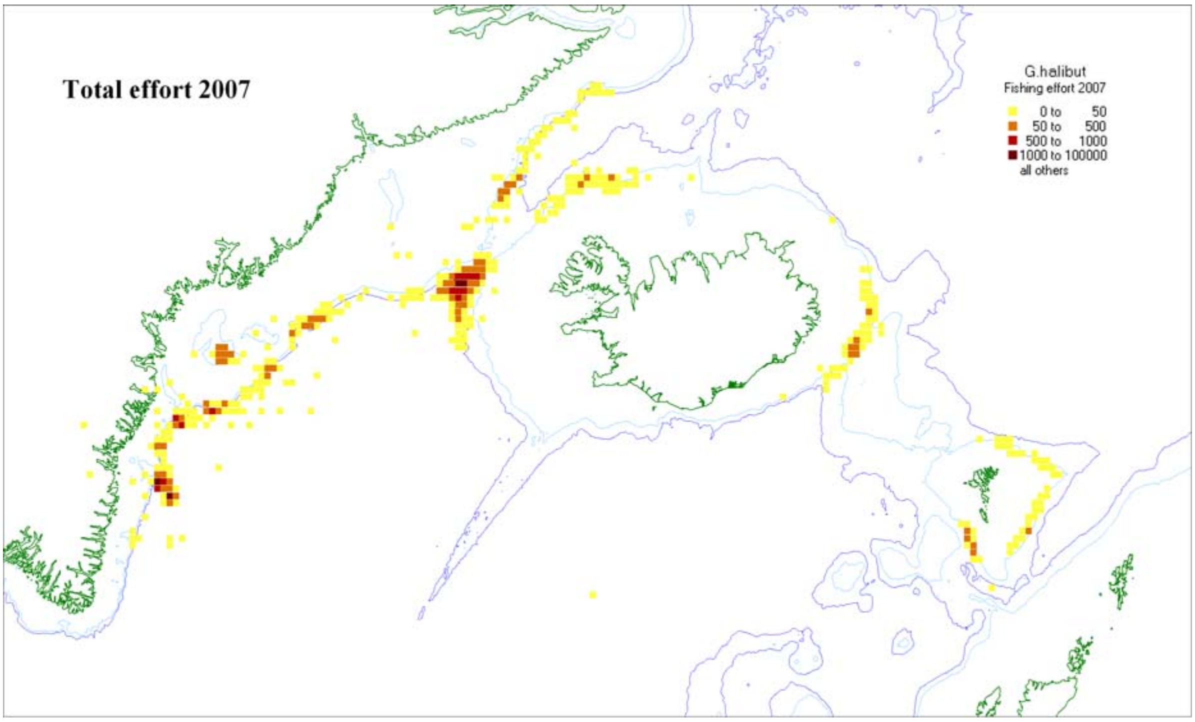


Figure 15.2. Greenland halibut V+XIV. Distribution of fishing effort 2007. 500m and 1000 m depth contours are shown.

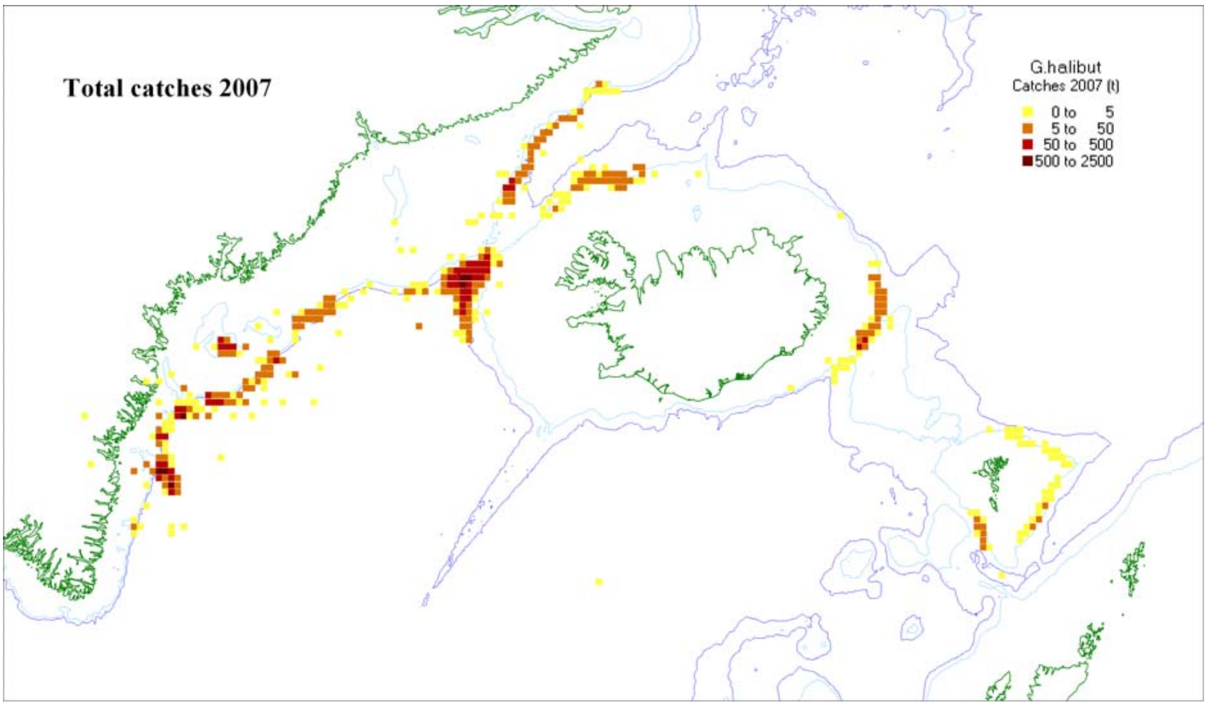


Figure 15.3. Greenland halibut V+XIV. Distribution of catches in the fishery in 2007. 500m and 1000 m depth contours are shown

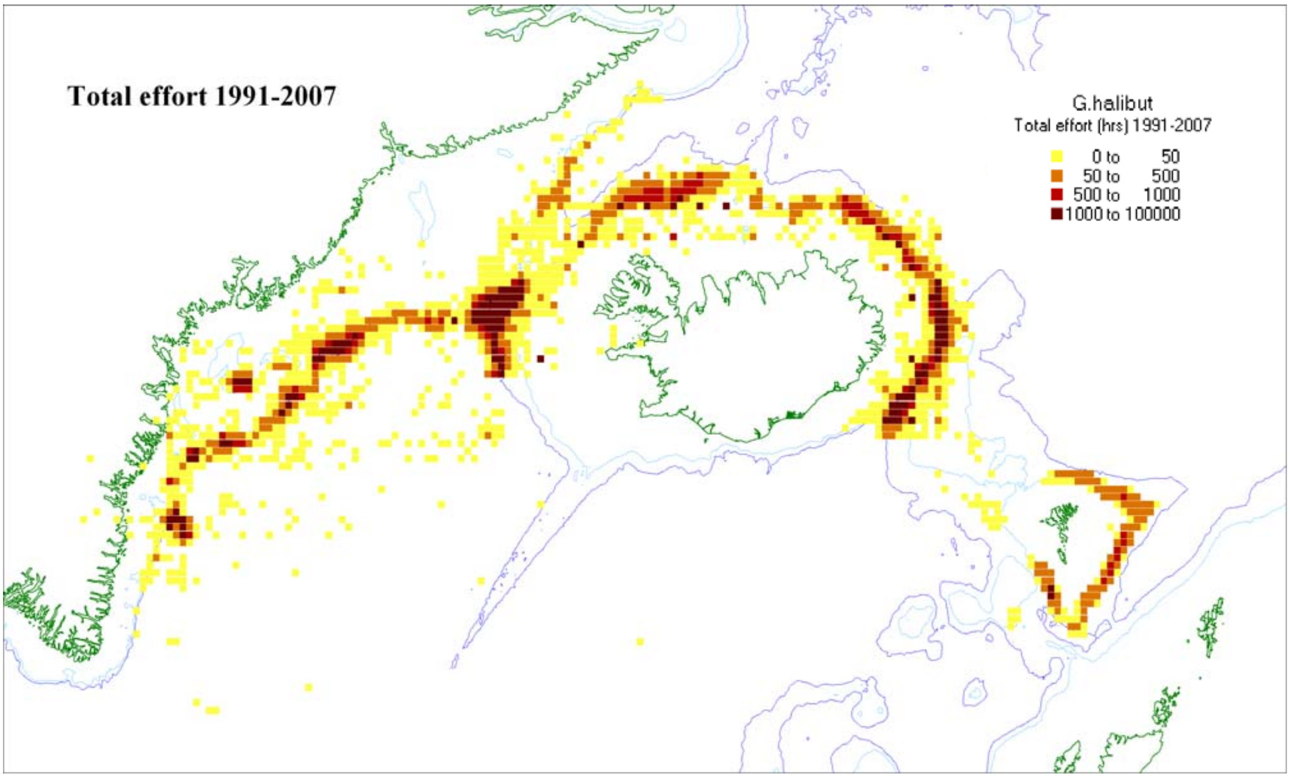


Figure 15.4. Greenland halibut V+XIV. Distribution of total fishing effort 1991-2007. The 500m and 1000 m depth contours are shown.

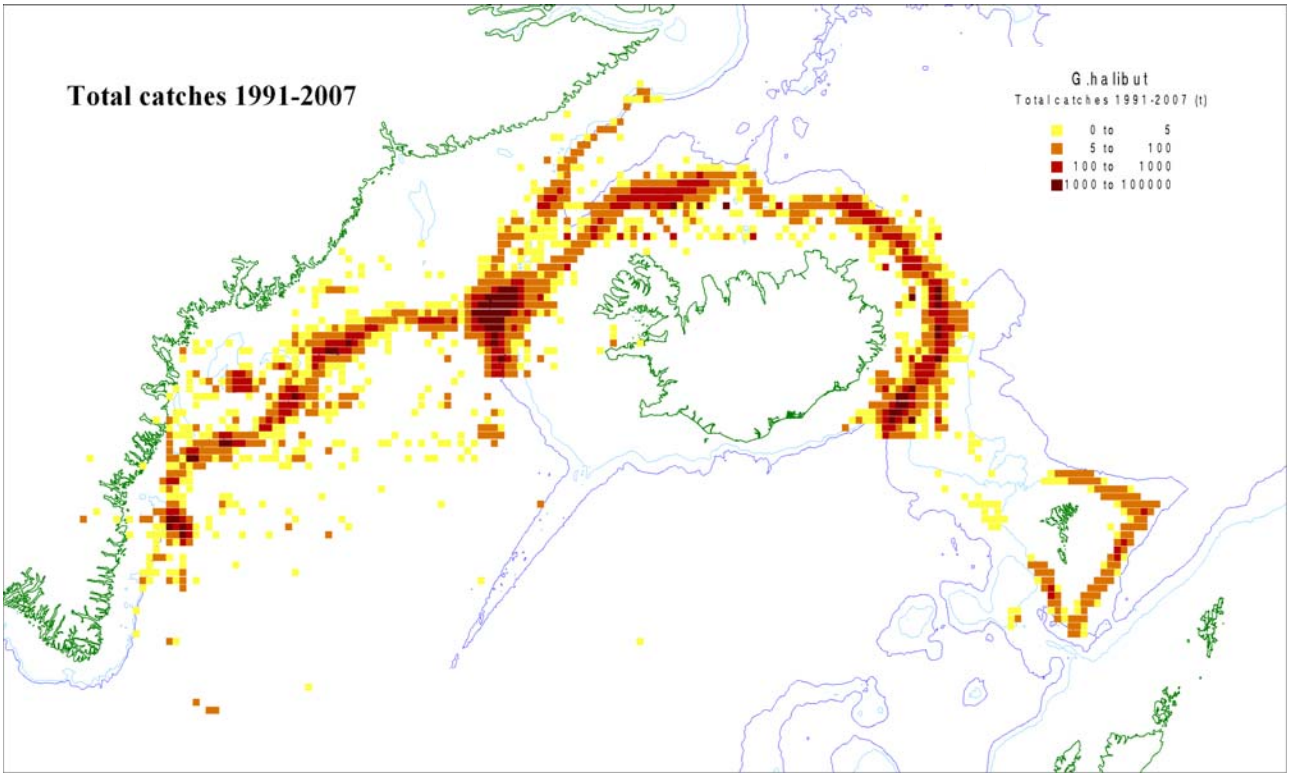


Figure 15.5. Greenland halibut V+XIV. Distribution of total catches in the fishery 1991-2007. 500m and 1000 m depth contours are shown.

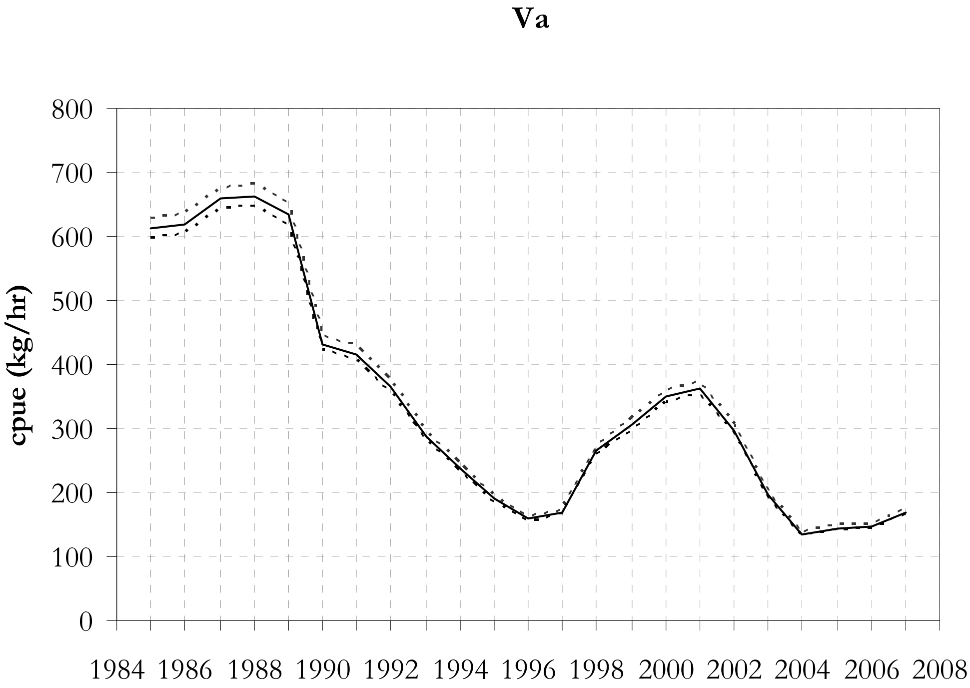


Figure 15.6. Standardised CPUE from the Icelandic trawler fleet in Va. 95% CI indicated.

Figure 15.7 Standardised CPUE from the Icelandic trawler fleet in Va by four main fishing areas in Va. 95% CI indicated.

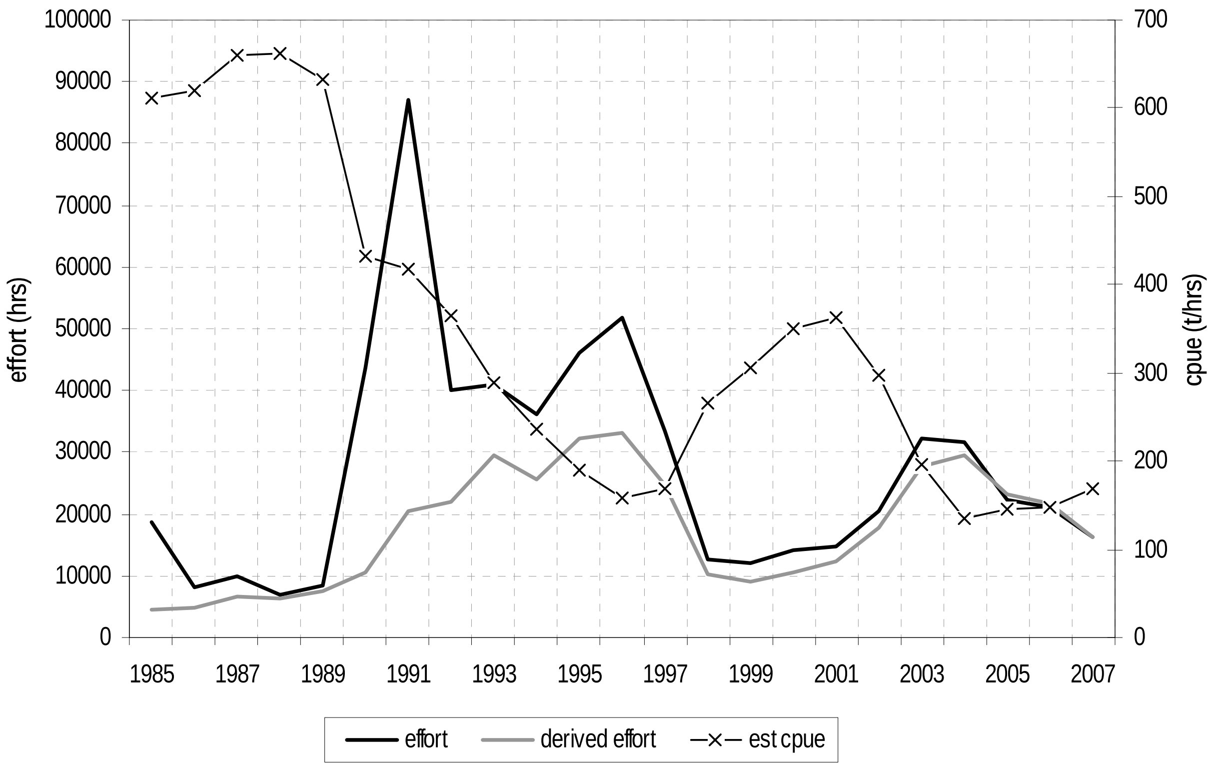


Figure 15.8. CPUE, observed and derived effort from Icelandic trawl fishery.

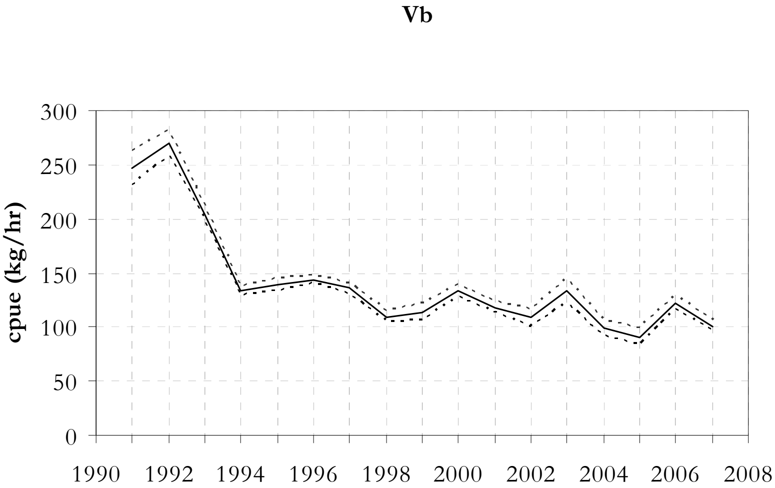


Figure 15. 9. Standardised CPUE from the Faroese trawler fleet. 95% CI indicated

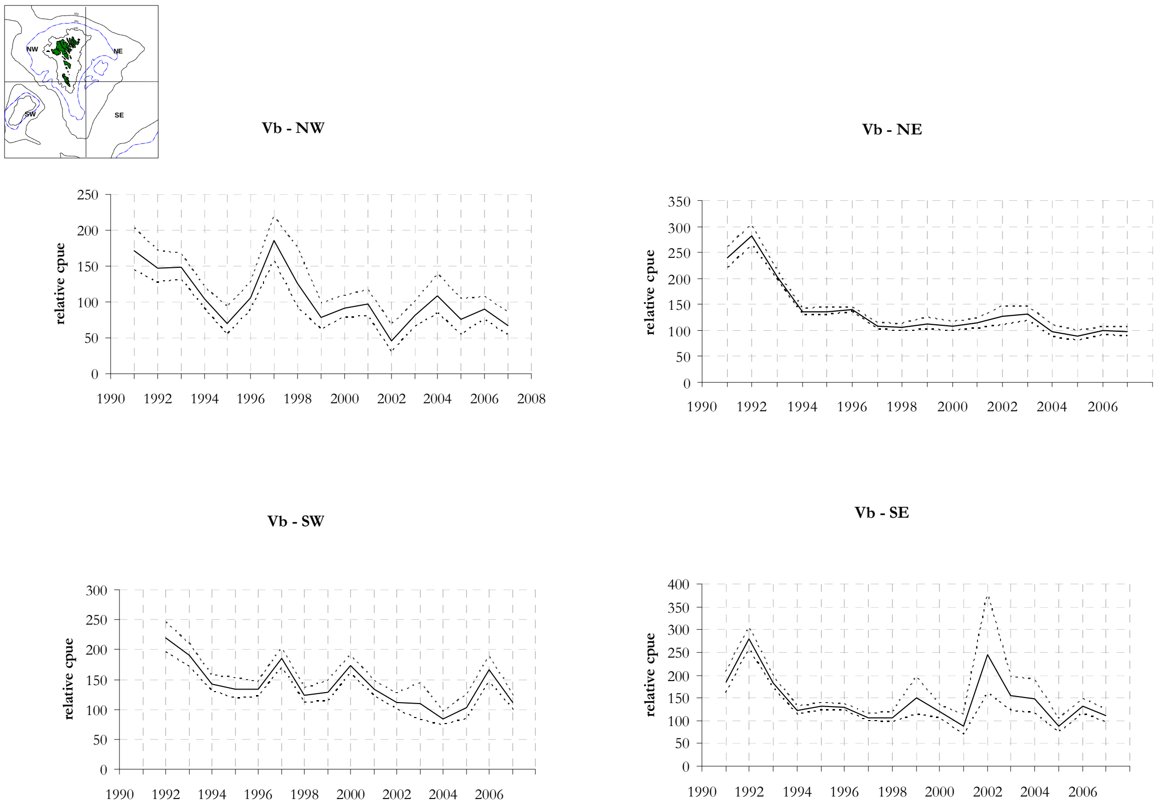


Figure 15.10. Standardised CPUE from the Faroese trawler fleet by four fishing areas as indicated on map. 95% CI indicated.

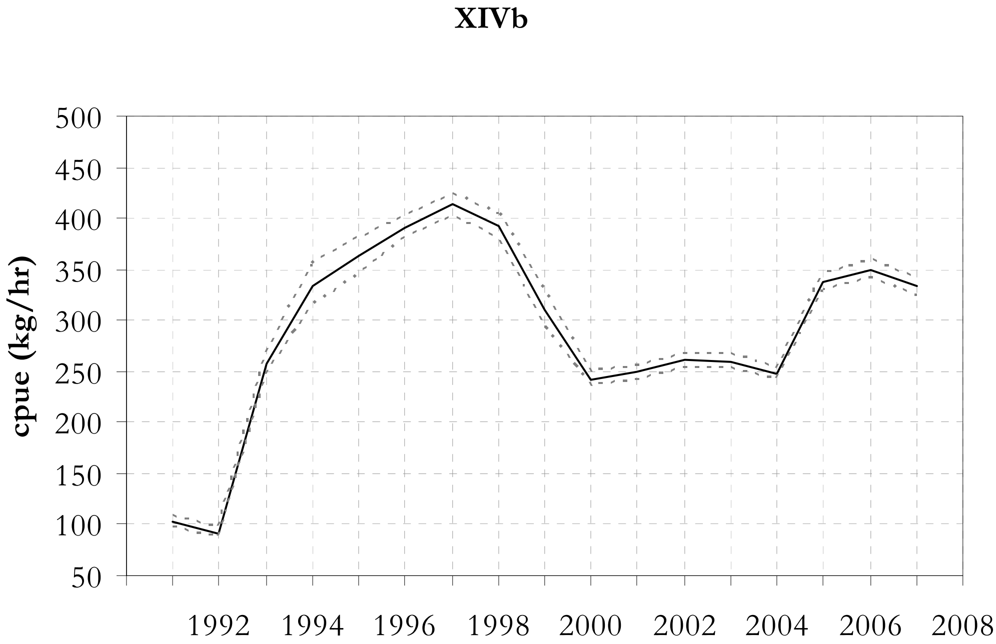


Figure 15.11. Standardised CPUE from trawler fleets in XIVb. 95% CI indicated

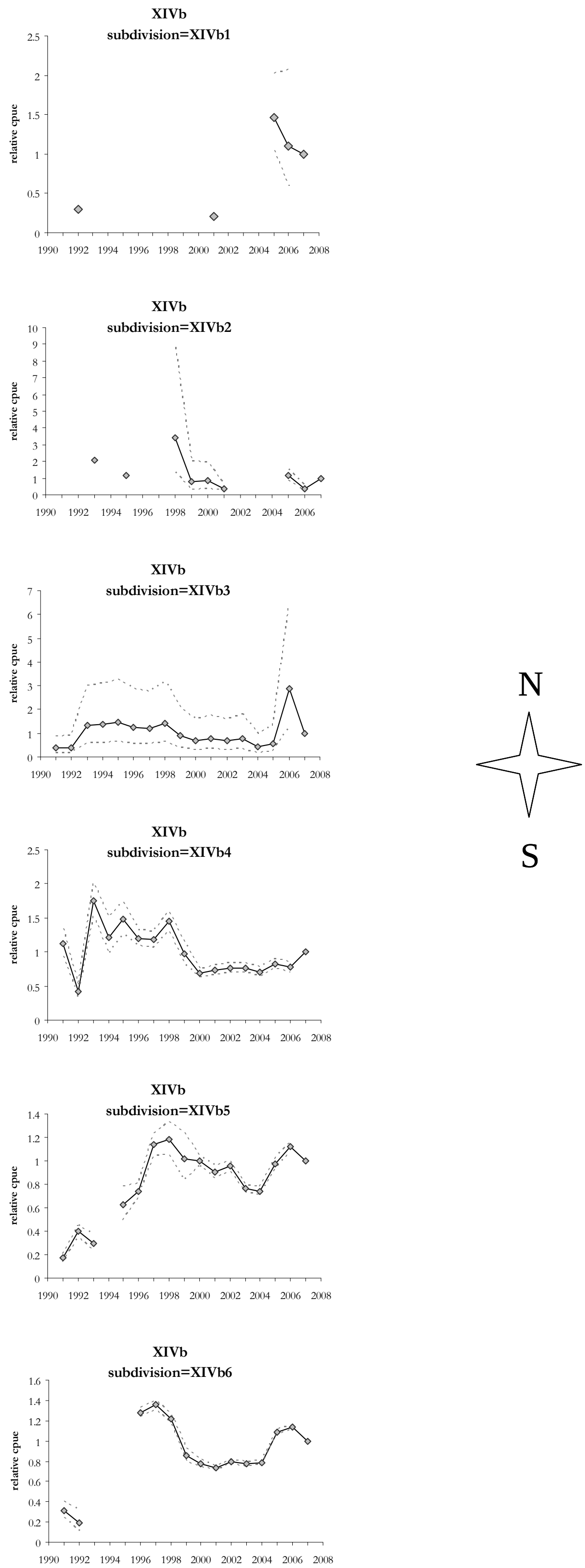


Figure 15.12. Standardised CPUE from trawler fleets in XIVb shown by subdivisions in XIVb in a north-south orientation. 95% CI indicated.

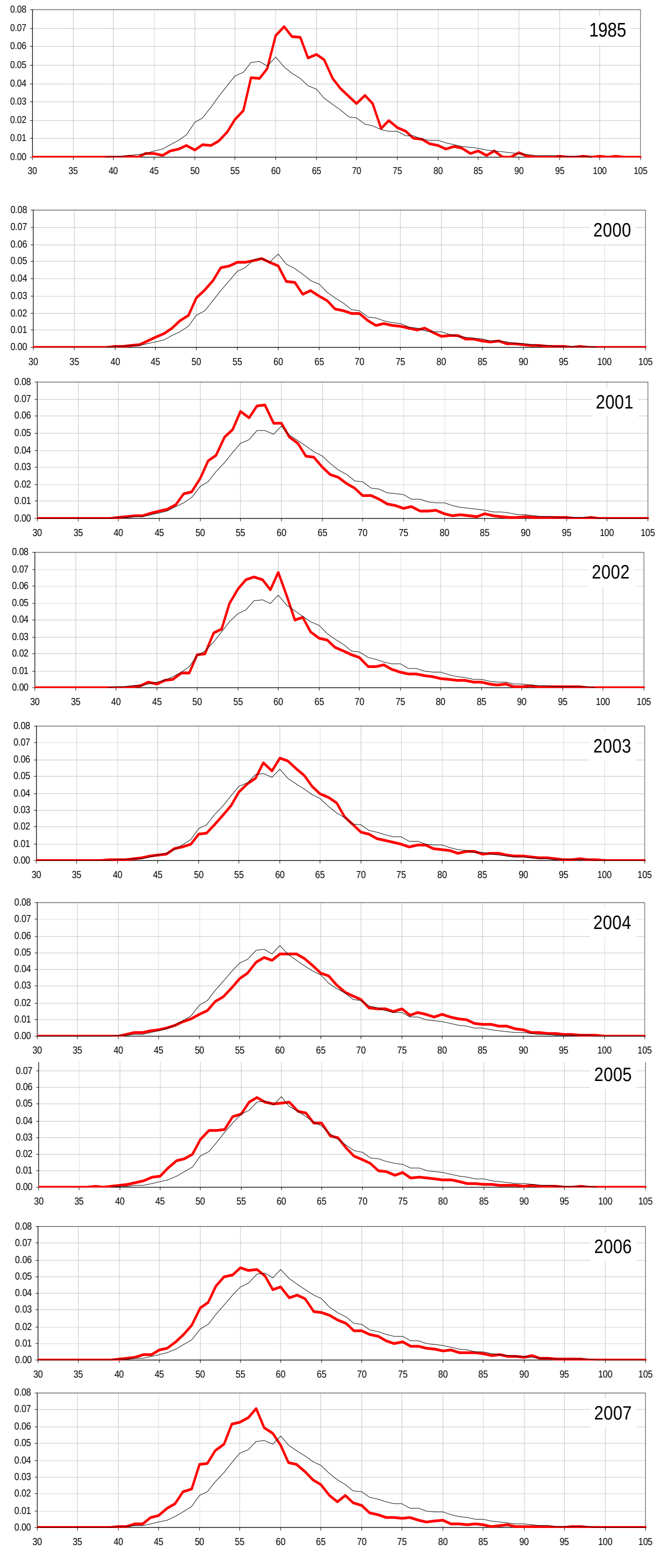


Figure 15.13. Length distributions from the commercial trawlfishery in the western fishing grounds of Iceland (Va) in the years 1985 and 2000 – 2007. The thin solid line is average of 1985-2007 and the thick red solid line is annual distribution.

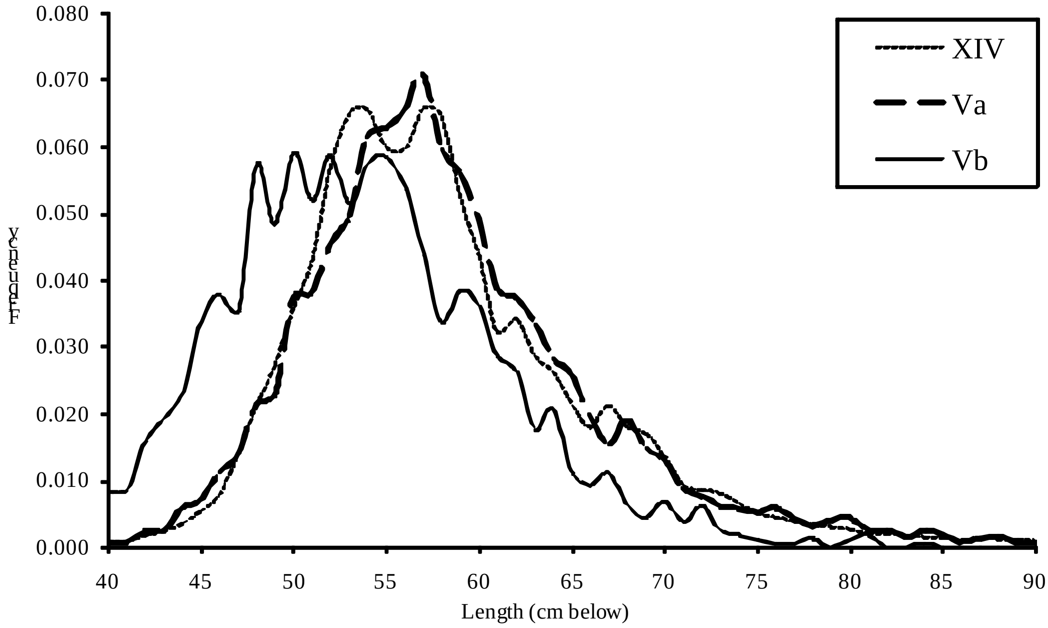


Figure 15.14. Length distributions of Greenland halibut caught in the commercial fishery in ICES Va, Vb and XIV in 2007.

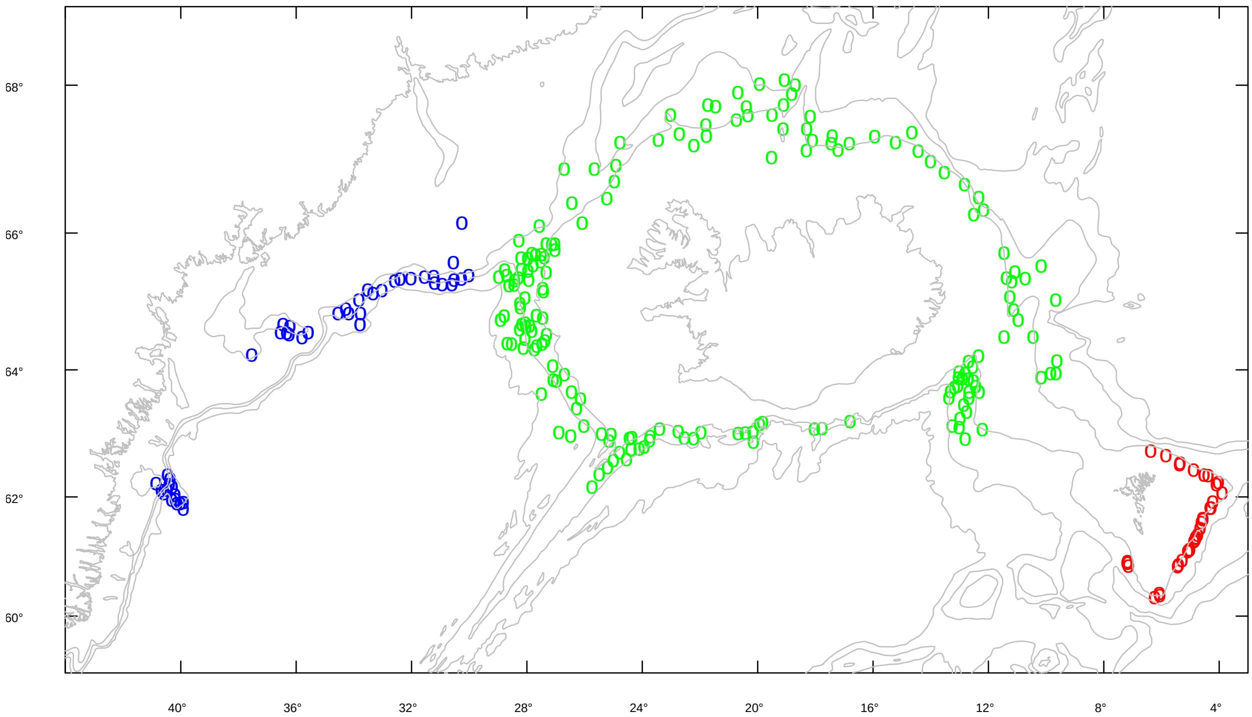
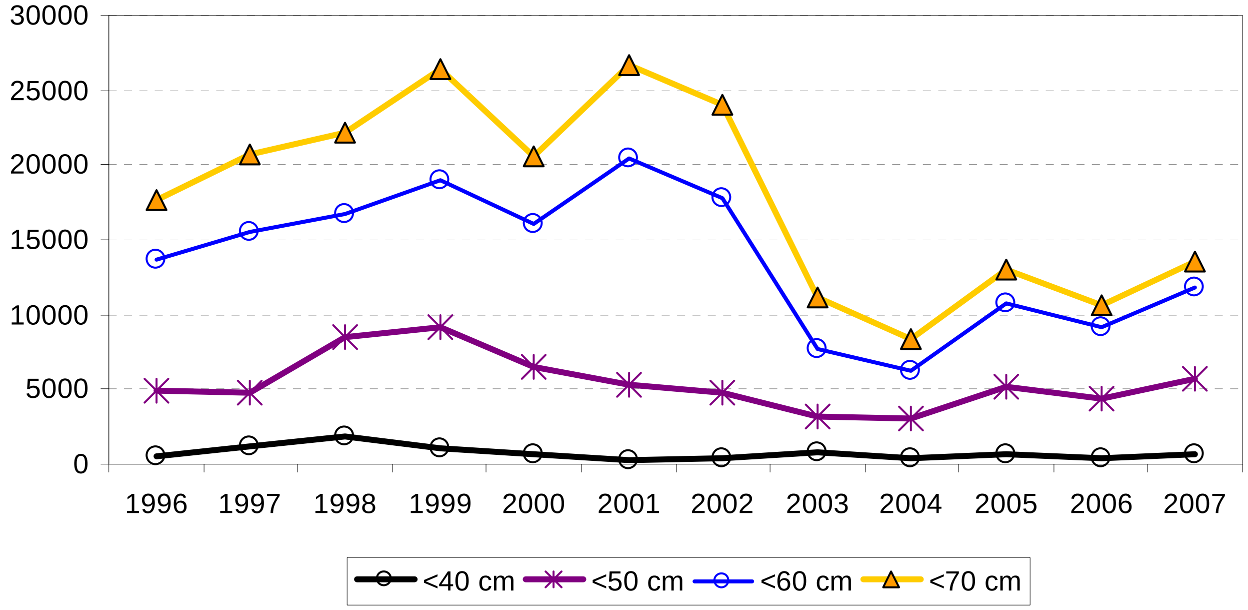


Figure 15.15. Surveyed area in XIV+V indicated as station positions in 2007 by the Greenland (n=46), Iceland (n=176) and Faroese surveys (n=41).

Figure 15.16. Distribution of catches from the Icelandic fall survey 1996-2007.



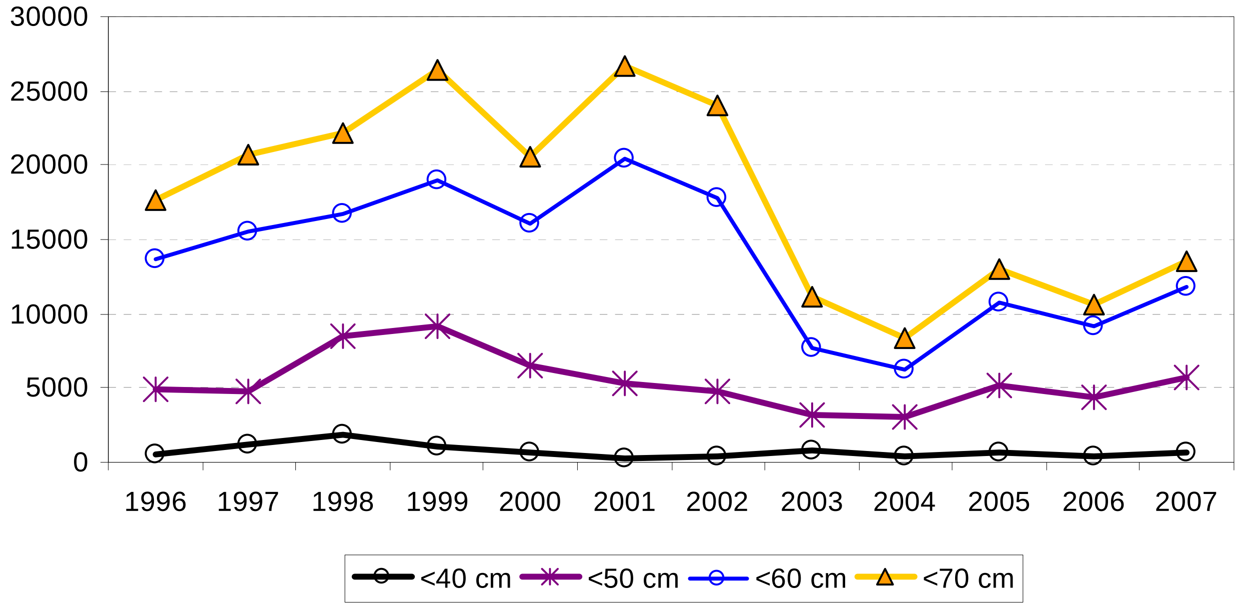


Figure 15.17. Greenland halibut in Icelandic fall groundfish survey; UPPER: biomass indices of lengths larger than indicated and, LOWER: abundance indices by length smaller than indicated.

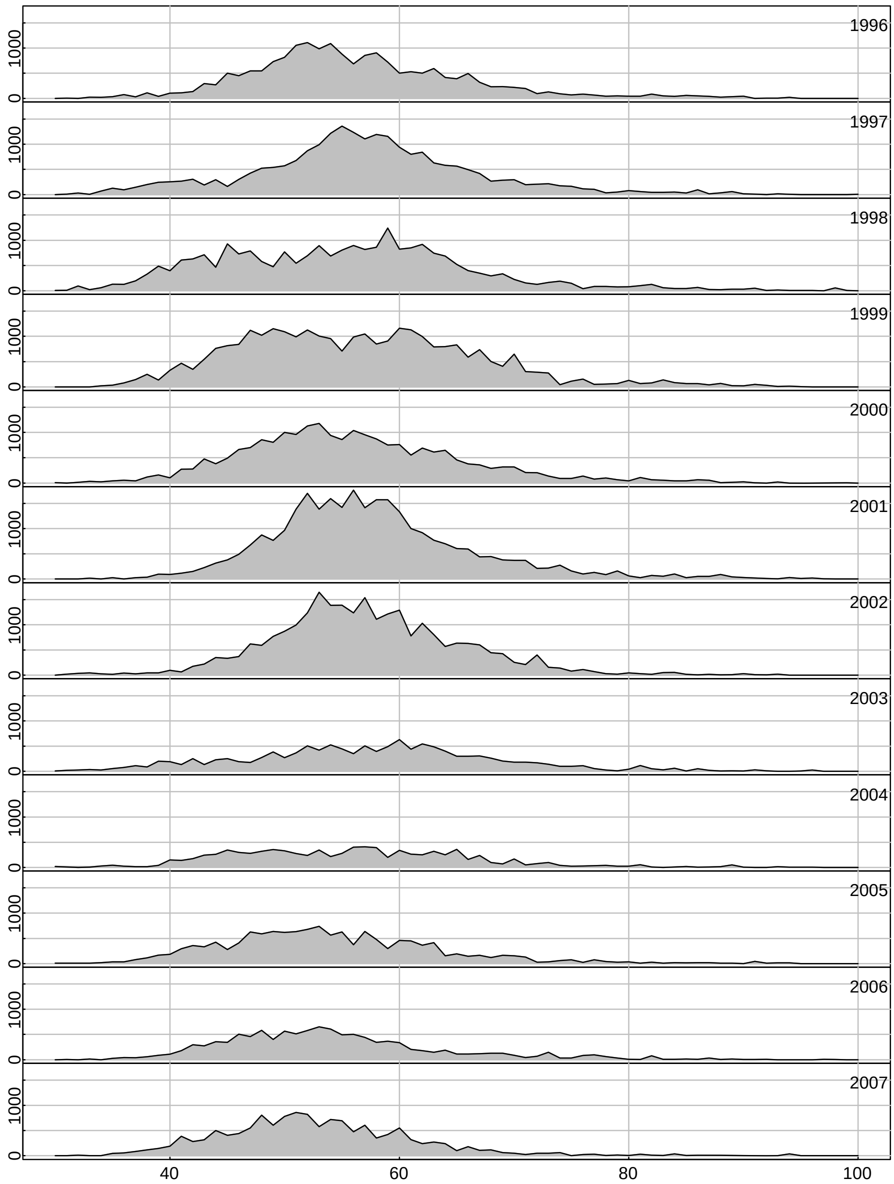


Figure 15.18. Abundance indices by length for the Icelandic fall survey 1996-2007.

Figure 15.19. Catch rates from a combined survey/fishermans survey in Vb.

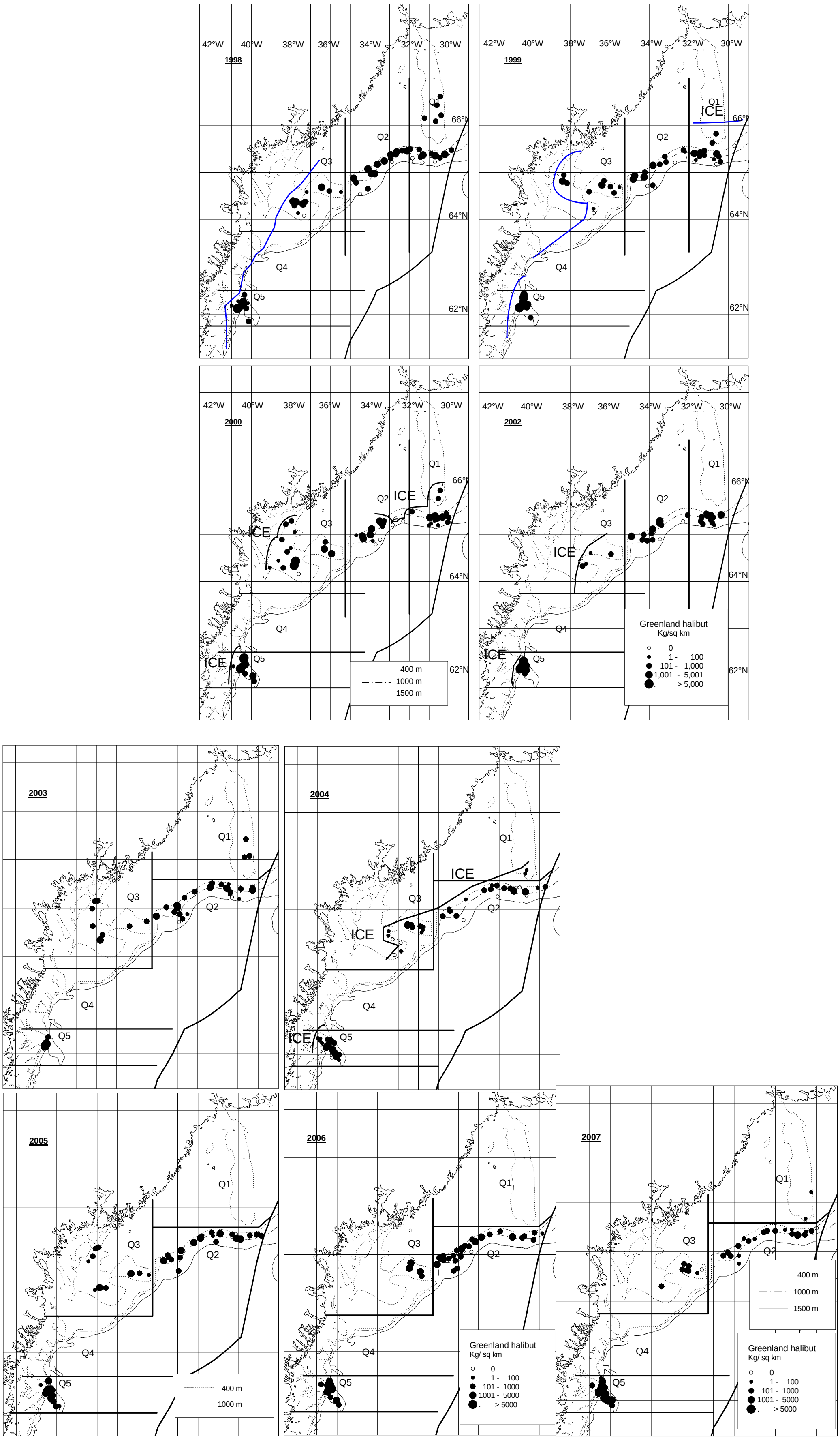


Figure. 15.20. Distribution of catches of Greenland halibut at East Greenland in 1998 – 2007 in the Greenland deep-water survey.

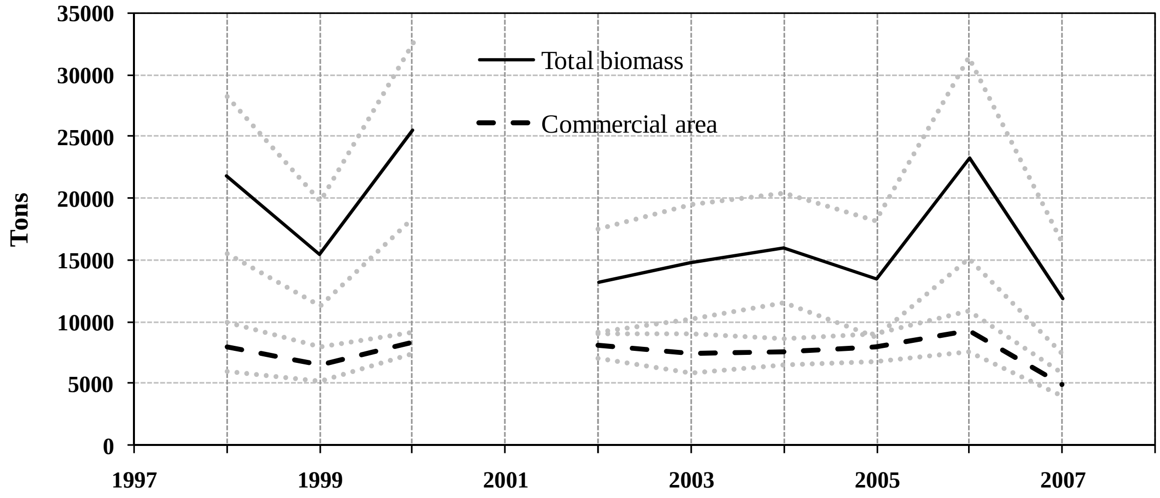


Figure 15.21. Estimated Biomass (t) in div. XIVb from the Greenland deep-water trawl survey with 95% CI indicated.Biomass Tot is is swept area estimates for the entire survey area, Biomass Com.is swept area estimates for strata Q2 and Q5 covered all years.

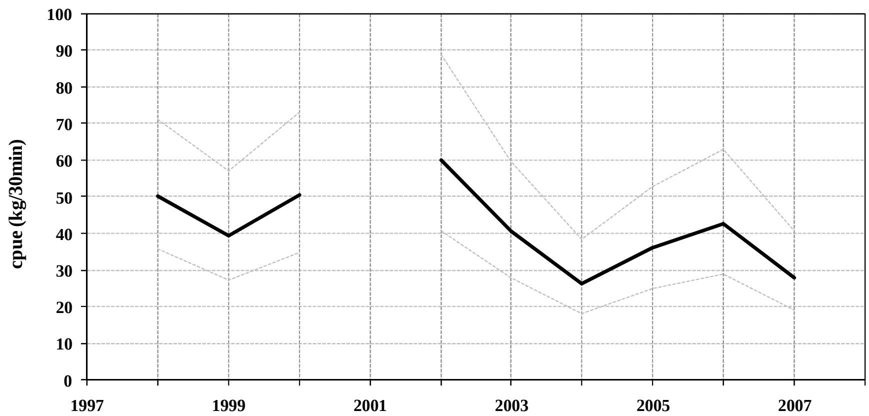


Figure 15.22. Standardised catch rates from the Greenland survey.(95% CI indicated.)

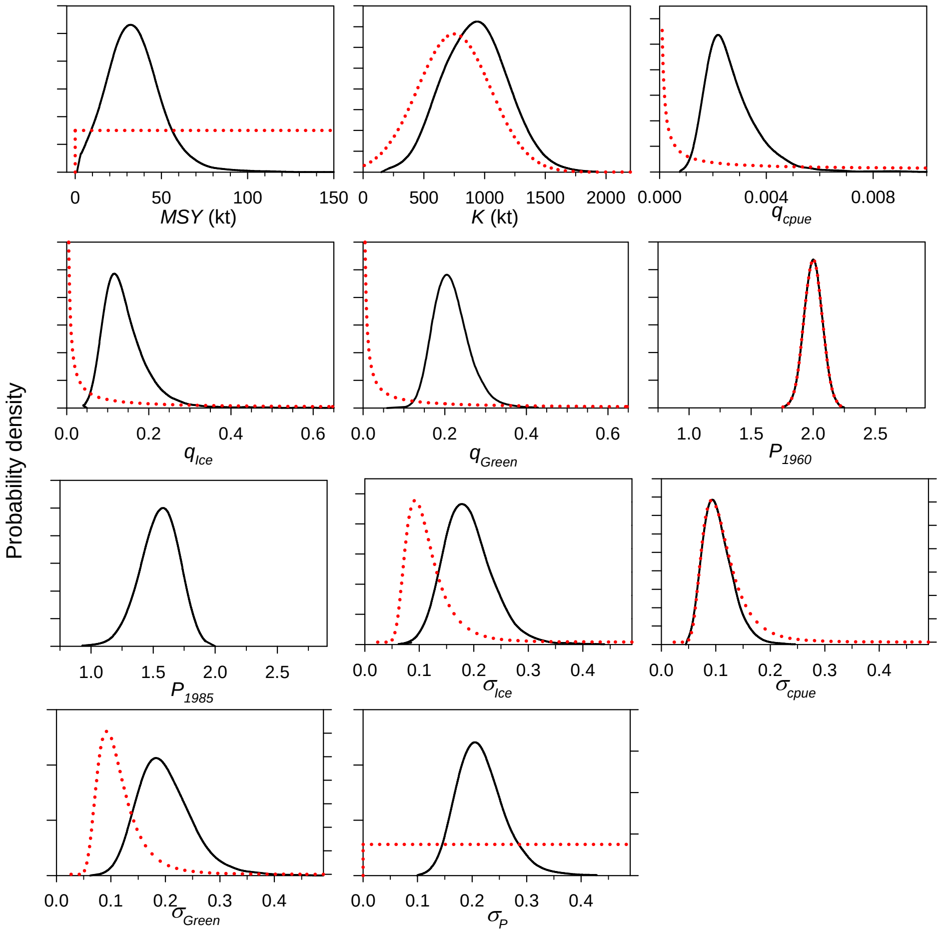


Figure 15.23. Probability density distributions of model parameters: estimated posterior (solid line) and prior (broken line) distributions.

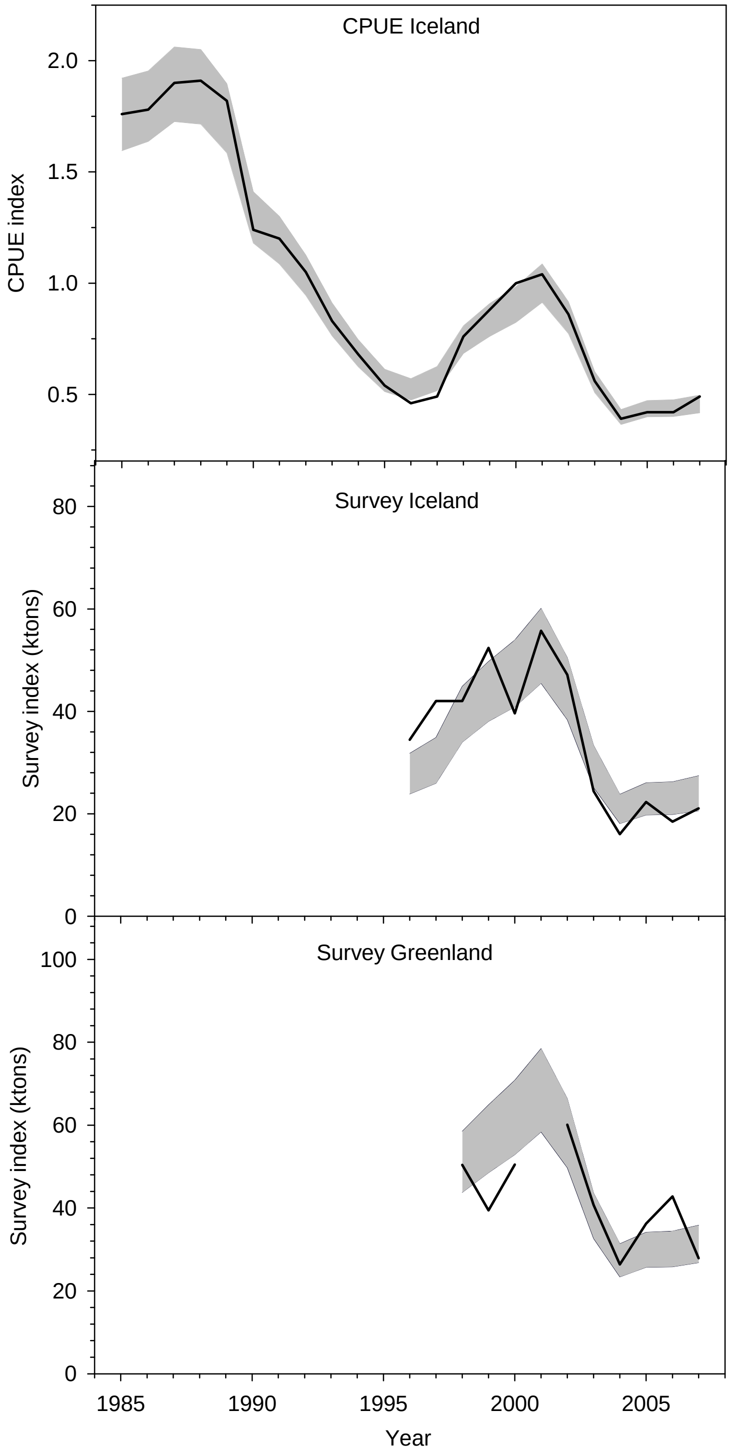


Figure 15.24. Observed (solid line) and predicted (shaded) series of the biomass indices used as input to the model. Gray shaded areas are inter-quartile range of the posteriors.

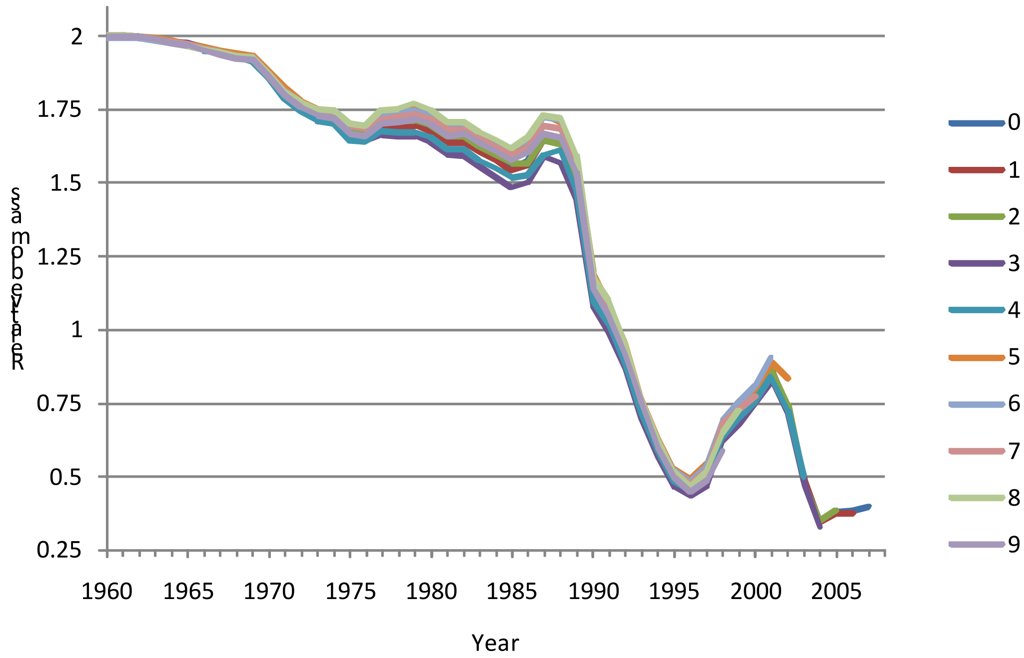


Figure 15.25. Retrospective plot of median relative biomass (*B*/*B*$_{msy}$). Relative biomass series are estimated by consecutively leaving out from 0 to 9 years of data.

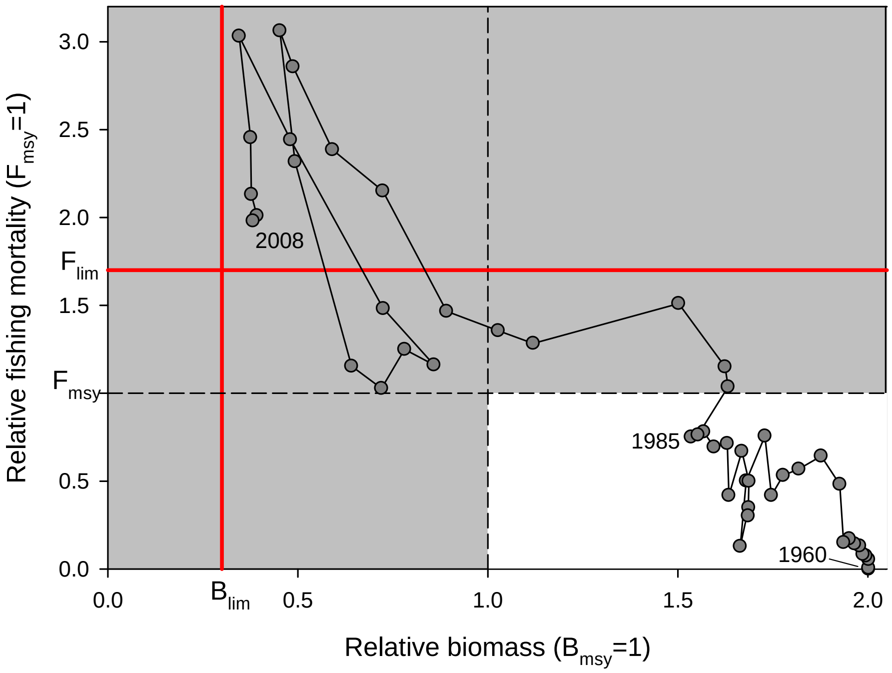


Figure 15.26. Estimated annual median biomass-ratio (B/B_{MSY}) and fishing mortality-ratio (F/F_{MSY}) 1985-2006. Suggested reference points for stock biomass, B_{lim}, and fishing mortality, F_{lim}, are indicated by red lines.

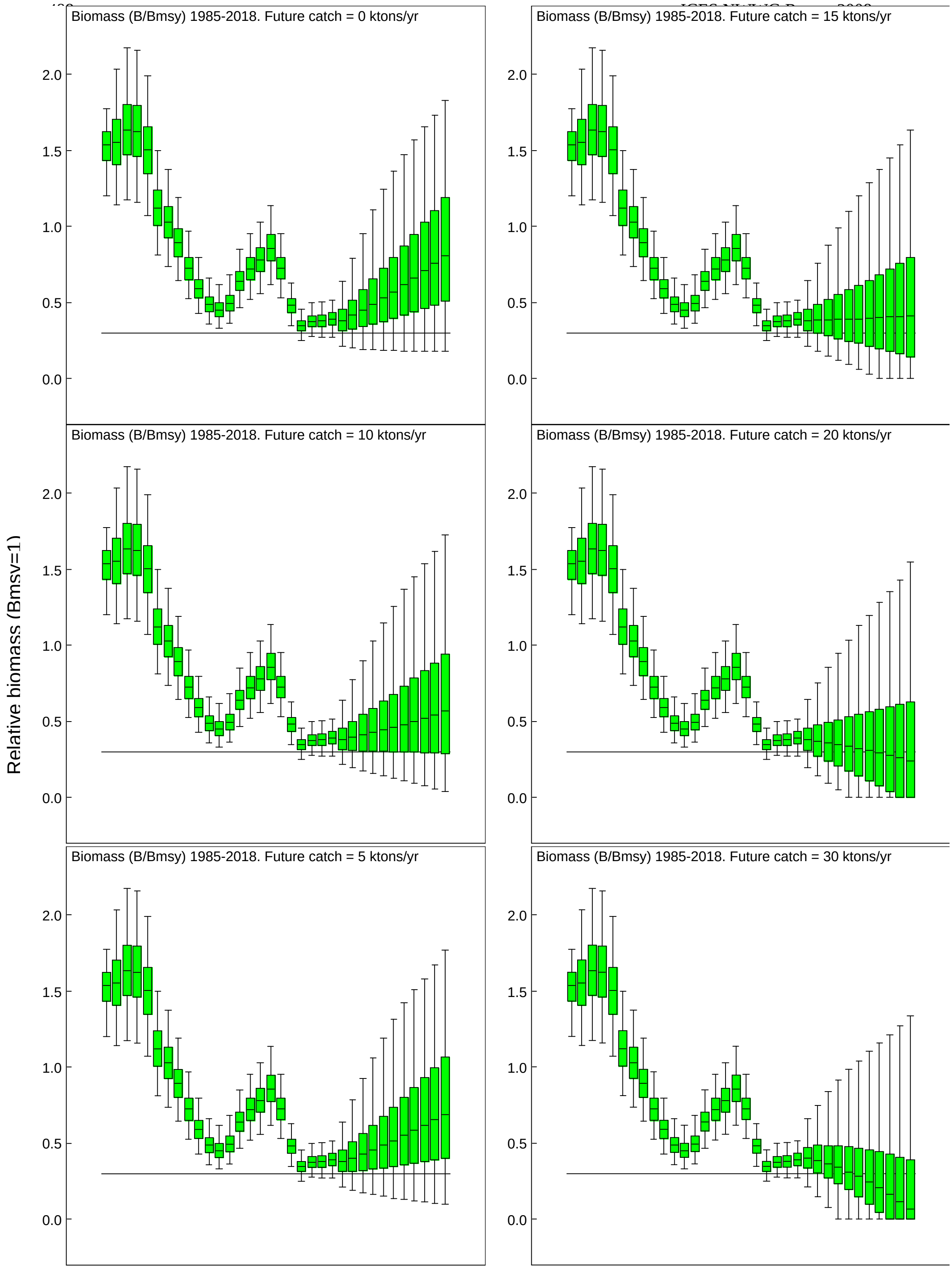


Figure 15.27. Estimated time series of relative biomass (B_t/B_{msy}). Boxes represent inter-quartile ranges and the solid black line at the (approximate) centre of each box is the median; the arms of each box extend to cover the central 95 per cent of the distribution. The vertical black line marks B_{lim} ($0.3B_{msy}$).

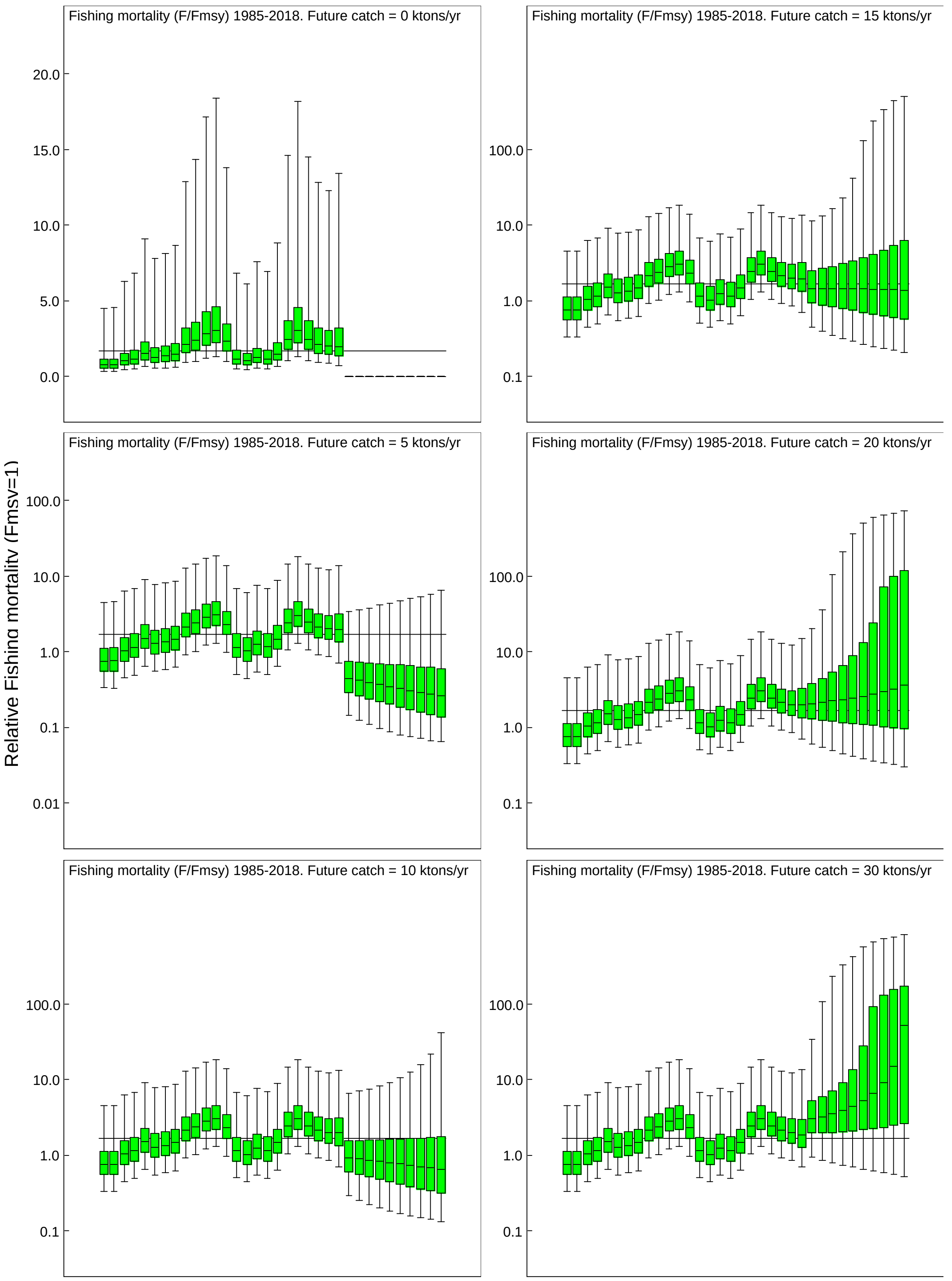


Figure 15.28. Estimated time series of relative fishingmortality (F_t/F_{msy}). Boxes represent inter-quartile ranges and the solid black line at the (approximate) centre of each box is the median; the arms of each box extend to cover the central 95 per cent of the distribution. The vertical black line marks F_{lim} ($1.7F_{msy}$).

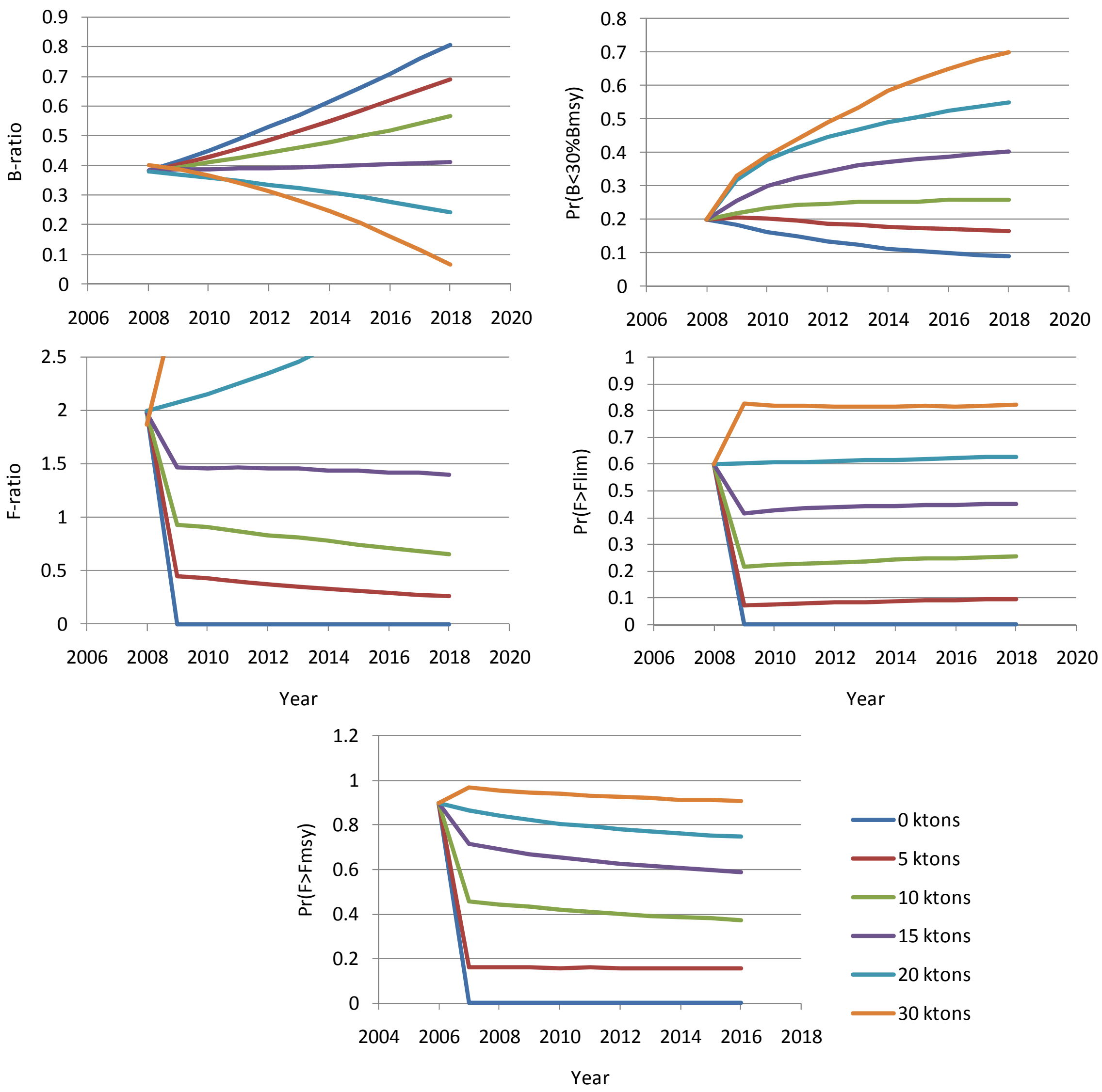


Figure 15.29. Projections: Medians of estimated posterior biomass- and fishing mortality ratios; estimated risk of exceeding F_{msy} and F_{lim} (1.7F_{msy}) or going below and B_{lim} given catches at 0, 5,10, 15, 20 and 30 ktons.

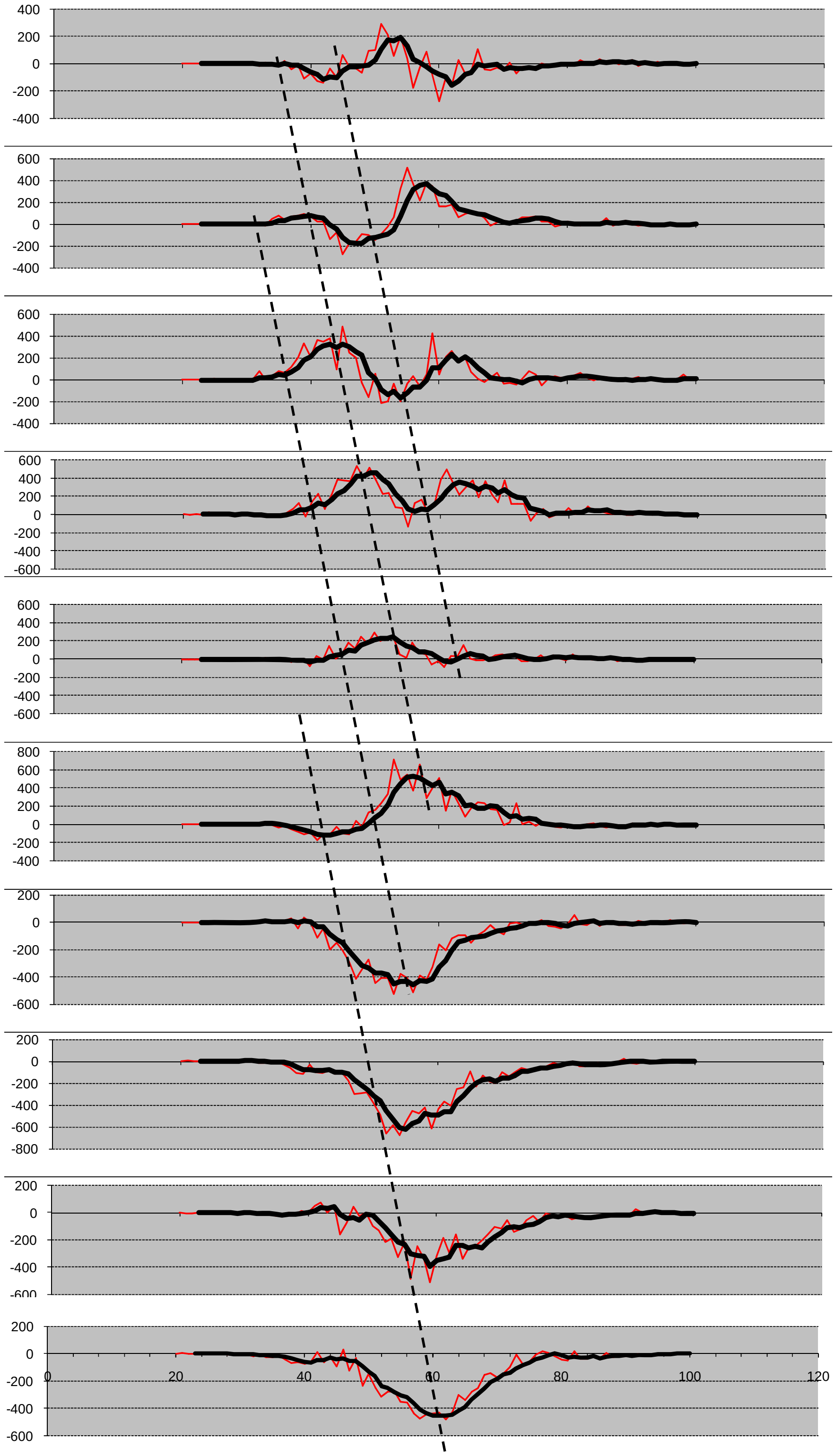


Figure 15.30. Length frequencies of GHL from the Icelandic survey 1996 (*top*)-2006 (*bottom*) shown as deviations from the mean. Dotted lines indicate traceable recruitment modes consisting of several yearclasses

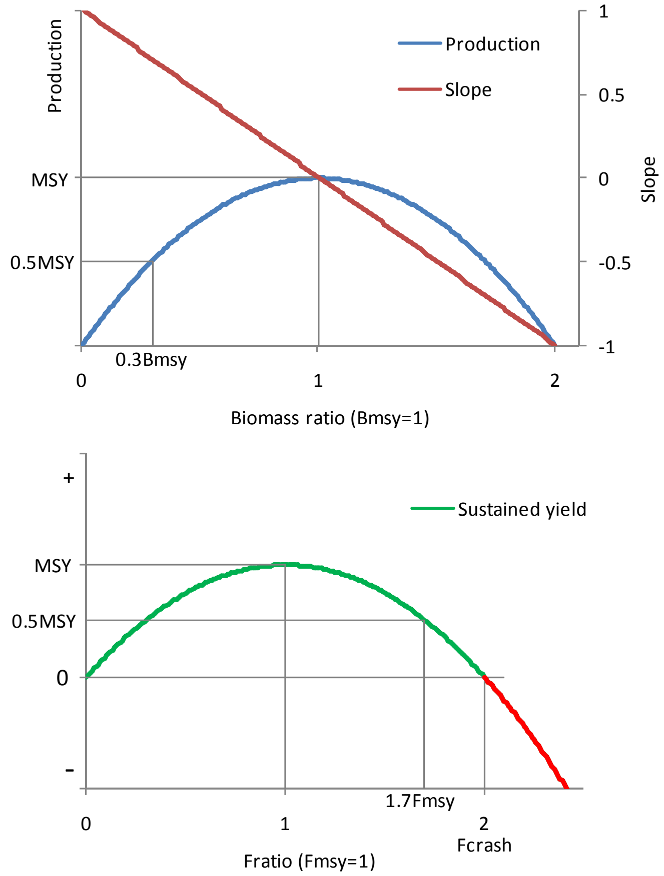


Figure 15.31. The logistic production curve in relation to stock biomass (B/Bmsy) (*upper*) and fishing mortality (F/Fmsy) (l*ower*). *Upper*: points of maximum sustainable yield (MSY) and corresponding stock size are shown as well as the slope (red line) of the production curve (blue line); *lower*: points of MSY and corresponding fishing mortality and Fcrash (F≥Fcrash do not have stable equilibriums and will drive the stock to zero).

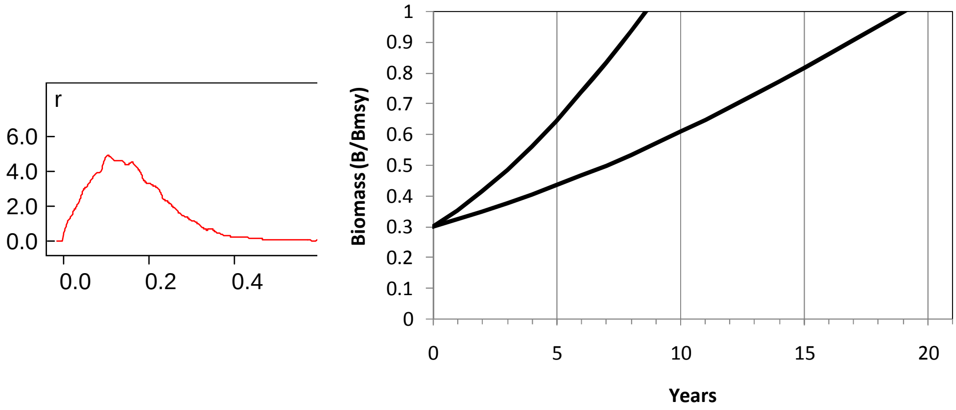


Figure 15.32. ***Left*:The posterior probability density distribution of *r*, the intrinsic rate of growth. Right: estimated recovery time from Blim (0.3Bmsy) to Bmsy (relative biomass = 1) given *r*-values ranging within the 95% conf. lim. of the posterior (left figure) and no fishing mortality.**

16 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 Subarea V, VI, XII and XIV (chapter 16.4), the abundance and distribution of juveniles (chapter 16.2.1), discards and by-catches (chapter 16.5.1).

The "Study Group on Stock Identity and Management Units of Redfishes" (SGSIMUR, 31 Aug-3 Sep 2004, Bergen, Norway; ICES 2005) 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 NAFO Subarea 1 and 2. A schematic illustration of the horizontal and vertical distribution of redfish in these areas is given in Figure 16.5.1. 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 19), separated from the demersal *S. mentella* (chapter 18). The *S. marinus* on the continental shelves of ICES Divisions Va, Vb and Subarea VI and XIV is dealt with in chapter 17. A review of the most recent information on stock identification of redfish will be carried out by an expert group early 2009.

16.1 Environmental and ecosystem information

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. Little is known about the copulation areas.

The Group is tasked with evaluating the stock status of redfish in ICES Subarea V, VI, XII, and XIV, including pelagic redfish in NAFO Subarea 1 and 2. Information on the ecosystems around the Faroe Islands, Iceland and Greenland is given in chapters 2, 7 and 13.

16.2 Environmental drivers of productivity

16.2.1 Abundance and distribution of 0-group and juvenile redfish

Available data on the distribution of juvenile *S. marinus* indicate that the nursery grounds are located in Icelandic and Greenland waters. No nursery grounds have been found in Faroese waters. Studies indicate that considerable amounts of juvenile *S. marinus* off East Greenland are mixed with juvenile *S. mentella* (Magnússon *et al.* 1988; 1990, ICES CM 1998/G:3). The 1983 Redfish Study Group report (ICES CM 1983/G:3) and Magnússon and Jóhannesson (1997) describe the distribution of 0-group *S. marinus* off East Greenland. The nursery areas for *S. marinus* in Icelandic waters are found all around Iceland, but are mainly located west and north of the island at depths between 50 and 350 m (ICES CM 1983/G:3; Einarsson, 1960; Magnússon and Magnússon 1975; Pálsson *et al.* 1997). As they grow, the juveniles migrate along the north coast towards the most important fishing areas off the west coast.

Indices for 0-group redfish in the Irminger Sea and at East Greenland areas were available from the Icelandic 0-group surveys from 1970–1995. Thereafter, the survey was discontinued. Above average year class strengths were observed in 1972, 1973–74, 1985–91, and in 1995.

There are very few juvenile demersal *S. mentella* in Icelandic waters (see chapter 9), and the main nursery area for this species is located off East Greenland (Magnússon et al. 1988, Saborido-Rey et al. 2004). Abundance and biomass indices of redfish smaller than 17 cm from the German annual groundfish survey, conducted on the continental shelf and slope of West and East Greenland down to 400 m, show that juveniles were abundant in 1993 and 1995-1998 (Figure 16.3.1). 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 1999-2007 survey results indicate low abundance and are similar to those observed in the late 1980s. Observations on length distributions of *S. mentella* fished deeper than 400 m indicate that a part of the juvenile *S. mentella* on the East Greenland shelf migrates into deeper shelf areas (WD12 of NWWG 2006, WD 03 of NWWG 2007) and into the pelagic zone in the Irminger Sea and adjacent waters (WD12 of NWWG 2006, Stransky 2000), with unknown shares.

16.3 Ecosystem considerations (General)

Information on the ecosystems around the Faroe Islands, Iceland and Greenland is given in chapters 2, 7 and 13.

16.4 Description of fisheries

There are three species of redfish commercially exploited in ICES Subarea V, VI, XII, and XIV, *S. marinus*, *S. mentella* and *S. viviparus*. The last one has only been of a minor commercial value in Icelandic waters and is exploited in two small areas south of Iceland at depths of 150-250 m. The landings of *S. viviparus* decreased from 1160 t in 1997 to 2-9 t in 2003-2006 (Table 16.1.1) due to decreased commercial interest in this species. The landings in 2007 amounted to 24 t.

The Group has in the past included the fraction of *S. mentella* that are caught with pelagic trawls above the western, south-western and southern continental slope of Iceland as part of the landing statistics of the demersal *S. mentella*. This practice has been in accordance with Icelandic legislation, where captains are obligated to report their *S. mentella* catch as either "pelagic redfish" or as "demersal redfish" depending in which fishing area they fish. According to this legislation, all catch outside the Icelandic EEZ and west of the 'redfish line' (red line shown in Figure 16.1.1, 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 Group accepts this praxis as pragmatic management measure, but notes that there is no biological information that could support this catch allocation.

As the Review Group in 2005 noted that this issue needed more elaboration, detailed portrayals of the geographical, vertical and seasonal distribution of the demersal *S. mentella* fisheries with different gears are presented here, as done last year (see below). Quantitative information on the fractions of the pelagic catches of demersal *S. mentella* is given in chapter 18. The proportion of the total demersal *S. mentella* catches taken by pelagic trawls has varied since 1991 between 0% and 44% (Table 18.3.2), and was on average 25%. No demersal *S. mentella* was caught by pelagic trawls in 2004-2006. 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 16.1.1). The pelagic catches of demersal *S. mentella* were taken in similar areas and depths as the bottom trawl catches (Figure 16.1.2). 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. 16.1.3) shows that the pelagic catches were in general taken during autumn, and only in 2003 and 2007, 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 16.1.4. 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.

16.5 Regulations (TAC, effort control, area closure, mesh size etc.)

Management of redfish differs between stock units and is given in sections 17.14 for *S. marinus*, section 18.7 for demersal *S. mentella* and section 19.10 for pelagic *S. mentella*.

The allocation of Icelandic *S. mentella* catches to the pelagic and demersal management unit has been based on the “redfish line” (see section 16.4).

16.5.1 Discards and by-catches

An offshore shrimp fishery with small meshed trawl (44 mm in the codend) began in the early 1970s off West Greenland. This fishery expanded to East Greenland in the beginning of the 1980s and was mainly conducted on the shallower part of the Dohrn Bank and on the continental shelf from 65°N to 60°N. Observer samples from the Greenland Fishery Licence Control showed that redfish is by-catch in the shrimp fishery off Greenland. Since 1st October 2000, sorting grids with 22 mm bar spacing have been mandatory to reduce the by-catches. New information on the effect of sorting grids was presented in WD 18, showing by-catch rates of redfish in the shrimp fishery of 0.5% by weight in 2006-2007.

In late 1980's, Iceland introduced a sorting grid with a bar spacing of 22 mm in the shrimp fishery to reduce the by-catch of juveniles in the shrimp fishery north of Iceland. This was partly done to avoid redfish juveniles as a by-catch in the fishery, but also juveniles of other species. Since the large year classes of *S. marinus* disappeared out of the shrimp fishing area, there in the early 1990's, observers report small redfish as being negligible in the Icelandic shrimp fishery.

16.6 Mixed fisheries, capacity and effort

The official statistics reported to ICES do not divide catch by species/stocks, and since the Review Group in 2005 recommended that “multispecies catch tables are not relevant to management of redfish resources”, these data are not given here and the best estimates on the landings by species/stock unit are given in the relevant chapters. Preliminary official landings data were provided by the ICES Secretariat, NEAFC and

NAFO, and various national data were reported to the Group. The Group, however, repeatedly faced problems in obtaining catch data, especially with respect to pelagic *S. mentella* (see chapter 19.11). Detailed descriptions of the fisheries are given in the respective chapters: *S. marinus* in chapter 17.3, demersal *S. mentella* in chapter 18.3 and pelagic *S. mentella* in chapter 19.3.

Information from various sources is used to split demersal landings into two redfish species, *S. marinus* and *S. mentella* (see WD22 of the NWWG 2006). In Division Va, if no direct information is available on the catches for a given vessel, the landings are allocated based on logbooks and samples from the fishery. According to the proportion of biological samples from each cell (one fourth of ICES statistical square), the unknown catches within that cell are split accordingly and raised to the landings of a given vessel. For other areas, samples from the landings are used as basis for dividing the demersal redfish catches between *S. marinus* and *S. mentella*.

Table 16.1.1. Landings of *S. viviparus* in Division Va.

Year	Landings (t)
1996	22
1997	1159
1998	994
1999	498
2000	227
2001	21
2002	20
2003	3
2004	2
2005	4
2006	9
2007	24

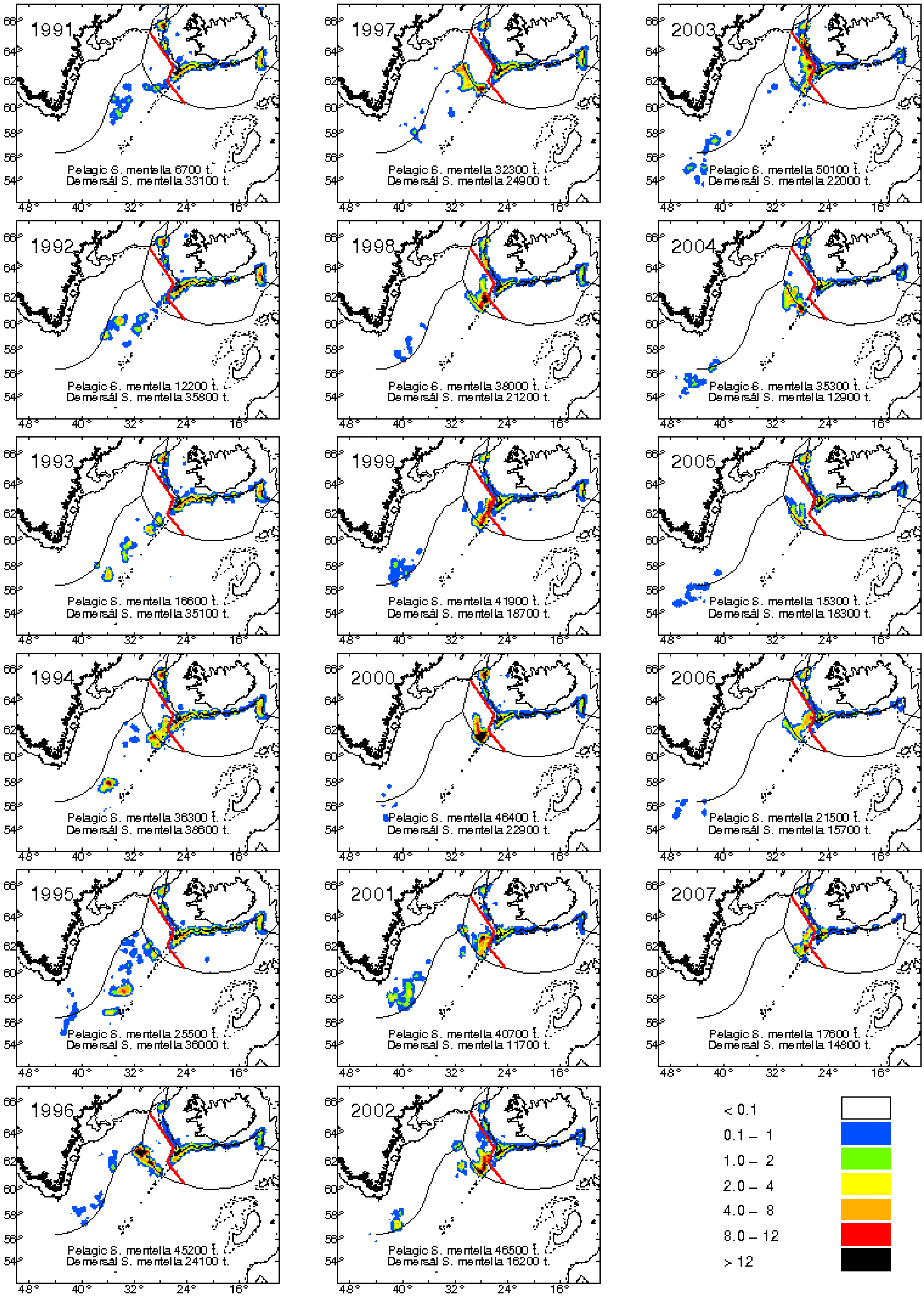


Figure 16.1.1 Geographical distribution of the Icelandic catches of *S. mentella*. The colour scale indicates catches (tonnes per NM²).

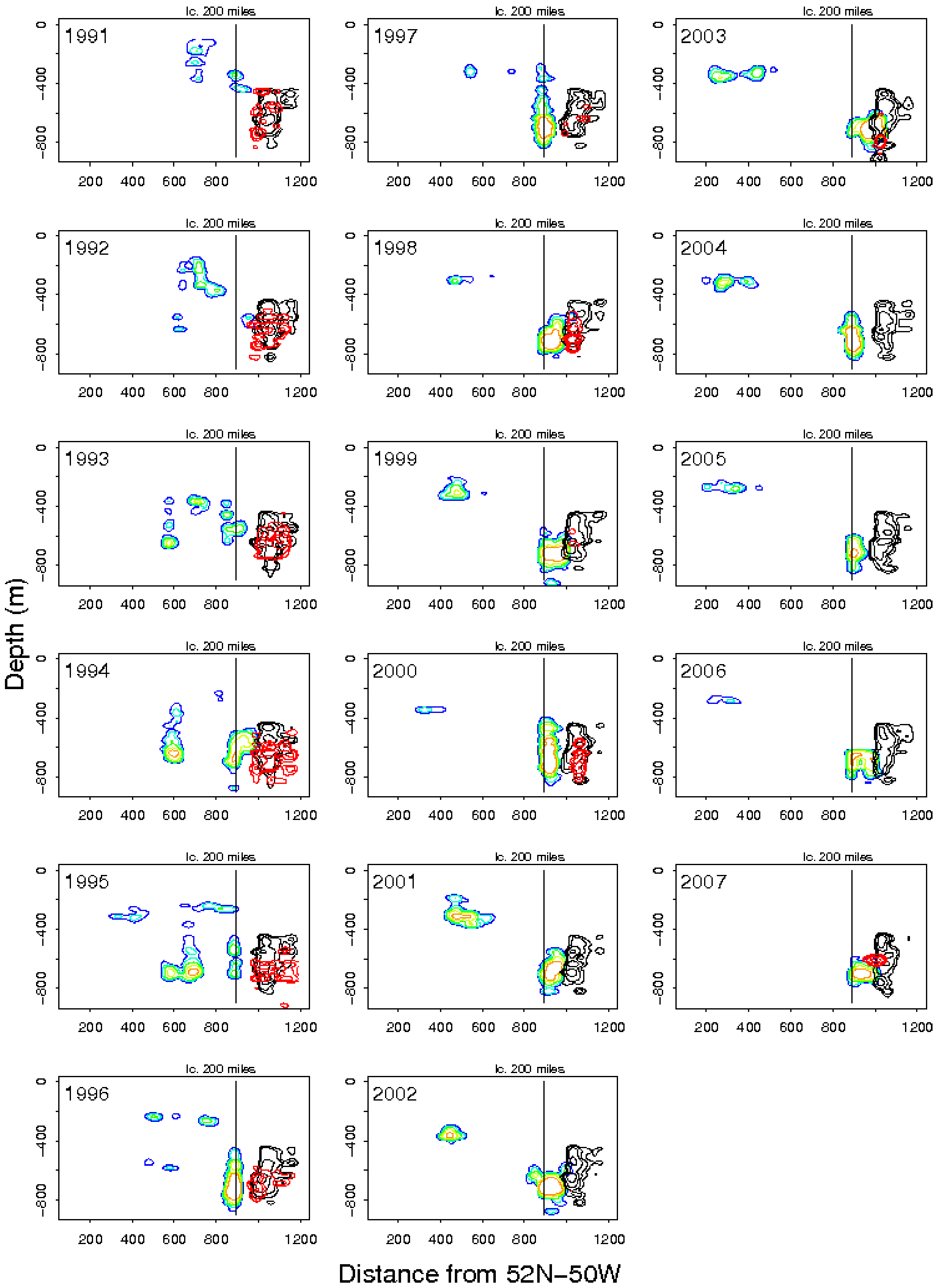


Figure 16.1.2 Distance-depth plot for Icelandic *S. mentella* catches, where distance (in NM) from a fixed position (52°N 50°W) is given. The contour lines indicate catches in a given area and distance. The coloured contours represent the fishery on pelagic *S. mentella*, the black contours indicate bottom trawl catches of demersal *S. mentella*, and the red contours represent catches of demersal *S. mentella* taken with pelagic trawls.

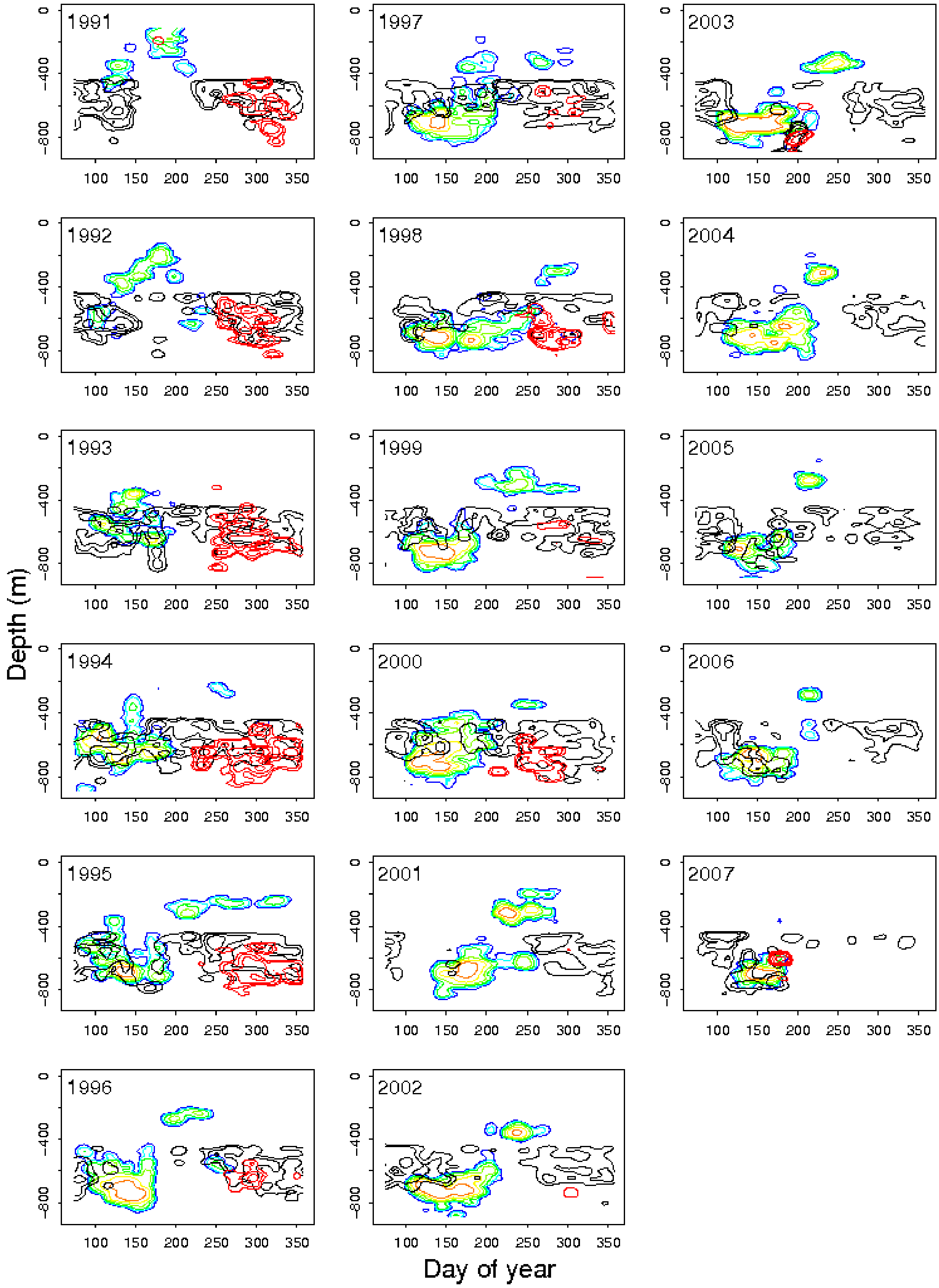


Figure 16.1.3 Depth-time plot for Icelandic *S. mentella* catches, where the y-axis is depth, the x-axis is day of the year and the colour indicates the catches. The coloured contours represent the fishery on pelagic *S. mentella*, the black contours indicate bottom trawl catches of demersal *S. mentella*, and the red contours represent catches of demersal *S. mentella* taken with pelagic trawls.

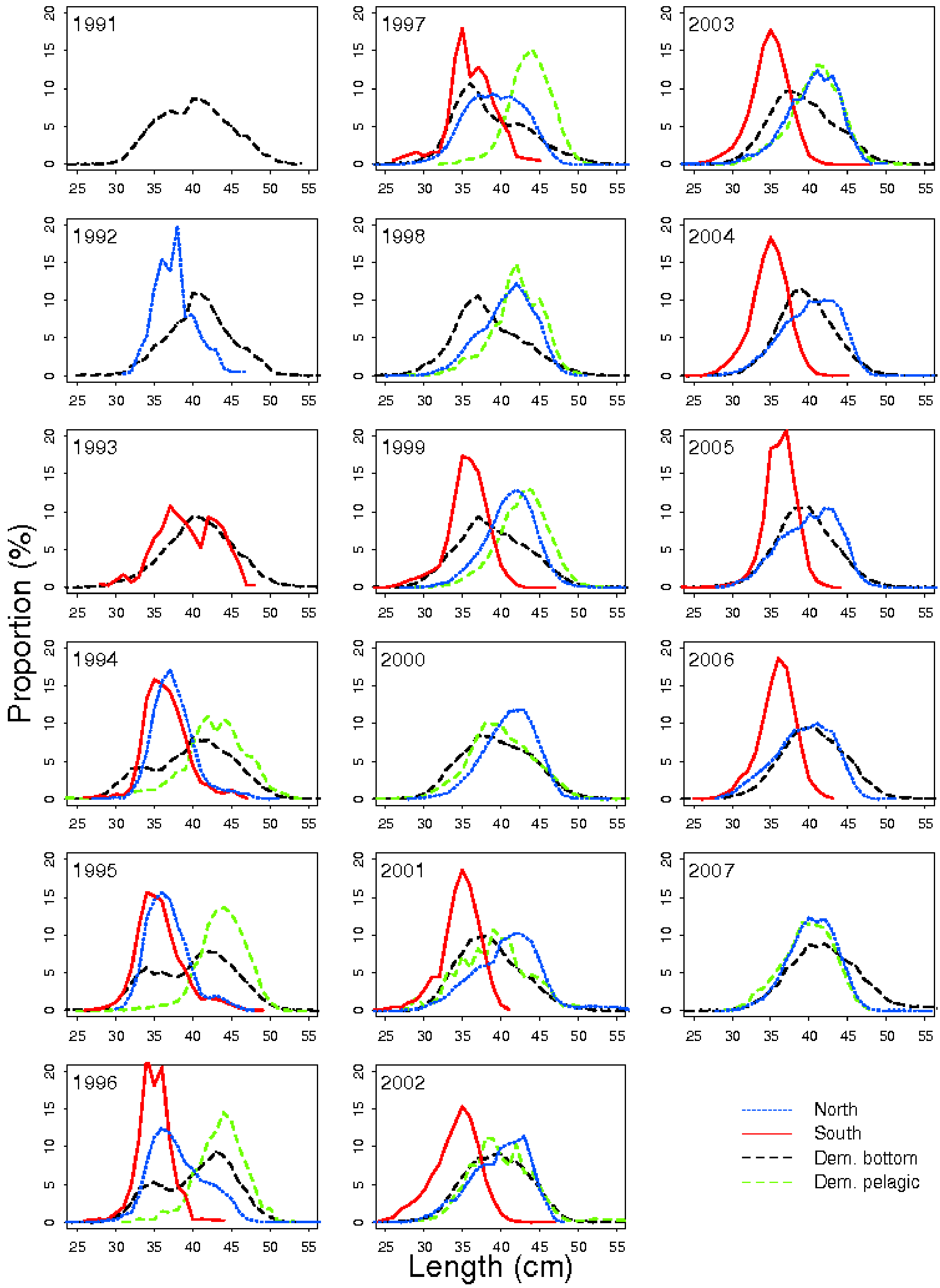


Figure 16.1.4 Length distributions from different Icelandic *S. mentella* fisheries. The blue lines represent the fishery on pelagic *S. mentella* in the northeastern area, the red lines the pelagic fishery in the southwestern area, the black lines indicate bottom trawl catches of demersal *S. mentella*, and the green lines represent catches of demersal *S. mentella* taken with pelagic trawls.

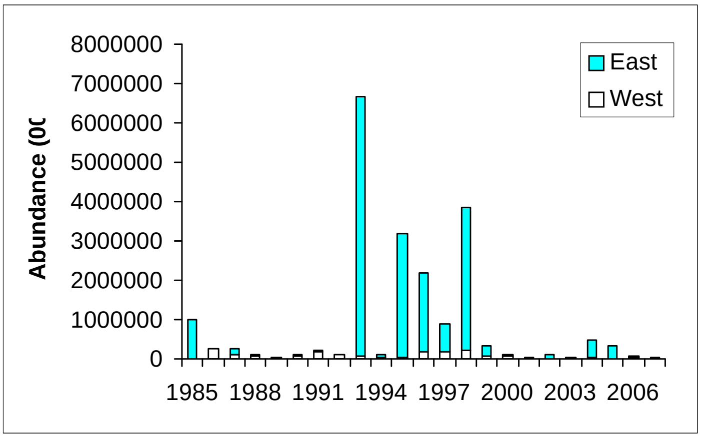


Figure 16.3.1 Survey abundance indices of juvenile *Sebastes* spp. (<17 cm) from the German groundfish survey conducted on the continental shelves off East and West Greenland 1985-2007.

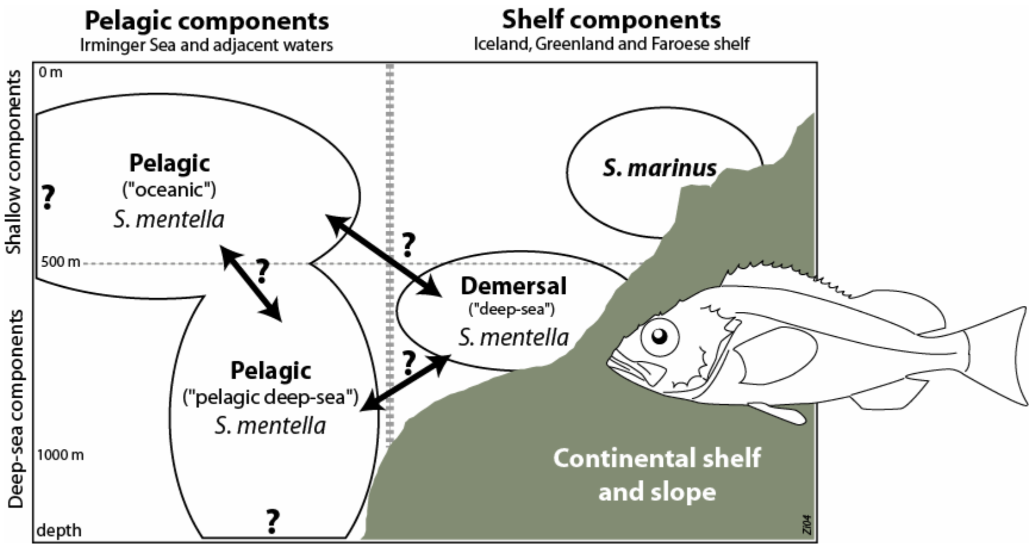


Figure 16.5.1 Possible relationship between redfish occurrences in the Irminger Sea and adjacent waters.

17 Golden redfish (*Sebastes marinus*) in Subareas V, VI and XIV

Executive summary

- Total landings in 2007 were about 40 500 t, about 2 000 t less than in 2006. About 98% of the catches were taken in Division Va.
- The basis for advice and the relative state of the stock is based on projection derived from the analytical GADGET model and survey index series. The GADGET model used only catches and survey indices from Va.
- Catch-at-age data from Va shows that the catch is dominated by two strong year classes. It is expected that the 1990 year class will be important in the catches in the next few years but the 1985 year class is disappearing.
- Survey indices of the fishable stock in Va decreased in recent years and was in 2008 13% below defined safe biological limits (Bpa). The fishable stock situation in Vb remains at low level, but has improved in XIV.
- Recruitment in Va has been low since 1993, but there is an indication of new year-classes observed as 8-10 years old fish in the October survey in 2006. There are signs of improved recruitment in XIV.
- The GADGET model predicts that catches in Va below 30 000 t would provide a fishable stock size above current biomass level for the next 5 year.

17.1 Stock description and management units

Golden redfish (*Sebastes marinus*) in ICES Subareas 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.

17.2 Scientific data

This chapter describes results from various surveys conducted annually on the continental shelves and slopes of Subareas V and XIV.

17.2.1 Division Va

Figure 17.2.1 shows the total biomass index from the Icelandic spring and autumn groundfish surveys with ±1 standard deviation in the estimate (68% confidence interval). The figure shows a large measurement error in some years most notably in recent years in both the March and October surveys, which is caused by relatively few tows accounting for a large part of the total amount caught and is also reflected in rapid changes of the indices from one year to another.

To get a more stable index, the index of fishable biomass for area from 0–400 m depth, based on an selection curve (Figure 17.2.2) 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 17.2.3 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 2004-2007 are about 60% of the highest observed value. The index of the fishable biomass decreased in 2007 and in

2008 and was about 13% below the Upa level (Figure 17.2.3). In comparison the total biomass index in both surveys has shown great variability, especially in recent years, without any clear trend. It is difficult to use such indices that are driven by few but large hauls, to interpret trends in stock size. The total indices were on the other hand used in the GADGET model (see below). This estimate of the fishable biomass could be used as a proxy for the SSB. Figure 17.2.4 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 17.2.5), which has been followed during the last years (first in 1987), has now reached the fishable stock. The increase in the survey index since 1995, therefore, reflects the recruitment of a relatively strong year classes (1985-year class and the 1990-year class). This has been confirmed by age readings (Figure 17.2.6). There is an indication of recruitment (fish less than 13 cm) observed in both groundfish surveys in 1998-2000 (Figure 17.2.7) and can be seen as 8-10 years old fish in the 2006 autumn survey (Figure 17.2.6). This recruitment is, however, not as large as observed in the 1987 and 1992 March surveys. A large amount of fish between 25 and 30 cm was observed in the 2005 survey, but not observed previously as smaller fish or in the 2006 survey. This could therefore be recruiting fish coming from East Greenland (Figures 17.2.9 and 17.2.10).

17.2.2 Division Vb

In Division Vb, CPUE of *S. marinus* were available from the Faeroes spring groundfish survey from 1994-2008 and the summer survey 1996-2007. Both surveys show similar trends in the indices (Figure 17.2.8). After an increase in the mid 1990s, CPUE decreased drastically and has been since 2000 stabilized at low levels.

17.2.3 Subarea XIV

From 1982 to 2007, relative abundance and biomass indices from the German groundfish survey for *S. marinus* (fish >17 cm) are illustrated in Figures 17.2.9. 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 with the estimate in 2007 at the highest. It should be noted that the CV for the indices are high and the increase is driven by few very large hauls. During the recent period of increase both the fishable biomass (> 30 cm) and the biomass pre-fishery recruits (17-30 cm) has increased considerable (Figures 17.2.9*c* and 17.2.10).

17.3 Information from the fishing industry

17.3.1 Landings

Total landings gradually decreased by more than 70% from about 130,000 t in 1982 to about 43,000 t in 1994 (Table 17.3.1 and Figure 17.3.1). Since then, the total annual landings have varied between 33,500 and 51,000 t. The total landings in 2007 were 40,300 t, which was 2,000 t less than in 2006. The majority of the golden redfish catch is taken in ICES Division Va and contributes between 90-95% of the total landings.

Landings of golden redfish in Division Va declined from about 63,000 t in 1990 to 34,000 t in 1996 (Table 17.3.1). Since then, landings have varied between 32,000 and 49,000 t. The landings in 2007 were about 39 500 t, about 2 000 t less than in 2006.

Between 90-95% of the golden redfish catch is taken by bottom trawlers targeting redfish (both fresh fish and factory trawlers; vessel length 48-65 m). The remaining catches are partly caught as by-catch in gillnet and long-line fishery. In 2007, 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 17.3.2).

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 17.3.1). In 2005, the landings were 2,500 t, but decreased to annual landings less than 700 t in 2006 and 2007. The majority of the golden redfish caught in Division Vb is taken by pair- and single trawlers (vessels larger than 1000 HP).

Annual landings from Subarea VI increased from 1978 to 1987 followed by a gradual decrease to 1992 (Table 17.3.1). In the 1995-2004 period, annual landings have ranged between 400 and 800 t, but decreased to 137 t in 2005. No landings of golden redfish were reported from Subarea VI in 2006 and 2007.

Annual landings from Subarea XIV have been more variable than in the other areas (Table 17.3.1). After the landings reached a record high of 31,000 t in 1982, the golden redfish fishery drastically reduced within the next three years (the landings from XIV were about 2,000 t in 1985). During the period 1985-1994, the annual landings from Subarea XIV varied between 600 and 4,200 t, but since 1995, there has been little or no directed fishery for golden redfish. In recent years, landings have been 200 t or less and are mainly taken as by-catch in the shrimp fishery. With the opening of the cod fishery off East Greenland in 2007, it is expected that by-catches of golden redfish will increase in Subarea XIV.

17.3.2 Discard

Although no direct measurements are available on discards, it is believed that there are no significant discards of golden redfish in the Icelandic redfish fishery due to area closures of important nursery grounds west of Iceland. Discard of redfish in bottom trawl fisheries directed towards other species are considered negligible (Palsson et al 2006).

Discard of redfish species in the shrimp fishery is described in Chapter 16 as the redfish is not split into species.

17.3.3 Biological data from the commercial fishery

The table below shows the fishery related sampling by gear type and Divisions in 2007. No sampling of the commercial catch from sub-divisions VI and XIV was carried out.

Area	Nation	Gear	Landings	Samples	No. length measured	No. Age read
Va	Iceland	Bottom trawl	41.398	336	52.538	
Vb	Faeroe	Bottom trawl/gillnets	656	42	822	

17.3.4 Landings by length and age

The length distributions from the Icelandic commercial trawler fleet in 1989-2007 show that the majority of the fish caught range between 30 and 45 cm (Figure 17.3.3). From 2000 to 2007, 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 17.3.4 and Table 17.3.2) 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 2003-2007 contributing between 25-30% of the total catch in weight. The average total mortality (Z), estimated from this 10-year series of catch-at-age data (Figure 17.3.5) is about 0.23 for age groups 15+, and about 0.20 for age groups 20+.

Length distribution from the Faeroes commercial catches for 2001-2007 indicates that the fish caught are on average larger than 40 cm with modes between 40 cm and 45 cm (Figure 17.3.6).

No length data from the catches have been available for several years in Subareas XIV and VI.

17.3.5 CPUE

Data used to estimate CPUE for golden redfish in Division Va 1986-2007 were obtained from log-books of the Icelandic bottom trawl fleet. Only those hauls were used that were taken above 450 m depth and that were comprised of at least 50% golden redfish (assumed to be the directed fishery towards the species). Non-standardized CPUE for each year (y) was calculated and from which total fishing effort for each year (y) was estimated according to:

$E_y = Y_y / CPUE_y$,

where *E* is the total fishing effort and *Y* is the total reported landings (Table 17.3.1).

CPUE indices were also estimated from this data set using a GLM multiplicative model (generalized linear models). This model takes into account changes in vessels over time, area (ICES statistical square), month and year effects. The outcome of the model run is given in Table 17.3.3 and the model residuals in Figure 17.3.8.

The CPUE index increased considerably in 2001 after being at low level 1993-1999 and was until 2006 high but stable (Figure 17.3.7). In 2006, the CPUE index decreased by 12% compared to the previous year but increased again in 2007. Effort towards golden redfish gradually decreased from 1986 until 2005 but has, since then, increased (Figure 17.3.7).

Un-standardized CPUE of the Faroese otterboard (OB) trawlers 1991-2007 gradually declined to a record low in 1997 but has since then increased and is now about 80% of the 1991 value (Figure 17.3.9). OB trawlers conduct a mixed fishery and direct their fishery to some extent towards golden redfish. Un-standardised CPUE from the Faeroese CUBA pair-trawler fleet, where golden redfish is mainly caught as by-catch in the saithe fishery, has been fairly stable since 1991 (Figure 17.3.9). Effort has in recent years fluctuated both for the CUBA and OB trawlers.

17.4 Methods

The BORMICON (**BOR**eal **M**igration and **CON**sumption model) has been used for assessment of *S.marinus* stock in Va since 1999 (Björnsson and Sigurdsson 2003). Since then the model has been developed further and is now referred as Gadget (**G**lobally applicable **A**rea **D**isaggregated **G**eneral **E**cosystem **T**oolbox, see www.hafro.is/gadget). The main settings and structure of the Gadget model for redfish are similar to what has been used in the BORMICON model (Björnsson and Sigurdsson (2003).

The Gadget 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.

Data used for tuning are:

- Length disaggregated survey indices (2 cm length increments, 4 cm for 5-8 cm fish) from the Icelandic groundfish survey in March 1985-2008.
- Length distribution from the Icelandic commercial catch since before 1980. The sampling effort was though relatively limited until the 1990's.
- Landings data by 6 month period.
- Age-length keys and mean length at age from the Icelandic groundfish survey in October 1996-2006.
- Age-length keys and mean length at age from the Icelandic commercial catch 1995-2007.

The simulation period is from 1970 to 2014 using data until 2008 for estimation. Two time steps are used each year. Natural mortality is set to 0.15 for the youngest age, decreasing gradually to 0.05 for age 5 and older. The ages used were 1 to 30 years, where the oldest age is treated as a plus group (fish 30 years and older). Recruitment was set at age 1. Length at recruitment was estimated separately prior to and after 1989.

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).

Four alternative settings of the Gadget model were run this year. The settings of the base case will not be described in detail, only how the alternatives differ from the base case. The three alternatives differ from the base case as follows:

Alternative 1. Power curve in the relationship between number in stock and abundance index for 15cm and smaller fish.

Alternative 2. Much more weight on age length keys.

Alternative 3. No age data.

17.4.1 Results

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 $\mathbf{F_{max}}$=0.15, $\mathbf{F_{0.1}}$=0.09 and maximum yield was estimated to be 225 g/recruit (1 year) (Figure 17.4.1). Maximum yield was estimated by the BORMICON model in 2000 giving 250 g/recruit. The reason for reduction is not clear but most of the aging data available are sampled after 2000 and the estimated selection pattern assumed fixed in the model has changed since then. 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 $\mathbf{F_{target}}$.

Figure 17.4.2 shows estimated recruitment, selection pattern, the mean length at age and available biomass from the model. The figure indicates that the 1985 and 1990 year classes are considerably larger than other year classes and that recruitment since the 1990-1991 year classes is on average poor.

Figure 17.4.3 shows development of the catchable biomass (biomass multiplied by the selection pattern) for different catch options after 2008. The results indicate that landings in excess of 30,000 tonnes will lead to substantial reduction of the stock in coming years. This value might have to be reduced in the near future if no sign of good recruitment will appear. Currently recruitment is based on indices from the groundfish survey that has not shown any good year class since the year class 1990 and age readings have confirmed that the two year classes that appeared large in the groundfish survey at ages 1-3 have been large. Recruitment from other areas is though not unlikely and there are signs that the survey might be underestimating some of the large year classes.

Figure 17.4.4 shows residuals from the model fit to the survey data, demonstrating substantial negative blocks in small fish for some of the small year classes. This could mean that recruitment is partly coming from other areas. Ways to reduce this problem is to have a power curve in the relationship between stock abundance and indices or not to do the fitting on log scale that leads to constant CV or low standard deviation for small year classes. Also observed are positive blocks around 30 cm in recent years that might be caused by measurement errors, but CV is quite high in recent years. Those positive blocks in recent years could also be caused by year classes that did not show up in the survey when they were small. That leads back to the earlier mentioned problem that the survey might not cover the nursery area of the stock.

Figure 17.4.5 shows survey indices vs. number in stock. There are some indications of nonlinear relationship for the smallest length groups but for the intermediate length groups (13-24 cm) the fit is reasonable and the relationship is linear. The same applies to the largest redfish, (45+) where the fit is good. The dynamic range of the data is quite large for this part of the stock seems is severely depleted. For the intermediate fish (27-38 cm) the range of stock size is relatively small and the noise in the data substantial but those are the length groups responsible for the large redfish hauls that are so common in the groundfish survey. These are also the sizes accounting for a large part of the stock biomass.

17.5 Reference points

The biological reference points are given in Table 17.5.1.

As described earlier F_{max} and $F_{0.1}$ were calculated by following one year class of million fishes for 45 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 as the mean weight in the stock. Those effects can be seen in Figure 17.4.1.

The group was asked for suggestions for reference points based on the Gadget model. As length of the data series is short compared to the live span of the fish all considerations about SSB-Recruitment or recruitment pattern are impossible. There are though indications that recruitment is uneven and that long period between good year classes should lead to more careful harvesting of the stock. The only reference points that are possible to get from the gadget run is the lowest value of SSB or SSB in 1990 when the last good year class was generated, the former as B_{lim} and the latter as B_{pa}. Reference points should not be taken at face value but rather defined in a relative sense. This precaution is taken as the level of the stock can change in future runs as the model is now based on 24 years of survey data and the year class seen in the 2nd March survey is still abundant in the fishery. The biological reference points based on the Gadget model were, however, not fully evaluated by the Group

Looking at possible ways to formulate advice the model indicates that catches around 30,000 t in the next 5 years will keep the SSB similar. However, because of poor recruitment, the total biomass is expected to decrease at this catch level.

Golden redfish 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 but below U_{pa} during the last two years (Figure 17.2.3). The survey index series is only available from 1985.

17.6 State of the stock

Golden redfish is mainly caught in ICES Division Va, contributing 90-95% of the total landings from Va, Vb, and XIV. The GADGET model and available survey information from Division Va show that the golden redfish 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 and landings in the last 6 years. It is expected that the 1990 year class will be important in the catches in the next few years but the 1985 year class is disappearing. There is an indication of new year classes that are observed as 8-10 year-old fish (about 25-30 cm) in the October survey. These year classes are, however, not as strong as the 1985- and the 1990-year classes and were not noticed in the March survey at age 1-4. The GADGET model estimated an exploitation rate of F=0.29 in 2007.

In Vb, survey indices are stable at low level and do not indicate an improved situation in the area. In Subarea XIV, the biomass of the fishable stock has increased in recent years and there are also 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 golden redfish 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 at low level Vb, but has improved in XIV.

17.7 Short term forecast

Results from the short term prediction are given in Table 17.7.1 and Figure 17.4.3. Based on the Gadget model, a decrease in the fishable biomass in Va is expected for all catch options above 30,000 t (the fishable biomass is used here as a proxy for SSB). This is due to the poor recruitment after the 1990-year class. The estimated average year class since 1992 is about 90 millions (at age 1) and maximum yield-per-recruit is estimated to about 225 g giving maximum landings in Va of around 20,000 t from those year classes.

17.8 Medium term forecast

No medium term forecast was carried out.

17.9 Uncertainties in assessment and forecast

The basis for advice and the relative state of the stock is based on projection derived from the analytical GADGET model and survey index series.

The estimate of the available biomass (SSB) in the beginning or 2008 is 170,000 t compared to 190,000 t when estimated last year. The changes are due to a change in model the (from BORMICION to GADGET) and addition of new data.

The model indicates that recruitment has been poor since the 1990 year class and maximum yield from the stock might reduce to 20-25,000 t after 5-10 years. There are though signs that the model (based on the March survey) has been underestimating recruitment in recent years. (Figure 17.4.8).

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.

Survey indices are disaggregated by length but 2 cm length increments (4cm for 5-8cm) are used instead of 1cm in the older runs. The size of length increments is always a question but the smaller the length groups the higher is the correlation between residuals and that correlation is not modelled. One option would be to used the total index or split in few groups by length. What needs to be done is to investigate the sensitivity of the model results to how the likelihood function is set up but the current work does not do extensive work in this context.

There are only available data on nursery grounds of golden redfish in Icelandic and Greenland waters but no nursery grounds are known in the Faeroese waters. In Icelandic waters, nursery areas are found mostly West and North of Iceland at depths between 50 m and approximately 350 m, but also in the South and East (ICES C.M. 1983/G:3; Einarsson, 1960; Magnússon and Magnússon 1975; Pálsson *et al.* 1997). Other nursery areas might be on the continental shelf off East Greenland. As length (age) increases, migration of young golden redfish 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.

17.10 Comparison with previous assessment and forecast

In Figure 17.4.6 the development of the available biomass according to the three Gadget runs described here is compared to a spaly run of the BORMICON model and the Gadget run from last year. In Figure 17.4.7 the estimated recruitment is compared. As may be seen from the figures the BORMICON model gives a more optimistic view of the stock, mostly due to the 1996 year class which is estimated stronger in BORMICON than in Gadget. What is causing this estimate of this year class in the BORMICON is not clear.

Figure 17.4.8 shows analytical retro of the GADGET model. The comparison between 2007 and 2008 is better than in the real time retro. The reason is not clear but it is possible that when the model was run last year not all the data were available for 2006 and early 2007, this applies especially to the age data that are usually behind. The analytical retro shows that recruitment has been underestimated. Real time retro for the BORMICON model presented last year showed less underestimation of recruitment.

The different Gadget runs show on the average similar recruitment although considerable difference may be noticed for some year classes, especially the small ones. Figure 17.4.9 shows the estimated mean weight at age from the BORMICON and the Gadget model. The estimated growth is similar as may be expected as age reading data used are the same. The figure does though not show “real” growth as the length based selection has substantial effect on mean weight at age.

17.11 Management plans and evaluation

17.12 Management consideration

Based on the model results, a TAC below 30,000 t in Va in the next 5 years would provide a fishable stock size above current biomass level at the end of that period, but the total biomass would decrease because of low recruitment since 1991 (Table 17.7.1). 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 20-25,000 t cannot be expected after 2012. The approximate **F** from the model would decrease from the current level and be close to $\mathbf{F_{max}}$.

Analytical retrospective pattern from the GADGET model indicates that recruitment has been underestimated in recent years. Recruitment is based on survey indices from Va in March which has been very low since 1993 compared to the 1985 and 1990 year classes. Results from age reading in recent years indicate that some of the year classes are larger than estimated by use of the survey indices. This could indicate that part of the recruitment comes from other areas.

The GADGET model uses only catches from Va and predicts that catches below 30 000 t would provide a fishable stock size above current biomass level for the next 5 year. Including total catches for the whole area (Division V and XIV) is only a matter of scaling as there are no surveys data available from Vb and XIV. On average, about 10% of the total catches 1985-2007 are taken in Vb and XIV and adding proportion to the catch predicted by the GADGET model would give 33 000 t for the whole area.

ACFM recommended in 2005-2007 that the total allowable catch in Division Va should be 35,000 t. However, the total annual catches in 2005-2007 were around 40,000-45,000 t. The Icelandic authorities give a joint quota for golden redfish and demersal *S. mentella* (see Chapter 18.7), which causes this difference. Joint quota also impedes direct management of golden redfish. TAC allocated to demersal *Sebastes* fishery should be given separately for each of the fish stocks.

The biomass of the fishable stock of *S. marinus* in Subarea XIV has increased in recent years and was in 2007 highest in the time series. There is, however, a large measurement error in 2007 caused by relatively few tows accounting for a large part of the total amount caught. This is reflected in rapid change of the index from 2006 to 2007 which may not reflect actual changes in biomass.

The present advice allow for a potential increase in the redfish fishery in Subarea XIVb. Here redfish and cod are found in the same areas and depths and historically these species have been taken in the same fisheries. An increased redfish fishery may therefore affect cod. ICES presently advice that no fishery should take place on offshore cod in Greenland waters. ICES therefore recommends measures that will keep effort on cod low in a potential redfish fishery.

Greenland have opened for an offshore cod fishery with a TAC of 15 000 t in 2008. To protect spawning aggregations of cod present management measures in Greenland EEZ prohibits trawl fishery for cod north of 63°N latitude. Restrictions on cod bycatch in fisheries directed towards other demersal fish (i.e. redfish and Greenland halibut) provide some protection of cod, but additional measures such as a closure of the redfish fishery north of 63°N could be considered.

Subarea XIV is an important nursery area for the entire resource. Measures to protect juvenile in Subarea XIV should be continued (sorting grids in the shrimp fishery).

No formal agreement on the management of *S. marinus* exists among the three coastal states, Greenland, Iceland and the Faeroe Islands. In Greenland and Iceland the fishery is regulated by a TAC and in the Faeroe Islands by effort limitation. The regulation schemes of those states have previously resulted in catches well in excess of TACs advised by ICES.

17.13 Ecosystem consideration

Not evaluated.

17.14 Regulation and their effects

There is no minimum landing size of golden redfish in Va. However, if more than 20% of a catch observed onboard is below 33 cm a small area can be closed temporarily. A large area west and southwest of Iceland is closed for fishing in order to protect young golden redfish.

There is no regulation of the golden redfish in Vb.

Since 2002 it has been mandatory in the shrimp fishery in Subarea XIV to use sorting grids in order to reduce by-catches of juvenile redfish in the shrimp fishery.

17.15 Changes in fishing technology and fishing patterns

There have been no changes in the fishing technology and the fishing pattern of golden redfish in Subareas V and XIV.

17.16 Changes in the environment

See chapters 2, 7, and 13.

Table 17.2.1 Index on fishable stock of golden redfish in the Icelandic groundfish survey 1985-2008 divided by depth intervals.

	Depth Intervals					
Year	< 100m	100-200m	200-400m	400-500m	0 - 400m	Total
1985	7.0	91.1	145.2	23.6	243.2	266.8
1986	2.0	86.1	179.9	12.1	268.0	280.1
1987	2.0	123.8	150.2	10.0	276.0	286.0
1988	1.1	94.6	110.1	4.0	205.8	209.7
1989	1.1	101.4	117.8	10.9	220.2	231.1
1990	2.3	67.9	81.0	22.2	151.2	173.4
1991	1.7	75.9	52.6	8.3	130.3	138.6
1992	1.2	62.2	58.5	9.4	121.9	131.3
1993	0.7	47.5	50.2	16.6	98.4	115.0
1994	0.5	57.7	51.4	1.3	109.6	110.9
1995	0.3	36.0	44.6	11.2	81.0	92.1
1996	0.8	44.3	76.5	21.1	121.5	142.6
1997	1.0	60.3	71.5	33.6	132.7	166.4
1998	1.6	56.9	71.2	2.7	129.7	132.4
1999	0.7	55.5	107.3	44.4	163.6	207.9
2000	2.0	46.7	68.5	8.1	117.2	125.4
2001	1.6	33.1	66.6	5.8	101.2	107.0
2002	1.8	64.0	74.2	11.4	140.1	151.4
2003	8.7	60.2	107.5	28.8	176.4	205.2
2004	7.9	48.8	91.6	102.3	148.4	250.6
2005	9.4	42.3	112.3	37.6	164.1	201.7
2006	6.0	52.6	95.7	17.0	154.4	171.4
2007	4.9	51.1	76.5	77.4	132.6	209.9
2008	5.5	38.5	85.1	33.1	129.1	162.2

Table 17.3.1 Official landings (in tonnes) of golden redfish, by area, 1978-2007 as officially reported to ICES. Landings statistics for 2007 are provisional.

	Area				
Year	Va	Vb	VI	XIV	Total
1978	31,300	2,039	313	15,477	49,129
1979	56,616	4,805	6	15,787	77,214
1980	62,052	4,920	2	22,203	89,177
1981	75,828	2,538	3	23,608	101,977
1982	97,899	1,810	28	30,692	130,429
1983	87,412	3,394	60	15,636	106,502
1984	84,766	6,228	86	5,040	96,120
1985	67,312	9,194	245	2,117	78,868
1986	67,772	6,300	288	2,988	77,348
1987	69,212	6,143	576	1,196	77,127
1988	80,472	5,020	533	3,964	89,989
1989	51,852	4,140	373	685	57,050
1990	63,156	2,407	382	687	66,632
1991	49,677	2,140	292	4,255	56,364
1992	51,464	3,460	40	746	55,710
1993	45,890	2,621	101	1,738	50,350
1994	38,669	2,274	129	1,443	42,515
1995	41,516	2,581	606	62	44,765
1996	33,558	2,316	664	59	36,597
1997	36,342	2,839	542	37	39,761
1998	36,771	2,565	379	109	39,825
1999	39,824	1,436	773	7	42,040
2000	41,187	1,498	776	89	43,550
2001	35,067	1,631	535	93	37,326
2002	48,570	1,941	392	189	51,092
2003	36,577	1,459	968	215	39,220
2004	31,686	1,139	519	107	33,451
2005	42,593	2,484	137	115	45,329
2006	41,521	656	0	34	42,211
2007[1)]	39,577	689	0	83	40,350

1) Provisional

Table 17.3.2 Landings of golden redfish in Va in weight (tonnes) by age 1995-2007. Highlighted are the 1985- and 1990-yearclasses. It should be noted that the catch-at-age results for 1996 are only based on three samples, which explains that there are no specimens older than 23 years.

Year/ Age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
7	62	0	33	24	7	40	122	130	201	227	236	187	141
8	374	360	230	285	350	65	138	910	211	849	782	1,063	468
9	1,596	825	482	596	1,623	852	395	767	1,366	499	1,925	2,221	1,821
10	9,436	3,701	1,039	1,211	1,259	4,308	1,623	841	1,120	2,109	1,526	3,724	2,567
11	2,719	9,127	2,702	1,132	1,855	1,894	7,763	3,188	1,197	795	3,139	2,145	3,478
12	1,319	2,102	11,583	3,252	2,528	2,277	1,807	11,065	3,952	982	1,919	2,841	1,993
13	3,534	1,317	2,828	12,532	2,450	1,703	1,983	3,095	9,788	2,035	1,378	1,641	3,194
14	5,671	1,477	1,373	2,085	15,566	2,375	1,252	2,630	2,361	8,661	3,027	1,302	1,095
15	5,971	4,347	3,142	2,039	1,244	14,878	839	1,856	1,978	2,158	11,920	2,849	1,001
16	1,730	5,456	3,666	2,413	1,276	1,777	11,686	3,029	1,218	1,723	2,138	10,226	2,293
17	852	934	3,035	3,416	1,823	1,184	523	12,046	2,267	826	1,472	2,112	9,829
18	368	379	900	2,051	2,665	1,624	787	2,097	6,427	1,401	1,333	1,186	1,411
19	1,134	259	642	1,018	2,228	2,427	1,068	1,174	761	5,342	1,315	684	780
20	1,144	340	925	729	1,271	2,191	1,801	663	410	1,120	6,797	958	804
21	503	1,157	449	523	479	544	970	1,411	604	336	412	5,658	940
22	677	988	520	391	217	447	420	1,028	791	491	466	644	5,155
23	1,427	791	681	427	341	270	437	743	755	620	868	235	780
24	664	0	587	665	218	64	169	363	379	600	636	384	118
25	762	0	749	516	930	393	130	294	303	284	446	485	663
26	365	0	271	401	279	340	126	185	75	106	97	73	343
27	350	0	136	427	649	193	293	83	83	180	324	269	358
28	725	0	192	360	228	528	204	297	27	153	215	202	228
29	0	0	149	54	105	371	153	500	106	138	31	174	37
30	133	0	30	226	231	441	375	174	197	161	227	274	77
Total	41,516	33,560	36,344	36,773	39,822	41,186	35,064	48,569	36,577	31,796	42,629	41,537	39,574

Table 17.3.3 Results of the GLM model to calculate standardized CPUE for Icelandic golden redfish fishery in Va. Note that the residuals are shown in Fig. 8.2.2.

Call: glm(formula = log(afli) ~ log(towingtime) + factor(year) + factor(month) + factor(ship) + factor(area), family = gaussian())

Deviance Residuals:

Min	1Q	Median	3Q	Max
-6.356742	-0.4792958	0.03168048	0.5152506	5.607132

	Value	Std..Error	t.value	ar	index	lower	upper
factor(year)1986	0.0000	0.0000	0.0000	1986	1.0000	1.0000	1.0000
factor(year)1987	0.0500	0.0374	1.3356	1987	1.0512	1.0126	1.0913
factor(year)1988	-0.0079	0.0382	-0.2081	1988	0.9921	0.9549	1.0307
factor(year)1989	0.0169	0.0386	0.4371	1989	1.0170	0.9785	1.0570
factor(year)1990	0.0396	0.0385	1.0281	1990	1.0404	1.0011	1.0813
factor(year)1991	0.0294	0.0320	0.9169	1991	1.0298	0.9973	1.0633
factor(year)1992	-0.1675	0.0323	-5.1792	1992	0.8458	0.8189	0.8736
factor(year)1993	-0.2946	0.0320	-9.2046	1993	0.7449	0.7214	0.7691
factor(year)1994	-0.3159	0.0330	-9.5647	1994	0.7291	0.7054	0.7536
factor(year)1995	-0.2931	0.0334	-8.7800	1995	0.7459	0.7214	0.7712
factor(year)1996	-0.2797	0.0339	-8.2465	1996	0.7560	0.7308	0.7821
factor(year)1997	-0.2898	0.0341	-8.5063	1997	0.7484	0.7233	0.7743
factor(year)1998	-0.2168	0.0345	-6.2917	1998	0.8051	0.7778	0.8333
factor(year)1999	-0.2729	0.0338	-8.0617	1999	0.7612	0.7359	0.7874
factor(year)2000	-0.1248	0.0339	-3.6759	2000	0.8827	0.8532	0.9132
factor(year)2001	0.0217	0.0352	0.6166	2001	1.0219	0.9866	1.0585
factor(year)2002	0.0620	0.0347	1.7840	2002	1.0639	1.0276	1.1015
factor(year)2003	0.0786	0.0361	2.1797	2003	1.0818	1.0435	1.1216
factor(year)2004	0.1314	0.0372	3.5283	2004	1.1404	1.0987	1.1837
factor(year)2005	0.0843	0.0356	2.3704	2005	1.0880	1.0500	1.1274
factor(year)2006	-0.0602	0.0348	-1.7314	2006	0.9415	0.9093	0.9749
factor(year)2007	-0.0104	0.0362	-0.2865	2007	0.9897	0.9545	1.0262

Analysis of Deviance Table

Gaussian model

Response: log(afli)

Terms added sequentially (first to last)

	Df	Deviance	Resid. Df	Resid. Dev	F Value	Pr(F)
NULL			25826	107217.4		
log(towingtime)	1	93672.67	25825	13544.8	121553.9	0
factor(year)	21	768.76	25804	12776.0	47.5	0
factor(month)	11	233.55	25793	12542.4	27.6	0
factor(ship)	146	1722.97	25647	10819.5	15.3	0
factor(area)	-16183	-21415.83	41830	32235.3	1.7	0

Table 17.5.1 Biological reference points for golden redfish in Division Va.

PARAMETERS	ESTIMATION
F_{max}	0.15
$F_{0.1}$	0.09
B_{pa}	125 000 t
Yield per recruit	225 g

Table 17.7.1 Golden redfish in Division Va. Output from short term prediction using results from the BORMICON model, where the annual landings after 2006 is set to 30 000 t. The table gives the SSB (the same as the catchable biomass), total biomass and landings in thousands tonnes F_{20} is the fishing mortality at age 20.

YEAR	SSB	F_{20}	TOTAL BIOMASS	LANDINGS
2007	161.9	0.29	278.3	39.6
2008	162.0	0.24	270.4	37
2009	168.5	0.23	268.9	30
2010	173.8	0.23	266.2	30
2011	176.4	0.23	262.4	30
2012	175.7	0.23	257.6	30
2013	171.8	0.23	252.0	30
2014	165.8	0.24	245.7	30

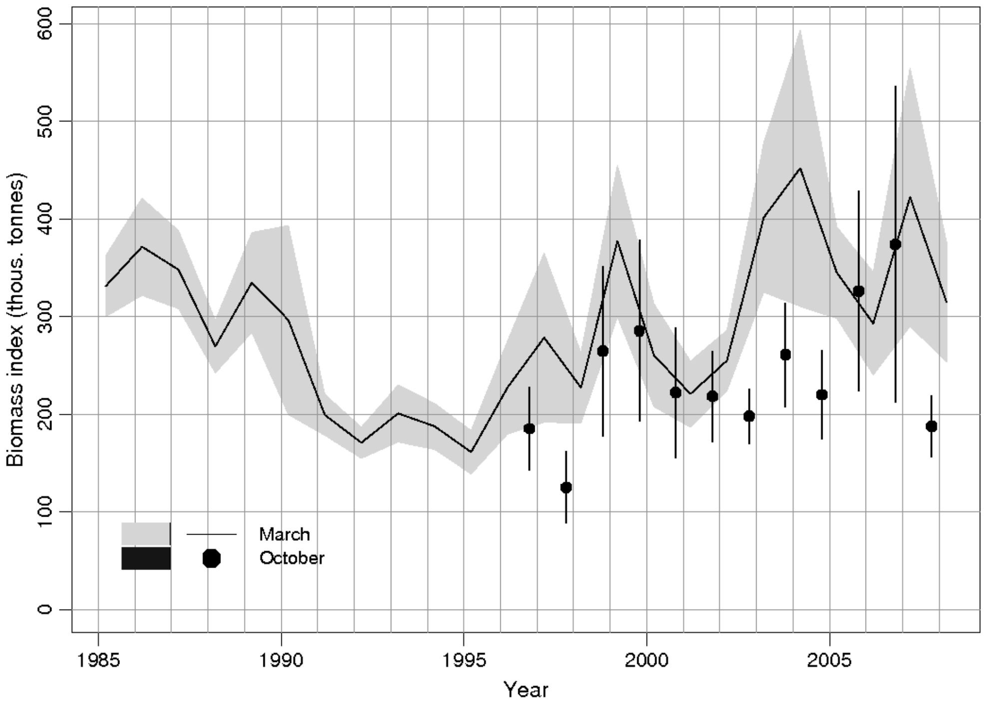


Figure 17.2.1 Total biomass indices of golden redfish from the groundfish surveys in March 1985-2008 (line, shaded area) and October 1996-2007 (points, vertical lines). The shaded area and the vertical bar show ±1 standard error of the estimate.

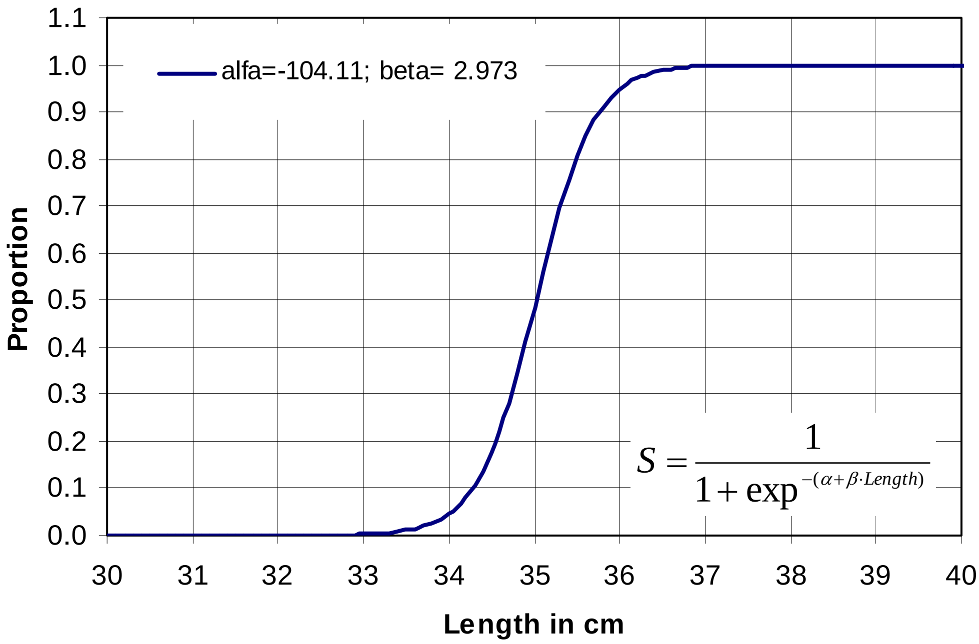


Figure 17.2.2 Selection pattern of golden redfish from the commercial fishery used to estimate the abundance of the fishable stock abundance. L_{50} = 35 cm.

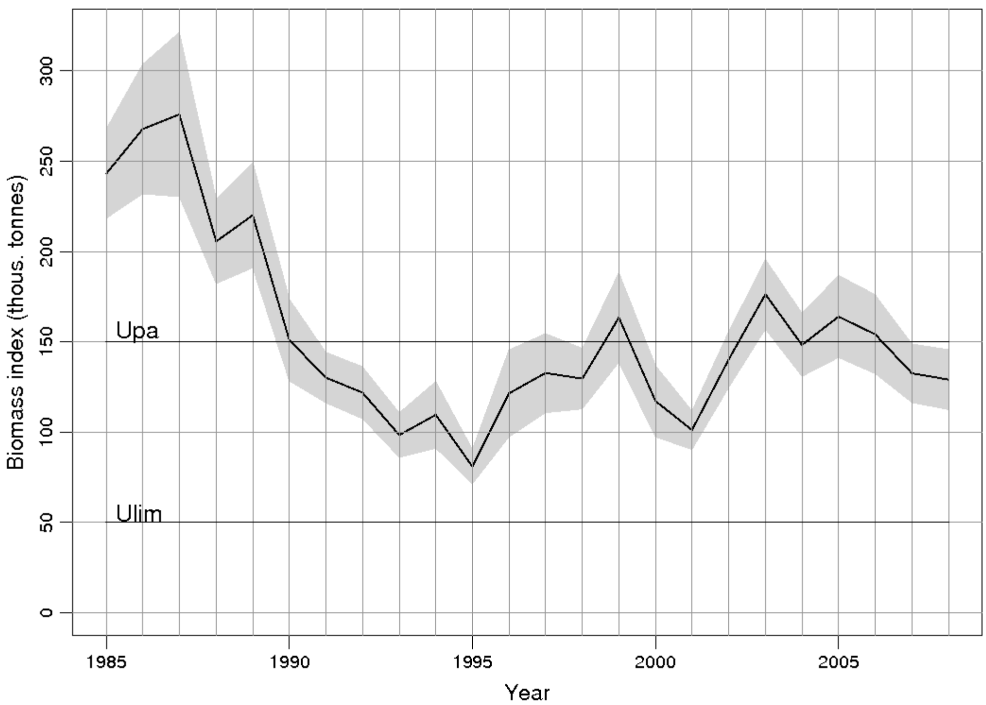


Figure 17.2.3 Index on fishable stock of golden redfish from Icelandic groundfish survey in March 1985-2008. The shaded area and the vertical bar show ±1 standard error of the estimate.

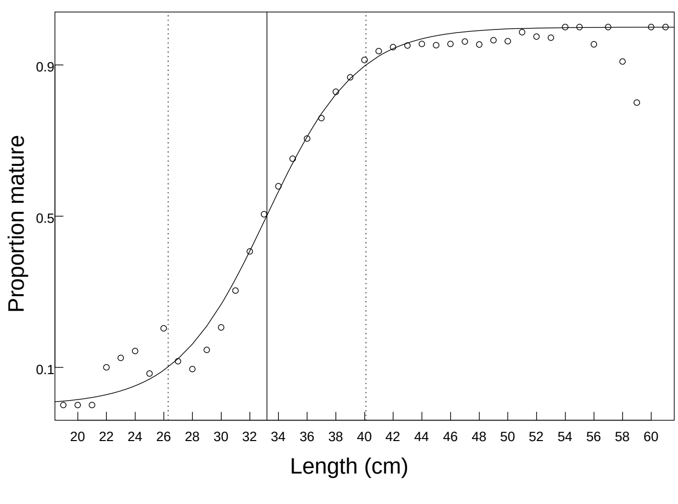


Figure 17.2.4 The proportion of mature golden redfish as a function of length from the commercial catch in Va 1995-2004 (all data pooled). The data points show the observed proportion mature and the lines the fitted maturity. The solid vertical line indicates the point where 50% of the fish mature and the two dotted lines indicate the 10% and 90% probability of being mature.

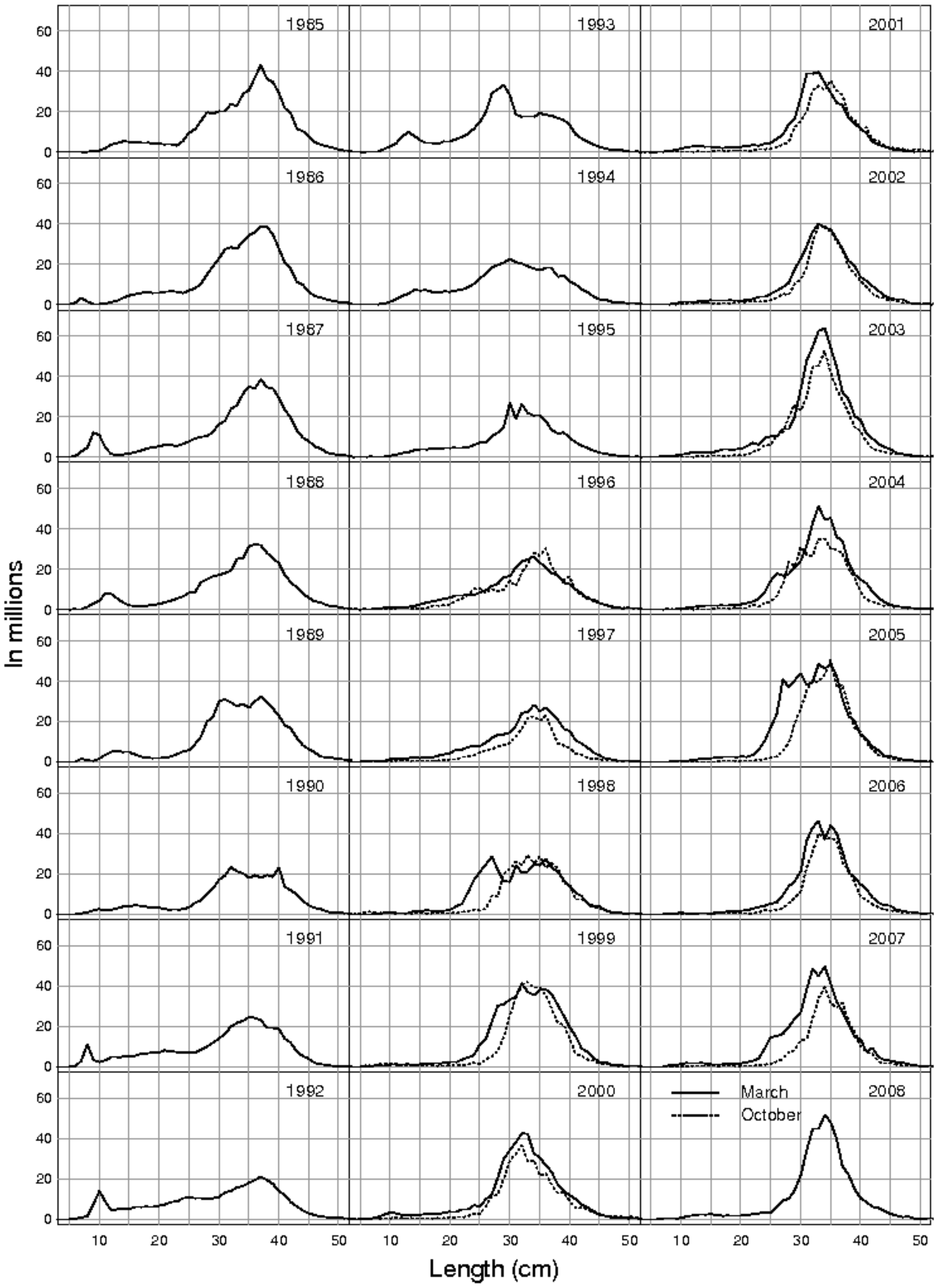


Figure 17.2.5 Length distribution of golden redfish in the bottom trawl surveys in March 1985-2008 (solid line) and in October 1996-2007 (broken lines) conducted in Icelandic waters.

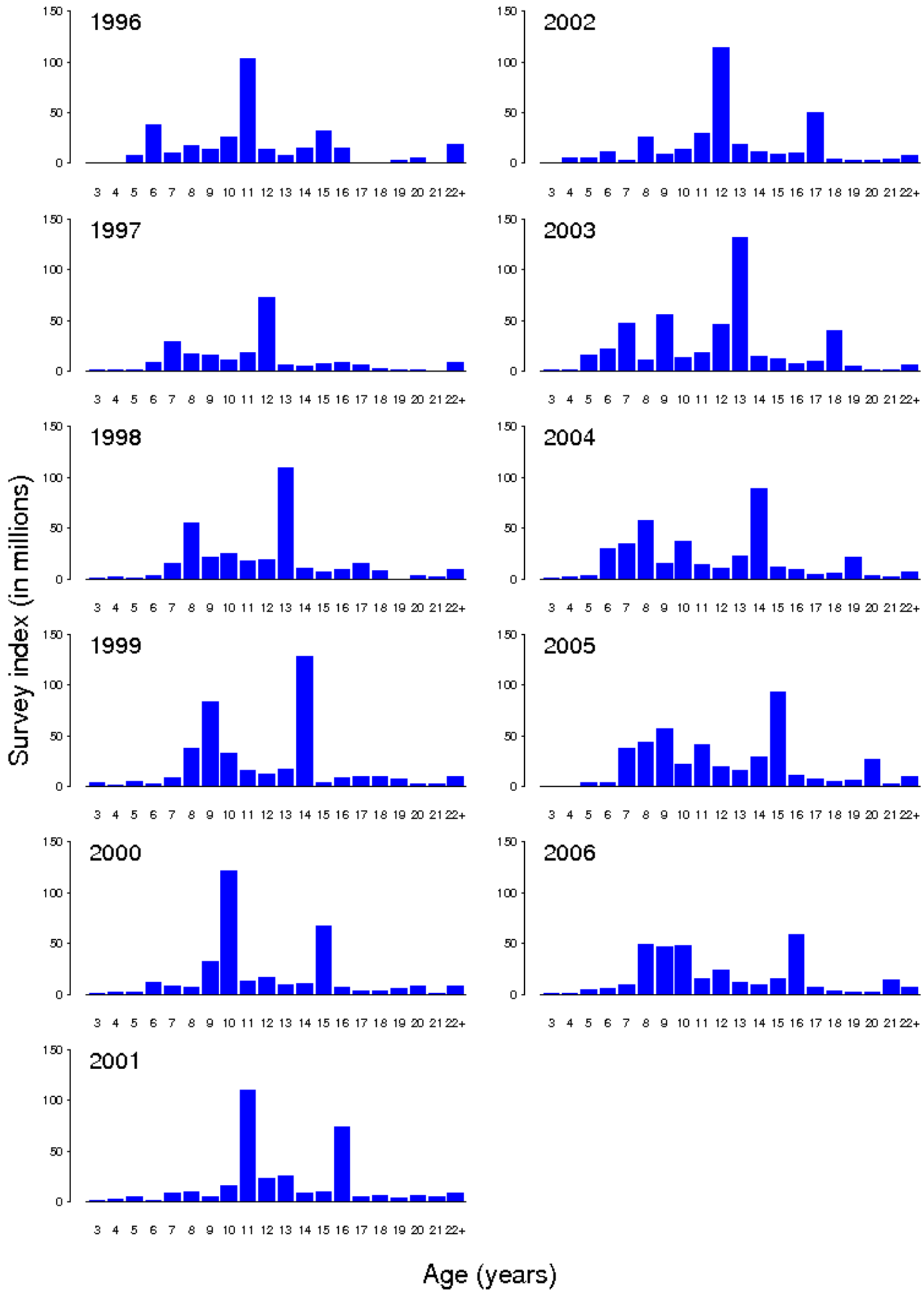


Figure 17.2.6 Age distribution of golden redfish in the bottom trawl survey in October conducted in Icelandic waters 1996-2006. No age readings were available for 2007.

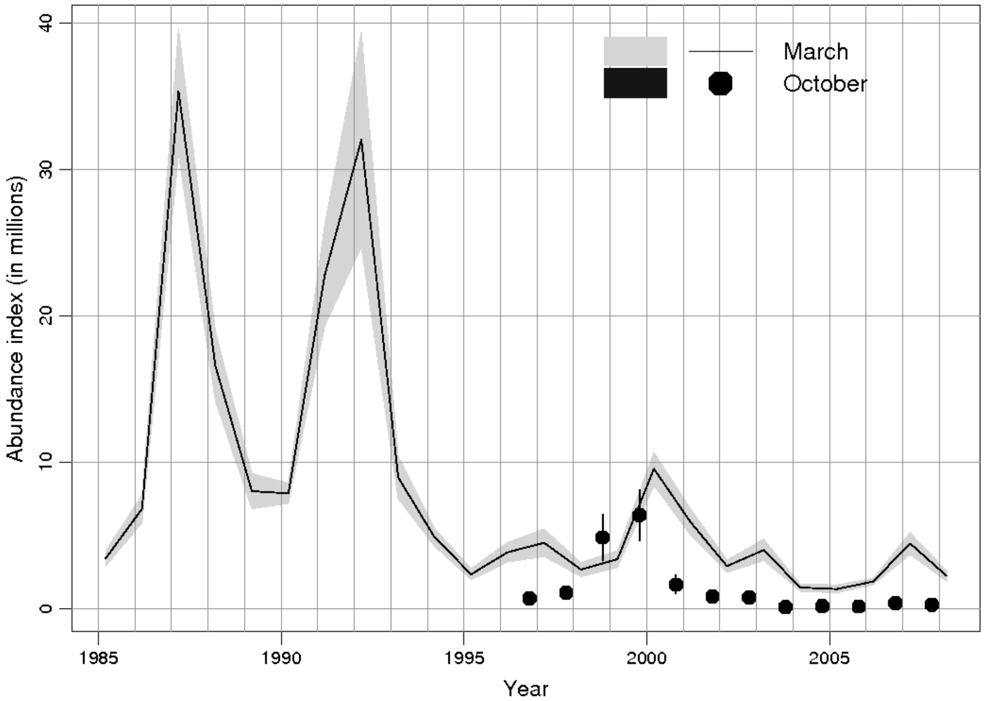


Figure 17.2.7 Indices of juvenile golden redfish (4-12) cm in millions from the grounfish surveys in March 1985-2008 (line, shaded area) and October 1996-2007 (points, vertical lines) conducted on the continental shelf and slope of Iceland. The shaded area and the vertical bar show ±1 standard error in the estimate of the indices.

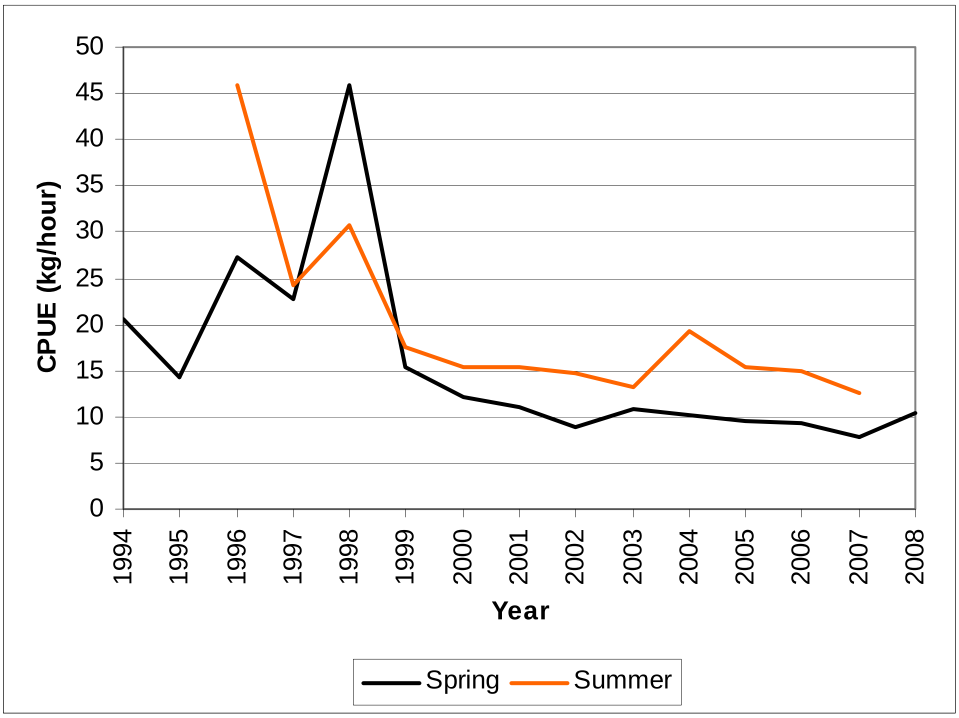


Figure 17.2.8 CPUE of golden redfish in the Faeroes spring groundfish survey 1994-2008 and the summer groundfish survey 1996-2007 in ICES Division Vb.

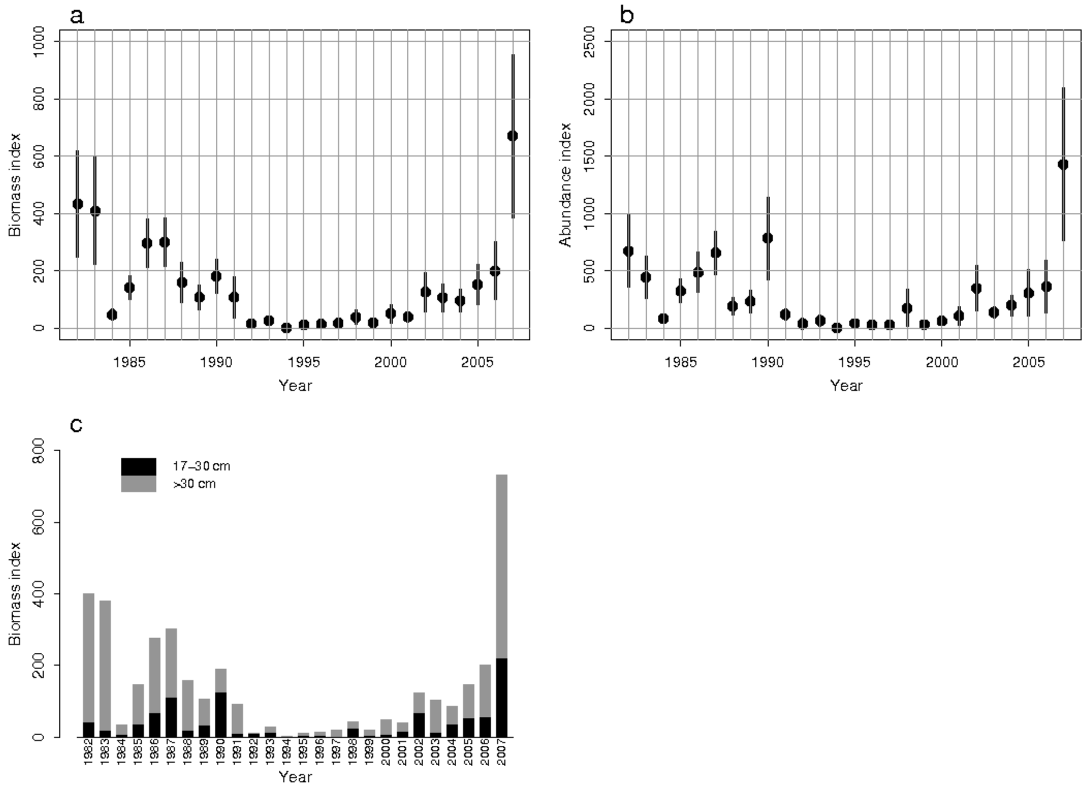


Figure 17.2.9 Golden redfish (≥17 cm). Survey abundance indices for East and West Greenland from the German groundfish survey 1982-2007. a) Total biomass index, b) total abundance index, c) biomass index divided by size classes (17-30 cm and > 30 cm).

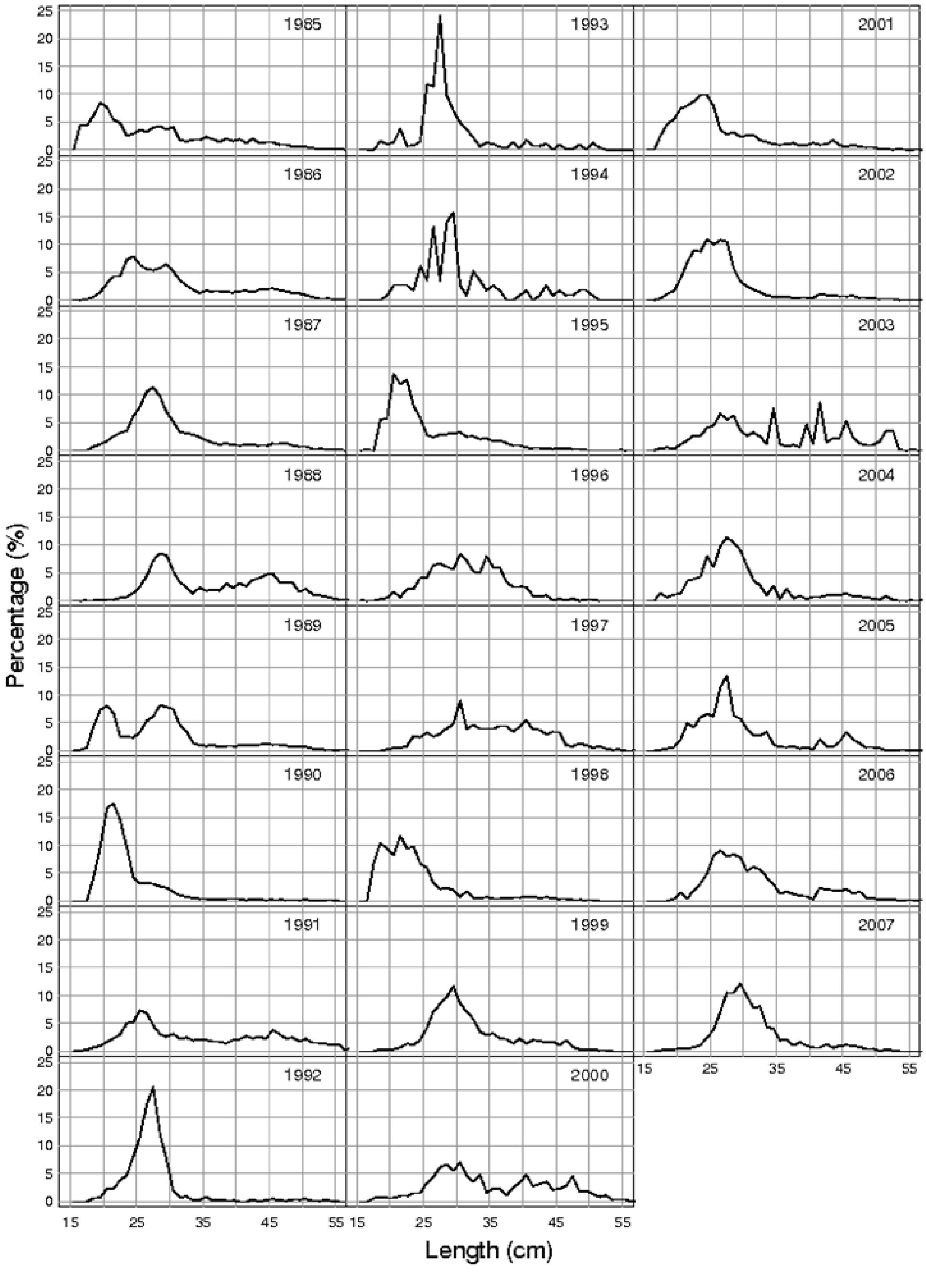


Figure 17.2.10 Golden redfish (>17 cm). Length frequencies for East and West Greenland 1985-2007.

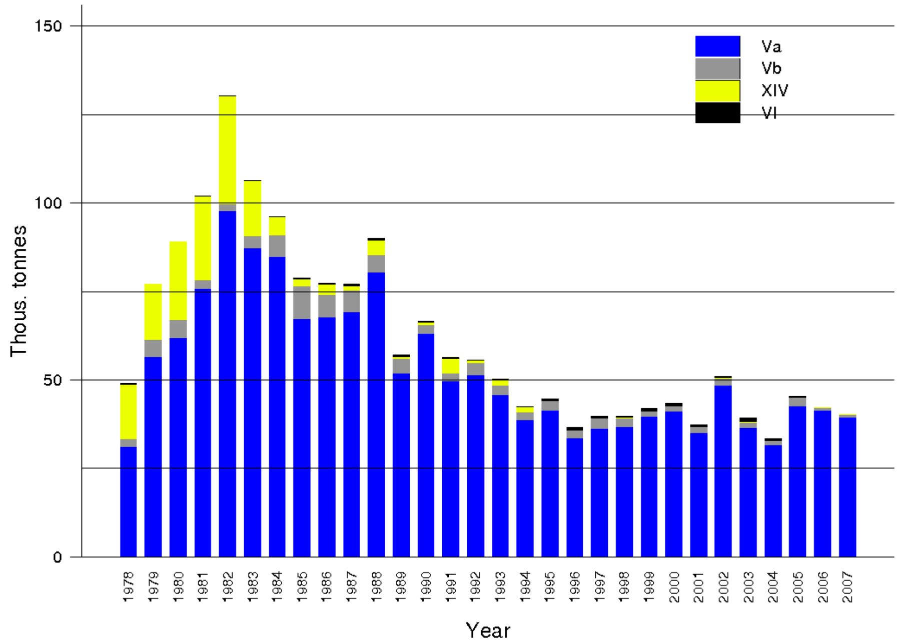


Figure 17.3.1 Nominal landings of golden redfish in tonnes by ICES Divisions 1978-2007. Landings statistics for 2007 are provisional.

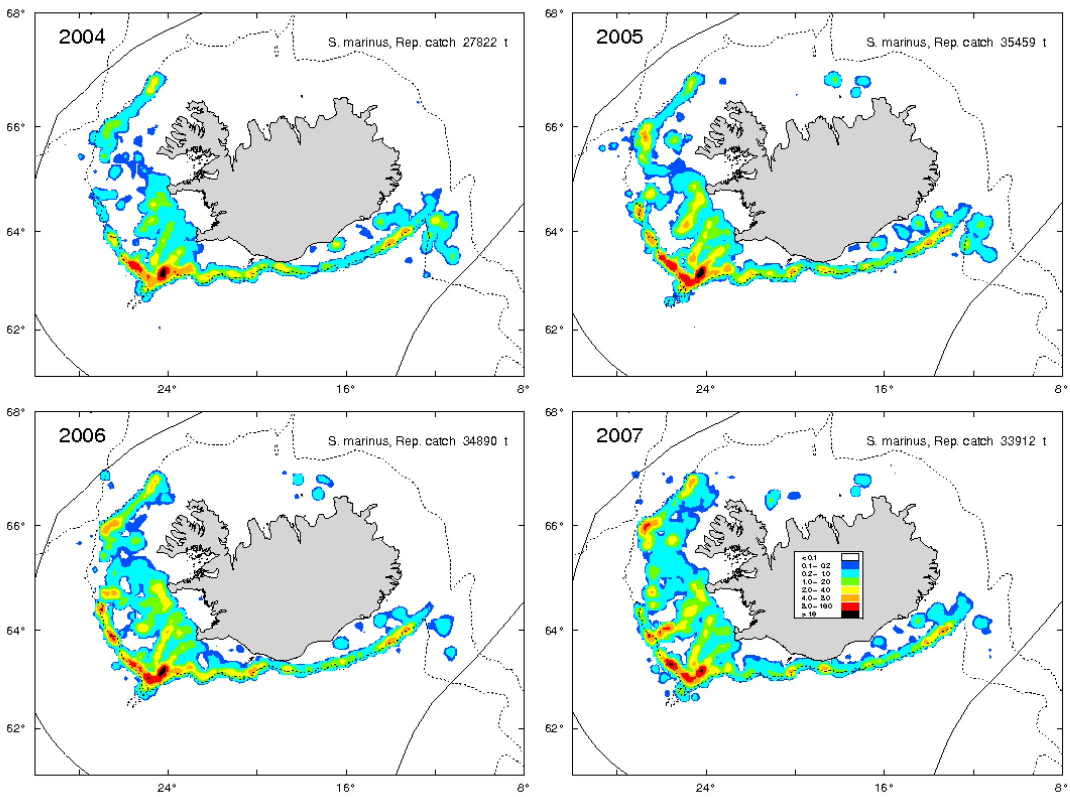


Figure 17.3.2 Geographical distribution of golden redfish bottom trawl catches in Division Va 2004-2007.

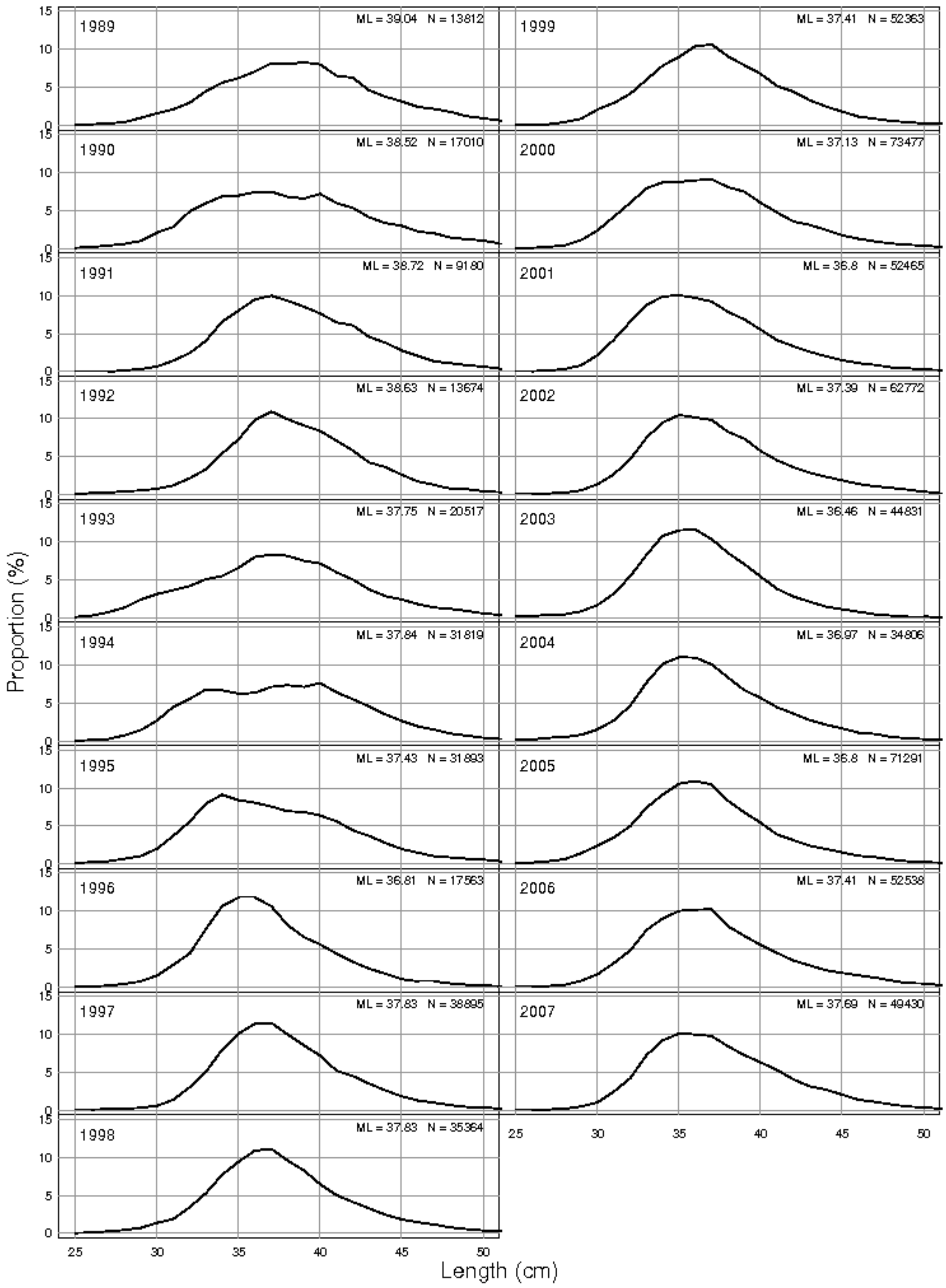


Figure 17.3.3 Length distribution of golden redfish in the commercial landings of the Icelandic bottom trawl fleet 1989-2007.

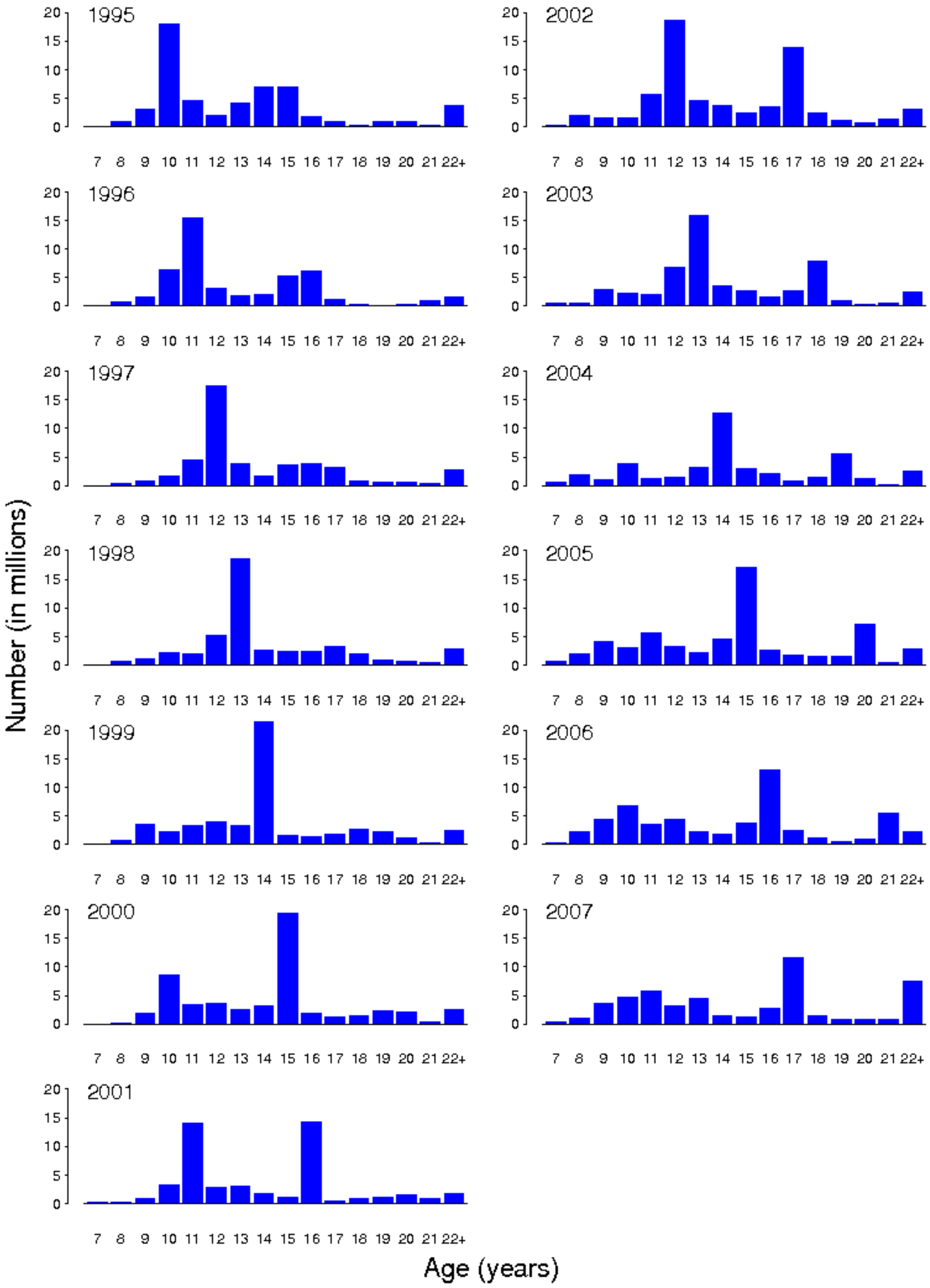


Figure 17.3.4 Catch-at-age of golden redfish in numbers in ICES Subdivision Va 1995-2007.

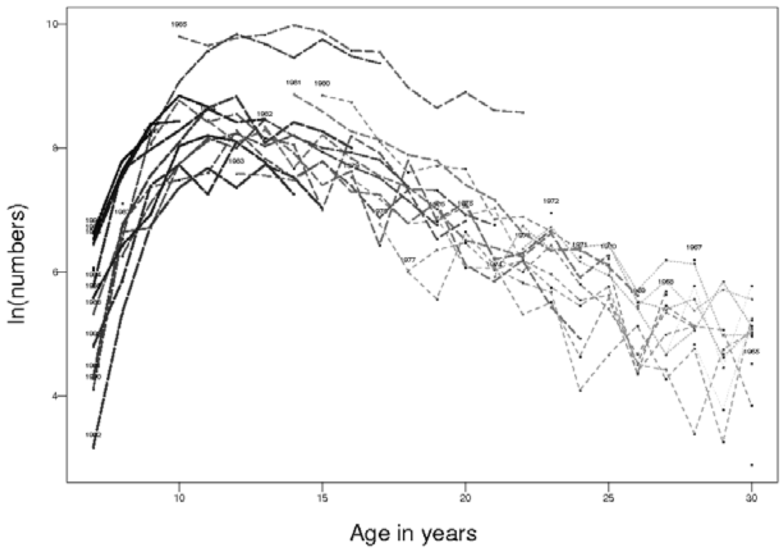


Figure 17.3.5 Catch curve of golden redfish based on the catch-at-age data in ICES Division Va 1995-2007.

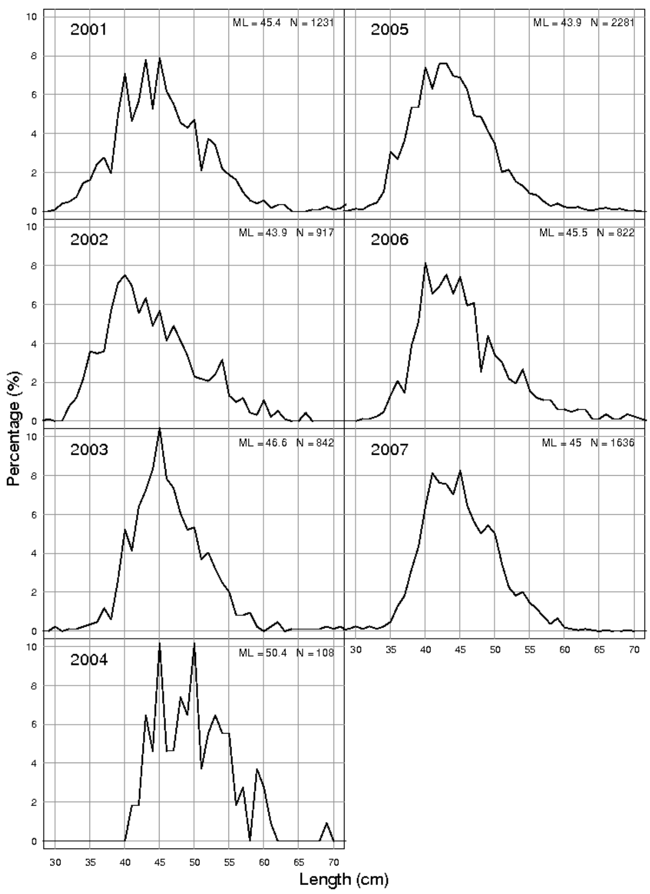


Figure 17.3.6 Length distribution of golden redfish from Faroese catches in 2001-2007.

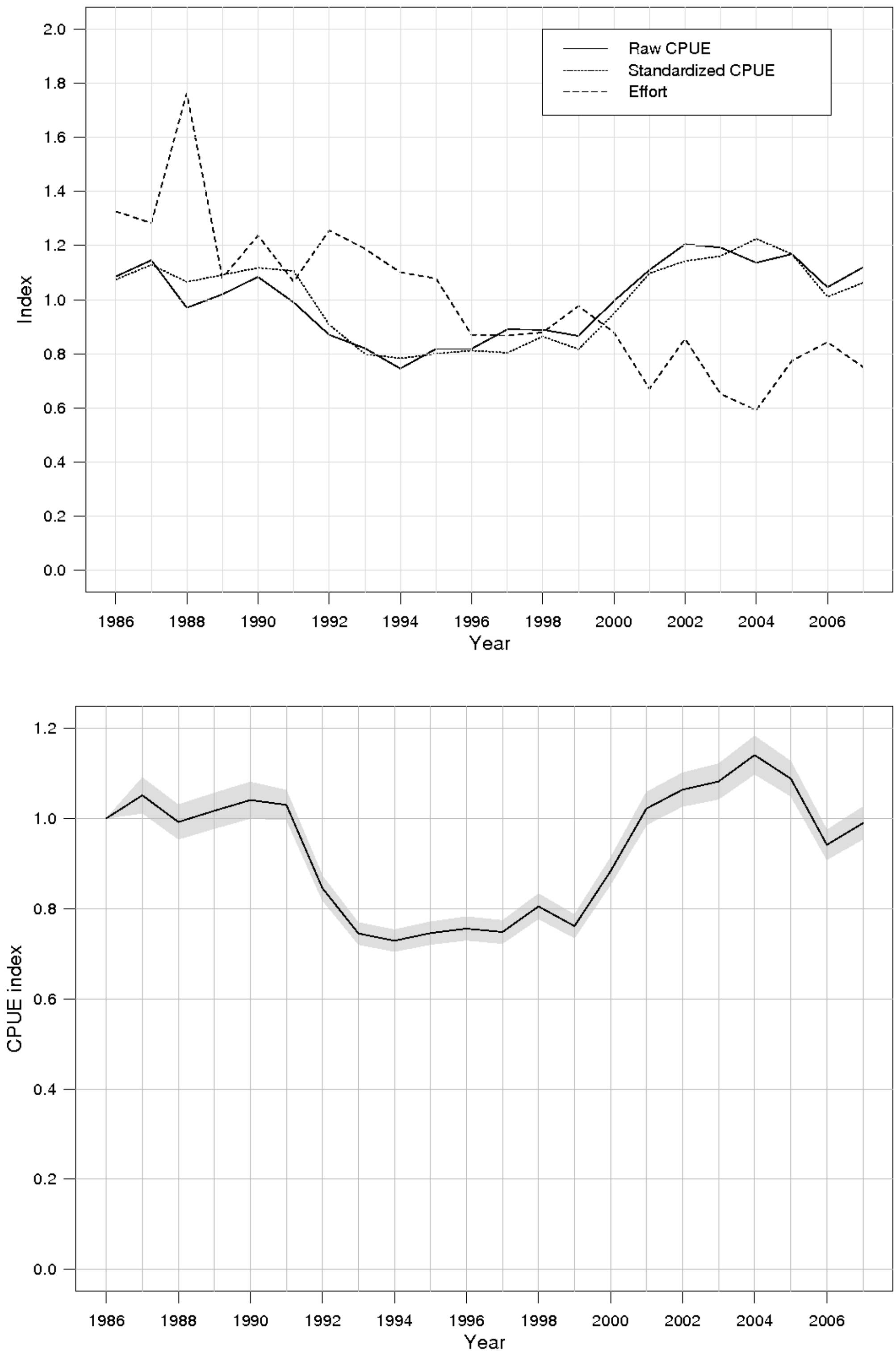


Figure 17.3.7 CPUE of golden redfish from Icelandic trawlers based on results from the GLM model 1985-2006 where golden redfish catch composed at least 50% of the total catch in each haul. The upper figure shows the raw CPUE index (sum(yield)/sum(effort)), standardized CPUE index estimated using a generalized linear model, and effort. The lower figure shows the index estimated using a generalized linear model and associated standard error.

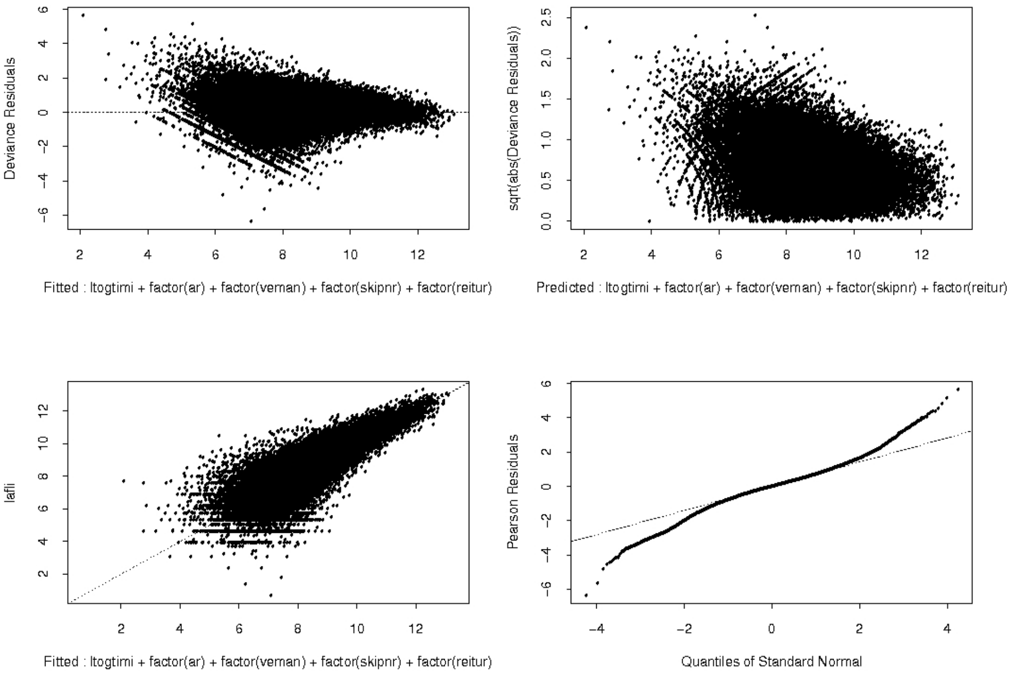


Figure 17.3.8 Residual of the GLM model (section 8.2.1) for the CPUE series of golden redfish in Va.

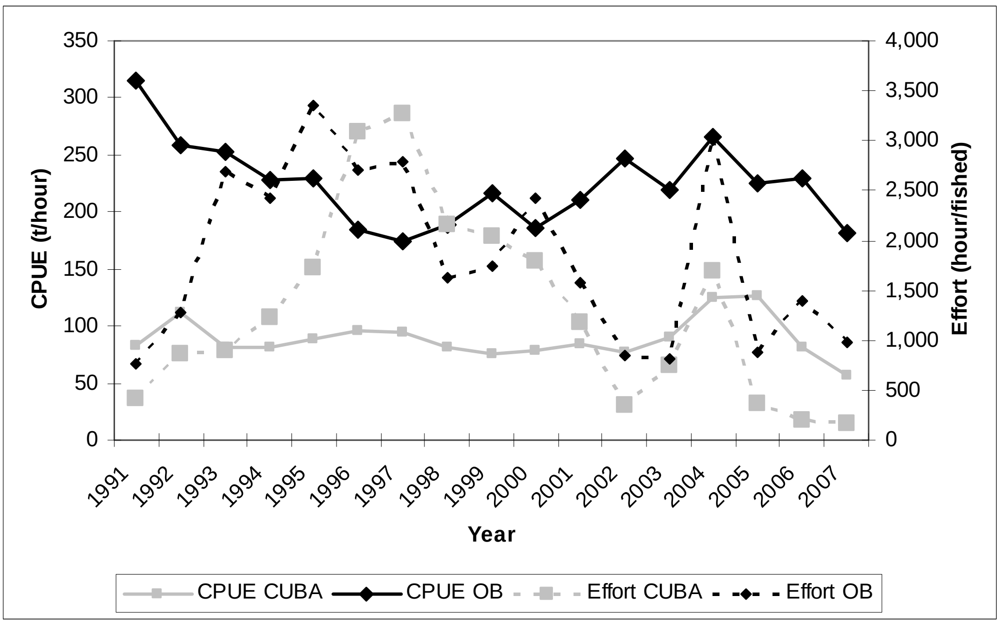


Figure 17.3.9 CPUE (solid lines) and effort (dotted lines) for golden redfish from the Faroese CUBA pair-trawlers (grey) and otterboard trawlers (black) in ICES Division Vb 1991-2007.

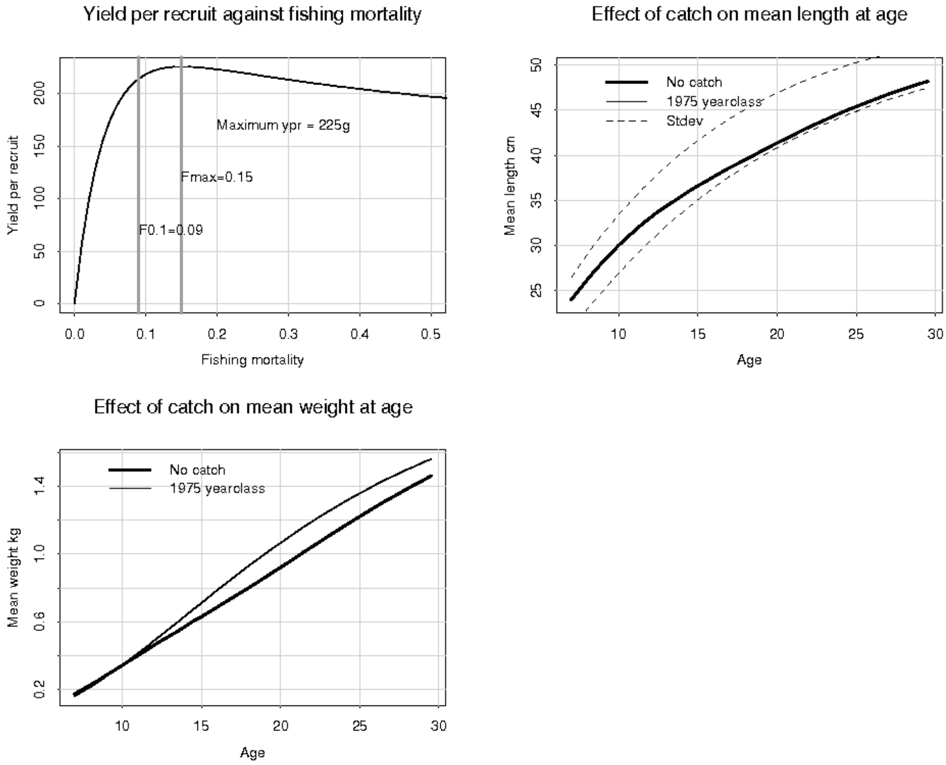


Figure 17.4.1 Results from the Gadget model for golden redfish using catch data from ICES Division Va. a) Yield-per-recruit, b) Mean length at age and effect of catch on length at age, c) Mean weight at age and effect of catch on weight at age.

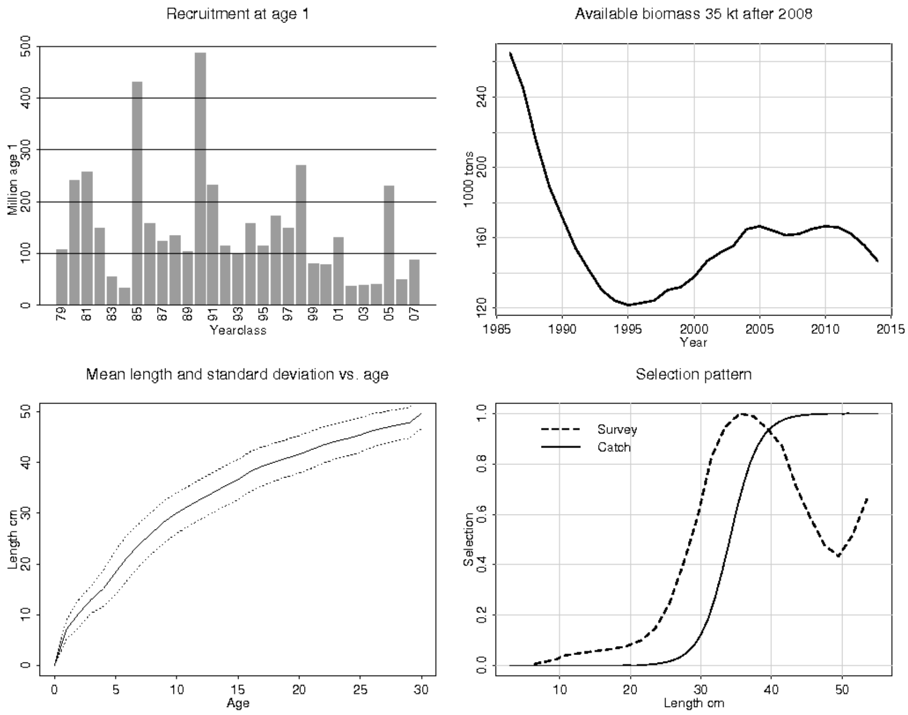


Figure 17.4.2 Results from the Gadget model for golden redfish using catch data from ICES Division Va. a) Estimated recruitment at age 1. b) Available biomass using 35 000 tonnes after 2008. c) Mean length at age. d) Estimated selection pattern of the commercial fleeit and the survey.

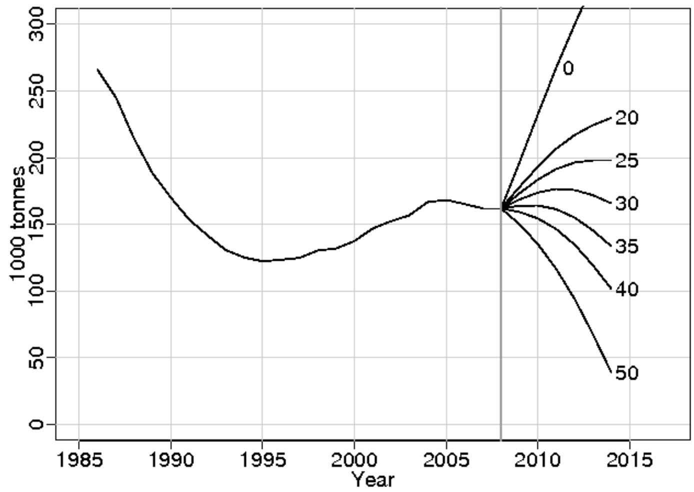


Figure 17.4.3 Development of catchable biomass of golden redfish using different catch options (0-60 000 t) after 2008.

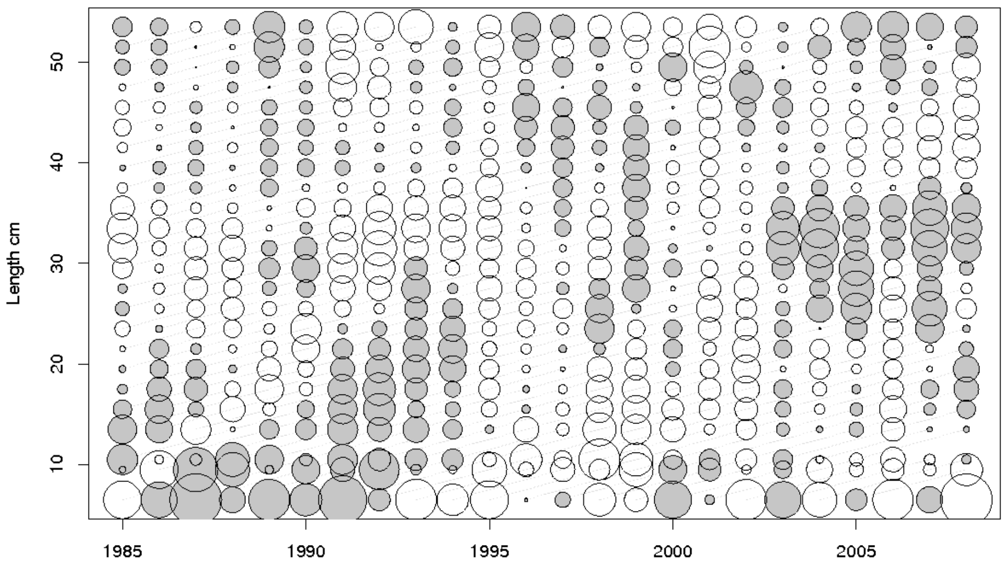


Figure 17.4.4 Residuals from the fit between model and survey indices. The shaded circles indicate positive residuals (survey results exceed model prediction). Largest residuals correspond to log(obs/mod) = 1.

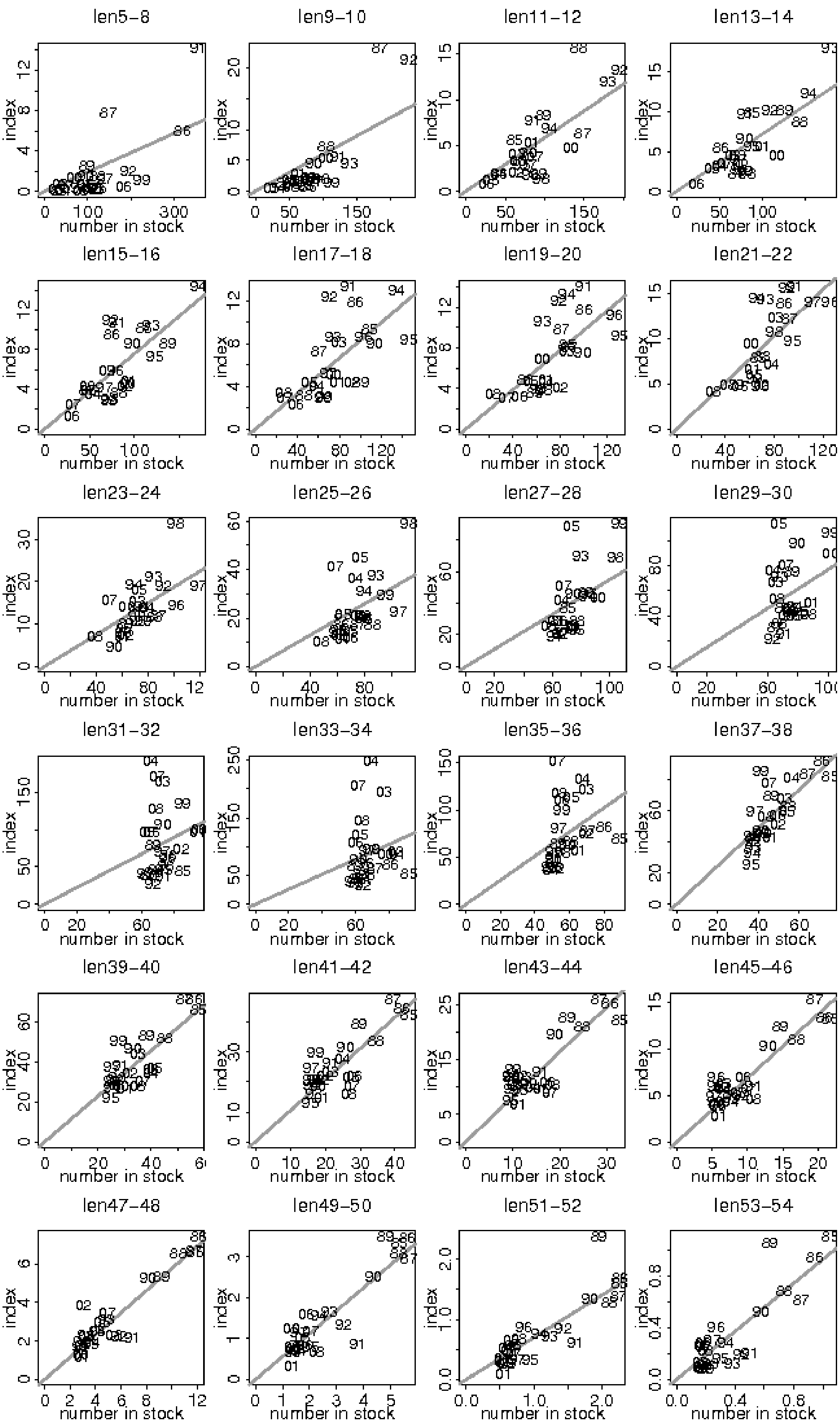


Figure 17.4.5 Survey indices for each length group plotted against the estimated number in stock from the model. The line shown is fitted on original scale but the model fit is on log scale.

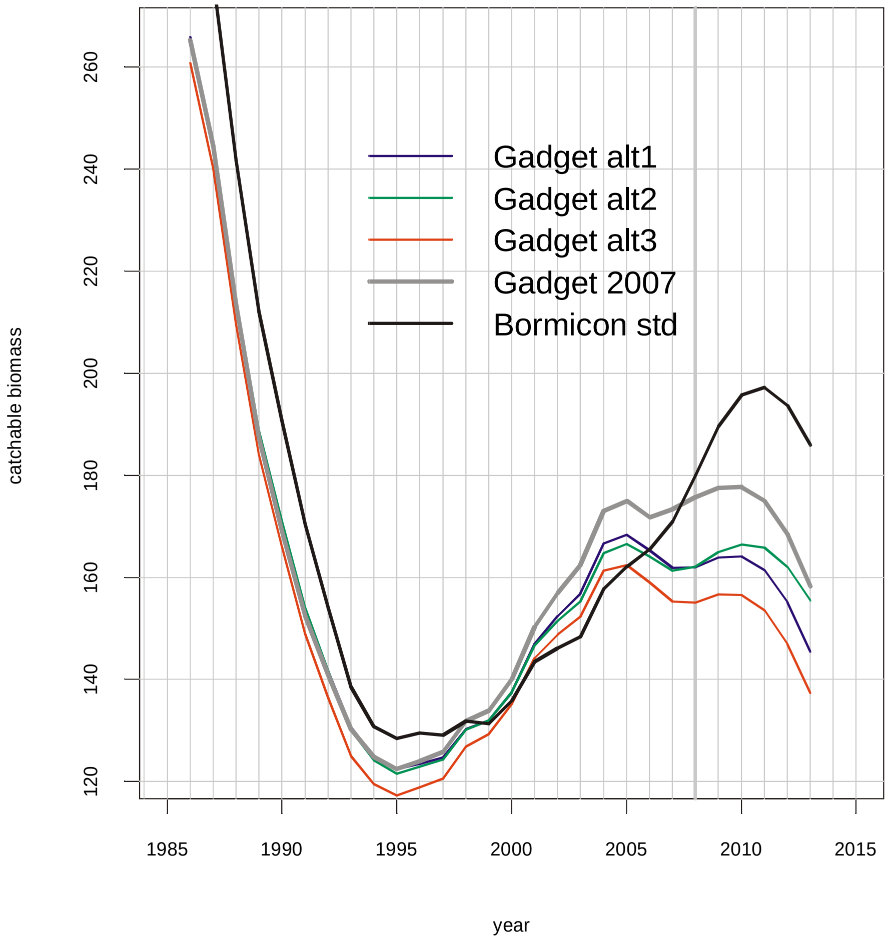


Figure 17.4.6 Comparison of the development of the available biomass in Va according to the GADGET runs this year, GADGET run last year and the SPALY Bormicon run. Prognosis is done with TAC constraint of 35 kt. Note the scale on y-axis does not start with 0.

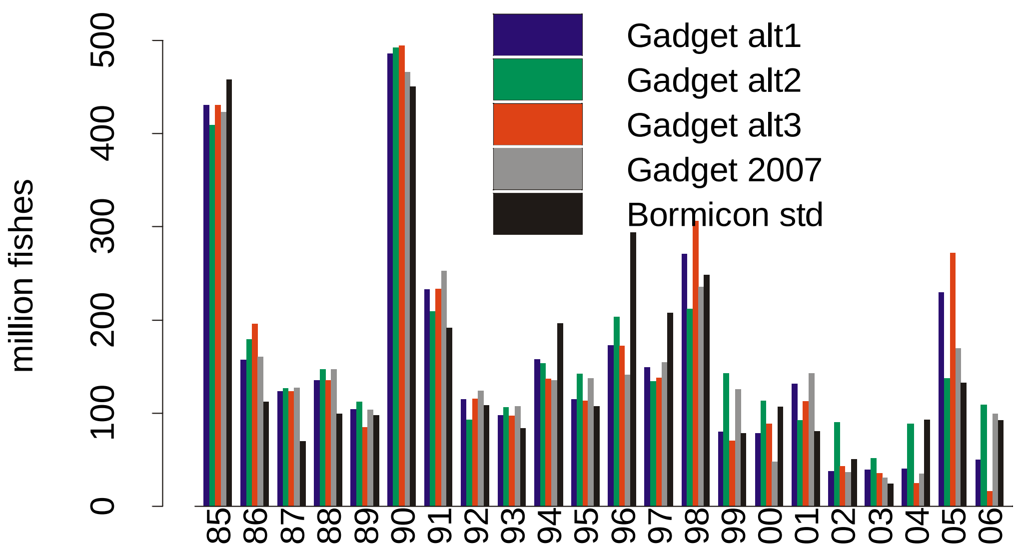


Figure 17.4.7 Comparison of the estimated recruitment according to the GADGET runs this year, GADGET run last year and the SPALY Bormicon run.

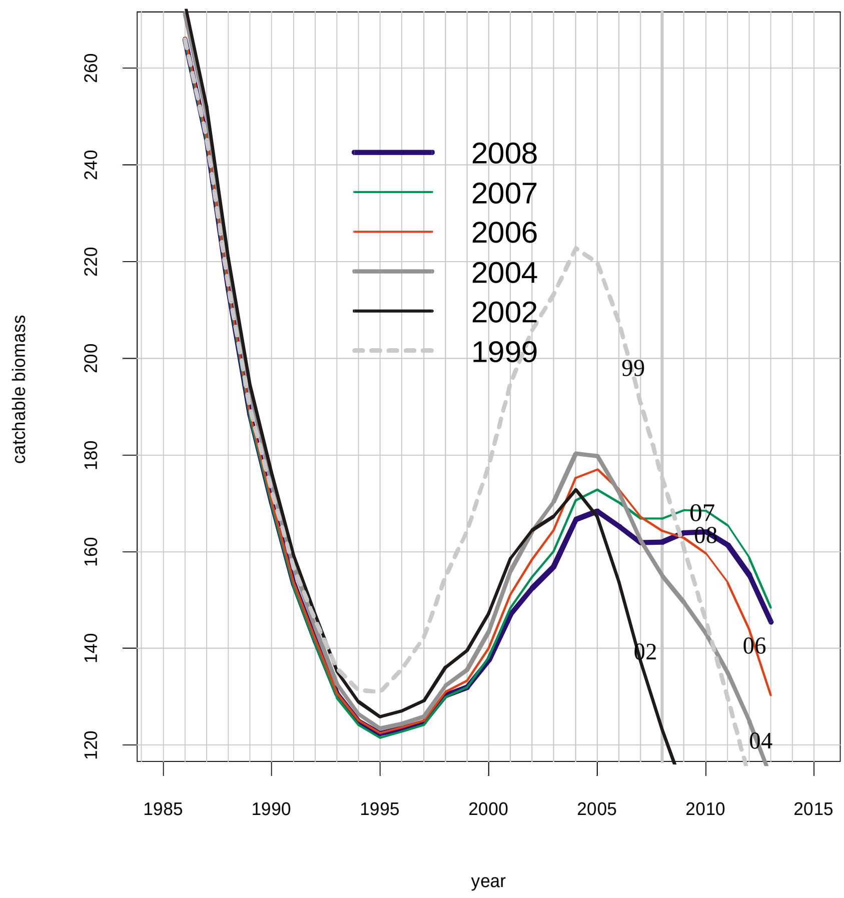


Figure 17.4.8 Analytical retro of the GADGET model.

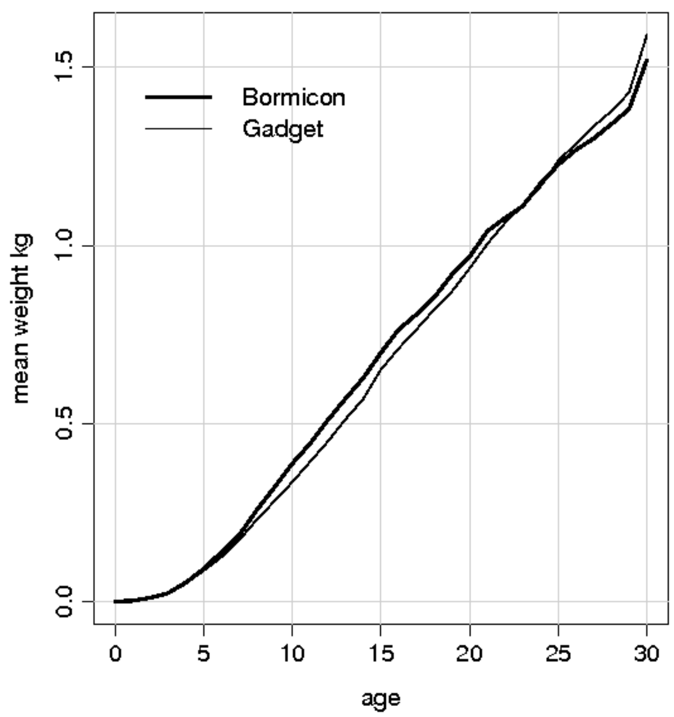


Figure 17.4.9 Comparison of the estimated recruitment according to the GADGET runs this year, GADGET run last year and the SPALY Bormicon run.

18 Demersal *Sebastes mentella* in V and XIV

Executive summary

- Total landings of demersal *S. mentella* in 2007 were about 17 500 t, about 3 000 t less than in 2006. About 92% of the catches were taken in Division Va.
- No formal assessment was conducted and there are no biological reference points for the species. Survey indices are used as basis for advice.
- Available survey biomass indices show that in Division Va the biomass has been low but stable in the last 6 years, but have increased in Sub-area XIV. In Division Vb, there is no reliable survey information available on fishable biomass.
- In recent years, good recruitment has been observed on the East Greenland shelf which is assumed to contribute to both the demersal and pelagic stock at unknown shares.

18.1 Stock description and management units

Demersal *Sebastes mentella* on the continental shelves and slopes around the Faeroe Islands (Vb), Iceland (Va), and off East Greenland (XIV) are treated as one stock unit and separated from the stock fished in the Irminger Sea (pelagic *S. mentella*, see Chapter 19). It is believed to have a common area of larval extrusion southwest of Iceland, a drift of the pelagic fry towards the nursery areas on relatively shallow waters off East Greenland, and feeding and copulation areas on the shelves and banks around the Faeroe Islands, Iceland and of East Greenland. The main fishing grounds of demersal *S. mentella* are in Icelandic waters.

Catches in VI have traditionally been included in this report and the Group continues to do so.

18.2 Scientific data

18.2.1 Division Va

The Icelandic autumn survey on the continental shelf and slope in Va 2000-2007, covering depths down to 1,200 m, shows that the fishable biomass index (fish > 30 cm) of demersal *S. mentella* have been variable with highest value in 2001 and the lowest ones in 2003 and 2007 (Figure 18.2.1*a* and *b*). Both biomass index of fish larger than 45 cm (Figure 18.2.1*c*) and abundance index of fish smaller than 30 cm (Figure 18.2.1*d*) were at lowest level in 2007. The length of the demersal *S. mentella* in the autumn survey is between 30 and 47 cm with modes ranging from 36-39 cm (Figure 18.2.2).

18.2.2 Division Vb

The Faroese spring and summer surveys in Division Vb are mainly designed for species inhabiting depths down to 500 m and do not cover the vertical distribution of demersal *S. mentella* fully. Therefore, the surveys will not be used in order to evaluate the status of the stock.

18.2.3 Division XIV

The German survey conducted on the continental shelf of West and East Greenland since 1982 cover nursery grounds in addition to adult distribution (0-400 m). The results indicate that juveniles are most abundant off East Greenland, while a negligible part of juveniles is distributed off West Greenland. Survey biomass increased in 2007 (Figure 18.2.3). Previously demersal *S. mentella* in pre-fishery size (less than 30 cm) has been abundant in the area, but since 2004 also redfish with fishable size (> 30 cm) has become abundant (Figure 18.2.3*c*). Figure 18.2.4 shows that the abundance is dominated by a strong year classes recorded for the first time in 1997 at a mean length of 22 cm. The juveniles observed at East and West Greenland will probably recruit to some extent to the demersal stock on the shelves of Greenland, Iceland and Faeroe Islands and partly to the pelagic stock as well (Stransky 2000). Juvenile demersal *S. mentella* are not observed in the spring and autumn surveys in Icelandic waters and in the surveys conducted in Faroes waters.

The Greenland halibut survey is a random stratified bottom trawl survey, conducted on the continental shelf and slope of East Greenland 1998-2007 (no survey was conducted in 2001) and covers depths from 400 m down to 1,500 m. Catch rates have been variable but with the 2007 catch rates at the highest (Figure 18.2.5). The length distributions in 2005-2007 are dominated by 20-25 cm fish (Figure 18.2.5).

18.3 Information from the fishing industry

18.3.1 Landings

Total annual landings of demersal *S. mentella* from Divisions Va and Vb and Subareas VI and XIV from 1978-2007 are presented in Table 18.3.1 and in Figure 18.3.1. The total landings varied between 20,000 and 84,000 t in 1978-1994. Since 1994, landings gradually decreased, and in 2001 annual landings were 24,000 t. Landings increased to about 31,000 t in 2003, mainly due to increased landings from Va. Annual landings decreased to about 17,500 in 2007 which were the lowest landings recorded since 1978.

In Division Va, annual landings gradually decreased from a record high of 57 000 t in 1994 to 17 000 t in 2001 t. Landings in 2003 increased to 28 500 t but have since then fluctuated between 16 000 t and 21 000. The landings in 2007 were about 16 000 t.

In Division Vb, landings gradually decreased from 15,000 t in 1986 to about 5,000 t in 2001. Since then the landings have varied between 1,400 and 4,000 t. The landings in 2007 were about 1,400 t which are the lowest landings from Division Vb since 1970.

In Subarea XIV, the annual demersal *S. mentella* landings have decreased drastically. In 1980-1994, landings varied between 2,000 and 19,000 t with the lowest landings in 1989 and the highest in 1994. In the following three years, the annual landings were less than 1,000 t and the redfish was mainly caught as bycatch in the shrimp fishery. In 1998, Germany started a directed fishery for redfish with annual landings around 1,000 t in 1998-2001, and landings increased to 1,900 t in 2002. Samples taken from the German fleet indicated that substantial quantities of the redfish caught, especially in 2002, were juveniles, i.e. fish less than 30 cm. There was very little demersal *S. mentella* fishery in XIV 2003-2005 (less than 400 t). In 2006 and 2007, only 12 and 23 t were reported, respectively.

In Subarea VI, the annual landings varied between 200 t and 1 100 t in 1978-2000. The landings from VI in 2004 were negligible (6 t), the lowest recorded since 1978. They increased again to 111 t in 2005 and 179 t in 2006. There was no demersal *S. mentella* fishery in VI in 2007.

18.3.2 Fisheries and fleets

Most of the fishery for demersal *S. mentella* in Va is a directed trawl fishery taken by bottom trawlers along the shelf and slope west, southwest, and southeast of Iceland at depths between 500 and 800 m (Figure 18.3.2). The proportion of demersal *S. mentella* catches taken by pelagic trawls 1991-2000 varied between 10 and 44% (Table 18.3.2). In 2001-2007, no pelagic fishery occurred or it was negligible, except in 2003 and 2007 (see below). In general, the pelagic fishery of demersal *S. mentella* has mainly been in the same areas as the bottom trawl fishery (Figure 18.3.3), but usually in later months of the year (Figure 18.3.4). The catches in the third and fourth quarter of the year decreased considerable in 2001-2007 compared with earlier years, mainly due to decreased pelagic fishery (Figure 18.3.4).

The catch pattern was different in 2003 and in 2007 than in prior to 2003 and in 2004-2006. The catches peaked in July in 2003 and in June 2007, which was unusual compared with other years (Figure 18.3.4). This pattern is probably associated with the pelagic *S. mentella* fishery within the Icelandic EEZ (see Figure 16.1.1). The pelagic *S. mentella* fishery has in recent years moved more northwards, and in 2003 and 2007 it merged with the demersal *S. mentella* fishery on the redfish line in July (Figure 16.1.3). When the pelagic *S. mentella* crossed the redfish line to the east, it was recorded as demersal *S. mentella* and caught either with pelagic or bottom trawls resulting in increased landings in 2003 (Figures 18.3.2-18.3.3 and 16.1.1).

A notable change in the catch pattern is that catches taken in the southeast fishing area has been gradually decreasing since 2000 and in 2007 very little demersal *S. mentella* was taken on these fishing grounds (Figure 18.3.2). This area has historically been an important fishing area for demersal *S. mentella*.

18.3.3 Sampling from the commercial fishery

The table below shows the 2007 biological sampling from the catch and landings of demersal *S. mentella* by ICES Division, gear and nation. No biological samples were taken in Subarea XIV in 2007.

Area	Nation	Gear	Landings (tonnes)	No. samples	No. length measured
Va	Iceland	Bottom trawl	13,467	203	30,015
Va	Iceland	Pelagic trawl	2,700	6	1,175
Vb	Faeroe Islands	Bottom trawl	1,376	76	6,838

18.3.4 Length distribution from the commercial catch

Length distributions of demersal *S. mentella* in Va from the bottom trawl fishery show an increase in the number of small fish in the catch in 1994 compared to previous years (Figure 18.3.5). The peak of about 32 cm in 1994 can be followed by approximately 1 cm annual growth in 1996-2002. The fish caught in 2004-2007 peaked around 37-39 cm and were on average bigger than in 2003. The length distribution of demersal *S. mentella* from the pelagic fishery, where available, showed that in most years the fish was on average bigger than taken in the bottom trawl fishery. An exception is the fish caught in 2007 which was on average smaller than the fish caught with bottom trawl (Figure 18.3.5).

Length distributions from the landings in 2001-2007 indicate that the fish caught in Vb are on average larger than the fish caught in Va and are slightly larger than 40 cm (Figure 18.3.6).

18.3.5 Catch per unit effort

18.3.5.1 Division Va

Data used to estimate CPUE for demersal *S. mentella* in Division Va 1986-2007 were obtained from log-books of the Icelandic bottom trawl fleet. Only those hauls were used that were taken below 450 m depth and that were comprised of at least 50% demersal *S. mentella*. Non-standardized CPUE for each year (y) was calculated and from which total fishing effort for each year (y) was estimated according to:

$$E_y = Y_y / CPUE_y,$$

where E is the total fishing effort and Y is the total reported landings (Table 18.3.1).

CPUE indices were also estimated from this data set using a GLM multiplicative model (generalized linear models). This model takes into account changes in vessels over time, area (ICES statistical square), month and year effects. The output of the model is given in Table 18.3.3 and the model residuals in Figure 18.3.8.

Trends in CPUE and effort are shown in Figure 18.3.7. CPUE gradually decreased from 1986 to a record low in 1994, but increased slightly annually to 2000. Since then, CPUE has stabilized. From 1991 to 1994, when CPUE decreased, the fishing effort increased drastically. Since then, effort decreased and is now at similar level as in the beginning of the series. Effort has not decreased as much annually in recent years as in 1995-2001, when the decrease was between 10% and 20% annually.

18.3.5.2 Subarea Vb

Non-standardized CPUE indices in Division Vb were obtained from the Faroese 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 decreased from 500 kg/hour in 1991 to 300 kg/hour in 1993 and remained at that level until 2004 (Figure 17.3.9). In 2005, the CPUE decreased to the lowest level in the time series and remained low in 2006 and is now close to the Upa level.

Fishing effort decreased between 2001 and 2003, but has since then varied between 6 000 and 12 000 hours.

18.3.5.3 Division XIV

Non-standardized CPUE data from Division XIV were available from 1998 to 2002 when the German fleet fished for *S. mentella* along the continental slope of East Greenland. CPUE decreased between 1998 and 1999, but increased since then annually. No CPUE and effort data were available from Subarea XIV in 2003-2007, as there was no effort exerted by the German fleet.

18.4 Methods

No formal assessment was conducted on this stock

18.5 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.

18.6 State of the stock

The Group concludes that the state of the stock is stable on a low level. With the information at hand, current exploitation rates can not be evaluated for the demersal *S. mentella* Subareas V and XIV.

The fishable biomass index of demersal *S. mentella* in Va from the Icelandic autumn survey shows that the biomass index for 2002-2007 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. The biomass of the fishable stock of *S. mentella* in Subarea XIV has increased in recent years now being the highest in the time series. Standardised CPUE indices in Division Va show a reduction from highs in the late 1980s, but there is an indication that the stock has started a slow recovery since the middle of 1990s, when CPUE was close to 50% of the maximum. The CPUE index has been increasing since 1995. In Division Vb, CPUE stabilised close to the 50% of the maximum in the time series from 1993 to 2006,

Recently, good recruitment has been observed on the East Greenland shelf (growth of about 2cm/yr) which is assumed to contribute to both the demersal and pelagic stock at unknown shares.

18.7 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 nature of the redfish fishery is targeting schools of fish using advancing technology. The effect of technological advances is to increase CPUE, but is unlikely to reflect biomass increase.

The advice for 2008 catch was 22 000 t, which corresponded to the lowest observed catch in Subarea V since 1980, taken in 2001 and 2004. The advised catch in recent years has not resulted in an increase in biomass indicators and seems therefore to be unsustainable.

The demersal *S. mentella* fishery southeast of Iceland has gradually ceased since 2000 and in 2007 very little fishing occurred in this area. This fishing area was prior to 2000 very important fishing area for demersal *S. mentella*.

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 at the redfish line. Those two fisheries merged again in 2007.

Icelandic authorities give a joint quota for golden redfish and demersal *S. mentella*. The working group reiterates its recommendation that the TAC of demersal *Sebastes* species **should be given separately**. There is a strong indication that demersal *S. mentella* and golden redfish in Va are spatially separated and therefore, separate quotas for these species can be given.

The biomass of the fishable stock of *S. mentella* in Subarea XIV has increased in recent years now being the highest in the time series. However, the stock size in Subarea XIV in relation to the total distribution area in V+XIV is unknown.

The stratification of the German survey is designed for cod. Indices for demersal *S. mentella* will be revaluated in terms of stratification for the species.

Bycatches of juvenile demersal *S. mentella* in the shrimp fishery off East Greenland was presented with new information in WD18 (see chapter 16.5.1). The effect of sorting grids show that the by-catch rates of redfish in the shrimp fishery are <1% (average 0.64% in 2006 and 0.52% in 2006-2007). The Group recommends a maximum protection of the juveniles in Division XIV.

The present advice allows for a potential increase in the redfish fishery in Subarea XIV. Here redfish and cod are found in the same areas and depths and historically these species have been taken in the same fisheries. An increased redfish fishery may therefore affect cod. ICES presently advice that no fishery should take place on offshore cod in Greenland waters. ICES therefore recommends measures that will keep effort on cod low in a potential redfish fishery.

Greenland have opened for an offshore cod fishery with a TAC of 15 000 t in 2008. To protect spawning aggregations of cod present management measures in Greenland EEZ prohibits any trawl fishery for cod north of 63°N latitude. Restrictions on cod bycatch in fisheries directed towards other demersal fish (i.e. redfish) provide some protection of cod, but additional measures such as a closure of the redfish fishery north of 63°N could be considered.

Table 18.3.1 Nominal landings (tonnes) of demersal *S. mentella* 1978-2007 by ICES Division.

Year	ICES Division					Total
	Va	Vb	VI	XII	XIV	
1978	3 902	7 767	18	0	5 403	17 090
1979	7 694	7 869	819	0	5 131	21 513
1980	10 197	5 119	1 109	0	10 406	26 831
1981	19 689	4 607	1 008	0	19 391	44 695
1982	18 492	7 631	626	0	12 140	38 889
1983	37 115	5 990	396	0	15 207	58 708
1984	24 493	7 704	609	0	9 126	41 932
1985	24 768	10 560	247	0	9 376	44 951
1986	18 898	15 176	242	0	12 138	46 454
1987	19 293	11 395	478	0	6 407	37 573
1988	14 290	10 488	590	0	6 065	31 433
1989	40 269	10 928	424	0	2 284	53 905
1990	28 429	9 330	348	0	6 097	44 204
1991	47 651	12 897	273	0	7 057	67 879
1992	43 414	12 533	134	0	7 022	63 103
1993	51 221	7 801	346	0	14 828	74 196
1994	56 720	6 899	642	0	19 305	83 566
1995	48 708	5 670	536	0	819	55 733
1996	34 741	5 337	1 048	0	730	41 856
1997	37 876	4 558	419	0	199	43 051
1998	33 125	4 089	298	3	1 376	38 890
1999	28 590	5 294	243	0	865	34 992
2000	31 393	4 841	885	0	986	38 105
2001	17 230	4 696	36	0	927	23 889
2002	19 045	2 552	20	0	1 903	23 520
2003	28 478	2 114	197	0	376	31 164
2004	17 564	3 931	6	0	389	21 890
2005	20 563	1 593	111	0	120	22 387
2006	17 208	3 421	179	0	12	20 819
2007[1)]	16 167	1 376	1	0	23	17 566

1) Provisional

Table 18.3.2 Proportion of the landings of demersal *S. mentella* taken in Va by pelagic and bottom trawls 1991-2007.

Year	Pelagic trawl	Bottom trawl
1991	22%	78%
1992	27%	73%
1993	32%	68%
1994	44%	56%
1995	36%	64%
1996	31%	69%
1997	11%	89%
1998	37%	63%
1999	10%	90%
2000	24%	76%
2001	3%	97%
2002	3%	97%
2003	28%	72%
2004	0%	100%
2005	0%	100%
2006	0%	100%
2007	17%	83%

Table 18.3.3 Results of the GLM model to calculate standardized CPUE for Icelandic demersal redfish fishery in Va. Note that the residuals are shown in Fig. 9.1.8.

```
Call: glm(formula = lafli ~ ltogtimi + factor(ar) + factor(veman) + factor(skipnr) +
factor(reitur), family =
        gaussian(), data = tmp)

Deviance Residuals:
       Min         1Q     Median       3Q      Max
 -4.395025 -0.3243588 0.01308939 0.346049 4.770235
```

	Value	StdError	t.value	ar	index	lower	upper
factor(year)1986	0.0000	0.0000	0.0000	1986	1.0000	1.0000	1.0000
factor(year)1987	0.0598	0.0429	1.3933	1987	1.0616	1.0170	1.1082
factor(year)1988	-0.0031	0.0422	-0.0740	1988	0.9969	0.9557	1.0399
factor(year)1989	-0.0459	0.0415	-1.1049	1989	0.9551	0.9163	0.9957
factor(year)1990	-0.1071	0.0392	-2.7312	1990	0.8984	0.8638	0.9343
factor(year)1991	-0.0681	0.0350	-1.9452	1991	0.9341	0.9020	0.9674
factor(year)1992	-0.3185	0.0347	-9.1787	1992	0.7273	0.7025	0.7529
factor(year)1993	-0.4191	0.0348	-12.0520	1993	0.6576	0.6351	0.6809
factor(year)1994	-0.5261	0.0348	-15.1012	1994	0.5909	0.5706	0.6118
factor(year)1995	-0.4904	0.0352	-13.9219	1995	0.6124	0.5912	0.6344
factor(year)1996	-0.4751	0.0360	-13.2006	1996	0.6218	0.5998	0.6446
factor(year)1997	-0.4226	0.0358	-11.8112	1997	0.6554	0.6323	0.6792
factor(year)1998	-0.4290	0.0376	-11.3986	1998	0.6512	0.6271	0.6762
factor(year)1999	-0.3772	0.0368	-10.2434	1999	0.6857	0.6610	0.7115
factor(year)2000	-0.3215	0.0374	-8.5920	2000	0.7251	0.6985	0.7527
factor(year)2001	-0.3303	0.0393	-8.4079	2001	0.7187	0.6910	0.7475
factor(year)2002	-0.3641	0.0377	-9.6473	2002	0.6948	0.6691	0.7215
factor(year)2003	-0.2923	0.0380	-7.6974	2003	0.7466	0.7188	0.7755
factor(year)2004	-0.3666	0.0386	-9.4971	2004	0.6931	0.6668	0.7204
factor(year)2005	-0.3550	0.0374	-9.4893	2005	0.7012	0.6754	0.7279
factor(year)2006	-0.3746	0.0384	-9.7504	2006	0.6875	0.6616	0.7145
factor(year)2007	-0.3743	0.0416	-9.0074	2007	0.6878	0.6598	0.7170

Analysis of Deviance Table

Gaussian model

Response: log(catch)

Terms added sequentially (first to last)

	Df	Deviance	Resid. Df	Resid. Dev	F Value	Pr(F)
NULL			25826	48431.46		
Log(towingtime	1	34886.70	25825	13544.76	89577.24	0
factor(year)	21	768.76	25804	12775.99	94.00	0
factor(month)	11	233.55	25793	12542.45	54.52	0
factor(ship)	146	1722.97	25647	10819.48	30.30	0
factor(area)	145	887.48	25502	9932.00	15.72	0

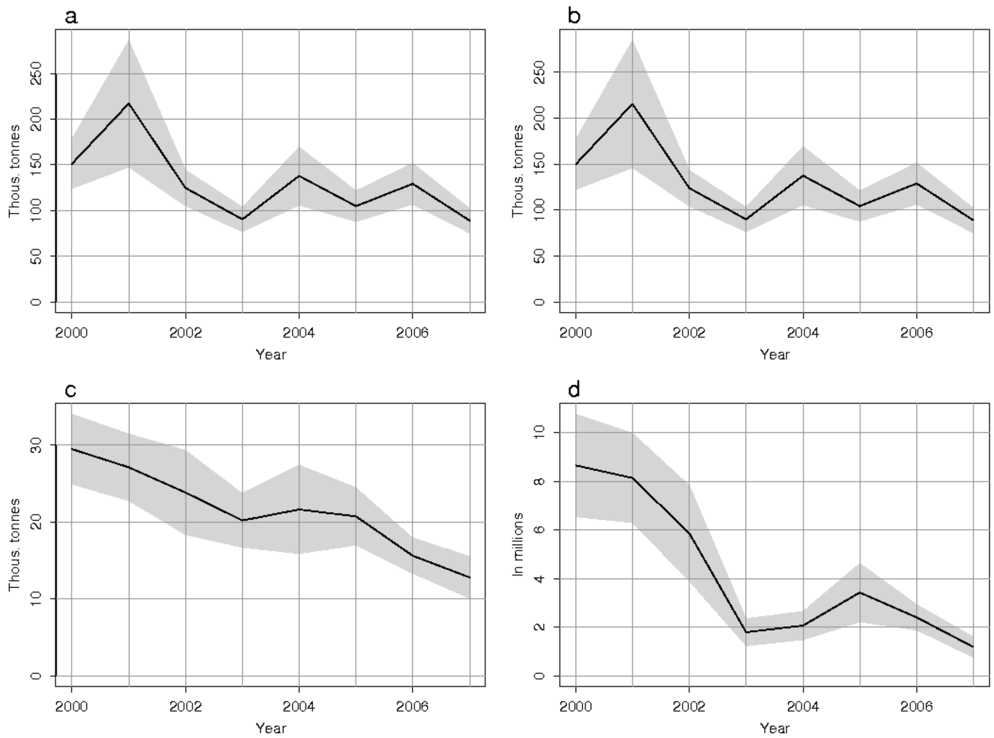


Figure 18.2.1 Survey indices of the Icelandic demersal *S. mentella* in the autumn survey in Division Va 2003-2007. a) Total biomass index, b) fishable biomass index (> 30 cm), c) biomass index of fish larger than 45 cm, d) abundance index of fish smaller than 30 cm.

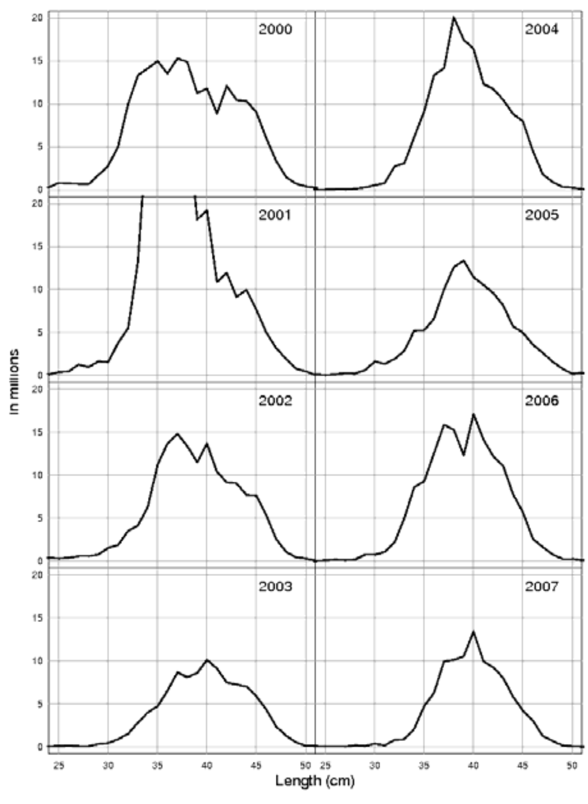


Figure 18.2.2 Length distribution of demersal *S. mentella* in the bottom trawl surveys in October 2000-2007 in ICES Division Va.

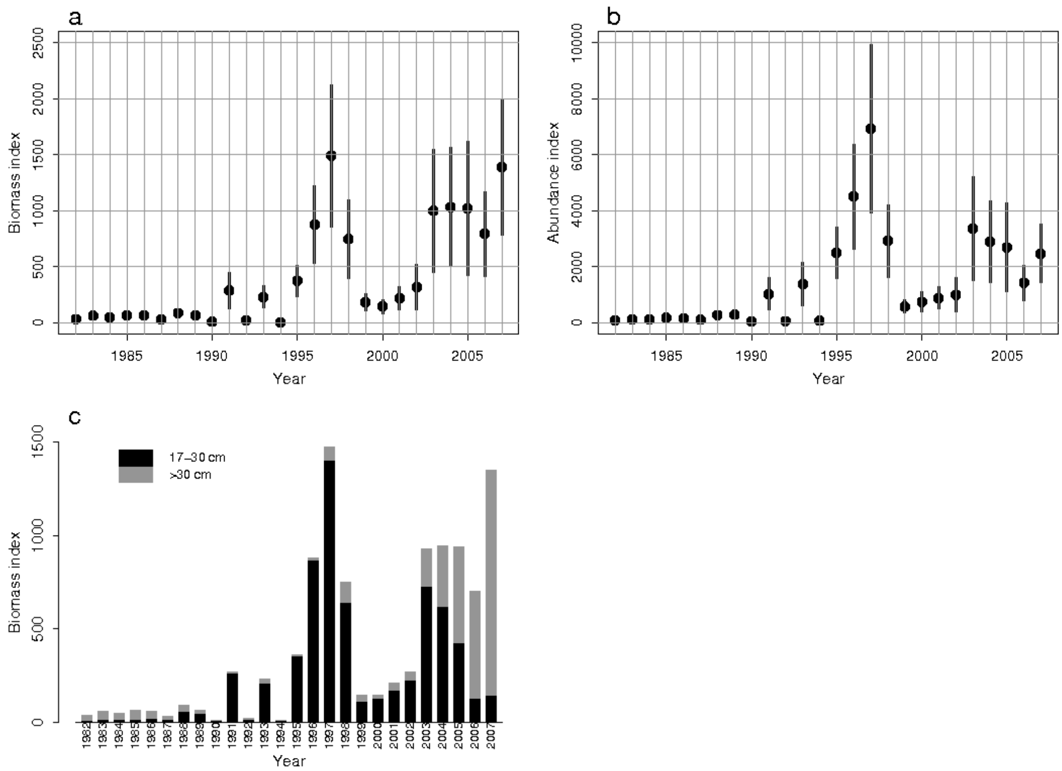


Figure 18.2.3 Demersal *S. mentella* (>=17 cm) survey indices on the continental shelf of East and West Greenland derived from the German groundfish survey 1982–2007. a) Total biomass index, b) total abundance index, c) biomass index divided to size classes (17-30 cm and > 30 cm).

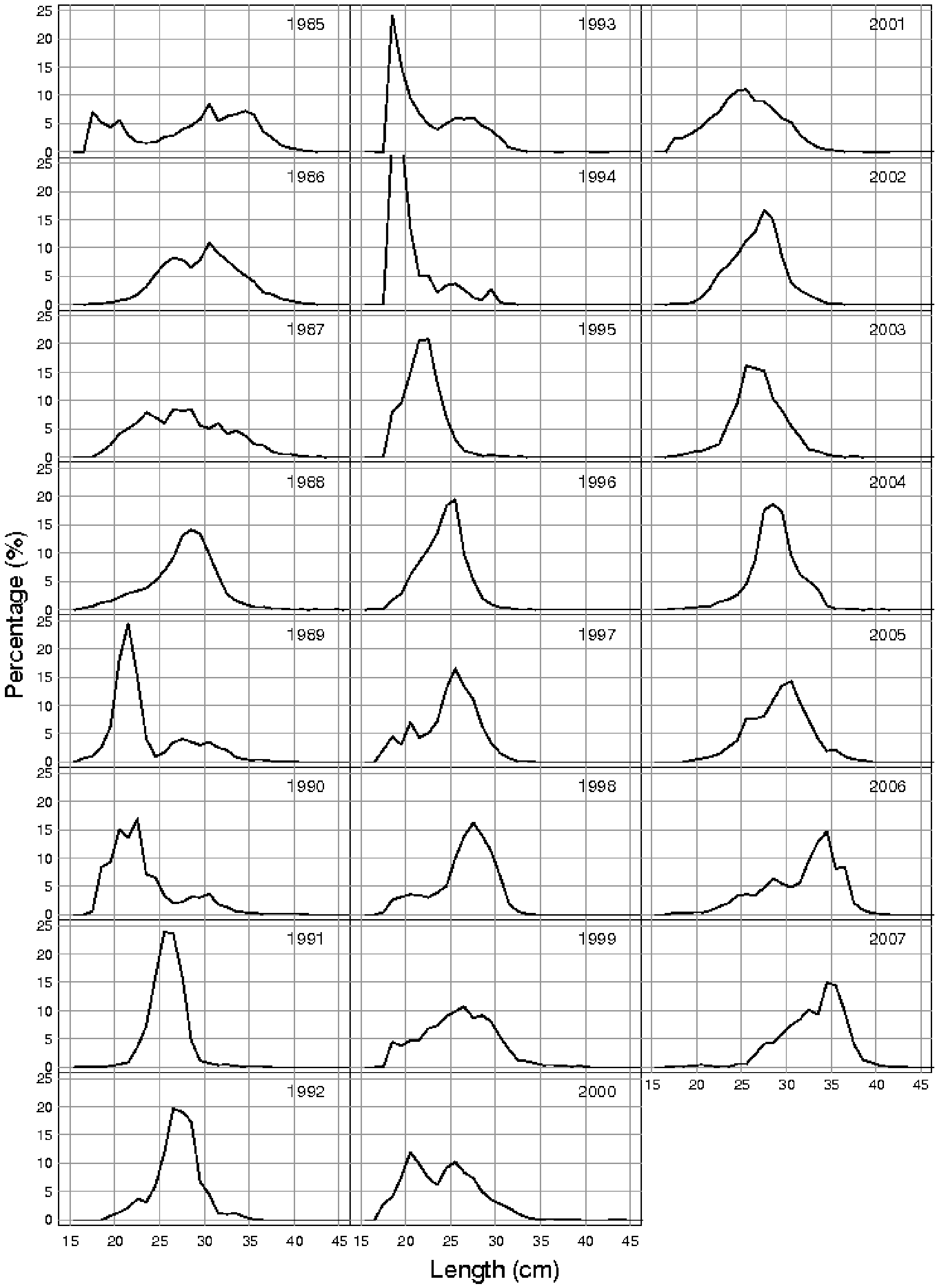
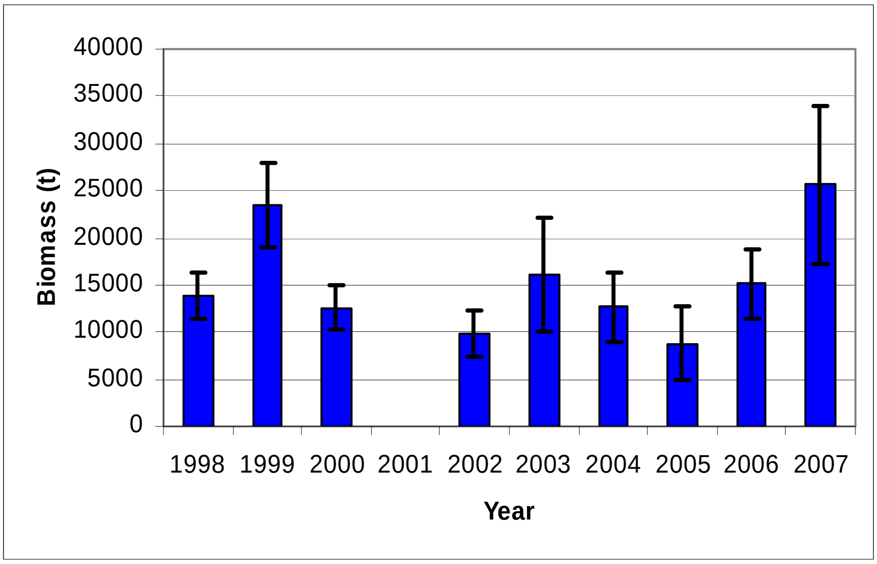
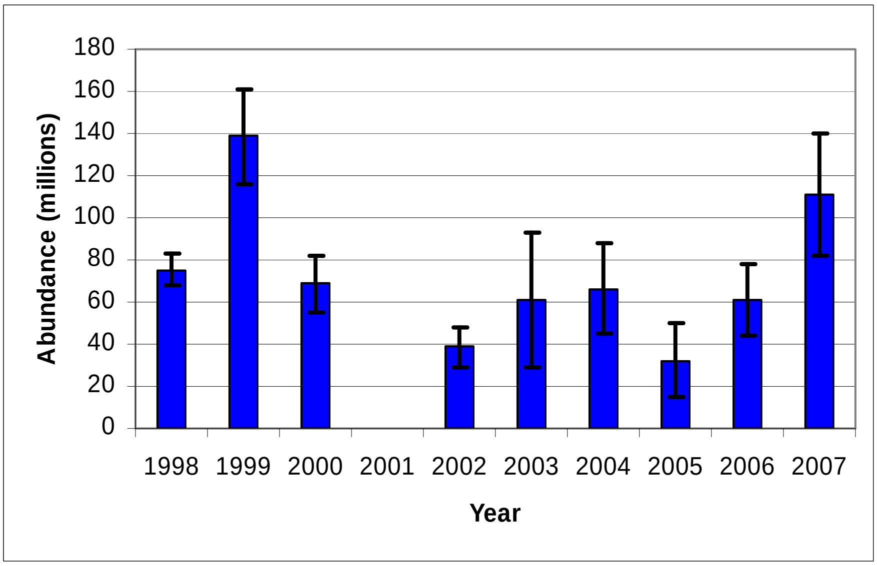


Figure 18.2.4 Demersal *S. mentella* on the continental shelves off East-Greenland. Length composition off Greenland is derived from the German groundfish survey 1985-2007.





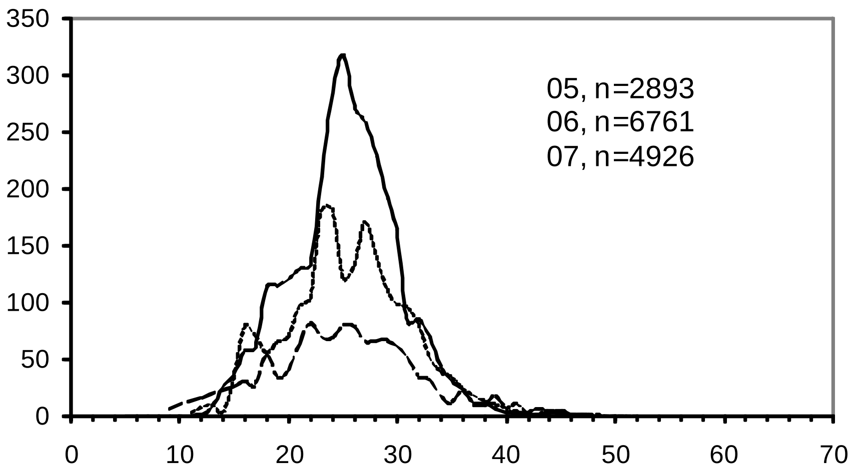


Figure 18.2.5 Total biomass (top), abundance (middle) estimates and associated standard error of demersal *S. mentella* from the Greenland halibut bottom trawl survey of East Greenland (ICES Division XIV) 1998-2006. No survey was conducted in 2001. Also shown is the overall length distribution (number per km²) from the same surveys 2004-2006 (bottom). Dashed line 2005, dotted line 2006, and solid line 2007.

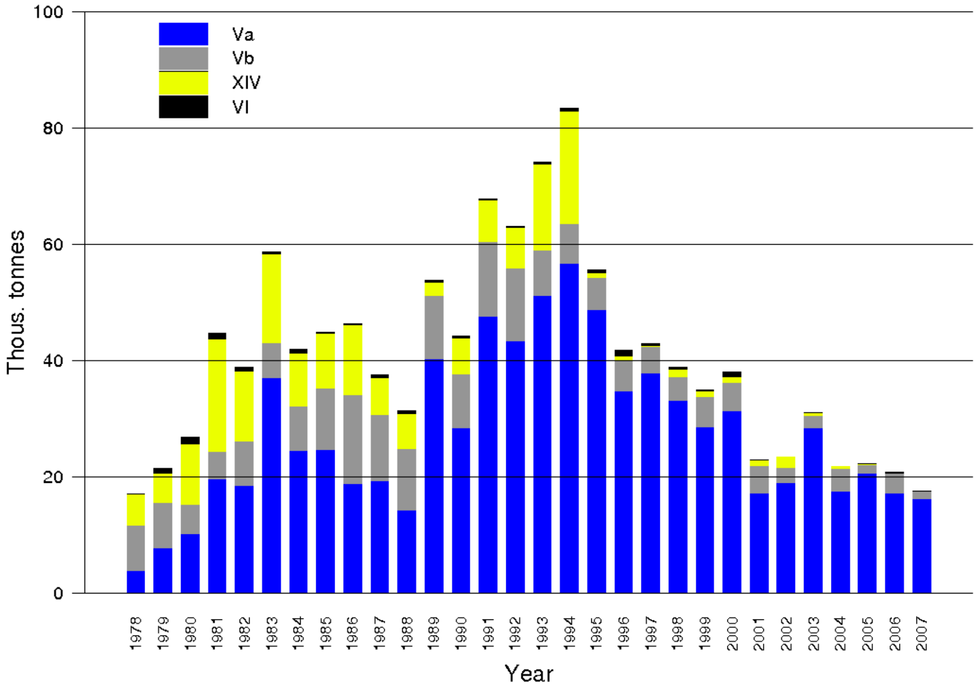


Figure 18.3.1 Nominal landings of demersal *S. mentella* (in tonnes) from ICES Divisions Va, Vb, VI and XIV 1978-2007.

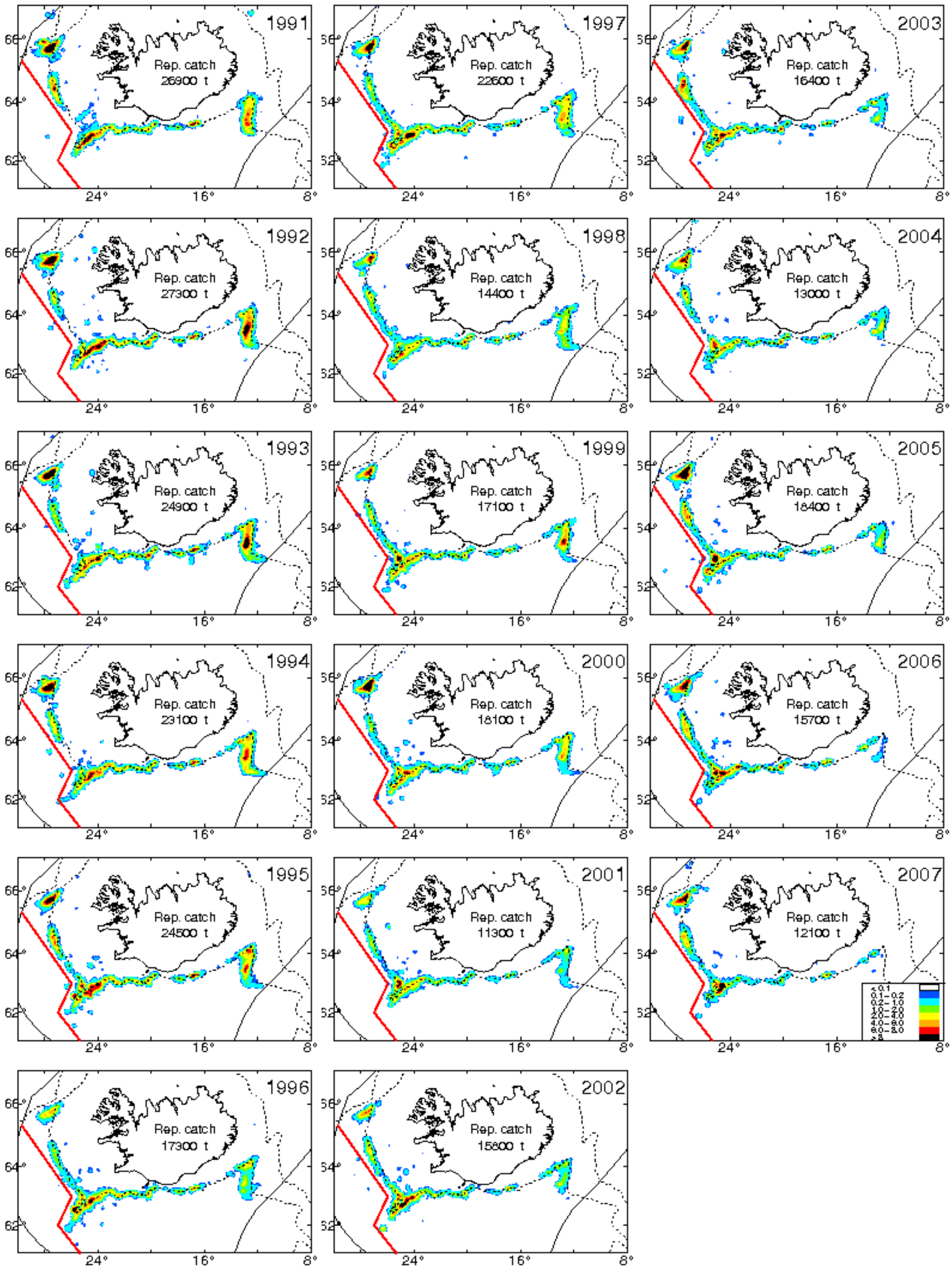


Figure 18.3.2 Geographical location of the demersal *S. mentella* catches in Icelandic waters 1991-2007 as reported in log-books of the Icelandic fleet using bottom trawl. The red line is the redfish line and the dotted line represents the 500 m isobaths.

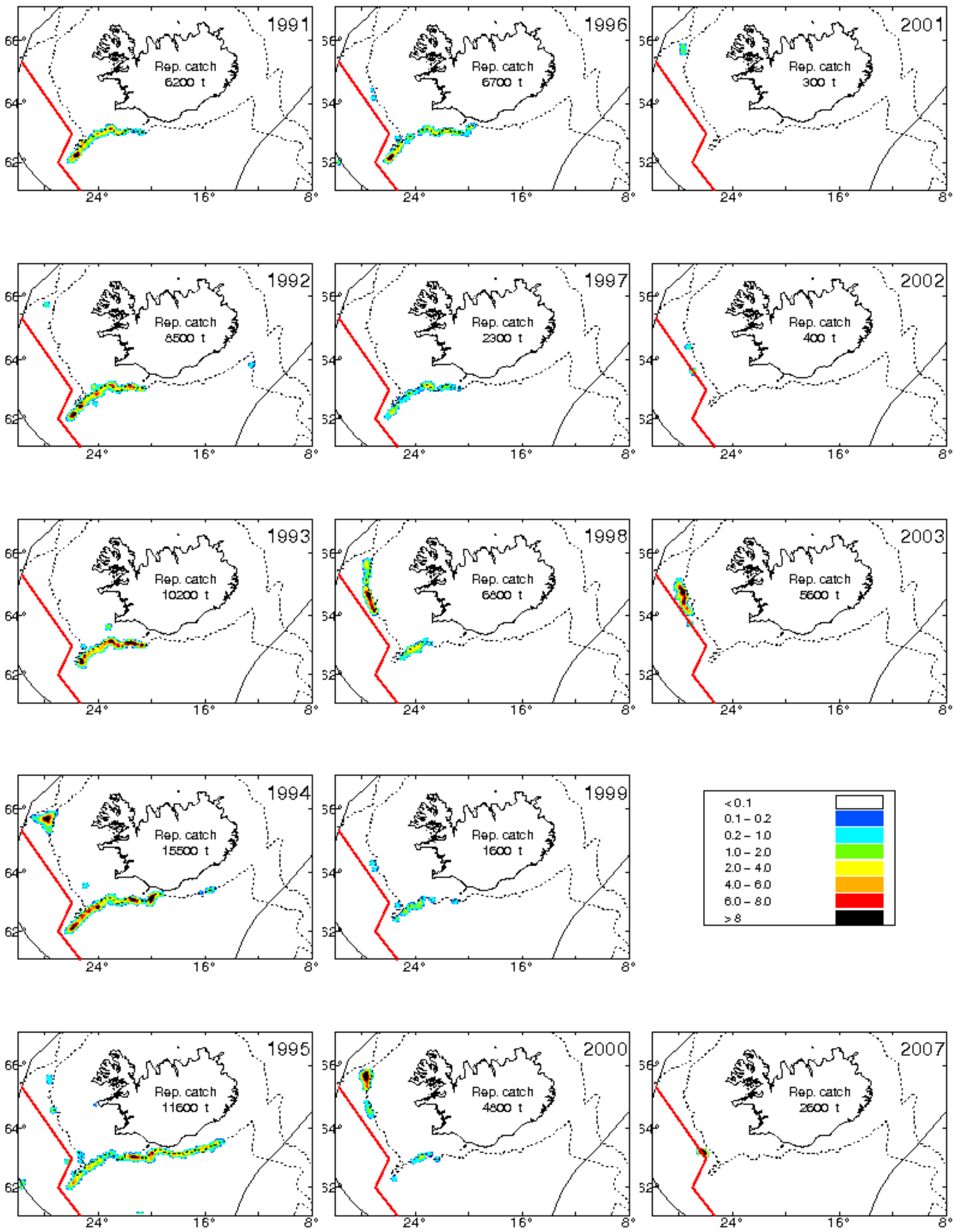


Figure 18.3.3 Geographical location of the demersal *S. mentella* catches in Icelandic waters 1991-2003 and 2007 as reported in log-books of the Icelandic fleet using pelagic trawl. The red line is the redfish line and the dotted line represents the 500 m isobaths.

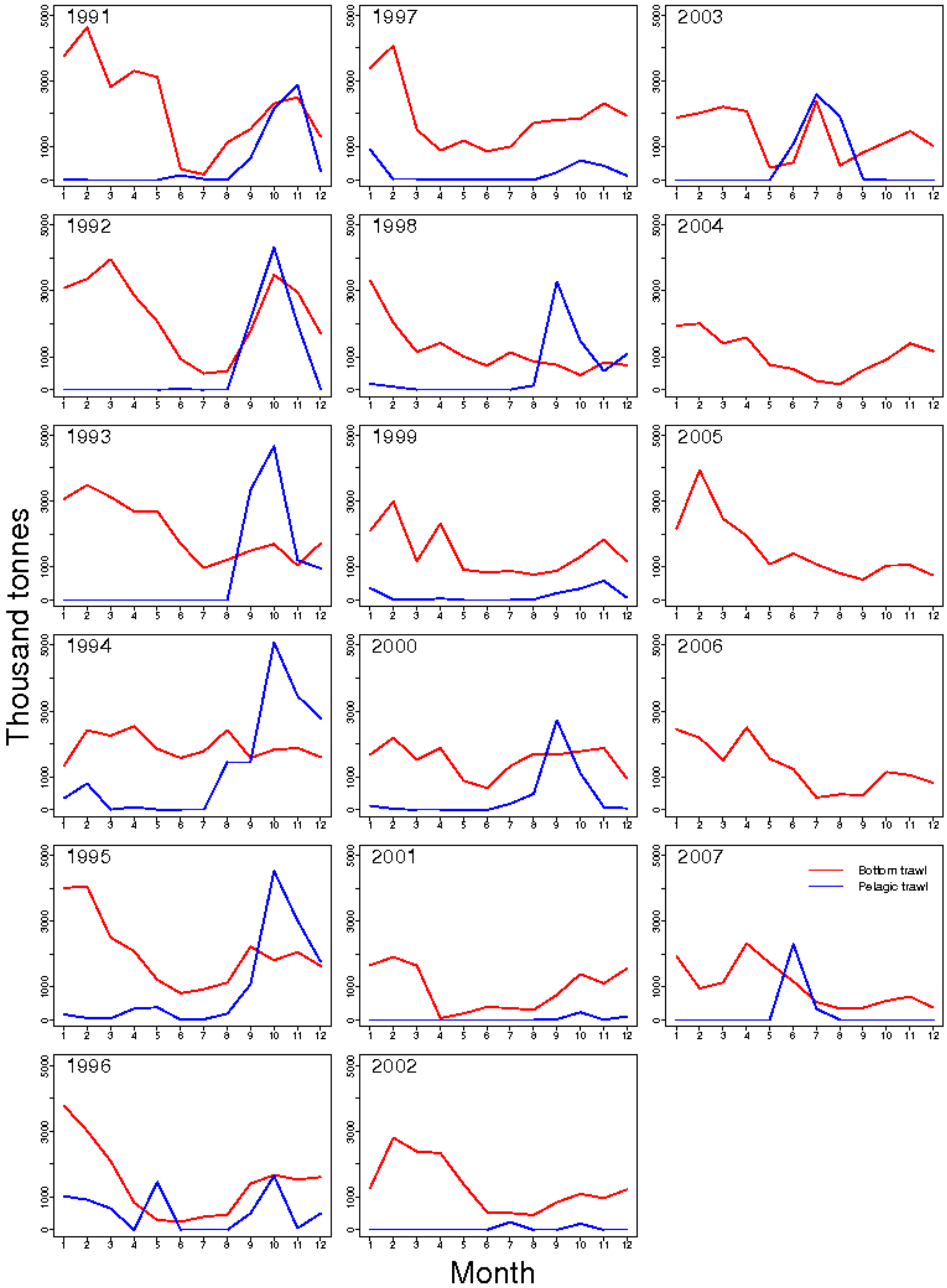


Figure 18.3.4 Nominal landings of demersal *S. mentella* (in tonnes) in Icelandic waters (ICES Division Va) of the Icelandic fleet using either bottom trawl (red line) or pelagic trawl (blue line) 1991-2007, divided by month.

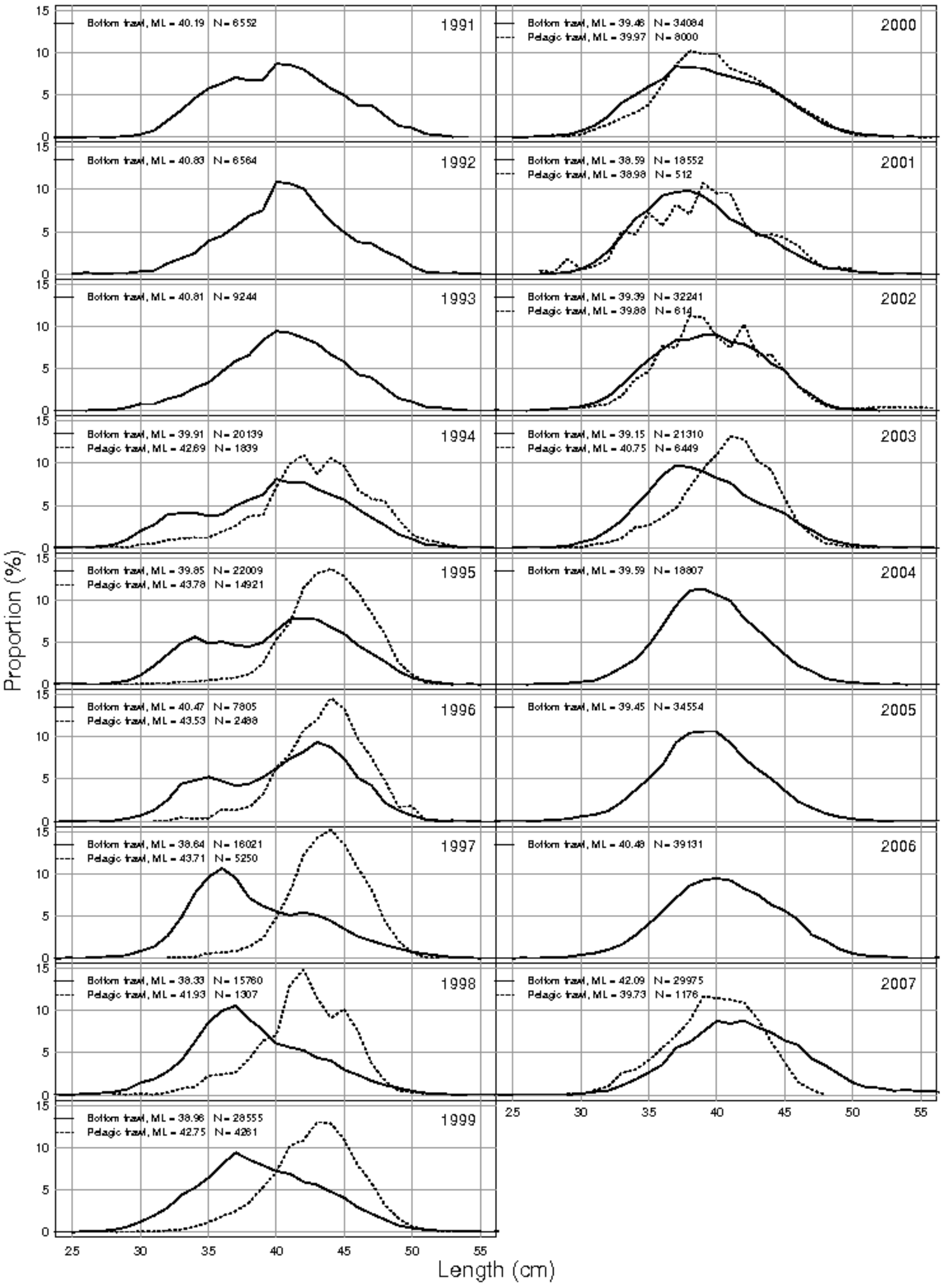


Figure 18.3.5 Length distributions of demersal *S. mentella* from the Icelandic landings taken with bottom trawl (solid line) and pelagic trawl (dotted line) in Division Va 1991-2007.

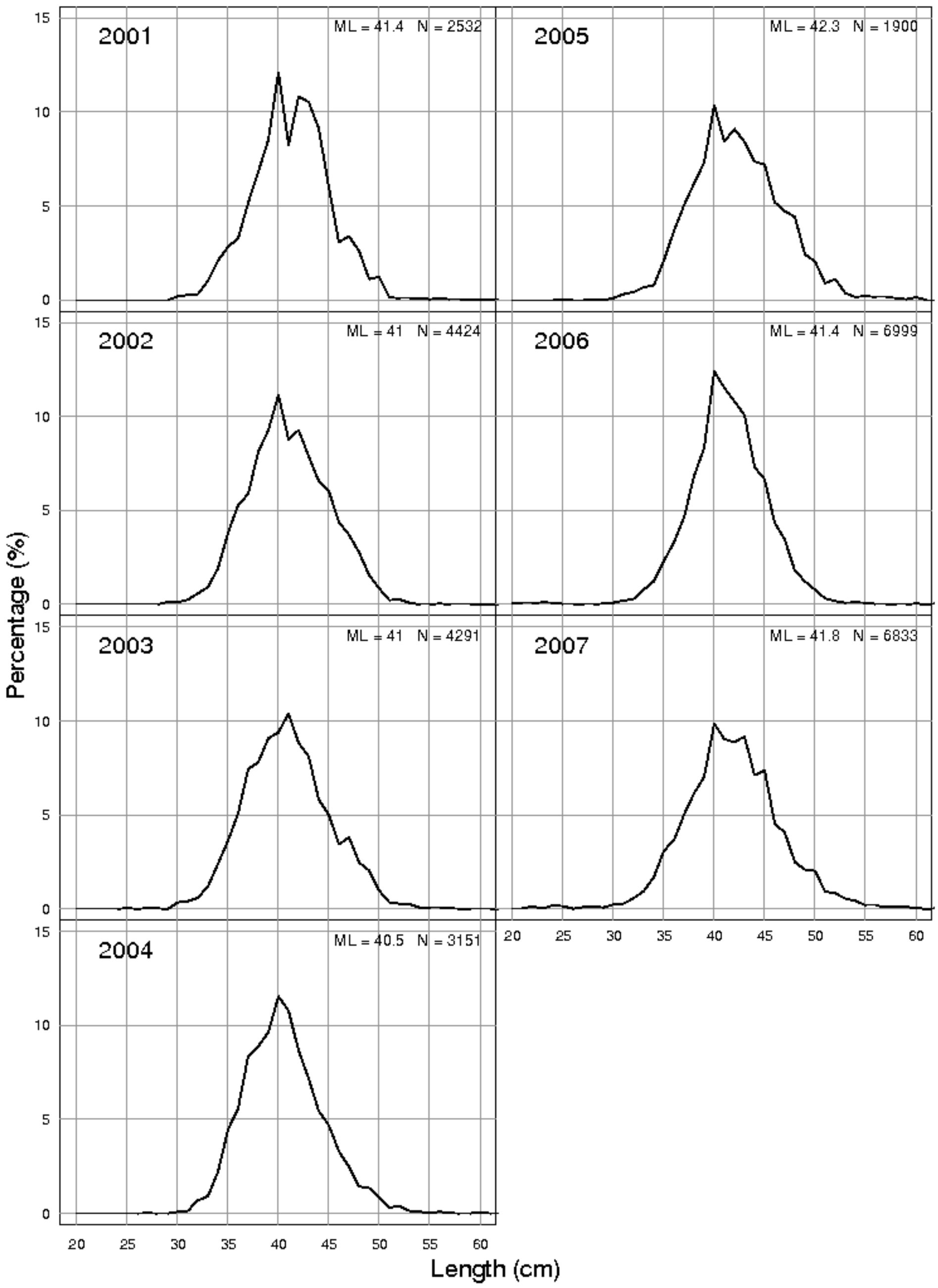


Figure 18.3.6 Length distribution of demersal *S. mentella* from landings of the Faeroese fleet in Division Vb 2001-2007.

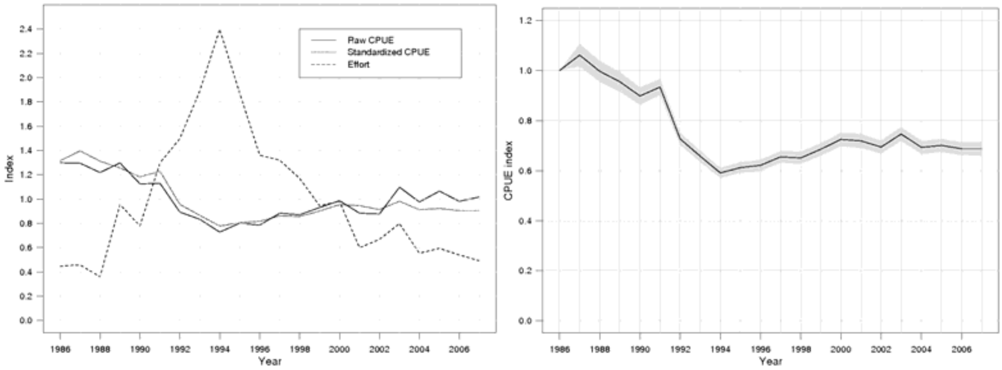


Figure 18.3.7 CPUE, relative to 1986, of demersal *S. mentella* from the Icelandic bottom trawl fishery in Division Va. CPUE based on a GLM model, based on data from log-books and where at least 50% of the total catch in each tow was demersal *S. mentella*. Also shown is fishing effort (hours fished in thousands).

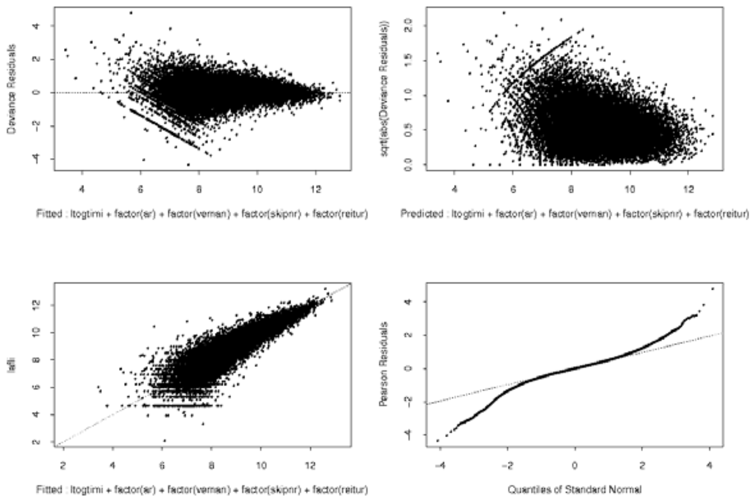


Figure 18.3.8 Residual of the GLM model (section 9.2.1) for the CPUE series of demersal *S. mentella.*

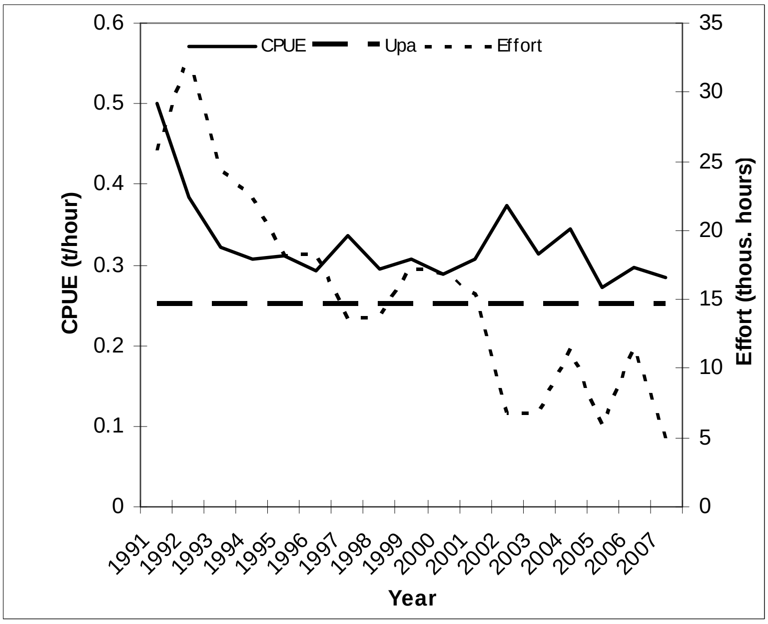


Figure 18.3.9 Demersal *S. mentella*.. CPUE (t/hour) and fishing effort (in thousands hours) from the Faeroese CUBA fleet 1991-2006 and where 70% of the total catch was demersal *S. mentella* .

19 Pelagic Sebastes mentella

19.1 Stock description and management units

This section includes information on the pelagic fishery for pelagic *S. mentella* in the Irminger Sea and adjacent areas (parts of Division Va, Subareas XII and XIV; eastern parts of NAFO Divisions 1F, 2H and 2J).

The stock identification within the pelagic redfish occurrences and relations to demersal *S. mentella* in adjacent shelf areas is uncertain (SGSIMUR: ICES CM 2005/ACFM:10). A review of the most recent information on this issue will be carried out early 2009.

19.2 Scientific data

19.2.1 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 at 2-3 years intervals (Table 19.2.1). In addition, several national surveys have been carried out. During the last decade, the horizontal and vertical coverage of the survey changed as the fishery explored new fishing grounds in southwesterly direction and deeper layers. Vertical coverage of the hydro-acoustic recording of redfish varied among years in relation to the upper boundary of the deep scattering layer (DSL), in which redfish echoes are difficult to identify. Since 2001, the varying depth layers within and deeper than the DSL were covered by standard trawl hauls to account for the incompletely covered vertical depth distribution of the pelagic redfish. These survey hauls were converted into hydro-acoustic measurement units (s_A values) by means of regression (Figure 19.2.1). The stock abundance estimates in these depths are considered highly uncertain. The most recent survey was carried out during June/July 2007 (ICES CM 2007/RMC:12).

19.2.1.1 Survey acoustic data

Since 1994, the results of the acoustic estimate show a drastic decreasing trend from 2.2 mio t to 0.6 mio t in 1999 and have fluctuated between 100 000-700 000 t in 2001-2007 (Table 19.2.1). The 2003 estimate, however, was considered as inconsistent with the time series due to a shift in the timing of the survey.

The most recent trawl-acoustic survey on pelagic redfish (*S. mentella*) in the Irminger Sea and adjacent waters was carried out by Iceland and Russia from mid-June to mid-July 2007. Approximately 350 000 NM^2 were covered. A total biomass of 372 000 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. 19.2.2). Biological samples from identification trawls in these depths showed a mean length of 34.7 cm. Figure 19.2.4 (upper panel) shows the length distribution.

The main results of the 2007 trawl-acoustic survey are given in Tables 19.2.2 and 19.2.3. Table 19.2.4 shows the share between NAFO and NEAFC Convention Areas in the surveys 1999-2007. In the acoustic layer, the NAFO shares varied between 46-56%, with the exception of 2003 when it was around 12%.

19.2.1.2 Survey trawl estimates

In addition to the acoustic measurements, redfish were estimated within and below the DSL by correlating catches and acoustic values at depths shallower than the DSL (Figure 19.2.1). The obtained correlation was used to convert the trawl data at greater depths to acoustic values and from there to abundance. 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 19.2.3). As the correlation between the catch and acoustic values is based on few data points only (Figure 19.2.1), 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 cannot 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 1999-2007 (Table 19.2.1) does not show a clear trend in biomass estimates deeper than 500 m (within and deeper than the DSL since 2005).

Biological samples from the trawls within and deeper than the DSL showed a mean length of 37.1 cm. Figure 19.2.4 (lower panel) shows the corresponding length distribution.

Table 19.2.4 shows the share between NAFO and NEAFC Convention Areas in the surveys 1999-2007. In the layer deeper than 500 m (within and deeper than the DSL since 2005), the NAFO shares varied between 12-35%, with the exception of 2003 when it was 6%.

19.2.2 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).

19.2.3 Biological sampling from the fishery

Length distributions of pelagic *S. mentella* from German, Icelandic, Polish, Portuguese, Russian and Spanish commercial catches were reported for 2007 (WD02, WD06, WD01, WD09, WD10, WD04). The length distributions by ICES and NAFO areas are given in Figures 19.1.6 and 19.1.7 for 2000-2007. 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 19.1.6). In 2005, a considerable decrease in mean length was observed, especially in Subareas XII and XIV (Figures 19.1.6 and 19.1.7). In 2006 and 2007, however, the mean lengths generally increased again to values observed in 2003 and earlier.

The biological sampling from catches of pelagic *S. mentella* in each Subarea/Division in 2007 is shown in the text table below.

Country	Area	Landings (t)	No. of samples	No. of fish measured
Germany	XIV	1,110	32	21,311
Iceland	XIV	17,530	73	13,309
Poland	XIV and NAFO 1F, 2J	825	55	18,769
Portugal	XIV	2,596	60	4,807
Russia	XIV and NAFO 1F, 2J, 2H	25,374	311	52,317
Spain	XIV	4,149	62	15,382

Biological samples from the catches in recent years, and also from the acoustic survey in 1999, suggested that new cohorts are entering into the fishable stock of pelagic redfish on an irregular basis (Stransky, 2000). Age readings within an otolith exchange between Germany, Iceland, Norway, and Spain, based on material collected in July 1999, showed that those cohorts (mean length 25-30 cm) are mainly consisting of 10 year old fish and that ageing error for fish older than 20 years is relatively high (Stransky et al. 2005a). If agreement is defined as ± 5 years, approximately 90% agreement would be obtained. A second set of age reading results within an otolith exchange program between Germany, Iceland, Norway and Spain based on material collected in 1998 and 1999 (Stransky et al. 2005a), showed the same results. Radiometric ageing (Stransky et al. 2005b), however, indicated that especially larger pelagic *S. mentella* from depths >500 m are generally underestimated by traditional otolith annuli counts. In 2006, a Workshop on Age Determination of Redfish [WKADR] was held in Vigo, Spain, which collated the latest knowledge on age determination methodology, ageing error and growth estimates (ICES CM 2006/RMC:09). The next workshop is suggested to be held in September 2008 in Nanaimo, Canada.

19.3 Information from the fishing industry

19.3.1 Summary of the development of the fishery

Russian trawlers started fishing pelagic *S. mentella* in 1982 and covered wide areas of the Irminger Sea (Figure 19.1.5). 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 19.1.1–19.1.2, Figure 19.1.1). From 2000 to 2004, the WG estimate of the catch has been between 126 000 and 161 000 t, highest in 2003. This is probably an underestimate due to incomplete reporting of catches (see section 19.3.3). Since 2000, significant catches were taken in NAFO Divisions 1F and 2J, up to 32 000 t (20% of total catches) in 2003. In 2007, however, only 5 600 t (9% of the total catches) were taken in the NAFO area. A small fraction of the catches reported as demersal catches in Division Va was caught with pelagic trawls in the past (see chapters 16 and 18).

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 9 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 19.1.2 and 19.1.3). There is almost no fishing activity in the period from November until late March or early April when the next fishing season starts. In 2005-2007, however, the fishery already stopped in early September, probably due to decreased catch rates in the southwestern area (WD01), and in 2006-2007, also due to an increased effort in the pelagic redfish fishery in the Norwegian Sea (ICES Div. IIa) in autumn, where parts of the same fleet are operating (cf. AFWG).

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 1998-2007, but mainly deeper than 600 m in the northeastern area in the first and second quarter, and at depths shallower than 500 m in the southwestern area in third and fourth quarter. The depth range of the fisheries of various nations is given in Table 19.1.3 and is shown for the Russian fleet in Figure 19.1.4.

The WG acknowledges information on trawling depths as provided by some nations, but recommends that all nations should report depth information in accordance with the NEAFC logbook format.

The following text table summarises the available information from fishing fleets in the Irminger Sea in 2007:

Faroes	3 factory trawlers
Germany	1 factory trawler
Greenland	1 factory trawler
Iceland	15 factory trawlers
Poland	1 factory trawler
Portugal	6 factory trawlers
Russia	26 factory trawlers
Spain	9 factory trawlers

A summary of the catches by nation as estimated by the Working Group is given in Table 19.1.2.

The historic development of the fisheries by nation can be found in the 2007 NWWG Report and in WD01, 02, 04, 06, 09 and 10.

19.3.2 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 was based on measurements from 1991-1993 when the fishery was mostly at depths shallower than 500 m. In May-July 1997, discard measurements on 10 vessels showed a discard rate of 10%. This was added to the landings in 1996 and 1997. Measurements from 1998 show that the discard rate had decreased to 2%. Information from observers from 2000-2006 indicate that discards is negligible, and therefore no catches were added to the Icelandic landings during that period.

The reported discards of the German fleet in 2007 were negligible.

Norwegian fishermen have earlier reported approximately 3% discards of redfish infested with parasites. This percentage has in recent years become less due to a change in the production from Japanese cut to mainly fillets at present. However, no recent information was given on this issue.

The Spanish discard estimates are based on measurements made by the scientific observers. As general rule, the discards rate of the Spanish fleet in Subarea XII and NAFO Div. 1F and 2J are related with the fraction of parasited fish. In Subarea XIV, the discard rates are more related with the magnitude of the haul catch. In 2007, the level of redfish discarded was negligible.

The level of redfish discarded by the Portuguese fleet, based on the observer reports, has been very small, between 0.6 and 3.8% of the catch. In 2007, discards amounted to 0.7%.

No information on possible discards was available from other countries participating in this fishery.

19.3.3 Illegal Unregulated and Unreported Fishing (IUU)

The Group had again difficulties in obtaining catch estimates from the various fleets. Furthermore, landings data were missing from some nations. The Group requests NEAFC and NAFO to provide ICES in time with all information that supports the Group with regard to more reliable catch statistics.

The WG has during the last years identified problems with unreported catches of pelagic redfish. There have been observations of individual vessels from nations not reporting catches to international organisations like ICES/NEAFC/FAO/NAFO. These unreported catches had, however, not been quantified as the number of nations not reporting and hence the effort of their vessels had been unknown. During the NWWG meeting in 2004, a presentation of an EU project (IMPAST; Chesworth and Lemoine 2004) dealing with this issue was given (WD29 of NWWG2004). Two studies were conducted by the EU Joint Research Centre (JRC) using a satellite imagery vessel detection system (VDS) to detect fishing vessels in the NEAFC regulated redfish fishery southwest of Iceland. Observations in June 2002, 2003 and 2004 indicated that the effort could have been 15-33% higher than reported to NEAFC (WD27 of NWWG2005). The latest information (Indregard 2006, Lemoine et al. 2006) confirms this order of magnitude with regard to IUU fisheries, as only 71 and 81% of the vessels visible in the VDS reported to the Vessel Monitoring System (VMS) in 2005 and 2006, respectively. Data from the 2007 campaign were not fully available to the Group, but preliminary information indicates that the unaccounted effort in 2007 was in the same range as 2006.

19.3.4 CPUE

Non-standardised CPUE series for the largest fleets (representing about 80% of landings) are given in Figure 19.2.5. Since 1995, there is a slightly decreasing trend in CPUE, both in the northeastern and the southwestern area. In 2006-2007, the CPUE increased again, mainly due to higher CPUE in the northeastern area, where especially the Icelandic fleet experienced high CPUE, mainly within their EEZ (see WD06). In the southwestern area, however, the CPUE was decreasing slightly.

The standardised CPUE series based on a GLM model have not been included in this year's assessment, as the model parameters have to be re-evaluated with respect to their effect on the outputs.

19.4 Methods

The assessment of pelagic redfish in the Irminger Sea and adjacent waters is based on survey indices, catches, CPUE and biological data. See sections 19.2 and 19.3 for details.

19.5 Reference points

For pelagic redfish in the Irminger Sea and adjacent waters, no analytical assessment is being carried out due to data uncertainties and the lack of reliable age data. Thus, no reference points can be derived.

19.6 State of the stock

In the absence of reference points and an analytical assessment, the state of the stock cannot be fully evaluated. Stock status is based mainly on the perception of stock trends derived from survey indices. The acoustic estimates from the survey in 2007 indicate that the stock size is low compared to the early 1990s. The stock size has not shown any clear trends since 1999.

Above-average recruitment can be derived from recent survey observations on the East Greenland shelf (section 18.2.3), which is assumed to contribute to the pelagic stock. The mean lengths of pelagic *S. mentella* in the fishery both in the northeastern and in the southwestern area were relatively stable.

19.7 Short term forecast

For pelagic redfish in the Irminger Sea and adjacent waters, no analytical assessment is being carried out due to data uncertainties and the lack of reliable age data. Thus, no short-term forecasts can be derived.

19.8 Uncertainties in assessment and forecast

19.8.1 Data considerations

Preliminary official landings data were provided by the ICES Secretariat, NEAFC and NAFO, and various national data were reported to the Group. The Group, however, repeatedly faced problems in obtaining catch data. The Group has during the last years identified problems with unreported catches of pelagic redfish. Current data available to the Group indicate that the reported effort (and consequently landings) could represent only around 80% of the real effort.

As in previous years, detailed descriptions on the horizontal, vertical and seasonal distribution of the fisheries were given.

The Group started to collate an international database with length distributions from the sampling of the fisheries on a spatially disaggregated level. Once complete, the horizontal and vertical differences in mean length by fishing areas can be illustrated as alternative to the portrayals by ICES/NAFO Divisions.

19.8.2 Assessment quality

The results of the international trawl-acoustic survey are given in sections 19.2.1.1 and 19.2.1.2. 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 areas, 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 19.1.3). Thus, the acoustic estimates cannot be considered as accurate measures of absolute stock size of redfish in this layer, as availability may have changed during the surveyed period, both horizontally and vertically. A decreasing trend in the relative biomass indices in the acoustic layer, however, is visible since 1991.

The biomass estimates for depths within and deeper than the DSL have to be considered as highly uncertain (see section 19.2.1.2). Within the time series from 1999 to 2007, the estimates in these depths have not shown a clear trend.

Taking the importance of the availability of fishery independent information about the pelagic redfish resource into account, the NWWG recommends a continuation of the international trawl-acoustic survey on pelagic redfish. The next survey is planned to be carried out in June/July 2009. As the coverage of the large survey area with only three vessels leads to large distances between hydroacoustic tracks and trawl hauls, an official ICES request for participation in the survey had been sent to other nations which take part in the pelagic redfish fisheries. Nevertheless, the Study Group on Redfish Stocks (SGRS) has not succeeded in involving more countries.

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.

19.9 Comparison with previous assessment and forecast

The data available for evaluating the stock status are similar to last year.

19.10 Management plans and evaluations

Pelagic redfish in the Irminger Sea and adjacent waters straddle in the ICES Div. Va, Subareas XII and XIV and NAFO Subareas 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 fisheries on pelagic redfish is based on setting a TAC and technical measures (minimum mesh size in the trawls is set at 100 mm).There has been no agreement on the TAC and allocation key between contracting parties in NEAFC since several years, and some countries had set autonomous quotas. The NEAFC TAC for pelagic redfish for 2007 was 46 000 t, "of which 2 875 tonnes will be allocated to NAFO, and 123 tonnes will be available to co-operating non contracting parties". As the NEAFC contracting parties did not reach an unanimous decision on the total TAC and allocation key, the total TAC in force was about 73 000 t in 2007, based on splitting factors set for 2004 and taking into account the autonomous quotas of Iceland and Russia. The total landings in 2007 (64 000 t) were below this total TAC in force. Taking the most recent estimates on IUU fisheries (chapter 19.3.3) into account, however, the actual removals in 2007 could have reached 80 000 t.

ACFM has advised for 2008 that catches of pelagic *S. mentella* are set at 20 000 t as a starting point for the adaptive part of the management plan. For 2008, NEAFC has set a rolled over TAC of 46 000 t. The total TAC in force for 2008 is about 64 000 t, since Russia has decreased its autonomous quota to 20 000 t.

19.11 Management considerations

The Group had again difficulties in obtaining catch estimates from the various fleets, and new information available indicates that unreported catches might be substantial. Furthermore, landings data were missing from some nations. The Group requests NEAFC and NAFO to provide ICES with all information that supports the Group with regard to more reliable catch statistics.

The main feature of the fishery since 1998 is a clear distinction between two widely separated fishing grounds with pelagic redfish fished at different seasons and different depths. Since 2000, the southwestern fishing grounds extended also into the NAFO Convention Area. Biological data, however, suggest that the aggregations in the NAFO Convention Area do not constitute a separate stock. The NAFO Scientific Council agreed with this conclusion (NAFO, 2005). The Group concludes that at this time there is not enough scientific basis available to propose an appropriate split of the total TAC among the two fisheries/areas.

The Group expects that under the current TAC regulations, a greater share of the catches in 2008 will be taken in the northeastern area, as the fishery in the beginning of the season starts in this area in April.

19.12 Ecosystem considerations

The fisheries on pelagic redfish in the Irminger Sea and adjacent waters is generally regarded as having negligible impact on other fish or invertebrate species due to very low by-catch and discard rates. As this fishery uses pelagic nets, the impact on the habitat is also regarded as negligible.

19.13 Regulations and their effects

see section 19.10

19.14 Changes in fishing technology and fishing patterns

see section 19.3.1

19.15 Changes in the environment

Analysis of the oceanographic situation during the 2007 international survey and long-term data including 2003, allows the following conclusions:

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 in the 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 temperature in the Irminger Sea may have an effect on the spatial and vertical distributions of *S. mentella* in the feeding area (Fig. 19.2.8; Pedchenko, 2005).

The results of the survey in 2003 were confirmed by the high 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).

In June/July 2005, the temperature of the water in the shallower layer (0-500 m) of the Irminger Sea was higher than normal (ICES, 2005b). As in the surveys 1999-2003, the redfish were aggregating in the southwestern part of the survey area, partly influenced by these hydrographic conditions. 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. In June/July 2007, again a higher temperature in the shallower layer was observed, as seen since 1996.

Table 19.1.1 Pelagic *S. mentella*. Catches (in tonnes) by area as used by the Working Group.

Year	Va	XII	XIV	NAFO 1F	NAFO 2J	NAFO 2H	Total
1982		39,783	20,798				60,581
1983		60,079	155				60,234
1984		60,643	4,189				64,832
1985		17,300	54,371				71,671
1986		24,131	80,976				105,107
1987		2,948	88,221				91,169
1988		9,772	81,647				91,419
1989		17,233	21,551				38,784
1990		7,039	24,477	385			31,901
1991		10,061	17,089	458			27,608
1992	1,968	23,249	40,745				65,962
1993	2,603	72,529	40,703				115,835
1994	15,472	94,189	39,028				148,689
1995	1,543	132,039	42,260				175,842
1996	4,744	42,603	132,975				180,322
1997	15,301	19,826	87,698				122,825
1998	40,612	22,446	53,910				116,968
1999	36,524	24,085	48,521	534			109,665
2000	44,677	19,862	50,722	11,052			126,313
2001	28,148	32,164	61,457	5,290	1,751	8	128,818
2002	37,279	24,026	66,194	15,702	3,143		146,344
2003	46,676	24,232	57,780	26,594	5,377	325	160,984
2004	14,456	9,679	76,656	20,336	4,778		125,905
2005	11,726	6,784	34,041	16,260	4,899	5	73,715
2006	16,380	2,146	50,607	12,939	593	260	82,925
2007	17,213	378	40,835	2,843	2,561	175	64,004

Table 19.1.2 Pelagic *S. mentella* catches (in tonnes) in ICES Div. Va, Subareas XII, XIV and NAFO Div. 1F, 2H and 2J by countries used by the Working Group. * Prior to 1991, the figures for Russia included Estonian, Latvian and Lithuanian catches.

Year	Bulgaria	Canada	Estonia	Faroes	France	Germany	Greenland	Iceland	Japan	Latvia	Lithuania	Netherlands	Norway	Poland	Portugal	Russia*	Spain	UK	Ukraine	Total
1982														581		60,000				60,581
1983						155										60,079				60,234
1984	2,961					989								239		60,643				64,832
1985	5,825					5,438								135		60,273				71,671
1986	11,385			5		8,574								149		84,994				105,107
1987	12,270			382		7,023								25		71,469				91,169
1988	8,455			1,090		16,848										65,026				91,419
1989	4,546			226		6,797	567	3,816						112		22,720				38,784
1990	2,690					7,957		4,537					7,085			9,632				31,901
1991			2,195	115		571		8,783					6,197			9,747				27,608
1992	628		1,810	3,765	2	6,447	9	15,478		780	6,656		14,654			15,733				65,962
1993	3,216		6,365	7,121		17,813	710	22,908		6,803	7,899		14,990			25,229			2,782	115,835
1994	3,600		17,875	2,896	606	17,152		53,332		13,205	7,404		7,357		1,887	17,814			5,561	148,689
1995	3,800	602	16,854	5,239	226	18,985	1,856	34,631	1,237	5,003	22,893	13	7,457		5,125	44,182	4,554		3,185	175,842
1996	3,500	650	7,092	6,271		21,245	3,537	62,903	415	1,084	10,649		6,842		2,379	45,748	7,229	260	518	180,322
1997		111	3,720	3,945		20,476		41,276	31				3,179	776	3,674	36,930	8,707			122,825
1998			3,968	7,474		18,047	1,463	48,519	31		1,768		1,139	12	4,133	25,837	4,577			116,968
1999			2,108	4,656		16,489	4,269	43,923					5,435	6	4,302	17,957	10,332	188		109,665
2000			11,951	2,837		12,499	4,283	45,232			430		5,232		3,731	29,224	10,894			126,313
2001			887	7,741		10,669	3,443	42,472			15,784		5,222		2,744	29,774	10,082			128,818
2002			15	4,383		13,212	4,099	44,492		1,841	21,823		5,291	428	3,086	39,267	8,407			146,344
2003				5,893		10,607	4,450	48,894		1,269	21,629		8,399	917	4,035	44,056	10,835			160,984
2004				5,447		3,377	3,169	36,826		1,114	3,698		8,998	2,907	4,419	44,275	11,675			125,905
2005				2,010		2,988	1,431	16,005		919	2,196		4,574	2,410	3,868	31,885	5,428			73,715
2006				3,832		2,824	744	22,138		1,803	1,760		6,248	2,019	2,685	28,623	10,249			82,925
2007			209	3,000		1,110	1,961	17,530		761	1,861		4,628	825	2,596	25,374	4,149			64,004

Table 19.1.3 Pelagic *S. mentella* catches (in tonnes) in 2007 by countries and depth (A), and in 1996-2007 by depth (B). (Working Group figures and/or as reported to NEAFC).

A.	TOTAL	NOT SPLITTED	SHALLOWER THAN 600 M	DEEPER THAN 600 M
Faroes	3,000	100 %		
Germany	1,110		10 %	90 %
Greenland	1,961	100 %		
Iceland	17,530		5 %	95 %
Latvia	761	100 %		
Lithuania	1,861	100 %		
Norway	4,628	100 %		
Poland	825		23 %	77 %
Portugal	2,596		20 %	80 %
Russia	25,374		34 %	66 %
Spain	4,149		8 %	92 %
Total	64,004			

B.	TOTAL	NOT SPLITTED	SHALLOWER THAN 600 M	DEEPER THAN 600 M
1996	180,322	18 %	20 %	62 %
1997	122,825	7 %	24 %	69 %
1998	116,968	0 %	21 %	79 %
1999	109,665	5 %	20 %	75 %
2000	126,313	23 %	28 %	49 %
2001	128,818	23 %	27 %	50 %
2002	146,344	26 %	19 %	55 %
2003	160,984	10 %	25 %	65 %
2004	125,905	10 %	23 %	67 %
2005	73,715	14 %	32 %	53 %
2006	82,925	17 %	16 %	67 %
2007	64,004	19 %	17 %	64 %

Table 19.2.1 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 and 2007. *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
2007*	349	731	372			1423	854

Table 19.2.2 Pelagic *S. mentella*. Results of the acoustic abundance and biomass estimation shallower than the DSL from the survey in June/July 2007.

Subarea	**A**	**B**	**C**	**D**	**E**	**F**	**Total**
Area (NM^2)	129,614	106,594	8,464	33,855	62,623	8,052	349,201
No. fishes ('000)	172,365	192,306	0	91,683	269,661	4,594	730,608
Biomass (t)	79,750	94,471	0	53,329	141,703	2,649	**371,902**

Table 19.2.3. Pelagic *S. mentella*. Results of the trawl estimation within and deeper than the DSL from the survey in June/July 2007.

	A	**B**	**C**	**D**	**E**	**F**	**Total**
Area (NM^2)	129,614	106,594	8,464	33,855	62,623	8,052	349,201
No. fishes ('000)	504,662	474,062	4,490	57,098	346,360	36,666	1,423,337
Biomass (t)	345,061	283,404	2,268	32,453	171,869	19,309	**854,364**
Lower CL	245,878	199,844	1,694	24,249	125,255	14,427	611,346
Upper CL	444,244	366,964	2,841	40,658	218,483	24,190	1,097,381

Table 19.2.4 Pelagic *S. mentella*. Survey biomass estimates 1999-2007 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
2007 < DSL*	198	53	174	47	372
2007 ≥ DSL	224	26	631	74	854
2007 Sum	422	34	805	66	1226

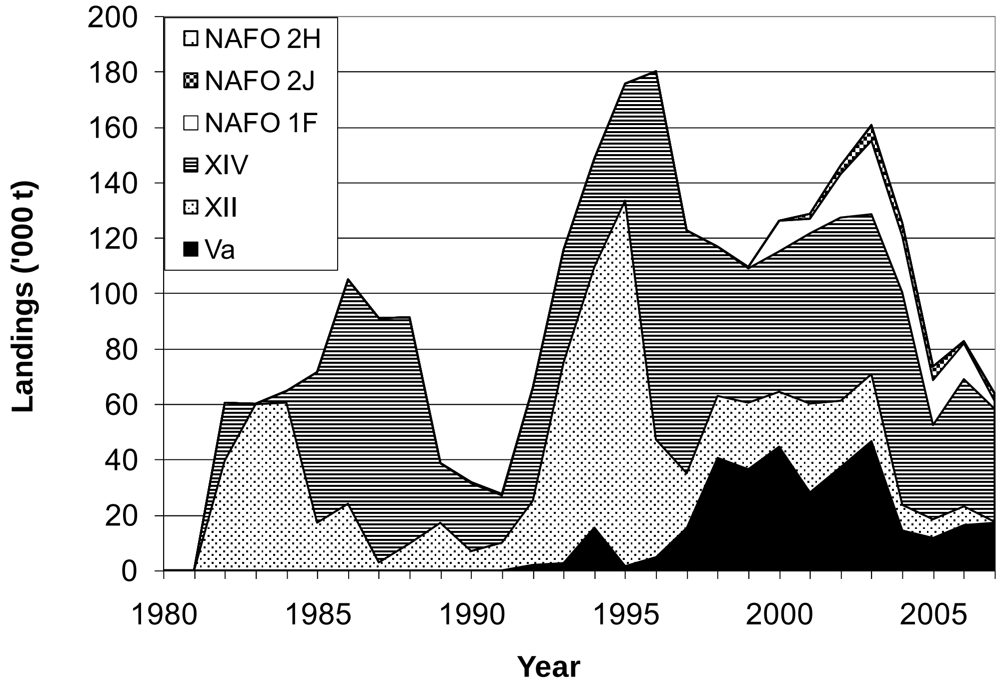


Figure 19.1.1 Landings of pelagic *S. mentella* (Working Group estimates, see Table 19.1.1).

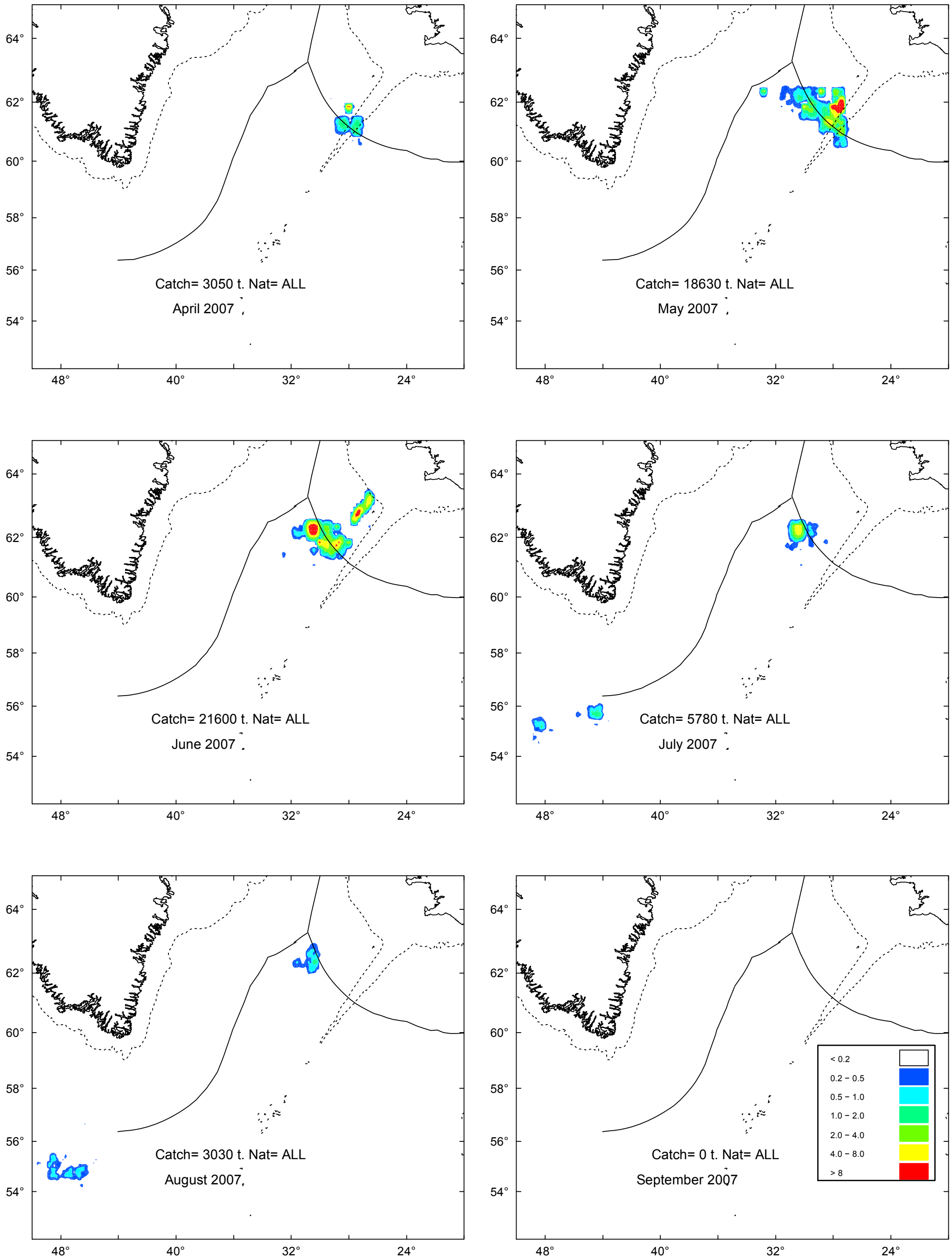


Figure 19.1.2 Fishing areas and total catch of pelagic redfish (*S. mentella*) by month(s) in 2007, derived from catch statistics provided by the Faroe Islands, Germany, Iceland and Russia. The catches in the legend are given as tonnes per square nautical mile.

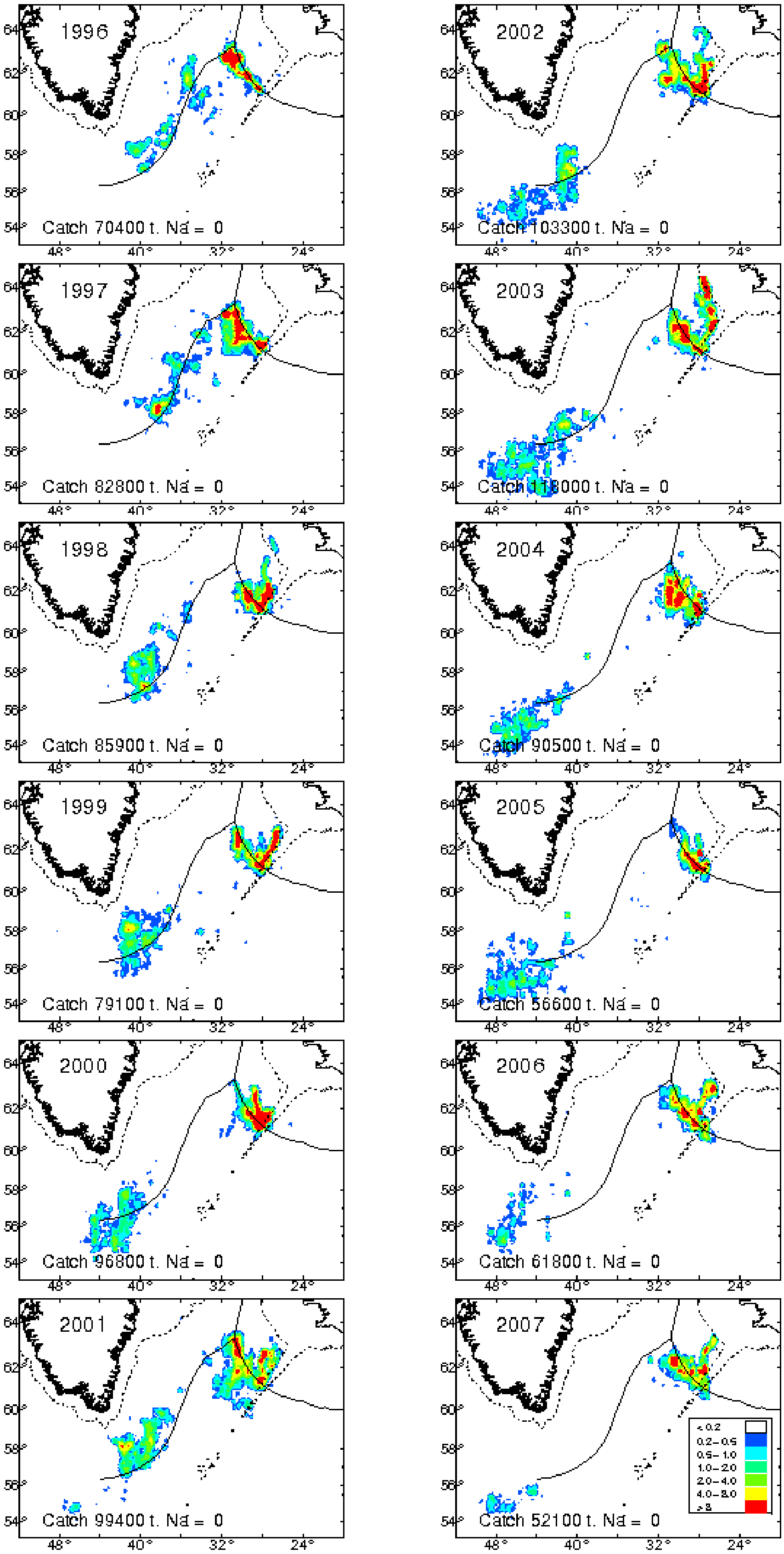


Figure 19.1.3 Fishing areas and total catch of pelagic redfish (*S. mentella*) in the Irminger Sea and adjacent waters 1996-2007. Data are from the Faroe Islands (1995-2007), Germany (1995-2007), Greenland (1999-2003), Iceland (1995-2007), Norway (1995-2003) and Russia (1997-2007). The catches in the legend are given as tonnes per square nautical mile.

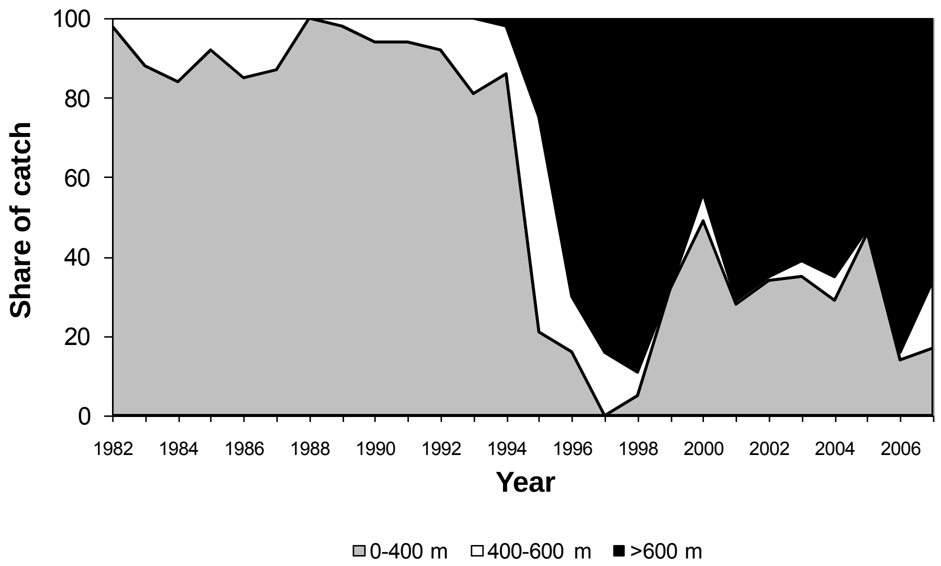


Figure 19.1.4 Percentage of the catch of *S. mentella* by Russian vessels by depth in the Irminger Sea in 1982-2007.

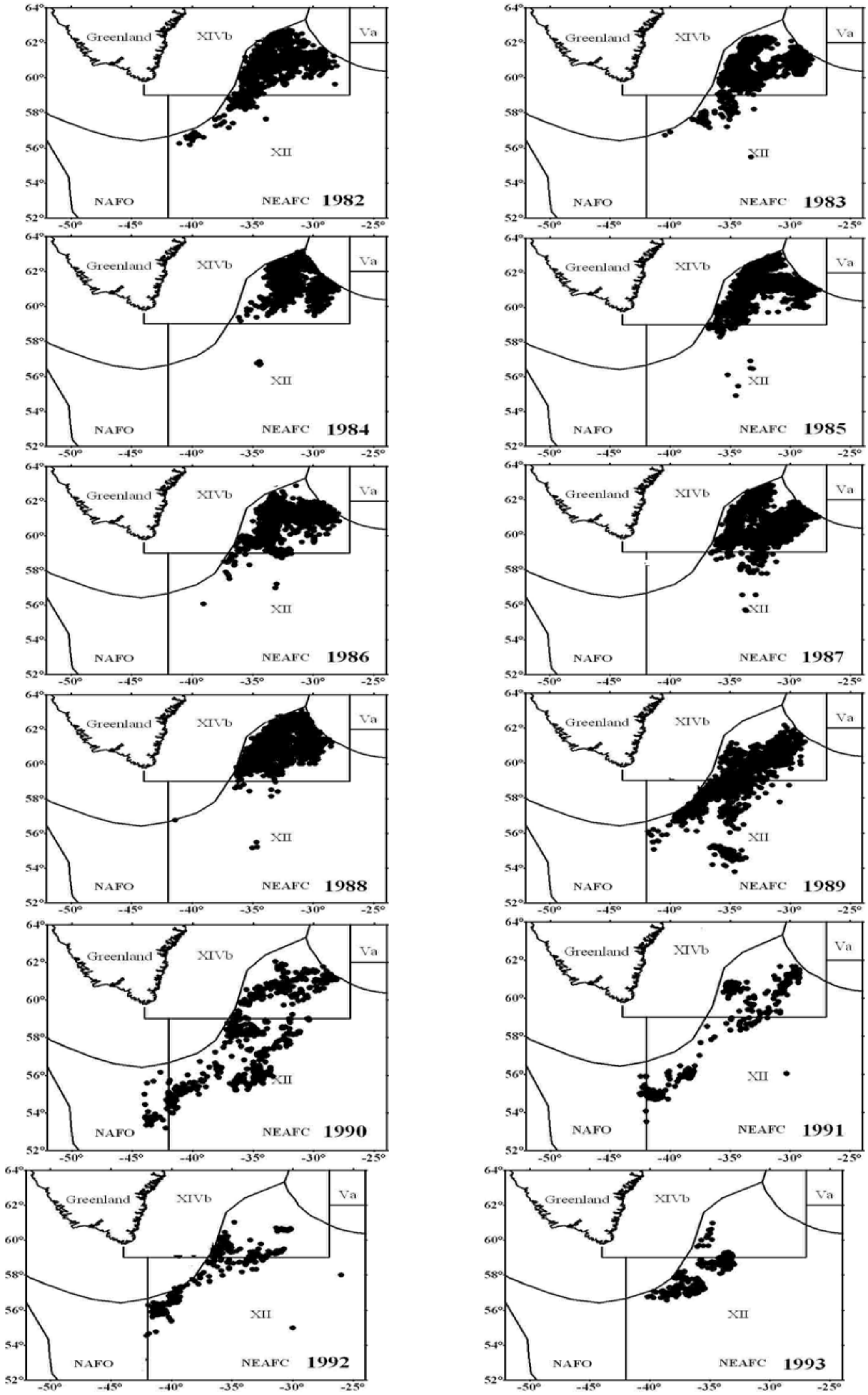


Figure 19.1.5 Location of the Russian fleet during fishery for *S. mentella* in the Irminger Sea in 1982-1993.

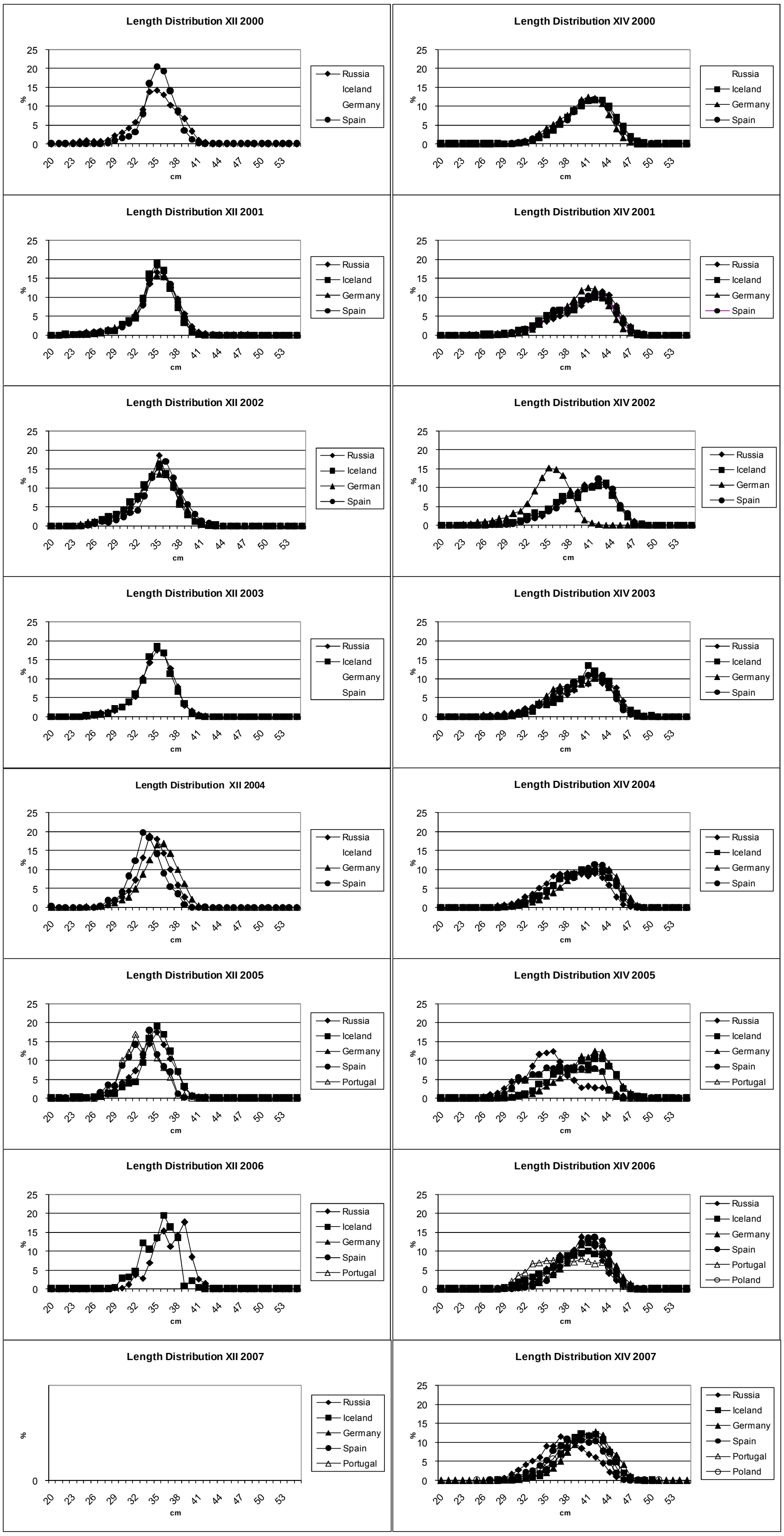


Figure 19.1.6 Length distributions from landings of pelagic *S. mentella* by ICES Subareas XII and XIV and country in 2000-2007.

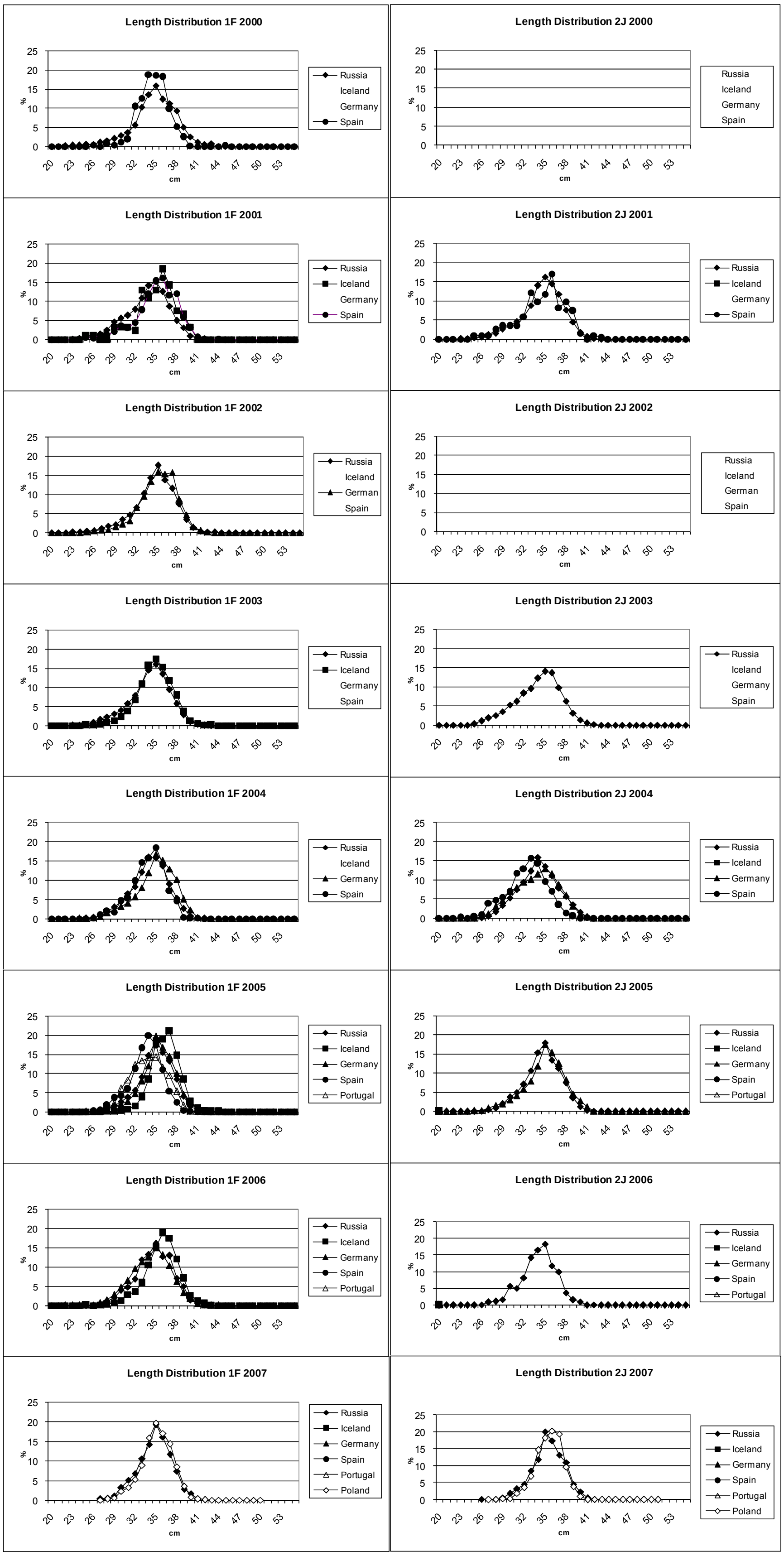


Figure 19.1.7 Length distributions from landings of pelagic *S. mentella* by NAFO Divisions 1F and 2J and country in 2000-2007.

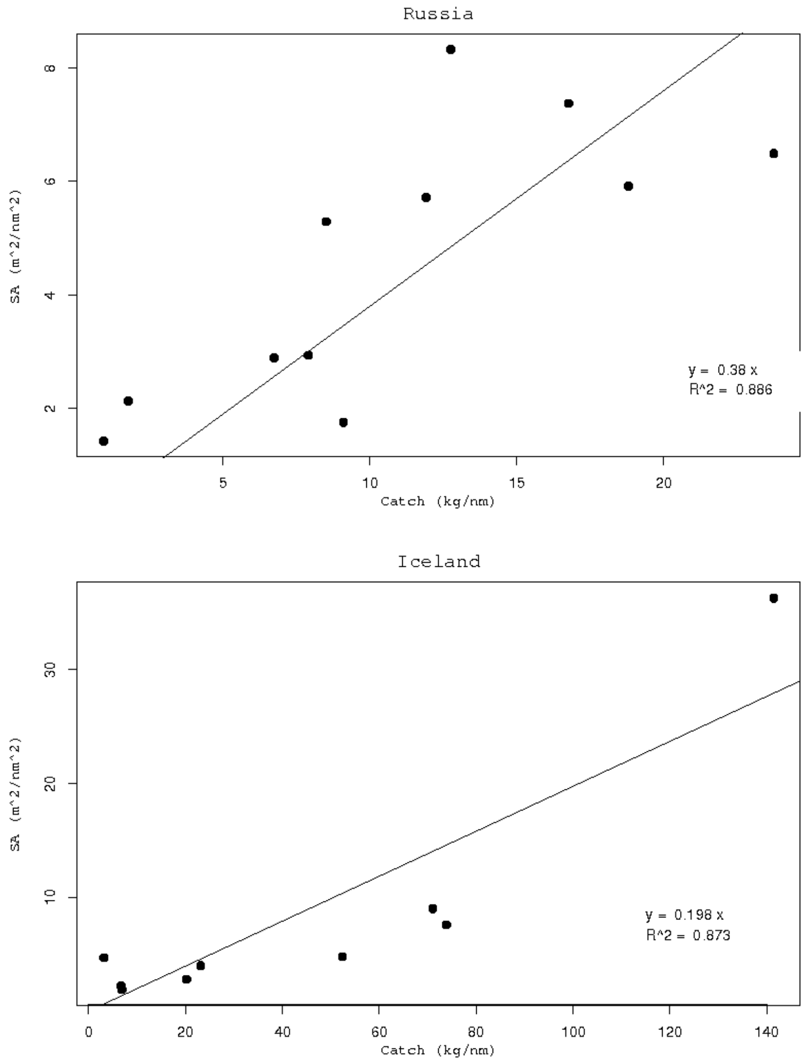


Figure 19.2.1 Regressions between catches and observed hydroacoustic s_A values, observed on the Russian and Icelandic vessel on the joint trawl-acoustic survey in June/July 2007 shallower than the DSL and used in the biomass calculations.

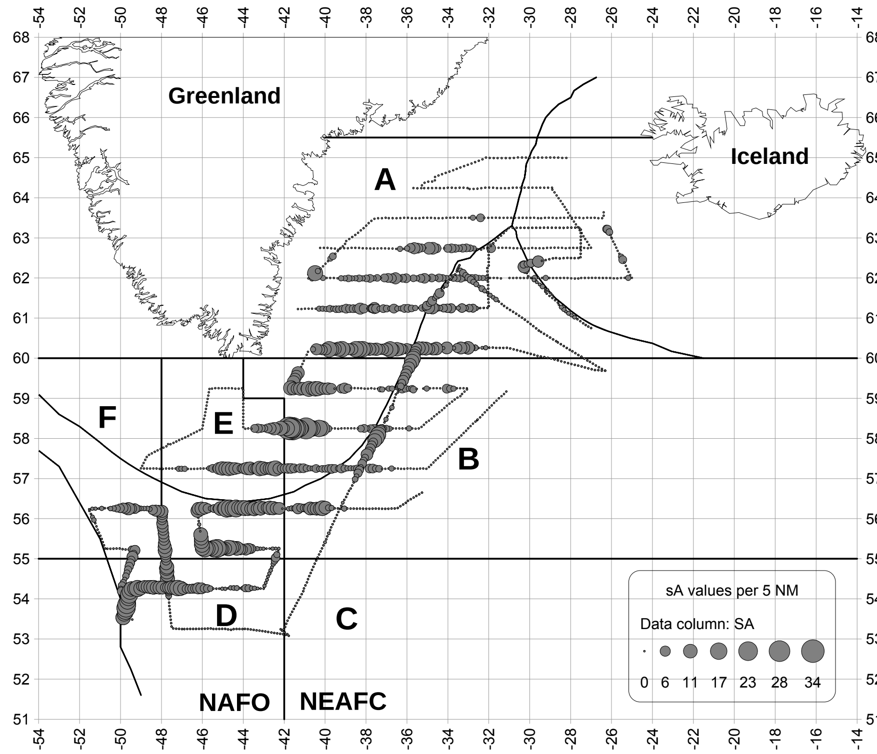


Figure 19.2.2 Pelagic *S. mentella*. Acoustic estimates (average sA values by 5 NM sailed) shallower than the deep-scattering layer (DSL) from the joint trawl-acoustic survey in June/July 2007.

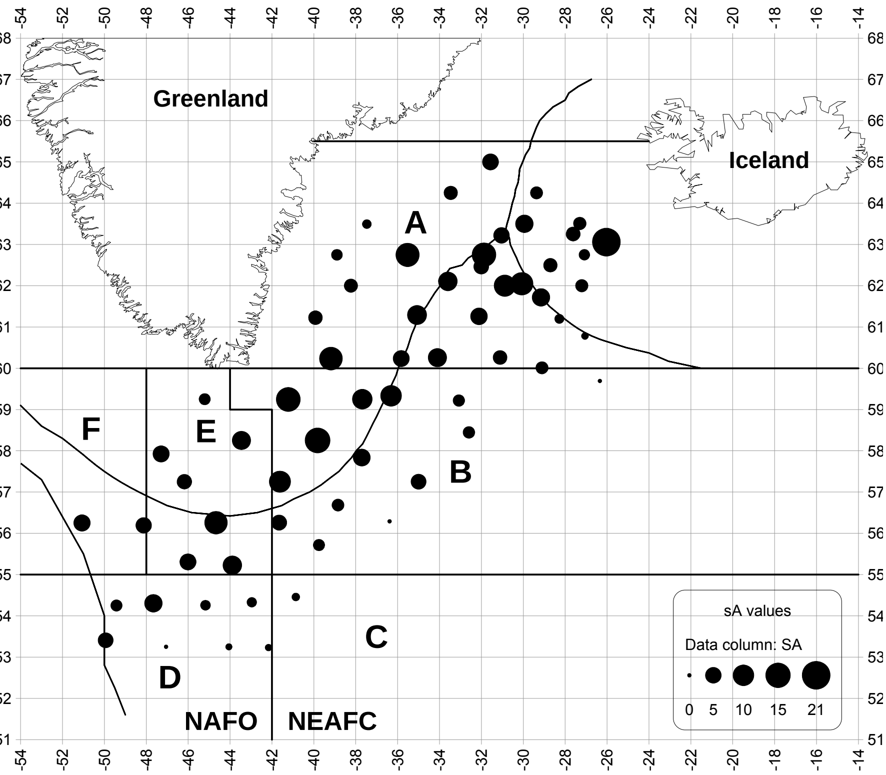


Figure 19.2.3 Pelagic *S. mentella*. Trawl estimates (sA values calculated from trawls; ICES CM 2007/RMC:12) within and deeper than the deep-scattering layer (DSL) from the joint trawl-acoustic survey in June/July 2007.

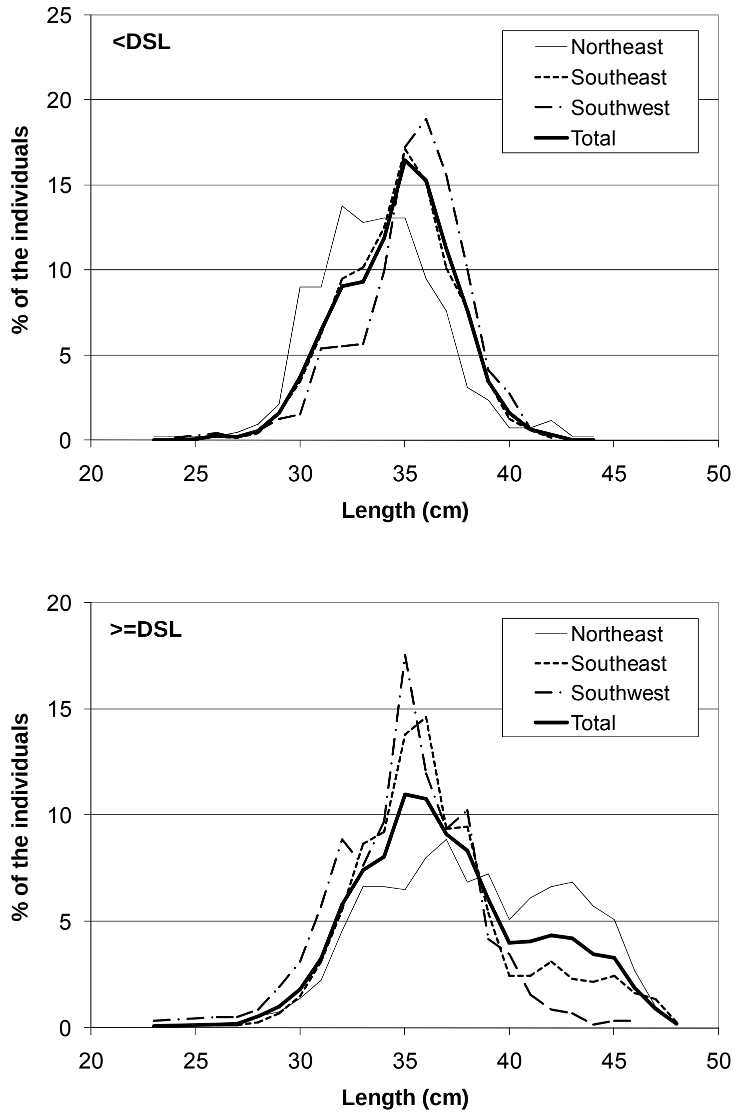


Figure 19.2.4 Length distribution of pelagic *S. mentella* redfish in the trawls, by geographical areas (ICES CM 2007/RMC:12) and total, shallower than the DSL, and within and deeper than the DSL from the joint trawl-acoustic survey in June/July 2007.

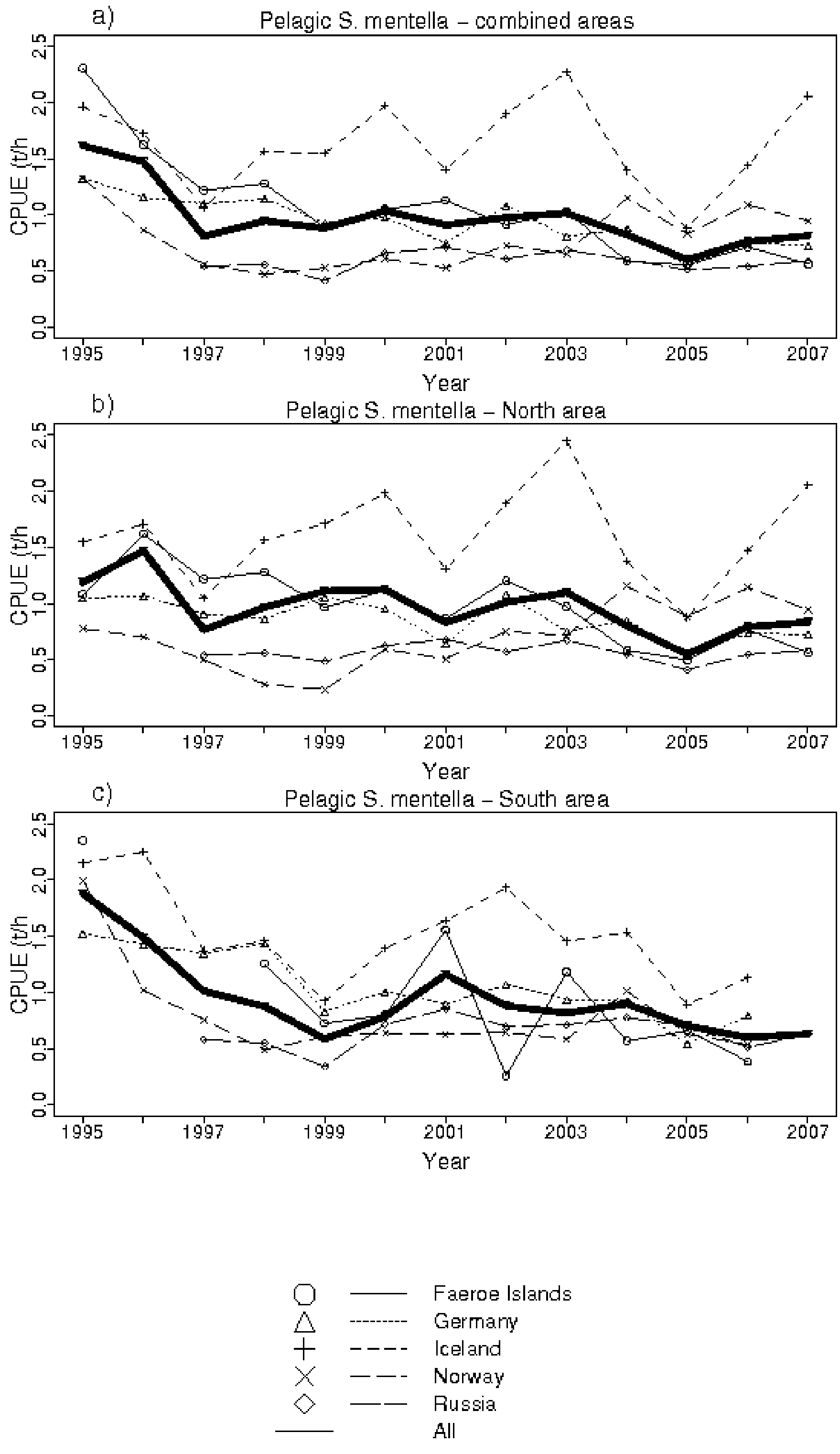


Figure 19.2.5 Trends in national non-standardised CPUE of the pelagic *S. mentella* fishery in the Irminger Sea and adjacent waters, based on log-book statistics in the joint international database. a) all areas, b) northeastern area, c) southwestern area.

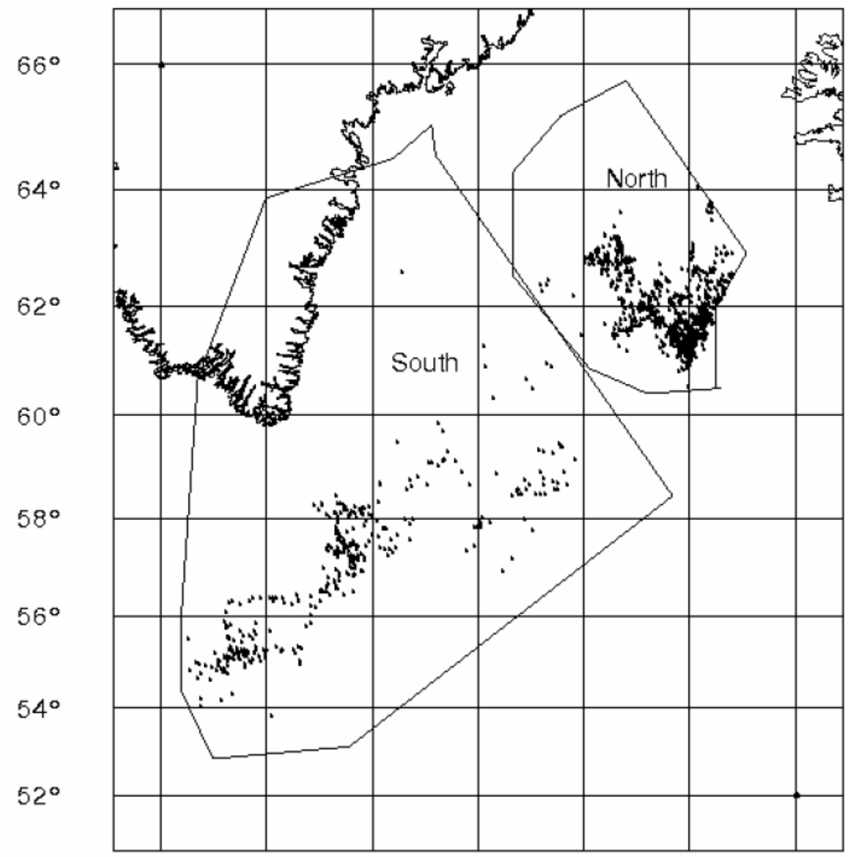


Figure 19.2.6. Division of areas between south an north. The points indicate positions of Icelandic available samples from the catches 1995-2005.

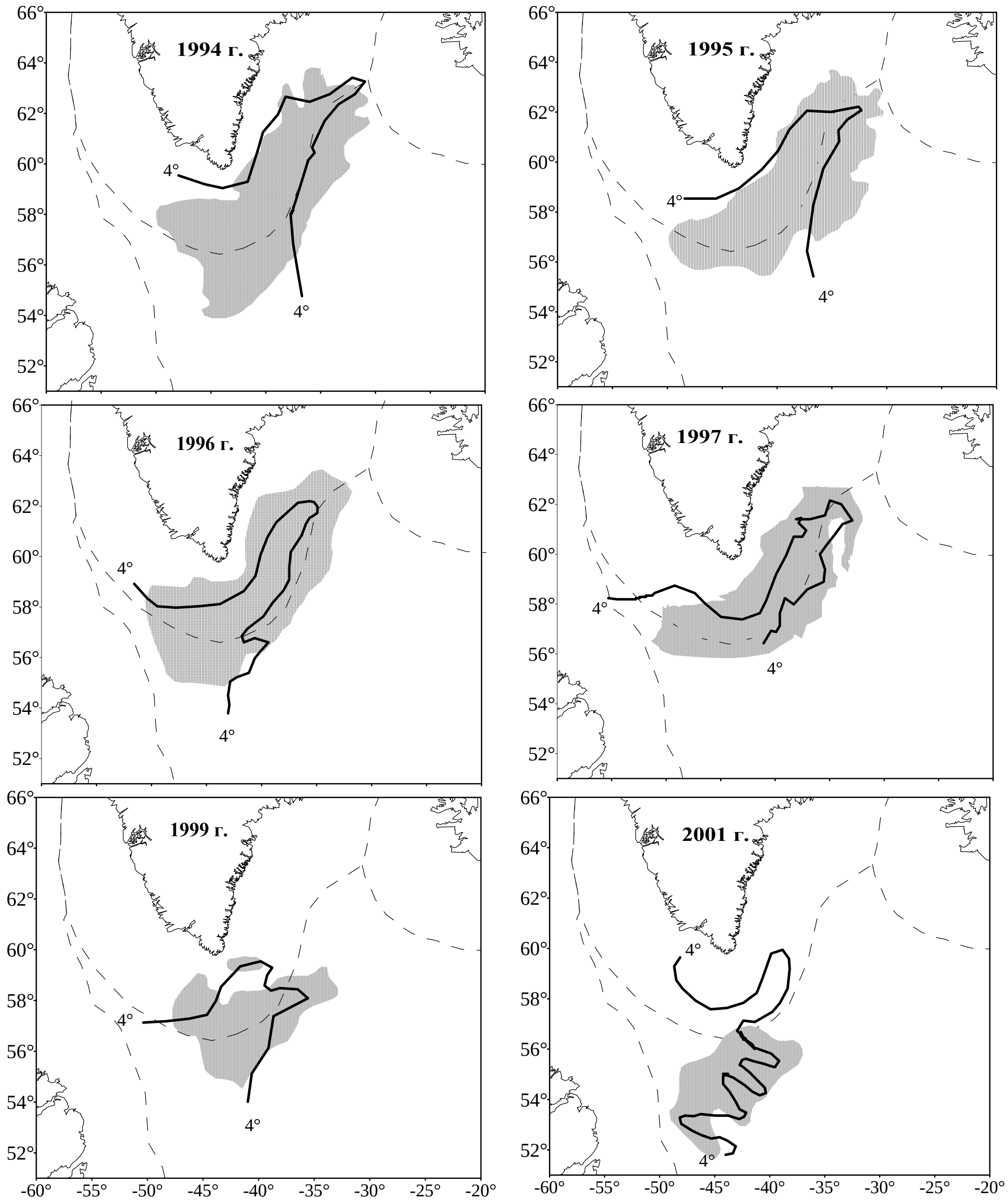


Figure 19.2.7 Temperature distribution (black 4°C line) on 200 m depth and main redfish stock distribution (shaded areas) derived from international and Russian redfish surveys in 1994-2001.

20 References

Björnsson, H. and Sigurdsson, T. 2003. Assessment of golden redfish (*Sebastes marinus* L) in Icelandic waters. Scientia Marina 67(Suppl.1): 301-314.

Cadrin, S.X., Friedland, K., Waldman, J.R. 2005. Stock Identification Methods: Applications in Fishery Science. Elsevier, San Diego, 736 pp.

Chesworth, J. and Lemoine, G. 2004. IMPAST: Improving Fisheries Monitoring by Integrating Passive and Active Satellite Technologies - Results and analyses from the second year's campaign. EU-JRC, Ispra, 84 pp.

Einarsson, H. 1960. The fry of *Sebastes* in Icelandic waters and adjacent seas. Rit Fiskideilar 2(7), 68 pp.

ICES 1983. Report on the NAFO/ICES Study Group on biological relationships of the West Greenland and Irminger Sea redfish stocks. ICES CM 1983/G:3, 11 pp.

ICES 1998. Report of the Study Group on Redfish Stocks. ICES CM 1998/G:3, 30 pp.

ICES 2000. Report of the North-Western Working Group. ICES CM 2000/ACFM:15, 338 pp.

ICES 2001. Report of the Working Group on Oceanic Hydrography. ICES CM 2001/C:06, 185 pp.

ICES 2002. The Annual ICES Ocean Climate Status Summary 2001/2002, Working Group on Oceanic Hydrography, 27 pp.

ICES 2003. Report of the Planning Group on Redfish Stocks. ICES CM 2003/D:08, 45 pp.

ICES 2005. Report Report of the Study Group on Stock Identity and Management Units of Redfishes (SGSIMUR). ICES CM 2005/ACFM:10, 334 pp.

ICES 2005. Report of the Study Group on Redfish Stocks (SGRS) [Results meeting]. ICES CM 2005/D:03, 48 pp.

ICES 2006. Report of the Workshop on Age Determination of Redfish (WKADR). ICES CM 2006/RCM:09, 47 pp.

ICES 2007. Report of the Study Group on Redfish Stocks (SGRS). ICES CM 2007/RMC:12, 54 pp.

Indregard, M., Lemoine, G., Cesena, C. and Alvarez, M. 2006. 2005 NEAFC VDS Campaign. European Commission, Report JRC IPSC/G03/R/MIN/min D(2006)(5828), 31 pp.

Lemoine, G., Indregard, M., Cesena, C., Thoorens, F.X., Greidanus, H., Dörner, H. 2006. Evaluation of vessel detection system use for monitoring if fisheries activities. ICES CM 2006/N:02, 10 pp.

Magnússon, J. and Magnússon, J.V. 1975. On the distribution and abundance of young redfish at Iceland 1974. Rit Fiskideilar 5(3), 22 pp.

Magnússon, J., Kosswig, K. and Magnússon, J.V. 1988. Young redfish on the nursery grounds in the East Greenland shelf area. ICES CM 1988/G:38, 13 pp.

Magnússon, J., Kosswig, K. and Magnússon, J.V. 1990. Further studies on young redfish in the East Greenland shelf area. ICES CM 1990/G:43, 15 pp.

Magnússon, J.V. and Jóhannesson, G. 1997. Distribution and abundance of 0-group redfish in the Irminger Sea and off East Greenland: relationships with adult abundance indices. ICES J. Mar. Sci. 54, 830-845.

Malmberg, S.A, Mortensen, J. and Jónsson, S., 2001. Oceanic fluxes in Icelandic waters. ICES CM 2001/W:08, 14pp.

Malmberg, S.A. and Valdimarsson, H., 2003. Hydrographic conditions in Icelandic waters, 1990-1999. ICES Marine Science Symposia 219, 1-453.

Mortensen, J. and Valdimarsson, H. 1999. Thermohaline changes in the Irminger Sea. ICES CM 1999/L:16.

NAFO 2005. Scientific Council Reports 2004, 306 pp.

Pálsson, Ó.K., Steinarsson, B.Æ., Jónsson, E., Gudmundsson, G, Stefánsson, G., Björnsson, H. and Schopka, S.A. 1997. Icelandic groundfish survey. ICES CM 1997/Y:29, 35 pp.

Pedchenko, A. P. 2000. Specification of oceanographic conditions of the Irminger Sea and their influence on the distribution of feeding redfish in 1999. ICES North-Western Working Group 2000, Working Document 22, 13 pp.

Pedchenko, A.P. 2001. Oceanographic conditions of the Irminger Sea and their influence on distribution of *Sebastes mentella*. Abstract of Ph.D. Thesis, St. Petersburg, 23 pp. (in Russian)

Pedchenko, A.P. 2005. The role of interannual environmental variations in the geographic range of spawning and feeding concentrations of redfish Sebastes mentella in the Irminger Sea. ICES J. Mar. Sci., 62: 1501-1510.

Stransky, C. 2000. Migration of juvenile deep-sea redfish (*Sebastes mentella* Travin) from the East Greenland shelf into the central Irminger Sea. ICES CM 2000/N:28, 10 pp.

Stransky, C., Gudmundsdottir, S., Sigurdsson, T., Lemvig, S., Nedreaas, K. and Saborido-Rey, F. 2005a. Age determination and growth of Atlantic redfish (*Sebastes marinus* and *S. mentella*): bias and precision of age readers and otolith preparation methods. ICES J. Mar. Sci., 62, 655-670.

Stransky, C., Kanisch, G., Krüger, A. and Purkl, S. 2005b. Radiometric age validation of golden redfish (*Sebastes marinus*) and deep-sea redfish (*S. mentella*) in the Northeast Atlantic. Fish. Res., 74: 186-197.

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ICES, Headquarters, 21 April – 29 April 2008

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Annex 2: Technical Minutes from Review Group on North Western stocks

REVIEW OF ICES NWWG REPORT 2008

9-10 May 2008

Reviewers:	Jan Horbowy (Poland, Chair) Pablo Abaunza (Spain) Olga Moura (Portugal) Noel Cardigan (Canada, by correspondence)
Chair WG:	Gudmundur Thordarson (Iceland)
Observer:	Jan Ivar Maråk (Norwegian Fishermen's Association)
ICES Secretariat:	Barbara Schoute

General

The Working Group is complimented for in general clearly structured and understandable report, which was presented by a well-informed chair.

Most of the report was prepared according to the new AMAWGC ToC

Group has not yet been able to produce integrated advice.

Drafting the summary sheets took much of the WG time, 2 days may not be enough in future.

The numbering of tables and figures is not consistent through the different stocks. The RG considers more useful to number tables and figures consistent with section number to which tables and figures are referred to.

The RG needs to see Quality Handbooks for all stocks in order to be able to review assessment updates in future. These will need to be provided in the WG report for 2009.

Benchmark assessment proposal

Benchmarks to be performed **before the next assessment**

STOCK	PROBLEM	LAST BENCHMARK
Faroe Saithe	High CV's in survey indices. Different models produce different estimates of stock size. Retrospective patterns very noisy.	2005
Icelandic Saithe	Catchability problems (demersal/pelagic behavior). Retrospective plots noisy. The assessment cannot be used for absolute values.	
Glh		
Had-iceg		

Overview section

Ecosystem and management system are only slightly updated.

Section 13, Greenland: Short comment: The text could be more complete if some of the descriptions and arguments were supported with more references.

Faroe Bank Cod

1) **Assessment type** Update assessment
2) **Assessment**: no analytical assessment, survey information avail able
3) **Forecast**: none
4) **Assessment model**: -
5) **Consistency**: same as last year
6) **Stock status**: Landings and cpue very low in recent years
7) **Man. Plan.**: mgt via effort

General comments

If there is age information from surveys, survey indices at age would be a possible option to further evaluate this stock.

Table with separated landings by fishing gear and by area would be useful, but with the current low landings it may not be achievable by area.

The RG considers still useful the recommendation from previous technical minutes in the sense that an age data based on the otoliths from surveys could be used for catches too.

Technical comments

Minor comments: The heading of figure 3.7.3. should be Summer survey instead of Autumn survey.

Figures 3.7.3 and 3.7.4 would show the information more clearly, if the x-axis have the same scale values (i.e. 20-120 cm).

Conclusions

RG agrees that the basis for advice is a very low stock, same as last year.

Faroe Plateau cod

1) **Assessment type** Update
2) **Assessment**: agreed
3) **Forecast**: agreed
4) **Assessment model**: XSA
5) **Consistency**: similar as last year
6) **Stock status**: historically low SSB, high F.
7) **Man. Plan.**: effort

General comments

Survey and CPUE match and indicate that stock is in a poor condition. Recruitment has been overestimated in the past.

The effects of environmental factors (e.g. primary production) on growth and recruitment were discussed by the WG but not implemented so far into prediction of recruitment

Technical comments

Minor comments: No Table 4.2.16 (section 4.8).

Conclusions

RG accepts the assessment and forecast by the WG.

Faroe haddock

1) **Assessment type** Update
2) **Assessment**: agreed
3) **Forecast**: agreed
4) **Assessment model**: XSA
5) **Consistency**: inline with last year assessment
6) **Stock status**: SSB > Bpa, F slightly above Fpa, recruitment has been low in recent years
7) **Man. Plan.**: effort

General comments

RG notes that the mean weight at age has decreased recently.

Last year, the WG recommended a Study Group on the evaluation of the management system (which the RG endorsed), this work is in progress on a local basis.

Technical comments

The estimate of stock size is consistent between the two tuning fleets. XSA assessment is confirmed by B-Adapt runs.

Standard assumption for prediction has been taken. Fbar = 0.3, average on the basis of some retrospective underestimation in F's in recent years.

Table 5.13: The difference between the 2009 (2 milion) and 2010 (12 milion) numbers at age 2 was discussed. This does not have a large impact on the forecast but the RG notes that a more pessimistic view on recruitment would be more logical, considering the latest years of ongoing low recruitment.

Conclusions

The group is asked to check the sensitivity of the forecast to the recruitment assumption in future.

The RG accepts assessment and forecast

Faroe Saithe

1) **Assessment type** update
2) **Assessment**: not accepted
3) **Forecast**: not accepted
4) **Assessment model**: XSA
5) **Consistency**: last 2 years assessment/forecast were rejected due to retrospective pattern (probably connected due to decreasing we@age)
6) **Stock status**: B < Bpa, F > Flim, R very low in recent years
7) **Man. Plan.**: effort

General comments

General problem is variability in pelagic/demersal occurrence of saithe, hence the problems in reliability of survey indices (high CV). The commercial CPUE indices were used for tuning. However, declining weight at age led to declining catchabilities not accounted for in the XSA. This is seen in residuals patterns, showing year effects.

Different models combined with survey and commercial tuning fleets (Xcam model, TSA, iterative cohort model, ADAPT and XSA) produce very different estimates of stock size and F. Retrospective patterns are very noisy.

Technical comments

The catchability plot does seem to have a clear shift between the end '90s and from 2002 onwards. Using an average will assume a higher catchability and thus higher SSB.

Conclusions

RG discussed the possibility to accept the assessment for trends only. The WG did accept the assessment in the understanding that it is still underestimating SSB/overestimating F, so estimates are precautionary. The RG agrees that trends seem more or less acceptable; the stock is in a positive state, even taking into account the pessimistic assumptions.

Same as last year, the RG does not accept the assessment. No improvements in assessment from the last years were found.

WG proposes a Benchmark for this stock (2005 was last one). RG supports this and advises this benchmark to take into account the 2007 RG proposals and 2008 methods WG.

Icelandic Saithe

1) **Assessment type** Exploratory assessment
2) **Assessment**: indicative of trends only
3) **Forecast**:
4) **Assessment model**: ADCAM
5) **Consistency**: not assessed last year due to absence of stock co-ordinator, assessment model changed from separa ble model to ADCAM
6) **Stock status**: B >Bpa, F > Fpa,
7) **Man. Plan.**: TAC based mgt

General comments

The selectivity/catchability issue for this stock is similar to Faroe saithe (both pelagic and demersal stock distribution, changes in weight at age). Survey data show large CV. Could a statistical model of survey data taking into account saithe behavior be developed ? .If not, may be survey design could be changed ?

The stock shows decrease in catch and survey weight at age. .

Retrospective plots are very noisy, but similar in trends. The uncertainty in the survey is an additional factor worrying the RG.

WG concludes that the current reference points are not applicable within the new assessment model.

Technical comments

The RG would have liked to see a detailed description of ADCAM. This could be dug out from a WG report a few years ago.

Conclusions

Figure 8.4.5: RG concludes that all models show similar trends in stock/fishery dynamic, but the assessment cannot be used for absolute values. The assessment is indicative for trends only because of the uncertainty in the survey and noisy retrospective trends.

Benchmark candidate: in case of a change in model, the reference points need consideration too.

Icelandic cod

1) **Assessment type** update
2) **Assessment**: agreed
3) **Forecast**: agreed
4) **Assessment model**: ADCAM-SMH
5) **Consistency**: assessment similar to last year
6) **Stock status**: no ref points, biomass is stable at low level, after some decline F is stable in most recent years
7) **Man. Plan.**: HCR, but often adapted, the current plan has not been not evaluated by ICES

General comments

TAC was set lower than the ICES advice last year. Catch and stock weight at age show same decrease in recent years, causing some uncertainty in the prediction.

Technical comments

S/R used in medium-term projections is a Ricker curve, the RG would like to see this picture in the report.

A constant HCR (20% of SSB) seems not to deliver increased catches on the long run. The size of the fish should increase however, ensuring higher values of catches in the long run.

Table 9.4.7a. Very high (unrealistic) B-Adapt estimates of F at some ages were noticed.

Conclusions

RG agrees with the conclusions of the WG.

Icelandic haddock

1) **Assessment type** Update
2) **Assessment**: accepted
3) **Forecast**: accepted
4) **Assessment model**: Adapt using two surveys
5) **Consistency**: consistent with last year
6) **Stock status**: SSB is rather high, F is slightly below long-term average.
7) **Man. Plan.**: none

General comments

The RG appreciated the modeling of annual growth, which changes affect the selection pattern. This has resulted in new selection curves which were used in prediction.

RG addresses the point that it would be interesting to look at the growth effect on a cohort basis, alternatively to the year-effect. This is because growth delay in earlier years is generally still apparent for the whole life-span of the fish.

Discards are not included in the assessment. They are assumed to have been reduced in latest years. A reduction in growth rate may increase discards even though surveys/sampling do not seem to show this. The RG has concerns about the effect of discards on assessment and prediction.

Technical comments

Table 10.6.2: it is important to be clear about the basis for inputs to the prediction, the RG misses the explanation of the shaded areas in this table.

Conclusions

Assessment and prediction are accepted

Greenland cod

1) **Assessment type** update
2) **Assessment**: not presented
3) **Forecast**: not presented
4) **Assessment model**:
5) **Consistency**:
6) **Stock status**: for years very small biomass, some increase in recent years (basing on survey indices), Year-classes in 2003 at about 25% of large 1984 y-c.
7) **Man. Plan.**: none, badly needed for both inshore and offshore fisheries.

General comments

Stock comprises 2 or 3 components with migration issues.

Technical comments

Survey changes seem to be difficult to compare, which makes it difficult to judge the time-line.

Icelandic summer spawning herring

1) **Assessment type** update
2) **Assessment**: accepted
3) **Forecast**: accepted
4) **Assessment model**: ADAPT (outcome intermediate between TSA and XSA)
5) **Consistency**: last year assessment not accepted
6) **Stock status**: B>Bpa, F>Fpa
7) **Man. Plan.**: The practice was to fish at F 0.22, no formal MP was adopted

General comments

The assessment has not been accepted in the last years due to poor retrospective patterns.

For cw@age strange pattern was noticed: fish seem to 'loose weight' between years (2006-2007). A WD explanation for this was accepted by WG.

"The RG agrees with the WG that in later years, the acoustic survey has improved its abundance estimates but there are still important uncertainties to be resolved. The survey could not cover the stock appropriately during the night and the coverage off the east and south coast was poor. The main concern of the WG regarding herring surveys is the lack of juvenile surveys in nursery areas. The last designed juveniles' survey took place in 2003. The RG agrees that a recruitment survey as recommended by the WG would increase the power of the assessment.

Technical comments

Retrospective patterns for ADAPT seems to have improved and is more consistent for the last years.

Conclusions

RG tends to accept the assessment based on better retrospective pattern, high survey coverage, similarity between the assessment model results of a few assessment models presented.

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Greenland Halibut

8) **Assessment type** Exploratory

9) **Assessment**: accepted assessment

10) **Forecast**: accepted

11) **Assessment model**: Bayesian framework

12) **Consistency**: same attempt last year was not accepted

13) **Stock status**: old BRP not relevant, biomass is low, F ca. 2*Fmsy,

14) **Man. Plan.**: none

General comments

Bayesian approach implementation is well documented, Schafer model was used, results presented relative to MSY parameters,

Last year Schaefer model approach was not accepted because the results were not convincing and there was no long time series returning to 'virgin biomass' included. This has been resolved this year.

RG would like to see a description of the differences between this new approach and the old (ASPIC) approach.

RG agrees with the Bayesian approach, including the earlier year time series as the RG proposed last year.

RG supports approach for BRP estimates (Blim & Flim) performed by WG.

Technical comments

Report needs to start with an overview of the stock characteristics.

Executive summary: sentence on “inherent uncertainty” needs re-wording. (Risk to Blim bullet) The RG thinks that an explanation for high risk is low SSB and uncertainty in the model.

Figure 15.15, 15.27 and 15.28 need better headings and/or axis description

Conclusions

The Bayesian assessment methodology has been published and has been performed by experts. However, the RG has not enough expertise in this method to validate it. The RG does accept this assessment on the basis of the good fit to survey and CPUE data and consistent retrospective pattern.

The projections need further explanation: what is the meaning of the risk % in forecasts (is this the risk of falling below Bmsy once in the period or separate for each year ?)

For next year, Bayesian expertise is needed in the RG to validate this assessment further.

Golden redfish (*Sebastes marinus*) in Subareas V, VI and XIV

1) **Assessment type** update from work last year
2) **Assessment**: supplementary to basis of advice
3) **Forecast**: not conducted
4) **Assessment model**: GADGET (BORMICON last year)
5) **Consistency**: similar to last year, autumn survey indices are the basis for the advice
6) **Stock status**: now survey indices 13% below Upa, recruitment low compared to 1985 and 1990
7) **Man. Plan.**: none

General comments

The analytical assessment has been taken as supplementary by ACFM last year, the WG used it as basis for an advice this year

Biomass index for 2007 is very high due to survey estimates from non-redfish surveys encountering patchy distributed fish. This index is not used in the tuning.

Survey residuals are rather high.

Technical comments

Figure: 17.4.5: some intermediate length group indices show poor correlation, this should be analysed, especially in light of relatively good consistency at lower and higher lengths.

Retrospective plots (Fig. 17.4.8) are hard to read with projections included and on a scale that does not start on 0. There seems to be a tendency to overestimate stock size.

Figure 17.4.9: mean weight or recruitment ? legend ?

Conclusions

The Bormicon/Gadget model has been used for several years as a supplement in assessing *S.marinus*. As on previous occasions the RG welcomes this and expects that such tools will play a bigger role in analytic assessments in the near future. The RG considers the results from the Gadget model on *S.marinus* plausible, however the report raises various points concerning the setup of the Gadget model but does not fully address them. The points include the different alternative runs, disaggregating of length indices, difference between Gadget and Bormicon and the sensitivity of the model results to how the likelihood function is set up. The RG recommends the WG to work on the above mentioned points and from that work it should be possible to formalize the procedure used when assessing *S.marinus* using Gadget.

The RG does not accept the assessment.

The RG stresses the need to explore the applicability of this advice for area XIV.

Redfish (Demersal *S mentella*) in Subareas V and XIV

1) **Assessment type** survey indices
2) **Assessment**: no analytical assessment
3) **Forecast**: not conducted
4) **Assessment model**:
5) **Consistency**:
6) **Stock status**: CPUE not indicative of trends, but catches and sur vey indices have gone down or have been stable at low level, decline in smaller fish.
7) **Man. Plan.**:

General comments

Stock structure: ICES maintained the current advisory *units* until more information becomes available (ACFM 2004). The 'red line' is used as a border for stock identification, not the fisheries type.

Conclusions

No conclusion on stock status can be drawn.

Redfish (Pelagic *Sebastes mentella*) in Irminger Sea and adjacent areas

1) **Assessment type** survey indices
2) **Assessment**: no analytical assessment
3) **Forecast**: not conducted
4) **Assessment model**: none
5) **Consistency**:
6) **Stock status**: acoustic estimates are lower than 1990's.
7) **Man. Plan.**: none

General comments

Little information on this stock, and many disagreements regarding stock structure and splitting of catches. Illegal and unreported catches make catch statistics unreliable.

A paragraph on the biology of these stocks is useful for the RG.

Technical comments

RG asks the WG to better explain the disregarding of CPUE levels.