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27 April - 4 May 2010

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International Council for the Exploration of the Sea

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Executive summary

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

Faroe Bank cod

Total reported landings in 2009 were 80 tonnes or the lowest observed since 1965. The summer and spring index indicate that the stock is well below its average biomass level and there is no indication of strong incoming year classes. The exploitation ratio has decreased sharply since 2006. In 2009 it is estimated to be at levels comparable to those in the 1990's for both the survey indices.

Faroe Plateau cod

The input data consisted of the catch-at-age matrix (ages 2-10+ years) for the period 1961-2009 and two age-disaggregated abundance indices obtained from the two Faroese groundfish surveys: the spring survey 1994-2010 (shifted back to the previous year) and the summer survey 1996-2009. The maturity ogives were obtained from the spring survey 1983-2010.

The assessment settings were the same as in the 2009 assessment. An XSA was run and tuned with the two survey indices. The fishing mortality in 2009 (average of ages 3-7 years) was estimated at 0.46, which was higher than the precautionary fishing mortality of 0.35 but lower than the limit fishing mortality (when 'bad things' may happen) of 0.68. The total stock size (age 2+) in the beginning of 2009 was estimated at 37 000 tonnes and the spawning stock biomass at 22 000 tonnes, which was slightly above the limit biomass (which should be avoided) of 21 000 tonnes.

The short term prediction until year 2012 showed an increasing trend with a stock size in 2012 of around 82 000 tonnes and a spawning stock biomass of around 55 000 tonnes.

The recruitment seems to be positively correlated with the total stock size of cod. It is, therefore, adviced to reduce the fishing mortality so that the stock increases. 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

Faroe haddock

Being an update assessment, the changes compared to last year are additions of new data from 2009, some minor revisions of the landings data for 2008 with corresponding revisions of the catch@age data and revisions of the survey data 2007-2009 due to errors in some formulas used in the calculation of the stratified indices at age. The main assessment tool is XSA tuned with 2 research vessel bottom trawl surveys. The results are in line with those from 2009, showing a declining SSB mainly due to poor recruitment. SSB is now estimated just above Blim and is predicted to decline below Blim in 2010-2011 with *status quo* fishing mortality. Fishing mortality in 2009 is estimated at 0.26 (Fpa = 0.25) and landings in 2009 were only 5 200 t. In recent years there has been a tendency to overestimate SSB and underestimate F.

Faroe saithe

The most recent benchmark assessment was completed in 2010.

The 2010 benchmark workshop explored the XSA model as well as ADAPT, TSA, separable statistical age-based and length-based models in association with updated catch-at-age data. The commercial CPUE series was also updated, standardized and the CPUE indices were multiplied by an area expansion factor to better represent a measure of total stock abundance. These data updates were found to significantly reduce the retrospective pattern previously observed in the assessment. The SSB, F and recruitment estimates generated by both models were comparable and the XSA assessment was adopted as the benchmark assessment because it had been the model historically used for this stock.

The fishing mortality in 2009 (average of ages 4-8 years) was estimated at F=0.47 and has remained quite stable around the average since 2006. The total stock size (age 3+) in the beginning of 2009 was estimated at 257 000 tonnes and the spawning stock biomass at 95 000 tonnes, which is around the long term average since 1961. SSB of saithe has been reduced by about 34% in 2009 with respect to 2006. For Faroe saithe, the highest recruitment has been observed at lower levels of SSB.

Demersal stocks in Icelandic waters (Divison Va)

Icelandic saithe

The model used for assessing saithe in Va is a separable statistical catch-age model implemented in ADMB as selected at the last benchmark meeting in 2010 (WKROUND, ICES-2010). Selectivity is estimated to be constant with age over time through the time period 1980-1995 but is then allowed to change to a different selection curve by age for the remaining time period 1996-2009.

A clear decline in Icelandic saithe stock biomass is evident since 2005 along with an associated rise in fishing mortality since about 2001 according to the assessment. Year classes 1998-2000 and 2002 are large but the year classes after 2003 are considerably smaller, fluctuating around the long term geometric mean. The stock size (B4+ and SSB) is below the long term average.

In the benchmark assessment Markov chain Monte Carlo algorithm for projections were used for estimating biological reference points and for MSY consideration. Resulting in Fmsy estimates of 0.28, Btrigger/Bpa at 80 kt and Bloss of 65 kt as candidate for Blim. The NWWG recommends that advice for 2011 is based on the estimated Fmsy corresponding landings of 40 kt.

Icelandic cod

The total reported landings in 2009 were 183 kt. Total landings in the last 5 fishing year have been relatively close to the set TAC for the Icelandic fleet. In the last fishing (2008/2009) the TAC was set to 160 kt and the landings were 168 kt.

Several assessment models were applied as in recent years. The results from the AD-Model builder statistical Catch at Age Model (ADCAM) as was used as the final run, as done in the previous years. This year both the spring and the fall survey were used in the tuning, compared with last year when only the spring survey was used in the final run.

The spawning stock has been relatively small in the last 40 years compared with the time before that. It reached a historical low in 1993 (120 kt) but has since then increased and is estimated to be around 300 kt in 2010. Fishing mortality has declined significantly in recent years, the present estimate of about 0.4 not seen since the early 1960's. First measurement of the 2008 and 2009 year classes indicate that they may at or above medium size.

Icelandic haddock

This years assessment gives similar indication of development of the stock as last years assessment. The year classes entering the fishable stock are much smaller than those disappearing and therefore the stock is decreasing rapidly. The 2008 and 2009 cohorts are estimated very small. Catch (or landings) in numbers in age were recalculated to include ages 10-12. The reason is that the large cohort from 2003 is reaching the maximum age in the catch at age data (age 9) but VPA models have to be based on assumptions about the oldest age group.

Same (similar) assessment procedure as last year (SPALY) was used to assess the state of the stock that is a Adapt type model tuned with both the surveys. The main problem in the assessment in recent years has been the slow growth observed. Size selection therefore results in year classes recruiting late to the fishery. There are no indications of improved growth in spite of smaller year classes.

According to prognosis there is a risk of the spawning stock going below Bloss in 2015. However lowering fishing mortality to 0.3 or lower will reduce the risk to less than 5%.

Icelandic summer spawning herring

The total reported landings in 2009/10 were 46 kt, the recommended TAC was 40 kt but additionally 7 kt were allocated to a research quota. TAC was 47 kt. Around 44 kt of the catch in 2009/10 was taken in a relatively small area in Breiðafjörður, in W Iceland, similar to the two preceding fishing seasons. The total estimate of the adult stock (age 4+) in the herring acoustic surveys in October 2009 was 610 kt, or 50 kt higher than in the January 2009 survey.

Higher prevalence of *Ichthyophonus* infection was observed in the fishable stock now than in last year or on average 43% compared to 32% in last year. Thus, 43% of the fishable stock is considered to die in the winter/spring 2010 because of the infections, which corresponds to $M_{infection}$=0.56 with respect to the results of the acoustic measurements 2009/10. Contrary to last year, the prevalence of infection in 2009/10 was age and length dependent, where younger and smaller herring had higher infection rate. This must be accounted for in the current and future assessment.

The resurrected herring juvenile survey indicates that the 2008 year class (age 1 in 2009) is not seriously infected by *Ichthyophonus* and the cohort could be above average size. Corresponding survey in 2008 indicated that the 2007 year class could be around average size, but since then *Ichthyophonus* infection has infected the cohort by an uncertain level.

This is an update assessment and no revisions of last year's data, only the 2009 data have been added to the input data. The final analytical assessment model, NFT-Adapt, indicate that the biomass of age 3+ is 507 kt and SSB is 430 kt in the beginning of year 2010. Accounting for the observed *Ichthyophonus* infection (on average 43%) in that period gives estimates of surviving biomass, or 294 kt of age 3+ and SSB of 246 kt in the beginning of fishing season 2010/11.

There is a great uncertainty in the assessment and the development of the *Ichthyophonus* infection in the stock. Under those circumstances it was neither considered appropriate nor beneficial by the working group to provide stock prognosis.

The WG recommends that a limited preliminary TAC of around 10 kt will be given for the fishing season 2010/2011 that can sustain a necessary sampling from purse seiners to get estimates of the *Ichthyophonus* infection and get information of the stock composition.

Due to the high uncertainty regarding the development of the *Ichthyophonus* infection in the summer 2010, the WG consider it necessary to postpone a recommendation of a total TAC until the results of a planned survey early next autumn and more information about the infection rates become available.

MSY based reference points have not been established for this stock. Because of uncertainty in this year's assessment due to the *Ichthyophonus* infection and because there is a plan to take the stock to a benchmark assessment in 2011, the WG decided that the benchmark meeting would be the most appropriate place to deal with it.

Capelin in the Iceland-East Greenland- Jan Mayen area

In 2009 no inital quota was issued for the fishing season in 2010. Acoustic biomass estimates of a SSB of 550 000 t prior to the spawning and as a result a quota of 150 000 t was allocated in February. The stock has been at low levels during the last 5 years. Low abundance of 1 year old capelin was measured in November- December 2009 acoustic surveys. The advice is therefore not to open the fishery in the season 2010/11 until acoustic assessment surveys have verified that a catch can be allowed with the usual prerequisite of a remaining SSB of 400 000 t in March 2011 after accounting for natural mortality.

The Icelandic capelin stock was on the agenda in the Benchmark Workshop WKSHORT 31 August – 4 September 2009. The WKSHORT meeting was unable to approve the assessment of the Icelandic capelin stock. This was mainly because there are reasons to believe that the value of M (natural mortality) used in the assessment and in the predictions (value of 0.035) is too low. The workshop recommended further work. That work is ongoing. In the absence of an accepted assessment methodology the WG decided to use the old assessment method to assess the state of the stock

Demersal stocks in Greenland waters

Cod stocks in Greenland

The offshore cod component has been severely depleted since 1990. The surveys indicate an improvement in recruitment with all year classes since 2002 (except the 2006 YC) estimated at sizes above the very small year classes seen in the 1990s. These good YC's have resulted in a increase in stock size during the 00s, but the levels are however far below historical levels. The total offshore stock has however declined in 2009 compared to 2008. This was mainly caused by a decrease in the abundance of the 2003 and 2005 YC in West Greenland.

The spawning in East Greenland that was first observed in 2007 by an exploratory fishery was confirmed by an Icelandic survey in 2009. The spawning stock comprised nearly entirely of ages 6 and 7 (2002-2003 yc's). This could imply a spawning migration of the strong 2003 YC from its previous main distribution in West Greenland to the spawning location in East Greenland. Tag-returns data supports such an eastward migration.

In the West Greenland inshore areas (NAFO Div. 1DE) two strong year classes are recognized, the 2005 and 2007 YC. In the southern inshore areas only the YC 2007 is recognized at a relatively weak level. Thus the 2005 YC is mainly observed in inshore areas of NAFO Divs 1D and 1E.

No sustainable offshore cod fishery at Greenland can be based on the infrequent inflow of cod from Iceland waters. Presently no management objectives have been set for this stock. A main management objective should therefore be to establish a robust offshore spawning stock comprised of several year classes that may improve the likelihood of future good recruitment. Such an objective could be a basis for a biomass reference point and thus determine reopening of the fishery in the future. In addition spatial criteria on distribution of spawning grounds could be included in the definition of such a reference point/basis, e.g. requirements of established spawning stocks at both East and West Greenland.

All management effort should therefore be given to secure the rebuilding of the indigenous Greenland off-shore cod stock. This implies that no offshore fishery should take place in 2011.

Greenland halibut

The input data to used for the assessment of Greenland halibut this year is unchanged form last year. From 2007 a logistic production model in a Bayesian framework has been used to assess stock status and for making predictions. The model includes 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 fishing mortality by far exceeds the value that maximizes yield (Fmsy). Stock biomass is estimated at 0.4BMSY, and the projected risk of exceeding this reference point will be relatively high at any catch level. Maintaining catches of 20 kt will result in a further decline of the stock and a high probability of being above FMSY. Setting TAC at 5kt will likely result in an increase in stock biomass (0.7BMSY over a decade) and F is projected to decrease to below 0.5FMSY.

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 in the recent past resulted in catches of about 25 kt compared to the recent advice by ICES of 5 kt. A basis for the advice is therefore an adaptive management plan that is coordinated among the three coastal states.

Redfish in Subareas V, VI, XII and XIV

Redfish are found in the entire North Atlantic and contribute important fishery resources around Iceland, the Faroe Islands, off Greenland and in the Irminger Sea. The "Workshop on Redfish Stock Structure" (WKREDS, 22-23 January 2009, Copenhagen, Denmark; ICES 2009) reviewed the stock structure of *S. mentella* in the Irminger Sea and adjacent waters. ACOM concluded, based on the outcome of the WKREDS meeting, that there are three biological stocks of *S. mentella* in the Irminger Sea and adjacent waters. This conclusion was primarily based on genetic information, i.e. microsatellite information, and supported by analysis of allozymes, fatty acids and other biological information on stock structure, such as some parasite patterns.

The adult redfish on the Greenland shelf has traditionally been attributed to several stocks, and there remains the need to investigate the affinity of adult *S. mentella* in this region. The East-Greenland shelf is most likely a common nursery area for the three biological stocks.

The WG provides advice for the following Sebastes units: The *S. marinus* on the continental shelves of ICES Divisions Va, Vb and Subarea VI and XIV, the demersal *S. mentella* on the Icelandic slope, the shallow and deep pelagic *S. mentella* units in the Irminger Sea and adjacent waters and finally advice for the Greenland shelf *S. mentella*.

*Golden redfish (*S. marinus*)*

Total landings in 2009 were about 40,000 t, about 5,000 t less than in 2008. About 99% 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 Division Va. Catch-at-age data from Va shows that the catch is dominated by two strong year classes from 1985 and 1990. 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. The significance of other age classes is increasing. Survey indices of the fishable stock in Va is in the vicinity of safe biological limits (Upa). The fishable stock situation in Vb remains at low level, but has improved in XIV. Recruitment in Va has been low since 1993 compared to the large 1985- and 1990 year classes, but there is an indication of improving new year classes observed as 8-13 years old fish in the October survey in 2009. There are signs of improved recruitment in XIV as well. 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.

Demersal S. mentella *on the Icelandic slope*

Total landings of demersal S. mentella in Icelandic waters in 2009 were about 18 700 t, about 7 000 t less than in 2008. 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 during the last 7 years. In recent years, good recruitment has been observed on the East-Greenland shelf which is assumed to contribute to the three redfish stocks at unknown shares.

Deep pelagic S. mentella

An international trawl-acoustic survey was conducted during the summer of 2009. Consequently ACOM released advice for deep pelagic *S. mentella* in the autumn of 2009. The only new available data to the WG since last years advice were catch statistics.

Shallow pelagic S. mentella

An international trawl-acoustic survey was conducted during the summer of 2009. Consequently ACOM released advice for shallow pelagic *S. mentella* in the autumn of 2009. The only new available data to the WG since last years advice were catch statistics.

Greenlandic slope S. mentella *in XIVb*

Total landings of demersal *S. mentella* in East Greenland waters in 2009 were about 900 t, which is large increase compared to 2008. In the latest decade *S. mentella* has mainly been a valuable by-catch in the fishery for Greenland halibut. However in 2009 a fishery directed towards demersal red-fish took place. No formal assessment was conducted and there are no biological reference points for the species. Information from logbooks and survey indices are used as basis for advice. Available survey biomass indices show that in Division XIVb the biomass has been high and stable in the last 7 years. Especially the fishable proportion of *S. mentella* has increased in that period and is presently at the highest level in the latest 30 years.

1 Introduction

1.1 Terms or Reference (ToR)

1.1.1 Specific ToR

2009/2/ACOM07 The **North-Western Working Group** [NWWG] (Chaired by: Guðmundur Þórðarson, Iceland) will meet at ICES Headquarters, 27 April – 4 May 2010 to:

a) address generic ToRs for Fish Stock Assessment Working Groups (see table below).

b) for Capelin in Subareas V, XIV and Division IIa west of 5°W, Beaked Redfish (*Sebastes mentella*) in Subareas V, XII, XIV and NAFO Subareas 1+2 (Shallow Pelagic stock < 500 m deep) and Beaked Redfish (*Sebastes mentella*) in Subareas V, XII, XIV and NAFO Subareas 1+2 (Deep Pelagic stock > 500 m deep) oversee the process of providing inter-sessional assessment.

The assessments will be carried out on the basis of the stock annex in National Laboratories, prior to the meeting. This will be coordinated as indicated in the table below.

Material and data relevant for the meeting must be available to the group no later than 14 days prior to the starting date.

NWWG will report by 11 May 2010 for the attention of ACOM.

Fish Stock	Stock Name	Stock Coord.	Assess. Coord. 1	Assess. Coord. 2	Advice
cod-farp	Cod in Subdivision Vb2 (Faroe Bank)	Far	Far	Far	Update
cod-farb	Cod in Subdivision Vb2 (Faroe Bank)	Far	Far	Far	Same
had-faro	Haddock in Division Vb	Far	Far	Far	Update
sai-faro	Saithe in Division Vb	Far	Far	Far	Update
cod-iceg	Cod in Division Va (Icelandic cod)	Ice	Ice	Ice	Update
had-iceg	Haddock in Division Va (Icelandic haddock)	Ice	Ice	Ice	Update
sai-icel	Saithe in Division Va (Icelandic saithe)	Ice	Ice	Ice	Update
her-vasu	Herring in Division Va (Icelandic summer-spawners)	Ice	Ice	Ice	Update
cap-icel	Capelin in Subareas V, XIV and Division IIa	Ice	Ice	Ice	Update
ghl-grn	Greenland halibut in Subareas V, VI, XII and XIV	Gre	Gre	Ice	Update
smr-5614	Redfish (*Sebastes marinus*) in Subareas V, VI, XII and XIV	Ice	Ice	Far	Update
smn-con	Redfish (*Sebastes mentella*) on the continental shelf	Ice	Ice	Ger	Update
smn-sp	Beaked Redfish (*S. mentella*) (Shallow Pelagic)	Ger	Ice	Spa	Update
smn-dp	Beaked Redfish (*S. mentella*) (Deep Pelagic)	Ger	Ice	Spa	Update
smn-gre	Beaked Redfish (S. mentella) Greenlandic Slope	Gre	Gre	Ice	Update
cod-ewgr	Cod in ICES Subarea XIV and NAFO Subarea 1	Gre	Ger	Ger	Update

1.1.2 Generic ToRs for Regional and Species Working Groups

The working group should focus on:

ToRs a) to g) for stocks that will have advice,

ToRs b) to f) for stocks with same advice as last year.

ToRs b) to c) and f) for stocks with no advice.

a) Produce a first draft of the advice on the fish stocks and fisheries under considerations and the regional overview according to ACOM guidelines.

b) Update, quality check and report relevant data for the working group:

   i) Load fisheries data on effort and catches (landings, discards, bycatch, including estimates of misreporting when appropriate) in the INTERCATCH database by fisheries/fleets. Data should be provided to the data coordinators at deadlines specified in the ToRs of the individual groups. Data submitted after the deadlines can be incorporated in the assessments at the discretion of the Expert Group chair;

   ii) Abundance survey results;

   iii) Environmental drivers.

   iv) Propose specific actions to be taken to improve the quality of the data (including improvements in data collection).

c) Produce an overview of the sampling activities on a national basis based on the INTERCATCH database);

d) In cooperation with the Secretariat, update the description of major regulatory changes (technical measures, TACs, effort control and management plans) and comment on the potential effects of such changes including the effects of newly agreed management and recovery plans.

e) For each stock update the assessment by applying the agreed assessment method (analytical, forecast or trends indicators) as described in the stock annex. If no stock annex is available this should be prepared prior to the meeting.

f) Produce a brief report of the work carried out by the Working Group. This report should summarise for the stocks and fisheries where the item is relevant:

   i) Input data (including information from the fishing industry and NGO that is pertinent to the assessments and projections);

   ii) Where misreporting of catches is significant, provide qualitative and where possible quantitative information and describe the methods used to obtain the information;

   iii) Stock status and 2011 catch options;

   iv) Historical performance of the assessment and brief description of quality issues with the assessment;

   v) Mixed fisheries overview and considerations;

   vi) Species interaction effects and ecosystem drivers;

   vii) Ecosystem effects of fisheries;

   viii) Effects of regulatory changes on the assessment or projections;

g) Where appropriate, check for the need to reopen the advice in autumn based on the new survey information and the guidelines in AGCREFA

h) Set MSY reference points (F_{MSY} and MSY $B_{trigger}$) according to the ICES MSY framework and following the guidelines developed by WKFRAME.

1.2 NWWG 2010 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.

As follows in section 1.4, no data was uploaded to the ICES InterCatch database.

Updates of stock annexes were only done for some of the stocks assessed by NWWG. Since last year only two new annexes have been added. That is for cod and saithe in Va. As has been pointed out by the ICES-secretariat, the updating of the annexes is most efficiently an inter-session task but this task was not fulfilled by stock/assessment coordinators. It is however the perception of the WG that fulfilling this task is a continuous process.

Due to the number of tasks that is put on WGs (Generic ToTs and bookkeeping) together with the reduced number of days allocated for the meeting the NWWG had to prioritise the tasks at the meeting. The main focus was on the adoption of assessments that were the basis for stock status and the premise for the forecasts. This was done to ensure that the basis for the advice was agreed upon. Individual report sections were reviewed either in plenary or in sub-groups. However some sections were not sufficiently reviewed at the meeting due to time constraints. The summary sheets were reviewed in plenary at the last day and should have been allocated more time, especially in light of the changes in the format of the sheets.

The system of update and benchmark assessments which has been adopted by ICES does not appear to be flexible enough to deal with sudden changes that may occur with the arrival of new data. Members of the WG discussed, as last year, the option of changing assessment method/settings to deal with such things. Two examples can be mentioned: Parasite infections of Icelandic herring which result in previous assumptions on natural mortality are no longer valid. Second example is the Icelandic cod, where the WG decided to take in another survey series and to estimate a migration from Greenland to Iceland in the final assessment.

An obvious flaw in the benchmark/update system came into light for the Capelin stock assessed by the WG. The stock was subjected to a benchmark (WKSHORT-2009) and the benchmark meeting rejected the current assessment procedure but did not come up with a new procedure. The WG decided to use the old assessment procedure

1.2.1 NWWG response to ToR h)

The generic ToR h) says:

Set MSY reference points (F_{MSY} and MSY $B_{trigger}$) according to the ICES MSY framework and following the guidelines developed by WKFRAME.

In general terms, ICES is aiming at changing the basis for its advice from F_{pa} - B_{pa} to F_{MSY}, combined with a trigger spawning biomass ($B_{trigger}$). The significance of $B_{trigger}$ is that, if a stock is assessed to be below this level, the F for the advice is reduced linearly with SSB.

WKFRAME has given guidelines for calculating F_{MSY} and MSY $B_{trigger}$. Also, NWWG has been requested by the ICES secretariat to provide catch options according to FMSY/ MSY $B_{trigger}$ as well as catch options in accordance with the MSY framework. However the complete set of guidelines from WKFRAME was not available until just before the start of the meeting, giving little time for consideration of MSY issues.

NWWG has made some progress on defining MSY based reference points for some of the stocks assessed by the group. The stocks can be divided into three groups

1. Stocks which have been fully evaluated in regards to MSY.

Due to the fact that the harvest control rule for cod in Va was evaluated by ICES in 2009 and found to be consistent with the MSY-approach therefore no further work should be needed on behalf of ICES.

The saithe in Va was the subject of a benchmark meeting in early 2010 (WKROUND-2010). Similar analysis was conducted on that stock as for cod in Va. A candidate harvest rule that is in conformity with the MSY concept has been identified and could hence be recommended to be implemented by managers.

2. Stocks where preliminary evaluations have been conducting regarding the MSY-approach

Some progress has been made on the MSY approach for haddock in Va following similar approach as was done on cod and saithe in Va. However further evaluations which take into account some of the characteristics of that stock were not done due to time constrains. Despite that the proposal made by the WG with regards to an advice next year that conforms to the MSY framework is considered more appropriate that basing it on arbitrary approaches such as $F_{0.1}$ or F_{max}.

Greenland halibut is assessed with a stock production model where MSY reference points are automatically estimated however due to time constraints no candidates for $B_{trigger}$ were proposed. It should however be stated that the present stock biomass is well be low any $B_{trigger}$ candidates

Preliminary work was done in regards of MSY reference points using a deterministic approach and mostly ignoring the stochastic elements which such evaluations should include. These stocks are cod in Vb, haddock in Vb, saithe in Vb.

3. No work done to evaluate candidates for MSY-based reference points.

No work was done regarding the MSY-framework for the redfish stocks assessed by NWWG. These stocks are proposed as candidates for benchmark in 2012 along with the stocks assessed by AFWG.

Icelandic summer spawning herring is set for a benchmark in 2011 and due to the great uncertainties in the assessment (*Icthyophonus* infection, retrospective patterns and discrepancy between analytical assessment and acoustic surveys) it was neither considered appropriate or beneficial to come up with candidates for MSY based reference points.

As for Capelin in the Iceland-East Greenland-Jan Mayen area the stock is managed by a constant escape strategy (leaving 400kt to spawn each year) which is in accordance to ICES view on the MSY approach to short lived species. However the stock was benchmarked in 2009 and the benchmark meeting rejected the old assessment procedure but did not propose a new one. So at present there is no accepted assessment procedure for Capelin in the Iceland-East Greenland-Jan Mayen area.

No work was done on the MSY framework for Faroe Bank cod due to time constrains.

During discussions in the group it was noted that simulations show that identifying a single F_{MSY} value is almost an impossible task. Effectively one can only identify a range of fishing mortalities that all would conform to the MSY concept. Hence, the NWWG considers that the only appropriate method to evaluate the MSY principle is by evaluating catch rules in a stochastic simulation framework that takes into account both natural and assessment noise (as has been done e.g. for the Icelandic cod and saithe and to some extent the Icelandic haddock). The resulting fishing mortalities that lead to optimum yield obtained within such a framework are not analogous to the F_{MSY} proxies obtained from applying the short-cut methods suggested e.g. in WKFRAME. The $B_{trigger}$ is effectively a management reference point. And in that sense it is also linked to the actual F_{target} set when the stock is above $B_{trigger}$. Higher F_{target} would automatically call for a higher $B_{trigger}$. Definition of $B_{trigger}$ can thus not be made independently from identification of candidate HCR that conform to the MSY concept. The simulation framework however provides a natural environment for defining appropriate $B_{trigger}$.

The WG notes that the implementation of the MSY framework is hasty and WGs are requested to come up with new set of reference points 'in a jiffy'. This is much in contrary to previous precautionary reference points which was very difficult to change in light of new information.

In the recommendations (1.5.1) a proposal on how to evaluate the NWWG stocks according to the MSY-framework is presented. This would result in a defined set of MSY reference points before 2011.

1.3 Assessment methods applied to NWWG stocks

The methods applied to assess the stock status of the NWWG stocks covers a wide range from descriptive to age based analytical assessments as follows:

Stock	*ASSESSMENT model*	*input**
Faroe Bank cod	*Descriptive*	*survey*
Faroe Haddock	*XSA*	*survey*
Faroe Saithe	*XSA*	*CPUE*
Faroe Plateau cod	*XSA*	*survey*
Iceland Saithe	*ADCAM (statistical catch at age)*	*survey*
Iceland cod	*ADCAM (statistical catch at age)*	*survey*
Iceland haddock	*Adapt type model*	*survey*
Iceland herring	*NFT-Adapt*	*survey*
Capelin	*Acoustics (absolute biomass)*	*survey*
Greenland cod	*Descriptive*	*survey*
Greenland halibut	*Stock production model (Bayesian)*	*survey+ CPUE*
S. marinus	*GADGET (age-length based cohort model)*	*survey*
S. mentella Iceland slope	*Descriptive*	*survey*
Deep pelagic S. mentella	*Descriptive*	*survey+CPUE*
Shallow pelagic S. mentella	*Descriptive*	*survey+CPUE*
S. mentella Greenland Slope	*Descriptive*	*survey*

* landings or landings by age are input to all assessments

1.4 InterCatch

Henrik Kjems-Nielsen from the ICES secretariat gave a presentation of the status of InterCatch (IC). Presently, the age-based assessments in the WG do not use IC. This is mainly due to the fact that most stocks in the WG, where advice is based on age-based analytical assessments, are national stocks where data are compiled at the national lab, i.e. only national fleets and surveys contribute to the assessment input. Therefore it is the feeling of many of the WG members that InterCatch is an additional layer of bureaucracy.

1.5 Recommendations

1.5.1 MSY workshop

The NWWG recommends that a separate workshop be set in place outside the annual assessment cycle. In this workshop the stocks that are assessed analytically in the NWWG will be evaluated. It might be appropriate to the workshop split into two parts, the first meeting would deal with the science/methods (October 2010), followed by a second meeting were the evaluation will be presented and reviewed by the group (January 2011). It is then anticipated that resulting report would then be reviewed through the conventional ICES channel.

1.5.2 Biennial advice on redfish

The group discussed the possibility of giving biennial advice on the redfish stocks assessed by the group:

- *S. marinus* on the continental shelves of ICES Divisions Va, Vb and Subarea VI and XIV,.
- Demersal *S. mentella* on the Icelandic slope,
- Shallow and deep pelagic *S. mentella* units in the Irminger Sea and adjacent waters
- Greenland shelf *S. mentella*.

The rationalle for giving biennial advice on the stocks listed above are:

- Redfish is a long-lived deepwater species and therefore sudden changes in the state of the stock are unlikely. This is the same argument used for giving biennial advice on the stocks covered by the Working Group on the Biology and Assessment of Deep Sea Fisheries Resources (WGDEEP)
- The *S. mentella* pelagic is assessed based on survey trends and the survey is conducted every two years. The only data available in intermediate years is catch data.

The WG decided to recommend that in the future ICES should give biennial advice on the redfish stocks assessed by NWWG.

1.5.3 Benchmark for redfish

The group suggests that the redfish stocks assessed by NWWG will be subject to a special redfish benchmark meeting in 2012 which would also include the redfish stocks assessed by AFWG. The table below presents the justification for benchmarking the stocks.

Candidate stocks	Supporting justification and comment(s)
Sebastes marinus in ICES Divisions Va, Vb, VI and XIV	Since 1999, experimental analytical assessments have been conducted on this stock using GADGET. It is time to review this approach and to decide on the most appropriate analytical assessment to use in future. The RGAFNW concluded last year that a benchmark assessment is urgently needed for this stock (expected in 2012).
Beaked Redfish (*Sebastes mentella*) in Division Va and Subarea XIV (Icelandic Slope stock)	ICES concluded in February 2009 that demersal *S. mentella* is to be divided to three biological stocks and that the *S. mentella* on the Icelandic continental shelf and slope should be treated as a separate biological stock and management unit. Beaked redfish on the Icelandic slope has been harvested since 1950s. The advice for this stock has been based on demersal survey since 2000 and before that on trends in cpue and landings. No analytical assessments have been attempted on this stock. The stock is considered stable at low level. The rebuilding of the stock, management plans and harvesting strategies will suffer from lacking an analytical assessment.
Beaked Redfish (*Sebastes mentella*) in Subareas V, XII, XIV and NAFO Subareas 1+2 (Deep Pelagic stock > 500 m)	In 2009, ICES concluded that the deep pelagic beaked redfish was a separate stock unit and should be managed as such. Stock perception is based on biennial survey since 1999 and no analytical assessment has been attempted. The stock is considered to have decreased. Management plans and harvesting strategies will suffer from lacking an analytical assessment. Benchmark assessment is therefore important and would benefit if it were in conjunction with the benchmark of *S. menella* in Subareas I and II.
Beaked Redfish (*Sebastes mentella*) in Subareas V, XII, XIV and NAFO Subareas 1+2 (Shallow Pelagic stock < 500 m)	In 2009, ICES concluded that the deep pelagic beaked redfish was a separate stock unit and should be managed as such. Stock perception is based on acoustic survey estimates since 1991 and no analytical assessment has been attempted. The stock is considered to be at very low level and no fishing is advised from this stock. Rebuilding, management plans and harvesting strategies will suffer from lacking an analytical assessment. Benchmark assessment is therefore important and would benefit if it were in conjunction with the benchmark of *S. menella* in Subareas I and II.
Beaked Redfish (*Sebastes mentella*) in Subarea XIV (demersal on Greenland slope)	ICES concluded in February 2009 that demersal *S. mentella* is to be divided to three biological stocks and that the *S. mentella* on the Icelandic continental shelf and slope should be treated as a separate biological stock and management unit. The WKREDS concluded that "Adult redfish on the Greenland Shelf have been attributed to several stocks and there remains a need to investigate the affinity of the adult *S. mentella* in this region. The east Greenland Shelf is most likely a common nursery area for the three biological stocks." (ICES CM 2009/ACOM:37). A plan of work required to achieve an understanding of population structure and origin of the adult demersal *S. mentella* in XIVb is needed. This could include stock discrimination studies by use of genetics, tagging etc.

1.5.4 Addition of new stocks to be assessed by NWWG

The group discussed the possibility of moving ling and tusk in V and XIV to the NWWG from the WGDEEP working group. The rationale for the move included:

1. These are not real deepwater species (mostly caught at depths above 400m)
2. Considered separate management units and as such fall completely under the NWWG area:
    a. Tusk in Va and XIV.
    b. Ling in Va.
    c. Ling in Vb.
3. The stocks are caught in a mixed fishery with many of the stocks assessed by NWWG such as cod and haddock
4. The scientists currently working on tusk and ling in Iceland and Faroe normally attend the NWWG meetings.
5. Knowledge on the fisheries and ecosystem in Greenland, Iceland and Faroe waters is one of the main expertise of NWWG members.

Arguments raised against mowing the stocks to the NWWG:

- The NWWG assesses many stocks and drafts advice annually so the workload is already great. There may not be time to assess more stocks each year.
- The basis for three management units is not strong and therefore ling and tusk may be connected to other management units covered by WGDEEP.
- WGDEEP has strong background in dealing with data poor stocks where NWWG mainly deals with stocks assessed on the basis of the results of analytical assessments.

The group did not come to any conclusion on the matter as there are pros and cons on moving the management units between WGDEEP and NWWG. NWWG would like to hear the views of WGDEEP on the issue.

1.5.5 InterCatch

NWWG recommends that uploading data to InterCatch will not be one of the ToRs for the group in the future. The rationale can be found in subsection 1.4.

1.6 Other issues

1.6.1 Duration of the meeting

In 2009 the NWWG was allocated 7 days but this year the time was extended to 8 days. Interruption of flight schedules due to the volcanic activity in Iceland lead to the chair and several members of the group missed the first day of the meeting. This reduced effective meeting time down to 7 days. The WG has many tasks and during the last two years has had to cut corners in reviewing the report. Because of this a meeting duration of 8 days should be considered the absolute minimum, 9 days should be adequate.

1.6.2 Term of the Chairman

The term of the current chairman (Gudmundur Thordarson) ends officially this year. However at last years meeting the chairman was away on paternity leave and Jesper Boje a member of the group and former chairman stepped in temporarily and ran the meeting in his place. Therefore the Chairman proposed to the group that his chairmanship be extended by one year to make up for the paternity leave. The group gracefully gave blessing to the chairman's proposal. However the group and the chairman acknowledge that the final decision will be in ACOM's hands.

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 2.1.2). 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 2.1.1.

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 2.1.1).

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 misreporting 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 (Groups 4,5), 2) the pair trawlers (Group 2) and 3) the longliners greater than 110 GRT (Group 3). 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. Plans are now initiated to include this fleet into the fishing days system without increasing the fishing mortality on especially the saithe stock and it is expected that a law proposal on this will be put forward in the Parliament later this year. The single trawlers less than 400 HP are given special licenses to target flatfishes 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 1998–2008 and Table 2.1.2 shows the number of allocated days inside the outer thick line (the "ring") in Figure 2.1.2. 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. Due to the serious decline of the Faroe Bank cod, the Bank has been closed since 1 January 2009 for all gears.

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.

As can been seen in Table 2.1.2 and Table 2.1.4, there have been some reductions in the number of allocated fishing days in order to reduce the fishing mortality; for the present fishing year the number of days were reduced by around 5%. From Table 2.1.1 it can be seen that the actual number of fishing days used by the fleets was reduced for 2008. Reasons are small catch rates combined with high costs of fishing and small fish prices. For the fishing years 2008/09 and 2009/10, a considerable number of fishing days have not been used of the same reasons as mentioned above.

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 primary production indices have been below average since 2002 except for 2004 and 2008-2009 when it was above average (Figure 2.1.3). The estimate of primary production in 2010 will not be available until July, but preliminary estimates suggest it to be even larger than in 2009. It will have little effect on the spawning stock size in the short term, but recruitment and total stock biomass will likely be improved. Potential positive effect 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. In 2008 new information became available on the productivity over the deep areas and is outlined in Working Document 20 from last year (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). 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 2009 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.

The hydrographical conditions over the deep areas also seem to affect Greenland halibut. There seems to be a negative relationship between the gyre index and the abundance/catches of Greenland halibut in Faroese waters some three years later (Steingrund and Hátún, 2009: working document 9). It is hypothesized that warmer-than-average surface water masses lead to a decrease in the preferred water masses for Greenland halibut in the deep waters (400-600 m) at the Faroes around three years later and vice versa.

2.1.4 Catchability analysis

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

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

For cod there seems to be a link between the primary production and growth of cod (Fig. 2.1.4). The primary production seems to be negatively correlated with the catchability of longlines (Figure 2.1.5), 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. 2.1.6).

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 Figure 2.1.7 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 2010 assessment of Faroe Plateau cod, haddock and saithe

A summary of selected parameters from the 2010 assessment of Faroe Plateau cod, Faroe haddock and Faroe saithe is shown in Figure 2.1.8. As mentioned in previous reports of this WG, landings of cod, haddock and saithe on the Faroes appear to be closely linked with the total biomass of the stocks. For cod, the exploitation ratio and fishing mortality has remained relatively stable over time, although they have been more fluctuating in recent years. For haddock, the exploitation rate was decreasing from the 1950s and 1960s, , 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.

Another main feature of the plots of landings, biomasses, mortalities and recruitment is the apparent periodicity during the time series with cod and haddock showing almost the same trends.

Alternative approach to evaluate the quality of the stock assessment. There is a strong positive correlation between individual growth of cod and a "food per fish" index (Steingrund *et al*., 2010). The food per fish index is calculated as total phytoplankton production on the Faroe Plateau (inner + outer areas) divided by the sum of cod, haddock and saithe biomasses (see Steingrund *et al*., 2010). This relationship, which is updated in Figure 2.1.9 to include the most recent years, may be regarded as a way to evaluate the quality (bias) of the stock assessments of cod, haddock and saithe. The points for 2007, 2008 and 2009 all lie on the right side of the regression line. This indicates that the total biomass of cod, haddock and saithe might be underestimated (the food per fish index should be lower), although this deviation could as well be regarded as purely coincidental. Conversely, the stock estimates for the most recent years are not likely to be overestimated because a further increase in food per fish would lead to outliers in the relationship between food per fish and cod growth (Figure 2.1.9).

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 also to be revised for the three Faroese stocks. The NWWG has done some preliminary work aiming at coming up with MSY reference points including Fmsy and Btrigger. The results so far have been presented under the different stock sections but should be regarded as very preliminary since much more work is needed for the Faroese stocks. And as was pointed out several times during the meeting, who is responsible for deciding upon new reference points?

2.1.7 Faroe saithe

The NWWG understands that ICES could not revise the biomass reference points for Faroe saithe because the assessment has not been accepted in recent years. However, this was solved during the benchmark assessment in February this year. Figure 6.5.1.2 of the 2010 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 was made available during summer 2008 but the results are not very conclusive and could not be used directly by this WG.

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 1998-08. 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
2008	10212	2827	3722
Average(98-08)	21488	2679	6290

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	Regulated by area and by-catch limitations	8225	3040	9320	22000
1997/1998		7199	2660	9328	23625
1998/1999		6839	2527	8861	22444
1999/2000		6839	2527	8861	22444
2000/2001		6839	2527	8861	22444
2001/2002		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
2008/2009		5073	3062	4795	18167
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.

Fleet segment	Allocated days 2008/09	Used days 2008/09	Allocated days 2009/10	Used days 2009/10 (by medio May)
Group 2	5073	4065	4406	3323
Group 3	3062	2273	2940	1663
Group 4A		415	1323	335
Group 4B	4795	1016	1756	934
Group 4T		1434	1540	750
Group 5A	7267	3256	6904	2066
Group 5B	10900	3803	10355	3461

Table 2.1.4. Allocated and used number of fishing days by fleet group under the fishing days system. Allocated number of days in 2008/09 for Groups 4A, 4B and 4T are here added together.

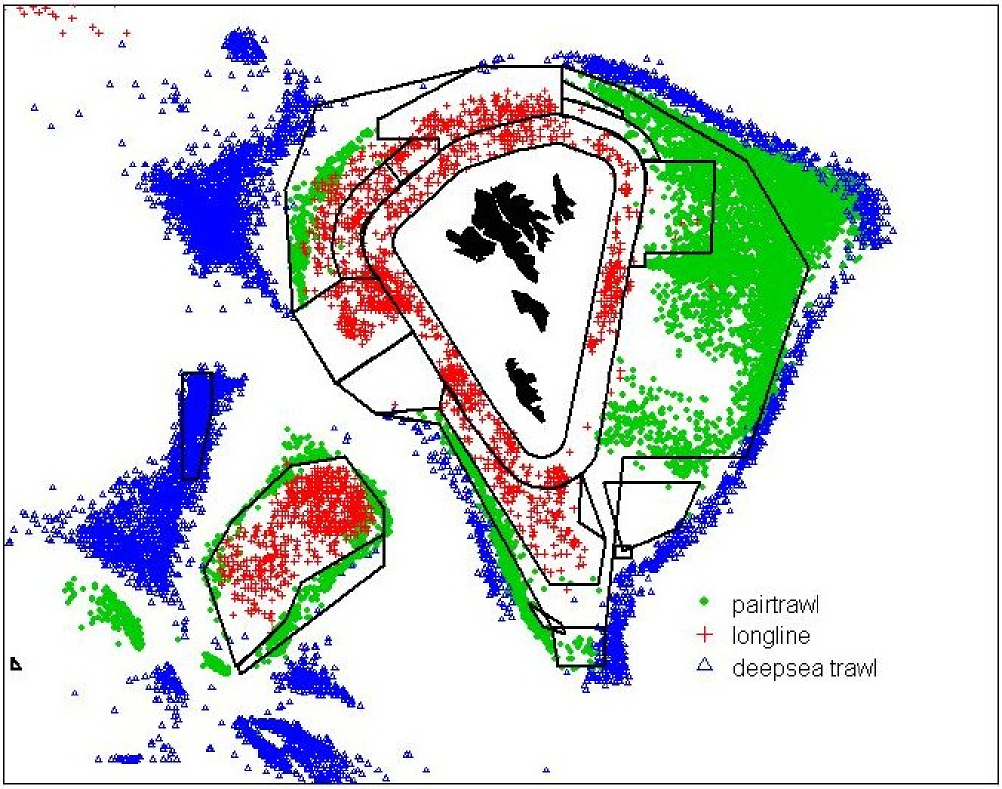
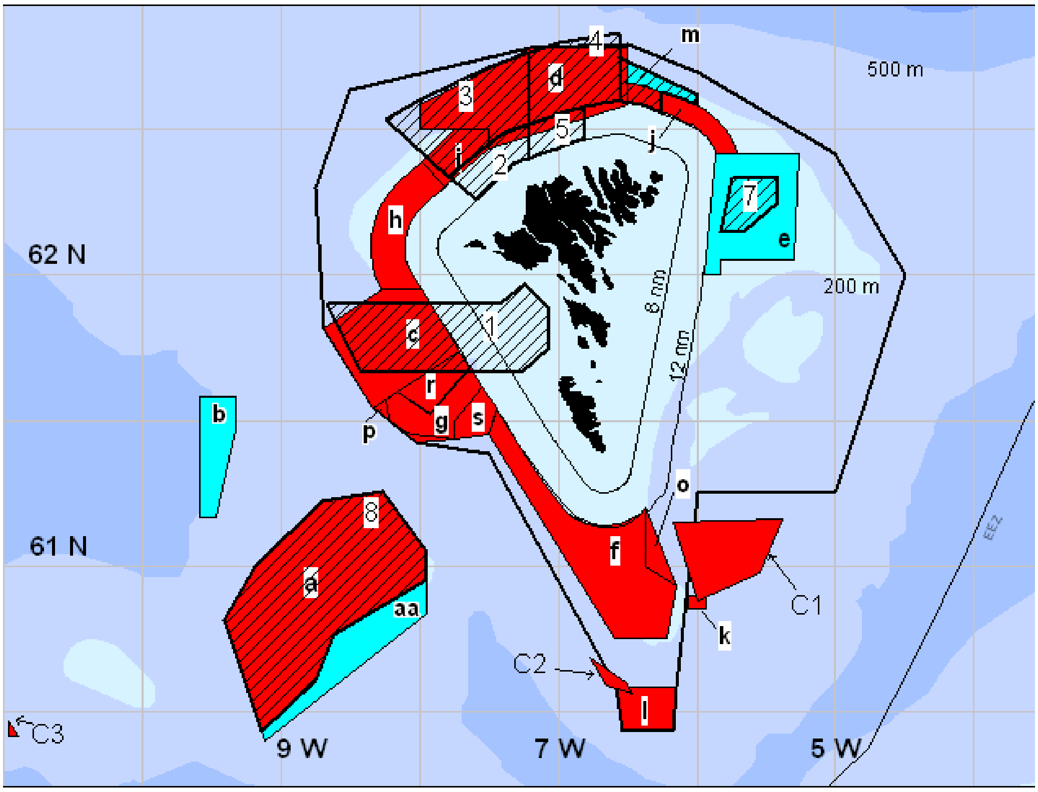


Figure 2.1.1. The 2000-2005 distribution of fishing activities by some major fleets.



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.

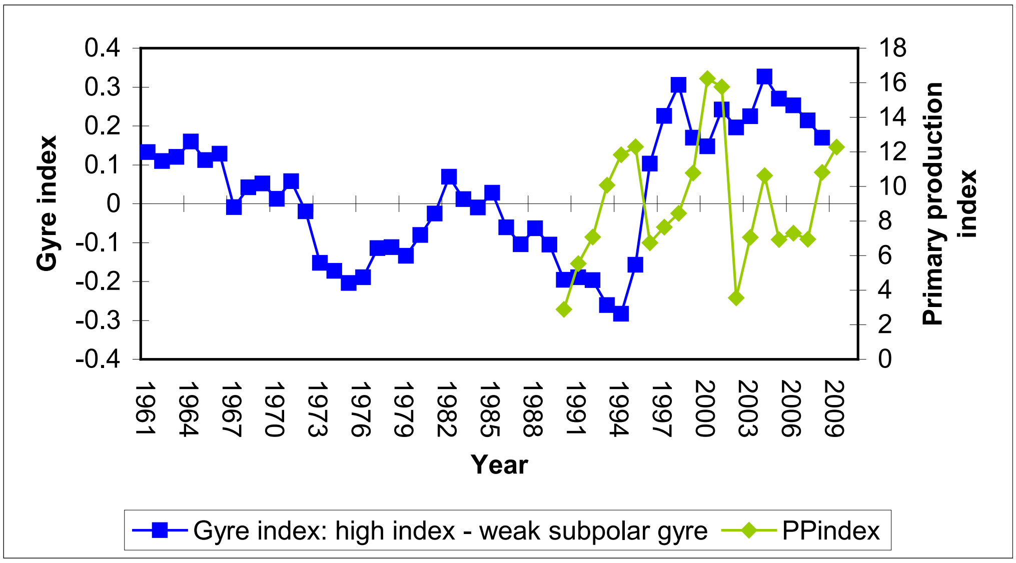


Figure 2.1.3. Temporal development of the phytoplankton index over the Faroe Shelf area (< 130 m) and the subpolar gyre index which indicates productivity in deeper waters.

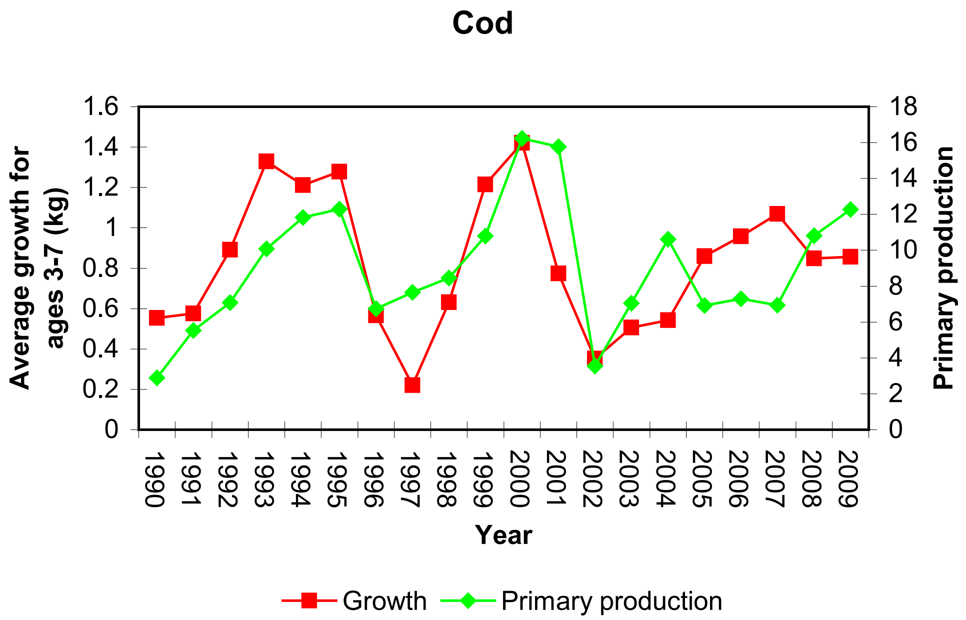


Figure 2.1.4 Faroe Plateau Cod. Relationship between primary production and growth of cod during the last 12 months.

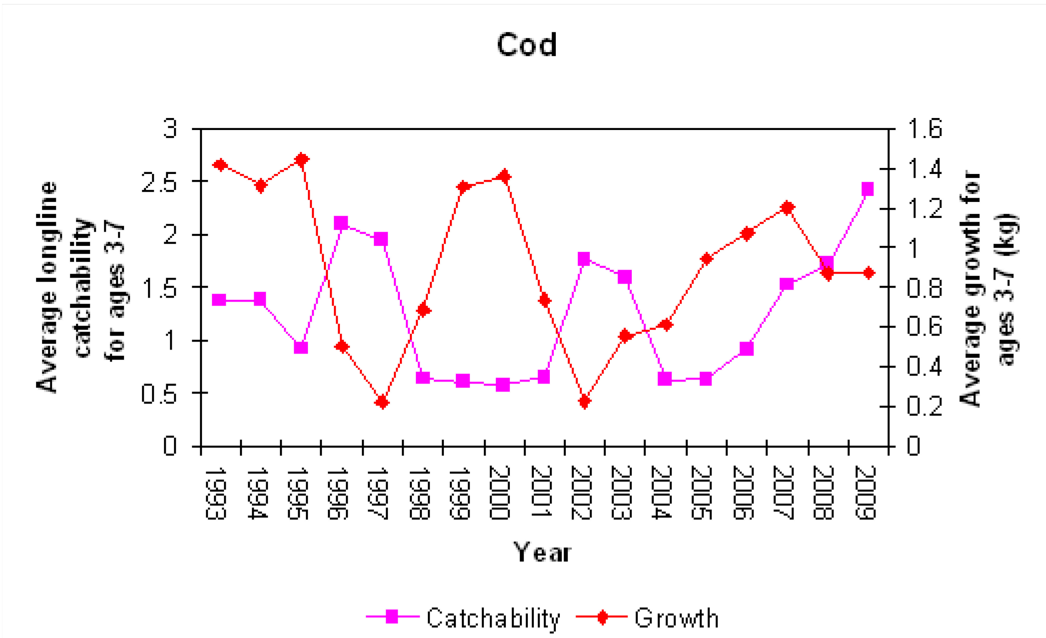


Figure 2.1.5. Faroe Plateau Cod. Relationship between long line catchability and primary production.

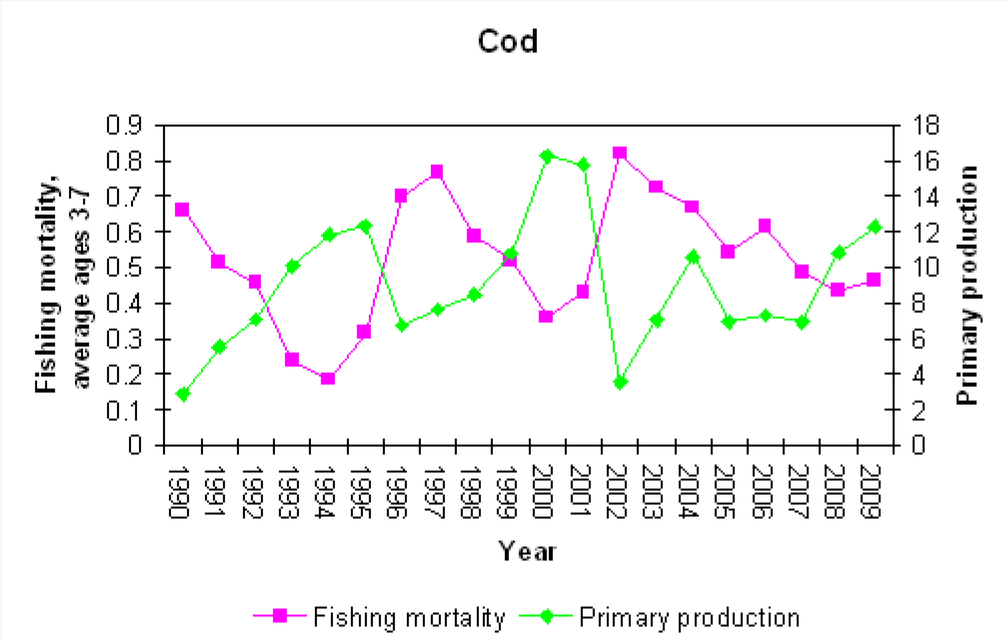


Figure 2.1.6. Faroe Plateau Cod. Relationship between fishing mortality and primary productivity.

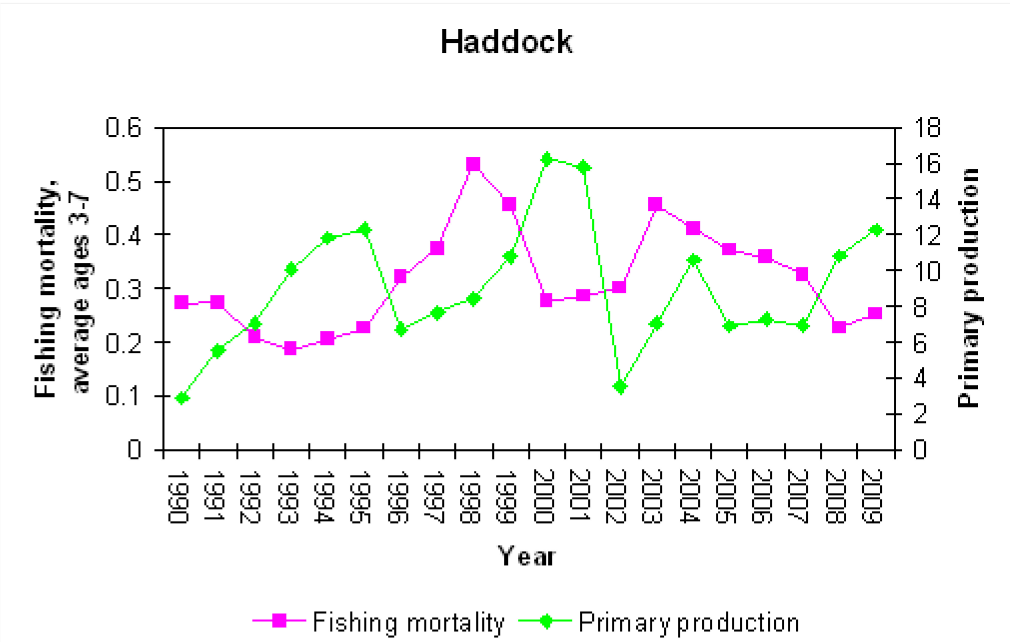


Figure 2.1.7. Faroe Haddock. Relationship between fishing mortality and primary productivity.

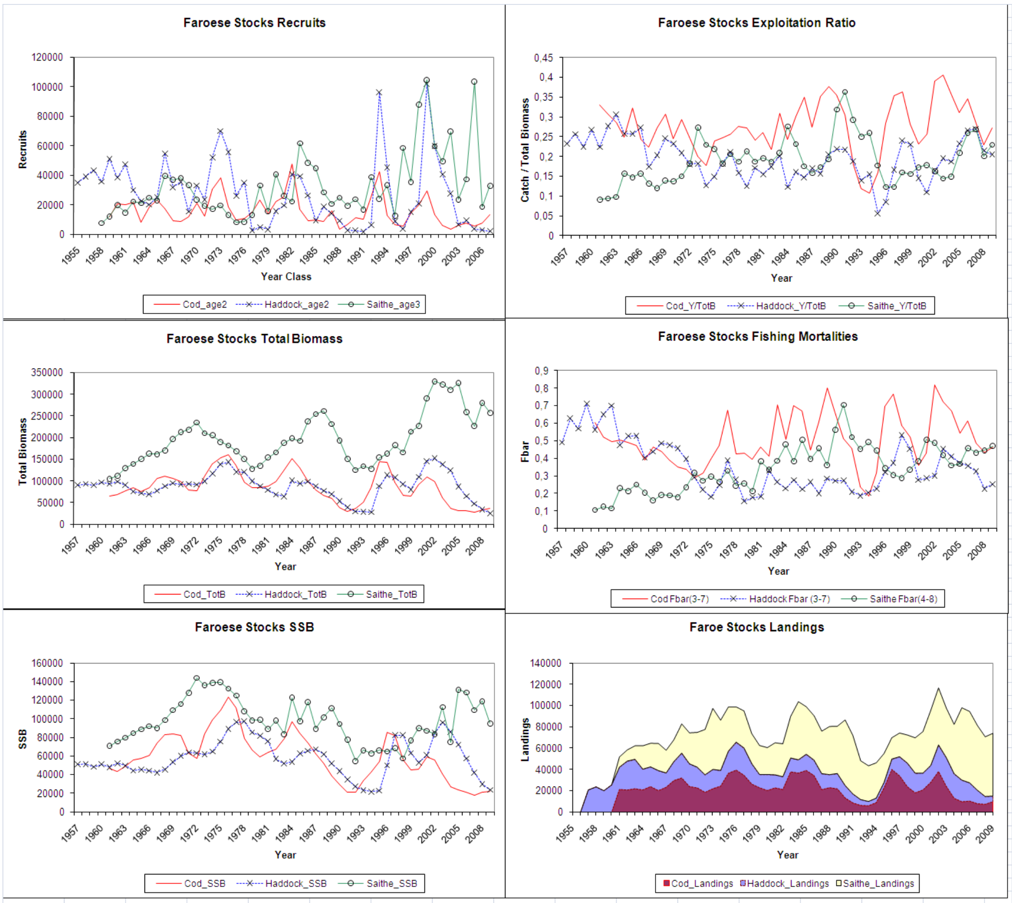


Figure 2.1.8. Faroe Plateau cod, Faroe haddock and Faroe saithe. 2010 stock summary.

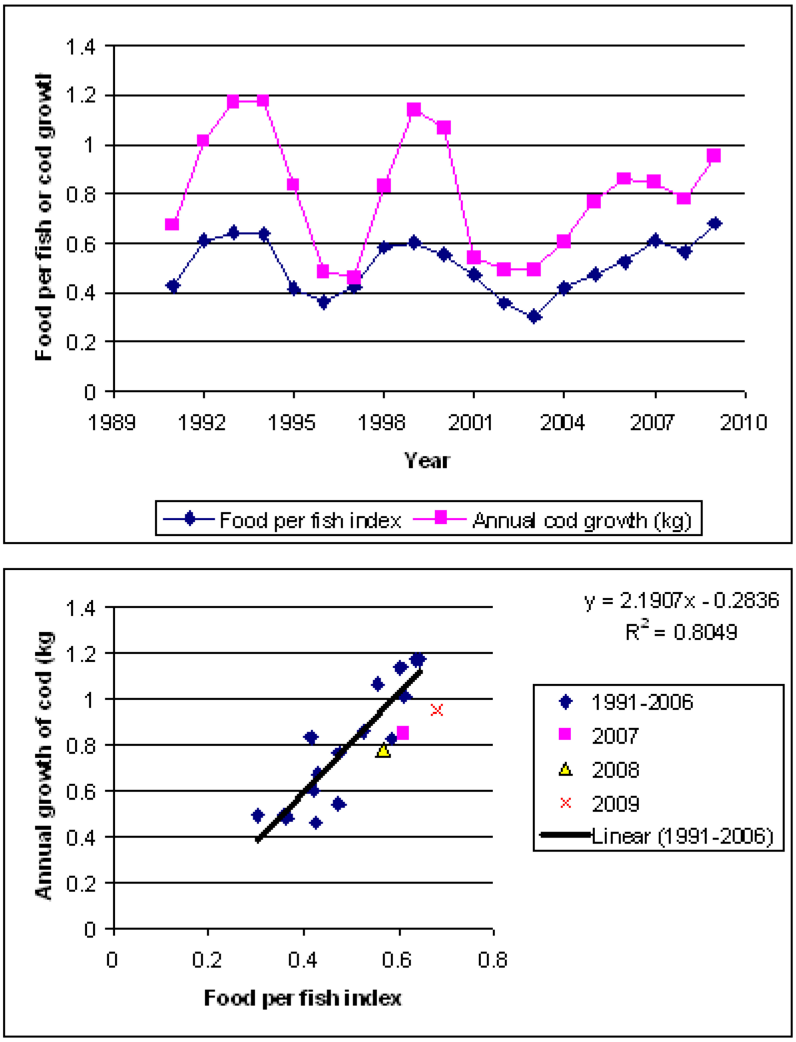


Figure 2.1.9. Relationship between individual growth of cod and a "food per fish" index. See text for explanations.

3 Faroe Bank Cod

Summary

- The total reported landings in 2009 were 80 tonnes the lowest observed since 1965.
- 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 has sharply decreased since 2006. In 2009 it is estimated to levels comparable to those in the 1990's for both survey indices.

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

Total nominal catches of the Faroe Bank cod from 1987 to 2009 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 2009 landings were estimated at 80t which is the lowest in the history of the fisheries (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). From 2005 to 2007 the effort has been reduced substantially. In the fishing years 2008-2009 and 2009-2010 no fishing days were allocated on the Bank.

[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 2010 index is 74 kg per tow, which is in the same observed as in 2009 and thus well below the average in the period 1996-2004. The 2009 summer index (58 kg per tow) has increased with respect to 2008. 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 to 2010 reflecting the weak year classes observed in the summer survey since 2004.

The recruitment is 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). According to the summer index the recruitment of 1 year old has been good from 2000 to 2003, while the recruitment has been relatively poor since 2004 (Figure 3.7.5) The spring recruitment index in 2010 shows no sign of incoming year classes Correlation between the spring and summer survey recruitment indices is fairly good (r^2=0.83)

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 has decreased since 2006 and in 2009 it is estimated to levels close to those in the 1996-2002.

3.2 Comparison with previous assessment and forecast

The status of the stock remains almost unchanged with respect to last year assessment. Both the spring and the summer indexes suggest the stock is well below average while there are no indications of incoming recruitment.

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

None

3.4 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.

Consistent with the advice given in 2009 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.

3.5 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. In 2009 fishing was restricted to all fishing gears from 1 January to 31 August. No fishing days are allocated in the 2009-2010 fishing year.

3.6 Changes in fishing technology and fishing patterns

None

3.7 Changes in the environment

None

Table 3.7.1. Faroe Bank (sub-division Vb2) cod. Nominal catches (tonnes) by countries 1986-2009 as officially reported to ICES. From 1992 the catches by Faroe Islands and Norway are used in the assessment.

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Faroe Islands	1836	3409	2966	1270	289	297	122	264	717	561	2051	3459
Norway	6	23	94	128	72	38	32	2	8	40	55	135
UK (E/W/NI)	-	-	-	-	2 [2]	1 [2]	74 [2]	186 [2]	56 [2]	43 [2]	126 [3]	61 [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]	277 [3]
Total	1905	3479	3097	1412	568	426	404	570	1008	1195	2614	3932
Used in assessment					289	297	154	266	725	601	2106	3594

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009 [*]
Faroe Islands	3092	1001		1094	1840	5957	3607	1270	1005	471	232	81
Norway	147	88	49	51	25	72	18	37	10	7	1	4
UK (E/W/NI)	27 [3]	51 [3]	18 [3]	50 [3]	42 [3]	15 [3]	15 [3]	24 [3]	1 [3]			338 [3]
UK (Scotland)	265 [3]	210 [3]	245 [3]	288 [3]	218 [3]	254 [3]	244 [3]	1129 [3]	278 [3]	53	32	
Total	3531	1350	312	1483	2125	6298	3884	2460	1294	531	265	423
Correction of Faroese catches in Vb2				-65	-109	-353	-214	-75	-60	-28	-14	-5
Used in assessment	3239	1089	1194	1080	1756	5676	3411	1232	955	450	219	80

[*] Preliminary

[1] Includes Vb1.

[2] Included in Vb1.

[3] Reported as Vb.

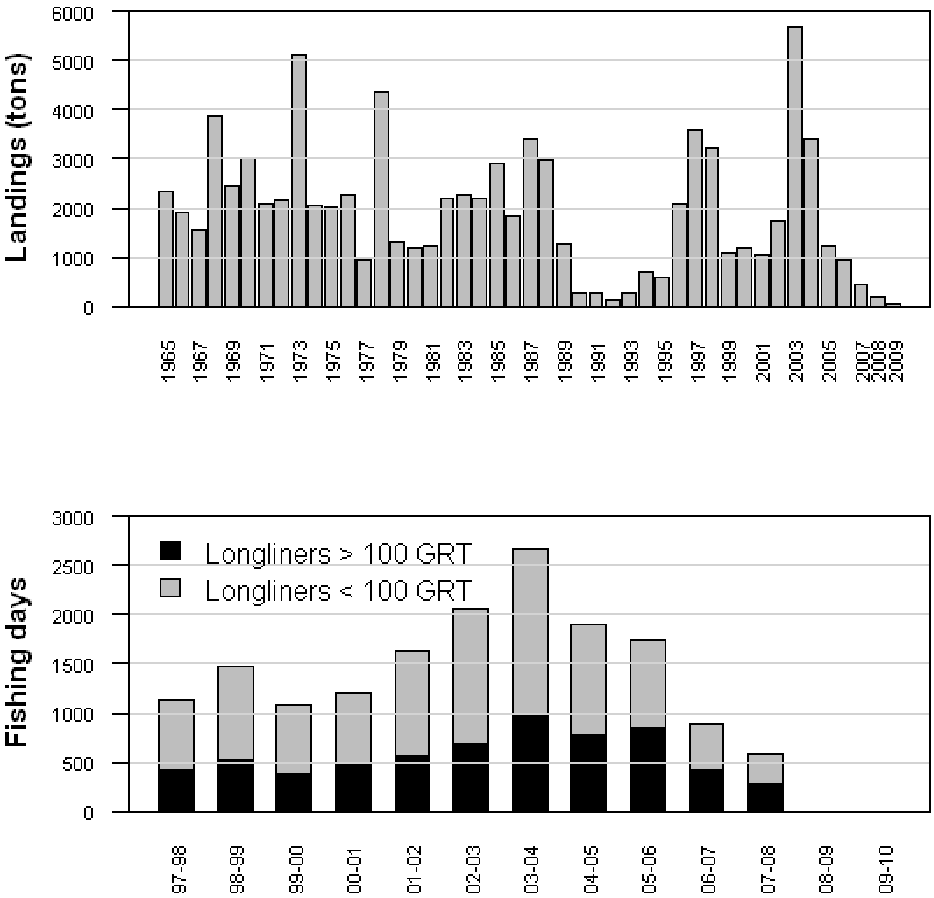


Figure 3.7.1. Faroe Bank (sub-division Vb2) cod. Reported landings 1965-2008. Since 1992 only catches from Faroese and Norwegian vessels are considered to be taken on Faroe Bank. Lower plot: fishing days (fishing year) 1997-2010 for long line gear type in the Faroe Bank.

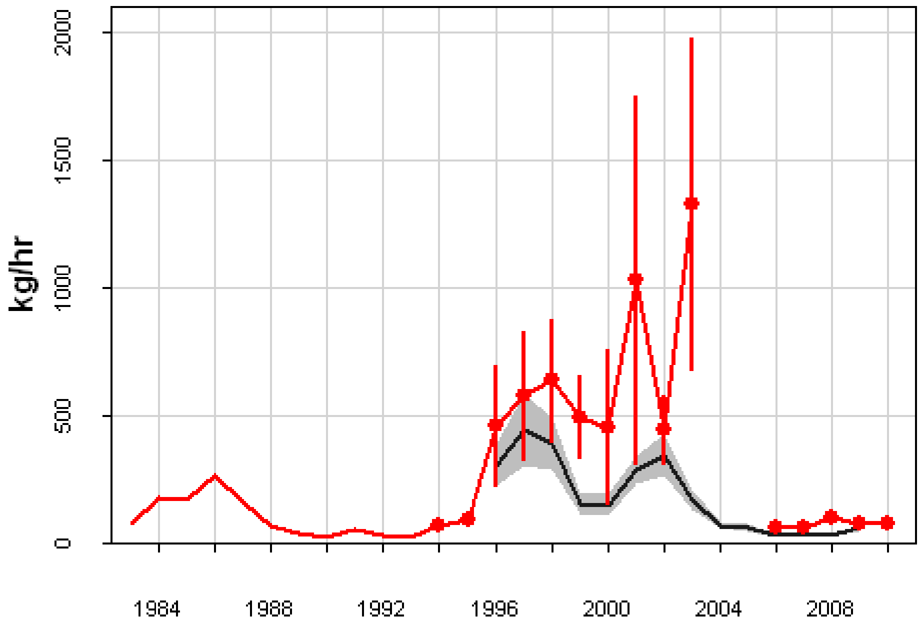


Figure 3.7.2. Faroe Bank (subdivision Vb2) cod. Catch per unit of effort in the spring groundfish survey and summer survey. Vertical bars and shaded areas show the standard error in the estimation of indexes.

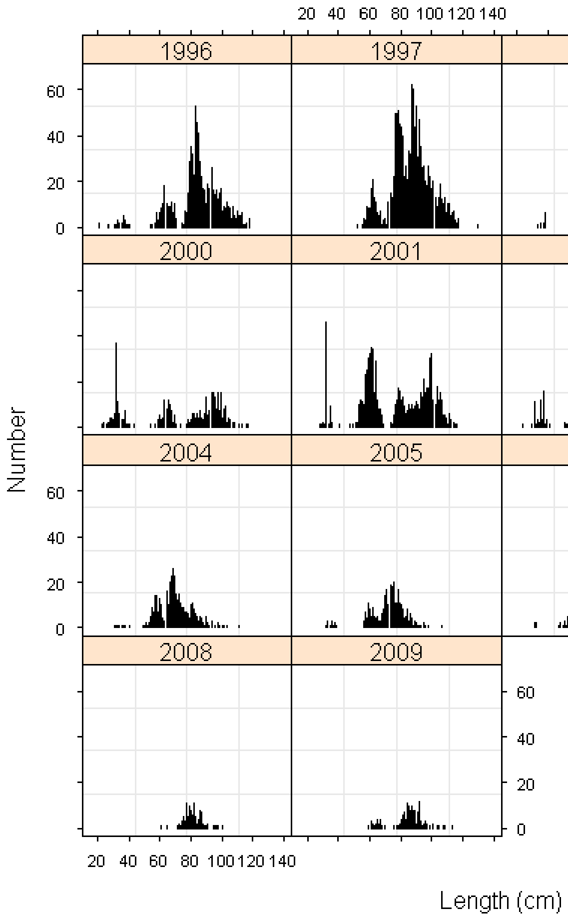


Figure 3.7.3. Faroe Bank (sub-division Vb2) cod. Length distributions in summer survey (1996-2009.)

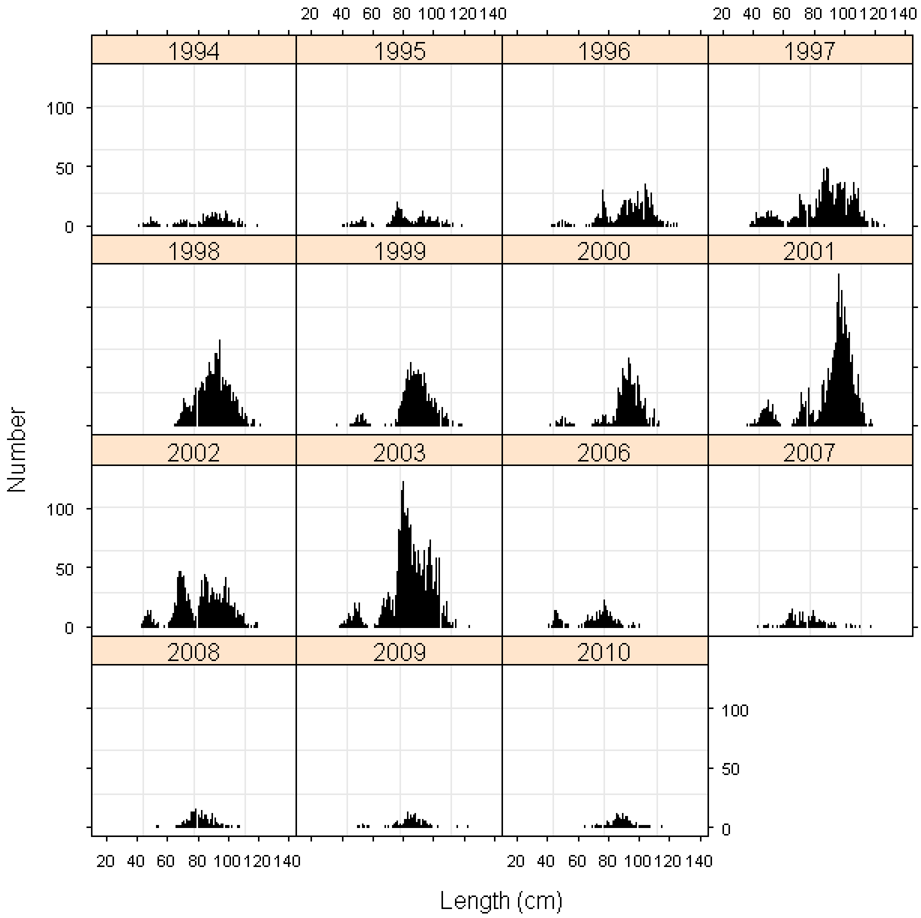


Figure 3.7.4. Faroe Bank (sub-division Vb2) cod. Length distributions in spring survey (1994-2003, 2006-2010.)

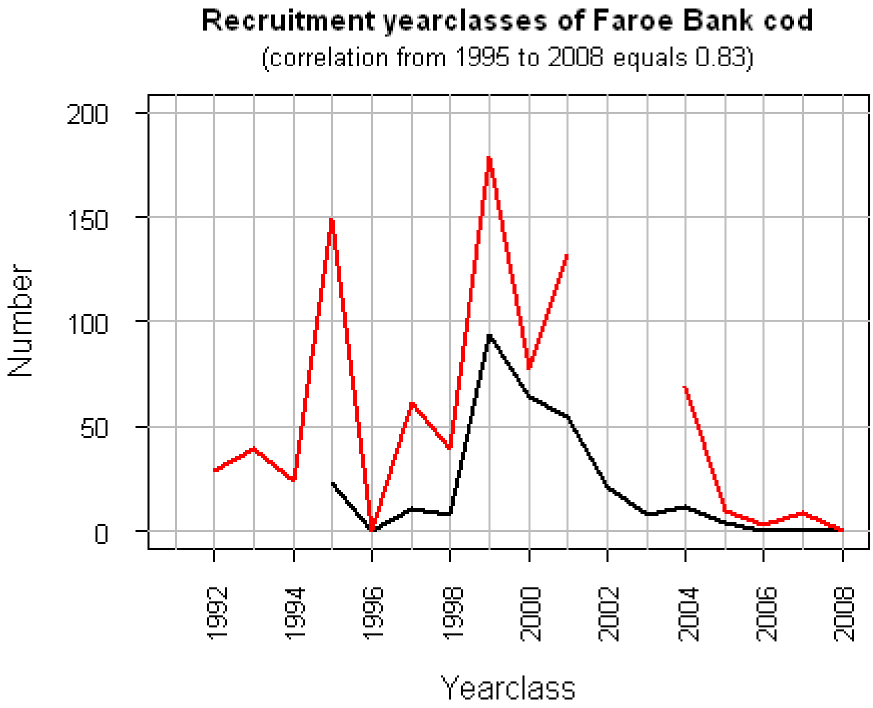


Figure 3.7.5. Faroe Bank (sub-division Vb2) cod. Correlation between recruitment year classes.

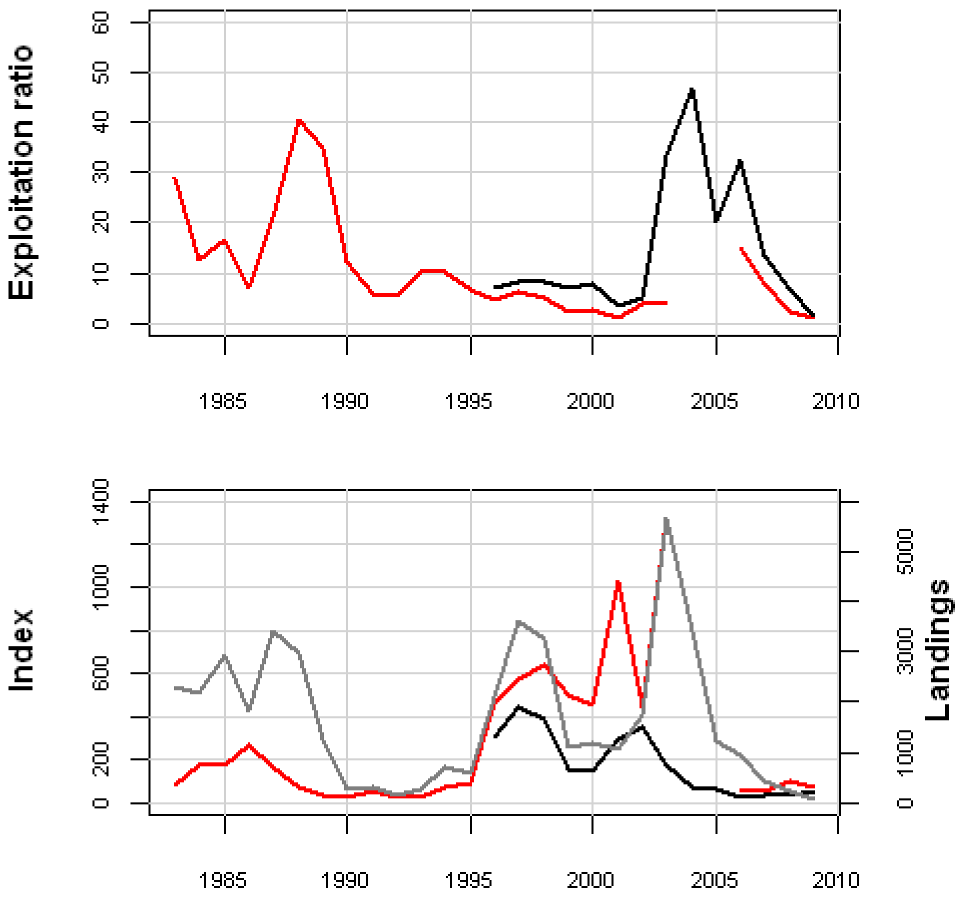


Figure 3.7.6. Faroe Bank (Subdivision Vb2) cod. Exploitation ratio (ratio of landings to survey interpreted as an index of exploitation rate). Lower plot: Landings and cpue (kg/hr) in spring and summer survey.

4 Faroe Plateau cod

Summary

The input data consisted of the catch-at-age matrix (ages 2-10+ years) for the period 1961-2009 and two age-disaggregated abundance indices obtained from the two Faroese groundfish surveys: the spring survey 1994-2010 (shifted back to the previous year) and the summer survey 1996-2009. The maturities were obtained from the spring survey 1983-2010.

The assessment settings were the same as in the 2009 assessment. An XSA was run and tuned with the two survey indices. The fishing mortality in 2009 (average of ages 3-7 years) was estimated at 0.46, which was higher than the precautionary fishing mortality of 0.35 but lower than the limit fishing mortality (when 'bad things' may happen) of 0.68. The total stock size (age 2+) in the beginning of 2009 was estimated at 37 000 tonnes and the spawning stock biomass at 22 000 tonnes, which was slightly above the limit biomass (which should be avoided) of 21 000 tonnes.

The short term prediction until year 2012 showed an increasing trend with a stock size in 2012 of around 82 000 tonnes and a spawning stock biomass of around 55 000 tonnes.

The recruitment seems to be positively correlated with the total stock size of cod. It is, therefore, adviced to reduce the fishing mortality so that the stock increases. 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

Both genetic and tagging data suggest that there are three cod stocks present in Faroese waters: on the Faroe Bank, on the Faroe Plateau and on the Faroe-Iceland Ridge. Cod on the Faroe-Iceland Ridge seem to belong to the cod stock at Iceland, and the WG in 2005 decided to exclude these catches from the catch-at-age calculations. The annex provides more information.

4.2 Scientific data

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 2007 and 2008. Landings-at-age for 2009 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 from 1961 to 2009 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.

Fleet	Size	Samples	Lengths	Otoliths	Weights
Open boats		22	36	640	2,869
Longliners	<100 GRT	39	905	1,256	6,694
Longliners	>100 GRT	29	400	781	5,208
Jiggers		13	535	360	1,492
Gillnetters		0	0	0	0
Sing. trawlers	<400 HP	0	0	0	0
Sing. trawlers	400-1000 HP	6	0	120	1,218
Sing. trawlers	>1000 HP	2	371	0	0
Pair trawlers	<1000 HP	12	0	539	1,935
Pair trawlers	>1000 HP	27	311	480	5,018
Total		128	2,522	3,536	21,565

Samples from commercial fleets in 2009.

Mean weight-at-age data for 1961-2009 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 2009 showed a discrepancy of 1 %.

Figure 4.2.2 shows the mean weight-at-age for 1961 to 2009. For 2010-2012 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 since 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 - 2009) and shown in Figure 4.2.3 (1983 - 2009). The observed values in 2010 and the estimated values in 2011-2012 are also shown in order to put them in perspective with previous observations. 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* is used as a tuning series. The catch curves showed a normal pattern (Figure 4.2.4). The stratified mean catch of cod per unit effort in 1994-2010 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 2006-2008 and were considerably higher in 2009 and 2010. 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 1996-2010.

The other tuning series used is the Summer Groundfish Survey. The stratified mean catch of cod per unit effort (kg/trawl hour) 1996-2009 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. Both tuning series are presented in Table 4.2.9.

Two commercial cpue series (longliners and pairtrawlers) are also presented (Tables 4.2.10 and 4.2.11, as well as Figure 4.2.7), although they are 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 since 1996 gathered data on the size composition of the landings but this information has not been used in this assessment.

4.4 Methods

This is 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.

The reference points based on the yield-per-recruit curve are the following: Fmax = 0.24, F0.1 = 0.11, F30%SPR = 0.17, Fmed = 0.41, Flow = 0.10, Fhigh = 1.03.

ICES has recently adopted a maximum-sustainable-yield approach. A preliminary simulation study (see 4.8) indicates that Fmsy is in the range of 0.30 to 0.45, probably close to 0.39 (i.e., higher than Fpa). The Btrigger (age 3+) may be close to 70kt, i.e., considerably higher than both Blim and Bpa. The simulation study is purely deterministic and could be elaborated in the future by taking stochastic (random) processes into account.

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 2009 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 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. There were year effects in both surveys since 2005. The stock estimates for 2009 seemed to be determined mostly by the spring survey.

The estimated fishing mortalities are shown in Tables 4.6.2 and 4.6.4 and Figures 4.6.2 and 4.6.3. The average F for age groups 3 to 7 in 2009 (F3-7) is estimated at 0.46, somewhat higher than Fpa = 0.35.

The F3-7 (Figure 4.6.3) 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 4.6.4: weighting by stock numbers, stock biomasses or catch weights. Although all measures of fishing mortality have in the last three assessments shown that the fishing mortality has increased since the introduction of the effort management system in 1996, this perception is about to change in the current assessment. The fishing mortality may only have increased slightly since 1996, but there have been oscillations that may be determined by the food availability in the ecosystem.

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 4.6.2. The stock-recruitment relationship is presented in Figure 4.6.5. The stock trajectory with respect to existing reference points is illustrated in Figure 4.6.6.

The assessment shows the poor recruitment for the 1984 to 1991 year classes, and the strong 1992 and 1993 year classes. Due to the continuous poor recruitment from 1984 to 1991 and the high fishing mortalities, the spawning stock biomass declined steadily from 1983 to 1992 when it was the lowest on record at 21 000 t. It increased sharply to above 80 000 t in 1996 and 1997 before declining to about 45 000 t in 1999. The spawning stock biomass increased to 59 000 t in 2001 but dropped to about 17 000 t in 2007 which is the lowest value observed during the assessment period from 1961-2008. The 2002 year class is likely the lowest observed and the 2003-2006 year classes are also weak according to the XSA run. The 2007 year class seems to be at bit stronger (13 millions). The 2008 year class may be strong (33 millions), but relies solely on the spring survey estimate in 2010 (shifted to 2009 in the tuning). This value was adjusted to 23 millions (see later).

In order to put the stock estimates in 2009 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. 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 4.6.7. 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 2009 was low compared with the entire period.

4.7 Short term forecast

The input data for the short term prediction are given in Table 4.7.1. The strength of the 2008 year class was estimated as the average of 33 and 16 millions. The higher value was obtained from the XSA run. The lower value was obtained from a regression of recruitment versus the number of 1-year-old cod caught deeper than 200 m in the spring survey. The reason for not using the 33 value was that such a high value is not expected when the contemporary age 3+ biomass (see Steingrund *et al*., 2010) is as low as 40 thousand tonnes. The strength of the 2009 year class was set equal to the 2008 year class, since, during high-productive periods (now in 2008-2010 and e.g. in 1993-1995), the year class preceding the first strong year class tends to be equally strong or stronger (e.g. yc 1992 vs yc 1993). After two strong year classes, the following one tends to be weaker and equal to the year class prior to the high-productive period (e.g. yc 1994 equal to yc 1991 and yc 2000 equal to yc 1997). Hence, the yc 2010 was set equal to yc 2007. The procedure used last year (the 2009-2010 year classes estimated as the average of the 2004-2008 year classes) gave almost the same SSB in 2012 (57000 t) as the alternative approach adopted here (55000 t). 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 2007-2009. The weights at age in the catches in 2010 were estimated from the commercial catches in January-February or the spring survey (ages 2-5 years). The weights in the catches in 2011 were set to the values in 2010, i.e., rather high values, whereas a lower value (average 2008-2010) was expected in 2012. The proportion mature in 2010 was set to the 2010 values from the spring groundfish survey, and for 2011-2012 to the average values for 2008-2010.

Table 4.7.2 shows that the landings in 2010 are expected to be 14 000 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 32 000 tonnes in 2010, 50 000 tonnes in 2011 and eventually 55 000 tonnes in 2012. The current short term prediction is therefore somewhat optimistic. The contribution of the various year-classes to the SSB in 2011 and 2012 is shown in Figure 4.7.1. It shows that the incoming year-classes (YC 2006-YC 2009) dominate the SSB.

A short term projection using the same procedures as last year is presented in Table 4.7.3 and Table 4.7.4.

4.8 Long term forecast

The input to the traditional long term forecast is presented in Table 4.8.1 and the result is presented in Table 4.8.2 and Figure 4.8.1.

As a response to the requirements from ICES to estimate the fishing mortality giving maximum sustainable yield (Fmsy) as well as a Btrigger (below which the fishing mortality has to be reduced), long term simulations were developed and performed during the meeting. These should be regarded as preliminary and as the first step to estimate the Fmsy. The procedure was as follows.

The simulations were based on the 1997-2006 period. 1997 was chosen because it was the first year after the effort management system was implemented. 2006 was chosen because the estimates of recruitment, stock size and fishing mortality were converged, i.e., updates from future assessments are not expected to change the conclusions of the simulations.

The driving variable was individual growth rate of cod. It was calculated as the weight increase of age y from the previous year to age y+1 the current year (ages y = 3-7 were considered) and the average taken. The weights-at-age were then estimated from the growth (simple regressions, sometimes lagged by up to 2 years, Table 4.8.3). In general there was a good correspondence between the observed and modelled weights (Figure 4.8.2, see also Figure 4.8.3). The F-at-age were also estimated from the growth in a similar manner (Table 4.8.3), and the there was a good correspondence between the observed and modelled Fs (Figure 4.8.4).

The recruitment was estimated from the growth and the contemporary biomass of age 3+ cod (see Steingrund *et al.* 2010 for further information). There is a positive relationship between recruitment and the contemporary age 3+ biomass up to around 80 thousand tonnes, a constant relationship up to 120 thousand tonnes, and a negative relationship at larger stock sizes (Figure 4.8.5). A "home-made" function is fitted through the points, and the expected recruitment at a given age 3+ biomass may be termed the "modelR". The modelR (in millions) = aB/(1+exp(D*(B/M-1))), where a=0.238, M=129, D=9.18, and B is the age 3+ biomass (in thousand tonnes) at the time of recruitment. Interestingly, the ratio between R and modelR (i.e., R/modelR) normally fluctuated between 0.3 and 2.3 during the 1925-2007 period (Steingrund *et al.*, 2010). When the growth was rapid, the R/modelR was high the following year and *vice versa*. This is because few cannibalistic cod enter the nearshore nursery areas of 1-year-old cod in years (summer) when growth is rapid and *vice versa* (Steingrund *et al*., 2010), thus affecting the recruitment of 2-year-old cod the following year. A relationship between growth and R/modelR (the following year) was obtained for the period 1994-2006 (Figure 4.8.6). The recruitment could, thus, be modelled as the R/modelR ratio (which in turn was modelled by the growth) multiplied by the modelR (i.e., applying the "home-made" equation).

The "home-made" function assumes a clear depensatory effect on recruitment when the contemporary age 3+ biomass is below 80 thousand tonnes. The XSA estimate of the strength of the 2008 year class (as strong as 33 millions), despite a low age 3+ biomass, may be a warning sign that this relationship may not hold. Alternatively, the 2008 yearclass strength may have been overestimated or that the stock size has been underestimated in the current assessment. A way to resolve this issue was to inspect a modified version of the recruitment function that was presented in Steingrund *et al*. (2010). The original recruitment function states that recruitment is directly proportional to the B/C ratio, where B is the contemporary age 3+ biomass of cod (< 80 thousand tonnes) and C is the abundance (CPUE) of cannibalistic cod present in the nearshore nursery areas of age 1 cod *the previous summer*. C may also be calculated as: C2 = the total age 3+ biomass (not to be confused with B, which refers to the next year) multiplied by the proportion of tagged cod that have moved into the nearshore areas (see Steingrund *et al*., 2010). Both B and C2 may be either over- or underestimated in the current assessment, but, importantly, the ratio between them (i.e., B/C2) may be less affected. If R is plotted against log(B/C2), it is seen that the relationship seems to hold (Figure 4.8.7).

The simulations, which are purely deterministic, started in the year 2010 (applying age 3+ population numbers from the current assessment as well as the observed growth from 2009 to 2010), and was run until year 3010, and the average for the 2501-3010 period taken for recruitment, B2+ biomass, B3+ biomass, SSB, and catch. The status quo scenario represented an individual growth varying in a sinusoidal manner between 0.2 and 1.4 kg per year with a period of 6, 8, 10 or 12 years between peaks, and where the F-multiplier (relative to the 1997-2006 period, Fbar = 0.60) ran from 0 to 1.5 with steps of 0.05. Other scenarios were also performed: less variable growth (peaks were 0.5 kg closer to the mean, i.e., growth varying between 0.7 and 0.9 kg), more rapid growth (+0.1 kg), and slower growth (-0.1 kg).

The results, in terms of recruitment, of the status quo run are shown in Figure 4.8.8. The recruitment increases with Fmultiplier increasing from 0 to 0.65 (i.e. actual F = 0.39), and suddenly drops sharply down to zero when Fmultiplier reaches 0.80-0.85. A similar result is obtained for the catch (Figure 4.8.9). The biomass estimates (B3+, SSB) decrease with increasing Fmultiplier, and a breakpoint is observed at an Fmultiplier of 0.80-0.85 (Figure 4.8.10 and Figure 4.8.11). Somewhat higher recruitment/biomass/catch is observed with shorter periods and more stable growth although the Fmultiplier is unchanged. A slight increase in growth of 0.1 kg causes a notable increase in the various stock estimates and increases the Fmultipliers by 0.1. A slight decrease in growth (-0.1 kg) reduces the Fmultipliers by more than 0.1. Table 4.8.4 summarizes the optimal results.

The fishing mortality in 2007-2009 (0.43 to 0.46) has been close to 0.39, which may be one candidate as Fmsy. Given the fact that the assessment tends to overestimate fishing mortality, it might well be the case that the cod fishery since 2007 has been sustainable in terms of fishing mortality. However, during slow-growth periods the fishing mortality tends to increase substantially (e.g. to 0.76 in 1997 and to 0.81 in 2002), i.e., far above sustainable levels. Hence, the number of fishing days has to be decreased, and area closures may also be necessary. Figures 4.8.12 and 4.8.13 show the average abundance of cod in March (1998-2006) and August (1997-2005) and provide a basis which areas should be closed for the fishery. The traditional yield-per-recruit relationship (Figure 4.8.1) may give the very misleading impression that there is nothing to lose by exerting high fishing mortalities on fish stocks because the yield-per-recruit curve is “flat” for high fishing mortalities. In contrast, the simulation study indicates a very different “cliff-edge” relationship, i.e., above a certain point, the stock will collapse in the future.

4.9 Uncertainties in assessment and forecast

The results from the retrospective analysis of the XSA (Figure 4.9.1) show that there has been a tendency to underestimate the recruitment and total stock/spawning stock biomass slightly, and to overestimate the fishing mortality. Regressions of assessment age 3+ biomass (up to 2003 and hence mostly determined by the catch-at-age) versus survey kg per hour (stratified) showed that there seemed to be a positive intercept for both surveys, i.e., the survey abundance estimates may not be directly proportional to population numbers. This may be related to the tendency of cod to occupy the shallow areas, which are not covered by the surveys, first and then colonize progressively the deeper waters as the stock size increases. Hence, during low-stock periods, the assessment seems to underestimate stock size and *vice versa* for high-stock periods. If this bias is corrected for in the survey abundance indices (all ages adjusted by the same coefficients), the diagnostics of the XSA run does, not surprisingly, look much better (lower logQ residuals). Interestingly, the retrospective pattern (also after 2003) also looks much better, i.e., there is little adjustment of recruitment, biomasses or fishing mortalities as the assessment period is extended. According to this procedure, the total stock size and SSB in 2009 are around 5 thousand tonnes larger than in the current assessment, and the fishing mortality at around 0.35 (as opposed to 0.46 in the current assessment).

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

The sampling of the catches for length measurements 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 has been at an historically low level but is currently increasing. There was a good agreement between the survey indices and when compared to the commercial tuning series.

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. The estimates of the incoming year classes in the short term projection were obtained in a different way this year.

Recruitment, total stock biomass and spawning stock biomass in 2009 were estimated higher in the current assessment compared to what was predicted last year, whereas the fishing mortality was considerably lower (Table 4.10.1).

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.

The management plan has not been evaluated by ICES.

4.12 Management considerations

The current assessment shows that the cod stock was below Blim of 21 000 tonnes in 2007-2008, but will likely increase to around 55 000 tonnes in 2012. The primary production was high in 2008-2009, and preliminary information indicates that it will also be high in 2010, i.e. supporting the increase indicated in the short term prediction. However, it has to be born in mind that it is very difficult to predict the strength of incoming large year classes in periods when the cod stock recovers. Hence, the short term prediction should be regarded as the best estimate that is at hand for the moment, but the perception may change in the next years' assessments.

Biomass estimates of Faroe Plateau cod reconstructed back in time (Figure 4.6.7) 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 2004-2009 when they fluctuated around 10 000 tonnes. Similar catches from smaller biomasses imply that the exploitation rates have increased over time.

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 4.6.7 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 was low, or average, during 2002-2007 and the high fishing mortalities in 2002-2005 were therefore not unexpected. The primary production in 2008 and 2009 was above average, and there are signs that it will be above average in 2010 also. Hence, the high fishing mortality in 2009 may be overestimated in the current stock assessment, i.e., the stock size might be underestimated.

A note on nominal and actual fishing days is worthwhile. The assessment F provides the result of the actual fishing days used at sea, and the simulations providing Fmsy, as well as reductions in F (by e.g. 35%), apply to the actual fishing days used. One reason why the fishing mortality has been so low the last three years is the fact that as many as 40% of the nominal fishing days have not been used. Hence, in order to obtain the maximal sustainable yield in the future, the nominal fishing days have to be reduced considerably more than the actual fishing days.

The Faroese fishing sector has played a substantial role in reducing the fishing mortality the last three years by not utilizing all available days at sea. However, these un-utilized fishing days seem to represent a major obstacle in rebuilding the cod stock to levels where it is able to produce the maximum long-term yield, because they will likely be activated when more cod can be fished. The number of un-utilized fishing days is largest for the small boats (less than half of the days used). If the Faroese Parliament wants to reduce these fishing days, it would probably be appropriate to do it already now in 2010, because it may prove difficult to reduce fishing days when the cod fishery has recovered.

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 2006-2009 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, except in 2008 and 2009, but it is not believed that this has any relationship with a change in the environment.

4.17 References

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.

Steingrund, P., Mouritsen, R., Reinert, J., Gaard, E., and Hátún, H. 2010. Total stock size and cannibalism regulate recruitment in cod (*Gadus morhua*) on the Faroe Plateau. ICES Journal of Marine Science, 67: 111-124.

Table 4.2.1. Faroe Plateau (Sub-division Vb1) COD. Nominal catches (tonnes) by countries, 1986-2009, 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	2008	2009 *
Denmark	-										
Faroe Islands	19,156		29,762	40,602	30,259	17,540	13,556	11,629	9,905	9,394	10,749
France	- *	1	9 [2]	20	14	2	-	7	1 [2]	1	
Germany	39	2	9	6	7	3 [2]		1 [2]			
Iceland	-	-	-	5	-						
Norway	450	374	531 *	573	447	414	201	49	71	40	14
Greenland	-	-	-		-			5			
Portugal						1					
UK (E/W/NI)[2]	51	18	50	42	15	15	24	1	3		
UK (Scotland)[1]	-	-	-	-	-	-	-	-	358	383	338
United Kingdom											
Total	19,696	395	30,361	41,248	30,742	17,975	13,781	11,692	10,338	9,818	11,101

* Preliminary

1) Included in Vb2.

2) Reported as Vb.

Table 4.2.2. Nominal catch (tonnes) of COD in sub-division Vb1 (Faroe Plateau) 1986-2009, 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	2008	2009 *
Officially reported	19,696	395	30,361	41,248	30,742	17,975	13,781	11,692	10,338	9,818	11,101
Faroese catches in Vb1		21,793 *									
Correction of Faroese catches in Vb1 [1]			-1,766	-2,409	-1,795	-1,041	-804	-690	-588	-557	-638
Faroese catch on the Faroe-Iceland ridge	-1,600	-1,400	-700	-600	-4,700	-4,000	-4,200	-800	-1,800	-1,828	-487
Greenland[2]									6		26
Russia[2]											4
Catches reported as Vb2:											
UK (E/W/NI)	-	-	-	-	-	-					
UK (Scotland)	210	245	288	218	254	244	1,129	278	53	32	
United Kingdom				-	-	-	-				
Used in the assessment	18,306	21,033	28,183	38,457	24,501	13,178	9,906	10,480	8,009	7,465	10,006

*) 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). Not updated from last year.

	ST>1000HP			
Year	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	Total Round.weig
1986	3271.3	5217.3	1771.7	454.3	1008.6	2143.8	2919.1	10221.4	5130.7	1767.3	152.2	434.3	34,492
1987	2109.9	3150.6	1330.3	113.9	619.5	1418.7	1694.6	5528.5	3081.9	2106.0	110.0	29.5	21,303
1988	584.4	3080.5	1088.5	573.2	1670.9	1638.3	1518.4	5632.5	3483.0	2833.5	137.2	33.5	22,272
1989	913.8	5947.1	1161.3	647.5	1900.8	1167.2	1131.6	2163.2	1710.8	3637.3	146.5	6.9	20,535
1990	483.1	4344.9	592.1	175.8	1005.3	454.3	526.3	868.6	1281.8	2394.0	79.1	26.7	12,232
1991	349.2	2588.7	579.2	167.3	652.4	275.0	382.7	681.7	1062.2	1410.4	46.0	8.4	8,203
1992	155.4	1545.1	412.6	1.1	418.3	132.6	212.6	712.0	1233.1	796.5	294.8	24.0	5,938
1993	126.3	918.9	884.1	0.0	514.5	236.4	206.3	815.8	1249.1	723.1	46.4	23.2	5,744
1994	270.1	1172.9	837.8	46.7	1672.1	231.4	462.8	721.5	2066.5	1191.1	45.6	4.6	8,724
1995	806.0	3424.5	1237.8	58.7	4748.7	789.4	904.6	1226.8	2349.4	3520.8	11.1	1.1	19,079
1996	1576.2	7487.1	1576.2	0.0	7881.2	1182.2	788.1	3152.5	7487.1	8275.3	0.0	0.0	39,406
1997	1054.3	9513.2	1467.9	162.1	3280.2	1700.5	982.7	1609.9	3793.4	9963.7	4.5	23.5	33,556
1998	559.9	7265.0	1389.1	312.9	1515.3	1463.9	1271.7	721.9	1998.1	6775.5	22.4	10.1	23,308
1999	524.5	4592.2	1033.5	439.5	1039.0	998.2	2260.2	1220.1	2768.1	4189.2	78.4	14.4	19,156
2000	501.1	4206.0	1984.0	206.0	2290.6	2095.0	2772.3	1236.8	3022.9	3426.8	29.7	16.0	21,793
2001	1052.6	8164.2	2128.2	48.2	4491.4	1854.4	1832.7	1487.9	2651.5	5132.9	0.0	1.2	28,838
2002	1440.0	12616.1	2223.8	103.4	3790.3	2553.8	2535.5	946.2	2771.1	9367.0	0.2	0.0	38,347
2003	1444.8	8428.2	1163.3	445.6	2180.5	872.2	4234.0	655.1	2166.3	7781.6	0.0	10.4	29,382
2004	737.0	5223.6	355.2	92.1	1105.6	276.4	2162.3	360.7	1963.6	4493.3	0.0	5.5	16,772
2005	565.0	4260.1	791.4	131.0	830.3	375.2	4352.2	258.6	990.1	2910.4	0.0	3.3	15,472
2006	534.0	3023.7	277.3	20.6	611.4	137.2	1111.1	214.6	570.2	2132.1	0.0	1.0	8,636
2007	450.7	2497.6	234.2	25.5	542.8	154.3	1548.5	147.6	421.8	2840.6	0.0	1.1	8,866
2008	389.6	2506.5	358.5	51.1	494.0	246.4	1115.6	75.5	237.6	2190.1	0.0	0.0	7,666
2009	493.9	2973.6	309.7	21.1	721.5	177.6	137.6	198.7	465.1	1646.1	0.0	0.0	7,146

Table 4.2.5. Faroe Plateau COD. Catch in numbers at age per fleet in 2009. 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 400-1000H	Single trwl > 1000 HP	Pair trwl 700-999 HI	Pair trwl > 1000 HP	Longliners > 100 GRT	Gillnetters	Others (scaling)	Catch-at-age
2	91	485	117	96	13	4	0	2	74	0	-6	876
3	164	974	275	229	117	37	5	25	456	0	-14	2268
4	62	344	101	68	40	33	10	35	174	0	-4	863
5	45	275	81	51	24	18	10	30	88	1	-4	619
6	17	120	29	20	8	9	7	19	68	1	-1	297
7	4	23	3	2	3	4	5	10	29	2	0	85
8	7	9	4	2	2	1	4	6	20	0	0	55
9	1	5	4	2	1	0	3	3	23	2	-1	43
10+	0	1	0	0	1	0	2	2	11	0	0	17
Sum	391	2236	614	470	209	106	46	132	943	6	-30	5123
G.weight	578	3432	842	617	356	269	201	469	2261	42	-53	9014

Others include industrial bottom trawlers, longlining for halibut, 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 1961-2009.

	age									
year	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	1182	1168	499	706	852	355	81	11	3
2007	0	540	1307	771	336	308	272	91	21	3
2008	0	293	776	799	439	191	160	159	58	20
2009	0	876	2268	863	619	297	85	55	43	17

Table 4.2.7. Faroe Plateau COD. Catch weight at age 1961-2009.

year \ age	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
2008	0	1.209	1.478	2.104	2.714	3.804	4.669	5.915	7.233	9.559
2009	0	0.805	1.431	2.287	2.723	3.435	5.081	6.281	8.312	9.959

Table 4.2.8. Faroe Plateau (sub-division Vb1) COD. Proportion mature at age 1983-2009. From 1961-1982 the average from 1983-1996 is used (as it was used in the 1990s).

	age									
year	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
2008	0	0.10	0.78	0.91	0.90	0.95	1.00	1.00	1	1
2009	0	0.09	0.61	0.81	0.96	0.94	0.96	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 2008
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
 200   68.8    370.1    328       401.2   160.1    52.4   27.5
 200  428.2   1980.6    817.7     551.4   393.1   132.1   47.8

SPRING SURVEY (shifted back to december)
1993 2008
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
 100   266.8    464       968.1    1151.1     425.1      73.4    31.4    24.8
 100   734.6   1285       737       534.9     378.8      98.4    40.8    17.1
```

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. The series differs from the one presented in the last years report, because the season is now September – December (and not January and June-December). Also the otoliths are only selected from deep (> 150 m) locations.

	2	3	4	5	6	7	8	9
1989	1200	1638	1783	1381	928	719	297	194
1990	116	2856	2057	834	465	419	200	0
1991	8	148	1401	869	329	225	65	93
1992	84	487	696	1234	760	353	129	62
1993	51	1081	2192	746	1062	398	67	107
1994	1314	2129	1457	2208	697	1241	461	53
1995	577	3645	5178	4199	2769	543	539	106
1996	242	10608	16683	7985	4410	194	0	723
1997	28	674	6038	9375	2413	944	113	0
1998	80	731	1805	5941	4904	801	286	0
1999	444	2082	1933	3008	5136	2220	218	4
2000	3478	3956	1737	956	1003	1694	382	0
2001	3385	6700	3009	555	415	797	862	25
2002	571	6409	5019	1235	432	400	41	228
2003	63	1341	4450	3630	870	270	152	145
2004	23	0	278	2534	2831	1733	274	184
2005	42	399	655	1766	2171	860	148	70
2006	93	135	699	755	1580	612	787	71
2007	64	916	1767	1392	802	656	206	46
2008	54	295	418	573	387	456	487	182
2009	11	734	801	756	448	247	147	105

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.

	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8
1993	405	2610	9306	3330	806	2754	847	258
1994	101	8105	14105	7863	4659	962	1187	71
1995	0	15249	23062	2895	2505	1568	708	1073
1996	0	2269	18658	13265	4153	8435	4513	1147
1997	0	1738	5837	26368	18089	2805	2807	402
1998	1892	4490	2025	2565	11738	2732	131	19
1999	849	10968	3811	985	1891	3759	548	109
2000	2695	10983	6710	998	780	1473	2136	109
2001	287	12999	7409	2660	515	1135	1808	2545
2002	105	6862	20902	10819	7759	1561	1945	1265
2003	16	2099	6057	15910	7778	1830	708	650
2004	59	510	1773	2438	3214	1059	293	71
2005	290	2119	1507	2260	2274	1329	166	12
2006	115	4428	4051	513	1679	1792	875	42
2007	279	3647	6507	2832	1964	1182	1140	137
2008	1247	2201	4366	4684	2516	1112	801	702
2009	302	2736	15482	6465	3103	2553	700	135

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

Lowestoft VPA Version 3.1

17/04/2010 18:06

Extended Survivors Analysis

COD FAROE PLATEAU (ICES SUBDIVISION Vb1) COD_ind_Surveys10.txt

CPUE data from file Surveys.TXT

Catch data for 49 years. 1961 to 2009. Ages 1 to 10.

Fleet,	First, year,	Last, year,	First, age ,	Last, age	Alpha,	Beta
SUMMER SURVEY ,	1996,	2009,	2,	8,	.600,	.700
SPRING SURVEY (shift,	1993,	2009,	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 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,	2000,	2001,	2002,	2003,	2004,	2005,	2006,	2007,	2008,	2009
1,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000
2,	.125,	.157,	.190,	.128,	.031,	.094,	.187,	.107,	.041,	.076
3,	.319,	.345,	.490,	.304,	.187,	.257,	.333,	.325,	.220,	.511
4,	.379,	.455,	.599,	.663,	.298,	.383,	.360,	.384,	.339,	.406
5,	.247,	.307,	.821,	.850,	.754,	.472,	.613,	.440,	.394,	.480
6,	.326,	.350,	.827,	.906,	.981,	.770,	.818,	.600,	.485,	.510
7,	.530,	.695,	1.360,	.896,	1.125,	.831,	.946,	.681,	.736,	.414
8,	.787,	.618,	1.220,	.926,	1.050,	.569,	.988,	.679,	1.194,	.611
9,	.189,	.706,	1.182,	1.671,	1.965,	1.089,	.289,	.764,	1.414,	1.428

XSA population numbers (Thousands)

	AGE								
YEAR ,	1,	2,	3,	4,	5,	6,	7,	8,	9,
2000 ,	3.63E+04,	1.97E+04,	1.07E+04,	2.74E+03,	2.15E+03,	2.68E+03,	2.17E+03,	2.11E+02,	4.50E+01,
2001 ,	1.62E+04,	2.97E+04,	1.43E+04,	6.35E+03,	1.53E+03,	1.37E+03,	1.58E+03,	1.05E+03,	7.86E+01,
2002 ,	7.61E+03,	1.33E+04,	2.08E+04,	8.27E+03,	3.30E+03,	9.23E+02,	7.92E+02,	6.48E+02,	4.62E+02,
2003 ,	4.44E+03,	6.23E+03,	8.98E+03,	1.04E+04,	3.72E+03,	1.19E+03,	3.31E+02,	1.67E+02,	1.57E+02,
2004 ,	7.46E+03,	3.63E+03,	4.49E+03,	5.42E+03,	4.39E+03,	1.30E+03,	3.93E+02,	1.10E+02,	5.40E+01,
2005 ,	9.35E+03,	6.11E+03,	2.88E+03,	3.05E+03,	3.30E+03,	1.69E+03,	4.00E+02,	1.04E+02,	3.17E+01,
2006 ,	7.21E+03,	7.66E+03,	4.55E+03,	1.82E+03,	1.70E+03,	1.68E+03,	6.42E+02,	1.43E+02,	4.84E+01,
2007 ,	9.74E+03,	5.90E+03,	5.20E+03,	2.67E+03,	1.04E+03,	7.55E+02,	6.08E+02,	2.04E+02,	4.35E+01,
2008 ,	1.61E+04,	7.97E+03,	4.35E+03,	3.07E+03,	1.49E+03,	5.49E+02,	3.39E+02,	2.52E+02,	8.47E+01,
2009 ,	4.11E+04,	1.32E+04,	6.26E+03,	2.86E+03,	1.79E+03,	8.22E+02,	2.77E+02,	1.33E+02,	6.25E+01,

Estimated population abundance at 1st Jan 2010

,	0.00E+00,	3.37E+04,	1.00E+04,	3.07E+03,	1.56E+03,	9.09E+02,	4.04E+02,	1.50E+02,	5.91E+01,

Taper weighted geometric mean of the VPA populations:

,	1.66E+04,	1.33E+04,	9.92E+03,	6.19E+03,	3.39E+03,	1.66E+03,	7.49E+02,	3.01E+02,	1.22E+02,

Standard error of the weighted Log(VPA populations) :

,	.6120,	.5978,	.5929,	.5845,	.5675,	.5847,	.6273,	.7030,	.8214,

Log catchability residuals.

Fleet : SUMMER SURVEY

Age	1993	1994	1995	1996	1997	1998	1999
1	No data for this fleet at this age						
2	99.99	99.99	99.99	-.17	.20	.35	-.88
3	99.99	99.99	99.99	.17	-.19	-.56	.56
4	99.99	99.99	99.99	.29	.40	-.50	-.04
5	99.99	99.99	99.99	.74	.01	.32	-.63
6	99.99	99.99	99.99	.23	-.13	.66	.17
7	99.99	99.99	99.99	.34	.02	-.32	.57
8	99.99	99.99	99.99	-.17	-.27	.14	.44

Age	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1	No data for this fleet at this age									
2	.12	.65	1.09	-.08	.61	.48	.77	-.45	-2.02	-.67
3	-.38	.10	.63	-.33	.08	.43	-.04	-.60	-.69	.82
4	.16	.19	.18	.19	-.11	.31	-.11	-.58	-.71	.32
5	-.71	-.04	.19	-.27	.51	.33	-.24	-.41	.01	.19
6	-.58	-.52	-.28	-.66	.33	.71	-.33	-.32	.10	.61
7	.08	-.25	-.35	-1.33	.16	.53	-.02	-.62	-.37	.55
8	-.25	-.04	-.42	-1.02	.24	.54	.04	-.43	-.42	.39

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,	-7.8769,	-6.8025,	-6.4791,	-6.2301,	-6.1875,	-6.1875,	-6.1875,
S.E(Log q),	.8091,	.4842,	.3601,	.4205,	.4690,	.5291,	.4351,

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,	1.01,	-.028,	7.86,	.33,	14,	.85,	-7.88,
3,	.91,	.516,	7.00,	.72,	14,	.45,	-6.80,
4,	.83,	1.529,	6.82,	.88,	14,	.29,	-6.48,
5,	.84,	1.121,	6.51,	.80,	14,	.35,	-6.23,
6,	.91,	.464,	6.29,	.68,	14,	.44,	-6.19,
7,	.90,	.464,	6.28,	.64,	14,	.49,	-6.26,
8,	1.34,	-1.492,	6.59,	.61,	14,	.55,	-6.28,

Fleet : SPRING SURVEY (shift

Age	1993	1994	1995	1996	1997	1998	1999
1	.03	-.28	.34	-.44	-.53	.53	-.40
2	-.77	-.82	.31	.03	-.07	.49	.39
3	-.53	.06	.12	.08	-.06	.19	.15
4	-.49	.04	.60	.01	.26	-.15	-.43
5	-.58	.77	.37	-.11	.27	.20	-.54
6	-.57	.85	.48	-.10	-.05	.23	.38
7	-.33	.42	.10	-.17	-.24	-.23	.12
8	-4.66	.74	.09	-1.60	.82	.01	-1.34

Age	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1	.30	.18	-.54	1.68	.79	-.25	-1.16	-.17	-.08	.00
2	.58	.81	-.11	.12	.45	-1.03	-.60	.06	-.18	.36
3	.29	.38	.58	-.46	.45	-.93	-.82	.07	.39	.03
4	-.07	.40	.14	-.15	.32	-.45	-.79	-.05	.72	.09
5	-.32	.09	.34	-.37	.41	-.66	-.40	-.21	.47	.25
6	.34	.10	-.32	-.46	.28	-.60	-.44	-.09	.02	-.06
7	-.75	.03	.07	-.29	-.69	-.90	-.36	-.54	-.10	.05
8	-1.67	.06	-.13	-.19	-.80	-1.17	.22	-.51	.39	.11

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	-8.4397	-7.0361	-6.0980	-5.7952	-5.7674	-5.9919	-5.9919	-5.9919
S.E(Log q)	.6330	.5355	.4371	.3984	.4290	.4016	.4209	1.4269

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	1.09	-.353	8.34	.53	17	.71	-8.44
2	.86	.781	7.34	.69	17	.47	-7.04
3	.81	1.454	6.64	.80	17	.34	-6.10
4	.83	1.454	6.27	.82	17	.32	-5.80
5	.87	.897	6.05	.77	17	.38	-5.77
6	.97	.195	6.03	.69	17	.40	-5.99
7	.93	.499	6.23	.79	17	.34	-6.22
8	.59	1.679	6.07	.52	17	.72	-6.56

Terminal year survivor and F summaries :

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

Year class = 2008

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SUMMER SURVEY	1.	.000	.000	.00	0	.000	.000
SPRING SURVEY (shift	33652.	.651	.000	.00	1	1.000	.000
F shrinkage mean	0.	2.00				.000	.000

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
33652.	.65	.00	1	.000	.000

Age 2 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	5123.	.838	.000	.00	1	.194	.144
SPRING SURVEY (shift	11990.	.421	.217	.52	2	.769	.064
F shrinkage mean	8206.	2.00				.037	.092

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
10025.	.37	.22	4	.605	.076

Age 3 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	3368.	.430	1.236	2.87	2	.332	.476
SPRING SURVEY (shift	2842.	.307	.073	.24	3	.643	.544

```
  F shrinkage mean  ,      6736.,   2.00,,,,                      .026,     .266

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      3074.,       .25,      .33,    6,   1.315,   .511


 Age  4   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       ,      1514.,  .284,       .328,   1.16,   3,  .443,     .416
 SPRING SURVEY (shift,      1586.,  .248,       .264,   1.06,   4,  .543,     .400

  F shrinkage mean  ,      1833.,   2.00,,,,                      .015,     .355

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      1557.,       .19,      .17,    8,    .929,   .406

 Age  5   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       ,       702.,  .245,       .277,   1.13,   4,  .470,     .587
 SPRING SURVEY (shift,      1155.,  .226,       .200,    .88,   5,  .515,     .395

  F shrinkage mean  ,       784.,   2.00,,,,                      .015,     .539

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
       909.,       .17,      .17,   10,   1.005,   .480


 Age  6   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       ,       432.,  .230,       .231,   1.01,   5,  .449,     .484
 SPRING SURVEY (shift,       387.,  .211,       .209,    .99,   6,  .537,     .527

  F shrinkage mean  ,       246.,   2.00,,,,                      .015,     .738

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
       404.,       .16,      .14,   12,    .908,   .510


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

 Year class = 2002

 Fleet,                Estimated,   Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,   s.e,       s.e,   Ratio,    , Weights,    F
 SUMMER SURVEY       ,       172.,  .229,       .161,    .70,   6,  .423,     .369
 SPRING SURVEY (shift,       138.,  .205,       .197,    .96,   7,  .562,     .442

  F shrinkage mean  ,        55.,   2.00,,,,                      .014,     .873

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
       150.,       .15,      .13,   14,    .833,   .414
```

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

Year class = 2001

Fleet,	Estimated,	Int,	Ext,	Var,	N,	Scaled,	Estimated
,	Survivors,	s.e,	s.e,	Ratio,	,	Weights,	F
SUMMER SURVEY ,	66.,	.262,	.138,	.53,	7,	.572,	.562
SPRING SURVEY (shift,	53.,	.228,	.083,	.36,	8,	.400,	.666
F shrinkage mean ,	34.,	2.00,,,,				.028,	.906

Weighted prediction :

Survivors,	Int,	Ext,	N,	Var,	F
at end of year,	s.e,	s.e,	,	Ratio,	
59.,	.18,	.08,	16,	.457,	.611

Age 9 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 ,	9.,	.264,	.112,	.43,	7,	.486,	1.702
SPRING SURVEY (shift,	9.,	.234,	.129,	.55,	8,	.337,	1.706
F shrinkage mean ,	62.,	2.00,,,,				.177,	.488

Weighted prediction :

Survivors,	Int,	Ext,	N,	Var,	F
at end of year,	s.e,	s.e,	,	Ratio,	
12.,	.39,	.23,	16,	.585,	1.428

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

YEAR	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	0.7036	0.826	0.8404	0.5411	0.7136	0.7136	0.6695
1987	0.0291	0.2211	0.4759	0.4855	0.5563	0.49	0.6229	0.5304	0.5304	0.4458
1988	0.067	0.3538	0.5649	0.55	0.7751	0.8003	0.8658	0.7181	0.7181	0.6088
1989	0.1675	0.4426	0.7641	0.7647	0.9656	1.0631	1.1076	0.9433	0.9433	0.8
1990	0.0756	0.3336	0.6316	0.7893	0.7041	0.8422	1.1261	0.8271	0.8271	0.6601
1991	0.0323	0.1959	0.4547	0.6009	0.7382	0.5776	0.7145	0.6227	0.6227	0.5135
1992	0.0201	0.0998	0.319	0.3533	0.6425	0.8701	0.4407	0.5293	0.5293	0.4569
1993	0.0132	0.1019	0.1861	0.2467	0.2069	0.4473	0.5509	0.3296	0.3296	0.2378
1994	0.0255	0.1128	0.1905	0.249	0.2137	0.1628	0.3283	0.9823	0.9823	0.1858
1995	0.0702	0.1617	0.4646	0.2801	0.3593	0.3212	0.2417	0.7669	0.7669	0.3174
1996	0.0306	0.1927	0.452	0.8091	0.9047	1.1298	0.8587	1.0849	1.0849	0.6977
1997	0.0348	0.1487	0.4115	0.8329	1.045	1.3961	1.3087	0.8589	0.8589	0.7668
1998	0.0887	0.1758	0.2727	0.6468	1.0517	0.7872	1.1569	0.7841	0.7841	0.5868
1999	0.0958	0.2839	0.2901	0.3175	0.6556	1.0589	0.7823	0.4839	0.4839	0.5212
2000	0.1246	0.3191	0.3795	0.2474	0.3256	0.5299	0.7873	0.1887	0.1887	0.3603
2001	0.1573	0.3445	0.4553	0.3073	0.35	0.6947	0.6181	0.7057	0.7057	0.4304
2002	0.1903	0.4901	0.599	0.8214	0.827	1.3601	1.2201	1.182	1.182	0.8195
2003	0.1282	0.3038	0.6634	0.85	0.9059	0.8958	0.9264	1.671	1.671	0.7238
2004	0.0309	0.1866	0.2975	0.7537	0.9808	1.1245	1.0501	1.9653	1.9653	0.6686
2005	0.0937	0.2574	0.3827	0.4716	0.7705	0.8305	0.5687	1.0888	1.0888	0.5425
2006	0.187	0.3334	0.3599	0.6132	0.8184	0.9456	0.9883	0.289	0.289	0.6141
2007	0.1066	0.3254	0.3843	0.4404	0.5996	0.6813	0.6791	0.7639	0.7639	0.4862
2008	0.0415	0.2198	0.3385	0.3943	0.4849	0.7365	1.1944	1.4138	1.4138	0.4348
2009	0.0761	0.5114	0.4065	0.48	0.5099	0.4142	0.6107	1.4281	1.4281	0.4644

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

YEAR	2	3	4	5	6	7	8	9	10+	TOTAL
1961	12019	7385	3747	2699	666	668	155	66	0	52630
1962	20654	7042	3616	1863	1245	335	210	56	0	59804
1963	20290	12907	3503	1825	752	584	190	87	0	66807
1964	21834	12893	6986	1710	895	358	294	112	0	55183
1965	8269	16037	7823	3639	830	416	151	169	0	60009
1966	18566	5999	10207	4085	1698	351	200	80	0	69829
1967	23451	13990	4034	6475	2133	842	109	70	0	72579
1968	17582	17744	9020	2525	3757	980	410	31	0	63439
1969	9325	13012	11522	4976	1212	1967	393	240	0	53161
1970	8608	6840	7843	6447	2682	561	965	138	0	48654
1971	11928	6684	4548	4456	3754	1516	238	519	0	59683
1972	21320	9469	4788	2981	2483	1760	779	92	0	59029
1973	12573	16664	6689	3187	1901	1109	902	499	400	81153
1974	30480	9639	10816	4037	1969	1209	626	533	342	106456
1975	38319	23000	6747	7217	2460	1103	581	378	476	102968
1976	18575	29035	13683	3572	3908	1279	636	304	466	83665
1977	9995	13853	20010	7765	1676	1909	489	274	18	69116
1978	10748	7799	8372	10190	2993	659	513	184	154	59930
1979	14997	8298	5282	4463	5433	1509	297	238	103	69423
1980	23582	11759	5226	2811	2206	2723	789	122	52	66369
1981	14000	18286	7579	2957	1491	1076	1477	339	150	74381
1982	22127	10878	11228	4413	1564	694	440	732	348	83150
1983	25156	17085	7128	6412	2449	854	284	207	200	118103
1984	47753	18652	8766	3339	2765	916	238	91	174	103839
1985	17312	35119	10535	4022	1411	1439	466	121	146	82175
1986	9501	13271	20171	5191	1783	459	389	102	81	63037
1987	9898	7588	7620	8858	2103	639	162	185	69	47726
1988	8681	7871	4981	3877	4463	987	321	71	53	50882
1989	16030	6647	4524	2318	1831	1683	363	110	16	38030
1990	3691	11100	3496	1725	883	571	476	98	50	30250
1991	6681	2802	6510	1522	641	358	201	126	57	32825
1992	11403	5296	1886	3383	683	251	164	81	90	35579
1993	10105	9150	3924	1122	1945	294	86	87	98	57578
1994	25190	8164	6766	2667	718	1295	154	41	28	97122
1995	42655	20105	5971	4578	1702	475	901	91	100	92306
1996	12876	32557	14003	3072	2833	973	282	579	77	75141
1997	6459	10224	21983	7295	1120	939	257	98	227	55840
1998	5926	5107	7215	11927	2597	322	190	57	50	50906
1999	14340	4440	3507	4497	5114	743	120	49	20	56918
2000	19722	10668	2737	2148	2680	2174	211	45	6	76666
2001	29699	14255	6349	1533	1373	1585	1048	79	13	72131
2002	13262	20776	8269	3297	923	792	648	462	11	56049
2003	6229	8976	10420	3719	1187	331	167	157	26	35648
2004	3632	4487	5424	4394	1301	393	110	54	46	27300
2005	6107	2883	3048	3298	1693	400	104	32	49	26966
2006	7658	4553	1825	1702	1685	642	143	48	13	25479
2007	5904	5200	2671	1042	755	608	204	43	6	26170
2008	7971	4345	3075	1489	549	339	252	85	29	34272
2009	13213	6261	2856	1794	822	277	133	63	24	66545
2010	33652	10025	3074	1557	909	404	150	59	17	49848

Table 4.6.4. Faroe Plateau (sub-division Vb1) COD. Summary table (1961-2009) and results from the short term prediction (2010-2012) are shown in bold.

	RECRUITS Age 2	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 3-7
1961	12019	65428	46439	21598	0.4651	0.6059
1962	20654	68225	43326	20967	0.4839	0.5226
1963	20290	77602	49054	22215	0.4529	0.4944
1964	21834	84666	55362	21078	0.3807	0.5017
1965	8269	75043	57057	24212	0.4244	0.4909
1966	18566	83919	60629	20418	0.3368	0.4743
1967	23451	105289	73934	23562	0.3187	0.39
1968	17582	110433	82484	29930	0.3629	0.4642
1969	9325	105537	83487	32371	0.3877	0.4375
1970	8608	98398	82035	24183	0.2948	0.3882
1971	11928	78218	63308	23010	0.3635	0.3526
1972	21320	76439	57180	18727	0.3275	0.3358
1973	12573	110713	83547	22228	0.2661	0.2886
1974	30480	139266	98434	24581	0.2497	0.3139
1975	38319	153663	109565	36775	0.3356	0.3947
1976	18575	161260	123077	39799	0.3234	0.4749
1977	9995	136211	112057	34927	0.3117	0.6757
1978	10748	96227	78497	26585	0.3387	0.4259
1979	14997	85112	66722	23112	0.3464	0.4273
1980	23582	85037	58886	20513	0.3484	0.3945
1981	14000	88409	63560	22963	0.3613	0.4648
1982	22127	98959	67031	21489	0.3206	0.4138
1983	25156	123244	78538	38133	0.4855	0.7057
1984	47753	152128	96759	36979	0.3822	0.5082
1985	17312	131199	84764	39484	0.4658	0.7016
1986	9501	99217	73658	34595	0.4697	0.6695
1987	9898	78283	62185	21391	0.344	0.4458
1988	8681	66043	52047	23182	0.4454	0.6088
1989	16030	58745	38282	22068	0.5765	0.8
1990	3691	38038	29036	13487	0.4645	0.6601
1991	6681	28686	21053	8750	0.4156	0.5135
1992	11403	35718	20746	6396	0.3083	0.4569
1993	10105	51109	33100	6107	0.1845	0.2378
1994	25190	83977	42553	9046	0.2126	0.1858
1995	42655	144405	54308	23045	0.4243	0.3174
1996	12876	142512	85217	40422	0.4743	0.6977
1997	6459	96988	81699	34304	0.4199	0.7668
1998	5926	66172	55810	24005	0.4301	0.5868
1999	14340	64988	44980	18306	0.407	0.5212
2000	19722	91094	46140	21033	0.4558	0.3603
2001	29699	109954	59040	28183	0.4774	0.4304
2002	13262	98355	55979	38457	0.687	0.8195
2003	6229	60513	40487	24501	0.6052	0.7238
2004	3632	37087	27120	13178	0.4859	0.6686
2005	6107	31939	23533	9906	0.4209	0.5425
2006	7658	30377	20953	10480	0.5002	0.6141
2007	5904	28202	17462	8009	0.4586	0.4862
2008	7971	32620	21443	7465	0.3481	0.4348
2009	13213	36838	22003	10006	0.4548	0.4644
2010	**22675**	**64081**	**32273**	**14048**	**0.4353**	**0.4618**
2011	**22675**	**85864**	**49976**	**20123**	**0.4027**	**0.4618**
2012	**13213**	**81581**	**55293**			
Avg.61-09	15843	85765	59277	22983	0.4001	0.5033

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

	Recr.	Source
YC2007	13213	XSA-output
YC2008	22675	Regressions
YC2009	22675	Same as YC2008
YC2010	13213	Same as YC2007

Age	Stock size 2009	Source
2	22675	Regressions
3	10025	XSA-output
4	3074	XSA-output
5	1557	XSA-output
6	909	XSA-output
7	404	XSA-output
8	150	XSA-output
9	59	XSA-output
10+	17	XSA-output

	Maturity			Exploitation pattern (not rescaled)			Weights		
	Observed	Av. 08-10	Av. 08-10	Av. 07-09	Av. 07-09	Av. 07-09		As 2010	Av.08-10
Age	2010	2011	2012	2010	2011	2012	2010	2011	2012
2	0.08	0.09	0.09	0.0747	0.0747	0.0747	1.053	1.053	1.022
3	0.61	0.67	0.67	0.3522	0.3522	0.3522	1.916	1.916	1.608
4	0.77	0.83	0.83	0.3764	0.3764	0.3764	2.729	2.729	2.373
5	0.94	0.93	0.93	0.4382	0.4382	0.4382	3.413	3.413	2.95
6	0.97	0.95	0.95	0.5315	0.5315	0.5315	3.768	3.768	3.669
7	1.00	0.99	0.99	0.6107	0.6107	0.6107	5.226	5.226	4.992
8	1.00	1.00	1.00	0.8281	0.8281	0.8281	7.347	7.347	6.514
9	1.00	1.00	1.00	1.2019	1.2019	1.2019	8.12	8.12	7.888
10+	1.00	1.00	1.00	1.2019	1.2019	1.2019	10.368	10.368	9.962

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

2010 Biomass	SSB	FMult	FBar	Landings
64081	32273	1.0000	0.4618	14048

2011 Biomass	SSB	FMult	FBar	Landings	2012 Biomass	SSB
85864	49976	0.0000	0.0000	0	103398	74300
.	49976	0.1000	0.0462	2089	100809	72030
.	49976	0.2000	0.0924	4096	98322	69853
.	49976	0.3000	0.1385	6025	95933	67765
.	49976	0.4000	0.1847	7880	93637	65761
.	49976	0.5000	0.2309	9664	91429	63837
.	49976	0.6000	0.2771	11380	89305	61989
.	49976	0.7000	0.3233	13032	87262	60214
.	49976	0.8000	0.3694	14623	85296	58509
.	49976	0.9000	0.4156	16155	83404	56870
.	49976	1.0000	0.4618	17631	81581	55293
.	49976	1.1000	0.5080	19053	79826	53778
.	49976	1.2000	0.5542	20424	78135	52319
.	49976	1.3000	0.6003	21746	76505	50916
.	49976	1.4000	0.6465	23022	74934	49565
.	49976	1.5000	0.6927	24252	73419	48265
.	49976	1.6000	0.7389	25440	71958	47012
.	49976	1.7000	0.7851	26586	70548	45806
.	49976	1.8000	0.8312	27693	69188	44644
.	49976	1.9000	0.8774	28762	67876	43524
.	49976	2.0000	0.9236	29795	66608	42444

Input units are thousands and kg - output in tonnes

Table 4.7.3. Faroe Plateau (sub-division Vb1) COD. Input to management option table. Procedures as in the last year's assessment.

	Recr.	Source
YC2007	13213	XSA-output
YC2008	33652	XSA-output
YC2009	13680	Average R in 2006-10
YC2010	13680	Same as YC2009

Age	Stock size 2009	Source
2	33652	XSA-output
3	10025	XSA-output
4	3074	XSA-output
5	1557	XSA-output
6	909	XSA-output
7	404	XSA-output
8	150	XSA-output
9	59	XSA-output
10+	17	XSA-output

	Maturity			Exploitation pattern (not rescaled)			Weights		
	Observed	Av. 08-10	Av. 08-10	Av. 07-09	Av. 07-09	Av. 07-09		As 2010	Av.08-10
Age	2010	2011	2012	2010	2011	2012	2010	2011	2012
2	0.08	0.09	0.09	0.0747	0.0747	0.0747	1.053	1.053	1.022
3	0.61	0.67	0.67	0.3522	0.3522	0.3522	1.916	1.916	1.608
4	0.77	0.83	0.83	0.3764	0.3764	0.3764	2.729	2.729	2.373
5	0.94	0.93	0.93	0.4382	0.4382	0.4382	3.413	3.413	2.95
6	0.97	0.95	0.95	0.5315	0.5315	0.5315	3.768	3.768	3.669
7	1.00	0.99	0.99	0.6107	0.6107	0.6107	5.226	5.226	4.992
8	1.00	1.00	1.00	0.8281	0.8281	0.8281	7.347	7.347	6.514
9	1.00	1.00	1.00	1.2019	1.2019	1.2019	8.12	8.12	7.888
10+	1.00	1.00	1.00	1.2019	1.2019	1.2019	10.368	10.368	9.962

Table 4.7.4. Faroe Plateau (sub-division Vb1) COD. Management option table. Procedures as in

2010 Biomass	SSB	FMult	FBar	Landings
75640	33197	1.0000	0.4618	14804

2011 Biomass	SSB	FMult	FBar	Landings	2012 Biomass	SSB
92372	59830	0.0000	0.0000	0	108237	79858
.	59830	0.1000	0.0462	2820	105176	77182
.	59830	0.2000	0.0924	5531	102235	74614
.	59830	0.3000	0.1385	8137	99410	72150
.	59830	0.4000	0.1847	10644	96695	69785
.	59830	0.5000	0.2309	13056	94086	67514
.	59830	0.6000	0.2771	15377	91577	65333
.	59830	0.7000	0.3233	17611	89164	63238
.	59830	0.8000	0.3694	19762	86844	61225
.	59830	0.9000	0.4156	21834	84611	59290
.	59830	1.0000	0.4618	23829	82463	57430
.	59830	1.1000	0.5080	25751	80395	55642
.	59830	1.2000	0.5542	27604	78404	53922
.	59830	1.3000	0.6003	29389	76488	52268
.	59830	1.4000	0.6465	31111	74642	50676
.	59830	1.5000	0.6927	32770	72864	49145
.	59830	1.6000	0.7389	34371	71151	47671
.	59830	1.7000	0.7851	35915	69500	46252
.	59830	1.8000	0.8312	37404	67910	44886
.	59830	1.9000	0.8774	38842	66377	43571
.	59830	2.0000	0.9236	40229	64899	42304

Input units are thousands and kg - output in tonnes

the last year's assessment.

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

	Expl. pattern	Weight at age	Prop mature
Age	Average 2000-2009 Not rescaled	Average 1978-2009	Average 1983-2010
2	0.1136	1.0462	0.08
3	0.3292	1.5684	0.56
4	0.4267	2.2619	0.84
5	0.5379	3.0458	0.94
6	0.6573	3.8214	0.98
7	0.8213	4.8583	0.99
8	0.8643	6.0807	1.00
9	1.0696	7.6658	1.00
10+	1.0696	9.5327	1.00

Table 4.8.2. Faroe Plateau (sub-division Vb1) COD. Output from yield per recruit calculations (long term prediction).

Reference point	F multiplier	Absolute F
Fbar(3-7)	1.0000	0.5545
FMax	0.4373	0.2425
F0.1	0.1985	0.11
F35%SPR	0.3095	0.1716
Flow	0.1766	0.0979
Fmed	0.7416	0.4112
Fhigh	1.8577	1.03

Weights in kilograms

Table 4.8.3. Faroe Plateau (sub-division Vb1) COD. Input to long-term simulations: modelling of weight-at-age and F-at-age as a function of individual growth.

Modelling weight-at-age as a function of annual growth
Growth is for the period from 1997 to 2006 (lag 0), 2005 (lag 1) or 2004 (lag 2)

	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10+
Lag (years)	1	1	1	2	2	2	0	0	1
Correlation coeff.	0.59	0.68	0.68	0.68	0.63	-0.67	0.95	0.92	0.87
N-2	7	7	7	6	6	6	8	8	7
F	3.82	6.05	5.95	5.27	3.86	4.83	73.02	42.56	21.65
P	0.08	0.04	0.05	0.06	0.09	0.07	0.01	0.01	0.02
Slope	**0.204**	**0.468**	**0.757**	**0.891**	**0.566**	**-0.473**	**2.605**	**3.242**	**3.663**
Intercept	**0.854**	**1.159**	**1.629**	**2.303**	**3.289**	**5.307**	**4.185**	**5.114**	**6.740**

Modelling F-at-age as a function of annual growth
Growth is for the period from 1997 to 2006 (lag 0), 2005 (lag 1) or 2004 (lag 2)

	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10+
Lag (years)	2	2	2	0	1	0	0	1	1
Correlation coeff.	0.77	0.84	0.66	-0.81	-0.85	-0.68	-0.71	-0.60	-0.60
N-2	6	6	6	8	7	8	8	7	7
F	8.68	14.58	4.62	14.81	17.80	6.92	8.02	3.86	3.86
P	0.04	0.03	0.07	0.01	0.02	0.03	0.02	0.08	0.08
Slope	**0.078**	**0.139**	**0.171**	**-0.380**	**-0.423**	**-0.380**	**-0.357**	**-0.702**	**-0.702**
Intercept	**0.060**	**0.197**	**0.284**	**0.940**	**1.122**	**1.316**	**1.273**	**1.558**	**1.558**

Table 4.8.4. Faroe Plateau (sub-division Vb1) COD. Output from long-term simulations: optimal values for Fmultiplier, Actual F and catch.

Ref. F 0.6

Simulation settings	Variable	Period				Min	Median	Max
		6 years	8 years	10 years	12 years			
Status quo growth	F mult.	0.65	0.65	0.65	0.6			
Less variable growth	F mult.	0.65	0.65	0.65	0.65	0.50	0.65	0.75
Increased growth	F mult.	0.75	0.75	0.75	0.65			
Decreased growth	F mult.	0.55	0.55	0.55	0.5			
Status quo growth	Actual F	0.39	0.39	0.39	0.36			
Less variable growth	Actual F	0.39	0.39	0.39	0.39	0.30	0.39	0.45
Increased growth	Actual F	0.45	0.45	0.45	0.39			
Decreased growth	Actual F	0.33	0.33	0.33	0.3			
Status quo growth	Catch (t)	28471	27497	25907	24409			
Less variable growth	Catch (t)	31713	31462	31153	30906	21732	27983	31713
Increased growth	Catch (t)	31017	29915	28468	27270			
Decreased growth	Catch (t)	25863	25135	23429	21732			

Table 4.10.1. Faroe Plateau (sub-division Vb1) COD. Population variables the terminal year, as observed in the current assessment, compared with what was predicted last year.

Variable	Assm. 2009	Assm. 2010	Change%
Year	2009	2009	
Recruitment	11321	13213	17
Total stock biomass	30745	36838	20
Spawning stock biomass	15877	22003	39
Fishing mortality	0.61	0.46	-24

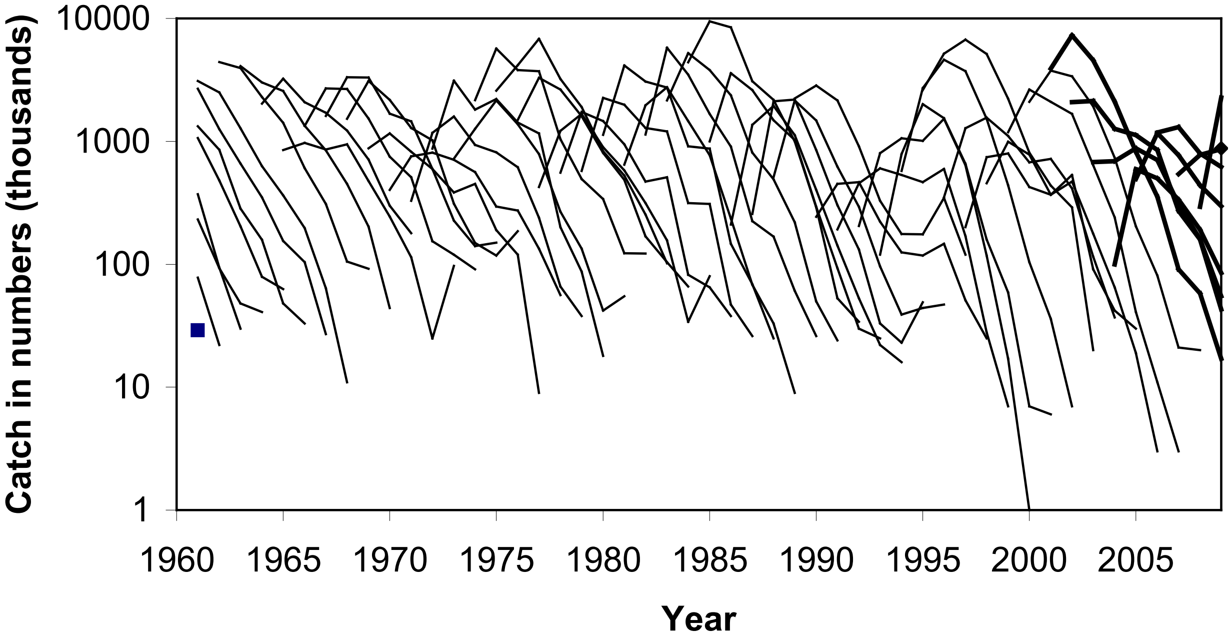


Figure 4.2.1. Faroe Plateau (sub-division VB1) COD. Catch in numbers at age shown as catch curves.

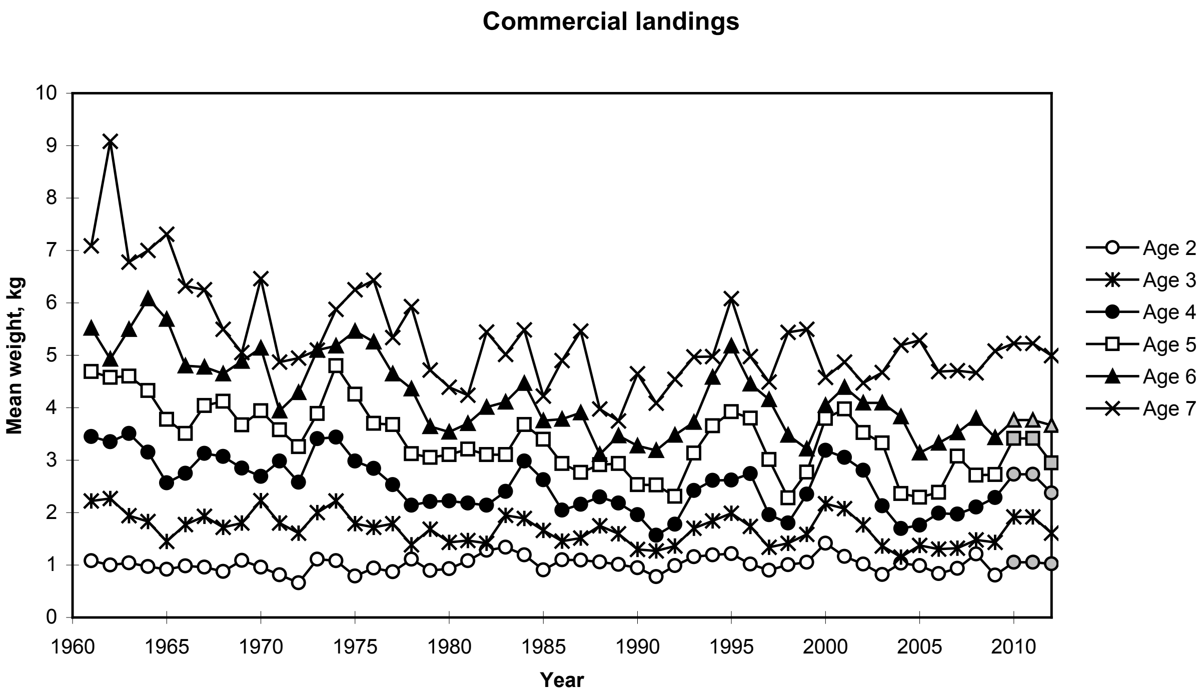


Figure 4.2.2. Faroe Plateau (sub-division VB1) COD. Mean weight at age 1961-2009. The estimated weights in 2010 are also shown. The weights in 2011 are set to the 2010 values. The weights in 2012 are set to the average values for 2008-2010.

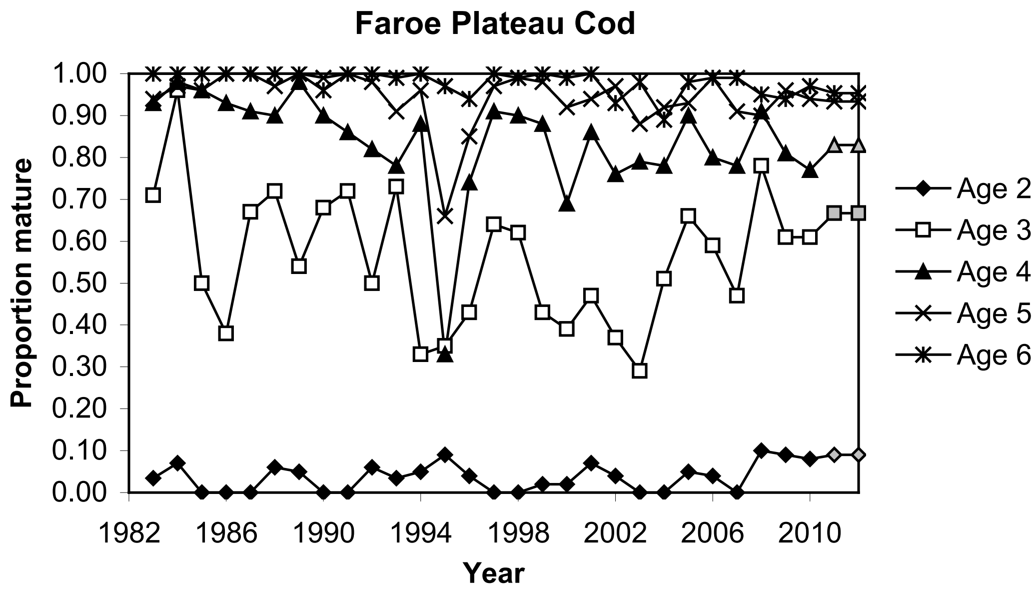


Figure 4.2.3. Faroe Plateau (sub-division VB1) COD. Proportion mature at age as observed in the spring groundfish survey. The values in 2011 and 2012 are estimated as the average of the 2008-2010 values.

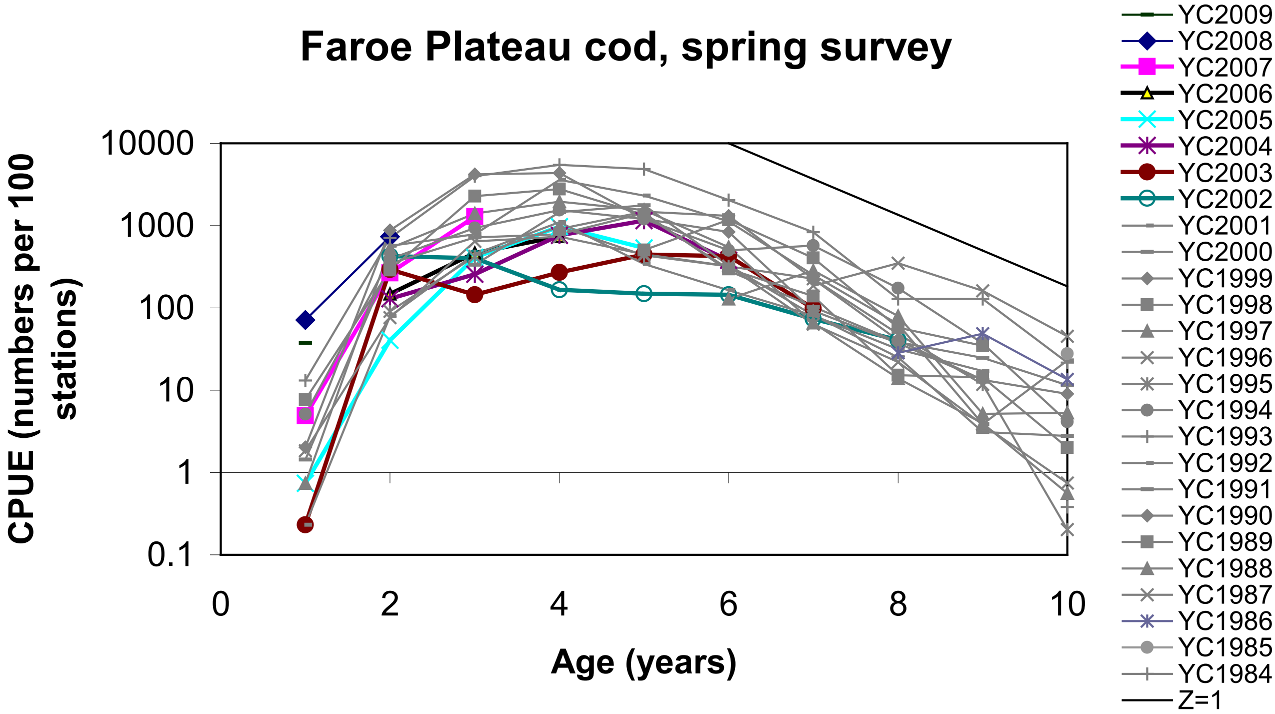


Figure 4.2.4. Faroe Plateau (sub-division VB1) COD. Catch curves from the spring groundfish survey.

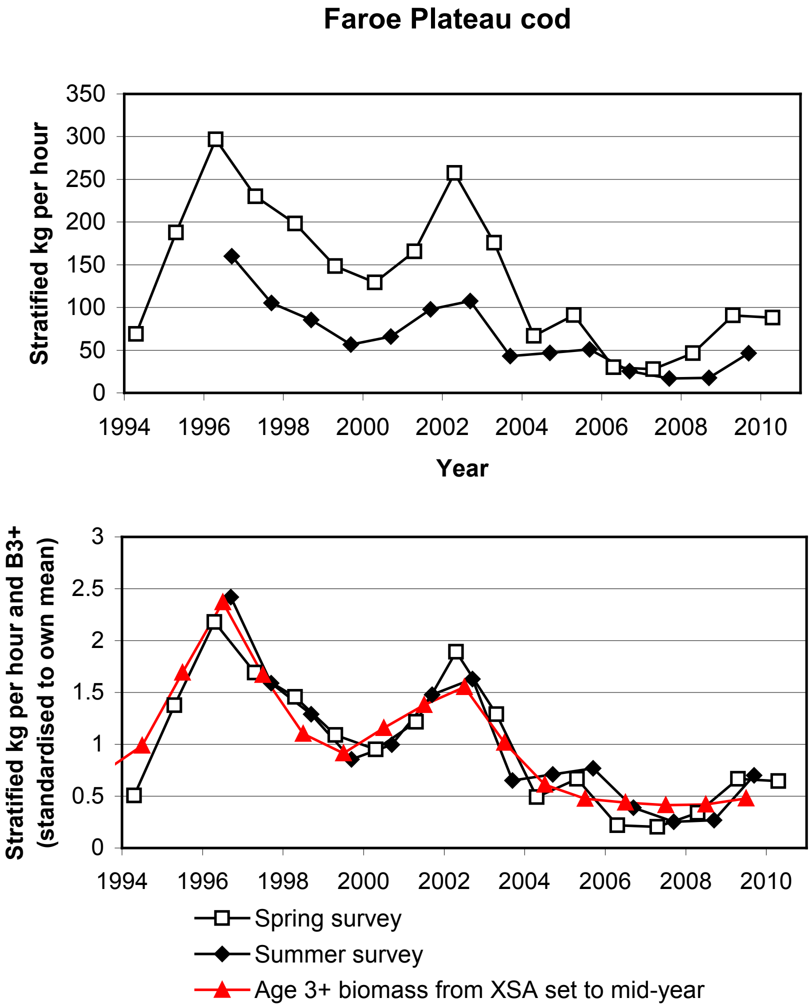


Figure 4.2.5. Faroe Plateau (sub-division VB1) COD. Stratified kg/hour in the spring and summer surveys. The age 3+ biomass obtained from the assessment is also included as an index.

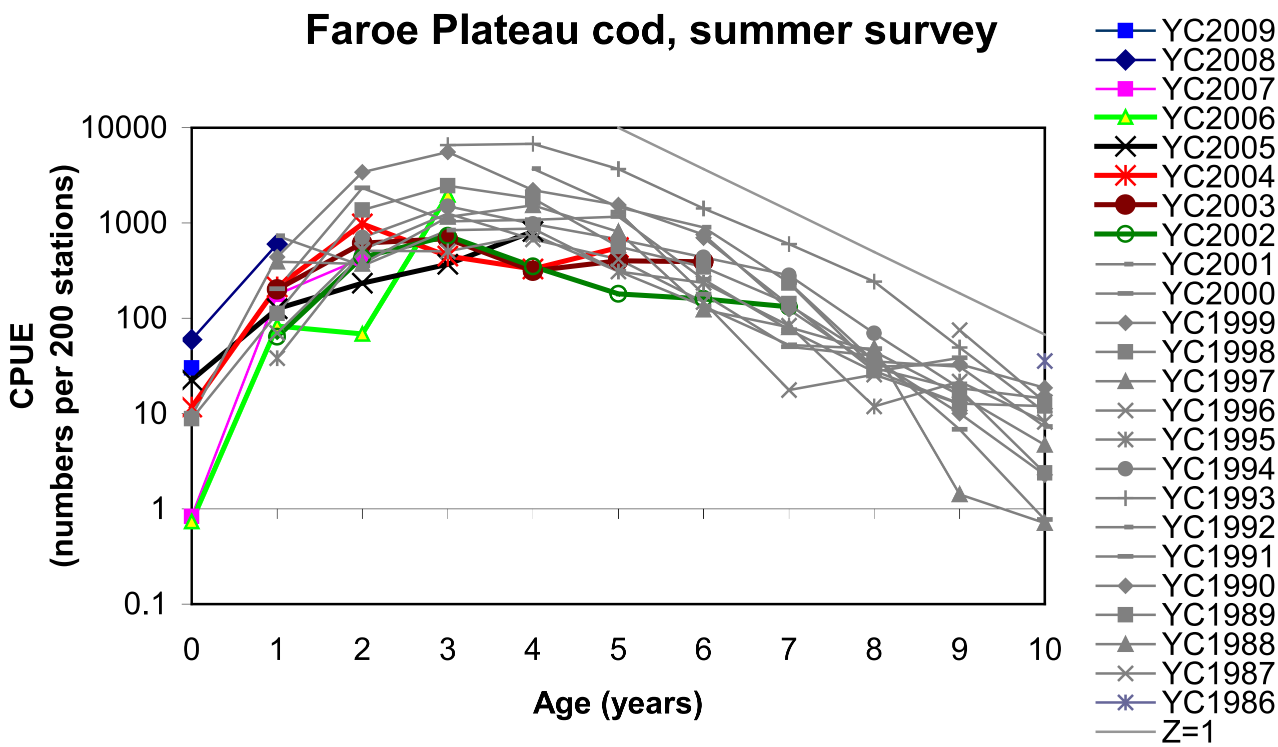


Figure 4.2.6. Faroe Plateau (subdivision VB1) COD. Catch curves from the summer groundfish survey.

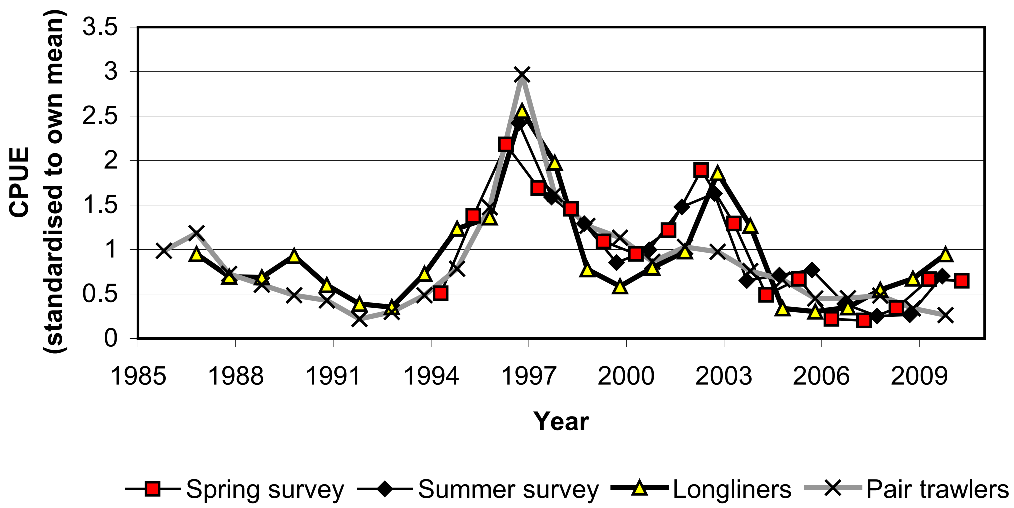
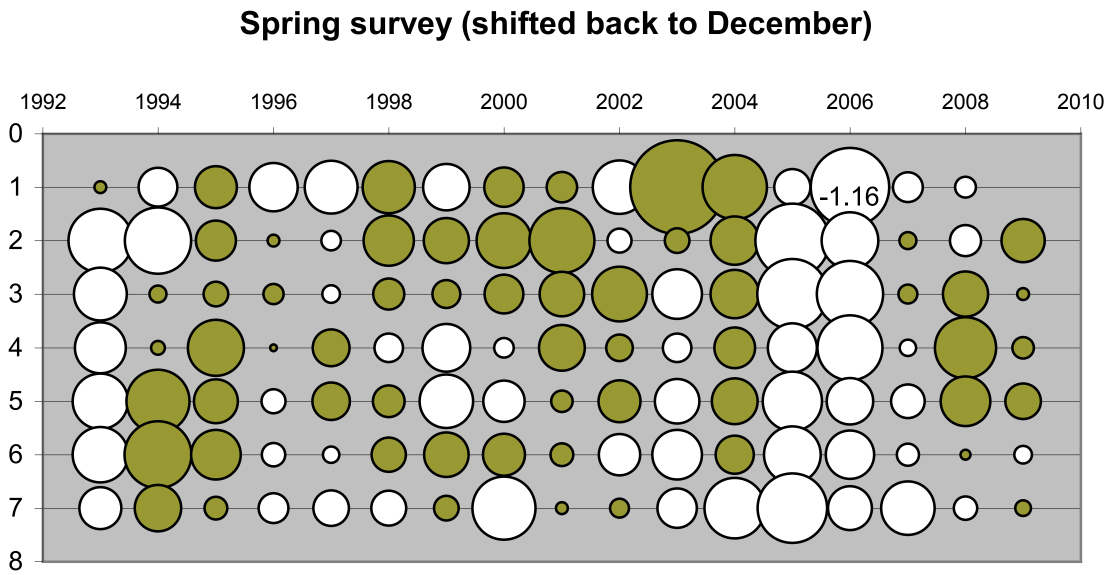


Figure 4.2.7. Faroe Plateau (sub-division VB1) COD. Standardised catch per unit effort for pair trawlers and longliners. The two surveys are shown as well.



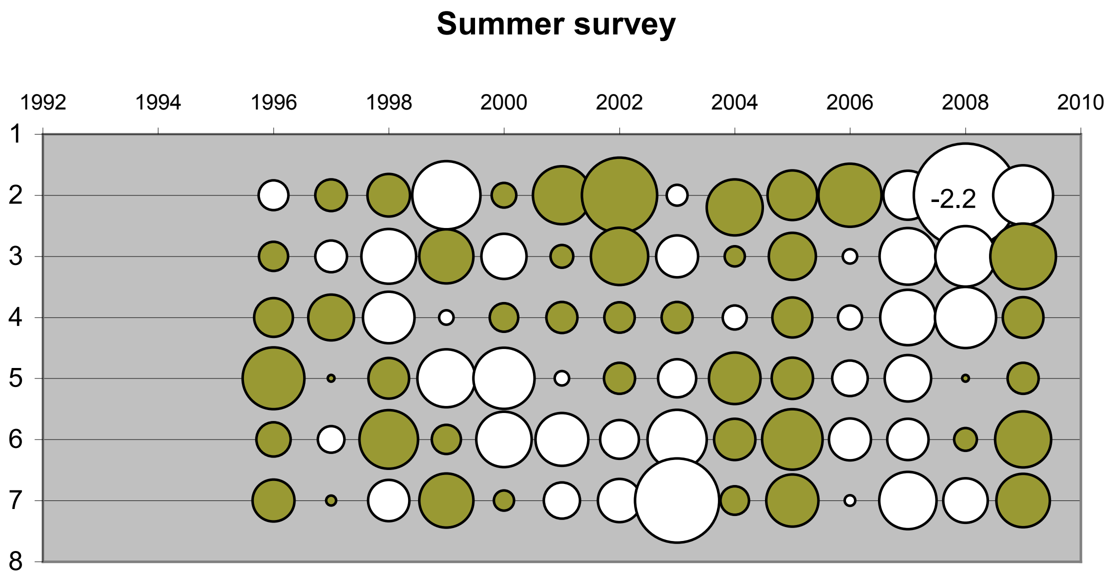
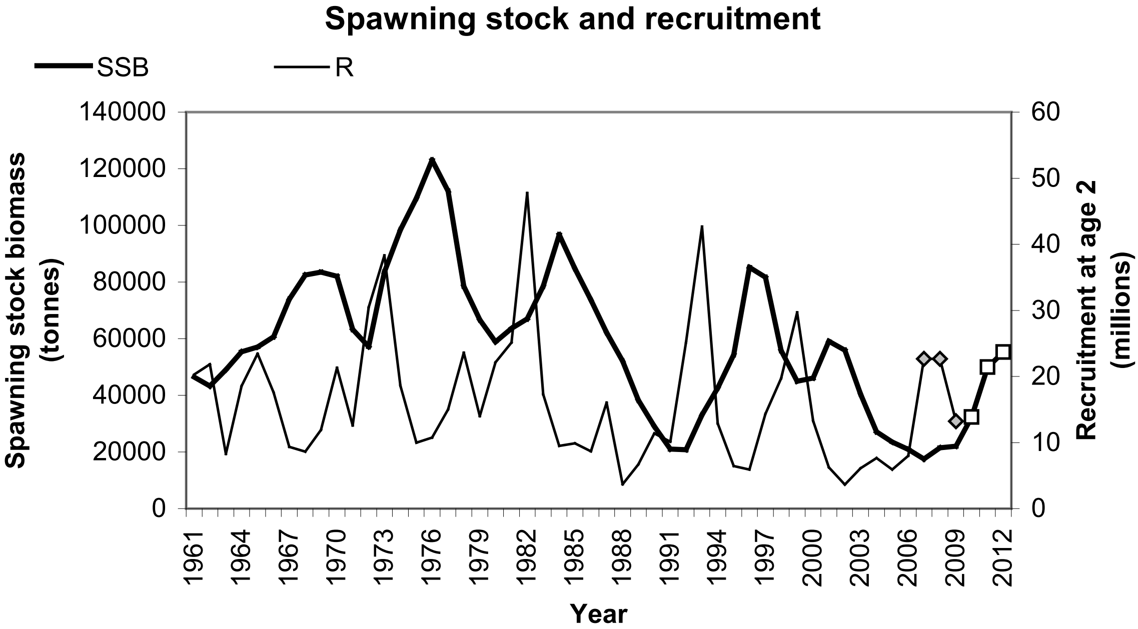


Figure 4.6.1. Faroe Plateau (sub-division VB1) COD. Log catchability residuals for the spring and summer survey. The residuals for age 8 are not presented because some values were off scale. White bubbles indicate negative residuals.



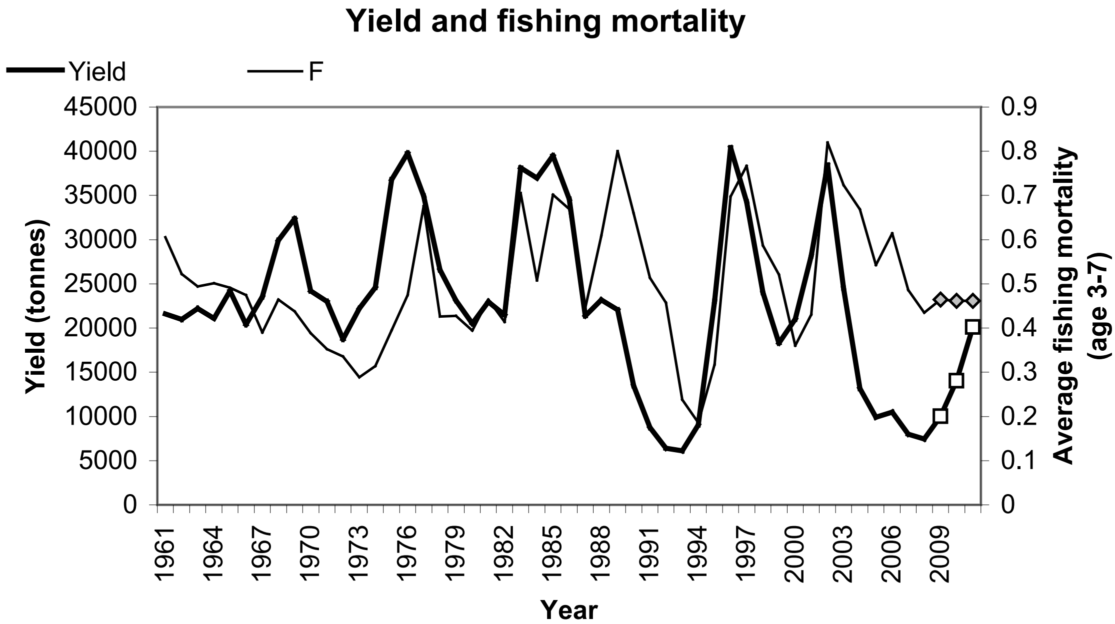


Figure 4.6.2. Faroe Plateau (sub-division VB1) COD. Yield and fishing versus year. Spawning stock biomass (SSB) and recruitment (year class) versus year. Points (white and grey) are taken from the short term projections.

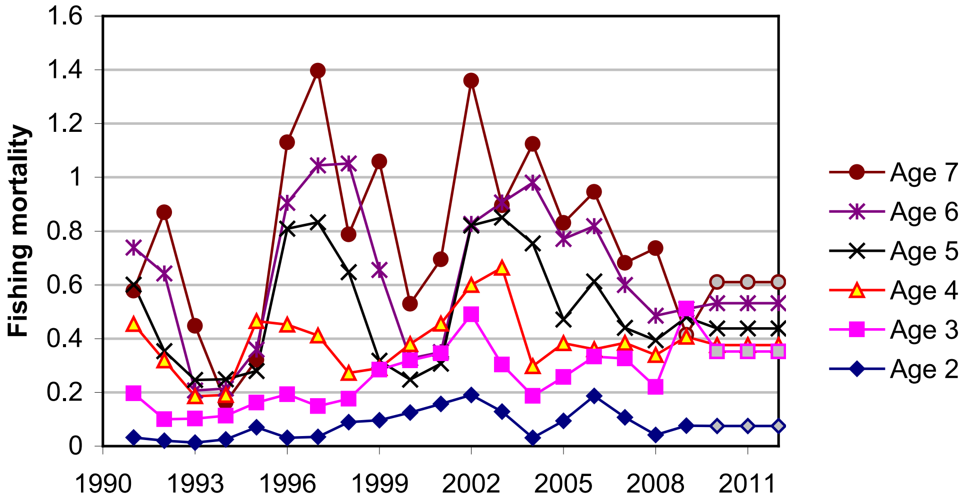


Figure 4.6.3. Faroe Plateau (sub-division VB1) COD. Fishing mortalities by age. The F-values in 2010-2012 are set to the average values in 2007-2009.

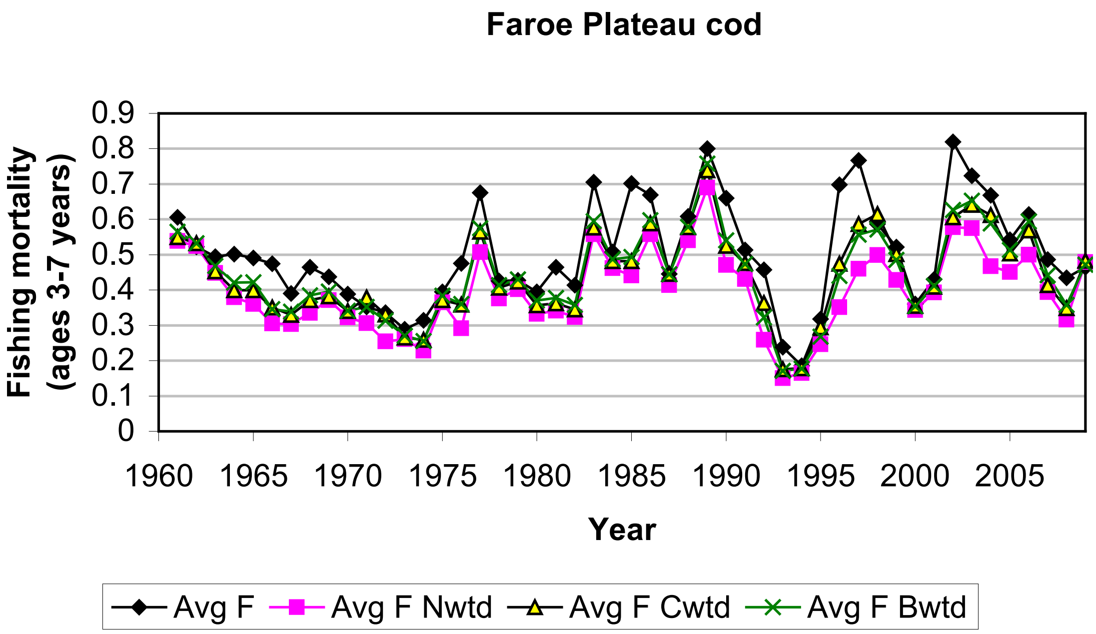


Figure 4.6.4. Faroe Plateau (sub-division VB1) COD. Different measures of fishing mortality: straight arithmetic average (Avg F), weighted by stock numbers (Nwtd), weighted by stock biomass (Bwtd) or weighted by catch (Cwtd).

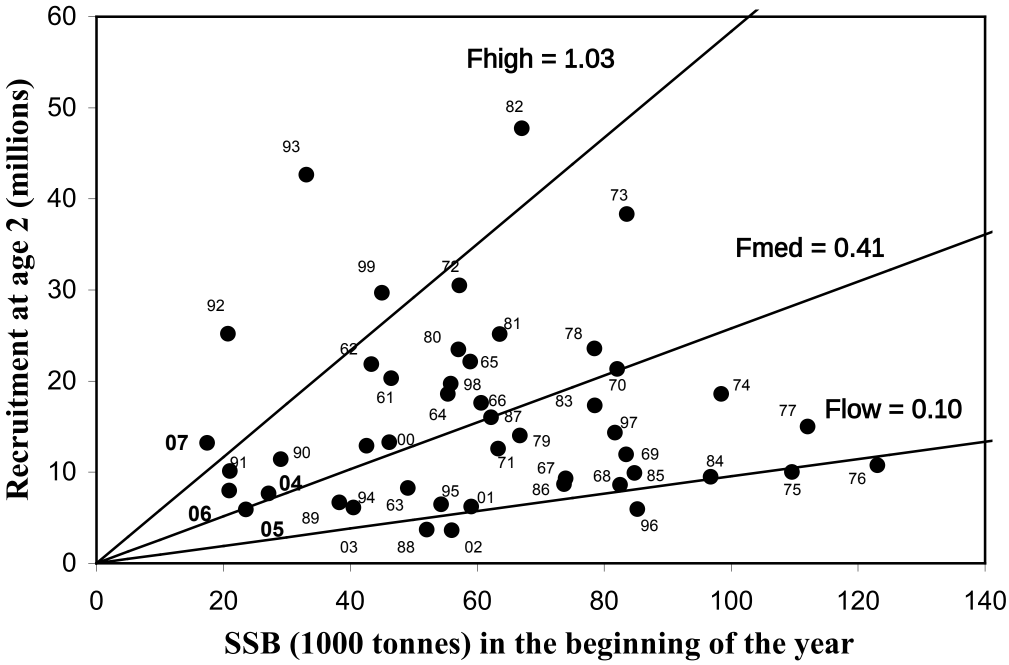


Figure 4.6.5. Faroe Plateau (sub-division VB1) COD. Spawning stock – recruitment relationship 1961-2007. Years are shown at each data point.

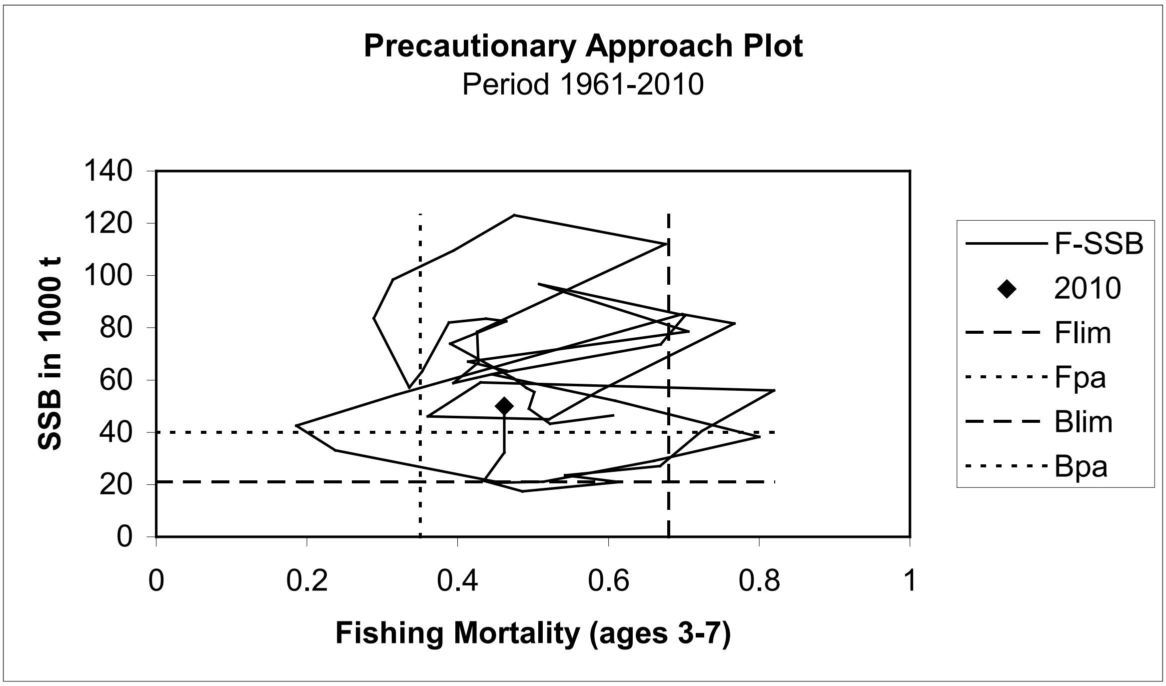


Figure 4.6.6. Faroe Plateau (sub-division VB1) COD. Spawning stock biomass versus fishing mortality 1961-2010.

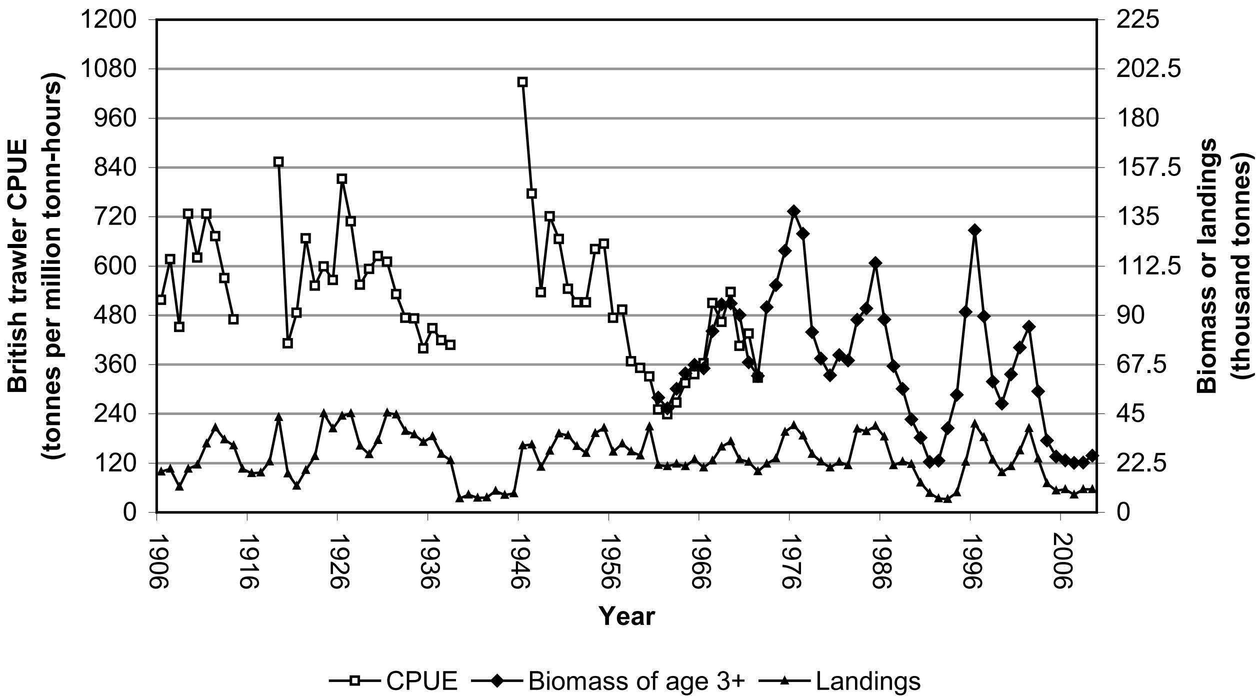
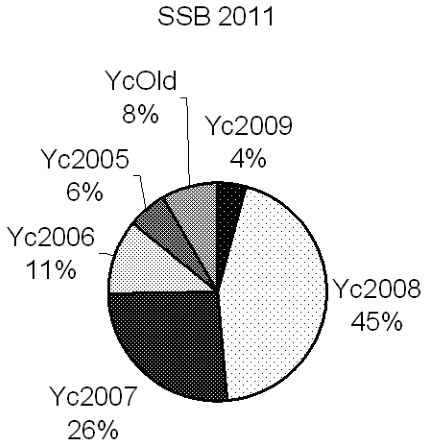


Figure 4.6.7. Faroe Plateau Cod. Stock development 1906-2009 based on cpues from british steam trawlers (1906-1925: cwts per days of absence from port), cpues from british trawlers (1924-1972: tonnes per million tonn hours) and the XSA-estimates (1961-2009: absolute biomass). The 1906-1925 series was scaled to the 1924-1972 series and the CPUEs refer to the first (left) axis while the XSA-estimates refer to the second axis.



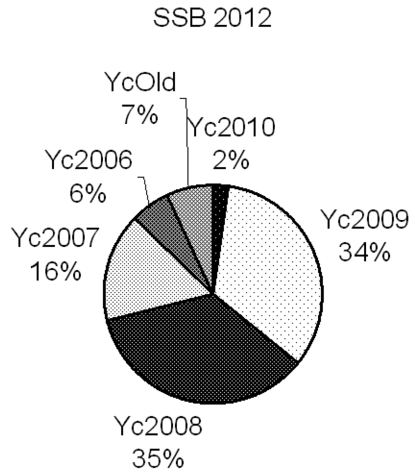
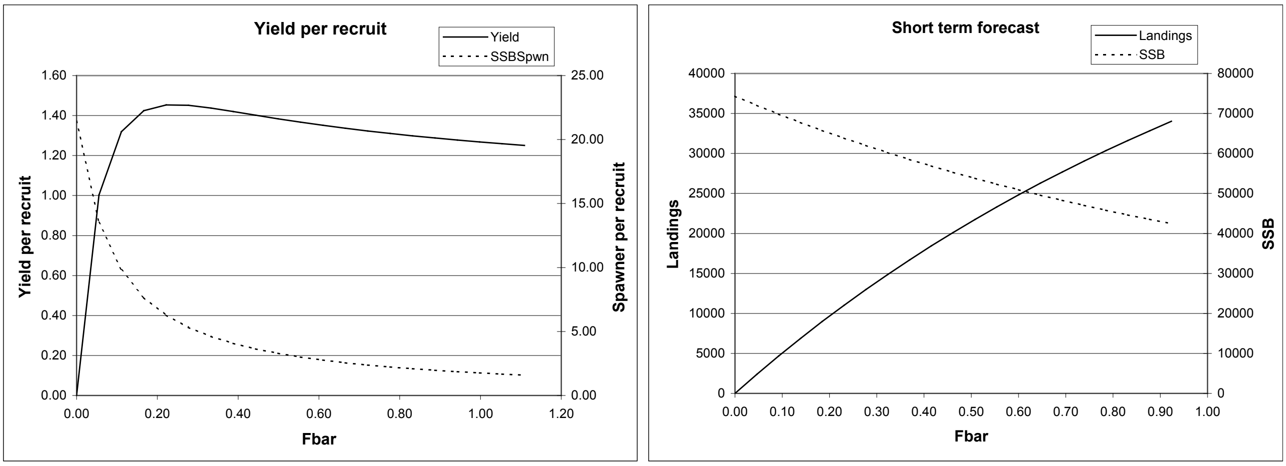


Figure 4.7.1. Contribution of various year classes to the spawning stock biomass in 2011 and 2012.



MFYPR version 1
Run: YR3
Time and date: 12:31 04/05/2010

Reference point	F multiplier	Absolute F
Fbar(3-7)	1.0000	0.5545
FMax	0.4373	0.2425
F0.1	0.1985	0.1100
F35%SPR	0.3095	0.1716
Flow	0.1766	0.0979
Fmed	0.7416	0.4112
Fhigh	1.8577	1.0300

Weights in kilograms

MFDP version 1
Run: Short1
Index file 2/5-2010
Time and date: 09:21 02/05/2010
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).

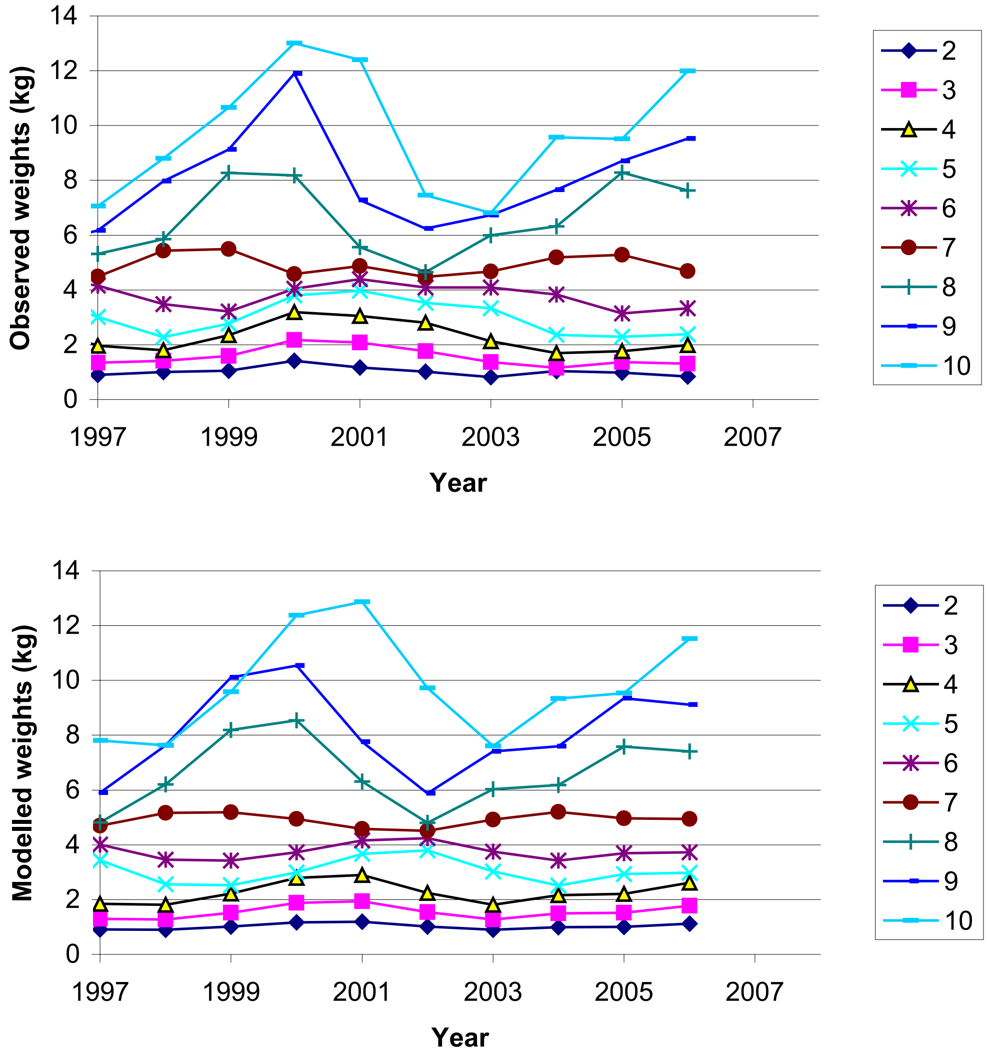


Figure 4.8.2. Faroe Plateau (sub-division VB1) COD. Input to long-term simulations: weight-at-age modelled as a function of growth. The observed values are also shown.

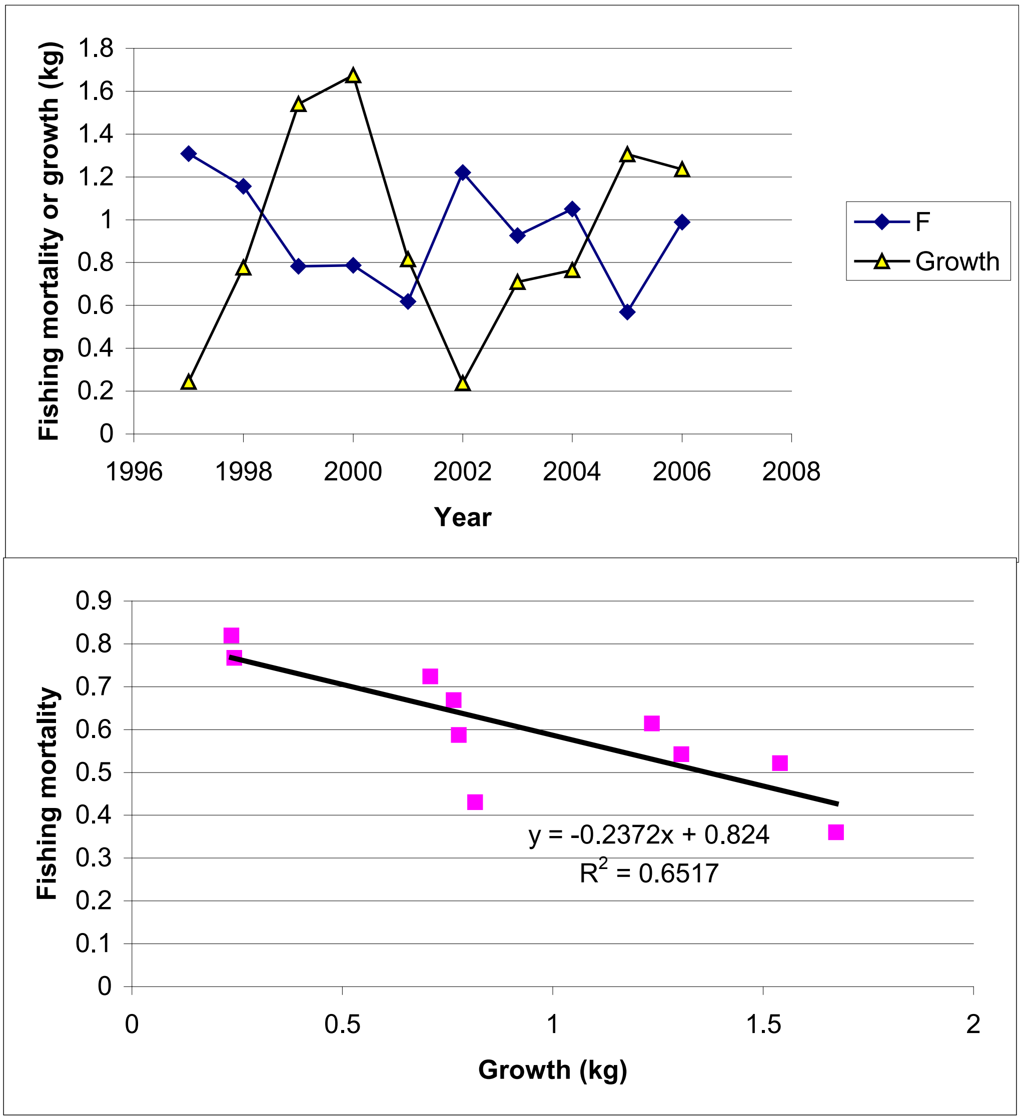


Figure 4.8.3. Faroe Plateau (sub-division VB1) COD. Relationship between growth and fishing mortality.

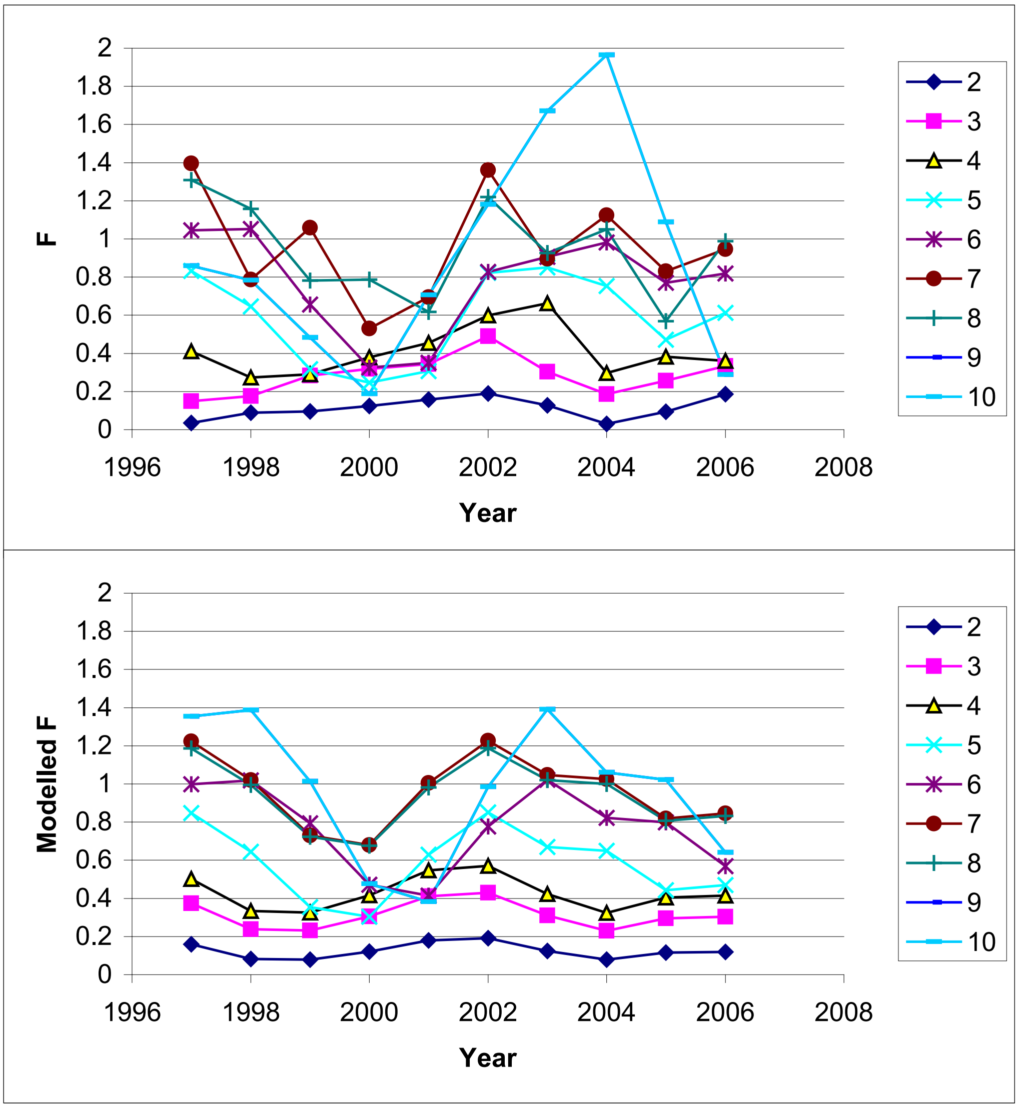


Figure 4.8.4. Faroe Plateau (subdivision VB1) COD. Input to long-term simulations: F-at-age modelled as a function of growth. The observed values are also shown.

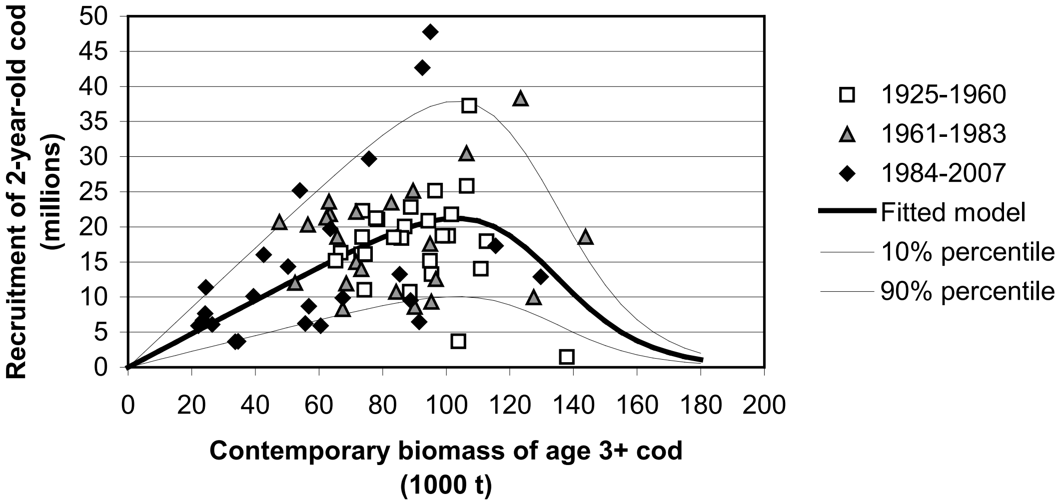
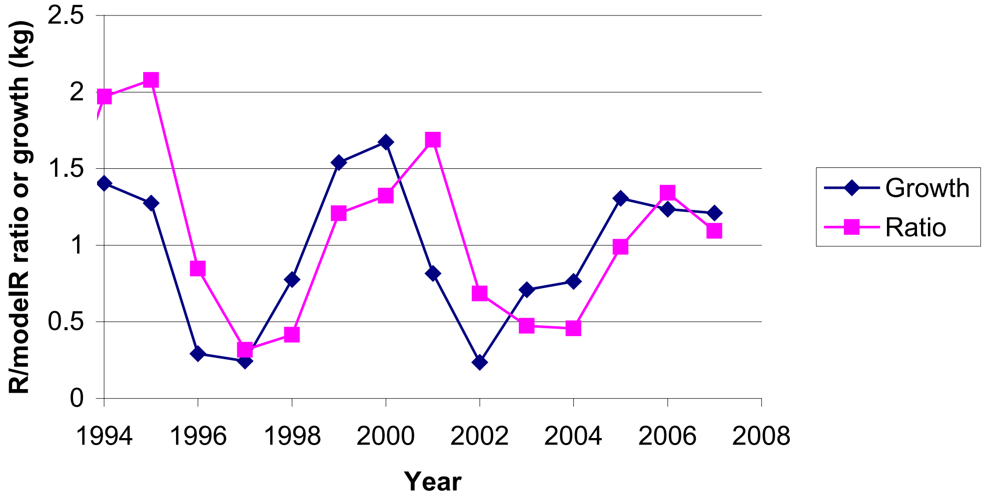


Figure 4.8.5. Faroe Plateau (subdivision VB1) COD. Relationship between recruitment and the size of the age 3+ biomass that is present at the same time (= contemporary biomass) as the recruitment event occurs at age 2 years. A description of the fitted function is provided in the text.



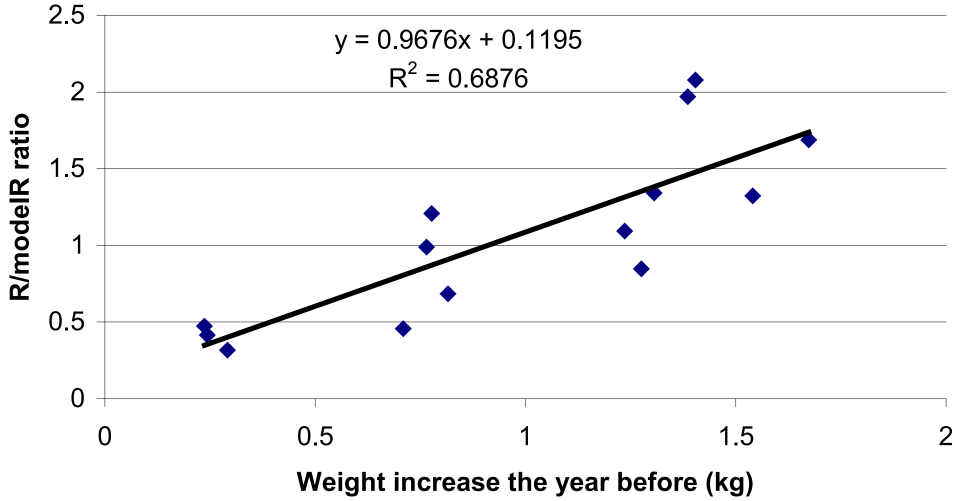


Figure 4.8.6. Faroe Plateau (subdivision VB1) COD. Input to long-term simulations: The R/modelR ratio modelled as a function of growth.

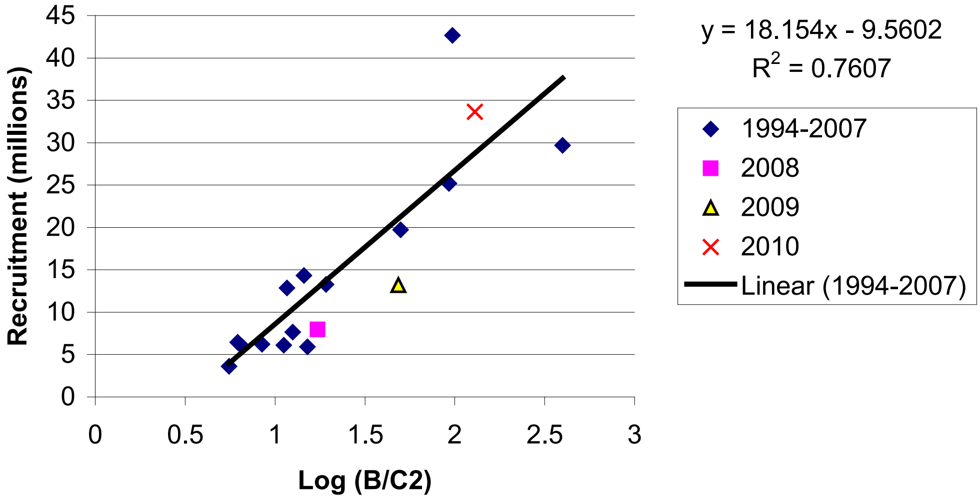


Figure 4.8.7. Faroe Plateau (sub-division VB1) COD. Investigating input to long-term simulations: Recruitment (R) as a function of log(B/C2), see text. Note that e.g. the "2010" label refers to the 2008 year class, etc.

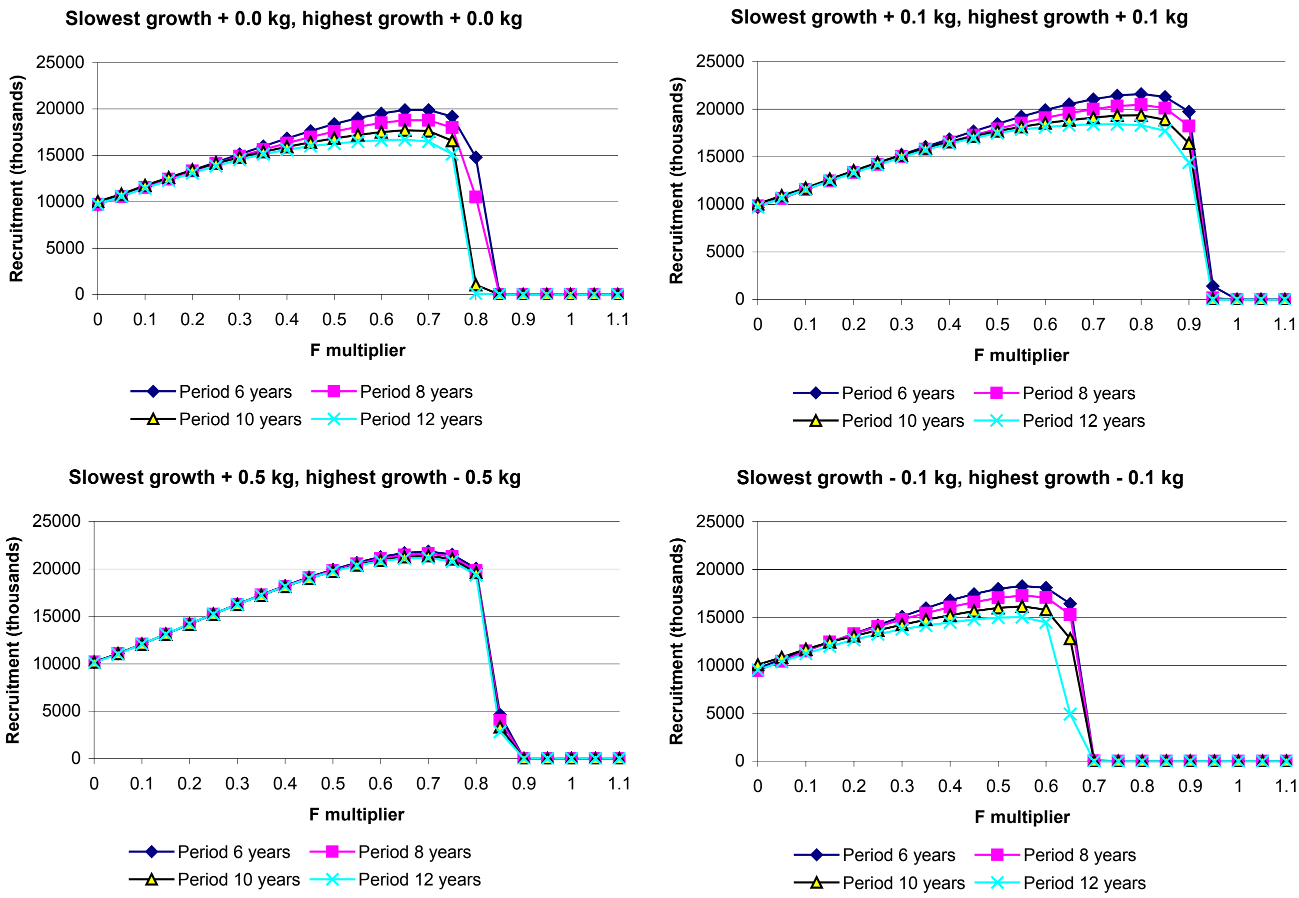


Figure 4.8.8. Faroe Plateau (sub-division VB1) COD. Results of long-term simulations: average recruitment for the 2501-3010 period.

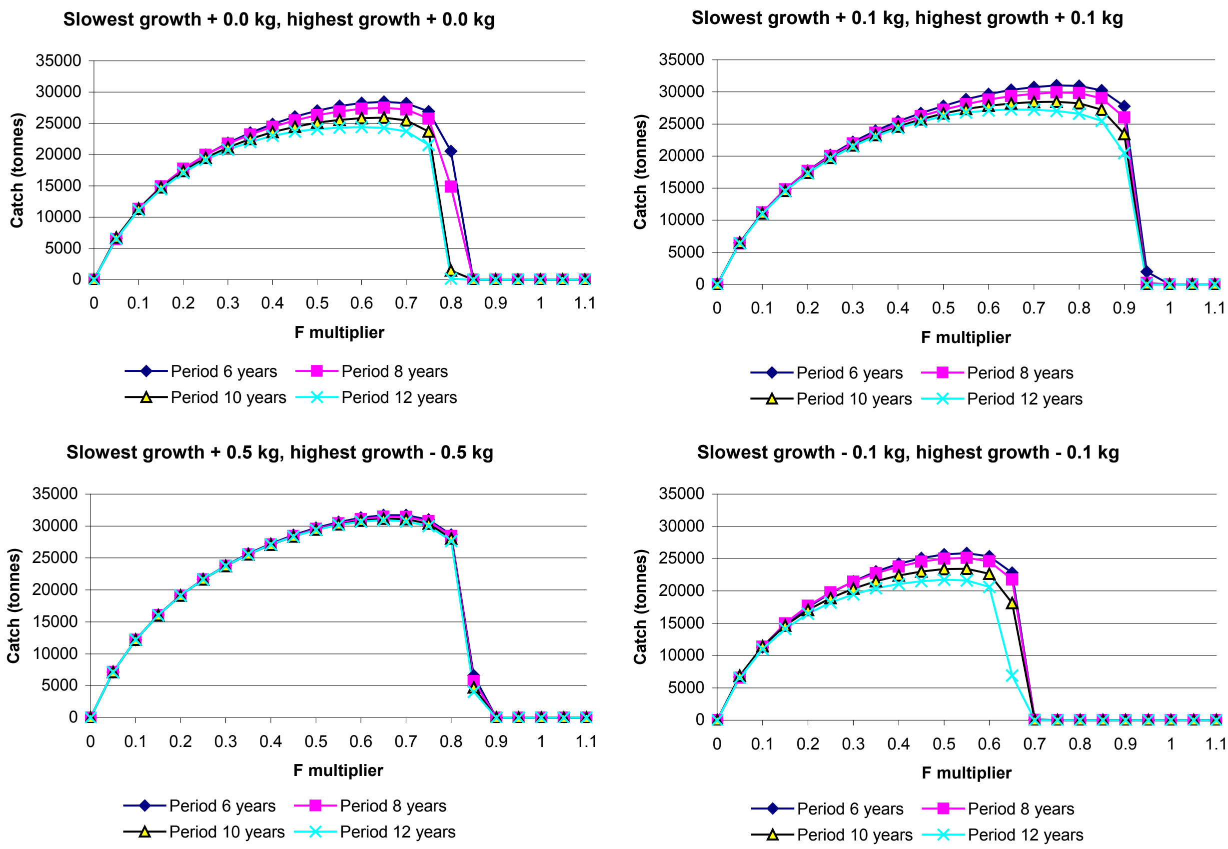


Figure 4.8.9. Faroe Plateau (sub-division VB1) COD. Results of long-term simulations: average catch for the 2501-3010 period.

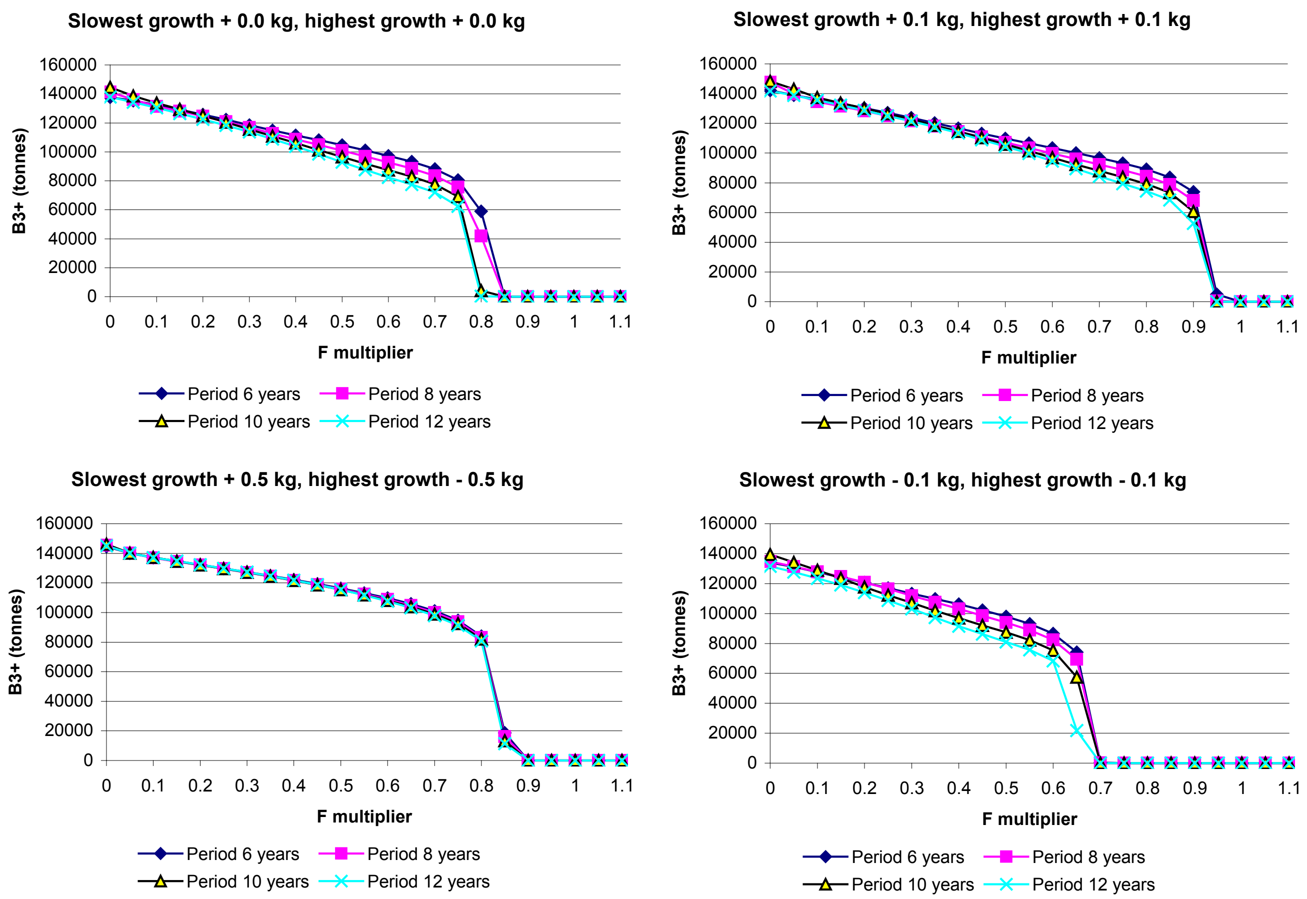


Figure 4.8.10. Faroe Plateau (sub-division VB1) COD. Results of long-term simulations: average B3+ for the 2501-3010 period.

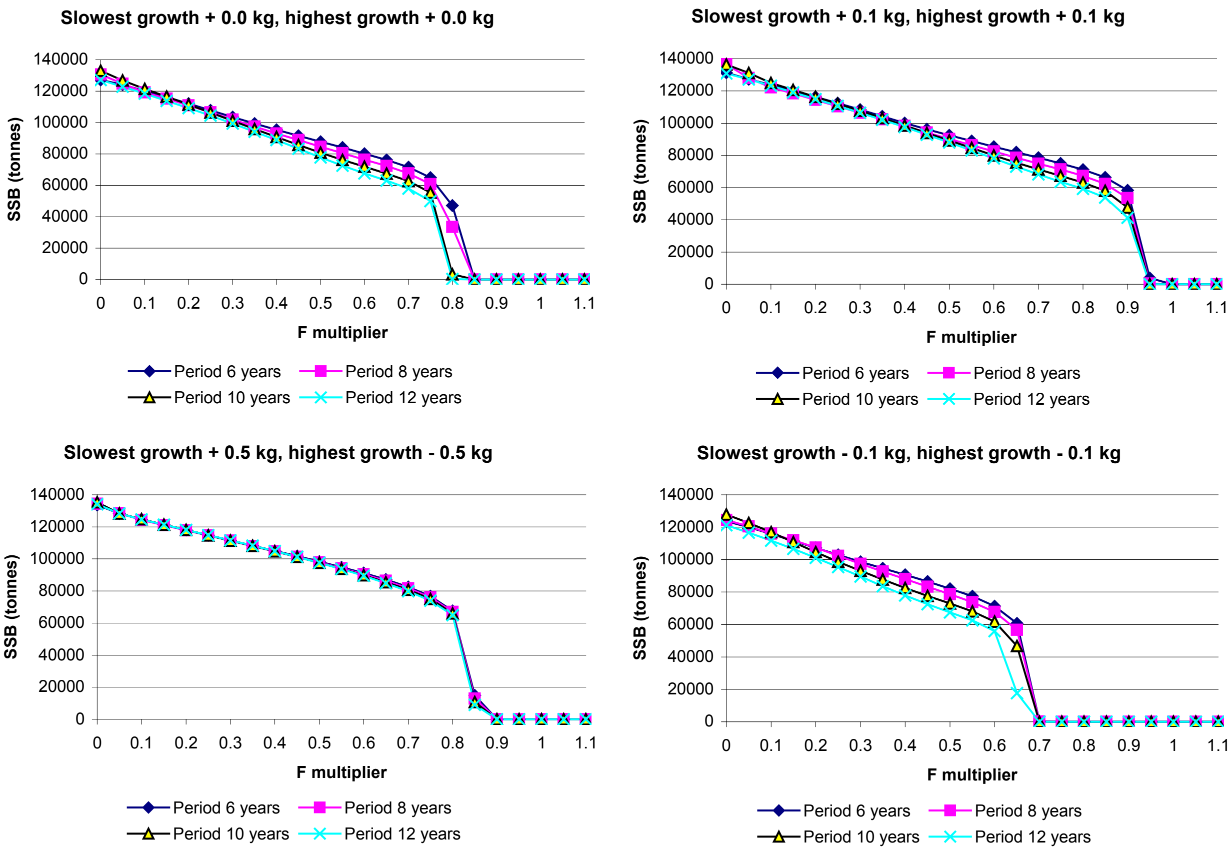


Figure 4.8.11. Faroe Plateau (sub-division VB1) COD. Results of long-term simulations: average spawning stock biomass for the 2501-3010 period.

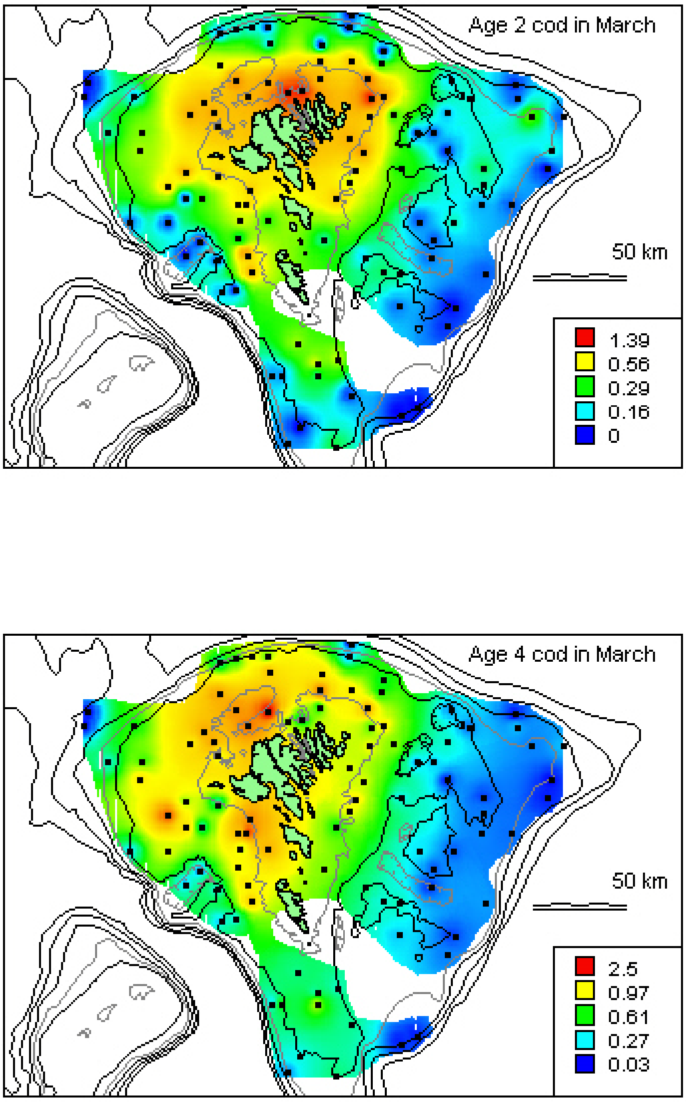
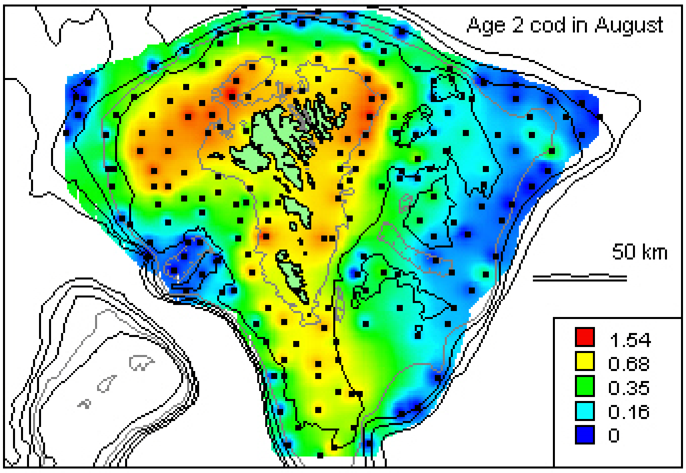


Figure 4.8.12. Mean abundance (log_{10}(numbers+1)) of 2 and 4 year-old cod in March 1998-2006 as observed in the spring groundfish survey. 100 m depth contours are shown.



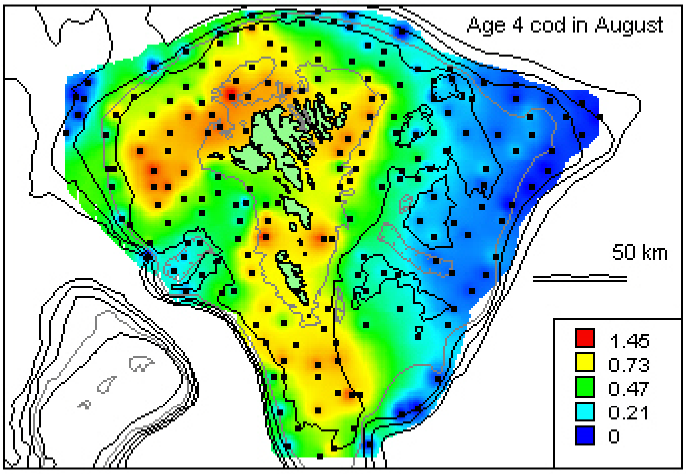


Figure 4.8.13. Mean abundance (log_{10}(numbers+1)) of 2 and 4 year-old cod in August 1997-2005 as observed in the summer groundfish survey. 100 m depth contours are shown.

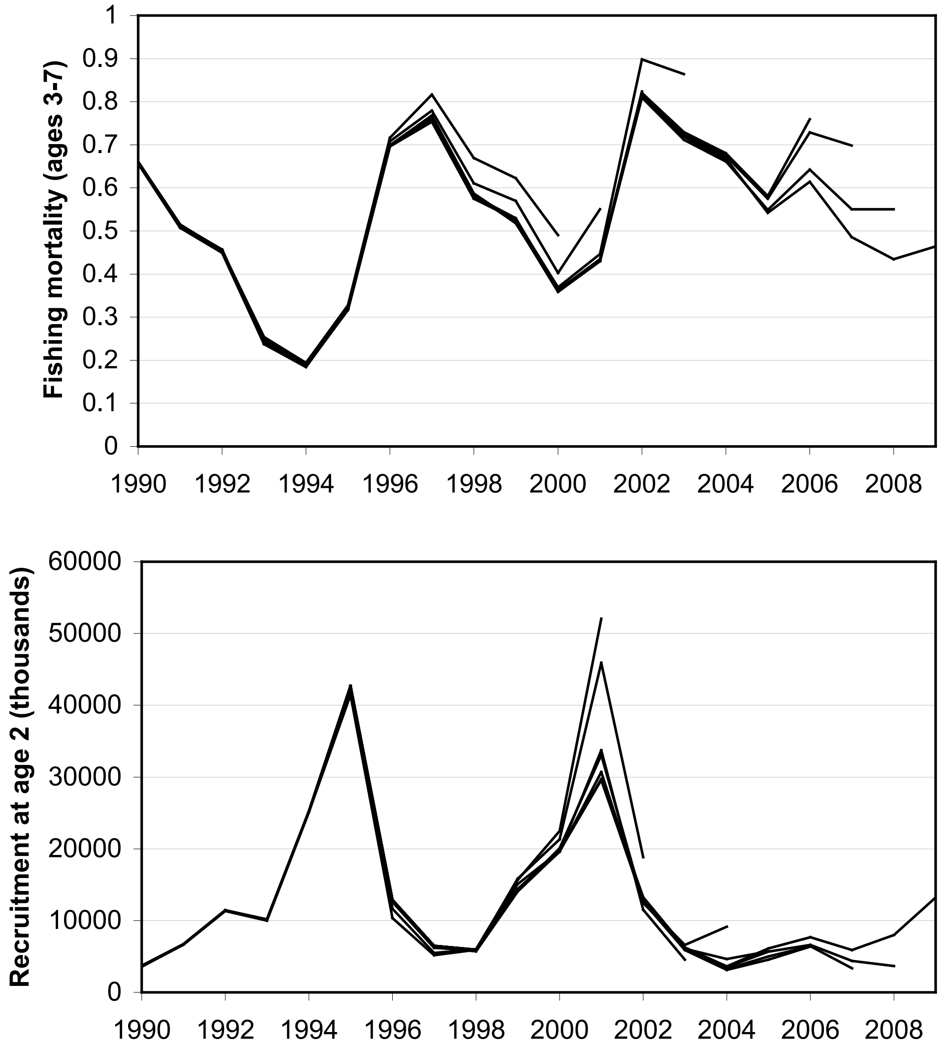
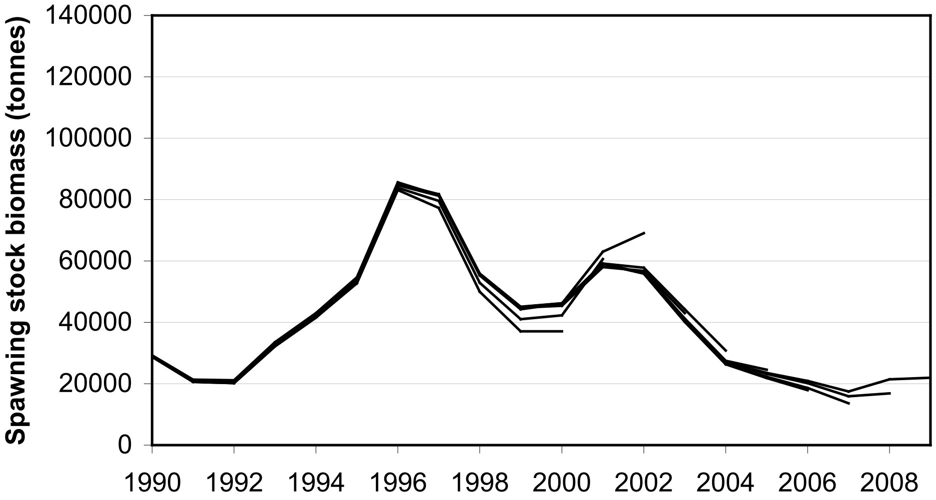


Figure 4.9.1. Faroe Plateau (sub-division VB1) COD. Results from the XSA retrospective analysis.



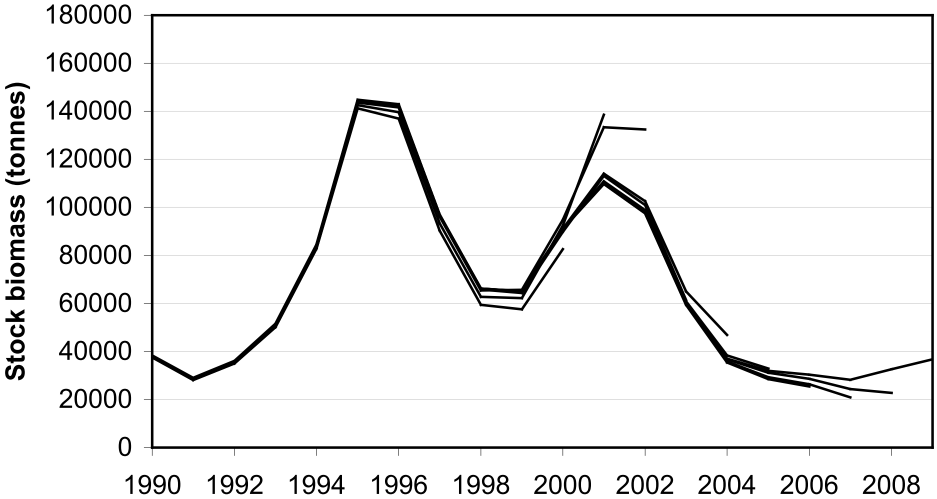


Figure 4.9.1. Faroe Plateau (sub-division VB1) COD. Results from the XSA retrospective analysis (continued).

5 Faroe haddock

Executive summary

Being an update assessment, the changes compared to last year are additions of new data from 2009, some minor revisions of the landings data for 2008 with corresponding revisions of the catch@age data and revisions of the survey data 2007-2009 due to errors in some formulas used in the calculation of the stratified indices at age. The main assessment tool is XSA tuned with 2 research vessel bottom trawl surveys. The results are in line with those from 2009, showing a declining SSB mainly due to poor recruitment. SSB is now estimated just above B_{lim} and is predicted to decline below B_{lim} in 2010-2011 with status quo fishing mortality. Fishing mortality in 2009 is estimated at 0.26 (F_{pa} = 0.25) and landings in 2009 were only 5 200 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 Sub-Division Vb1, are generally believed to belong to the same stock and are treated as one management unit named Faroe haddock. Haddock is distributed all over the Faroe Plateau and the Faroe Bank from shallow water down to more than 450 m. Spawning takes place from late March to the beginning of May with a peak in the middle of April and occurs in several areas on the Faroe Plateau and on the Faroe Bank. Haddock does not form as dense spawning aggregations as cod and saithe, nor does it perform ordinary spawning migrations. After spawning, eggs and fry are pelagic for about 4 months over the Plateau and Bank and settling starts in August. This is a prolonged process and pelagic juveniles can be found at least until September. Also during the first years of life they can be pelagic and this vertical distribution seems to be connected to year class strength, with some individuals from large year classes staying pelagic for a longer time period. The O-group settles all around the Faroe Plateau but during the first 1-2 years the young haddock migrates to shallower waters; no special nursery areas can be found, because the young haddock are widely 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 2009 to about 5 200 t. Most of the landings are taken from the Faroe Plateau; the 2009 landings from the Faroe Bank (Sub-Division Vb2), where the area shallower than 200 m depths has been closed to all fishing since the fiscal year 2008-2009, amounted to only about 190 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 2010 may be at the same level as those in 2009.

Faroese vessels have taken almost the entire catch since the late 1970s (Figure 5.1). Table 5.3 shows the proportion of the Faroese landings taken by each fleet category since 1985. The longliners have taken most of the catches in recent years followed by the trawlers. This was also the case in 2009, but the share by longliners was much less than normal: longliners 62% and trawlers 38% (Figure 5.3), compared to longliners 81% and trawlers 19% in 2008.

5.2.2 Catch-at-age

For the Faroese landings, catch-at-age data were provided for fish taken from the Faroe Plateau. The sampling intensity in 2009 is shown in Table 5.4 and it was in general higher than in recent years.

The normal procedure has been to disaggregate samples from each fleet category by season (Jan-Apr, May-Aug and Sep-Dec) and then raise them by the corresponding catch proportions to give the annual catch-at-age in numbers for each fleet; this year, the samples from some fleets (the single trawlers and the pair trawlers<1000 HP) had to be replaced by using 2 seasons only (Jan-Jun, Jul-Dec. The results are given in Table 5.4. Catches of some minor fleets and from the Faroe Bank have been included under the "Others" heading. No catch-at-age data were available from other nations fishing in Faroese waters. Therefore, catches by trawlers from France, Russia and UK were assumed to have the same age composition as the 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 5.4 the LN(catch-at-age in numbers) is shown for the whole period of analytical assessments.

In general the catch-at-age matrix in recent years appears consistent although from time to time a few small year classes are disturbing this consistency, both in numbers and mean weights at age. Also there are some problems with what ages should be included in the plus group; there are some periods where only a few fishes are older than 9 years, and other period with a quite substantial plus group (10+). These problems have been addressed in former reports of this WG and will not be further dealt with here. No estimates of discards of haddock are available. However, since almost no quotas are used in the management of the fisheries on this stock, the incentive to discard in order to high grade the catches should be low. The landings statistics is therefore regarded as being adequate for assessment purposes. The ban on discarding as stated in the law on fisheries should also – in theory – keep the discarding at a low level.

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; since then the mean weights have increased again except for the youngest ages. 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 1982–2010. 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 5.6).

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 2010 assessment but catch per unit effort for some selected fleets (logbook data) is used as additional information on the status of the stock (see section 5.4.1.1).

5.4 Methods

This assessment is an update of the 2009 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) are the same except for the addition of the 2009 data. However, the tuning files had to be revised since errors were found in some formulas calculating the stratified mean numbers at age from the surveys. This means that the indices at age for the tuning files has been changed from 2007 onwards. The effects of these revisions were negligible as compared to the 2009 assessment and the conclusions on the status of the stock made in 2009 are still valid (see the working document "Revised tuning data for Faroe Haddock").

5.4.1.1 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), 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 part of this fleet is not obliged to keep logbooks. The age-aggregated cpue series for longliners and pair trawlers are presented in Figure 5.7. In general the two series show the same trends although in some periods the two series are conflicting; this has been explained by variations in catchability of the longlines due to the above mentioned changes in productivity of the ecosystem (see chapter 2).

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 5.9 (spring surveys 1994-2010) and Figure 5.10 (summer surveys 1996-2009). Biomass estimates (kg/hour) are available for both series since they were initiated (Figure 5.8), and in general, there is a good agreement between them. Age disaggregated data are available for the whole summer series, but due to problems with the database (see earlier reports), age disaggregated data for the spring survey are only available since 1994. The calculation of indices at age is based on age-length keys with a smoother 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 in recent years, 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 5.11-5.12 and show consistent patterns. Further analyses of the performances of the two series are shown in figures 5.13 – 5.15. In general there is a good relationship between the indices for one year class in two successive years (Figures 5.13-5.14). The same applies when comparing the corresponding indices at age from the two surveys (Figure 5.15).

A SPALY (same procedure as last year) run, with the same settings of the XSA as in 2009 and tuned with the two surveys combined and revised as compared to last year (Table 5.8), with 2009 data included and some minor revisions of recent catch figures, gave similar 2008 estimates as the 2009 assessment (Table 5.9), although the recruitment and biomass were overestimated and the fishing mortality slightly underestimated in the 2009 assessment (Section 5.10). The log q residuals for the two surveys are shown in Figure 5.16.

The retrospective analysis of fishing mortality, recruitment and spawning stock biomass of this XSA is shown in Figure 5.17. 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 but the behaviour of the small year classes from 2005 -2007 should be carefully inspected.

It has been questioned if a rather heavy shrinkage of 0.5 is the most appropriate for a stock like Faroe haddock where biological parameters and fishing mortality (catchability) are closely linked to productivity changes in the ecosystem. In order to investigate the possible effect of the shrinkage, an exploratory XSA was run without shrinkage (Shr. 2.0). The resulting retrospective pattern is shown in Figure 5.17A. In general, the XSA shrunk 2.0 seem to converge later than the one shrunk 0.5 but there is not much differences in the patterns and it is difficult to choose one run over the other just from the figures. But the run shrunk 2.0 give a bit more optimistic picture of the development of the stock, the recent estimates of recruitment, total biomass and spawning stock biomass are higher than in this years spaly assessment and the F_{bar} lower.

Results. The fishing mortalities from the final XSA run are given in Table 5.10 and in Figure 5.18. According to this the fishing mortality showed an overall decline since the early 1960s and has been estimated to be below or at the natural mortality of 0.2 in several years from the late 1970s. It increased again in the years 1993-1998 to reach more than 0.5 in 1998. After that there was a drop to below 0.3 in 2000-2002 followed by an increase in 2003 to about 0.45. Since then the fishing mortality has decreased every year and is estimated in this years assessment to 0.25 in 2009 (equal to F_{pa}).

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 5.20. From Figure 5.19, showing the recruit/spawning stock relationship, and from Table 5.17, $\mathbf{F}_{med}$, and $\mathbf{F}_{high}$ were calculated at 0.26 and 1.15, respectively. F_{max} could not be estimated due to the flat YPR curve. $F_{0.1}$ is estimated at 0.19. The F35%SPR was estimated at 0.25.

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.

The working group have investigated possible candidates for $F_{MSY.}$ Given the short time for such exercises, it was impossible to come up with solid based candidates. Further considerations need to take into account the cyclic changes of the Faroe Plateau ecosystem and the linkage between primary productivity and factors like recruitment, growth and catchability.The estimation of a $B_{trigger}$ for this stock is very important taking into account changes in the productivity.

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 5.18. According to this assessment, the period up to the mid 1970s was characterized by relative high and stable landings, recruitment and spawning stock biomass and the stock was able to withstand relatively high fishing mortalities. Since then the spawning stock biomass has shown large fluctuations due to cyclical changes in recruitment, growth and maturity (Figures 5.5 and 5.6). The fishing mortality seem not to be the decisive factor in this development since it most of the period has fluctuated around the F_{pa}

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 (102 mio. at age 2). Also the YC's from 2000 and 2001 are estimated well above average and the 2002 YC as average, but the more recent YC's are estimated or predicted to be small. However, the most recent surveys indicate that the 2008 and 2009 YC's are larger than the ones from 2005-2007 (Figure 5.13A). During the last decade or so, the fishing mortality has increased in years with high stock biomass, even above f_{lim}.

5.7 Short term forecast

5.7.1 Input data

The input data for the short-term predictions are estimated in accordance with the procedures last year and given in Tables 5.13-14. All year classes up to 2008 are taken directly from the 2010 final XSA, the 2010 year class at age 2 is estimated from the 2010 XSA age 1 applying a natural mortality of 0.2 in a forward calculation of the numbers using basic VPA equations. The YC 2010at age 2 in 2012 is estimated as the geometric mean of the 2-year-olds since 1980. 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 2007–2009 fishing mortality matrices from the final VPA and re-scaling to 2009. 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 and Table 5.6, most ages have increased again in 2007-2009. After inspection of the mean weights at age since 1976, the mean weight-at-age for ages 4-10 in 2010-2012 was set equal to the weights for 2009 (which could turn out to be underestimates), and the weights for ages 2-3 as the average of the 2007-2009 weights.

The maturity ogive for 2010 is based on samples from the Faroese Groundfish Spring Survey 2009 and 2010, and the ogives in 2011-2012 are estimated as the average of the smoothed 2009-2010 values.

5.7.2 Results

Although the allocated number of fishing days for the fishing year 2009-2010 was reduced by 5% as compared to the year before, it should not be unrealistic to assume fishing mortalities in 2010 as the average of some recent years, here the average of F(2007-2009); however, possible changes in the catchability of the fleets (which seem to be linked to productivity changes in the environment) could undermine this assumption; low prices on haddock will also have a similar effect. The landings in 2010 are then predicted to be about 4 300 t, and continuing with this fishing mortality will result in 2011 landings of about 3 700 t. The SSB will decrease to 17 000 t in 2010, 15 000 t in 2011, and increase to 20 000 t in 2011 which is below B_{lim} (22 000t). The results of the short-term prediction are shown in Table 5.15 and in Figure 5.20. A tentative exercise running the short term prediction a few more years more than usual indicates that with the same settings and a status quo fishing mortality, the spawning stock biomass will increase above B_{lim} in 2014. The contribution by year-classes to the age composition of the predicted 2011 and 2012 SSB's is shown in Figure 5.22.

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 1977–2009 period. The maturity o-gives are averages for the years 1982-2009. The exploitation pattern is the same as in the short term prediction.

The results are given in Table 5.17, Figure 5.20 and under Biological reference points.

5.9 Uncertainties in assessment and forecast

Retrospective pattern indicates a tendency to overestimate spawning stock biomass and underestimate fishing mortality. Similarly there is a tendency to overestimate recruitment. Recruitment estimates from surveys are not very consistent for small cohorts.

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. The landings statistics is therefore regarded as being adequate for assessment purposes. The ban on discarding as stated in the law on fisheries should also – in theory – keep the discarding at a low level.

The sampling of the catches for length measurements, otolith readings and length-weight relationships has improved as compared to the last 3 years and is considered to be adequate.

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

5.10 Comparison with previous assessment and forecast

As explained previously in the report, this assessment is an update of the 2009 assessment. Except for some major revisions of the tuning data since 2007 (see section 5.4), 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 2009 data.

Following differences in the 2008 estimates were observed as compared to last year:

Comparisons between 2009 and 2010 assessment of 2008 data
The year of comparison is 2008

	R at age 2 (thousands)	Total B (tonnes)	SSB (tonnes)	Landings (tonnes)	F (3-7)
2009 spaly	3990	41127	32312	7582	0.2213
2010 spaly	2994	34167	29948	7329	0.2269
%-change	-25	-17	-7	-3	3

It can be seen, that the main differences are in the recruitment and total biomass (overestimated) while fishing mortality has been slightly 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 on average 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, gear specifications, 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.

5.17 Proportion mature at age

The proportion mature at age in 2010 is estimated as the average of the observed data in 2009 and 2010. For 2011 and 2012, the average for 2008 to 2010 is used.

Age	2010	2011	2012
2	0.00	0.01	0.01
3	0.57	0.61	0.61
4	0.95	0.94	0.94
5	0.99	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

5.18 Catch&Stock weights at age

Catch and stock weights at age 2010-2012 for ages 2 and 3 were estimated as the average weights at age in the catch 2008-2010 and kept constant for all years; This has been the practice in recent years. By inspection of the mean weights at age since 1976 (Fig. 5.6), it was decided to use the estimated point-values for 2009 for the ages 4-10+, and apply them to all the years 2010-2012.

Age	2010	2011	2012
2	0.580	0.580	0.580
3	0.675	0.675	0.675
4	0.860	0.860	0.860
5	0.991	0.991	0.991
6	1.082	1.082	1.082
7	1.151	1.151	1.151
8	1.379	1.379	1.379
9	1.727	1.727	1.727
10+	2.435	2.435	2.435

Exploitation pattern

The exploitation pattern is estimated like last year as the average fishing mortality matrix in 2007-2009 from the final VPA in 2010, re-scaled to 2009, and kept constant for all 3 years.

Age	2009	2010	2011
2	0.0193	0.0193	0.0193
3	0.1252	0.1252	0.1252
4	0.1871	0.1871	0.1871
5	0.2130	0.2130	0.2130
6	0.3268	0.3268	0.3268
7	0.4134	0.4134	0.4134
8	0.4393	0.4393	0.4393
9	0.2967	0.2967	0.2967
10+	0.2967	0.2967	0.2967

Table 5.1 Faroe Plateau (Sub-division Vb1) HADDOCK. Nominal catches (tonnes) by countries 1982-2009, 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	2008	2009[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	6,675	4,889
France[1]				2[2,7]	-[2]	6	8[7]	2	4	1[5]	+	12[7]	4	3	+[7]
Germany	5	-	-		33	1	2	6	1	6		1			
Greenland					30[6]	22[6]	0[6]	4[6]				1	13		7[7]
Iceland								4							
Norway	28	45	45	71	411	355	257[2]	227	265	229	212	57	61	26	8
Russia										16				10	
Spain										49					
UK (Engl. and Wales)	23	5	22	30[1]	59[7]	19[7]	4[7]	11[7]	14	8	1	1			
UK (Scotland)[11]	-	…	…	…					185	186	126	106	35	60	
United Kingdom															91[7]
Total	4,605	9,202	16,652	19,238	17,176	14,023	13,728	21,030	22,084	19,490	18,361	15,778	11,801	6,774	4,995
Working Group estimate[4,5,8]	4,948	9,642	17,924	22,210	18,482	15,821	15,890	24,933	26,942	23,101	20,305	17,191	12,656	7,329	5,183

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,
1982-2009, 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	2008	2009 [2]
Faroe Islands	303	338	1,133	2,810	1,110	1,565 [5]	1,948	3,698	4,804	3,594	1,899	1,412	832	550	188
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]	15	5	[4]
Total	343	440	1,272	2,972	1,306	1,798	2,162 1	3,903	4,858	3,611	1,944	1,413	855	555	188

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 5.3 Total Faroese landings of haddock from Division Vb 1985-2009 by each fleet category (%).

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
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	6	4
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	34	27
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	41	30
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	7	13
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	2	2
Pairtrawlers < 1000HP	19	20	17	11	7	5	7	11	13	10	8	7	6	5	6	7	6	4	4	2	2	2	3	3	5
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	7	18
Nets	0	0	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	0	0
Other gears	0	1	1	2	1	1	1	1	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 5.4

Catch at age 2009

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	Vb1 Sampled Fleets	Vb Others Vb1+Vb2	Vb Foreign Trawlers	Vb Foreign LLiners	Vb Total All fleets
1	0	0	0	0	0	0	0	0	0	0	0	0
2	3	19	4	0	0	0	0	26	1	0	0	27
3	34	160	79	27	2	4	9	314	12	2	0	328
4	27	142	111	52	4	10	35	382	14	4	1	401
5	27	153	191	75	7	20	55	527	20	6	1	554
6	19	117	177	71	8	22	73	486	18	8	1	513
7	35	253	346	173	22	55	183	1067	40	21	2	1130
8	21	160	208	107	18	40	139	692	26	17	1	737
9	10	80	69	34	9	13	49	264	10	9	0	284
10	1	8	16	5	3	2	8	42	2	3	0	47
11	0	0	0	0	0	0	1	1	0	0	0	1
12	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
14	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0
Total no.	176	1091	1201	544	73	167	551	3802	144	70	5	4021
Catch, t.	181	1205	1548	559	92	186	637	4408	167	88	7	4670

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 tra Pair Trawl. = Pair trawlers

Comm. Sampling 2009	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 Others Vb1+Vb2	Vb1 All Faroese Fleets	Vb2 All Faroese fleet	Vb Foreign Trawlers	Vb Foreign LLiners	Vb Total
No. samples	15	24	30	5	4	11	37	0	126	0	0	0	126
No. lengths	2831	4730	6396	1044	850	2394	7736	0	25981	0	0	0	25981
No. weights	2831	4337	5991	1044	0	2394	7381	0	23978	0	0	0	23978
No. ages	239	660	776	60	0	240	659	0	2634	0	0	0	2634

Table 5.5 Faroe haddock. Catch number-at-age

Run title : FAROE HADDOCK (ICES DIVISION Vb) HAD_IND

At 19/04/2010 15:55

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

YEAR,	1957,	1958,	1959,
AGE			
0,	0,	0,	0,
1,	45,	116,	525,
2,	4133,	6255,	3971,
3,	7130,	8021,	7663,
4,	8442,	5679,	4544,
5,	1615,	3378,	2056,
6,	894,	1299,	1844,
7,	585,	817,	721,
8,	227,	294,	236,
9,	94,	125,	98,
+gp,	58,	105,	47,
TOTALNUM,	23223,	26089,	21705,
TONSLAND,	20995,	23871,	20239,
SOPCOF %,	89,	90,	90,

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

YEAR,	1960,	1961,	1962,	1963,	1964,	1965,	1966,	1967,	1968,	1969,
AGE										
0,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
1,	854,	941,	784,	356,	46,	39,	90,	70,	49,	95,
2,	6061,	7932,	9631,	13552,	2284,	1368,	1081,	1425,	5881,	2384,
3,	10659,	7330,	13977,	8907,	7457,	4286,	3304,	2405,	4097,	7539,
4,	6655,	5134,	5233,	7403,	3899,	5133,	4804,	2599,	2812,	4567,
5,	2482,	1937,	2361,	2242,	2360,	1443,	2710,	1785,	1524,	1565,
6,	1559,	1305,	1407,	1539,	1120,	1209,	1112,	1426,	1526,	1485,
7,	1169,	838,	868,	860,	728,	673,	740,	631,	923,	1224,
8,	243,	236,	270,	257,	198,	1345,	180,	197,	230,	378,
9,	85,	59,	72,	75,	49,	43,	54,	52,	68,	114,
+gp,	28,	13,	22,	23,	7,	8,	9,	13,	12,	20,
TOTALNUM,	29795,	25725,	34625,	35214,	18148,	15547,	14084,	10603,	17122,	19371,
TONSLAND,	25727,	20831,	27151,	27571,	19490,	18479,	18766,	13381,	17852,	23272,
SOPCOF %,	88,	88,	89,	89,	101,	94,	109,	101,	102,	108,

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

YEAR,	1970,	1971,	1972,	1973,	1974,	1975,	1976,	1977,	1978,	1979,
AGE										
0,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
1,	57,	55,	43,	665,	253,	94,	40,	0,	0,	1,
2,	1728,	717,	750,	3311,	5633,	7337,	4396,	255,	32,	1,
3,	4855,	4393,	3744,	8416,	2899,	7952,	7858,	4039,	1022,	1162,
4,	6581,	4727,	4179,	1240,	3970,	2097,	6798,	5168,	4248,	1755,
5,	1624,	3267,	2706,	2795,	451,	1371,	1251,	4918,	4054,	3343,
6,	1383,	1292,	1171,	919,	976,	247,	1189,	2128,	1841,	1851,
7,	1099,	864,	696,	1054,	466,	352,	298,	946,	717,	772,
8,	326,	222,	180,	150,	535,	237,	720,	443,	635,	212,
9,	68,	147,	113,	68,	68,	419,	258,	731,	243,	155,
+gp,	10,	102,	95,	11,	147,	187,	318,	855,	312,	74,
TOTALNUM,	17731,	15786,	13677,	18629,	15398,	20293,	23126,	19483,	13104,	9326,
TONSLAND,	21361,	19393,	16485,	18035,	14773,	20715,	26211,	25555,	19200,	12424,
SOPCOF %,	102,	97,	96,	97,	97,	117,	107,	98,	99,	104,

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

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

YEAR,	1980,	1981,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,
AGE										
0,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
1,	0,	0,	0,	0,	25,	0,	0,	0,	0,	0,
2,	143,	74,	539,	441,	1195,	985,	230,	283,	655,	63,
3,	58,	455,	934,	1969,	1561,	4553,	2549,	1718,	444,	1518,
4,	3724,	202,	784,	383,	2462,	2196,	4452,	3565,	2463,	658,
5,	2583,	2586,	298,	422,	147,	1242,	1522,	2972,	3036,	2787,
6,	2496,	1354,	2182,	93,	234,	169,	738,	1114,	2140,	2554,
7,	1568,	1559,	973,	1444,	42,	91,	39,	529,	475,	1976,
8,	660,	608,	1166,	740,	861,	61,	130,	83,	151,	541,
9,	99,	177,	1283,	947,	388,	503,	71,	48,	18,	133,
+gp,	86,	36,	214,	795,	968,	973,	712,	334,	128,	81,
TOTALNUM,	11417,	7051,	8373,	7234,	7883,	10773,	10443,	10646,	9510,	10311,
TONSLAND,	15016,	12233,	11937,	12894,	12378,	15143,	14477,	14882,	12178,	14325,
SOPCOF %,	100,	109,	92,	106,	106,	106,	101,	102,	97,	100,

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

YEAR,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,
AGE										
0,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
1,	0,	0,	0,	43,	1,	0,	1,	0,	0,	9,
2,	105,	77,	40,	113,	277,	804,	326,	77,	106,	174,
3,	1275,	1044,	154,	298,	191,	452,	5234,	2913,	1055,	1142,
4,	1921,	1774,	776,	274,	307,	235,	1019,	10517,	5269,	942,
5,	768,	1248,	1120,	554,	153,	226,	179,	710,	9856,	4677,
6,	1737,	651,	959,	538,	423,	132,	163,	116,	446,	6619,
7,	1909,	1101,	335,	474,	427,	295,	161,	123,	99,	226,
8,	885,	698,	373,	131,	383,	290,	270,	93,	87,	26,
9,	270,	317,	401,	201,	125,	262,	234,	220,	95,	20,
+gp,	108,	32,	162,	185,	301,	295,	394,	516,	502,	192,
TOTALNUM,	8978,	6942,	4320,	2811,	2588,	2991,	7981,	15285,	17515,	14027,
TONSLAND,	11726,	8429,	5476,	4026,	4252,	4948,	9642,	17924,	22210,	18482,
SOPCOF %,	102,	106,	106,	103,	100,	103,	100,	103,	101,	100,

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

YEAR,	2000,	2001,	2002,	2003,	2004,	2005,	2006,	2007,	2008,	2009,
AGE										
0,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
1,	73,	19,	0,	0,	3,	0,	0,	0,	6,	0,
2,	1461,	4380,	1515,	132,	243,	84,	248,	76,	66,	27,
3,	3061,	3128,	14039,	3419,	2007,	1659,	447,	984,	202,	328,
4,	210,	2423,	2879,	13486,	4802,	3824,	2571,	548,	911,	401,
5,	682,	173,	1200,	2214,	10426,	6703,	3958,	2737,	420,	554,
6,	2685,	451,	133,	944,	1163,	6082,	5434,	3316,	1460,	513,
7,	2846,	1151,	239,	162,	409,	538,	3286,	2763,	1693,	1130,
8,	79,	1375,	843,	333,	89,	146,	137,	1119,	1244,	737,
9,	1,	17,	1095,	854,	166,	28,	63,	89,	317,	284,
+gp,	71,	18,	33,	920,	811,	153,	70,	9,	39,	48,
TOTALNUM,	11169,	13135,	21976,	22464,	20119,	19217,	16214,	11641,	6358,	4022,
TONSLAND,	15821,	15890,	24933,	26942,	23101,	20305,	17191,	12656,	7329,	5183,
SOPCOF %,	103,	100,	100,	100,	99,	100,	100,	100,	101,	100,

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

Run title : FAROE HADDOCK (ICES DIVISION Vb) HAD_IND

At 19/04/2010 15:55

Table 2 Catch weights at age (kg)

YEAR,	1957,	1958,	1959,
AGE			
0,	.0000,	.0000,	.0000,
1,	.2500,	.2500,	.2500,
2,	.4700,	.4700,	.4700,
3,	.7300,	.7300,	.7300,
4,	1.1300,	1.1300,	1.1300,
5,	1.5500,	1.5500,	1.5500,
6,	1.9700,	1.9700,	1.9700,
7,	2.4100,	2.4100,	2.4100,
8,	2.7600,	2.7600,	2.7600,
9,	3.0700,	3.0700,	3.0700,
+gp,	3.5500,	3.5500,	3.5500,
SOPCOFAC,	.8937,	.8983,	.9034,

Table 2 Catch weights at age (kg)

YEAR,	1960,	1961,	1962,	1963,	1964,	1965,	1966,	1967,	1968,	1969,
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,	.8832,	.8832,	.8929,	.8915,	1.0111,	.9383,	1.0885,	1.0117,	1.0246,	1.0787,

Table 2 Catch weights at age (kg)

YEAR,	1970,	1971,	1972,	1973,	1974,	1975,	1976,	1977,	1978,	1979,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.2500,	.2500,	.2500,	.2500,	.2500,	.2500,	.2500,	.0000,	.0000,	.3000,
2,	.4700,	.4700,	.4700,	.4700,	.4700,	.4700,	.4700,	.3110,	.3570,	.3570,
3,	.7300,	.7300,	.7300,	.7300,	.7300,	.7300,	.7300,	.6330,	.7900,	.6720,
4,	1.1300,	1.1300,	1.1300,	1.1300,	1.1300,	1.1300,	1.1300,	1.0440,	1.0350,	.8940,
5,	1.5500,	1.5500,	1.5500,	1.5500,	1.5500,	1.5500,	1.5500,	1.4260,	1.3980,	1.1560,
6,	1.9700,	1.9700,	1.9700,	1.9700,	1.9700,	1.9700,	1.9700,	1.8250,	1.8700,	1.5900,
7,	2.4100,	2.4100,	2.4100,	2.4100,	2.4100,	2.4100,	2.4100,	2.2410,	2.3500,	2.0700,
8,	2.7600,	2.7600,	2.7600,	2.7600,	2.7600,	2.7600,	2.7600,	2.2050,	2.5970,	2.5250,
9,	3.0700,	3.0700,	3.0700,	3.0700,	3.0700,	3.0700,	3.0700,	2.5700,	3.0140,	2.6960,
+gp,	3.5500,	3.5500,	3.5500,	3.5500,	3.5500,	3.5500,	3.5500,	2.5910,	2.9200,	3.5190,
SOPCOFAC,	1.0249,	.9688,	.9597,	.9690,	.9678,	1.1696,	1.0741,	.9784,	.9947,	1.0380,

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

Table 2 Catch weights at age (kg)

YEAR	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
AGE										
0	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
1	.0000	.0000	.0000	.0000	.3590	.0000	.0000	.0000	.0000	.0000
2	.6430	.4520	.7000	.4700	.6810	.5280	.6080	.6050	.5010	.5800
3	.7130	.7250	.8960	.7400	1.0110	.8590	.8870	.8310	.7810	.7790
4	.9410	.9570	1.1500	1.0100	1.2550	1.3910	1.1750	1.1260	.9740	.9230
5	1.1570	1.2370	1.4440	1.3200	1.8120	1.7770	1.6310	1.4620	1.3630	1.2070
6	1.4930	1.6510	1.4980	1.6600	2.0610	2.3260	1.9840	1.9410	1.6800	1.5640
7	1.7390	2.0530	1.8290	2.0500	2.0590	2.4400	2.5190	2.1730	1.9750	1.7460
8	2.0950	2.4060	1.8870	2.2600	2.1370	2.4010	2.5830	2.3470	2.3440	2.0860
9	2.4650	2.7250	1.9610	2.5400	2.3680	2.5320	2.5700	3.1180	2.2480	2.4240
+gp	3.3100	3.2500	2.8560	3.0400	2.6860	2.6860	2.9220	2.9330	3.2950	2.5140
SOPCOFAC	1.0017	1.0870	.9238	1.0554	1.0593	1.0559	1.0141	1.0197	.9695	1.0025

Table 2 Catch weights at age (kg)

YEAR	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
AGE										
0	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
1	.0000	.0000	.0000	.3600	.0000	.0000	.3600	.0000	.0000	.2780
2	.4380	.5470	.5250	.7550	.7540	.6660	.5340	.5190	.6220	.5040
3	.6990	.6930	.7240	.9820	1.1030	1.0540	.8580	.7710	.8460	.6240
4	.9390	.8840	.8170	1.0270	1.2540	1.4890	1.4590	1.0660	1.0160	.9740
5	1.2040	1.0860	1.0380	1.1920	1.4650	1.7790	1.9930	1.7990	1.2830	1.2200
6	1.3840	1.2760	1.2490	1.3780	1.5930	1.9400	2.3300	2.2700	2.0800	1.4900
7	1.5640	1.4770	1.4300	1.6430	1.8040	2.1820	2.3510	2.3400	2.5560	2.4560
8	1.8180	1.5740	1.5640	1.7960	2.0490	2.3570	2.4690	2.4750	2.5720	2.6580
9	2.1680	1.9300	1.6330	1.9710	2.2250	2.4900	2.7770	2.5010	2.4520	2.5980
+gp	2.3350	2.1530	2.1260	2.2400	2.4230	2.6780	2.5820	2.6760	2.7530	2.9530
SOPCOFAC	1.0195	1.0635	1.0554	1.0320	.9969	1.0331	1.0043	1.0250	1.0106	.9973

Table 2 Catch weights at age (kg)

YEAR	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
AGE										
0	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
1	.2800	.2800	.0000	.0000	.3670	.0000	.0000	.0000	.4910	.0000
2	.6610	.6080	.5840	.5710	.5740	.5380	.4750	.6280	.6360	.4820
3	.9360	.9400	.8570	.7150	.7700	.6490	.6010	.6690	.7540	.7340
4	1.1660	1.3740	1.4050	1.0080	.8870	.7970	.7680	.8590	.8600	.9850
5	1.4830	1.7790	1.7990	1.5370	1.1590	1.0200	.9110	.9690	.9910	1.1300
6	1.6160	1.9710	1.9740	1.9110	1.6380	1.2450	1.1260	1.0600	1.0820	1.2640
7	1.8930	2.1190	2.3010	2.0910	1.8700	1.8430	1.3740	1.2450	1.1510	1.3570
8	2.8210	2.3730	2.3700	2.3010	2.4380	2.0610	2.1580	1.4750	1.3790	1.5450
9	3.7490	2.7500	2.6260	2.4060	2.3570	2.2630	2.2110	2.2660	1.7270	1.7920
+gp	3.1960	3.9660	3.1300	2.5350	2.4170	2.5790	2.5690	2.2560	2.4350	2.1540
SOPCOFAC	1.0349	.9960	1.0010	1.0048	.9929	.9988	.9986	1.0000	1.0063	.9953

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

Run title : FAROE HADDOCK (ICES DIVISION Vb) HAD_IND

At 19/04/2010 15:55

Table 5 Proportion mature at age

YEAR,	1957,	1958,	1959,
AGE			
0,	.0000,	.0000,	.0000,
1,	.0000,	.0000,	.0000,
2,	.0600,	.0600,	.0600,
3,	.4800,	.4800,	.4800,
4,	.9100,	.9100,	.9100,
5,	1.0000,	1.0000,	1.0000,
6,	1.0000,	1.0000,	1.0000,
7,	1.0000,	1.0000,	1.0000,
8,	1.0000,	1.0000,	1.0000,
9,	1.0000,	1.0000,	1.0000,
+gp,	1.0000,	1.0000,	1.0000,

Table 5 Proportion mature at age

YEAR,	1960,	1961,	1962,	1963,	1964,	1965,	1966,	1967,	1968,	1969,
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,	1970,	1971,	1972,	1973,	1974,	1975,	1976,	1977,	1978,	1979,
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 5.7Faroe haddock. Proportion mature-at-age (cont.).

Table 5 Proportion mature at age

YEAR,	1980,	1981,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,
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,	.0800,	.0800,	.0800,	.0300,	.0300,	.0500,	.0500,	.0200,
3,	.4800,	.4800,	.6200,	.6200,	.7600,	.6200,	.4300,	.3200,	.2400,	.2200,
4,	.9100,	.9100,	.8900,	.8900,	.9800,	.9600,	.9500,	.9100,	.8900,	.8700,
5,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	.9900,	.9800,	.9800,	.9900,
6,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
7,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
8,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
9,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
+gp,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,

Table 5 Proportion mature at age

YEAR,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.0800,	.1600,	.1800,	.1100,	.0500,	.0300,	.0300,	.0100,	.0100,	.0100,
3,	.3700,	.5800,	.6500,	.5000,	.4200,	.4700,	.4700,	.4700,	.3600,	.3500,
4,	.9000,	.9300,	.9100,	.8500,	.8600,	.9100,	.9300,	.9100,	.8700,	.8600,
5,	1.0000,	1.0000,	1.0000,	.9700,	.9600,	.9600,	.9800,	1.0000,	.9900,	.9900,
6,	1.0000,	1.0000,	1.0000,	.9900,	.9900,	.9900,	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,	2000,	2001,	2002,	2003,	2004,	2005,	2006,	2007,	2008,	2009,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.0200,	.0900,	.0800,	.0700,	.0000,	.0100,	.0100,	.0200,	.0100,	.0100,
3,	.3600,	.5400,	.4900,	.4500,	.3500,	.3400,	.4200,	.5200,	.6400,	.6100,
4,	.8700,	.9300,	.9700,	.9700,	.9400,	.9100,	.9100,	.9100,	.9500,	.9300,
5,	.9900,	1.0000,	1.0000,	.9900,	.9900,	.9900,	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 5.8Faroe haddock. 2010 tuning file.

```
FAROE Haddock (ICES SUBDIVISION VB)       COMB-SURVEY-SPALY-10-jr.txt
102
SUMMER SURVEY
1996 2009
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   8968.12  8908.60  6973.94 3364.52  125.74
200    3908.73  7047.44  1676.69   1520.65  4177.57  5114.12 2491.34  552.65
200    4682.23  1967.06  1153.27   2544.21   995.53  3105.84 3178.90 1379.37
200   10512.01  1343.66   410.40   1336.32  1270.33   933.93 2228.54 1224.04
SPRING SURVEY SHIFTED
1993 2009
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  3267.40   1577.20
100   1191.70   1873.30   4202.40   1008.90   3511.30  3712.50   2875.00
100    667.90   2182.60    820.20   1694.90    599.50  1665.00   1463.80
100   4119.00   2079.00   1125.10    405.90    916.80   371.50    924.90
```

100 6945.00 4658.10 638.10 418.70 196.20 280.20 265.90

Table 5.9 Faroe haddock 2010 xsa.

Lowestoft VPA Version 3.1 3/05/2010 17:19

Extended Survivors Analysis

FAROE HADDOCK (ICES DIVISION Vb) HAD_IND

CPUE data from file D:\Vpa\vpa2010\vpa\input-files\comb-survey-spaly-10-jr.txt

Catch data for 53 years. 1957 to 2009. Ages 0 to 10.

Fleet,	First, year,	Last, year,	First, age ,	Last, age	Alpha,	Beta
SUMMER SURVEY ,	1996,	2009,	1,	8,	.600,	.700
SPRING SURVEY SHIFTE,	1993,	2009,	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 had not converged after 40 iterations

Total absolute residual between iterations
39 and 40 = .00011

Final year F values

Age ,	0,	1,	2,	3,	4,	5,	6,	7,	8,	9
Iteration 39,	.0000,	.0000,	.0139,	.1644,	.2198,	.1932,	.3556,	.3328,	.3023,	.2446
Iteration 40,	.0000,	.0000,	.0139,	.1644,	.2198,	.1932,	.3556,	.3327,	.3023,	.2446

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,	2000,	2001,	2002,	2003,	2004,	2005,	2006,	2007,	2008,	2009
0,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000
1,	.001,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.003,	.000
2,	.079,	.049,	.028,	.004,	.010,	.014,	.029,	.023,	.025,	.014
3,	.316,	.243,	.217,	.083,	.069,	.085,	.096,	.156,	.078,	.164
4,	.184,	.445,	.371,	.335,	.160,	.182,	.183,	.164,	.212,	.220
5,	.261,	.227,	.414,	.547,	.471,	.351,	.291,	.303,	.183,	.193
6,	.340,	.276,	.273,	.680,	.630,	.559,	.539,	.424,	.262,	.356
7,	.282,	.238,	.230,	.629,	.724,	.685,	.682,	.585,	.399,	.333
8,	.654,	.213,	.275,	.581,	.885,	.623,	.365,	.522,	.576,	.302
9,	.323,	.278,	.263,	.498,	.653,	.791,	.607,	.430,	.271,	.245

Table 5.9Faroe haddock 2010 xsa (cont.)

XSA population numbers (Thousands)

YEAR	AGE 0	1	2	3	4	5	6	7	8	9
2000	8.92E+04	1.25E+05	2.12E+04	1.25E+04	1.38E+03	3.28E+03	1.03E+04	1.28E+04	1.82E+02	4.01E+00
2001	6.08E+04	7.31E+04	1.02E+05	1.60E+04	7.45E+03	9.43E+02	2.07E+03	6.00E+03	7.91E+03	7.74E+01
2002	4.15E+04	4.98E+04	5.98E+04	7.95E+04	1.03E+04	3.91E+03	6.16E+02	1.28E+03	3.87E+03	5.23E+03
2003	9.94E+03	3.40E+04	4.07E+04	4.76E+04	5.24E+04	5.81E+03	2.11E+03	3.84E+02	8.36E+02	2.41E+03
2004	1.41E+04	8.14E+03	2.78E+04	3.32E+04	3.59E+04	3.07E+04	2.75E+03	8.77E+02	1.68E+02	3.83E+02
2005	5.53E+03	1.15E+04	6.66E+03	2.26E+04	2.54E+04	2.50E+04	1.57E+04	1.20E+03	3.48E+02	5.66E+01
2006	4.47E+03	4.53E+03	9.46E+03	5.38E+03	1.70E+04	1.73E+04	1.44E+04	7.35E+03	4.95E+02	1.53E+02
2007	3.24E+03	3.66E+03	3.71E+03	7.52E+03	4.00E+03	1.16E+04	1.06E+04	6.89E+03	3.04E+03	2.81E+02
2008	1.26E+04	2.65E+03	2.99E+03	2.97E+03	5.26E+03	2.78E+03	7.00E+03	5.68E+03	3.14E+03	1.48E+03
2009	3.18E+04	1.03E+04	2.17E+03	2.39E+03	2.25E+03	3.49E+03	1.89E+03	4.41E+03	3.12E+03	1.45E+03

Estimated population abundance at 1st Jan 2010

, 0.00E+00, 2.60E+04, 8.46E+03, 1.75E+03, 1.66E+03, 1.48E+03, 2.35E+03, 1.09E+03, 2.59E+03, 1.89E+03,

Taper weighted geometric mean of the VPA populations:

, 2.63E+04, 2.18E+04, 1.83E+04, 1.47E+04, 1.01E+04, 6.20E+03, 3.67E+03, 2.02E+03, 9.49E+02, 4.28E+02,

Standard error of the weighted Log(VPA populations) :

, 1.0685, 1.0739, 1.0713, 1.0061, .9737, .9445, .9385, .9696, 1.1265, 1.3918,

Log catchability residuals.

Fleet : SUMMER SURVEY

Age	1993	1994	1995	1996	1997	1998	1999
0	No data for this fleet at this age						
1	99.99	99.99	99.99	1.07	.13	-.28	-.35
2	99.99	99.99	99.99	-.12	.37	-.21	-.42
3	99.99	99.99	99.99	.37	.21	-.38	1.56
4	99.99	99.99	99.99	-.38	.47	.08	-.47
5	99.99	99.99	99.99	-.09	.06	.11	.16
6	99.99	99.99	99.99	.16	.37	-.33	-.01
7	99.99	99.99	99.99	-.08	-.40	.92	.24
8	99.99	99.99	99.99	-.13	.11	.57	.39

Age	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
0	No data for this fleet at this age									
1	-.02	.02	.31	.05	-.17	-.05	-.54	-.21	.29	-.26
2	-.01	.03	-.07	-.06	.25	.21	.09	.71	-.35	-.41
3	.24	.43	.39	-.11	-.18	.07	-.36	-.83	-.33	-1.09
4	-.64	.33	.18	.40	-.11	.25	.04	-.30	-.03	.18
5	-.11	-.89	.20	.62	.34	.11	.17	-.18	-.26	-.24
6	.02	-.42	-.56	-.19	-.13	.68	.21	.14	-.05	.12
7	-.04	-.08	-.44	-.33	-.49	.20	.25	-.05	.27	.12
8	.26	-.17	-.35	.30	-.77	-1.26	-.54	-.77	.14	-.15

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	-4.8902	-5.2215	-5.7356	-5.7272	-5.8159	-5.7598	-5.7598	-5.7598
S.E(Log q)	.3897	.3161	.6396	.3395	.3498	.3237	.3731	.5504

Table 5.9Faroe haddock 2010 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,	.98,	.191,	4.97,	.90,	14,	.40,	-4.89,
2,	.99,	.132,	5.26,	.94,	14,	.33,	-5.22,
3,	.89,	.846,	6.16,	.83,	14,	.57,	-5.74,
4,	.84,	3.193,	6.29,	.97,	14,	.22,	-5.73,
5,	.87,	2.250,	6.18,	.96,	14,	.27,	-5.82,
6,	.93,	1.201,	5.92,	.96,	14,	.30,	-5.76,
7,	1.01,	-.161,	5.73,	.93,	14,	.39,	-5.75,
8,	1.08,	-.835,	5.88,	.89,	14,	.57,	-5.93,

Fleet : SPRING SURVEY SHIFTE

Age ,	1993,	1994,	1995,	1996,	1997,	1998,	1999
0 ,	-.67,	.87,	.81,	-1.18,	-.37,	-.44,	-.25
1 ,	-.52,	-.93,	.36,	.56,	-.21,	-.16,	-.26
2 ,	-.56,	-.66,	-.09,	.44,	.52,	-1.97,	.36
3 ,	-.03,	-.05,	-.26,	.61,	.45,	.25,	-.50
4 ,	-.25,	-.12,	-.07,	.50,	.59,	.32,	-.29
5 ,	-.24,	-1.03,	-.20,	1.08,	.68,	-.15,	.02
6 ,	.34,	-.41,	-.32,	-.12,	-.70,	-.25,	.14
7 ,	No data for this fleet at this age						
8 ,	No data for this fleet at this age						

Age ,	2000,	2001,	2002,	2003,	2004,	2005,	2006,	2007,	2008,	2009
0 ,	.26,	.46,	.03,	-.17,	.63,	-.54,	.20,	-.06,	.40,	.00
1 ,	-.36,	-.54,	.07,	.12,	.57,	.26,	-.01,	.35,	.63,	.07
2 ,	-.25,	.17,	.02,	.13,	.23,	.07,	.72,	.02,	.55,	.29
3 ,	-.51,	-.22,	.03,	-.12,	.04,	.11,	.07,	.32,	-.26,	.07
4 ,	-1.85,	-.04,	-.31,	.70,	.01,	.04,	.52,	.18,	.38,	-.31
5 ,	-1.13,	-.88,	-.38,	.10,	.67,	.35,	.79,	.40,	.21,	-.29
6 ,	-.61,	-.51,	-.96,	-.39,	.41,	.48,	1.15,	.67,	.47,	.62
7 ,	No data for this fleet at this age									
8 ,	No data for this fleet at this age									

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

Age ,	0,	1,	2,	3,	4,	5,	6
Mean Log q,	-5.9316,	-5.2797,	-5.9123,	-6.0637,	-6.3260,	-6.4561,	-6.6465,
S.E(Log q),	.5514,	.4379,	.6279,	.3038,	.5823,	.6369,	.5833,

Table 5.9Faroe haddock 2010 xsa (cont.)

Regression statistics :

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
0,	.95,	.483,	6.15,	.85,	17,	.54,	-5.93,
1,	1.24,	-2.509,	4.20,	.88,	17,	.47,	-5.28,
2,	.90,	.977,	6.28,	.85,	17,	.56,	-5.91,
3,	.91,	1.731,	6.34,	.96,	17,	.26,	-6.06,
4,	.80,	2.670,	6.83,	.92,	17,	.40,	-6.33,
5,	.88,	1.144,	6.70,	.86,	17,	.55,	-6.46,
6,	.78,	3.043,	6.94,	.93,	17,	.37,	-6.65,

Terminal year survivor and F summaries :

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

Year class = 2009

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,	26035.,	.567,	.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
26035.,	.57,	.00,	1,	.000,	.000

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

Year class = 2008

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
SUMMER SURVEY ,	6517.,	.403,	.000,	.00,	1,	.433,	.000
SPRING SURVEY SHIFTE,	10333.,	.353,	.160,	.45,	2,	.567,	.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
8461.,	.27,	.18,	3,	.688,	.000

Table 5.9Faroe haddock 2010 xsa (cont.)

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

 Year class = 2007

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SUMMER SURVEY       ,      1528.,   .254,       .346,   1.36,   2,  .517,     .016
 SPRING SURVEY SHIFTE,      2475.,   .310,       .208,    .67,   3,  .348,     .010

   F shrinkage mean  ,      1198.,    .50,,,,                        .135,     .020

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      1748.,       .18,      .18,    6,    .997,   .014


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

 Year class = 2006

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Esti-
mated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SUMMER SURVEY       ,      1114.,   .237,       .195,    .82,   3,  .409,
.236
 SPRING SURVEY SHIFTE,      2052.,   .220,       .096,    .44,   4,  .480,
.135

   F shrinkage mean  ,      2907.,    .50,,,,                        .111,
.097

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      1661.,       .15,      .16,    8,   1.015,   .164


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

 Year class = 2005

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Esti-
mated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SUMMER SURVEY       ,      1726.,   .197,       .282,   1.43,   4,  .476,
.191
 SPRING SURVEY SHIFTE,      1180.,   .207,       .085,    .41,   5,  .426,
.268

   F shrinkage mean  ,      1827.,    .50,,,,                        .098,
.181

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      1476.,       .14,      .14,   10,    .981,   .220
```

Table 5.9Faroe haddock 2010 xsa (cont.)

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

 Year class = 2004

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Esti-
mated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SUMMER SURVEY       ,      2101.,   .175,       .109,    .62,   5,  .527,
.214
 SPRING SURVEY SHIFTE,      3203.,   .199,       .120,    .60,   6,  .376,
.145

   F shrinkage mean  ,      1322.,    .50,,,,                        .098,
.322

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      2353.,       .13,      .11,   12,    .850,   .193

 Age  6   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       ,      1011.,   .156,       .095,    .61,   6,  .558,     .378
 SPRING SURVEY SHIFTE,      1364.,   .190,       .105,    .55,   7,  .343,     .293

   F shrinkage mean  ,       741.,    .50,,,,                        .099,     .486

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      1087.,       .12,      .08,   14,    .675,   .356


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

 Year class = 2002

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SUMMER SURVEY       ,      2688.,   .150,       .052,    .35,   7,  .604,     .322
 SPRING SURVEY SHIFTE,      3284.,   .191,       .070,    .37,   7,  .282,     .271

   F shrinkage mean  ,      1189.,    .50,,,,                        .115,     .621

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      2590.,       .12,      .09,   15,    .753,   .333
```

Table 5.9Faroe haddock 2010 xsa (cont.)

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

 Year class = 2001

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SUMMER SURVEY       ,      2131.,   .156,       .062,    .40,   8,  .607,     .272
 SPRING SURVEY SHIFTE,      2448.,   .191,       .118,    .62,   7,  .235,     .241

   F shrinkage mean  ,       813.,    .50,,,,                        .158,     .599

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      1890.,       .13,      .12,   16,    .877,   .302


 Age  9   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       ,       973.,   .168,       .044,    .26,   8,  .523,     .234
 SPRING SURVEY SHIFTE,      1051.,   .192,       .209,   1.09,   7,  .183,     .219

   F shrinkage mean  ,       788.,    .50,,,,                        .294,     .282

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
       927.,       .17,      .07,   16,    .395,   .245
```

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

Run title : FAROE HADDOCK (ICES DIVISION Vb) HAD_IND

At 19/04/2010 15:55

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR,	1957,	1958,	1959,
AGE			
0,	.0000,	.0000,	.0000,
1,	.0010,	.0024,	.0132,
2,	.1394,	.1939,	.1066,
3,	.3707,	.4378,	.3860,
4,	.6163,	.5737,	.4782,
5,	.3909,	.5386,	.4195,
6,	.4380,	.6346,	.6458,
7,	.6340,	.9504,	.9184,
8,	.5599,	.7839,	.8206,
9,	.5321,	.7028,	.6625,
+gp,	.5321,	.7028,	.6625,
FBAR 3- 7,	.4900,	.6270,	.5696,

Table 8 Fishing mortality (F) at age

YEAR,	1960,	1961,	1962,	1963,	1964,	1965,	1966,	1967,	1968,	1969,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0150,	.0219,	.0149,	.0106,	.0018,	.0017,	.0032,	.0012,	.0014,	.0024,
2,	.2074,	.1875,	.3232,	.3801,	.0876,	.0691,	.0610,	.0641,	.1261,	.0860,
3,	.4599,	.4162,	.5866,	.5639,	.3723,	.2354,	.2370,	.1873,	.2647,	.2363,
4,	.6926,	.4209,	.5980,	.7261,	.5193,	.4767,	.4515,	.2971,	.3483,	.5320,
5,	.5260,	.4387,	.3480,	.5591,	.5369,	.3678,	.5006,	.2997,	.2847,	.3330,
6,	.6591,	.5879,	.6706,	.4026,	.6107,	.5882,	.5421,	.5406,	.4540,	.4975,
7,	1.2130,	.9483,	1.0499,	1.2493,	.3375,	.9618,	.9128,	.6906,	.8367,	.8277,
8,	.9667,	.8742,	.9736,	1.1139,	1.2027,	2.3618,	.7509,	.6634,	.5851,	1.0631,
9,	.8198,	.6600,	.7351,	.8185,	.6472,	.9619,	.6373,	.5022,	.5057,	.6566,
+gp,	.8198,	.6600,	.7351,	.8185,	.6472,	.9619,	.6373,	.5022,	.5057,	.6566,
FBAR 3- 7,	.7101,	.5624,	.6506,	.7002,	.4753,	.5260,	.5288,	.4031,	.4377,	.4853,

Table 8 Fishing mortality (F) at age

YEAR,	1970,	1971,	1972,	1973,	1974,	1975,	1976,	1977,	1978,	1979,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0033,	.0015,	.0016,	.0114,	.0033,	.0015,	.0014,	.0000,	.0000,	.0002,
2,	.0551,	.0526,	.0253,	.1677,	.1266,	.1230,	.0908,	.0108,	.0010,	.0004,
3,	.2528,	.1936,	.4226,	.4320,	.2172,	.2650,	.1878,	.1128,	.0547,	.0458,
4,	.3344,	.4186,	.2853,	.2392,	.3730,	.2412,	.3810,	.1815,	.1665,	.1255,
5,	.3639,	.2754,	.4517,	.3143,	.1279,	.2116,	.2216,	.5273,	.2115,	.1913,
6,	.5561,	.5560,	.1495,	.2703,	.1714,	.0957,	.2871,	.7246,	.3819,	.1408,
7,	.8740,	.8385,	.6720,	.1951,	.2134,	.0859,	.1601,	.3904,	.5760,	.2721,
8,	.5430,	.4224,	.4066,	.2907,	.1433,	.1599,	.2538,	.3788,	.4968,	.3303,
9,	.5386,	.5061,	.3957,	.2633,	.2068,	.1595,	.2621,	.4437,	.3689,	.2130,
+gp,	.5386,	.5061,	.3957,	.2633,	.2068,	.1595,	.2621,	.4437,	.3689,	.2130,
FBAR 3- 7,	.4762,	.4564,	.3962,	.2902,	.2206,	.1799,	.2475,	.3873,	.2781,	.1551,

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

Table 8 Fishing mortality (F) at age

YEAR,	1980,	1981,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0000,	.0000,	.0000,	.0000,	.0006,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.0325,	.0237,	.0383,	.0252,	.0329,	.0280,	.0096,	.0337,	.0393,	.0049,
3,	.0285,	.1373,	.4617,	.1916,	.1167,	.1693,	.0940,	.0925,	.0679,	.1205,
4,	.2025,	.1314,	.3708,	.3479,	.3894,	.2390,	.2489,	.1843,	.1860,	.1360,
5,	.2749,	.2111,	.2917,	.3497,	.2170,	.3473,	.2595,	.2619,	.2363,	.3320,
6,	.2135,	.2264,	.2774,	.1382,	.3335,	.4160,	.3586,	.3078,	.3056,	.3201,
7,	.1702,	.2004,	.2523,	.2990,	.0853,	.2082,	.1571,	.4742,	.2079,	.5161,
8,	.3954,	.0919,	.2265,	.3101,	.2928,	.1719,	.5174,	.5840,	.2376,	.3877,
9,	.2526,	.1730,	.2853,	.2906,	.2650,	.2780,	.3101,	.3648,	.2359,	.3405,
+gp,	.2526,	.1730,	.2853,	.2906,	.2650,	.2780,	.3101,	.3648,	.2359,	.3405,
FBAR 3- 7,	.1779,	.1813,	.3308,	.2653,	.2284,	.2760,	.2236,	.2641,	.2007,	.2849,

Table 8 Fishing mortality (F) at age

YEAR,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0000,	.0000,	.0000,	.0061,	.0000,	.0000,	.0001,	.0000,	.0000,	.0004,
2,	.0124,	.0290,	.0167,	.0709,	.0490,	.0093,	.0080,	.0095,	.0320,	.0125,
3,	.1298,	.1650,	.0746,	.1662,	.1645,	.1054,	.0770,	.0915,	.1733,	.5577,
4,	.2205,	.2687,	.1778,	.1842,	.2582,	.3128,	.3653,	.2187,	.2380,	.2311,
5,	.2327,	.2178,	.2714,	.1859,	.1485,	.3077,	.4181,	.4705,	.3282,	.3443,
6,	.3564,	.3165,	.2593,	.2021,	.2114,	.1847,	.3819,	.5291,	.6179,	.3836,
7,	.4222,	.4026,	.2665,	.1969,	.2447,	.2238,	.3599,	.5596,	1.2984,	.7534,
8,	.4613,	.2673,	.2296,	.1577,	.2418,	.2613,	.3291,	.3648,	1.0441,	1.9270,
9,	.3407,	.2963,	.2422,	.1862,	.2220,	.2595,	.3486,	.4907,	.7968,	.7274,
+gp,	.3407,	.2963,	.2422,	.1862,	.2220,	.2595,	.3486,	.4907,	.7968,	.7274,
FBAR 3- 7,	.2723,	.2741,	.2099,	.1871,	.2055,	.2269,	.3204,	.3739,	.5312,	.4540,

Table 8 Fishing mortality (F) at age

YEAR,	2000,	2001,	2002,	2003,	2004,	2005,	2006,	2007,	2008,	2009,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0006,	.0003,	.0000,	.0000,	.0004,	.0000,	.0000,	.0000,	.0025,	.0000,
2,	.0794,	.0486,	.0284,	.0036,	.0097,	.0140,	.0294,	.0229,	.0247,	.0139,
3,	.3160,	.2433,	.2171,	.0827,	.0691,	.0847,	.0964,	.1563,	.0782,	.1644,
4,	.1836,	.4452,	.3707,	.3348,	.1601,	.1820,	.1831,	.1642,	.2123,	.2198,
5,	.2612,	.2266,	.4144,	.5472,	.4707,	.3510,	.2909,	.3028,	.1828,	.1932,
6,	.3400,	.2758,	.2728,	.6799,	.6299,	.5592,	.5386,	.4238,	.2619,	.3556,
7,	.2818,	.2383,	.2302,	.6286,	.7241,	.6847,	.6820,	.5854,	.3992,	.3327,
8,	.6539,	.2133,	.2754,	.5806,	.8847,	.6226,	.3650,	.5221,	.5756,	.3022,
9,	.3225,	.2778,	.2629,	.4980,	.6525,	.7908,	.6074,	.4300,	.2708,	.2446,
+gp,	.3225,	.2778,	.2629,	.4980,	.6525,	.7908,	.6074,	.4300,	.2708,	.2446,
FBAR 3- 7,	.2765,	.2859,	.3010,	.4546,	.4108,	.3723,	.3582,	.3265,	.2269,	.2531,

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

Run title : FAROE HADDOCK (ICES DIVISION Vb) HAD_IND

At 19/04/2010 15:55

Terminal Fs derived using XSA (With F shrinkage)

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

YEAR,	1957,	1958,	1959,
AGE			
0,	64927,	54061,	77651,
1,	47944,	53158,	44261,
2,	35106,	39212,	43417,
3,	25440,	25003,	26445,
4,	20280,	14377,	13213,
5,	5517,	8965,	6632,
6,	2786,	3055,	4284,
7,	1377,	1472,	1326,
8,	585,	598,	466,
9,	252,	274,	224,
+gp,	154,	227,	106,
TOTAL,	204367,	200401,	218024,

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

YEAR,	1960,	1961,	1962,	1963,	1964,	1965,	1966,	1967,	1968,	1969,
AGE										
0,	58761,	71715,	45400,	33843,	30192,	37948,	81924,	47768,	53238,	23136,
1,	63576,	48109,	58715,	37170,	27709,	24719,	31069,	67073,	39109,	43587,
2,	35763,	51279,	38537,	47362,	30110,	22644,	20203,	25356,	54852,	31975,
3,	31954,	23796,	34806,	22837,	26515,	22585,	17302,	15563,	19470,	39587,
4,	14717,	16517,	12850,	15850,	10638,	14961,	14613,	11176,	10566,	12234,
5,	6706,	6028,	8877,	5786,	6278,	5182,	7604,	7617,	6798,	6106,
6,	3570,	3245,	3182,	5132,	2708,	3005,	2937,	3774,	4622,	4187,
7,	1839,	1512,	1476,	1332,	2809,	1204,	1366,	1398,	1800,	2403,
8,	433,	448,	480,	423,	313,	1641,	377,	449,	574,	638,
9,	168,	135,	153,	148,	114,	77,	127,	146,	189,	262,
+gp,	54,	29,	46,	45,	16,	14,	21,	36,	33,	45,
TOTAL,	217540,	222811,	204522,	169929,	137402,	133981,	177543,	180356,	191250,	164161,

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

YEAR,	1970,	1971,	1972,	1973,	1974,	1975,	1976,	1977,	1978,	1979,
AGE										
0,	49622,	35418,	78971,	104857,	83633,	39132,	52368,	4154,	7378,	5209,
1,	18942,	40627,	28998,	64656,	85849,	68473,	32039,	42875,	3401,	6040,
2,	35600,	15457,	33213,	23703,	52334,	70059,	55976,	26195,	35103,	2785,
3,	24022,	27584,	12006,	26514,	16410,	37751,	50720,	41852,	21216,	28711,
4,	25590,	15275,	18609,	6442,	14093,	10812,	23713,	34416,	30611,	16445,
5,	5884,	14997,	8229,	11454,	4152,	7946,	6955,	13263,	23501,	21218,
6,	3583,	3348,	9322,	4289,	6849,	2992,	5265,	4562,	6409,	15573,
7,	2084,	1682,	1572,	6573,	2680,	4724,	2226,	3235,	1810,	3581,
8,	860,	712,	595,	657,	4428,	1772,	3549,	1553,	1792,	833,
9,	180,	409,	382,	325,	402,	3141,	1237,	2254,	870,	893,
+gp,	26,	281,	319,	52,	865,	1396,	1515,	2613,	1109,	424,
TOTAL,	166395,	155789,	192216,	249521,	271696,	248198,	235562,	176973,	133200,	101712,

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

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

YEAR,	1980,	1981,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,
AGE										
0,	23627,	29274,	60836,	58894,	39530,	14092,	28016,	21190,	13993,	4442,
1,	4264,	19344,	23968,	49808,	48218,	32365,	11537,	22937,	17349,	11457,
2,	4944,	3491,	15838,	19623,	40779,	39455,	26498,	9446,	18780,	14204,
3,	2279,	3919,	2792,	12479,	15667,	32306,	31412,	21487,	7478,	14783,
4,	22455,	1813,	2797,	1440,	8435,	11415,	22330,	23411,	16037,	5720,
5,	11876,	15015,	1302,	1580,	833,	4679,	7358,	14254,	15942,	10902,
6,	14347,	7386,	9954,	796,	912,	549,	2707,	4647,	8981,	10305,
7,	11075,	9488,	4822,	6175,	568,	535,	296,	1548,	2797,	5417,
8,	2234,	7649,	6357,	3068,	3749,	427,	356,	207,	789,	1860,
9,	490,	1232,	5712,	4150,	1842,	2290,	294,	174,	95,	509,
+gp,	423,	249,	947,	3461,	4568,	4403,	2931,	1198,	670,	308,
TOTAL,	98016,	98861,	135323,	161475,	165102,	142515,	133736,	120500,	102910,	79907,

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

YEAR,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,
AGE										
0,	3984,	2723,	9615,	143575,	67594,	13483,	5554,	23037,	31583,	152186,
1,	3637,	3262,	2229,	7872,	117549,	55341,	11039,	4548,	18861,	25858,
2,	9380,	2978,	2671,	1825,	6406,	96240,	45310,	9037,	3723,	15442,
3,	11572,	7585,	2368,	2150,	1392,	4994,	78067,	36801,	7329,	2952,
4,	10730,	8321,	5265,	1800,	1491,	967,	3680,	59180,	27495,	5046,
5,	4088,	7046,	5207,	3609,	1225,	943,	579,	2091,	38937,	17743,
6,	6404,	2652,	4640,	3250,	2453,	865,	568,	312,	1069,	22960,
7,	6126,	3671,	1582,	2931,	2174,	1626,	589,	317,	150,	472,
8,	2647,	3288,	2009,	992,	1971,	1394,	1064,	336,	148,	34,
9,	1033,	1366,	2061,	1308,	694,	1267,	879,	627,	191,	43,
+gp,	410,	137,	828,	1198,	1662,	1418,	1468,	1456,	995,	405,
TOTAL,	60012,	43029,	38475,	170510,	204612,	178538,	148797,	137743,	130483,	243142,

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

YEAR,	2000,	2001,	2002,	2003,	2004,	2005,	2006,	2007,	2008,	2009,	2010,
AGE											
0,	89239,	60777,	41538,	9942,	14106,	5531,	4467,	3238,	12623,	31799,	0,
1,	124599,	73063,	49760,	34008,	8140,	11549,	4529,	3657,	2651,	10335,	26035,
2,	21163,	101947,	59802,	40740,	27844,	6662,	9456,	3708,	2994,	2165,	8461,
3,	12485,	16005,	79504,	47591,	33235,	22577,	5378,	7517,	2967,	2392,	1748,
4,	1384,	7453,	10273,	52390,	35870,	25395,	16983,	3999,	5264,	2246,	1661,
5,	3279,	943,	3909,	5806,	30690,	25023,	17331,	11578,	2778,	3486,	1476,
6,	10295,	2068,	616,	2115,	2750,	15693,	14422,	10608,	7003,	1894,	2353,
7,	12809,	5999,	1285,	384,	877,	1199,	7345,	6891,	5685,	4412,	1087,
8,	182,	7912,	3870,	836,	168,	348,	495,	3041,	3142,	3123,	2590,
9,	4,	77,	5234,	2406,	383,	57,	153,	281,	1477,	1447,	1890,
+gp,	283,	81,	157,	2566,	1847,	305,	168,	28,	181,	243,	1083,
TOTAL,	275723,	276325,	255947,	198783,	155911,	114339,	80727,	54547,	46764,	63541,	48385,

Table 5.12. Faroe haddock. Stock summary of the 2010 VPA.

Run title: FAROE HADDOCK (ICES DIVISION Vb) HAD_IND

At 19/04/2010 15:55

Table 16 Summary (without SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

	Recruits Age 0	Recruits Age 2	Total Biomass	Total SSB	Landings	Yield/SSB	FBAR(3-7)
1957	64927	35106	90264	51049	20995	0.4113	0.49
1958	54061	39212	92975	51409	23871	0.4643	0.627
1959	77651	43417	89969	48340	20239	0.4187	0.5696
1960	58761	35763	96422	51101	25727	0.5035	0.7101
1961	71715	51279	93296	47901	20831	0.4349	0.5624
1962	45400	38537	98262	52039	27151	0.5217	0.6506
1963	33843	47362	90204	49706	27571	0.5547	0.7002
1964	30192	30110	75561	44185	19490	0.4411	0.4753
1965	37948	22644	71884	45605	18479	0.4052	0.526
1966	81924	20203	68774	44027	18766	0.4262	0.5288
1967	47768	25356	77101	42086	13381	0.3179	0.4031
1968	53238	54852	87971	45495	17852	0.3924	0.4377
1969	23136	31975	94878	53583	23272	0.4343	0.4853
1970	49622	35600	92143	59958	21361	0.3563	0.4762
1971	35418	15457	92931	63921	19393	0.3034	0.4564
1972	78971	33213	91507	63134	16485	0.2611	0.3962
1973	104857	23703	98978	61622	18035	0.2927	0.2902
1974	83633	52334	116877	64631	14773	0.2286	0.2206
1975	39132	70059	138906	75406	20715	0.2747	0.1799
1976	52368	55976	143627	89222	26211	0.2938	0.2475
1977	4154	26195	121046	96379	25555	0.2652	0.3873
1978	7378	35103	120583	97237	19200	0.1975	0.2781
1979	5209	2785	99508	85405	12424	0.1455	0.1551
1980	23627	4944	87644	81909	15016	0.1833	0.1779
1981	29274	3491	78971	75854	12233	0.1613	0.1813
1982	60836	15838	68316	56812	11937	0.2101	0.3308
1983	58894	19623	63975	51821	12894	0.2488	0.2653
1984	39530	40779	100707	53834	12378	0.2299	0.2284
1985	14092	39455	94007	62619	15143	0.2418	0.276
1986	28016	26498	98569	65628	14477	0.2206	0.2236
1987	21190	9446	87699	67339	14882	0.221	0.2641
1988	13993	18780	77478	61949	12178	0.1966	0.2007
1989	4442	14204	69656	51782	14325	0.2766	0.2849
1990	3984	9380	53649	43766	11726	0.2679	0.2723
1991	2723	2978	38807	34717	8429	0.2428	0.2741
1992	9615	2671	29149	27012	5476	0.2027	0.2099
1993	143575	1825	28810	23243	4026	0.1732	0.1871
1994	67594	6406	27470	21618	4252	0.1967	0.2055
1995	13483	96240	87940	22763	4948	0.2174	0.2269
1996	5554	45310	113238	49896	9642	0.1932	0.3204
1997	23037	9037	107659	82300	17924	0.2178	0.3739
1998	31583	3723	92606	82214	22210	0.2701	0.5312
1999	152186	15442	80142	63146	18482	0.2927	0.454
2000	89239	21163	109356	53021	15821	0.2984	0.2765
2001	60777	101947	145503	61003	15890	0.2605	0.2859
2002	41538	59802	152104	84792	24933	0.294	0.301
2003	9942	40740	138083	96060	26942	0.2805	0.4546
2004	14106	27844	123868	86000	23101	0.2686	0.4108
2005	5531	6662	87380	72084	20305	0.2817	0.3723
2006	4467	9456	64726	57230	17191	0.3004	0.3582
2007	3238	3708	47022	42017	12656	0.3012	0.3265
2008	12623	2994	34167	29948	7329	0.2447	0.2269
2009	31799	2165	25273	23400	5183	0.2215	0.2531
Arith. Mean	40798	28090	87880	57910	16674	0.2936	0.3586
Units	(Thousands)	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

Table 5.13. Management options table - INPUT DATA descriptions.

Stock size

The stock in numbers 2010 is taken directly from the 2010 XSA. The year class 2009 at age 2 (in 2011) is estimated from the 2010 XSA age 1 applying a natural mortality of 0.2 in foreward calculation of the number using the standard VPA equation. The year class 2010 at age 2 (in 2012) is estimated as the geomean of the year classes since 1980.

Age	2010	2011	2012
2	8461	21300	12100
3	1748		
4	1661		
5	1476		
6	2353		
7	1087		
8	2590		
9	1890		
10+	1083		

Numbers in thousands (predicted values rounded).

Table 5.14 Faroe haddock. Management option table - Input data

MFDP version 1
Run: man
Time and date: 09:42 4/22/2010
Fbar age range: 3-7

2010

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
2	8461	0.2	0	0	0	0.58	1.93E-02	0.58
3	1748	0.2	0.57	0	0	0.675	0.125202	0.675
4	1661	0.2	0.95	0	0	0.86	0.187159	0.86
5	1476	0.2	0.99	0	0	0.991	0.213	0.991
6	2353	0.2	1	0	0	1.082	0.32683	1.082
7	1087	0.2	1	0	0	1.151	0.4134	1.151
8	2590	0.2	1	0	0	1.379	0.4393	1.379
9	1890	0.2	1	0	0	1.727	0.29673	1.727
10	1083	0.2	1	0	0	2.435	0.29673	2.435

2011

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
2	21300	0.2	0.01	0	0	0.58	1.93E-02	0.58
3	.	0.2	0.61	0	0	0.675	0.125202	0.675
4	.	0.2	0.94	0	0	0.86	0.187159	0.86
5	.	0.2	1	0	0	0.991	0.213	0.991
6	.	0.2	1	0	0	1.082	0.32683	1.082
7	.	0.2	1	0	0	1.151	0.4134	1.151
8	.	0.2	1	0	0	1.379	0.4393	1.379
9	.	0.2	1	0	0	1.727	0.29673	1.727
10	.	0.2	1	0	0	2.435	0.29673	2.435

2012

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
2	12100	0.2	0.01	0	0	0.58	1.93E-02	0.58
3	.	0.2	0.61	0	0	0.675	0.125202	0.675
4	.	0.2	0.94	0	0	0.86	0.187159	0.86
5	.	0.2	1	0	0	0.991	0.213	0.991
6	.	0.2	1	0	0	1.082	0.32683	1.082
7	.	0.2	1	0	0	1.151	0.4134	1.151
8	.	0.2	1	0	0	1.379	0.4393	1.379
9	.	0.2	1	0	0	1.727	0.29673	1.727
10	.	0.2	1	0	0	2.435	0.29673	2.435

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 21/04/2010
Time and date: 09:42 4/22/2010
Fbar age range: 3-7

2010 Biomass	SSB	FMult	FBar	Landings
22248	16747	1	0.2531	4261

2011 Biomass	SSB	2012 FMult	FBar	Landings	Biomass	SSB
29377	15293	0	0	0	35250	23424
.	15293	0.1	0.0253	413	34813	23000
.	15293	0.2	0.0506	816	34389	22588
.	15293	0.3	0.0759	1208	33977	22188
.	15293	0.4	0.1012	1589	33575	21799
.	15293	0.5	0.1266	1960	33185	21421
.	15293	0.6	0.1519	2322	32805	21053
.	15293	0.7	0.1772	2674	32436	20696
.	15293	0.8	0.2025	3017	32076	20348
.	15293	0.9	0.2278	3351	31726	20010
.	15293	1	0.2531	3676	31386	19682
.	15293	1.1	0.2784	3993	31054	19362
.	15293	1.2	0.3037	4302	30732	19051
.	15293	1.3	0.3291	4603	30417	18748
.	15293	1.4	0.3544	4897	30111	18454
.	15293	1.5	0.3797	5183	29813	18167
.	15293	1.6	0.405	5462	29523	17889
.	15293	1.7	0.4303	5734	29240	17617
.	15293	1.8	0.4556	6000	28964	17353
.	15293	1.9	0.4809	6258	28695	17096
.	15293	2	0.5062	6511	28433	16845

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 21/04/2010
Time and date: 10:36 4/22/2010
Fbar age range: 3-7

Age	M	Mat	PF	PM	SWt	Sel	CWt
2	0.2	0.05	0	0	0.558	0.0193	0.558
3	0.2	0.47	0	0	0.797	0.1252	0.797
4	0.2	0.91	0	0	1.058	0.1871	1.058
5	0.2	0.99	0	0	1.371	0.2130	1.371
6	0.2	1.00	0	0	1.667	0.3268	1.667
7	0.2	1.00	0	0	1.948	0.4134	1.948
8	0.2	1.00	0	0	2.186	0.4393	2.186
9	0.2	1.00	0	0	2.428	0.2967	2.428
10	0.2	1.00	0	0	2.748	0.2967	2.748

Weights in kilograms

Table 5.17 Faroe haddock. Long-term Prediction - Results

MFYPR version 1
Run: ypr
Time and date: 10:36 4/22/2010
Yield per results

FMult	Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNosJan	SSBJan	SpwnNosSpwn	SSBSpwn
0	0	0	0	5.5167	8.4551	4.0704	7.511	4.0704	7.511
0.1	0.0253	0.0941	0.1733	5.0477	7.2937	3.6033	6.3515	3.6033	6.3515
0.2	0.0506	0.166	0.2938	4.69	6.4289	3.2474	5.4885	3.2474	5.4885
0.3	0.0759	0.2228	0.3799	4.4081	5.7648	2.9674	4.8261	2.9674	4.8261
0.4	0.1012	0.2687	0.4426	4.1803	5.2417	2.7413	4.3047	2.7413	4.3047
0.5	0.1266	0.3066	0.4891	3.992	4.8209	2.5549	3.8857	2.5549	3.8857
0.6	0.1519	0.3386	0.524	3.8337	4.4763	2.3982	3.5428	2.3982	3.5428
0.7	0.1772	0.366	0.5505	3.6983	4.1896	2.2646	3.2577	2.2646	3.2577
0.8	0.2025	0.3897	0.5708	3.5811	3.9477	2.1491	3.0175	2.1491	3.0175
0.9	0.2278	0.4105	0.5864	3.4783	3.7411	2.0481	2.8125	2.0481	2.8125
1	0.2531	0.429	0.5985	3.3873	3.5626	1.9588	2.6357	1.9588	2.6357
1.1	0.2784	0.4455	0.608	3.306	3.407	1.8791	2.4817	1.8791	2.4817
1.2	0.3037	0.4604	0.6154	3.2327	3.2701	1.8075	2.3463	1.8075	2.3463
1.3	0.329	0.474	0.6212	3.1663	3.1486	1.7427	2.2264	1.7427	2.2264
1.4	0.3543	0.4863	0.6257	3.1055	3.0399	1.6836	2.1193	1.6836	2.1193
1.5	0.3797	0.4977	0.6292	3.0498	2.9422	1.6294	2.0231	1.6294	2.0231
1.6	0.405	0.5082	0.6319	2.9983	2.8537	1.5795	1.9361	1.5795	1.9361
1.7	0.4303	0.518	0.6339	2.9505	2.7731	1.5333	1.857	1.5333	1.857
1.8	0.4556	0.5271	0.6355	2.906	2.6994	1.4904	1.7848	1.4904	1.7848
1.9	0.4809	0.5356	0.6366	2.8645	2.6316	1.4504	1.7185	1.4504	1.7185
2	0.5062	0.5436	0.6374	2.8255	2.5691	1.4129	1.6573	1.4129	1.6573

Reference point	F multiplier	Absolute F
Fbar(3-7)	1	0.2531
FMax	2.3257	0.5886
F0.1	0.7383	0.1869
F35%SPR	1.0042	0.2542
Fhigh	4.5271	1.1458
Fmed	1.0101	0.2557
Flow	-99	

Weights in kilograms

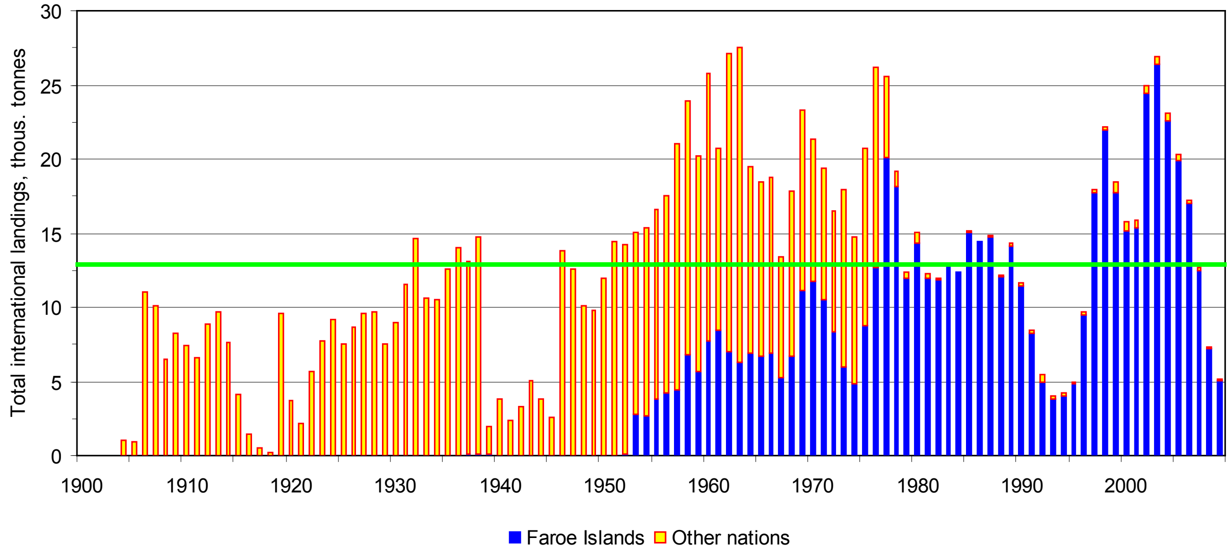


Figure 5.1. Haddock in ICES Division Vb. Landings by all nations 1904-2009. Horisontal line average for the whole period.

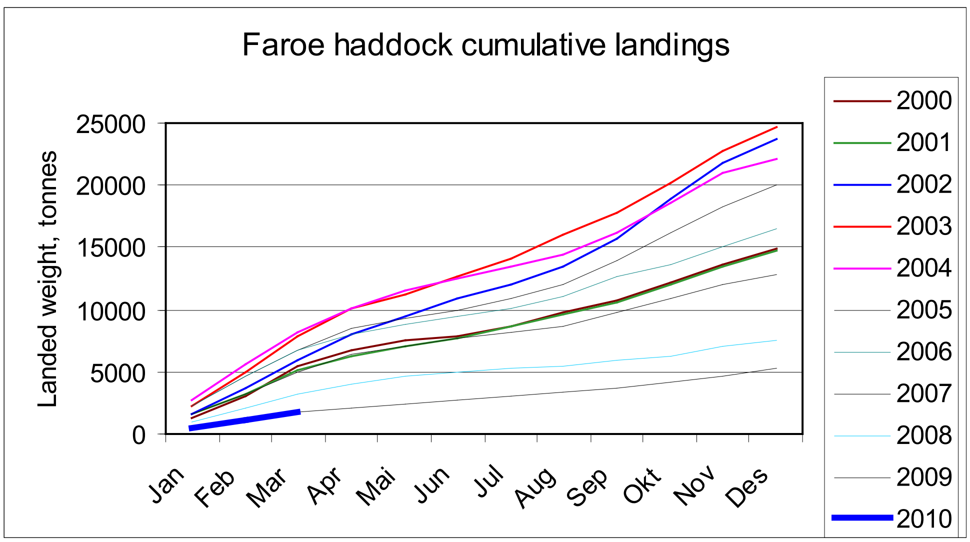


Figure 5.2. Faroe haddock. Cumulative Faroese landings from Vb.

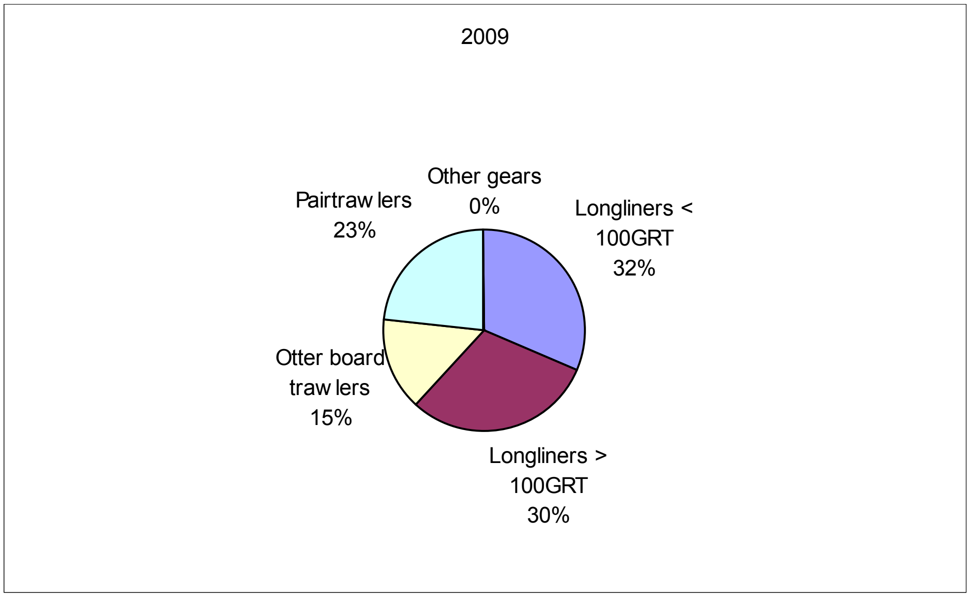


Figure 5.3. Faroe haddock. Contribution (%) by fleet to the total Faroese landings 2009.

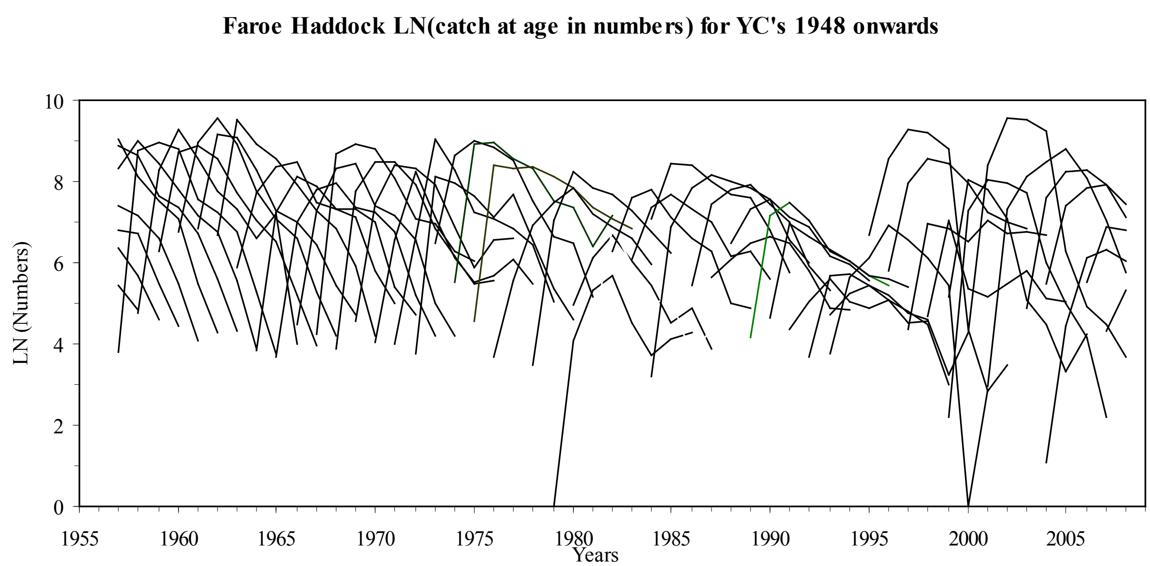


Figure 5.4. Faroe haddock. LN(catch@age in numbers) for YC's 1948 onwards.

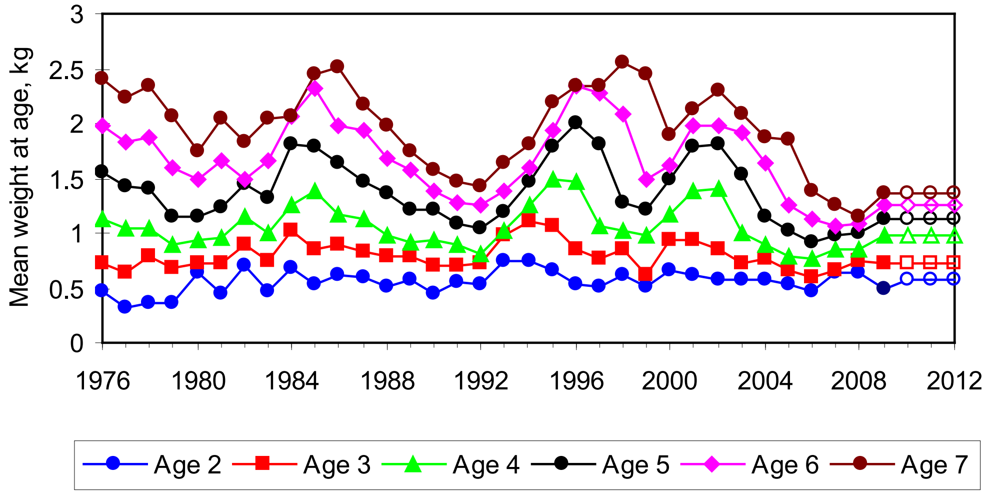


Figure 5.5. Faroe haddock. Mean weight at age (2-7). 2010-2012 are predicted values used in the short term prediction (open symbols).

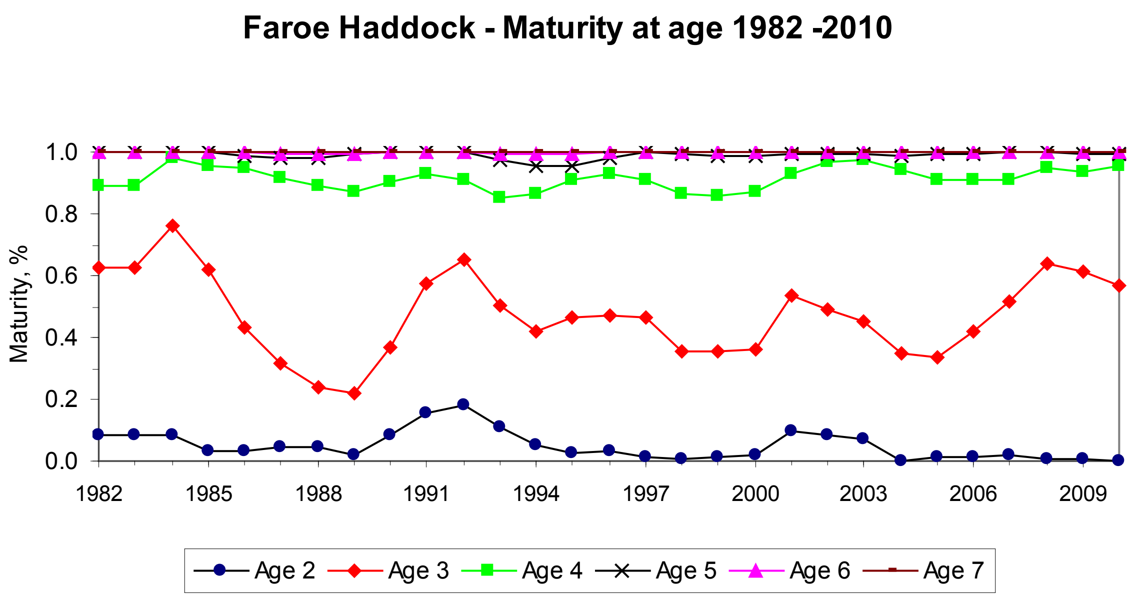


Figure 5.6. Faroe haddock. Maturity at age since 1982. Running 3-years average of survey observations.

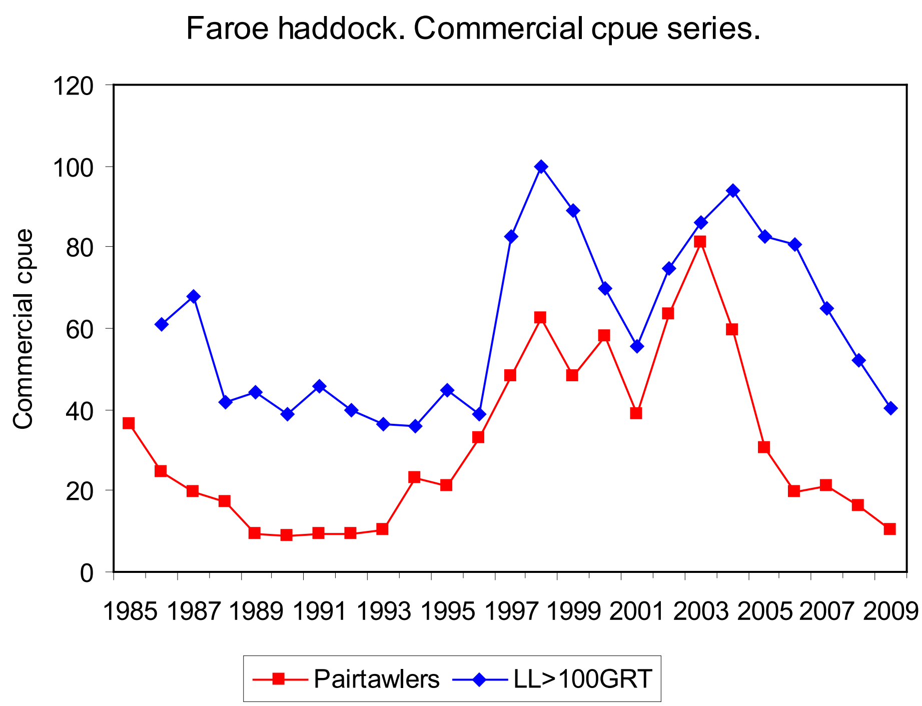


Figure 5.7. Pair trawlers > 1000 HP and longliners > 100 HP.

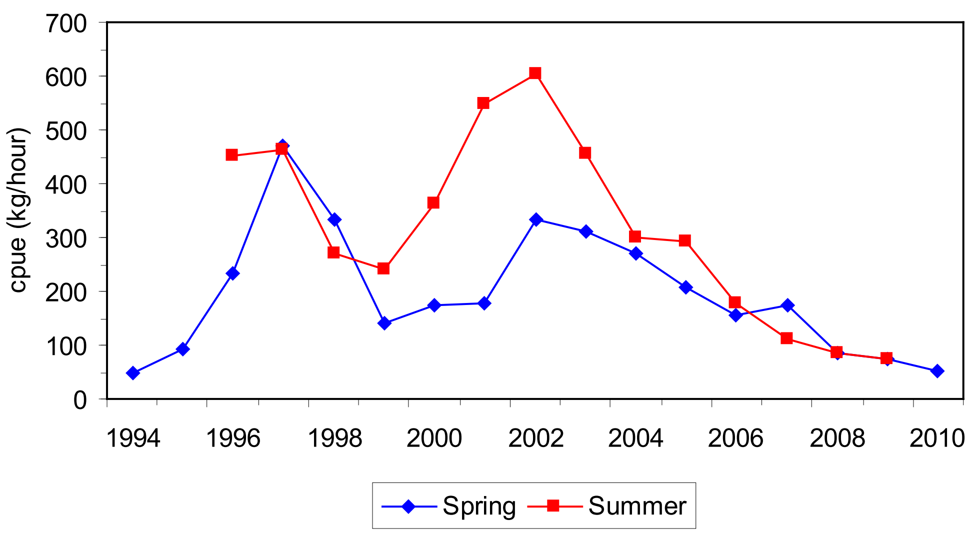
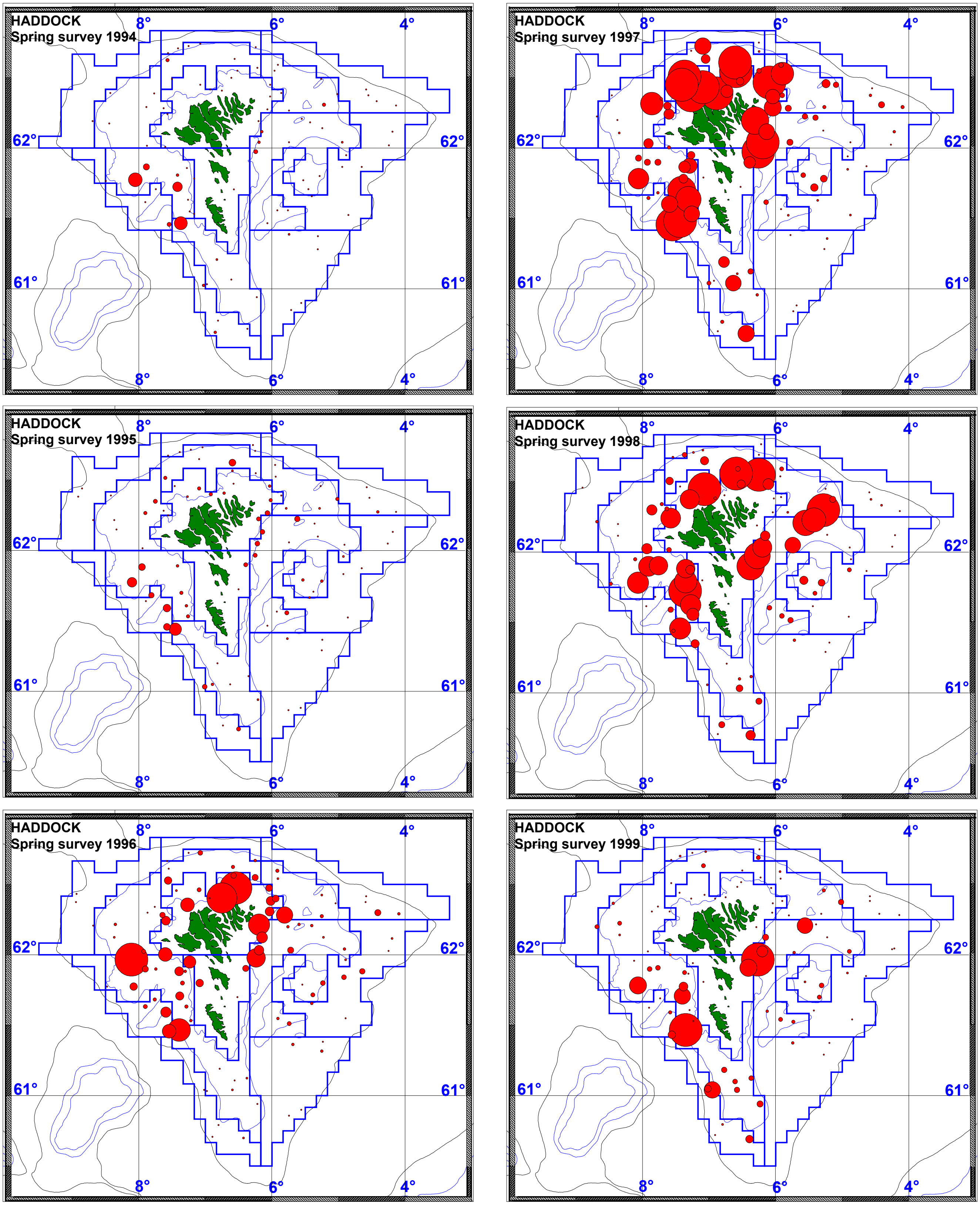
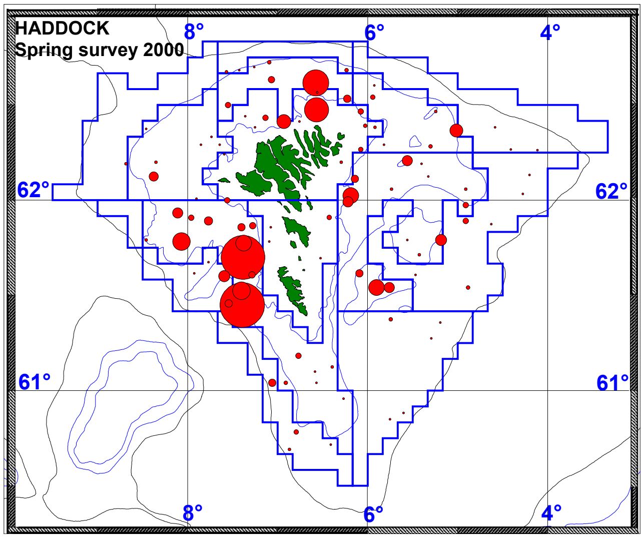
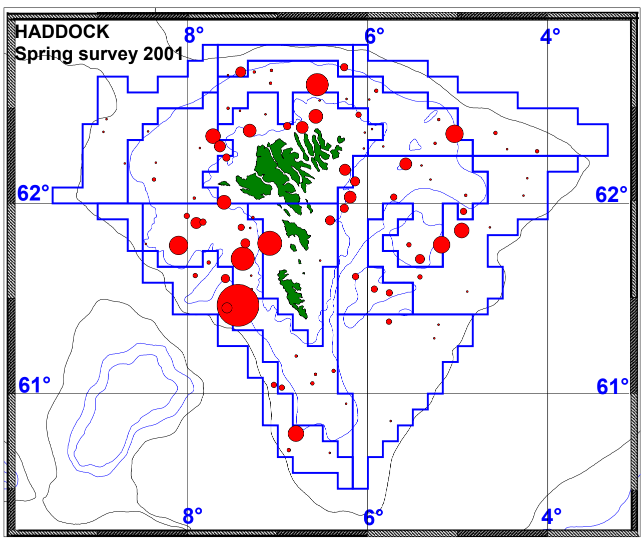
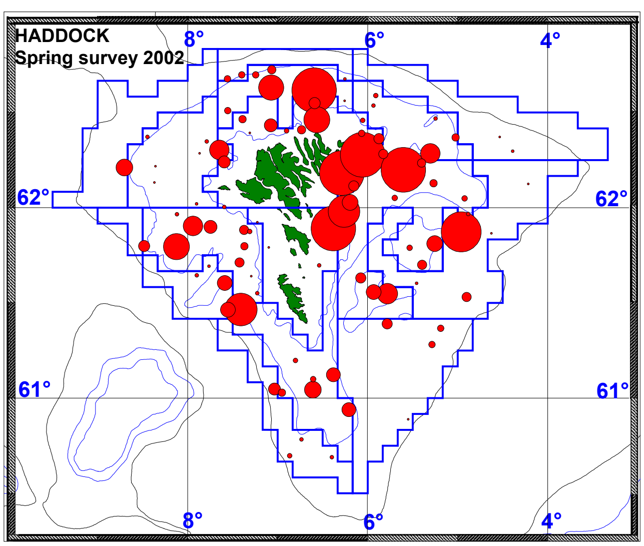


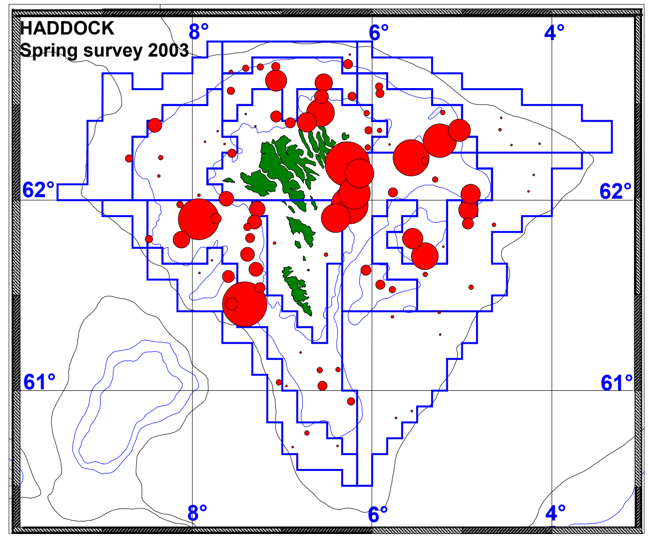
Figure 5.8. Faroe haddock. CPUE (kg/trawlhour) in the spring and summer surveys.


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


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


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


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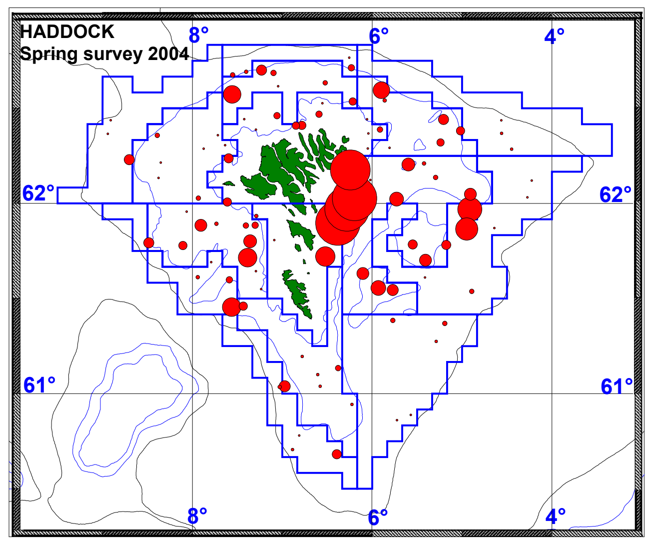
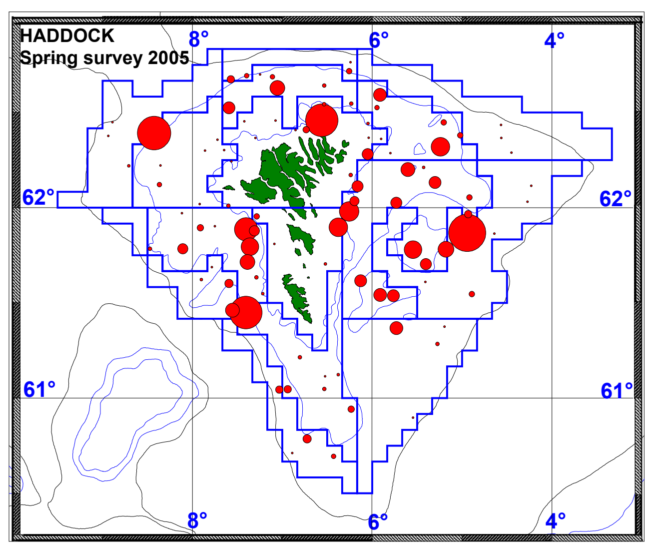
Spring survey 2003
8°
6°
4°
62°
62°
61°
61°
8°
6°
4°


HADDOCK
Spring survey 2004
8°
6°
4°
62°
62°
61°
61°
8°
6°
4°


HADDOCK
Spring survey 2005
8°
6°
4°
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62°
61°
61°
8°
6°
4°

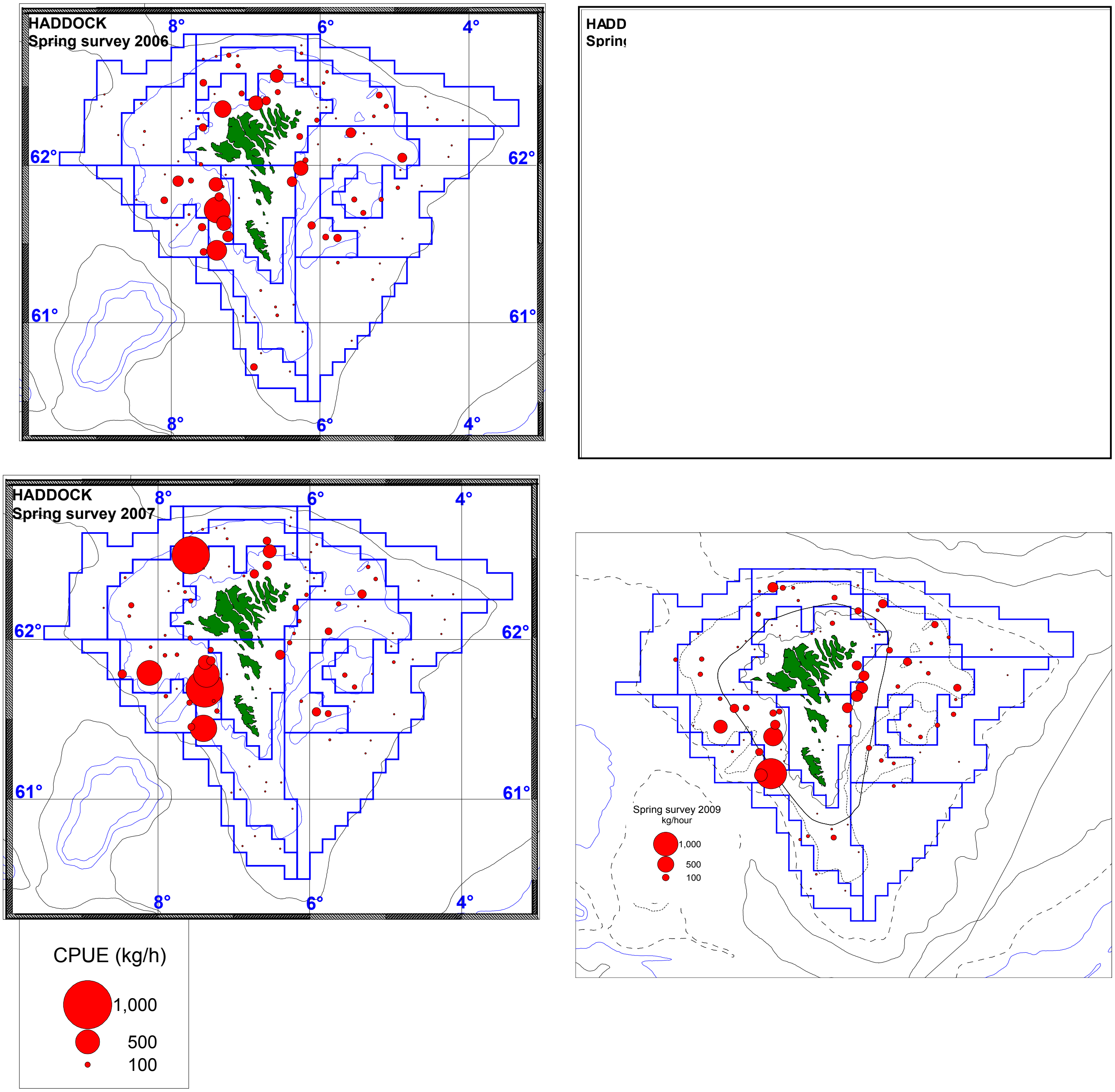
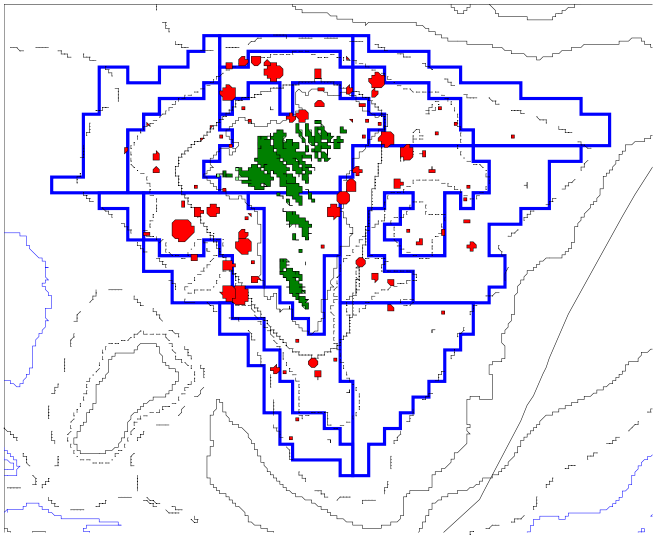
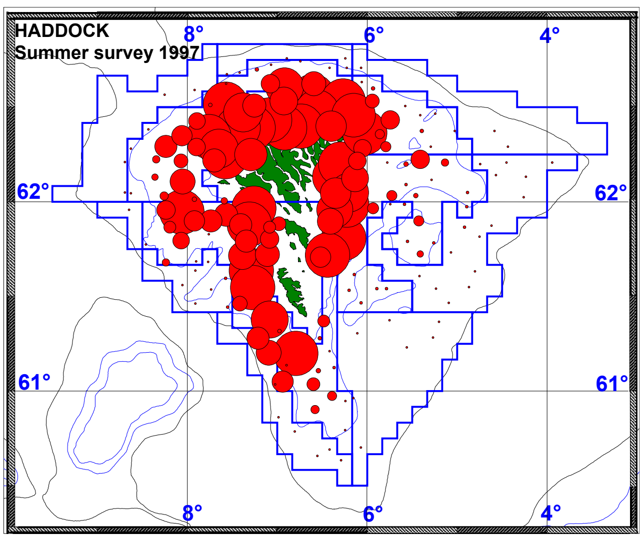
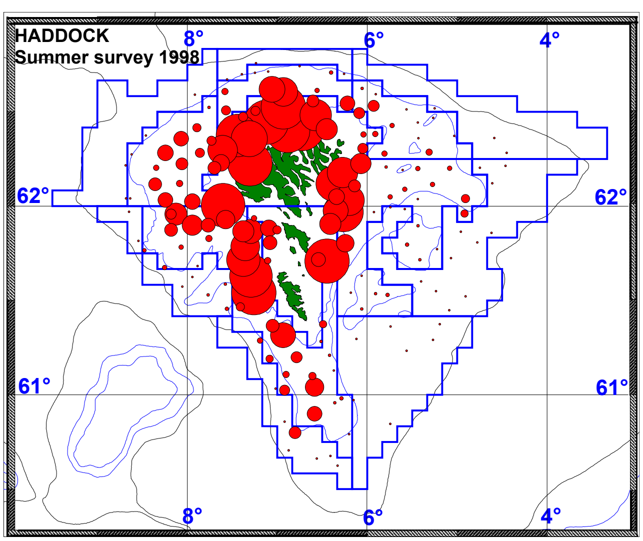


Figure 5.9. Distribution of Faroe haddock catches by year in the spring surveys 1994-2010.




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


HADDOCK
Summer survey 1998
8°
6°
4°
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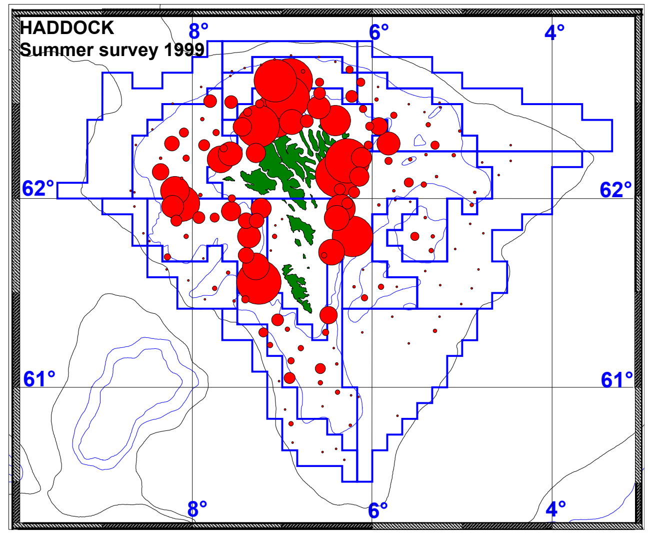
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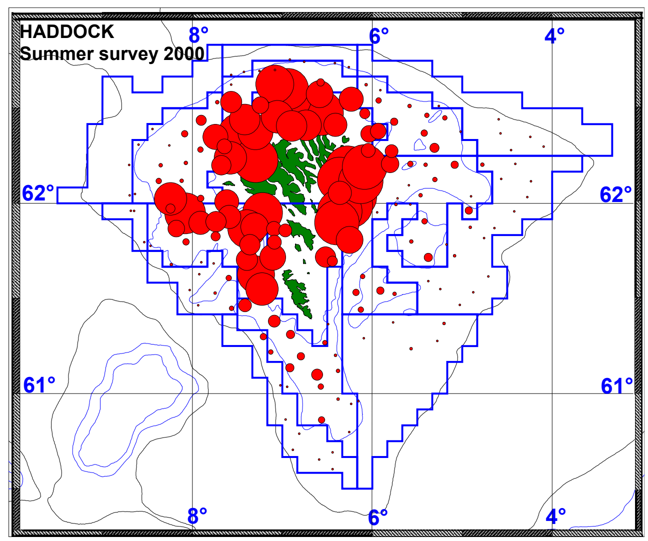
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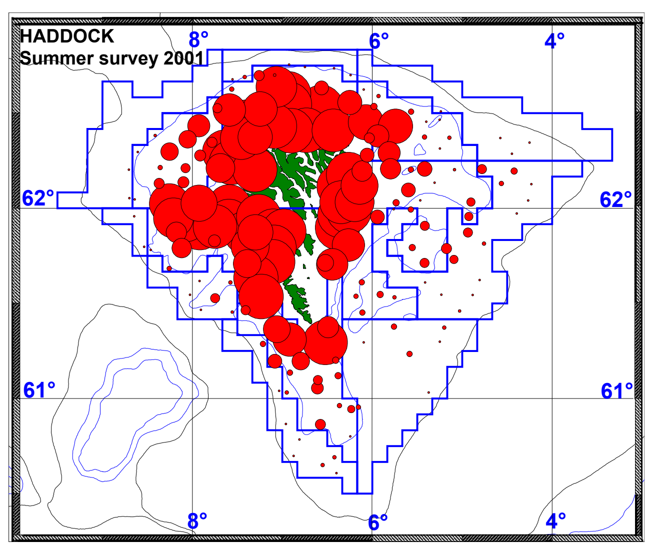
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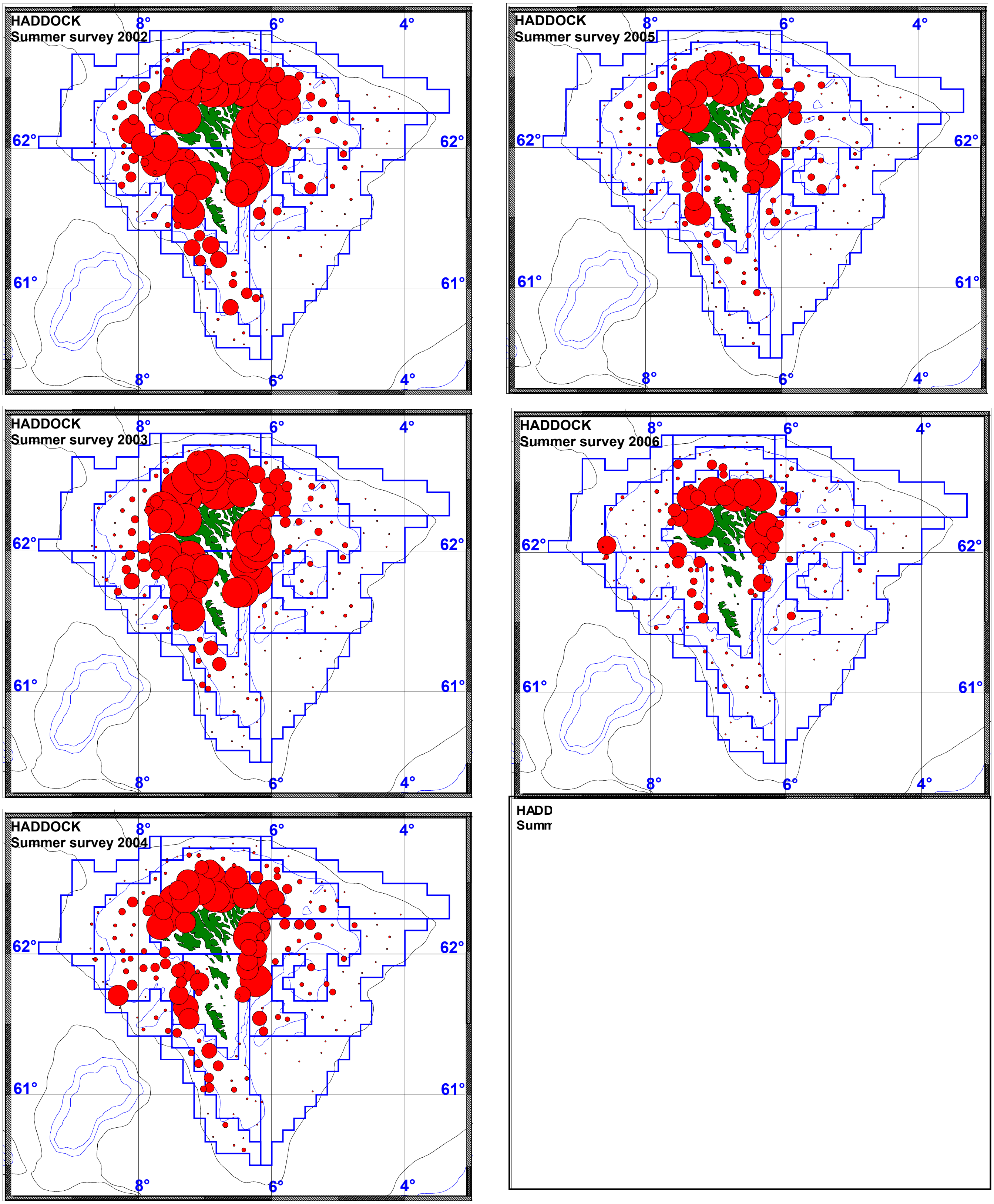
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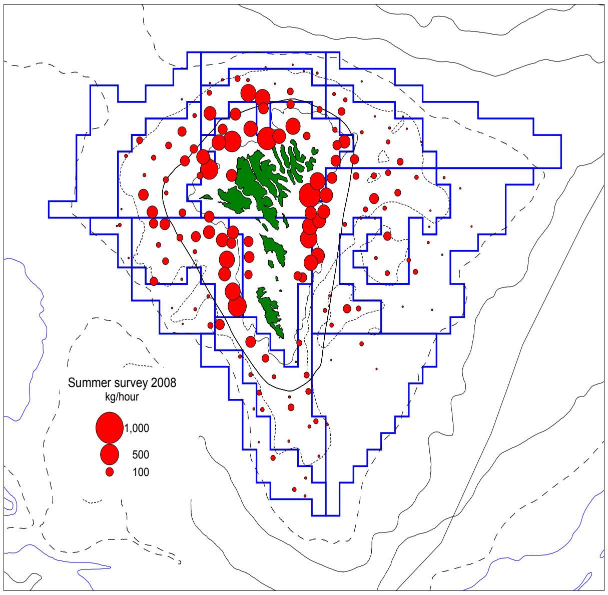
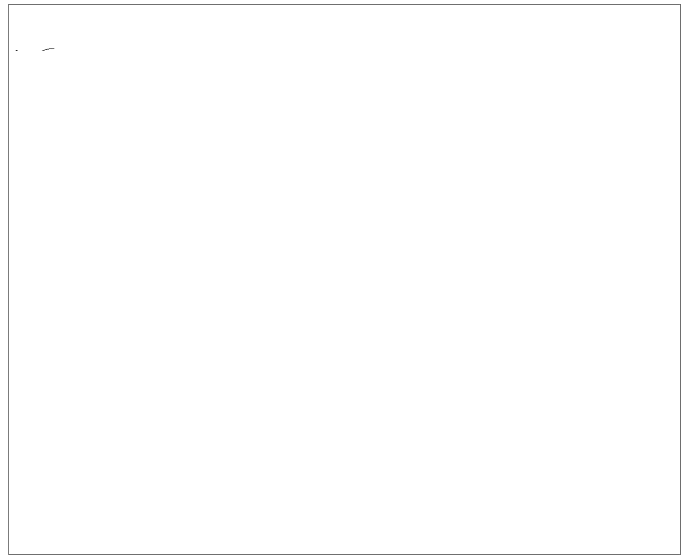
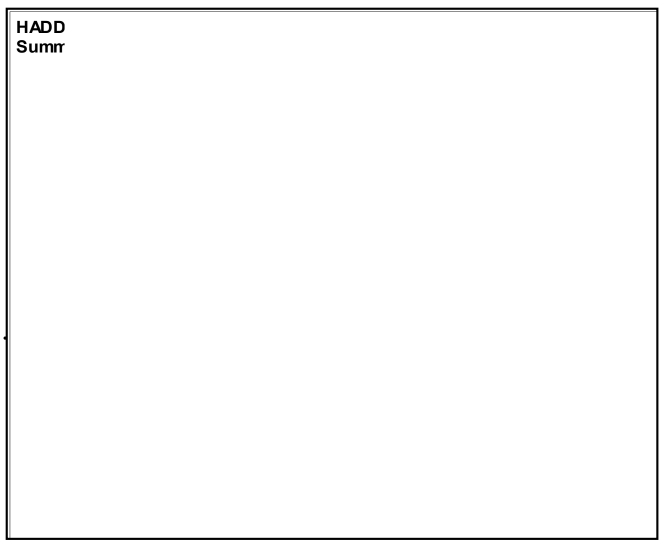






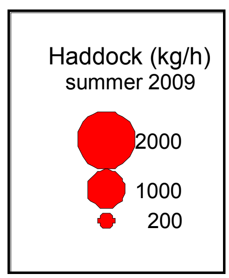
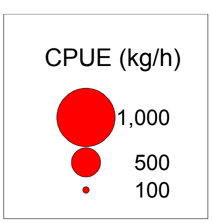


Figure 5.10. Distribution of Faroe haddock catches by year in the summer surveys 1996-2009.



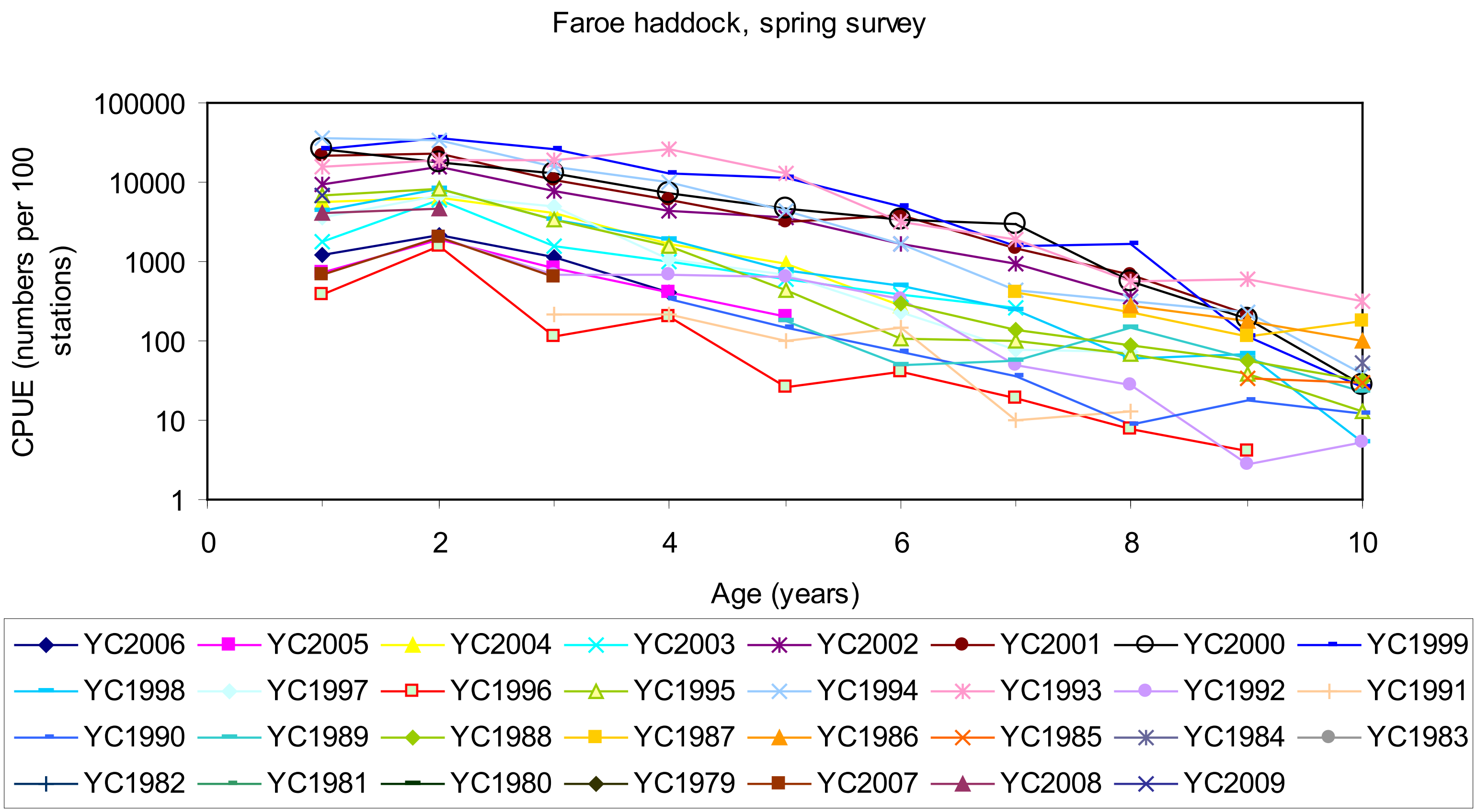


Figure 5.11. Faroe haddock. LN (c@age in numbers) in the spring survey.

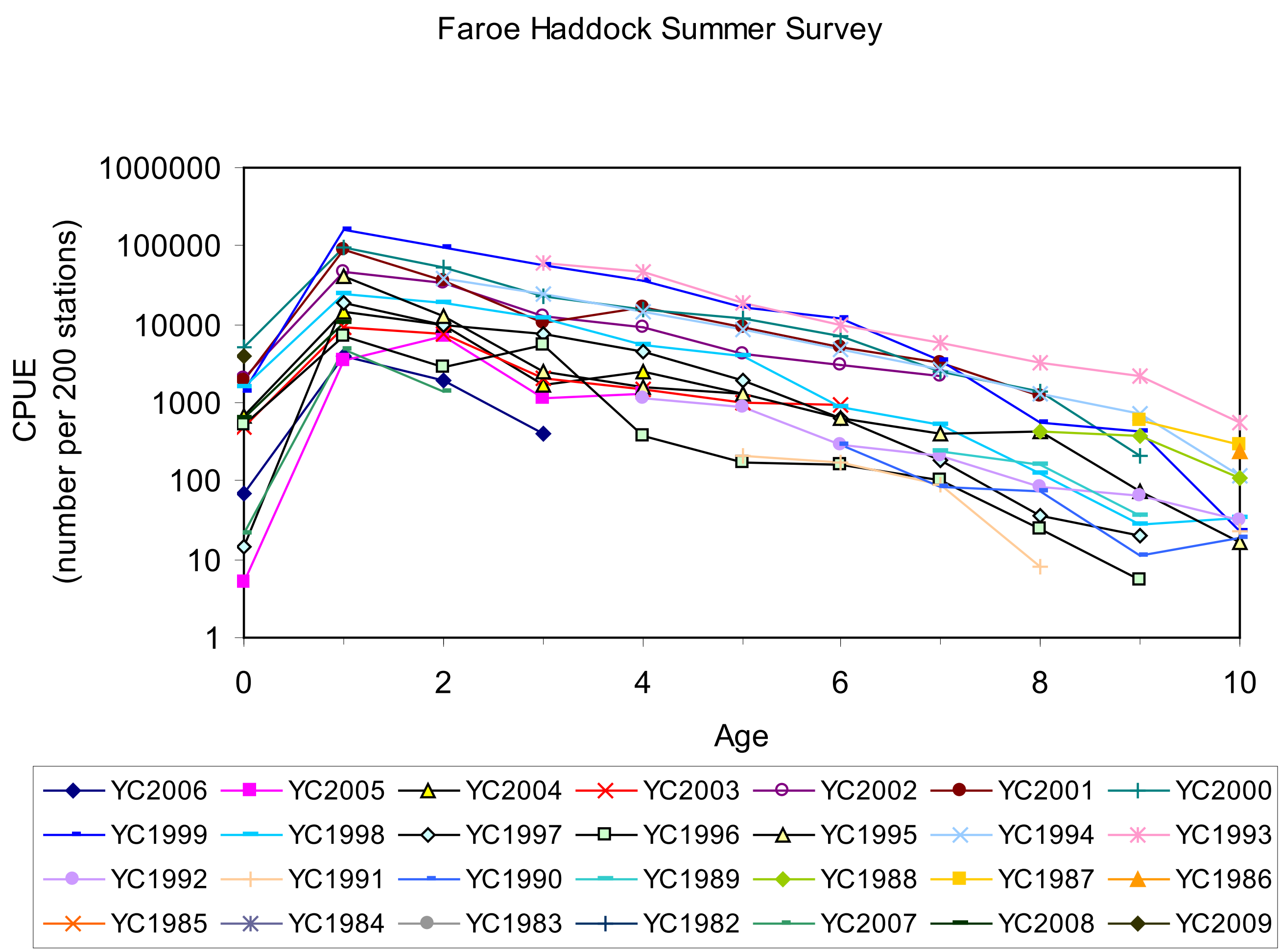


Figure 5.12. Faroe haddock. LN (c@age in numbers) in the summer survey.

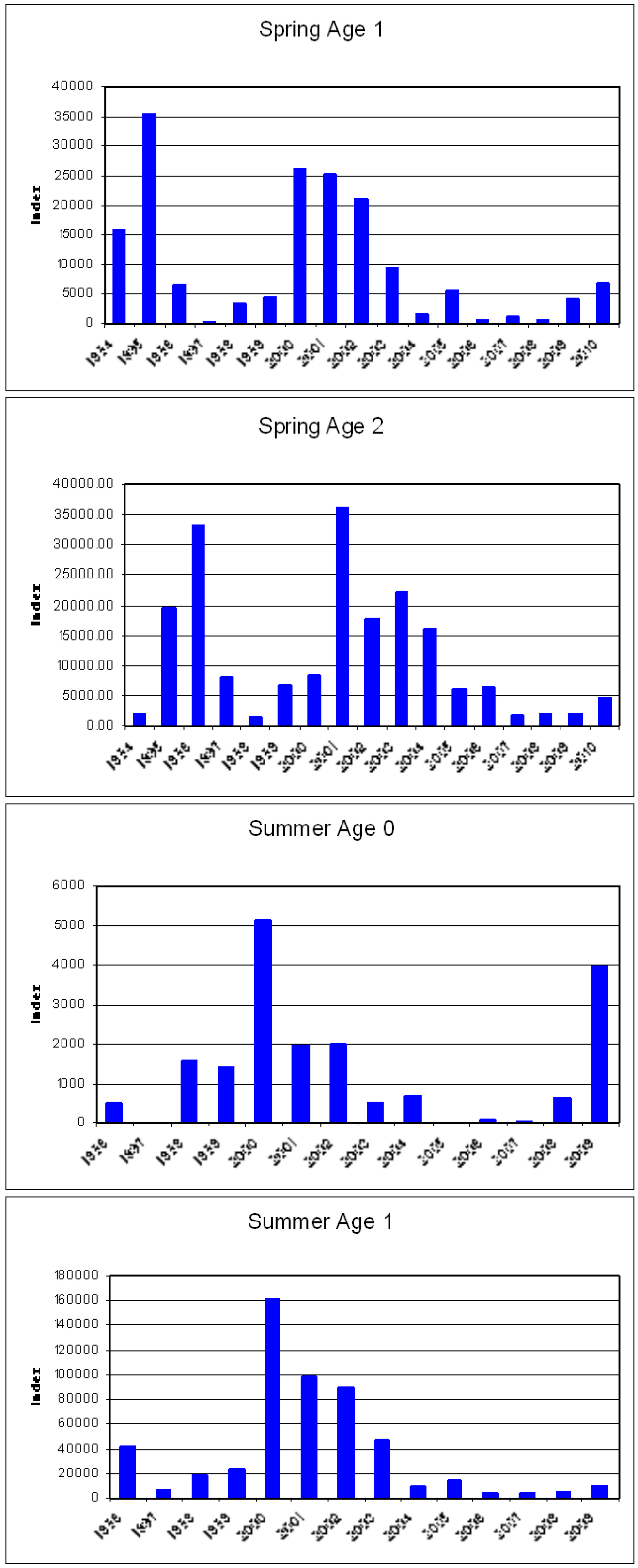


Figure 5.13A. Indices at ages 0-2 from the two groundfish surveys.

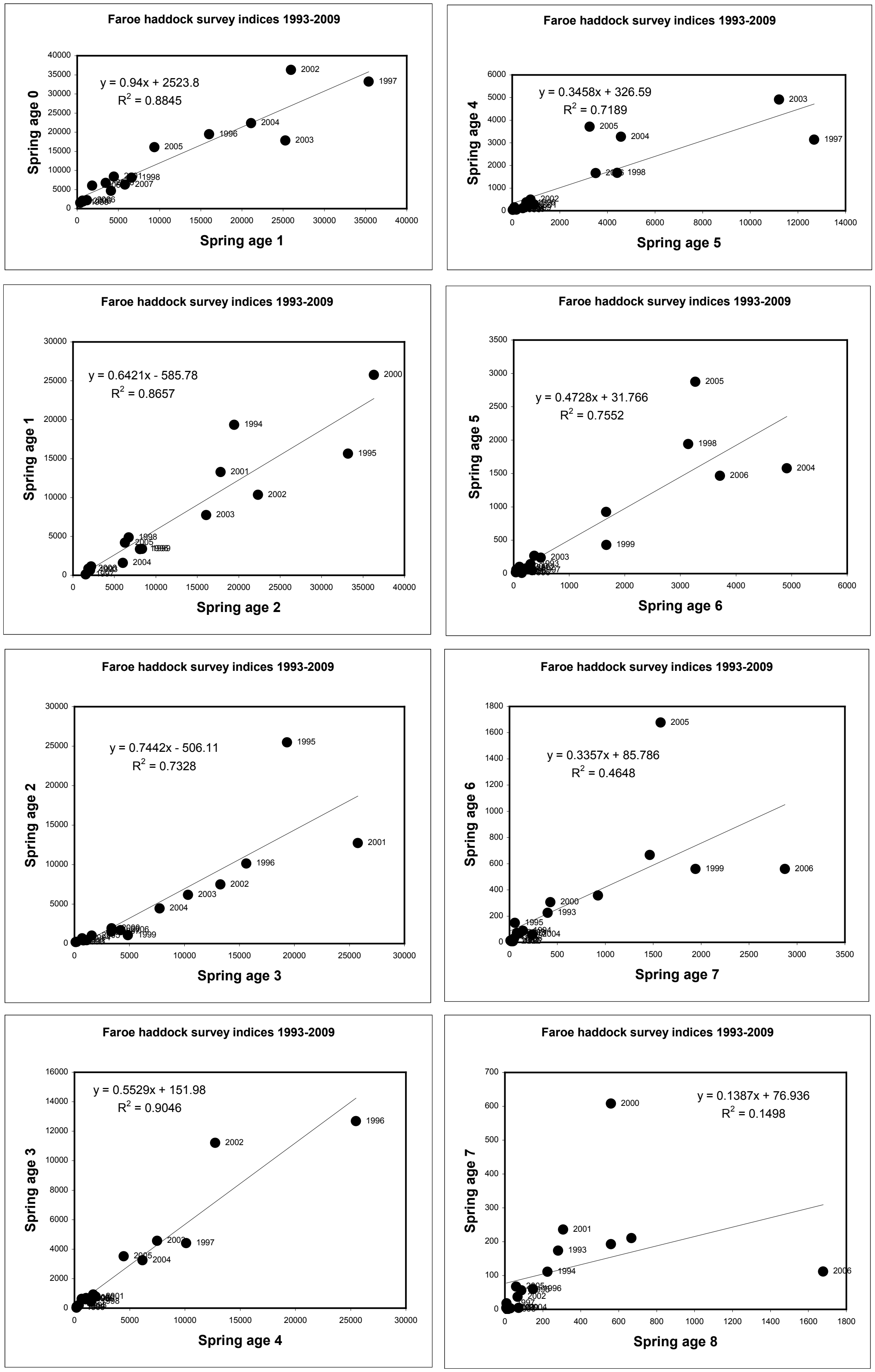


Figure 5.13. Faroe haddock. Comparison between spring survey indices (shifted) at age and the indices of the same YC one year later.

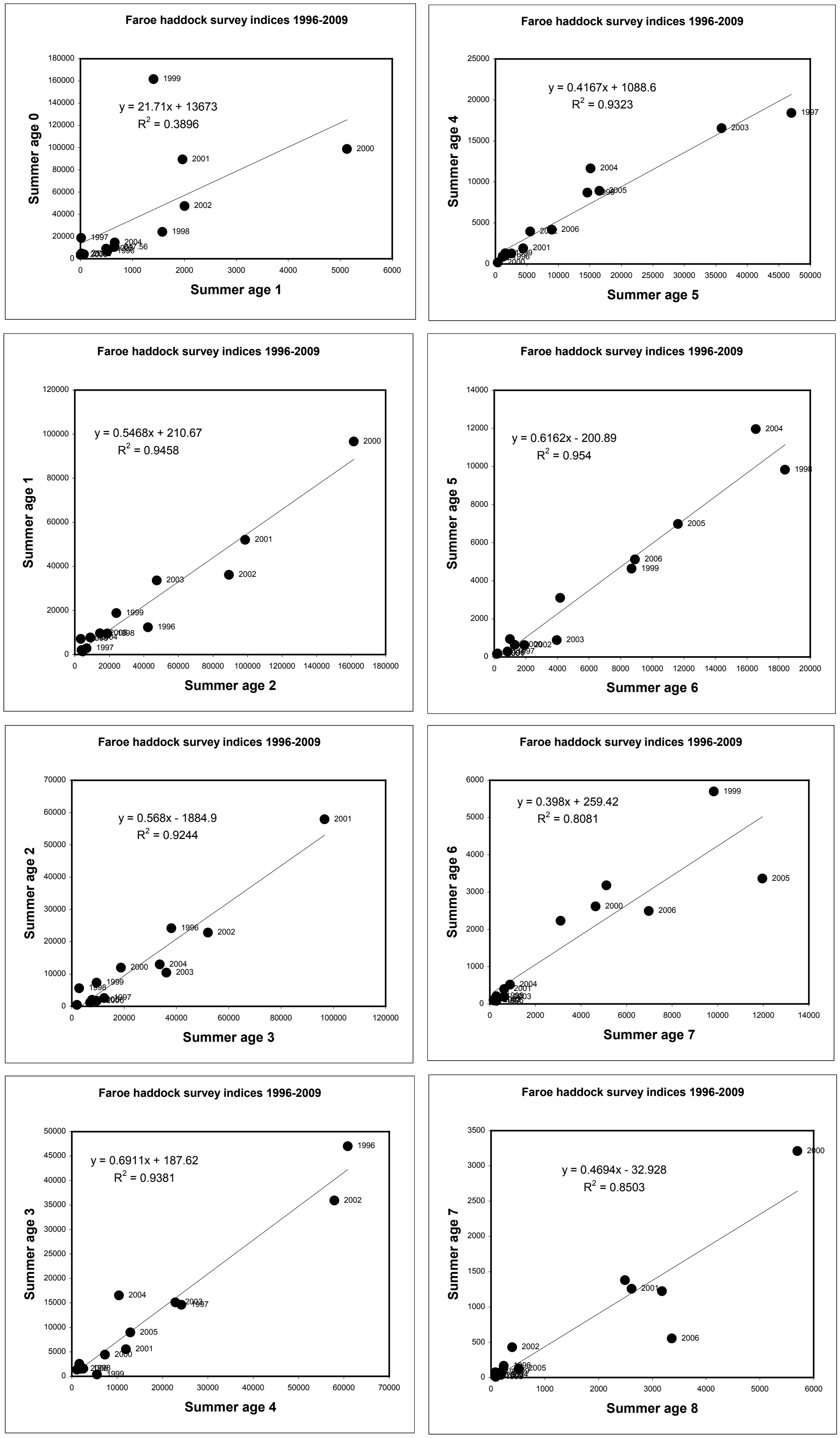


Figure 5.14. Faroe haddock. Comparison between summer survey indices at age and the indices of the same YC one year later.

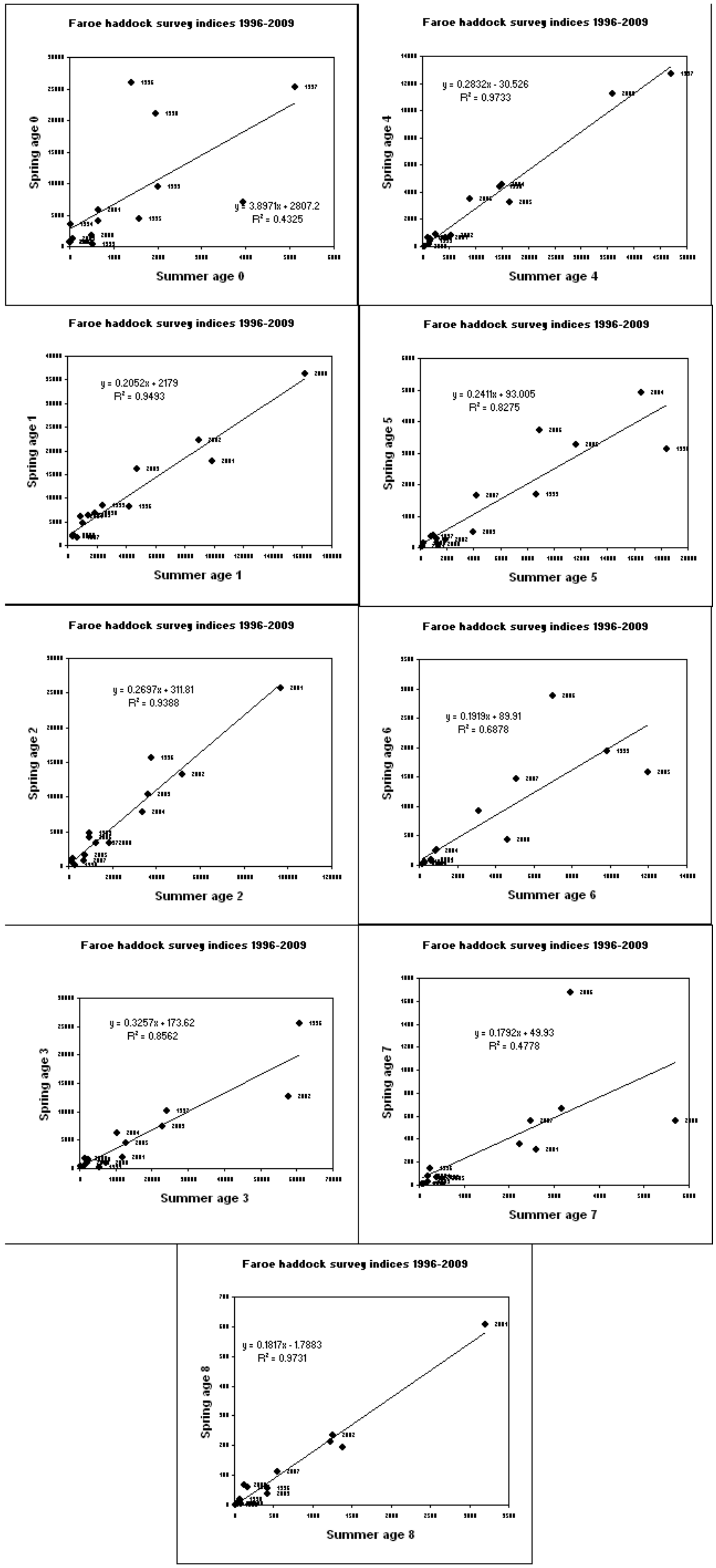
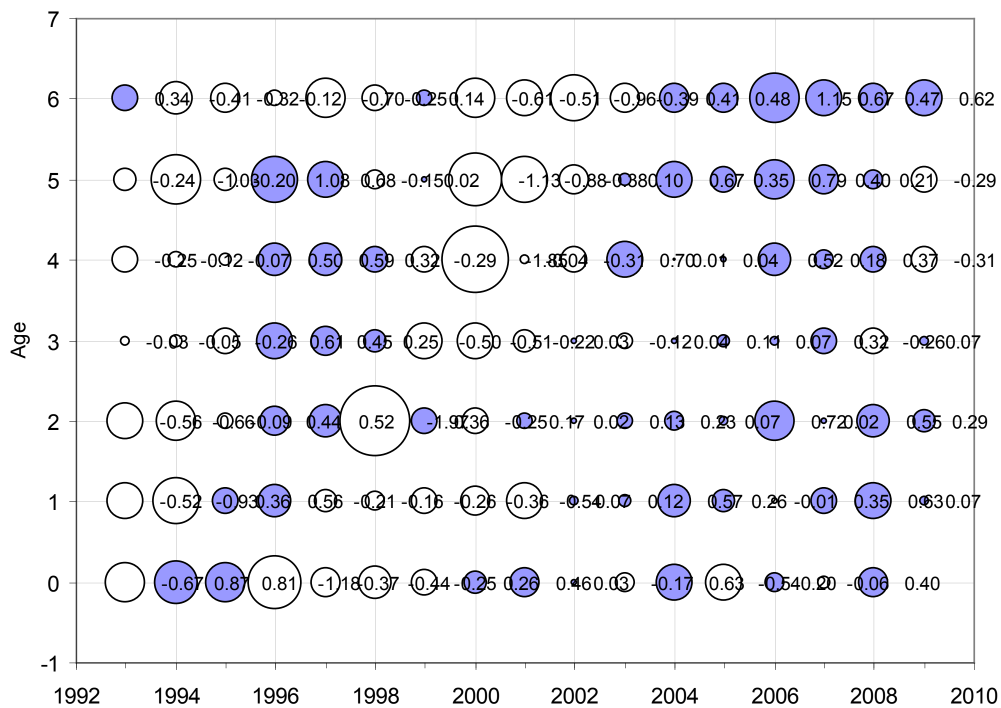


Figure 5.15. Faroe haddock. Comparison between indices at age from the spring survey (shifted) and the summer survey.

Faroe haddock. Spring survey log q residuals.



Faroe haddock. Summer survey log q residuals.

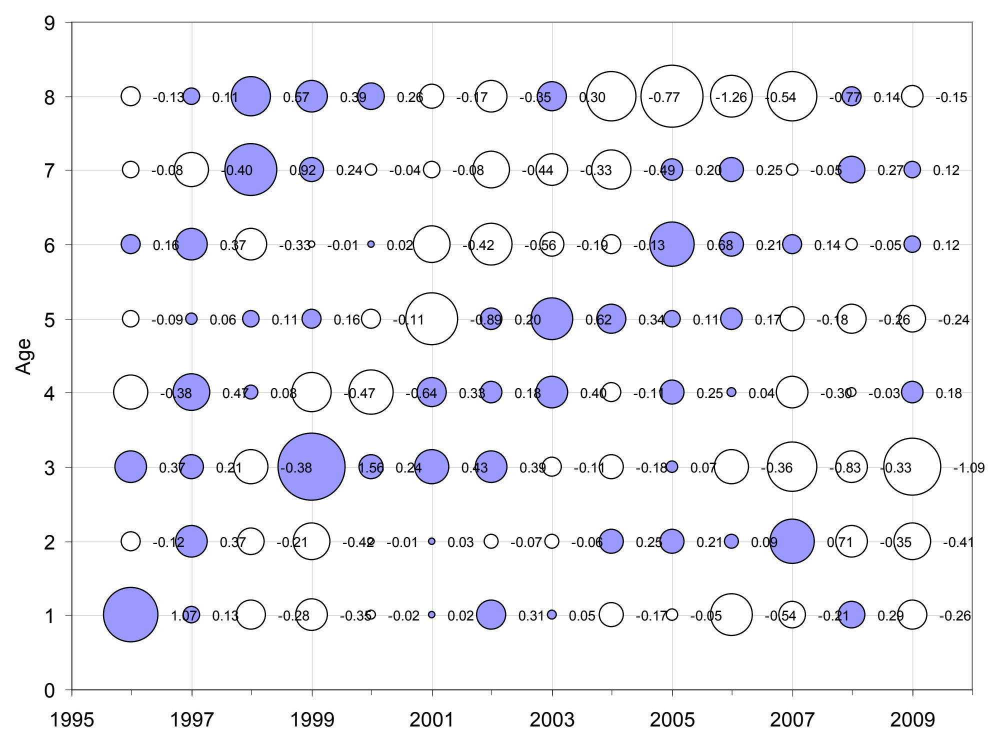


Figure 5.16. Faroe haddock survey log q residuals.

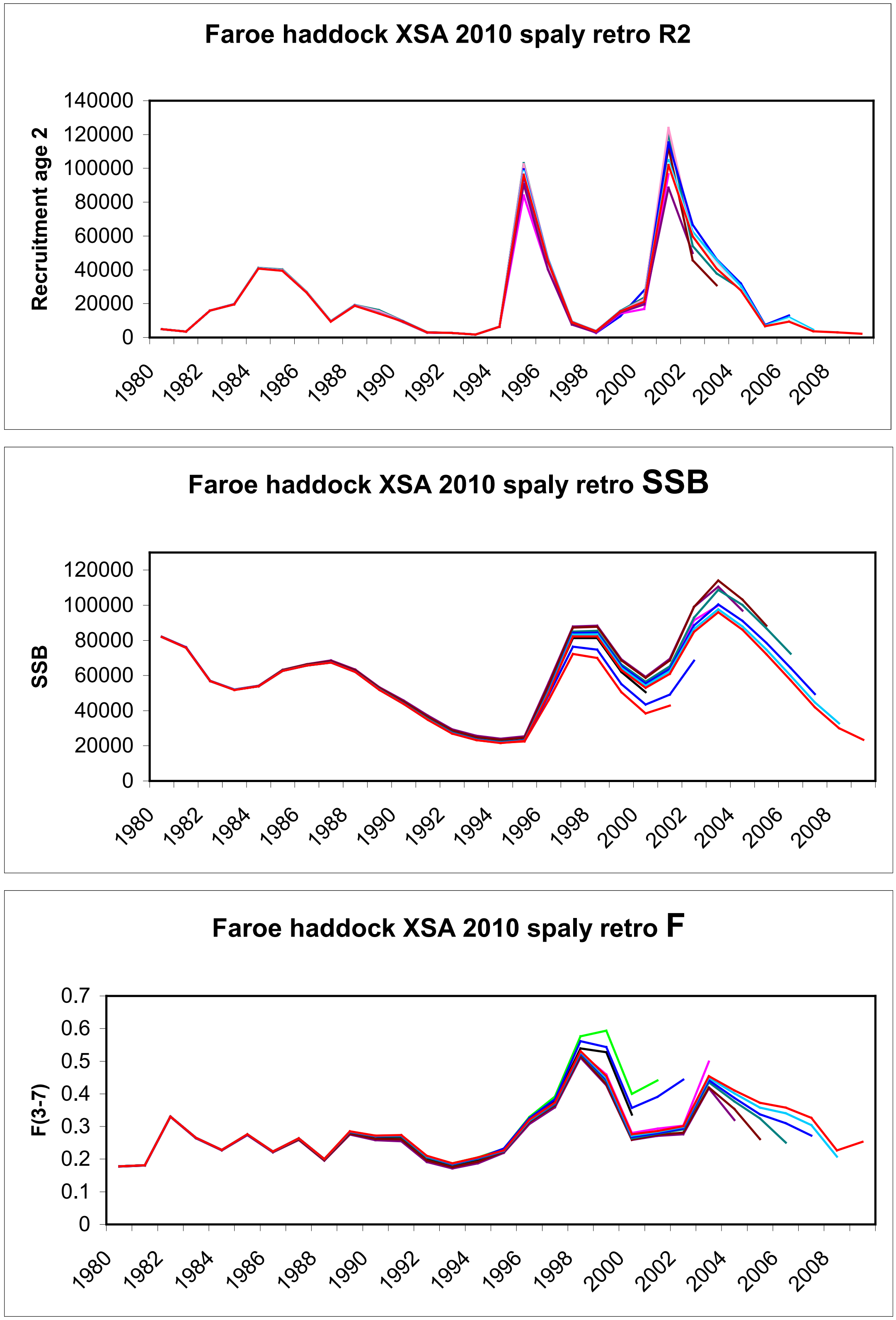


Figure 5.17. Faroe haddock. Retrospective analysis of the 2010 XSA.

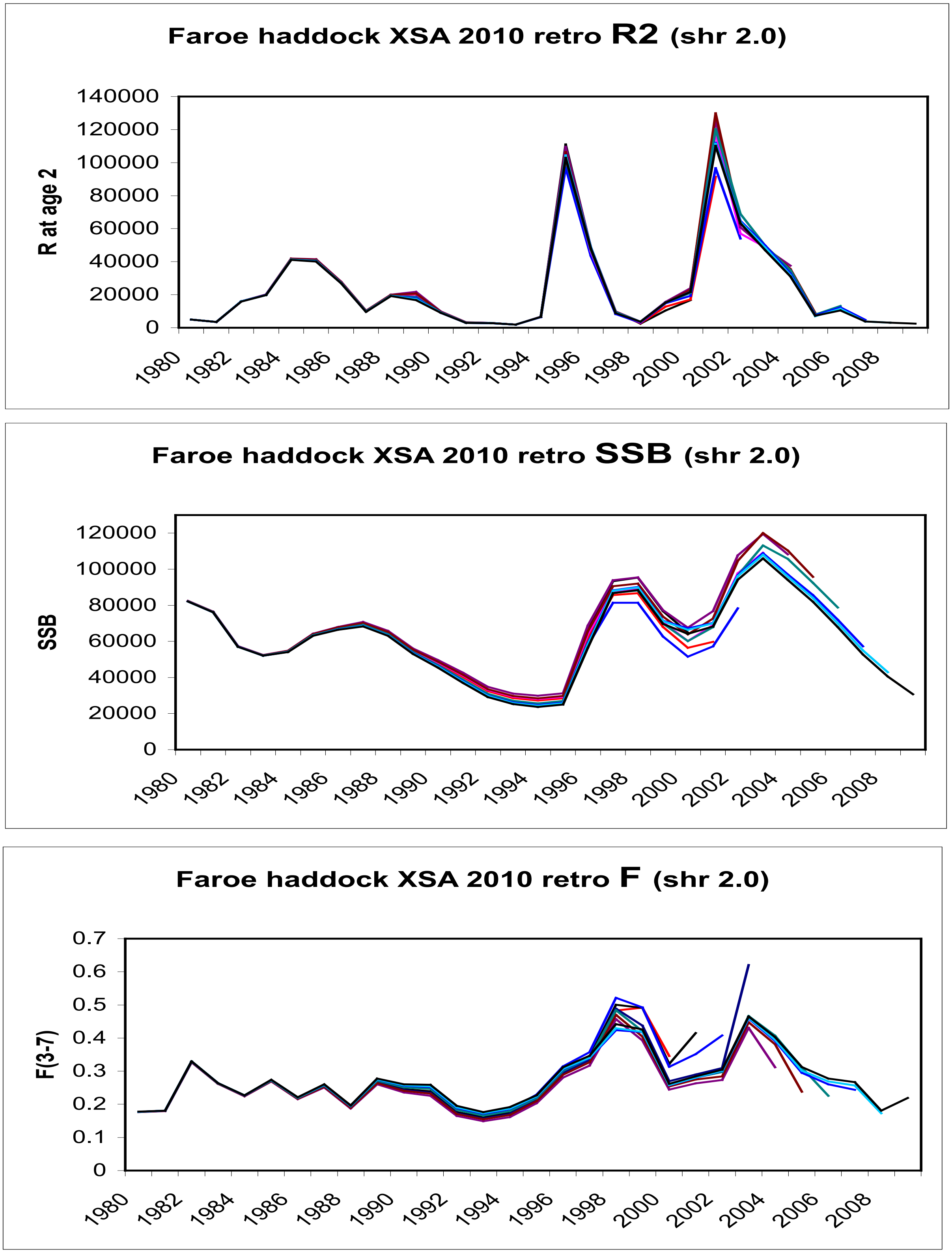


Figure 5.17A. Faroe haddock. Retrospective analysis on the 2010 EXP XSA (shr 2.0).

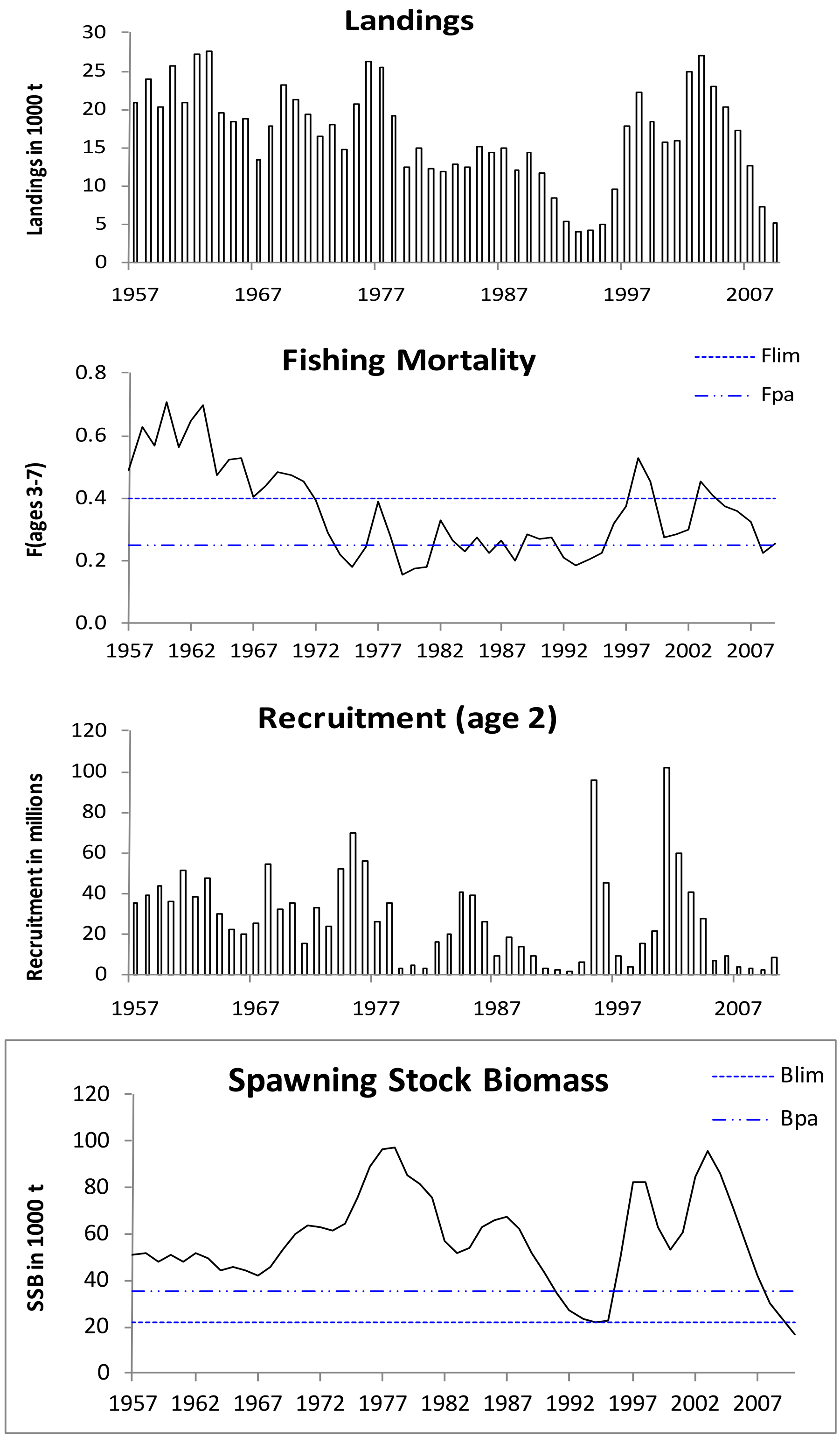
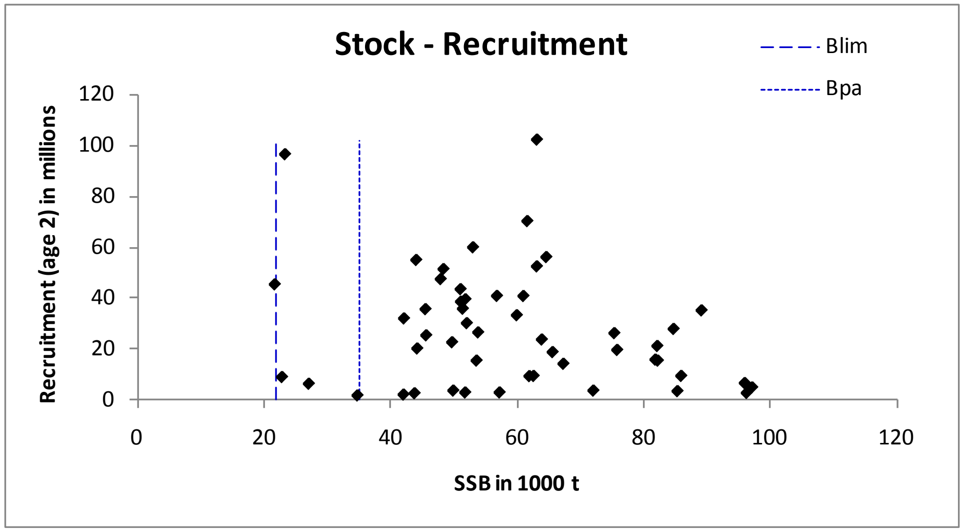
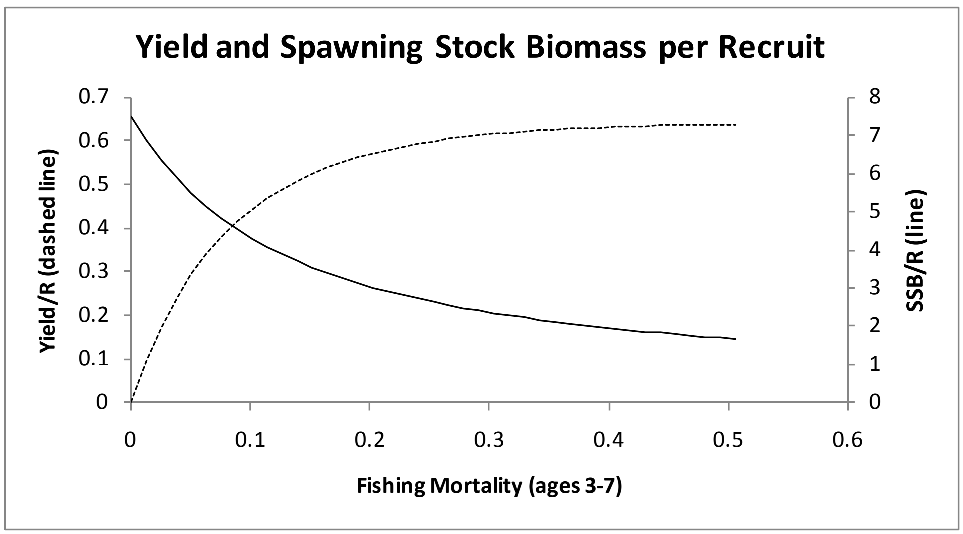


Figure 5.18. Faroe haddock (Division Vb) standard graphs from the 2010 assessment.





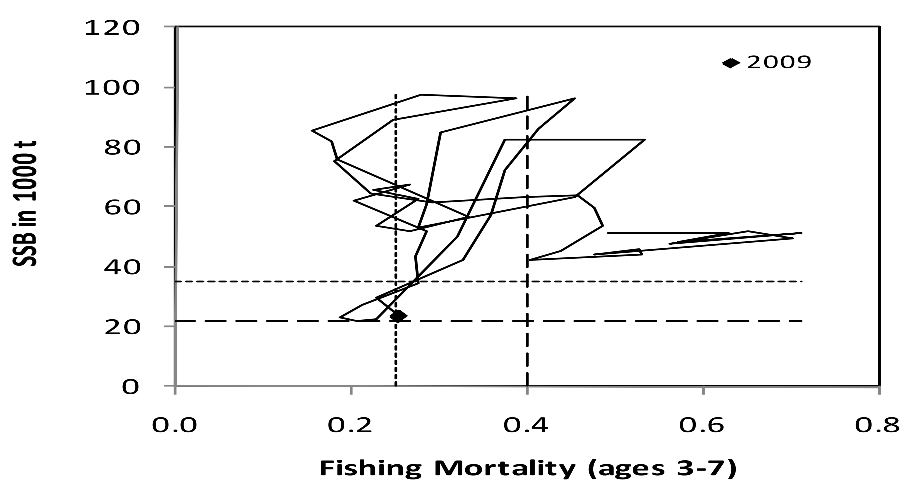


Figure 5.18 (cont.). Faroe haddock (Division Vb) standard graphs from the 2010 assessment.

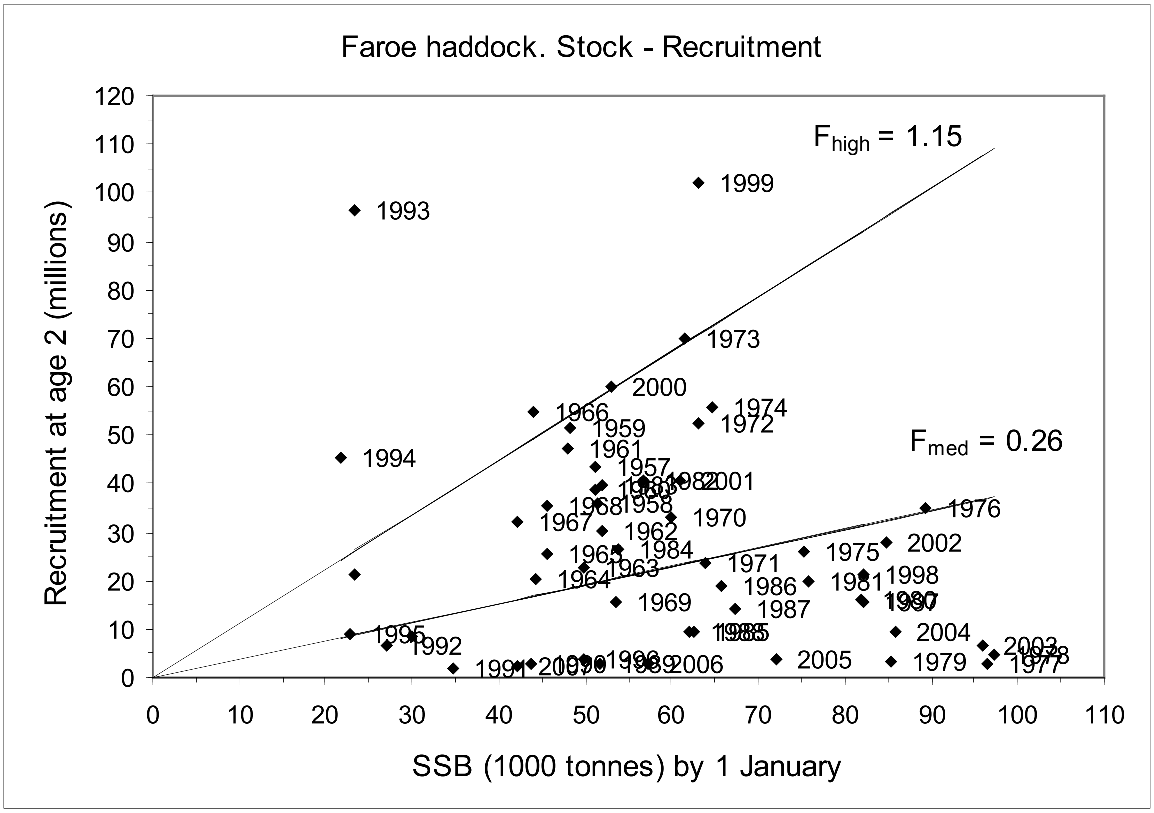
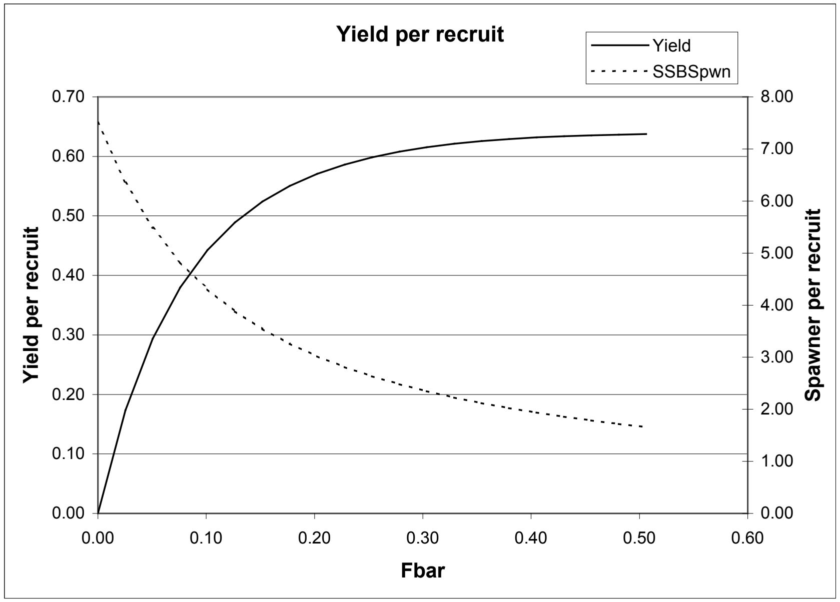
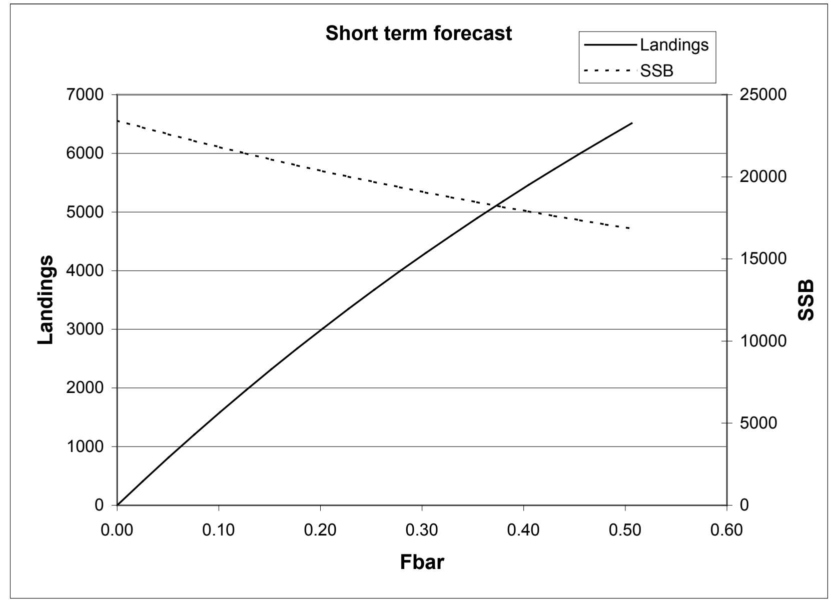


Figure 5.19. Faroe haddock. SSB-R plot.





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Time and date: 10:36 4/22/2010

Reference point	F multiplier	Absolute F
Fbar(3-7)	1	0.2531
FMax	2.3257	0.5886
F0.1	0.7383	0.1869
F35%SPR	1.0042	0.2542
Flow	-99	
Fmed	1.0101	0.2557
Fhigh	4.5271	1.1458

Weights in kilograms

MFDP version 1
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Index file 21/04/2010
Time and date: 09:42 4/22/2010
Fbar age range: 3-7

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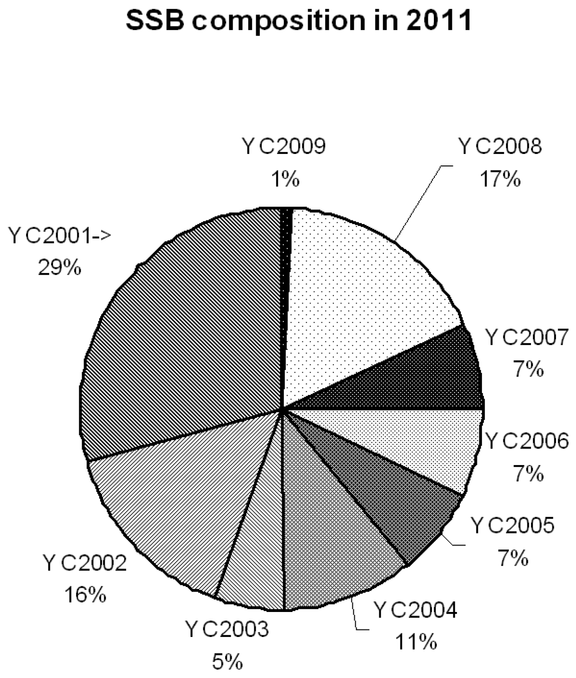
Figure 5.20. Faroe haddock. Prediction output.



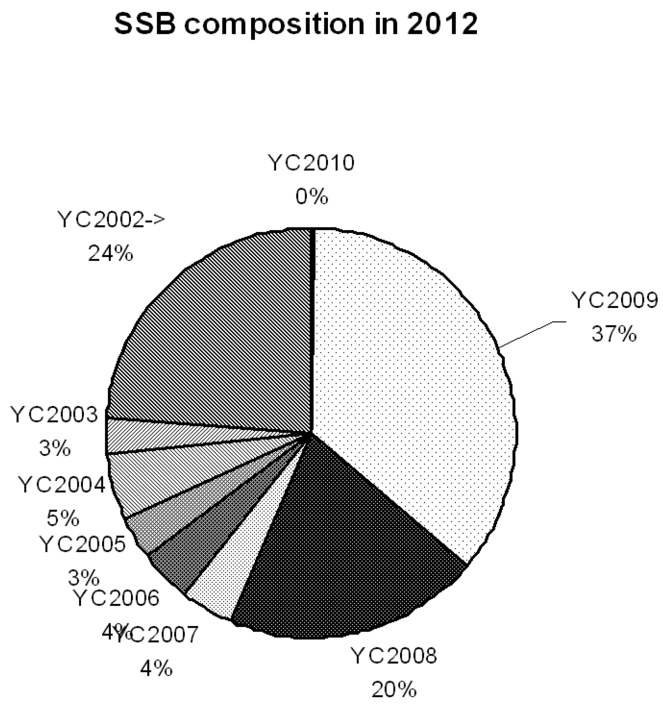


Figure 5.21. Faroe haddock. Projected composition of the number by year-classes in the SSB's in 2011 and 2012

6 Faroe Saithe

Executive summary

The most recent benchmark assessment was completed in 2010.

The 2010 benchmark workshop explored the XSA model as well as ADAPT, TSA, separable statistical age-based and length-based models in association with updated catch-at-age data. The commercial CPUE series was also updated, standardized and the density indices were multiplied by an area expansion factor to better represent a measure of total stock abundance. These data updates were found to significantly reduce the retrospective pattern previously observed in the assessment. The SSB, F and recruitment estimates generated by both models were comparable and the XSA assessment was adopted as the benchmark assessment because it had been the model historically used for this stock.

The fishing mortality in 2009 (average of ages 4-8 years) was estimated at F=0.47 and has remained quite stable around the average since 2006. The total stock size (age 3+) in the beginning of 2009 was estimated at 257 000 tonnes and the spawning stock biomass at 95 000 tonnes, which is around the long term average since 1961. SSB of saithe has been reduced by about 34% in 2009 with respect to 2006.

For Faroe saithe, the highest recruitment has been observed at lower levels of SSB.

6.1 Stock description and management units.

See the stock annex.

6.2 Scientific data

6.2.1 Trends in landings and fisheries

Nominal landings of saithe from Faroese grounds (Division Vb) have varied cyclically between 10 000 t and 68 000 t since 1961. 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 6.2.1.1, Figure 6.2.1.1) but has declined to 56 000 tonnes in 2008. Landings have risen to 59 000 t in 2009.

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 - 67% of the reported landings in 1992-2009 (Table 6.2.1.2). The smaller pair trawlers (<1000 HP) and single trawlers (400-1000HP) have a more mixed fishery and they have accounted for about 10-20% of the total landings of saithe in the 1997—2009 period while the percentage of total landings by large single trawlers (>1000 HP) has halved in 2009 with respect to 2008 (9.6%). The share of catches by the jigger fleet has steadily increased since 2007 although it accounted to only 4% of total landings in 2009.

Cumulative landings of saithe for the domestic fleets since 2000 are shown in Figure 6.2.1.2. Landings in the first three months of 2010 are slightly below of those in 2008.

Catches used in the assessment are presented in Table 6.2.2.1. Foreign catches that have been reported to the Faroese Authorities but not officially reported to ICES are also included in the Working Group estimates. Catches in Subdivision IIa, which lies immediately north of the Faroes, have also been included. Little or no discarding is thought to occur in this fishery.

6.2.2 Catch at age

Catch at age is based on length, weight and otoliths samples from Faroese landings of small and large single and pair trawlers, and landing statistics 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 6.2.2.1 and 6.2.2.2). Sampling intensity in 2009 was higher than in 2008 (4.1%) (Table 6.2.2.3.)

6.2.3 Weight at age

Mean weights at age have varied by a factor of about 2 during the 1961—2009 period. Mean weights at age were generally high during the early 1980s and they subsequently decreased from the mid 1980s to the early 1990s (Table 6.2.3.1 and Figure 6.2.3.1). Mean weights increased again in the period 1992-96 but have shown a general decrease thereafter. Since 2006 weights for age groups (4 to 8) have showed a slight increase whereas mean weight at age of the 2006 year class (age 3 in 2009) is estimated at a historic low

6.2.4 Maturity at age

Maturity at age data from the spring survey is available from 1983 onward (Steingrund, 2003.) Due to poor sampling in 1988 the proportion mature for that year was calculated as the average of the two adjacent years. At the benchmark assessment working group the maturity ogives from 1983 to 2010 were predicted according to a logistic model (Ridao, 2010 WD06). For 1962 to 1982 the average maturity of predicted ogives of the 1983-2009 period were used (Table 6.2.4.1 and Figure 6.2.4.1.) Proportion mature for most age groups show an upward trend since 2004.

6.2.5 Indices of stock size

6.2.5.1 Surveys

There are two annual groundfish surveys conducted in Faroese waters. The spring survey was initiated in 1983, while the summer survey began in 1996. The two surveys are not considered reliable indices of saithe abundance in Vb (Stock Annex B.3 and Benchmark report WKROUND 2010.) Trends in catch rates (CPUE) from both surveys are presented in Figure 6.2.5.1.1.

6.2.5.2 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. A GLM model and a spatial scaling factor is used to standardised the CPUE series (Stock Annex B.4., Benchmark report, WKROUND 2010.) Observed and predicted annual CPUEs derived from this approach are shown in figure 6.2.5.2.1. The benchmark working group regarded this novel approach to developing the commercial series as reasonable (Benchmark report, WKROUND 2010.) Information from the fishing industry

No additional information beyond the landings from the commercial fleet was presented for incorporation in the assessment.

6.3 Methods

The assessment model adopted at the benchmark assessment in 2010 is described in the Stock annex (Sec. C) and in the benchmark report (WKROUND 2010.) The 2010 XSA is calibrated with the standardized 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. Diagnostics are presented in Table 6.4.2 and model outputs in Tables 6.4.3-5. Patterns in log-catchability residuals from the XSA and Adapt models are very similar and relatively random in recent years (Figure 6.4.1).

The 2010 assessment indicates that the point estimator of SSB in 2009 is close to 96 000 t and average fishing mortality (Fbar) is estimated to F=0.47. The assessment model suggests that fishing mortality has remained reasonably stable in recent years at an average level of F=0.45 from 2006 to 2009. Predicted number of recruits in 2009 is closed to 19 millions the lowest level since 1998. For comparison the results from Adapt and a separable catch-at-age models are also presented in figure 6.4.2. Retrospective patterns show a period of overestimation in average fishing mortality (2005-2009) while the assessment tends to underestimate F prior to 2005 (Figure 6.4.3.) This implies that biomass was correspondingly underestimated from 2005 to 2009 and overestimated before 2005. This could be explained by changes in the vertical distribution of the stock or changes in the selection pattern. With respect to recruitment the retrospective trend is very similar to that of F and SSB. The 2005 year-class was predicted at a historic high in 2008 but it is showing much weaker in 2009 and it might be expected to become even weaker in coming years. Age disaggregated survey indices do not suggest that numbers of 3-year old saithe in faroe waters are as high as predicted by the assessment. Estimated fishing mortalities-at-age are presented in Table 6.4.3 and in Figure 6.4.4. and stock numbers-at-age (start of year) in Table 6.4.4 Reference points

6.3.1 Biological reference points and MSY framework

At the 2010 Benchmark assessment the new MSY framework was assessed. In order to consider how FMSY should be evaluated, a brief summary of existing reference points is given, as well as proposals for changes that are found in previous NWWG reports (Stock annex Sec. G.) There are indications of a negative correlation between total stock size and growth. In addition total stock size is highly correlated with hydrographical conditions south-west of the Faroes some 4 years before, whereas the recruitment shows a weaker correlation (Figure 6.5.1.1.) There appears to be a negative relationship between the size of the spawning stock and subsequent recruitment, and the relationship is different for small-stock and large-stock situations.

In order to evaluate reference points, high-growth small-stock situations (1991-1998) and slow-growth large-stock situations (2002-2009) are compared. As a reference yield-per-recruit analysis is performed on the entire historical period (1961-2009.)

The yield-per-recruit is much higher for small-stock periods (i.e. high-growth) than for large-stock periods (i.e. slow-growth)(Figure 6.5.1.2), as well as spawning stock per recruit. Estimated $\mathbf{F}_{max}$ used as a proxy for $\mathbf{F}_{MSY}$ in periods of high growth is 0.44 which is very close to that obtained when the entire time series is selected ($\mathbf{F}_{max}$=0.43) When the saithe stock experiences a period of slow growth the expected maximum yield obtained is lower $\mathbf{F}_{max}$=0.34.

Table 1 below summarizes current and alternative reference points explored at the benchmark assessment (WKROUND 2010.). The current $\mathbf{F}_{pa}$ is lower than any of the three proposed F_{max} values. One canditate for the FMSY is the average of 0.44 and 0.34, i.e. 0.39 (taking rounding of the former values into account). $B_{trigger}$ could be set at the current B_{lim} of 60 thousand tonnes. The current F_{pa}=0.28 also seems too low if the goal is to maximize yield. These values are by no means regarded as proxies for FMSY until a proper evaluation is performed.

Given the time constrained by the WG it might be suggested that a Management Strategy Evaluation (MSE) be considered for examination of harvest control strategies for faroe saithe. A range of F reference points including for this stock are established. The most appropriate F level is probably somewhere in the middle. A MSE approach would not only be useful from a management strategy view point under stationary assumptions, but also allow exploration of the influence of environmental drivers have on long-term management actions.

Yield and spawning biomass per recruit

F reference points

	Fish Mort Ages 4-8	Yield/R	SSB/R
Average last 3 years	0.45	1.45	2.75
Fmax	0.42	1.45	2.94
F0.1	0.15	1.28	7.15
Fmed	0.36	1.45	3.40

Table 1. Faroe saithe (Division Vb). Alternative reference points evaluated at the Benchmark assessment group 2010 (WKROUND 2010)

Reference Points using 2010 Benchmark Results				
Reference point	**Small stock**	**Large stock**	**All sizes**	**Remarks**
	1991-98	2002-08	1961-2009	
Blim	50	50	50	Based on NWWG07 algorithm
Flim	0.54	1.00	0.77	New SSB per R applied to new Blim
Fmax	0.44	0.34	0.43	
Average Recruits	24	64	33	

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

Reference points established in previous benchmark assessment working groups.

The SSB-R relation with respect to reference fishing mortalities (Fhigh, Fmed and Flow) is presented in Figure 6.5.1.2 while the history of the stock/fishery in relation to the existing four reference points can be seen in Figure 6.5.1.3.

6.4 State of the stock – historical and compared to what is now

Recruitment in the 1980s was close to the historical average (32 millions). The strongest year class since 1986 was produced in the 1990s and the average for that decade was about 28 millions (Figure 6.6.1). The 1998 (88 millions)1999 (104 millions) and 2005 year classes (103 millions) are the largest observed in the available time series. However the predicted number of 3-years old saithe in 2008 is probably much lower than expected and it will probably diminish in subsequent years. In addition although groundfish surveys are in general unreliable to establish year-class strength for species like saithe both Faroese annual surveys do suggest that the 2005 year-class is not as strong as the assessment predicts. Relatively low Fs during the 1960s and recruitment above average in early-1970s caused an increase in SSB well above the historical average around the mid-1970s. while landings peaked to almost 58 000 t. in 1973. Increasing Fs since 1980 lead to a decrease in the spawning stock biomass of saithe throughout the mid-1980s although recruitment of the 1983 year class rose to 61 000 millions, i.e. double the average from 1961 to 2009. The historically low SSB persisted in 1992-1998 (Table 6.4.5 and Figure 6.6.2.) and this along with low Fs caused landings to steeply declined to around 20 000 tonnes in 1996. The SSB has increased since 1999 to above 131 000t in 2005 with the maturation of the 1995, 1996, 1997 and 1999 year classes and thereafter decreased to around 95 000 t. in 2009. The relation between stock and recruitment (Figure 6.6.3) shows that the highest recruitment has been observed at lower levels of SSBs. Trends in total biomass are characterised by three distinctive cycles of around 15 years in amplitude comparable to those in recruitment estimates since 1961 (Figure 6.6.4.)

The 95 000t SSB in 2009 is above both the biomass reference points B_{pa} and B_{lim} while fishing mortality F=0.47 is slightly higher than Flim.

6.5 Short term forecast

6.5.1 Input data

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

Population numbers at age 3 for the base short term prediction is calculated as the geometric mean of estimated recruitment strength from 1995 to 2009. Natural mortality is set to constant 0.2. Weights-at-age for 2010-2012 are set equal to 2009 values (Table 6.7.1.1).

Proportion mature for 2010 is taken as the average of predicted maturity ogives from 2009 and 2010 while for 2011 and 2012 it is calculated as the mean of 2008-2010. The exploitation pattern for short term prognosis is set to the unscaled three year average from 2007 to 2009 (as suggested by ACFM, 2004).

6.5.2 Projection of catch and biomass

Results from predictions with management option are presented in Table 6.7.2.1.

At status quo F=0.45 landings would reach 61 900 t in 2010 and 56 900 t in 2011 while spawning stock biomass is expected to around 115 000 tonnes in 2010 and 2011 and decreased to 100 000 tonnes in 2012. Landings in 2010 are predicted to rely on the three most recent year classes (72%) while in the SSB these year-classes will contribute to around 76% of the spawning biomass in 2011 (Figure 6.7.1.1.)

6.6 Medium term forecasts and yield per recruit

No medium term projections were performed for faroe saithe.

6.6.1 Input data to yield per recruit

The input data to long term prediction are shown in Table 6.8.1.1.

Mean weights-at-age for 1961-2009 were used for the long term projection. Natural mortality is set to constant 0.2. Proportion mature-at-age is taken as the average of smoothed values from 1982-2010.

The exploitation pattern was set equal to the average of the last five years (2005-2009) (as suggested from ACFM, 2004). Results from the yield per recruit analysis are shown in Table 6.8.1.2 and Figure 6.8.1.1.

6.7 Uncertainties in assessment and forecast

Although some retrospective pattern still remains, updating the data input to the model, specifically with regard to catch at age and the commercial CPUE tuning index, has significantly improved the magnitude of the pattern and would appear to facilitate reasonable application of model findings to management actions (Benchmark report 2010.) Retrospective patterns show a period of overestimation in average fishing mortality (2005-2009) while the assessment tends to underestimate F prior to 2005 (Figure 6.4.3.) This implies that biomass was correspondingly underestimated from 2005 to 2009 and overestimated before 2005. With respect to recruitment the retrospective trend is very similar to that of F and SSB. The 2005 year-class was predicted at a historic high in 2008 but it is showing much weaker in 2009 and it might be expected to become even weaker in coming years.

6.7.1 Assessment quality

The assessment is tuned with commercial CPUE data. Problems associated with the use of commercial CPUE data (e.g. increased efficiency due to technological creep etc.) may affect the assessment. The standardisation of commercial CPUE data carried out at the 2010 benchmark assessment (Sec. 6.2.5.2 and Stock annex sec. B.4) has resulted in a substantial reduction in the bias observed in the retrospective pattern. In addition there are no indications that changes in stock growth have an effect on catchability as given by the relation between weight- and catchability-at-age derived from the XSA and Adapt models (Figure 6.9.1.)

6.8 Comparison with previous assessment and forecast

In previous assessment there was a consistent bias to over- and under-estimate F and SSB respectively. The current adopted assessment shows two different periods of overestimation in F from 2005-2009 and underestimation before up to 2004 implying underestimation and overestimation of SSB respectively. These biases are less pronounced in the current accepted assessment. Various factors could explain this pattern, e.g. by changes in the vertical distribution of saithe which might have also affect the selection pattern. The retrospective trend in recruitment of three-year old saithe is very similar to that observed for F and SSB Management plans and evaluations

No management plan exists for saithe in Division Vb

6.9 Management considerations

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

As it was mentioned in section 6.5 in order to evaluate reference points several scenarios with high-growth small-stock situations (1991-1998), slow-growth large-stock situations (2002-2009) and on the entire historical period (1961-2009) were compared.

The yield-per-recruit obtained is much higher for small-stock periods (i.e. high-growth) than for large-stock periods (i.e. slow-growth)(Figure 6.5.1.2), as well as spawning stock per recruit. Estimated $\mathbf{F}_{max}$ used as a proxy for $\mathbf{F}_{MSY}$ in periods of high growth is 0.44 which is very close to that obtained when the entire time series is selected ($\mathbf{F}_{max}$=0.43) When the saithe stock experiences a period of slow growth the expected maximum yield obtained is lower $\mathbf{F}_{max}$=0.34.

One canditate for the FMSY is the average $\mathbf{F}_{max}$=0.39 obtained under different conditions. $\mathbf{B}_{trigger}$ could be set at the current $\mathbf{B}_{lim}$ of 60 thousand tonnes. The current $\mathbf{F}_{pa}$=0.28 also seems too low if the goal is to maximize yield. These values are by no means regarded as proxies for FMSY until a proper evaluation is performed. However given time constrains this year the WG suggests that a Management Strategy Evaluation (MSE) framework be used for evaluation of reference points and harvest control rules. A MSE approach would not only be useful from a management strategy view point under stationary assumptions, but also allow exploration of the influence of environmental drivers have on long-term management actions.

6.10 Ecosystem considerations

No evidence is available to indicate that the fishery is impacting the marine environment. A Ph.D. project was launched in 2008, with the aim of investigate the role of climatic and oceanographic factors in the dynamics of Faroe saithe.

6.11 Regulations and their effects

It seems to be no relationship between number of fishing days and fishing mortality, probably because of large fluctuations in catchability. Area restriction is an alternative to reduce fishing mortality- and this is used to protect small saithe in Faroese area.

6.12 Changes in fishing technology and fishing patterns

See section 6.2.

6.13 Changes in the environment

According to existing literature the productivity of the ecosystem clearly affects both cod and haddock recruitment and growth (Gaard et al., 2002), a feature outlined in Steingrund and Gaard (2005). The primary production on the Faroe Shelf (< 130 m depth), over the period May through June, varied interannually by a factor of five, giving rise to low- or high-productive periods of 2-5 years duration (Steingrund and Gaard, 2005). The productivity over the outer areas seems to be negatively correlated with the strength of the Subpolar Gyre (Hátún et al., 2005; Hátún et al., 2009; Steingrund et al., 2010), which may regulate the abundance of saithe in Faroese waters (Steingrund and Hátún, 2008). When comparing a gyre index (GI) 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 (Figure 6.16.1.)

There is a negative relationship between mean weight-at-age and the stock size of saithe in Faroese waters. This could be due to simple density-dependence, where there is a competition for limited food resources. Stomach content data show that the food of saithe is dominated by blue whiting, Norway pout, and krill, and the annual variations in the stomach fullness are mainly attributable to variations in the feeding on blue whiting. There seems to be no relationship between stomach fullness and weights-at-age for saithe (í Homrum *et al*. WD 2009).

6.14 References

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Table 6.2.1.1. Faroe saithe (Division Vb). Nominal catches (tonnes round weight) by countries, 1988-2009, as officially reported to ICES.

Country	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Denmark	94	-	2	-	-	-	-	-	-	-	-
Estonia	-	-	-	-	-	-	-	-	-	16	-
Faroe Islands	44402	43,624	59,821	53,321	35,979	32,719	32,406	26,918	19,267	21,721	25,995
France [3]	313	-	-	-	120	75	19	10	12	9	17
Germany	-	-	-	32	5	2	1	41	3	5	-
German Dem.Rep.	-	9	-	-	-	-	-	-	-	-	-
German Fed. Rep.	74	20	15	-	-	-	-	-	-	-	-
Greenland	-	-	-	-	-	-	-	-	-	-	-
Ireland	-	-	-	-	-	-	-	-	-	-	-
Netherlands	-	22	67	65	-	-	-	-	-		-
Norway	52	51	46	103	85	32	156	10	16	67	53
Portugal	-	-	-	-	-	-	-	-	-	-	-
UK (Eng. & W.)	-	-	-	5	74	279	151	21	53	-	19
UK (Scotland)	92	9	33	79	98	425	438	200	580	460	337
USSR/Russia [2]	-	-	30	-	12	-	-	-	18	28	-
Total	45027	43,735	60,014	53,605	36,373	33,532	33,171	27,200	19,949	22,306	26,065
Working Group estimate [4,5]	45285	44,477	61,628	54,858	36,487	33,543	33,182	27,209	20,029	22,306	26,421

Country	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009 [1]
Denmark	-	-	-	-	-	-	-	34	-		
Estonia	-	-	-	-	-	-	-	-	-		
Faroe Islands	32,439		49,676	55,165	47,933	48,222	71,496	70,696	64,552	60,104	58,308
France	-	273	934	607	370	147	123	315	108	97	
Germany	100	230	667	422	281	186	1	49	3	3	
Greenland	-	-		125	-			73			
Irland	-	-	5	-	-	-	-	-	-		
Norway	160	72	60	77	62	82	82	35	81	38	23
Portugal	-	-	-	-	-	5	-	-	-		
Russia	-	20	1	10	32	71	210	104	114	38	44
UK (E/W/NI)	67	32	80	58	89	85	32	88	4		
UK (Scotland)	441	534	708	540	610	748	4,322	1,011	408	400	
United Kingdom											685
Total	33,207	1,161	52,131	57,004	49,377	49,546	76,266	72,405	65,270	60,680	59,060
Working Group estimate [4,5,6,7]	33,207	39,020	51,786	53,546	46,555	46,355	68,008	67,103	60,819	56,172	59,060

Table 6.2.1.2. Faroe saithe (Division Vb). Total Faroese landings (rightmost column) and the contribution (%) by each fleet category. Averages for 1985-2009 are given at the bottom.

Year	Open boats	Long-liners <100 GRT	Single trawl <400 HP	Gillnets	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	59711
2008	0.2	0.3	1.5	0.0	3.2	0.2	20.4	16.0	57.7	0.5	0.0	0.0	55596
2009	0.4	0.2	3.3	0.0	4.3	0.1	9.6	15.1	66.8	0.2	0.0	0.0	58308
Average	0.3	0.2	0.7	0.1	5.8	1.7	16.6	19.7	54.1	0.2	0.5	0.1	43325

Table 6.2.2.1. Faroe saithe (Division Vb). Catch number at age by fleet categories in 2009 (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	0	0	0	0	0	0	0
3	12	404	20	154	4	594	39	634
4	185	3285	625	4082	161	8338	321	8659
5	232	777	635	3377	67	5088	76	5164
6	64	179	287	1283	31	1844	18	1862
7	165	360	866	3612	105	5108	35	5143
8	67	118	363	1402	35	1984	12	1996
9	56	92	340	1153	30	1671	9	1680
10	36	62	185	751	21	1053	6	1059
11	13	23	48	195	7	287	2	289
12	1	2	15	21	1	40	0	41
13	0	0	0	3	0	3	0	3
14	0	0	1	0	0	1	0	1
15	0	0	0	0	0	0	0	0
Total No.	829	5303	3385	16033	462	26012	518	26531
Catch, t.	1998	8540	8630	38090	1051	58308	752	59060

Table 6.2.2.2. Faroe saithe (Division Vb). Catch number at age (thousands) from the commercial fleet.

year	3	4	5	6	7	8	9	10	11	12	13	14+
1961	183	379	483	403	216	129	116	82	45	27	6	49
1962	562	542	617	495	286	131	129	113	71	29	13	63
1963	614	340	340	415	406	202	174	158	94	169	61	44
1964	684	1908	1506	617	572	424	179	150	100	83	47	44
1965	996	850	1708	965	510	407	306	201	156	120	89	76
1966	488	1540	1201	1686	806	377	294	205	156	94	52	79
1967	595	796	1364	792	1192	473	217	190	97	75	38	27
1968	614	1689	1116	1095	548	655	254	128	89	59	40	88
1969	1191	2086	2294	1414	1118	589	580	239	115	100	36	54
1970	1445	6577	1558	1478	899	730	316	241	86	48	46	38
1971	2857	3316	5585	1005	828	469	326	164	100	54	13	33
1972	2714	1774	2588	2742	1529	1305	1017	743	330	133	28	49
1973	2515	6253	7075	3478	1634	693	550	403	215	103	25	58
1974	3504	4126	4011	2784	1401	640	368	340	197	124	45	96
1975	2062	3361	3801	1939	1045	714	302	192	193	126	64	108
1976	3178	3217	1720	1250	877	641	468	223	141	96	60	131
1977	1609	2937	2034	1288	767	708	498	338	272	129	80	121
1978	611	1743	1736	548	373	479	466	473	407	211	146	178
1979	287	933	1341	1033	584	414	247	473	368	206	136	349
1980	996	877	720	673	726	284	212	171	196	156	261	369
1981	411	1804	769	932	908	734	343	192	92	128	176	717
1982	387	4076	994	1114	380	417	296	105	88	56	49	797
1983	2483	1103	5052	1343	575	339	273	98	98	99	25	416
1984	368	11067	2359	4093	875	273	161	52	65	59	18	176
1985	1224	3990	5583	1182	1898	273	103	38	26	72	41	162
1986	1167	1997	4473	3730	953	1077	245	104	67	33	56	69
1987	1581	5793	3827	2785	990	532	333	81	43	5	11	81
1988	866	2950	9555	2784	1300	621	363	159	27	43	15	2
1989	451	5981	5300	7136	793	546	185	83	55	10	2	27
1990	294	3833	10120	9219	5070	477	123	61	60	18	19	42
1991	1030	5125	7452	5544	3487	1630	405	238	128	77	22	19
1992	521	4067	3667	2679	1373	894	613	123	63	37	52	19
1993	1316	2611	4689	1665	858	492	448	245	54	34	10	8
1994	690	3961	2663	2368	746	500	307	303	150	28	19	2
1995	398	1019	3468	1836	1177	345	241	192	104	73	25	19
1996	297	1087	1146	1449	1156	521	132	77	64	45	29	8
1997	344	832	2440	1767	1335	624	165	71	29	48	29	23
1998	163	1689	1934	3475	1379	683	368	77	32	28	24	21
1999	322	655	3096	2551	4113	915	380	147	24	27	5	37
2000	811	2830	1484	4369	2226	2725	348	186	56	18	2	5
2001	1125	2452	8437	2155	3680	1539	1334	293	90	24	19	13
2002	302	8399	5962	9786	862	1280	465	362	33	36	8	1
2003	330	2432	11152	3994	4287	417	419	304	91	40	3	0
2004	76	2011	8544	8762	2125	1807	265	293	146	100	10	2
2005	454	2949	9490	16613	7102	843	810	32	102	27	3	0
2006	1479	5060	7804	7735	10327	3771	642	283	32	12	12	5
2007	830	3316	11292	6466	3777	4289	1536	406	81	11	9	3
2008	4574	3021	3580	9338	3596	2236	2068	451	158	13	6	0
2009	634	8659	5164	1862	5143	1996	1680	1059	289	41	3	1

Table 6.2.2.3. Faroe saithe (Division Vb). Sampling intensity in 2000-2009.

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	
2008	**Lengths**	0	6892	3694	13995	234	24815	2.6
	Otoliths	0	690	600	1500	0	2790	
	Weights	0	0	2517	12914	234	15665	
2009	**Lengths**	511	5273	3695	23352	0	32831	4.1
	Otoliths	97	301	599	2519	0	3516	
	Weights	511	0	3494	19060	0	23065	

Table 6.2.3.1. Faroe saithe (Division Vb). Catch weights at age (kg) from the commercial fleet.

year	3	4	5	6	7	8	9	10	11	12	13	14+
1961	1.43	2.30	3.35	4.29	5.13	6.16	7.06	7.27	7.50	8.20	9.15	9.99
1962	1.27	2.05	3.29	4.19	5.15	5.66	6.47	6.71	7.15	7.90	8.45	9.66
1963	1.28	2.20	3.21	4.57	5.06	5.93	6.26	8.00	7.27	8.55	9.02	9.82
1964	1.18	2.06	3.27	4.26	5.04	5.69	6.66	6.84	7.69	8.35	8.12	9.42
1965	1.18	2.13	2.94	4.10	4.88	5.93	6.32	7.29	8.07	7.88	9.48	9.85
1966	1.36	2.03	3.06	3.66	4.59	5.52	6.84	7.27	7.66	8.12	10.21	9.88
1967	1.27	1.78	2.53	3.57	4.37	5.31	5.81	6.55	7.81	7.59	8.55	9.14
1968	1.30	1.74	2.04	3.12	4.05	5.18	6.24	7.52	8.05	8.65	8.30	9.75
1969	1.19	1.67	2.30	2.85	3.67	5.00	5.71	6.41	6.55	7.59	7.95	9.10
1970	1.24	1.45	2.25	2.85	3.52	4.42	5.44	5.73	6.66	7.31	9.05	9.63
1971	1.10	1.32	1.82	2.98	3.70	4.27	5.39	5.97	6.49	7.17	7.38	9.61
1972	1.04	1.49	2.06	2.83	3.79	4.18	4.81	5.29	6.95	6.73	7.59	9.61
1973	1.31	1.75	1.90	2.70	4.43	5.26	6.16	6.33	8.08	8.78	9.78	11.12
1974	1.62	1.72	2.49	2.82	3.52	5.20	6.28	6.45	7.07	7.77	8.76	10.83
1975	1.29	1.92	2.62	3.62	4.13	4.75	5.95	7.07	8.35	9.03	9.98	11.08
1976	1.16	1.79	3.07	3.29	4.58	4.65	5.12	6.31	7.07	7.07	7.81	9.71
1977	1.22	1.64	2.66	3.79	4.24	5.60	5.35	5.91	6.84	6.73	6.95	9.26
1978	1.49	2.32	3.07	3.75	4.91	4.37	5.28	5.83	6.05	6.71	7.69	8.52
1979	1.22	1.88	2.62	3.40	4.18	4.95	5.69	6.38	7.02	7.26	8.15	9.62
1980	1.23	2.12	3.32	4.28	5.16	6.42	6.87	7.09	7.93	8.07	8.59	10.14
1981	1.31	2.13	3.00	3.81	4.75	5.25	5.95	6.43	7.00	7.47	8.14	9.43
1982	1.34	1.85	2.95	3.58	4.93	6.24	7.23	7.24	8.35	8.35	8.96	10.23
1983	1.21	2.03	2.97	4.14	4.72	5.90	6.81	7.05	7.25	8.29	9.48	10.51
1984	1.43	1.95	2.47	3.85	5.18	6.35	7.83	6.75	8.64	8.47	8.56	10.80
1985	1.40	2.03	2.97	3.60	5.34	7.20	6.97	9.86	10.67	10.46	10.20	13.05
1986	1.72	1.99	2.62	3.28	4.19	5.59	6.05	6.15	9.54	9.82	7.30	12.77
1987	1.61	1.84	2.40	3.18	4.07	5.15	5.50	6.63	6.34	10.25	8.49	10.48
1988	1.50	1.98	1.98	2.94	3.80	4.42	5.12	6.71	9.04	9.36	9.14	10.22
1989	1.31	1.74	1.91	2.37	3.81	4.67	5.51	5.97	6.94	8.54	9.51	10.48
1990	1.22	1.63	1.83	2.05	2.87	4.47	5.42	6.47	6.34	8.42	7.38	8.64
1991	1.24	1.57	1.86	2.21	2.65	3.38	4.82	5.52	6.41	7.40	8.08	8.67
1992	1.26	1.60	2.07	2.55	3.06	4.08	5.01	6.77	7.75	8.30	7.79	9.30
1993	1.41	1.86	2.32	3.13	3.73	4.39	5.21	6.54	8.40	7.28	9.41	9.64
1994	1.50	1.95	2.27	2.94	4.21	4.97	5.66	5.95	6.89	8.75	9.75	7.99
1995	1.46	2.18	2.42	2.90	3.65	5.06	5.44	6.17	7.08	7.74	7.30	7.10
1996	1.43	1.88	2.50	3.23	3.74	4.96	6.38	6.75	7.47	7.28	8.47	10.13
1997	1.48	1.78	2.03	2.78	3.60	4.77	5.98	7.66	7.88	8.54	9.49	10.41
1998	1.39	1.71	1.95	2.41	3.30	4.22	5.00	6.39	6.67	8.21	8.49	8.85
1999	1.37	1.71	1.91	2.40	2.85	4.12	5.26	5.53	6.96	8.03	8.35	8.91
2000	1.48	1.61	2.08	2.36	2.98	3.48	4.85	5.27	6.52	4.73	8.81	8.97
2001	1.33	1.59	1.79	2.59	3.06	3.87	4.37	5.57	6.70	5.78	7.75	7.77
2002	1.14	1.46	1.65	1.97	3.13	3.59	4.51	5.14	6.42	8.03	4.76	11.36
2003	1.12	1.30	1.61	1.98	2.53	3.97	4.83	5.50	6.10	6.99	5.96	10.00
2004	1.14	1.33	1.45	1.79	2.56	3.16	4.15	5.17	6.02	6.19	7.06	9.39
2005	1.15	1.33	1.52	1.67	2.09	2.98	3.79	6.09	6.13	6.65	7.42	10.00
2006	1.13	1.22	1.46	1.79	2.04	2.44	3.86	4.22	5.15	6.44	6.91	5.37
2007	1.06	1.39	1.41	1.82	2.36	2.68	3.28	4.10	5.00	6.33	7.84	7.97
2008	1.15	1.31	1.67	1.82	2.40	2.90	3.10	3.73	4.77	6.07	6.45	10.00
2009	0.94	1.49	1.89	2.41	2.60	3.15	3.63	4.02	5.01	5.83	6.31	9.01

Table 6.2.4.1. Faroe saithe (Division Vb). Proportion mature at age.

year	3	4	5	6	7	8	9	10	11	12	13	14+
1961	0.08	0.25	0.56	0.82	0.94	0.98	0.99	1	1	1	1	1
1962	0.08	0.25	0.56	0.82	0.94	0.98	0.99	1	1	1	1	1
1963	0.08	0.25	0.56	0.82	0.94	0.98	0.99	1	1	1	1	1
1964	0.08	0.25	0.56	0.82	0.94	0.98	0.99	1	1	1	1	1
1965	0.08	0.25	0.56	0.82	0.94	0.98	0.99	1	1	1	1	1
1966	0.08	0.25	0.56	0.82	0.94	0.98	0.99	1	1	1	1	1
1967	0.08	0.25	0.56	0.82	0.94	0.98	0.99	1	1	1	1	1
1968	0.08	0.25	0.56	0.82	0.94	0.98	0.99	1	1	1	1	1
1969	0.08	0.25	0.56	0.82	0.94	0.98	0.99	1	1	1	1	1
1970	0.08	0.25	0.56	0.82	0.94	0.98	0.99	1	1	1	1	1
1971	0.08	0.25	0.56	0.82	0.94	0.98	0.99	1	1	1	1	1
1972	0.08	0.25	0.56	0.82	0.94	0.98	0.99	1	1	1	1	1
1973	0.08	0.25	0.56	0.82	0.94	0.98	0.99	1	1	1	1	1
1974	0.08	0.25	0.56	0.82	0.94	0.98	0.99	1	1	1	1	1
1975	0.08	0.25	0.56	0.82	0.94	0.98	0.99	1	1	1	1	1
1976	0.08	0.25	0.56	0.82	0.94	0.98	0.99	1	1	1	1	1
1977	0.08	0.25	0.56	0.82	0.94	0.98	0.99	1	1	1	1	1
1978	0.08	0.25	0.56	0.82	0.94	0.98	0.99	1	1	1	1	1
1979	0.08	0.25	0.56	0.82	0.94	0.98	0.99	1	1	1	1	1
1980	0.08	0.25	0.56	0.82	0.94	0.98	0.99	1	1	1	1	1
1981	0.08	0.25	0.56	0.82	0.94	0.98	0.99	1	1	1	1	1
1982	0.08	0.25	0.56	0.82	0.94	0.98	0.99	1	1	1	1	1
1983	0	0.04	0.45	0.94	1	1	1	1	1	1	1	1
1984	0.06	0.4	0.87	0.98	1	1	1	1	1	1	1	1
1985	0.04	0.16	0.47	0.8	0.95	0.99	1	1	1	1	1	1
1986	0.08	0.48	0.9	0.98	0.99	0.99	0.99	1	1	1	1	1
1987	0.08	0.22	0.48	0.75	0.92	0.98	1	1	1	1	1	1
1988	0.09	0.24	0.5	0.75	0.9	0.96	0.99	1	1	1	1	1
1989	0.09	0.25	0.52	0.77	0.9	0.95	0.97	1	1	1	1	1
1990	0.09	0.21	0.4	0.63	0.82	0.92	0.97	1	1	1	1	1
1991	0.07	0.19	0.45	0.74	0.91	0.97	0.99	1	1	1	1	1
1992	0.01	0.07	0.33	0.76	0.95	0.99	1	1	1	1	1	1
1993	0.06	0.23	0.58	0.86	0.96	0.99	0.99	1	1	1	1	1
1994	0.03	0.18	0.59	0.9	0.98	1	1	1	1	1	1	1
1995	0.01	0.17	0.74	0.97	0.99	0.99	0.99	1	1	1	1	1
1996	0.03	0.16	0.52	0.86	0.97	0.99	0.99	1	1	1	1	1
1997	0.04	0.14	0.4	0.74	0.93	0.98	1	1	1	1	1	1
1998	0.03	0.09	0.23	0.49	0.75	0.91	0.98	1	1	1	1	1
1999	0.09	0.18	0.34	0.53	0.72	0.86	0.94	1	1	1	1	1
2000	0.1	0.21	0.4	0.62	0.8	0.91	0.96	1	1	1	1	1
2001	0.03	0.12	0.34	0.67	0.89	0.97	0.99	1	1	1	1	1
2002	0.08	0.17	0.31	0.5	0.69	0.84	0.93	1	1	1	1	1
2003	0.09	0.21	0.41	0.65	0.83	0.93	0.97	1	1	1	1	1
2004	0.03	0.08	0.19	0.39	0.65	0.84	0.94	1	1	1	1	1
2005	0.08	0.19	0.37	0.6	0.79	0.91	0.96	1	1	1	1	1
2006	0.12	0.23	0.41	0.62	0.79	0.89	0.95	1	1	1	1	1
2007	0.06	0.16	0.35	0.6	0.81	0.92	0.97	1	1	1	1	1
2008	0.09	0.23	0.49	0.76	0.91	0.97	0.99	1	1	1	1	1
2009	0.03	0.11	0.32	0.63	0.86	0.95	0.98	1	1	1	1	1
2010	0.06	0.23	0.59	0.86	0.96	0.98	0.99	1	1	1	1	1

Table 6.4.1. Faroe saithe (Division Vb). Effort (hours) and catch in number at age for commercial pair trawlers (1995-2009)

year	effort	3	4	5	6	7	8	9	10	11
1995	11043	47	180	577	236	146	49	24	19	14
1996	47289	310	958	821	1119	503	282	133	127	70
1997	35510	199	533	1488	1013	768	333	73	33	10
1998	35105	107	656	1148	1486	730	325	170	40	13
1999	43571	174	487	1554	2016	2024	817	190	83	12
2000	44259	434	1566	913	2700	1333	1604	192	106	31
2001	42367	611	1438	4946	1165	1855	748	618	127	29
2002	41972	133	3976	3964	6888	520	682	246	177	25
2003	40211	141	1494	6560	2373	2263	197	212	124	35
2004	37343	43	1200	5089	5116	1035	762	113	116	53
2005	34003	188	1189	4039	7266	3130	320	291	7	43
2006	26749	140	1176	2410	2584	3700	1376	268	85	14
2007	25970	204	879	2913	1815	1034	1215	435	110	19
2008	26617	796	762	947	2641	1063	726	611	156	51
2009	71291	154	4082	3377	1283	3612	1402	1153	751	195

Table 6.4.2. Faroe saithe (Division Vb). Diagnostics from XSA with commercial pair trawler tuning series.

FLR XSA Diagnostics 2010-04-29 17:23:16

CPUE data from FLIndices(sai.indices[[3]])

Catch data for 49 years. 1961 to 2009. Ages 3 to 14.

	fleet	first age	last age	first year	last year	alpha	beta
1	PairTrawlers_GLM_SD	3	11	1995	2009	0	1

Time series weights :

Tapered time weighting not applied

Catchability analysis :

Catchability independent of 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

Minimum standard error for population
estimates derived from each fleet = 0.3

prior weighting not applied

Regression weights

age \ year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
all	1	1	1	1	1	1	1	1	1	1

Fishing mortalities

age \ year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
3	0.025	0.014	0.003	0.006	0.002	0.007	0.072	0.025	0.050	0.038
4	0.068	0.100	0.140	0.032	0.047	0.084	0.104	0.227	0.118	0.126
5	0.236	0.294	0.375	0.280	0.150	0.323	0.334	0.354	0.410	0.305
6	0.421	0.637	0.664	0.466	0.371	0.485	0.477	0.512	0.560	0.388
7	0.476	0.773	0.572	0.701	0.487	0.588	0.643	0.453	0.605	0.702
8	0.722	0.724	0.684	0.608	0.740	0.363	0.731	0.612	0.535	0.830
9	0.522	1.002	0.498	0.499	1.048	0.918	0.522	0.768	0.687	1.049
10	0.730	1.219	0.848	0.724	0.803	0.319	1.026	0.753	0.535	0.961
11	0.707	1.009	0.397	0.527	0.976	0.742	0.615	0.984	0.763	0.807
12	0.519	0.773	1.904	1.280	2.673	0.467	0.172	0.441	0.398	0.451
13	0.679	2.095	0.644	0.871	1.573	0.681	0.391	0.189	0.461	0.148
14	0.679	2.095	0.644	0.871	1.573	0.681	0.391	0.189	0.461	0.148

XSA population number (Thousand)

year \ age	3	4	5	6	7	8	9	10	11	12	13	14
2000	35634	47780	7814	14056	6493	5857	946	397	122	49	4	11
2001	87922	28441	36558	5054	7554	3302	2329	460	157	49	24	16
2002	104719	70966	21066	22297	2188	2855	1311	700	111	47	19	2
2003	59795	85463	50502	11853	9401	1012	1180	652	246	61	6	0
2004	49429	48658	67771	31257	6091	3818	451	587	259	119	14	3
2005	69831	40400	38018	47755	17663	3064	1491	129	215	80	7	0
2006	23667	56762	30408	22540	24067	8035	1746	487	77	84	41	17
2007	37428	18038	41894	17835	11455	10360	3166	848	143	34	58	19
2008	103475	29893	11768	24083	8751	5961	4601	1203	327	44	18	0
2009	18640	80579	21740	6396	11268	3911	2857	1896	577	125	24	8

Estimated population abundance at 1st Jan 2010

age

year	3	4	5	6	7	8	9	10	11	12	13	14
2010	1389	14687	58138	13127	3551	4572	1396	819	594	211	65	17

Fleet: PairTrawlers_GLM_SD

Log catchability residuals.

age \ year	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
3	-0.111	0.798	0.319	0.676	-0.587	0.820	0.297	-1.398	-0.735	-1.660	-0.434	0.624	0.549	0.881	-0.038
4	0.346	-0.333	-0.151	-0.243	0.211	-0.177	0.316	0.447	-0.727	-0.301	-0.013	-0.115	0.828	0.104	-0.190
5	0.621	-0.465	-0.517	-0.262	-0.459	-0.013	0.204	0.580	0.209	-0.325	0.196	0.147	0.055	0.202	-0.173
6	-0.172	-0.140	-0.073	-0.663	-0.021	0.040	0.361	0.675	0.197	0.027	0.099	0.052	-0.022	0.049	-0.408
7	0.097	-0.433	0.152	-0.014	-0.225	-0.077	0.274	0.164	0.276	-0.091	0.089	0.210	-0.376	-0.037	-0.010
8	0.016	0.089	0.026	-0.114	0.486	0.190	0.045	0.090	-0.104	0.052	-0.668	0.228	-0.172	-0.192	0.028
9	-0.120	0.340	-0.095	0.186	-0.101	-0.196	0.318	-0.232	-0.232	0.406	0.197	0.028	0.053	-0.040	0.236
10	-0.415	1.005	-0.012	0.098	0.185	0.169	0.444	0.216	-0.078	0.069	-1.346	0.368	-0.011	-0.129	0.182
11	-0.099	0.133	-0.480	-0.134	-0.631	0.108	-0.039	-0.097	-0.451	0.174	0.147	0.238	0.108	0.153	-0.039

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

	3	4	5	6	7	8	9	10	11
Mean_Logq	-15.8154	-13.8081	-12.6218	-12.0930	-11.8851	-11.7573	-11.7573	-11.7573	-11.7573
S.E_Logq	0.8116	0.3829	0.3597	0.3052	0.2168	0.2511	0.2168	0.4977	0.2660

Terminal year survivor and F summaries:

Age 3 Year class =2006

source	scaledWts	survivors	yrcls
PairTrawlers_GLM_SD	0.846	14133	2006
fshk	0.154	18135	2006

Age 4 Year class =2005

source	scaledWts	survivors	yrcls
PairTrawlers_GLM_SD	0.958	48061	2005
fshk	0.042	63458	2005

Age 5 Year class =2004

source	scaledWts	survivors	yrcls
PairTrawlers_GLM_SD	0.955	11039	2004
fshk	0.045	12581	2004

Age 6 Year class =2003

source	scaledWts	survivors	yrcls
PairTrawlers_GLM_SD	0.965	2361	2003
fshk	0.035	2702	2003

Age 7 Year class =2002

source	scaledWts	survivors	yrcls
PairTrawlers_GLM_SD	0.957	4527	2002
fshk	0.043	6201	2002

Age 8 Year class =2001

source	scaledWts	survivors	yrcls
PairTrawlers_GLM_SD	0.951	1436	2001
fshk	0.049	2190	2001

Age 9 Year class =2000

source	scaledWts	survivors	yrcls
PairTrawlers_GLM_SD	0.94	1037	2000
fshk	0.06	1248	2000

Age 10 Year class =1999

source	scaledWts	survivors	yrcls
PairTrawlers_GLM_SD	0.851	712	1999
fshk	0.149	957	1999

Age 11 Year class =1998

source	scaledWts	survivors	yrcls
PairTrawlers_GLM_SD	0.952	202	1998
fshk	0.048	204	1998

```
 Age 12 Year class =1997

source
     scaledWts survivors yrcls
fshk         1        28  1997

 Age 13 Year class =1996

source
     scaledWts survivors yrcls
fshk         1         2  1996
```

Table 6.4.3. Faroe saithe (Division Vb). Fishing mortality (F) at age.

year	3	4	5	6	7	8	9	10	11	12	13	14	Fbar
1961	0.03	0.06	0.11	0.14	0.12	0.1	0.11	0.11	0.11	0.18	0.13	0.13	0.11
1962	0.05	0.1	0.13	0.16	0.14	0.1	0.14	0.15	0.13	0.1	0.12	0.12	0.13
1963	0.04	0.04	0.09	0.12	0.19	0.14	0.19	0.25	0.18	0.49	0.31	0.31	0.11
1964	0.05	0.14	0.25	0.22	0.24	0.3	0.18	0.24	0.25	0.24	0.24	0.24	0.23
1965	0.05	0.09	0.19	0.25	0.28	0.26	0.37	0.32	0.42	0.53	0.43	0.43	0.21
1966	0.03	0.1	0.17	0.28	0.35	0.35	0.31	0.46	0.43	0.49	0.46	0.46	0.25
1967	0.03	0.05	0.13	0.16	0.33	0.35	0.35	0.34	0.41	0.38	0.38	0.38	0.2
1968	0.03	0.1	0.1	0.14	0.16	0.31	0.33	0.36	0.26	0.47	0.36	0.36	0.16
1969	0.03	0.14	0.19	0.18	0.21	0.25	0.49	0.59	0.64	0.52	0.59	0.59	0.19
1970	0.04	0.26	0.14	0.18	0.16	0.2	0.21	0.39	0.43	0.61	0.48	0.48	0.19
1971	0.09	0.14	0.37	0.13	0.14	0.12	0.13	0.16	0.28	0.53	0.33	0.33	0.18
1972	0.09	0.07	0.15	0.32	0.29	0.35	0.4	0.49	0.54	0.73	0.59	0.59	0.24
1973	0.13	0.33	0.44	0.3	0.32	0.21	0.25	0.27	0.25	0.32	0.28	0.28	0.32
1974	0.22	0.31	0.36	0.31	0.19	0.2	0.16	0.24	0.21	0.23	0.23	0.23	0.27
1975	0.14	0.35	0.53	0.29	0.18	0.14	0.13	0.12	0.21	0.2	0.18	0.18	0.3
1976	0.2	0.34	0.3	0.33	0.21	0.16	0.13	0.14	0.12	0.15	0.14	0.14	0.27
1977	0.15	0.28	0.38	0.38	0.34	0.26	0.18	0.13	0.25	0.16	0.18	0.18	0.33
1978	0.09	0.23	0.27	0.16	0.18	0.38	0.27	0.26	0.23	0.31	0.27	0.27	0.24
1979	0.04	0.18	0.28	0.25	0.26	0.31	0.34	0.49	0.33	0.17	0.33	0.33	0.26
1980	0.09	0.15	0.21	0.22	0.28	0.2	0.26	0.42	0.39	0.23	0.34	0.34	0.21
1981	0.01	0.23	0.19	0.45	0.53	0.51	0.38	0.39	0.41	0.47	0.43	0.43	0.38
1982	0.03	0.18	0.19	0.48	0.33	0.5	0.4	0.19	0.32	0.48	0.33	0.33	0.34
1983	0.07	0.1	0.37	0.42	0.49	0.55	0.74	0.22	0.28	0.71	0.41	0.41	0.39
1984	0.02	0.5	0.33	0.58	0.54	0.45	0.56	0.29	0.22	0.27	0.26	0.26	0.48
1985	0.06	0.24	0.51	0.28	0.58	0.31	0.31	0.24	0.23	0.42	0.3	0.3	0.38
1986	0.02	0.14	0.45	0.77	0.38	0.79	0.52	0.58	0.9	0.52	0.67	0.67	0.51
1987	0.04	0.14	0.42	0.57	0.48	0.37	0.6	0.32	0.5	0.14	0.32	0.32	0.4
1988	0.02	0.09	0.36	0.63	0.58	0.63	0.47	0.65	0.17	1.6	0.81	0.81	0.46
1989	0.02	0.2	0.23	0.49	0.37	0.51	0.38	0.18	0.49	0.09	0.25	0.25	0.36
1990	0.02	0.2	0.63	0.79	0.8	0.39	0.2	0.21	0.2	0.29	0.23	0.23	0.56
1991	0.05	0.42	0.77	0.88	0.8	0.66	0.69	0.76	0.91	0.42	0.7	0.7	0.7
1992	0.03	0.26	0.6	0.71	0.56	0.49	0.56	0.46	0.46	0.74	0.56	0.56	0.52
1993	0.06	0.21	0.55	0.6	0.52	0.39	0.48	0.46	0.38	0.48	0.44	0.44	0.45
1994	0.05	0.27	0.34	0.6	0.6	0.65	0.46	0.72	0.57	0.35	0.55	0.55	0.49
1995	0.01	0.09	0.41	0.41	0.69	0.63	0.78	0.58	0.59	0.61	0.6	0.6	0.44
1996	0.01	0.04	0.14	0.3	0.49	0.76	0.52	0.62	0.39	0.55	0.53	0.53	0.35
1997	0.01	0.05	0.12	0.33	0.5	0.54	0.58	0.6	0.5	0.57	0.86	0.86	0.31
1998	0.01	0.07	0.15	0.24	0.46	0.52	0.73	0.59	0.6	1.48	0.64	0.64	0.29
1999	0.01	0.07	0.18	0.3	0.49	0.63	0.62	0.74	0.37	1.86	1.36	1.36	0.34
2000	0.03	0.07	0.24	0.42	0.48	0.72	0.52	0.73	0.71	0.52	0.68	0.68	0.38
2001	0.01	0.1	0.29	0.64	0.77	0.72	1	1.22	1.01	0.77	2.1	2.1	0.51
2002	0	0.14	0.38	0.66	0.57	0.68	0.5	0.85	0.4	1.9	0.64	0.64	0.49
2003	0.01	0.03	0.28	0.47	0.7	0.61	0.5	0.72	0.53	1.28	0.87	0.87	0.42
2004	0	0.05	0.15	0.37	0.49	0.74	1.05	0.8	0.98	2.67	1.57	1.57	0.36
2005	0.01	0.08	0.32	0.49	0.59	0.36	0.92	0.32	0.74	0.47	0.68	0.68	0.37
2006	0.07	0.1	0.33	0.48	0.64	0.73	0.52	1.03	0.62	0.17	0.39	0.39	0.46
2007	0.03	0.23	0.35	0.51	0.45	0.61	0.77	0.75	0.98	0.44	0.19	0.19	0.43
2008	0.05	0.12	0.41	0.56	0.61	0.54	0.69	0.54	0.76	0.4	0.46	0.46	0.45
2009	0.04	0.13	0.31	0.39	0.7	0.83	1.05	0.96	0.81	0.45	0.15	0.15	0.47

Table 6.4.4. Faroe saithe (Division Vb). Stock number at age (start of year) (Thousands).

year	3	4	5	6	7	8	9	10	11	12	13	14+	TOTAL
1961	7827	7422	5158	3352	2114	1494	1233	905	468	180	53	431	30637
1962	12256	6243	5734	3786	2379	1535	1107	904	666	343	123	593	35669
1963	19837	9526	4621	4136	2652	1689	1138	789	638	481	254	182	45945
1964	14812	15686	7492	3476	3011	1804	1200	775	503	438	241	225	49661
1965	22363	11508	11116	4771	2287	1947	1093	821	499	322	283	240	57249
1966	21229	17408	8653	7556	3033	1411	1226	618	490	267	155	233	62279
1967	24898	16940	12859	5998	4660	1754	814	738	321	260	134	94	69468
1968	22879	19846	13149	9294	4194	2737	1008	470	432	175	145	317	74646
1969	39799	18176	14720	9755	6618	2938	1648	595	269	273	90	133	95016
1970	37092	31507	12994	9976	6708	4407	1872	825	271	116	133	109	106011
1971	38447	29061	19844	9229	6831	4678	2948	1247	457	144	52	131	113068
1972	33424	28892	20793	11194	6647	4843	3406	2118	873	284	69	120	112662
1973	23622	24910	22050	14682	6684	4058	2784	1868	1062	416	112	258	102506
1974	19421	17064	14737	11651	8873	3994	2696	1782	1165	675	247	525	82829
1975	17327	12730	10238	8436	7020	5997	2691	1874	1151	776	441	740	69419
1976	19709	12320	7381	4943	5152	4802	4264	1930	1361	768	521	1133	64283
1977	13106	13261	7176	4487	2916	3425	3352	3068	1378	986	542	816	54511
1978	8333	9274	8200	4035	2508	1693	2163	2293	2206	882	691	837	43115
1979	8686	6270	6016	5142	2808	1716	953	1350	1450	1438	531	1354	37712
1980	13074	6852	4289	3712	3276	1770	1030	557	677	854	991	1390	38471
1981	33144	9803	4816	2860	2430	2025	1192	652	301	377	558	2253	60411
1982	15670	26764	6393	3248	1498	1168	994	666	360	163	193	3113	60230
1983	40828	12480	18225	4335	1651	883	579	546	450	215	83	1368	81642
1984	26070	31180	9219	10350	2334	831	416	227	358	280	86	840	82192
1985	22321	21011	15515	5414	4770	1119	434	195	139	234	176	690	72017
1986	61837	17167	13592	7651	3363	2188	669	262	125	90	127	154	107225
1987	48576	49572	12248	7081	2889	1891	817	326	120	42	44	322	123928
1988	44807	38340	35344	6565	3278	1469	1067	368	194	60	30	4	131525
1989	28596	35901	28721	20292	2856	1507	641	545	157	134	10	132	119493
1990	20704	23005	23982	18719	10156	1621	740	357	371	79	101	222	100057
1991	24967	16685	15366	10478	6984	3728	895	494	237	250	48	41	80174
1992	19520	19509	9024	5838	3562	2563	1577	367	190	79	135	49	62411
1993	23776	15510	12293	4070	2356	1674	1290	737	189	98	31	25	62047
1994	16868	18275	10336	5822	1826	1152	925	650	381	106	50	5	56396
1995	38964	13186	11378	6053	2624	820	491	480	258	177	61	46	74538
1996	24227	31541	9874	6178	3294	1083	359	184	219	117	79	21	77176
1997	33375	19567	24840	7047	3747	1651	415	174	81	122	55	43	91118
1998	12721	27014	15267	18130	4171	1860	787	191	79	40	56	48	80363
1999	58714	10267	20589	10750	11699	2167	905	312	87	35	7	54	115585
2000	35634	47780	7814	14056	6493	5857	946	397	122	49	5	11	119162
2001	87922	28441	36558	5054	7555	3302	2329	460	157	49	24	16	171865
2002	104719	70966	21067	22297	2188	2855	1311	700	111	47	19	2	226282
2003	59796	85463	50502	11853	9401	1012	1180	652	246	61	6	0	220171
2004	49429	48658	67771	31257	6091	3818	451	587	259	119	14	3	208454
2005	69831	40400	38018	47755	17663	3064	1491	129	215	80	7	0	218653
2006	23667	56762	30408	22540	24067	8035	1746	487	77	84	41	17	167930
2007	37428	18038	41895	17835	11455	10360	3166	848	143	34	58	19	141279
2008	103475	29893	11768	24083	8751	5961	4601	1203	327	44	18	0	190123
2009	18640	80579	21740	6396	11268	3911	2857	1896	577	125	24	8	148021
2010	0	14692	58163	13120	3552	4572	1396	819	594	211	65	23	97207

Table 6.4.5. Faroe saithe (Division Vb). Summary table.

year	Rec	TB	SSB	Land	y/SSB	Fbar
1961	7827	105008	70790	9592	0.13	0.11
1962	12256	111502	75429	10454	0.15	0.13
1963	19837	129760	79695	12693	0.17	0.11
1964	14811	139220	84410	21893	0.26	0.23
1965	22362	150301	88791	22181	0.27	0.21
1966	21229	162608	91895	25563	0.28	0.25
1967	24897	161577	90155	21319	0.23	0.2
1968	22879	170302	98678	20387	0.2	0.16
1969	39798	197296	109307	27437	0.26	0.19
1970	37091	212236	115753	29110	0.26	0.19
1971	38446	218370	127847	32706	0.23	0.18
1972	33424	234817	143985	42663	0.3	0.24
1973	23621	210054	135846	57431	0.42	0.32
1974	19420	205554	138756	47188	0.34	0.27
1975	17326	189790	139157	41576	0.3	0.3
1976	19708	181583	132333	33065	0.25	0.27
1977	13105	168852	125021	34835	0.27	0.33
1978	8332	150476	108074	28138	0.26	0.24
1979	8686	127853	98253	27246	0.27	0.26
1980	13073	134892	98766	25230	0.26	0.21
1981	33144	153814	88914	30103	0.35	0.38
1982	15670	165578	98095	30964	0.33	0.34
1983	40827	187644	83309	39176	0.47	0.39
1984	26069	198239	122877	54665	0.45	0.48
1985	22320	192625	97114	44605	0.49	0.38
1986	61836	237925	118096	41716	0.38	0.51
1987	48576	254065	89185	40020	0.47	0.4
1988	44807	261611	101566	45285	0.45	0.46
1989	28596	231060	111369	44477	0.41	0.36
1990	20704	193549	94345	61628	0.67	0.56
1991	24966	151177	77332	54858	0.71	0.71
1992	19519	124856	54628	36487	0.64	0.52
1993	23775	134127	66176	33543	0.5	0.45
1994	16867	128135	62836	33182	0.52	0.49
1995	38964	153824	65985	27209	0.4	0.44
1996	24226	163036	64639	20029	0.3	0.35
1997	33375	182022	68252	22306	0.33	0.31
1998	12720	165832	57211	26421	0.45	0.29
1999	58714	213351	76677	33207	0.43	0.34
2000	35633	226322	90108	39020	0.43	0.38
2001	87921	290762	87130	51786	0.59	0.51
2002	104718	329717	83556	53546	0.64	0.49
2003	59795	322605	112666	46555	0.41	0.42
2004	49428	310516	74835	46355	0.62	0.36
2005	69831	325493	131344	68008	0.52	0.37
2006	23666	259244	128222	67103	0.52	0.46
2007	37428	226645	109182	60819	0.56	0.43
2008	103474	280158	118970	56172	0.47	0.45
2009	18639	257189	95115	59060	0.63	0.47
2010	**42559**	**240264**	**114562**	**61879**	**0.54**	**0.45**
2011	**42559**	**224905**	**114835**	**56843**	**0.5**	**0.45**
2012	**42559**	**209941**	**100706**			
Arith. Mean	32742	197616	97606	37531	0.39	0.34

Table 6.7.1.1. Faroe saithe (Division Vb). Input data for prediction with management options (recruitment for year classes 2007 to 2009 is the geometric mean from 1995 to 2009)

2010

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	42559	0.2	0.05	0	0	0.94	0.04	0.94
4	14692	0.2	0.17	0	0	1.49	0.16	1.49
5	58163	0.2	0.46	0	0	1.89	0.36	1.89
6	13120	0.2	0.75	0	0	2.41	0.49	2.41
7	3552	0.2	0.91	0	0	2.6	0.59	2.6
8	4572	0.2	0.97	0	0	3.15	0.66	3.15
9	1396	0.2	0.99	0	0	3.63	0.84	3.63
10	819	0.2	1	0	0	4.02	0.75	4.02
11	594	0.2	1	0	0	5.01	0.85	5.01
12	211	0.2	1	0	0	5.83	0.43	5.83
13	65	0.2	1	0	0	6.31	0.27	6.31
14	23	0.2	1	0	0	9.01	0.27	9.01

2011

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	42559	0.2	0.06	0	0	0.94	0.04	0.94
4	-	0.2	0.19	0	0	1.49	0.16	1.49
5	-	0.2	0.47	0	0	1.89	0.36	1.89
6	-	0.2	0.75	0	0	2.41	0.49	2.41
7	-	0.2	0.91	0	0	2.6	0.59	2.6
8	-	0.2	0.97	0	0	3.15	0.66	3.15
9	-	0.2	0.99	0	0	3.63	0.83	3.63
10	-	0.2	1	0	0	4.02	0.75	4.02
11	-	0.2	1	0	0	5.01	0.85	5.01
12	-	0.2	1	0	0	5.83	0.43	5.83
13	-	0.2	1	0	0	6.31	0.27	6.31
14	-	0.2	1	0	0	9.01	0.27	9.01

2012

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	42559	0.2	0.06	0	0	0.94	0.04	0.94
4	-	0.2	0.19	0	0	1.49	0.16	1.49
5	-	0.2	0.47	0	0	1.89	0.36	1.89
6	-	0.2	0.75	0	0	2.41	0.49	2.41
7	-	0.2	0.91	0	0	2.6	0.59	2.6
8	-	0.2	0.97	0	0	3.15	0.66	3.15
9	-	0.2	0.99	0	0	3.63	0.84	3.63
10	-	0.2	1	0	0	4.02	0.75	4.02
11	-	0.2	1	0	0	5.01	0.85	5.01
12	-	0.2	1	0	0	5.83	0.43	5.83
13	-	0.2	1	0	0	6.31	0.27	6.31
14	-	0.2	1	0	0	9.01	0.27	9.01

Input units are thousands and kg - output in tonnes

Table 6.7.2.1. Faroe saithe (Division Vb). Prediction with management option, recruitment for year classes 2007 to 2009 is the geometric mean from 1995 to 2009.

2010				
Biomass	SSB	FMult	FBar	Landings
240264	114562	1.000	0.449	61879

2011					2012	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
224905	114835	0.000	0.000	0	268915	149894
.	114835	0.100	0.045	6936	261695	143774
.	114835	0.200	0.090	13552	254812	137962
.	114835	0.300	0.135	19868	248249	132440
.	114835	0.400	0.180	25897	241988	127194
.	114835	0.500	0.225	31654	236014	122207
.	114835	0.600	0.269	37155	230312	117467
.	114835	0.700	0.314	42412	224866	112958
.	114835	0.800	0.359	47438	219664	108670
.	114835	0.900	0.404	52245	214693	104590
.	114835	1.000	0.449	56843	209941	100706
.	114835	1.100	0.494	61244	205397	97010
.	114835	1.200	0.539	65458	201050	93490
.	114835	1.300	0.584	69492	196890	90137
.	114835	1.400	0.629	73358	192908	86942
.	114835	1.500	0.674	77063	189094	83898
.	114835	1.600	0.719	80615	185441	80996
.	114835	1.700	0.764	84021	181939	78229
.	114835	1.800	0.808	87290	178582	75590
.	114835	1.900	0.853	90426	175363	73073
.	114835	2.000	0.898	93438	172274	70670

Input units are thousands and kg - output in tonnes

Table 6.8.1.1. Faroe saithe (Division Vb). Yield per recruit input data.

Age	M	Mat	PF	PM	SWt	Sel	CWt
3	0.2	0.070	0	0	1.306	0.049	1.306
4	0.2	0.219	0	0	1.777	0.164	1.777
5	0.2	0.508	0	0	2.352	0.301	2.352
6	0.2	0.769	0	0	3.042	0.394	3.042
7	0.2	0.906	0	0	3.868	0.417	3.868
8	0.2	0.963	0	0	4.765	0.431	4.765
9	0.2	0.984	0	0	5.575	0.445	5.575
10	0.2	1.000	0	0	6.323	0.451	6.323
11	0.2	1.000	0	0	7.181	0.443	7.181
12	0.2	1.000	0	0	7.784	0.577	7.784
13	0.2	1.000	0	0	8.296	0.504	8.296
14	0.2	1.000	0	0	9.045	0.504	9.045

Weights in kilograms

Table 6.8.1.2. Faroe saithe (Division Vb). Yield per recruit, summary table.

MFYPR version 2a
Run: farSai
Time and date: 10:10 27/04/2010
Yield per results

FMult	Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNosJ	SSBJan	SpwnNosS	SSBSpwn
0	0	0	0	5.5167	22.0295	3.4222	18.261	3.4222	18.261
0.1	0.0341	0.1289	0.6039	4.8747	17.3973	2.8031	13.697	2.8031	13.697
0.2	0.0683	0.2176	0.9356	4.4338	14.4305	2.3838	10.7941	2.3838	10.7941
0.3	0.1024	0.283	1.1293	4.109	12.3877	2.0795	8.8112	2.0795	8.8112
0.4	0.1366	0.3337	1.2471	3.8577	10.9056	1.8479	7.3856	1.8479	7.3856
0.5	0.1707	0.3744	1.3208	3.6563	9.7866	1.6652	6.3199	1.6652	6.3199
0.6	0.2048	0.4079	1.3676	3.4904	8.9149	1.5173	5.4985	1.5173	5.4985
0.7	0.239	0.4362	1.3976	3.3508	8.2183	1.3948	4.8495	1.3948	4.8495
0.8	0.2731	0.4605	1.4167	3.2313	7.6496	1.2917	4.326	1.2917	4.326
0.9	0.3073	0.4816	1.4285	3.1276	7.1772	1.2037	3.8965	1.2037	3.8965
1	0.3414	0.5002	1.4355	3.0364	6.7788	1.1277	3.5388	1.1277	3.5388
1.1	0.3755	0.5167	1.4392	2.9555	6.4382	1.0614	3.2371	1.0614	3.2371
1.2	0.4097	0.5315	1.4406	2.883	6.1439	1.003	2.9799	1.003	2.9799
1.3	0.4438	0.5449	1.4404	2.8177	5.8869	0.9512	2.7583	0.9512	2.7583
1.4	0.478	0.5571	1.4391	2.7583	5.6605	0.9049	2.5659	0.9049	2.5659
1.5	0.5121	0.5682	1.4371	2.704	5.4595	0.8633	2.3973	0.8633	2.3973
1.6	0.5462	0.5785	1.4346	2.6542	5.2797	0.8257	2.2488	0.8257	2.2488
1.7	0.5804	0.588	1.4317	2.6082	5.1179	0.7915	2.1169	0.7915	2.1169
1.8	0.6145	0.5967	1.4286	2.5656	4.9715	0.7604	1.9993	0.7604	1.9993
1.9	0.6487	0.6049	1.4254	2.526	4.8382	0.7318	1.8937	0.7318	1.8937
2	0.6828	0.6126	1.4221	2.489	4.7163	0.7056	1.7985	0.7056	1.7985

Reference	F multiplier	Absolute F
Fbar(4-8)	1	0.3414
FMax	1.2356	0.4218
F0.1	0.4243	0.1449
F35%SPR	0.4924	0.1681
Flow	0.3829	0.1307
Fmed	1.044	0.3564
Fhigh	2.7615	0.9428

Weights in kilograms

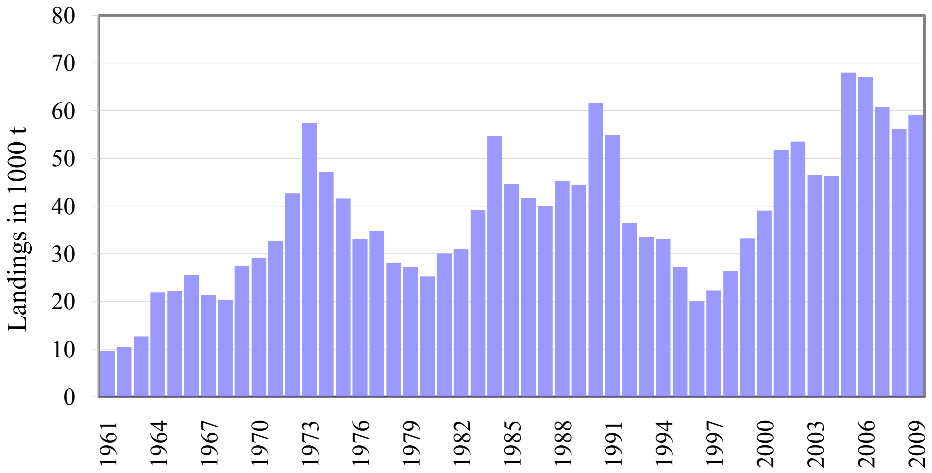


Figure 6.2.1.1. Faroe saithe (Division Vb). Landings in 1000 tonnes.

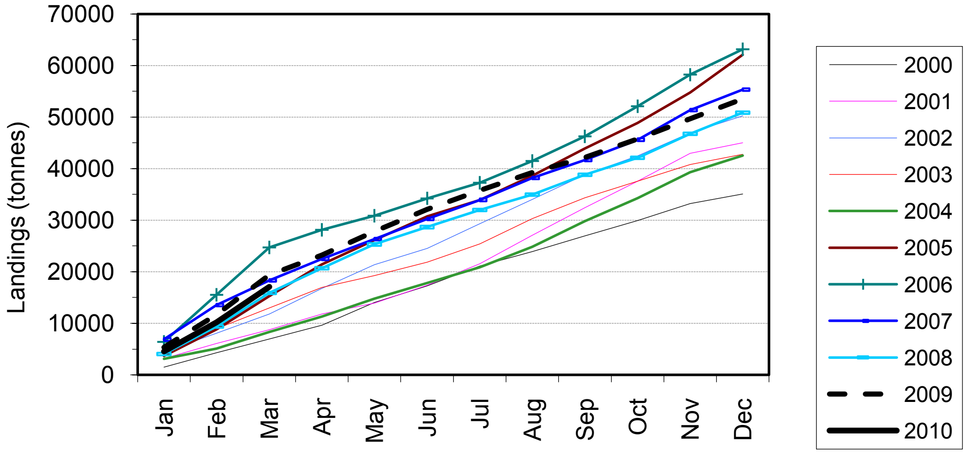


Figure 6.2.1.2. Saithe in the Faroes (Division Vb). Cumulative Faroese landings.

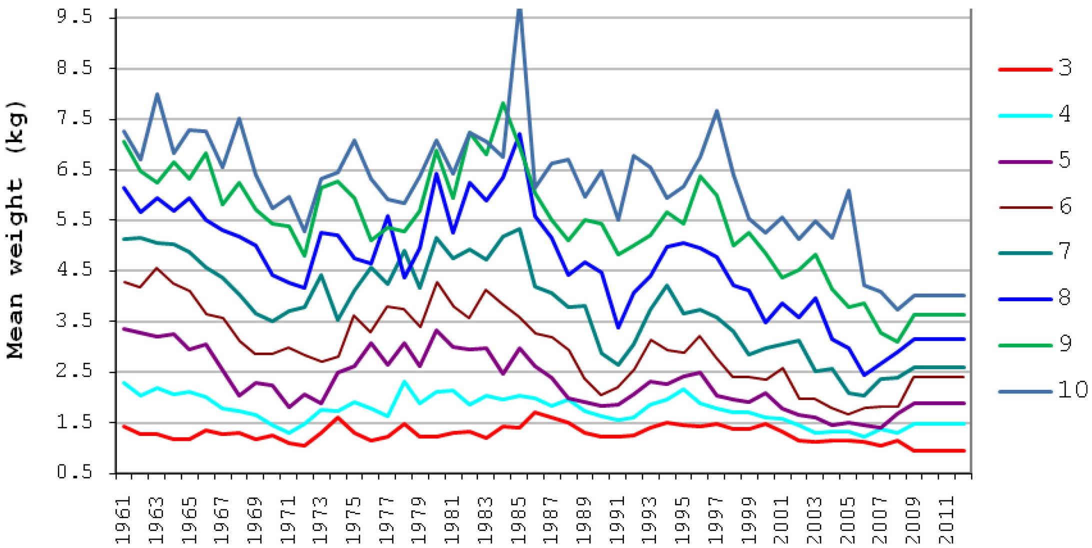


Figure 6.2.3.1. Faroe saithe (Division Vb). Mean weight at age (kg) in commercial catches (ages 3-10) (1961-2012). 2010-2012 values are predicted.

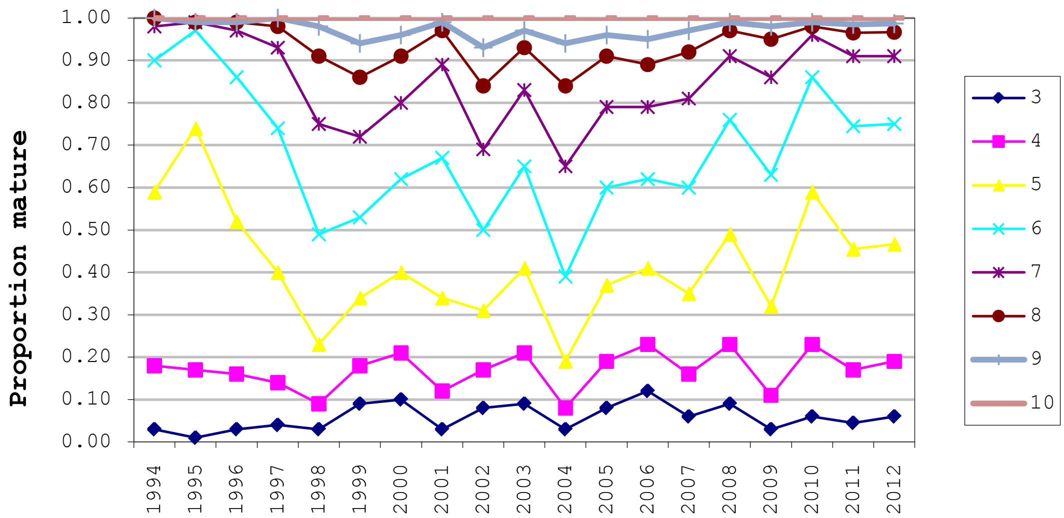


Figure 6.2.4.1. Faroe saithe (Division Vb). Proportion mature at age (ages 3-10) from the spring survey for period 1994-2010. 2011-2012 values are predicted.

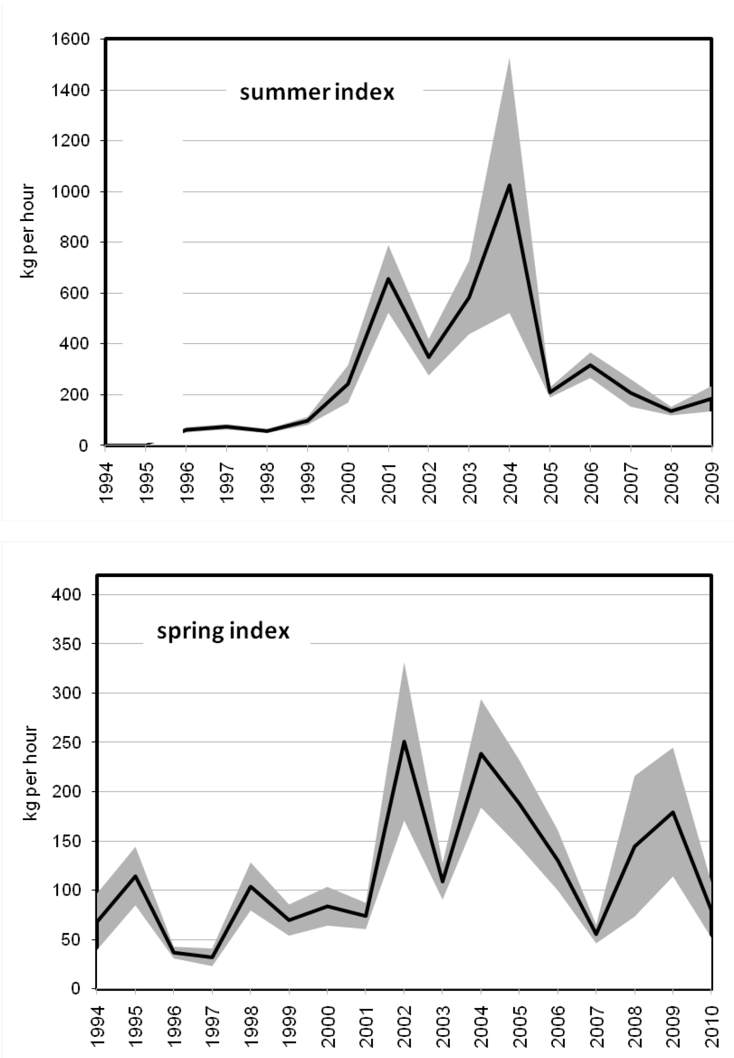


Figure 6.2.5.1.1. Faroe saithe (Division Vb). Catch rates (kg/hour) from the spring (1996-2009) and summer survey (1994-2010)

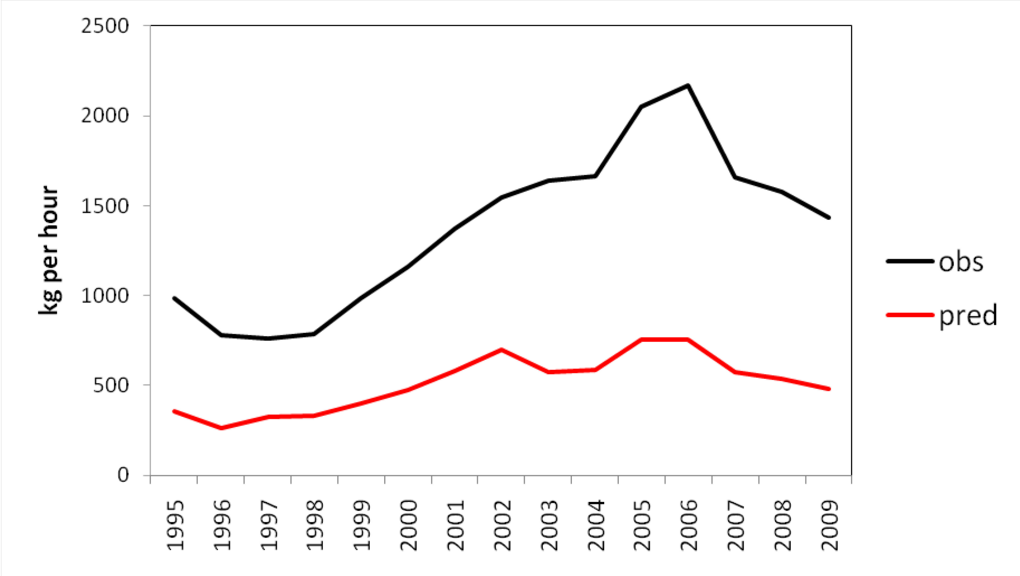


Figure 6.2.5.2.1 Faroe saithe (Division Vb). Observed (black line) and predicted (red line) catch rates (kg per hour) for the commercial fleet (pairtrawlers) used for tunning the assessment

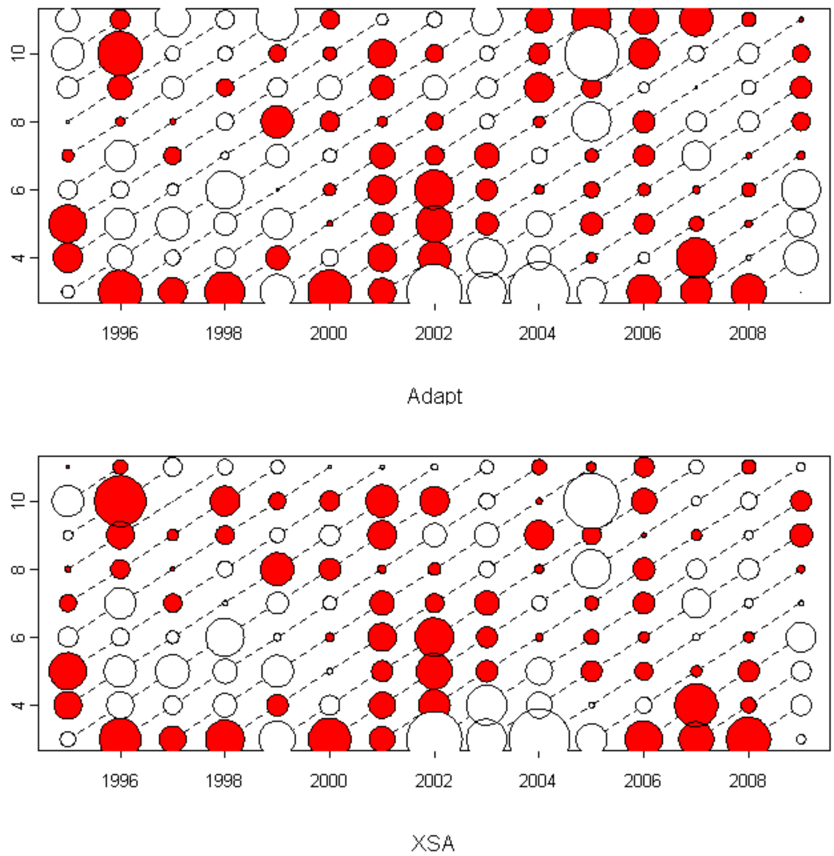


Figure 6.4.1. Faroe saithe (Division Vb). Log-catchability residuals for age groups 3 –11 from Adapt and XSA models.

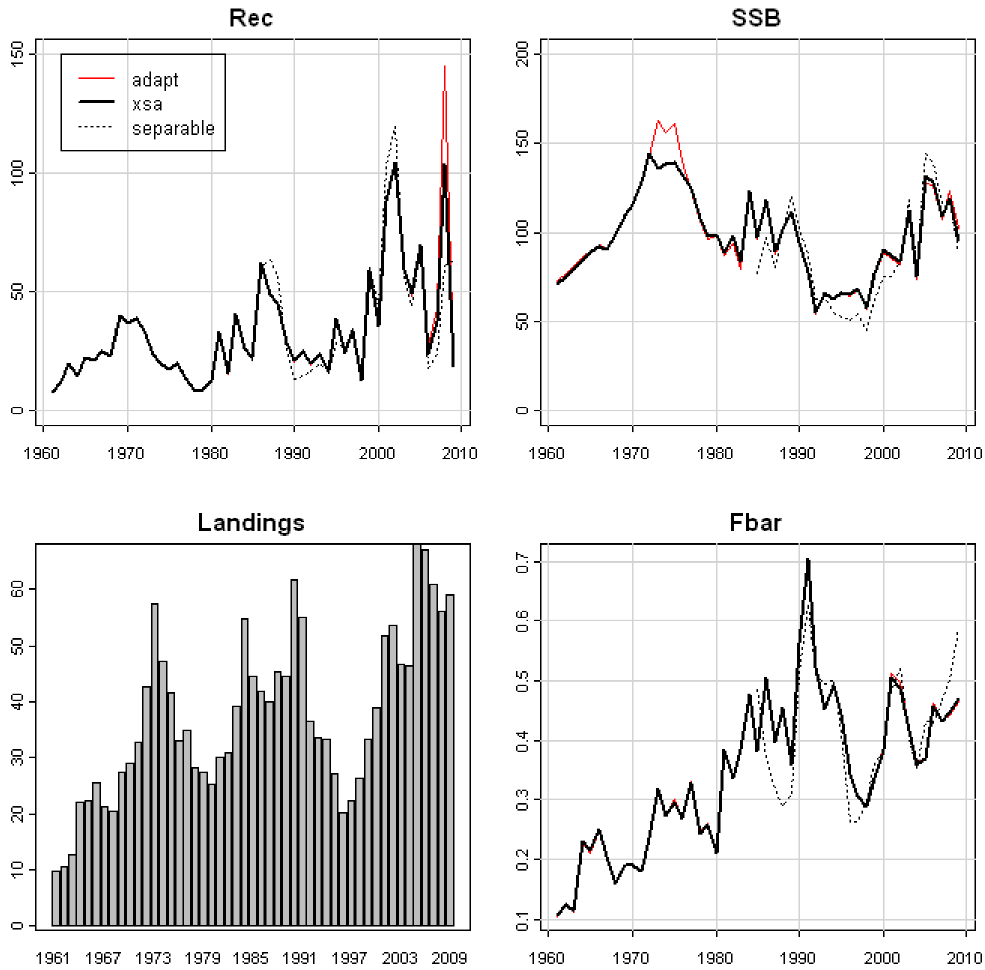


Figure 6.4.2. Faroe saithe (Division Vb). Comparison of different assessment models XSA (thick - black line), Adapt (thick-red line) and statistical separable catch-at-age (dotted line) models

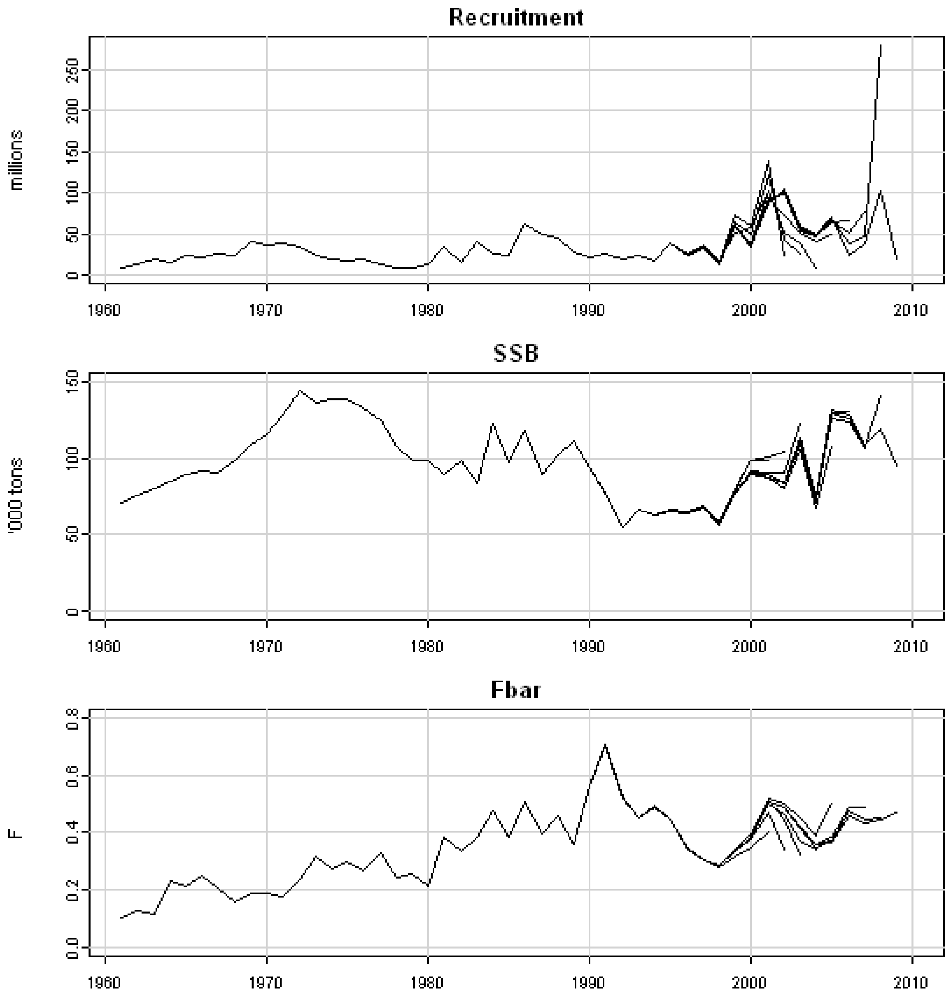


Figure 6.4.3. Faroe saithe (Division Vb). Retrospective analysis of recruitment at age 3, spawning stock biomass and average fishing mortality over age groups 4-8 from the 2010 assessment.

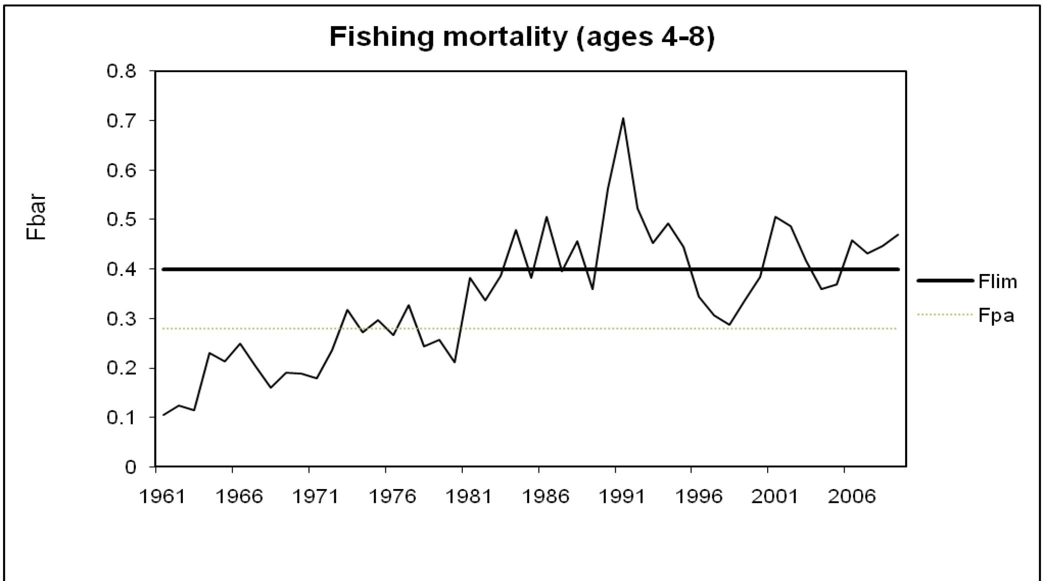


Figure 6.4.4. Faroe saithe (Division Vb). Fishing mortality (average F ages 4-8).

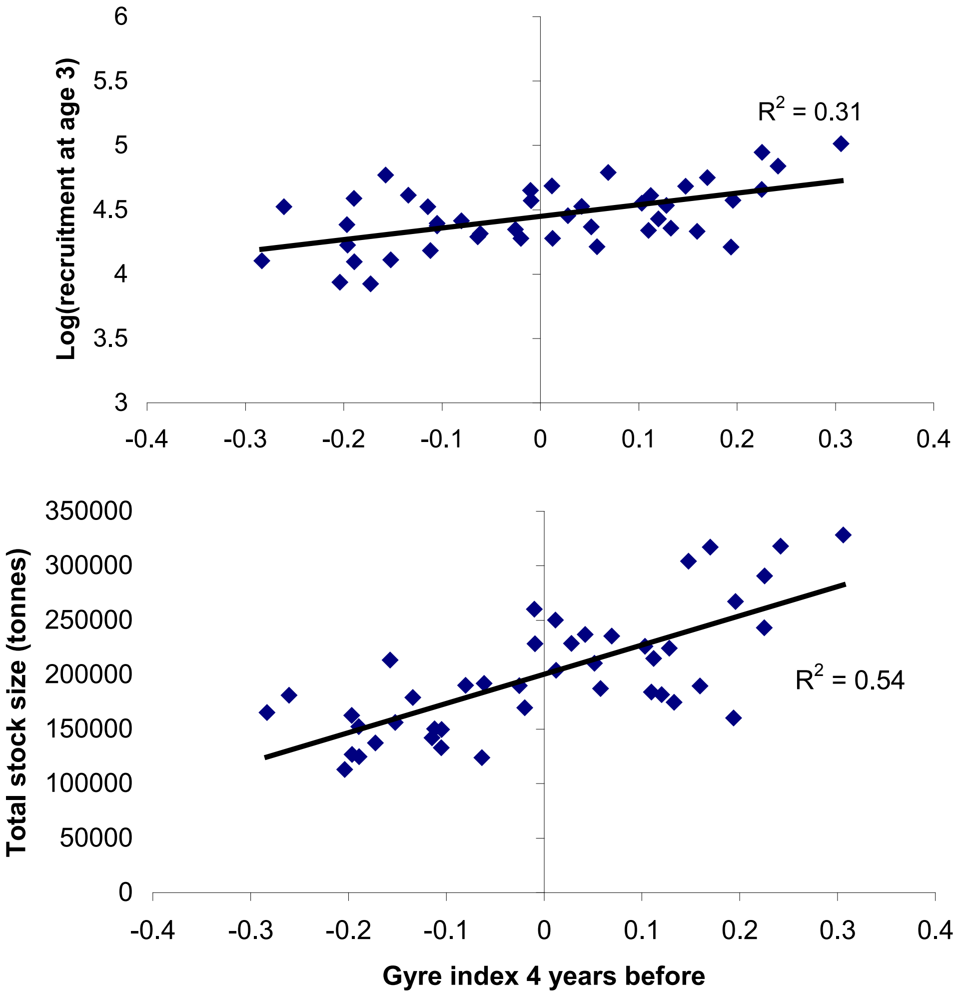


Figure 6.5.1.1. Relationship between the gyre index and both recruitment (top figure) and total stock biomass estimates (bottom figure.) Note that a large gyre index indicates a small subpolar gyre, and, consequently, a large influx of plankton-rich warmer-than-average water to the outer areas (bottom depth > 150 m) around the Faroes, where saithe typically are found.

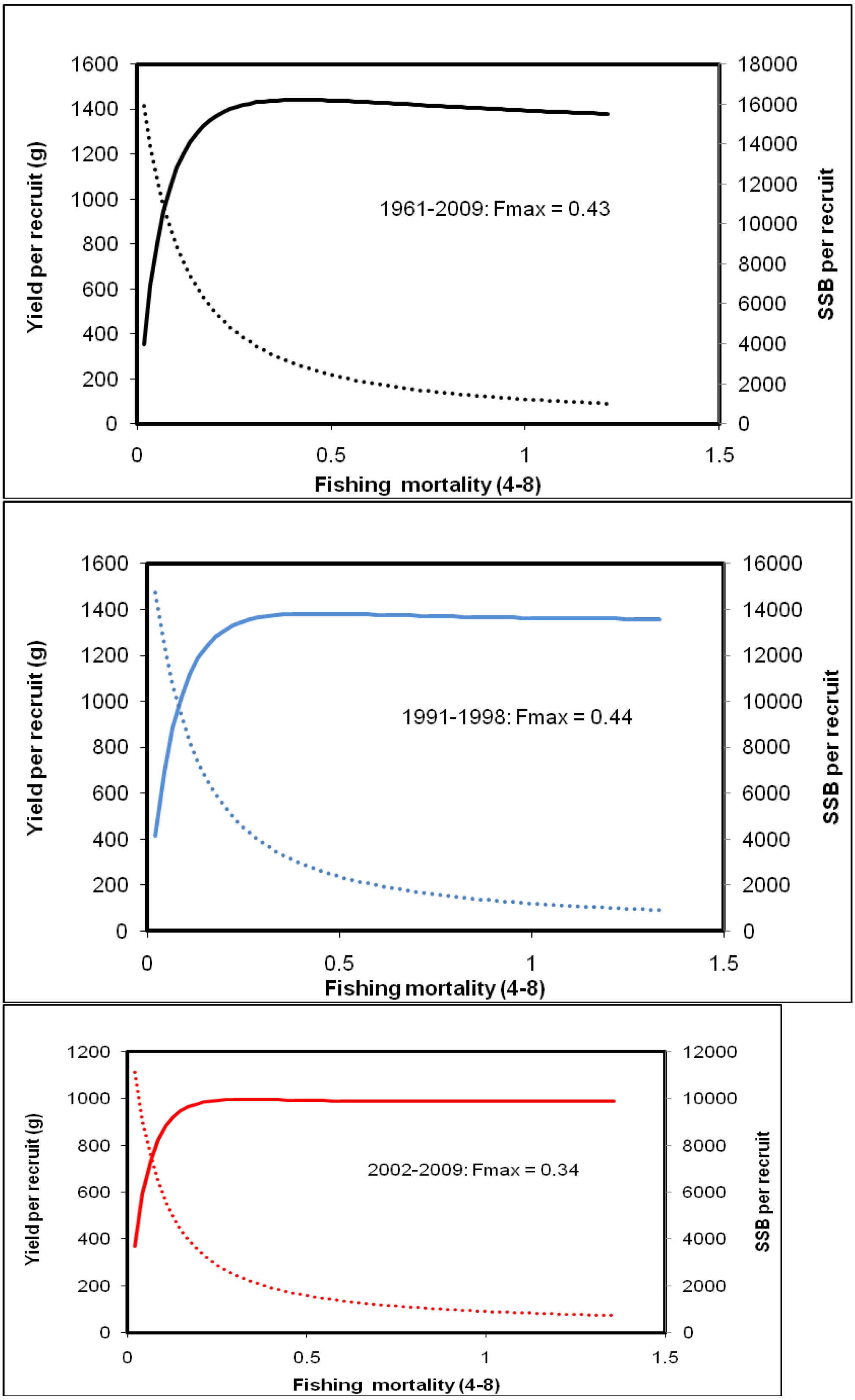


Figure 6.5.1.2. Yield per recruit calculations on the entire historical period (1961-2009) (top figure), for scenario with high-growth (small-stock) situations (1991-1998)(middle figure) and slow-growth (large-stock) situations (2002-2009)(bottom figure.)

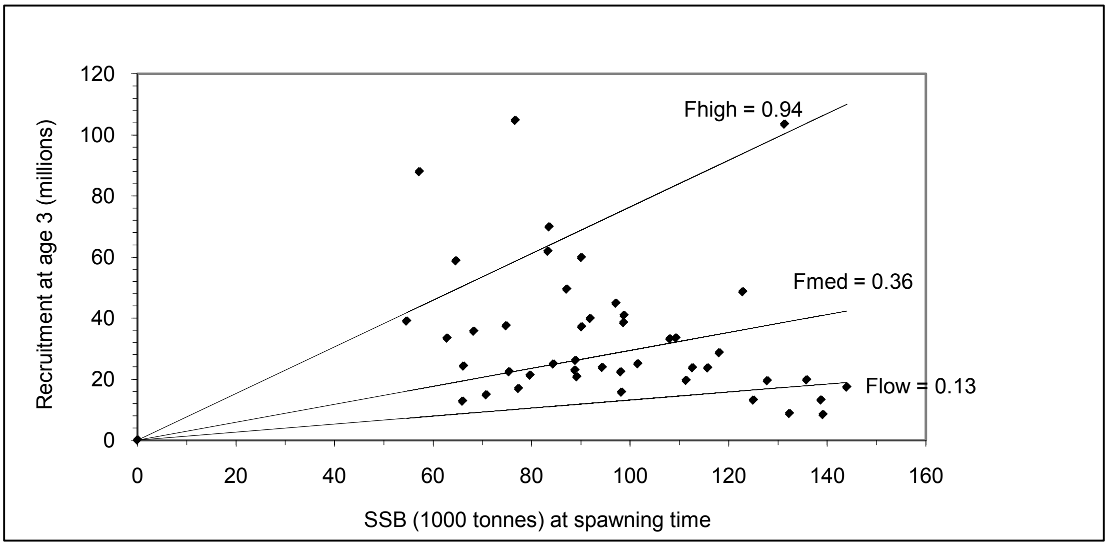


Figure 6.5.1.2. Faroe saithe(Division Vb). Stock-Recruitment plot.

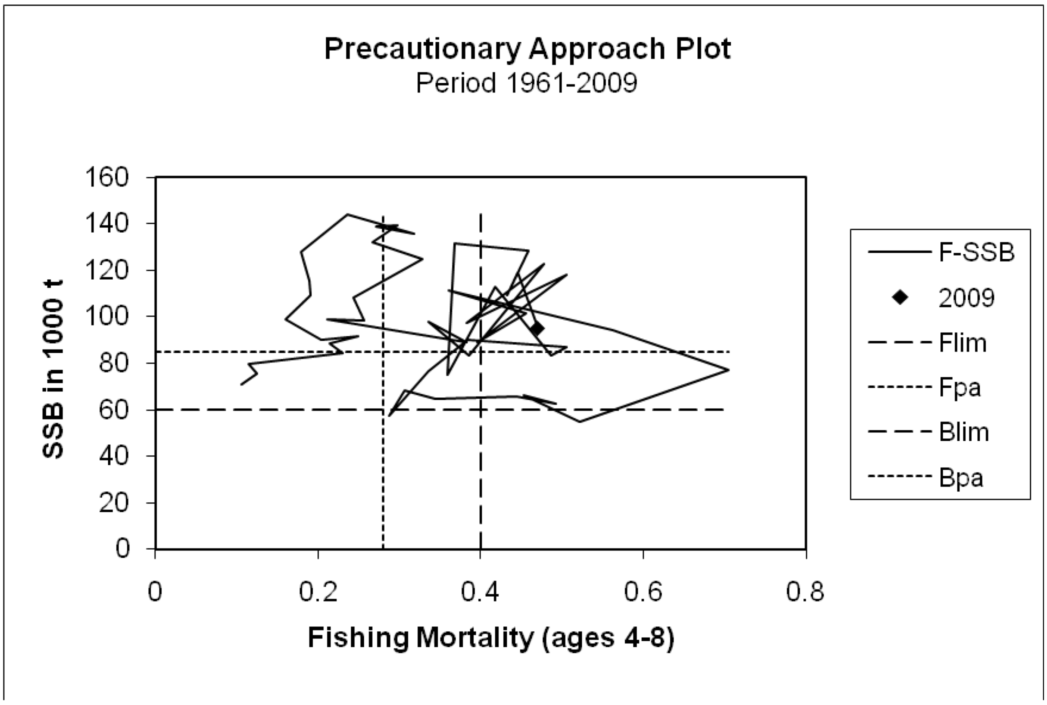


Figure 6.5.1.3. Faroe saithe(Division Vb). Precautionary approach plot, period 1961-2008. The history of the stock/fishery in relation to the four reference points.

Figure 6.6.1. Faroe saithe (Division Vb). Recruitment at age 3 (millions).

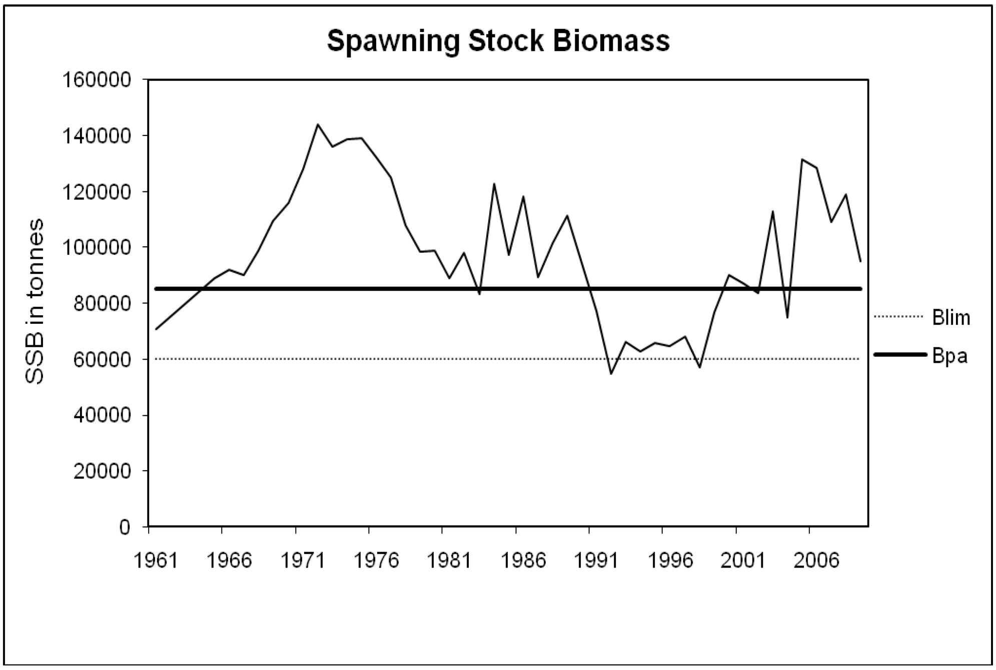


Figure 6.6.2. Faroe saithe (Division Vb). Spawning stock biomass (tonnes).

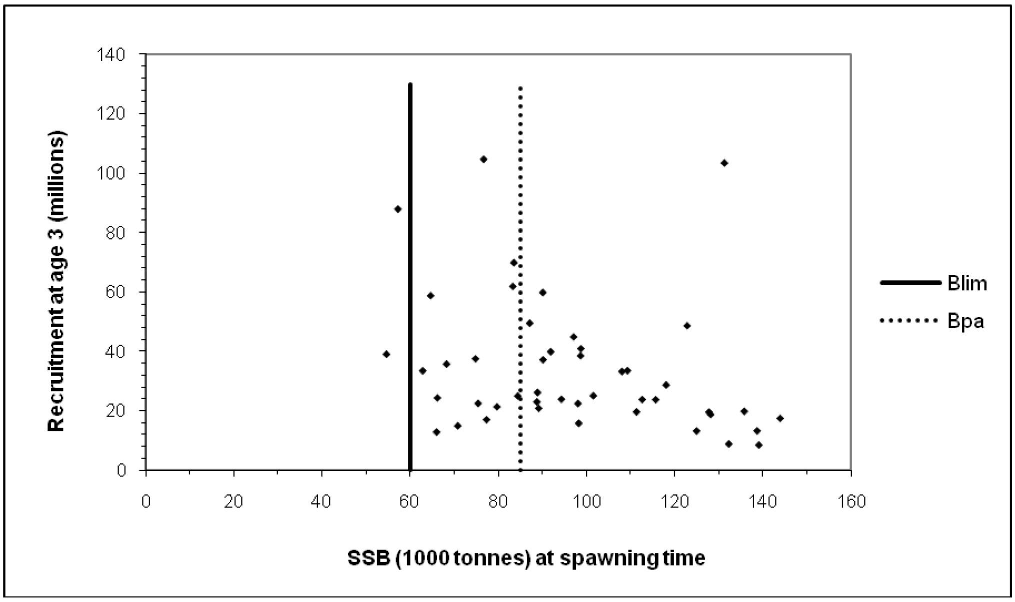


Figure 6.6.3. Faroe saithe (Division Vb). Stock-Recruitment plot.

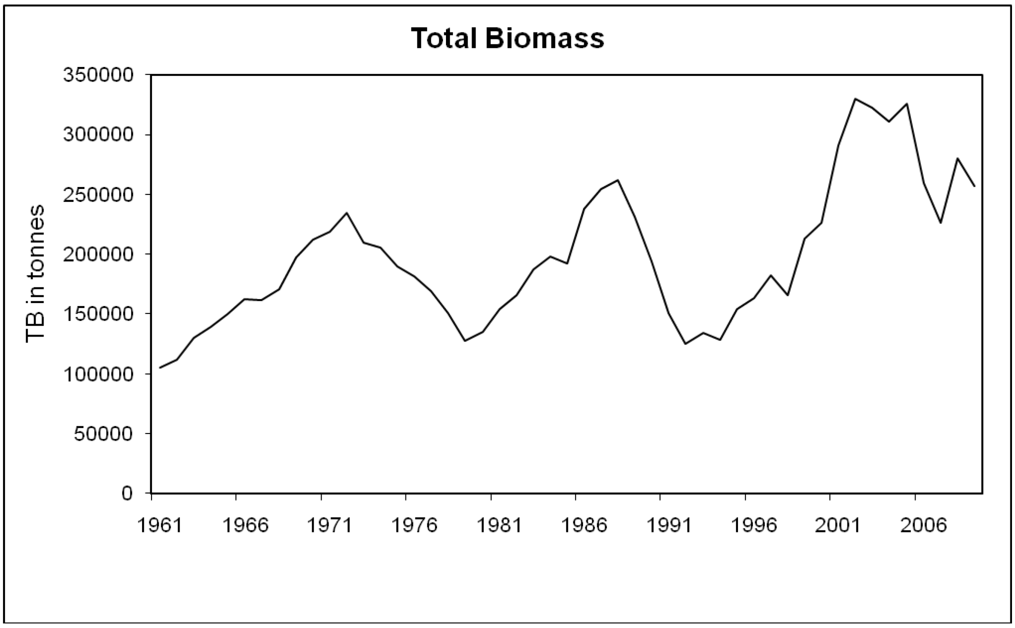
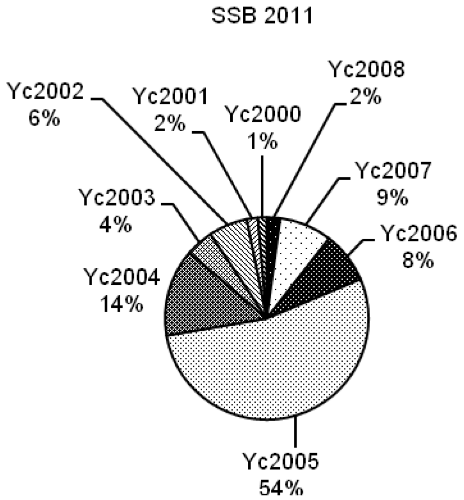


Figure 6.6.4. Faroe saithe (Division Vb). Total biomass (tonnes)



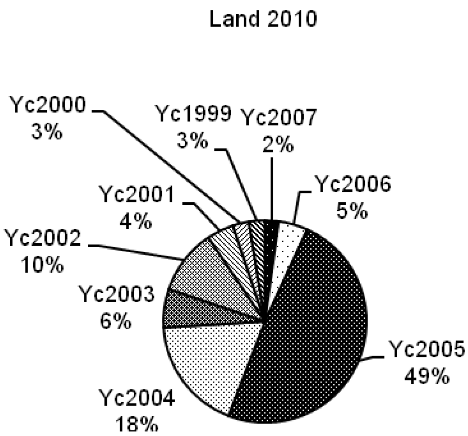


Figure 6.7.1.1. Faroe saithe (Division Vb). Projected composition in landings (upper figure) and SSB (lower figure) by year classes.

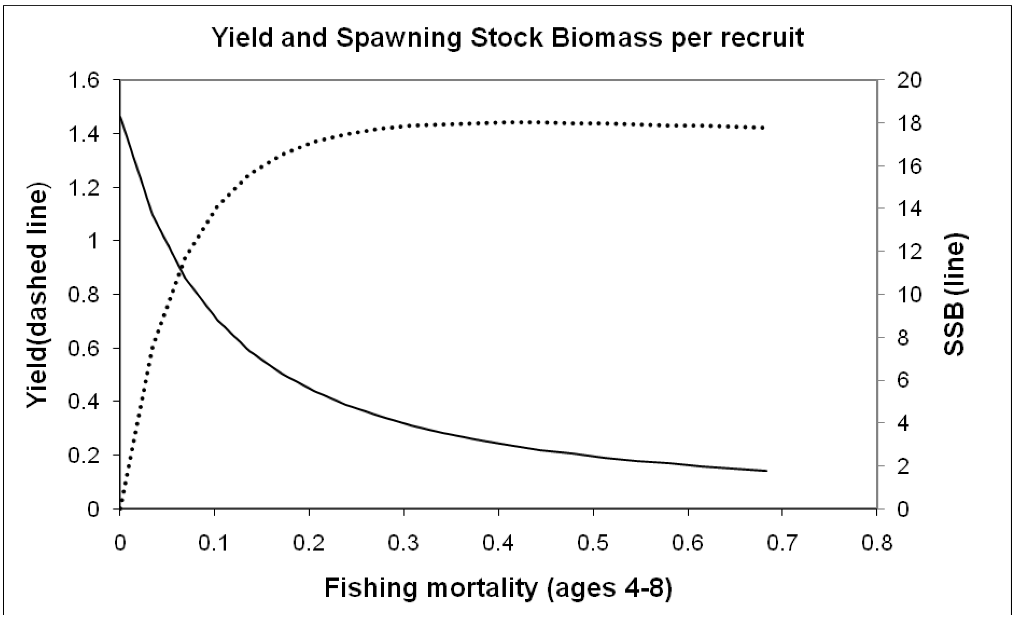


Figure 6.8.1.1. Faroe saithe (Division Vb). Yield- and spawning per recruit analysis.

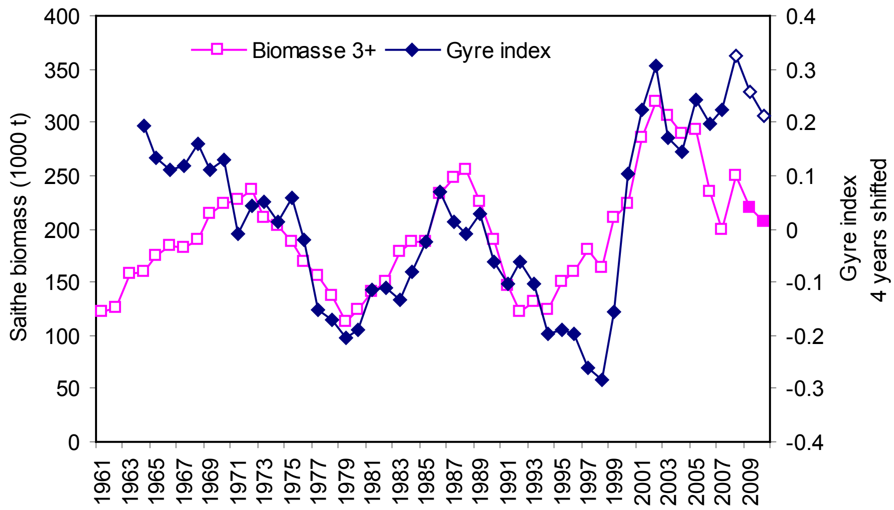


Figure 6.16.1. Faroe saithe (Division Vb). Relationship between the Gyre index (4 years shifted) and saithe biomasse (age 3+) in Faroese waters. Values for 2009-2010 are taken from the short term prediction.

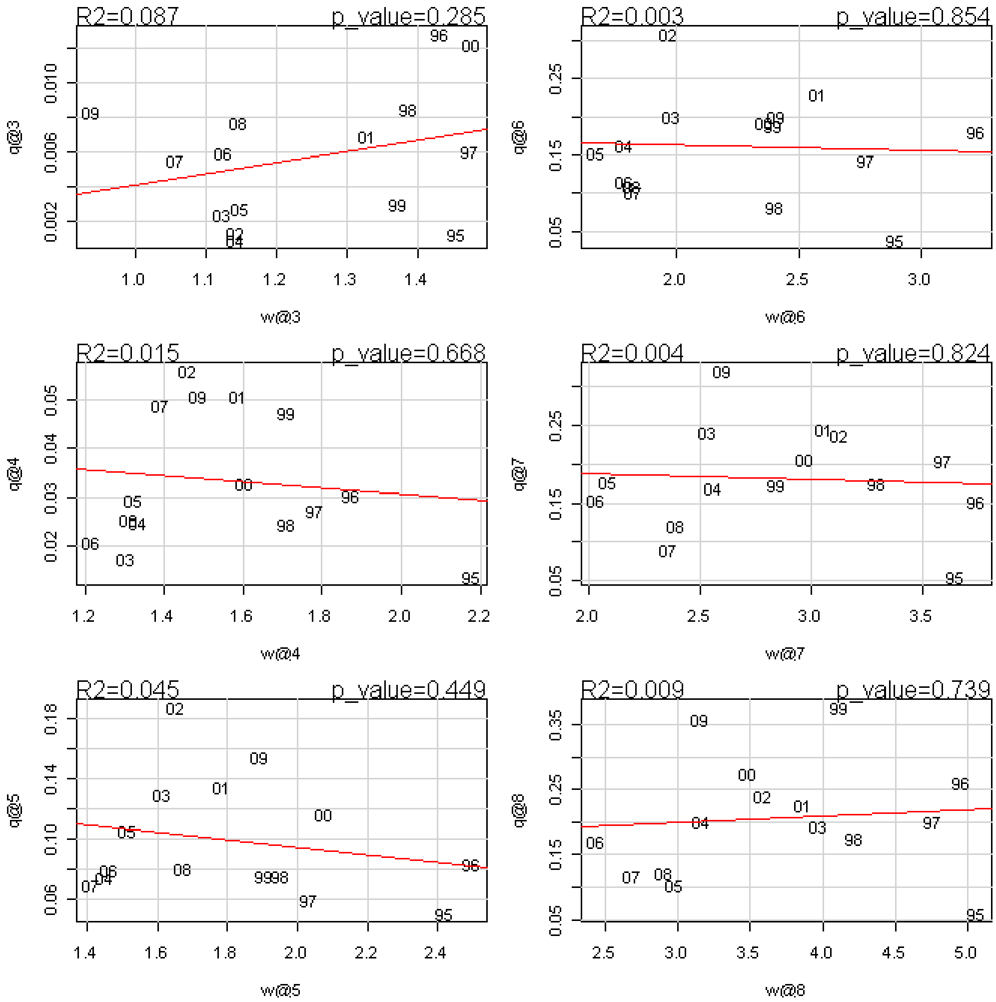


Figure 6.9.1.1. Faroe saithe (Division Vb). Relation between weight-at-age (x-axis) and catchability at-age (y-axis.)

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 this is reflected in the topography around the country. Generally hard bottom is found in shallower areas while softer sediments dominate in the throughs and outside the continental slope. The shelf around Iceland is narrowest off the south coast and is cut by submarine canyons around the country.(Figure 7.3.4)

The Polar Front lies west and north of Iceland and separates the cold and southward flowing waters of Polar origin from the northward flowing waters of Altantic origin. South and east of Iceland the North Atlantic Current flows towards the Norwegian Sea. The Irminger Current is a branch of the North Atlantic Current and flows northwards over and along the Reykjanes Ridge and along the western shelf brake. In the Denmark Strai it divides into a branch that flows northeastward and eastward to the waters north of Iceland and another branch that flows south-westwards along 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, which is part of a cyclonic gyre in the Iceland Sea., and continues into the Norwegian Sea along the Atlantic water flowing eastwards over the Iceland-Faroes Ridge (Stefansson 1962, Valdimarsson and Malmberg 1999).

The Icelandic Shelf is a high (150-300 gC/m2-yr) productivity ecosystem according to 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 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)

After 1996 a rise in both temperature and salinity were observed in the Atlantic water south and west of Iceland. Temperature and salinity have remained at similar high levels 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 notorious changes for Atlantic water in this area. Off central N-Iceland similar changes have been observed although with higher interannual variability. This period has been characterized with an increase of temperature and salinity in the winter 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. 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 7.3.3. and 7.3.4.). 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 East and then West-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 West-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 West-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 2007 amounted to 1.4 million tonnes where pelagic fishes amounted to 0.9 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	60	Pelagic and bottom trawl
Vessels > 100 t	145	Purse seine, longline, trawl, gillnet
Vessels > 10< 100 t	312	Gillnet, longline, danish seine, trawl, jiggers
Vessels < 10 t	312	Jiggers, longline
Open boats	700	Jiggers, longliners (including recreational fishers)
Total	1469	

[1)]*Source: Statistic Iceland - http://www.statice.is/*

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, blue whiting and mackerel 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 and mackerel is exclusively carried out with pelagic trawl. Additionally 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 <45 cm haddock and 20% or more of <33 cm redfish). If, in a given area, there are several consecutive quick closures the Minister of Fisheries can with regulations close the area for longer time forcing the fleet to operate in other areas. Inspectors from the

Directorate of Fisheries supervise these closures in collaboration with the Marine Research Institute. In 2008, 93 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 negligible 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. Unpublished report 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 by-catch 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

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Table 7.1 Overview of the 2008 landings of fish and marine invertebrates caught by the Icelandic fleet categorized by gear types. Based on landing statistics from the Directorate of Fisheries. Landings are given in tonnes.

Species/gear	Bottom Trawl	Danish seine	Pelagic trawl	Jiggers	Neprops trawl	Dredge	Long line	Purse seine	Gillnets	Shrimp trawl	Other	Total
Herring	0	0	222,308	0	0	0	0	148,506	0	0	0	370,814
Blue whitting	0	0	163,794	0	0	0	0	0	0	0	0	163,794
Cod	64,451	8,428	99	3,569	792	0	53,880	15	19,511	422	336	151,504
Capelin	0	0	24,948	0	0	0	0	124,083	0	0	0	149,031
Atlantic mackerel	0	0	112,336	8	0	0	0	8	0	0	0	112,352
Haddock	51,650	16,409	53	16	219	0	33,060	2	944	33	15	102,402
Saithe	59,143	1,172	252	2,468	104	0	617	2	6,359	0	25	70,142
golden redfish	48,214	527	13	43	300	0	1,017	0	154	1	1	50,269
deepwater redfish	19,374	0	6	0	0	0	3	0	0	0	0	19,384
common wolffish	7,046	1,642	1	10	79	0	5,808	0	54	0	7	14,648
Greenland halibut	10,621	0	147	0	0	0	22	0	715	193	0	11,698
greater argentine	8,774	0	264	0	0	0	0	0	0	0	0	9,038
Ling	1,509	291	1	8	416	0	5,002	0	510	0	1	7,738
Iceland cyprine	0	0	0	0	0	7,629	0	0	0	0	0	7,629
Tusk	114	0	0	5	12	0	6,756	0	45	0	1	6,934
Offshore redfish	2,958	0	3,828	0	0	0	0	0	0	0	0	6,786
European plaice	2,603	3,832	0	0	3	0	87	0	198	1	1	6,726
Blue ling	2,082	54	1	0	29	0	1,454	0	33	0	0	3,654
Monk fish	381	475	0	0	341	0	62	0	1,687	0	0	2,947
lemon sole	1,318	1,282	0	0	31	0	0	0	2	0	0	2,635
Shrimp	0	0	0	0	1	0	0	0	0	2,197	0	2,198
spotted wolffish	1,004	7	1	0	2	0	1,073	0	7	8	0	2,101
Nephrops	3	0	0	0	2,068	0	0	0	0	0	0	2,070
Whiting	928	151	0	1	21	0	557	0	29	1	1	1,688
witch flounder	102	1,166	0	0	158	0	0	0	1	0	1	1,428
Lumpfish roe	0	0	0	0	0	0	0	0	1,345	0	0	1,345
sea cucumber	0	0	0	0	0	1,051	0	0	0	0	0	1,051
common dab	24	759	0	0	0	0	7	3	4	0	0	798
starry ray	59	93	0	0	0	0	470	0	13	1	0	636
Atlantic halibut	180	46	0	1	14	0	242	0	18	0	0	502
Whelk	0	0	0	0	0	0	0	0	0	0	398	398
long rough dab	50	211	0	0	1	0	15	0	1	0	0	278
sailfluke	34	126	0	0	36	0	0	0	0	0	0	197
Skate	24	37	0	0	4	0	26	0	33	1	0	127
Sea urchin	0	0	0	0	0	123	0	0	0	0	3	126
dogfish	3	11	0	0	0	0	32	0	23	0	0	68
Mueller's bristlemouth fish	0	0	49	0	0	0	0	0	0	0	0	49
Shark	32	0	0	0	0	0	8	0	0	1	0	42
female lumpfish	12	2	16	0	0	0	0	0	9	0	0	39
male lumpfish	2	2	0	0	0	0	0	0	33	0	0	37
rock grenadier	29	0	0	0	0	0	0	0	0	0	0	29
redfish	15	0	0	0	0	0	3	0	0	0	0	18
Not itemized by species	11	0	0	0	0	0	1	0	0	0	0	12
sharp-nosed skate	0	0	0	0	0	0	9	0	0	0	0	10
Squid	7	0	0	0	0	0	0	0	0	0	0	7
Fuller's ray	0	0	0	0	0	0	4	0	0	0	0	4
orange roughy	4	0	0	0	0	0	0	0	0	0	0	4
blue mussel	0	0	0	0	0	3	0	0	0	0	0	3
black sea bream	0	0	0	0	0	0	1	0	0	0	0	2
white hake	0	0	0	0	0	0	1	0	0	0	0	2
rat-tail	0	0	0	0	0	0	1	0	0	0	0	1
porbeagle	0	0	0	0	0	0	0	0	0	0	0	1
grey gurnard	0	1	0	0	0	0	0	0	0	0	0	1
Harbour crab	0	0	0	0	0	0	0	0	0	0	0	1
green pollack	0	0	0	0	0	0	0	0	0	0	0	1
greater forkbeard	0	0	0	0	0	0	1	0	0	0	0	1
Total	282,762	36,725	528,119	6,131	4,636	8,807	110,222	269,318	31,730	2,859	789	1,285,399

Table 7.2. Estimates of discard of cod and haddock in the Icelandic fisheries in 2008. Source: Ólafur K. Pálsson, Höskuldur Björnsson, Ari Arason, Eyþór Björnsson, Guðmundur Jóhannesson og Þórhallur Ottesen 2008. Discards in demersal Icelandic fisheries 2008. Marine Research Institute, report series (manuscript for printing).

	Gear	*Landings (tonnes)*	*Discards*		
			Numbers (thous.)	*Weight (tonnes)*	% Weight
COD	Longline	53878	621	425	0.79
	Gillnet	19112	28	45	0.23
	Danish Seine	8417	194	94	1.12
	Bottom trawl	56853	606	526	0.92
	Total	**138260**	**1449**	**1090**	**0.79**
HADDOCK	Longline	33056	722	478	1.45
	Danish Seine	16406	1536	895	5.46
	Bottom trawl	50906	1144	562	1.1
	Total	**100368**	**3402**	**1935**	**1.93**

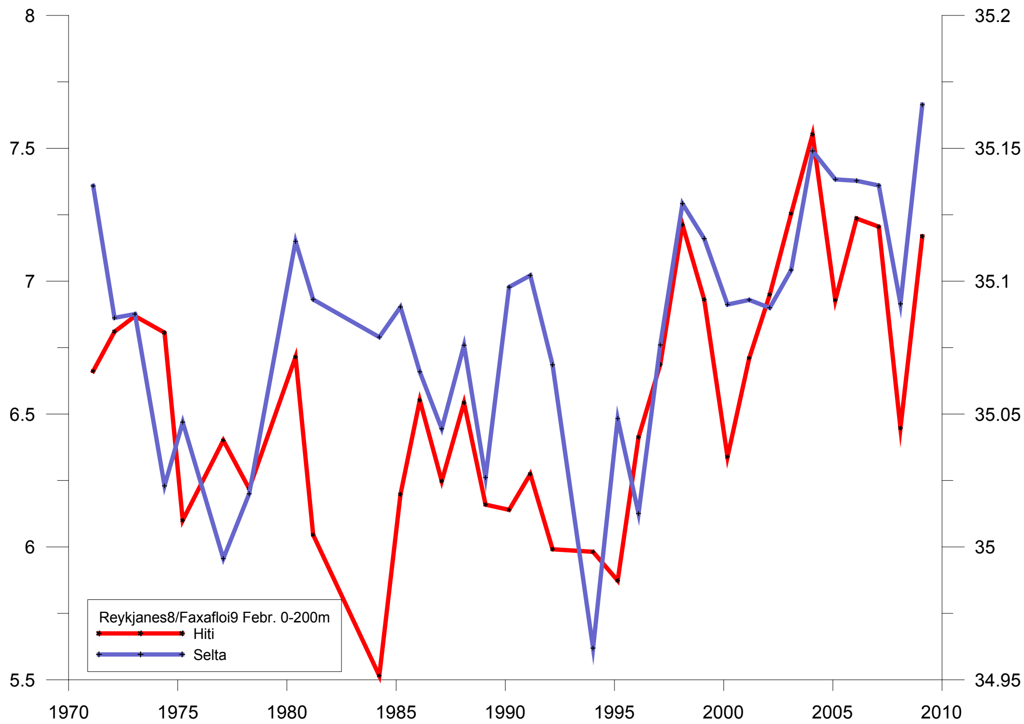


Figure 7.3.1. Temperature and salinity in winter west of Iceland 1971-2009. Mean 0-200m

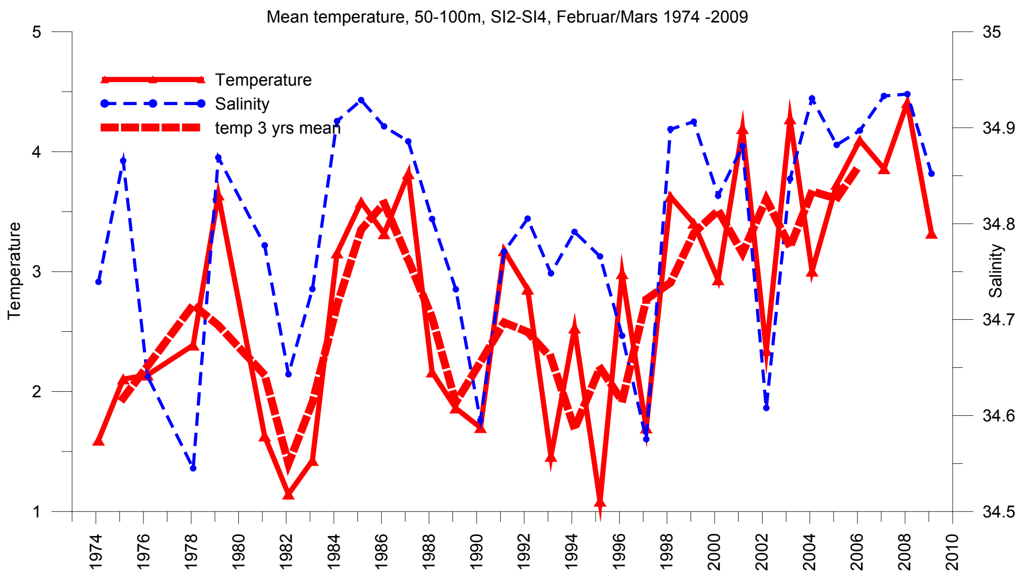


Figure 7.3.2. Temperature and salinity off central North-Iceland 1974-2009.

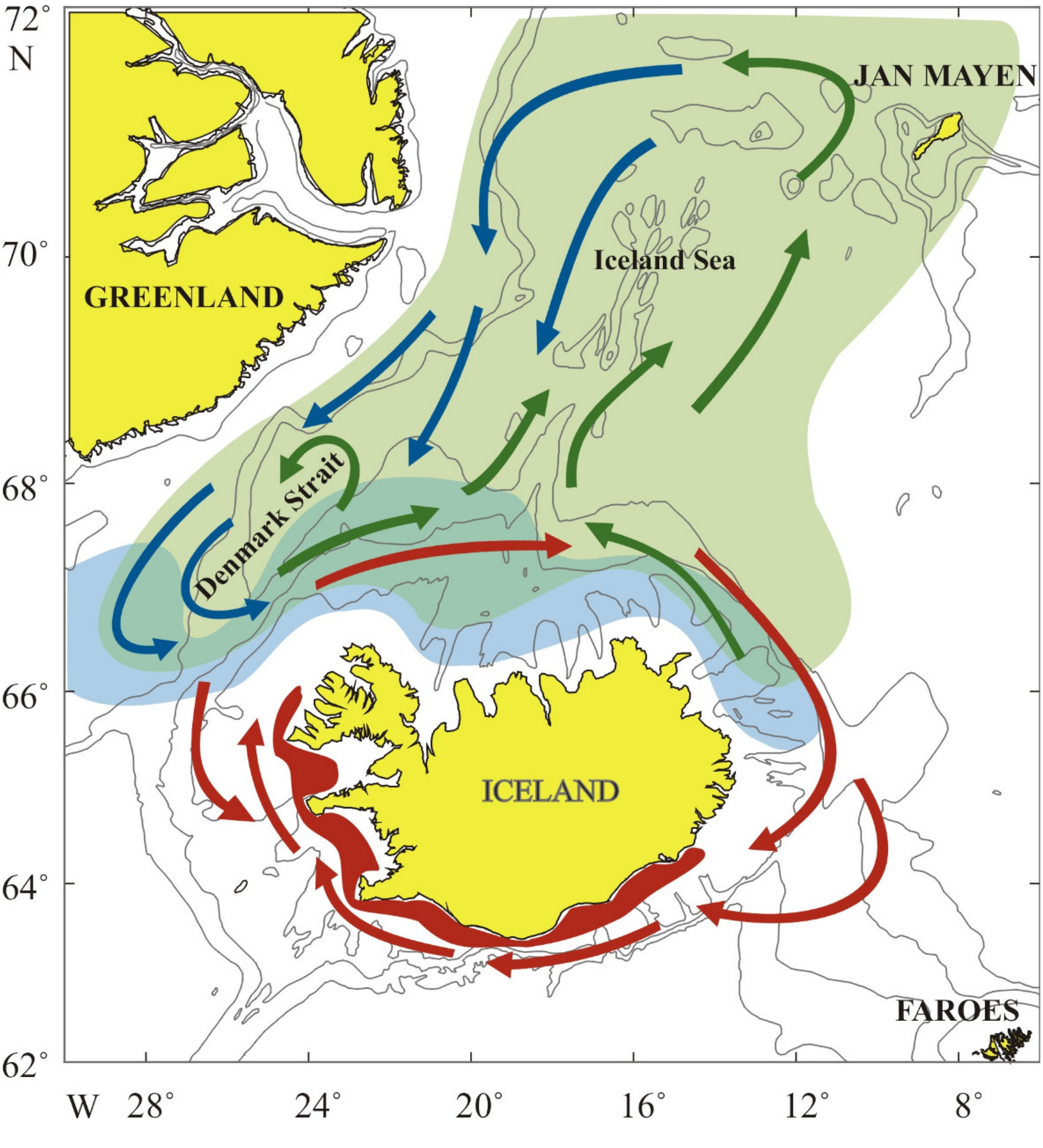


Figure 7.3.3. Distribution and migrations of capelin in the Iceland/East-Greenland/Jan Mayen area before 2001. Red: Spawning grounds; Green: Adult feeding area; Blue: Distribution and feeding area of juveniles; Green arrows: Adult feeding migrations; Blue arrows: Return migrations; Red arrows: Spawning migrations; Depth contours are 200, 500 and 1000 m (Vilhjalmsson 2002)

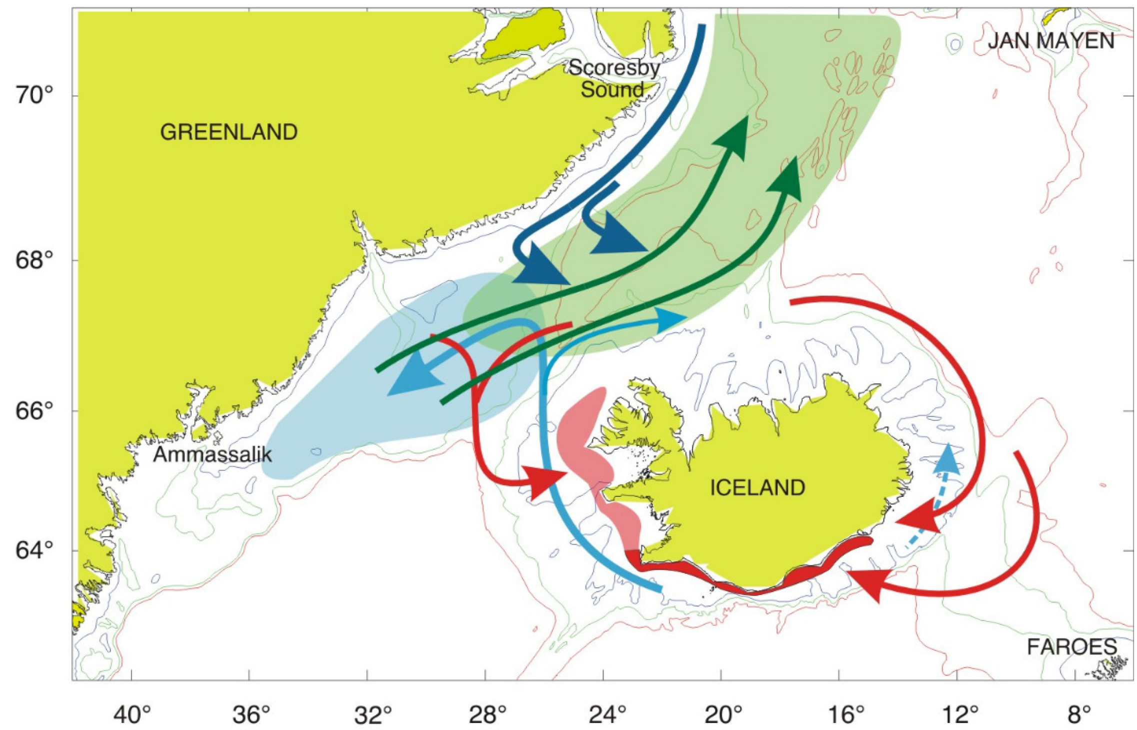


Figure 7.3.4. Likely changes of distribution and migration routes of capelin in the Iceland/Greenland/Jan Mayen area in the last 3-4 years. Green: Feeding area; Light blue: Juvenile area; Red area: Main spawning grounds; Lighter red colour: Lesser importance of W-Iceland spawning areas; Light blue arrows: Larval drift; Dark green arrows: Feeding migrations; Dark blue arrows: Return migrations; Red arrows: Spawning migrations. Depth contours are 200, 500 and 1000 m.

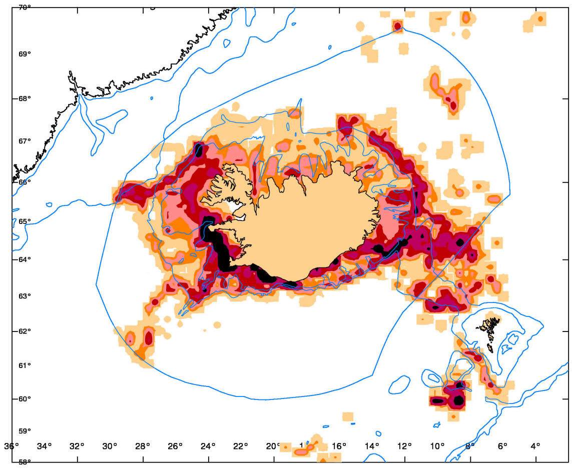


Figure 7.4.1. Distribution of total catch of all species by the Icelandic fishing fleet in Icelandic EEZ and adjacent waters in 2008. The Icelandic EEZ is shown as a blue, contour lines indicate 500 and 1000 m depth.

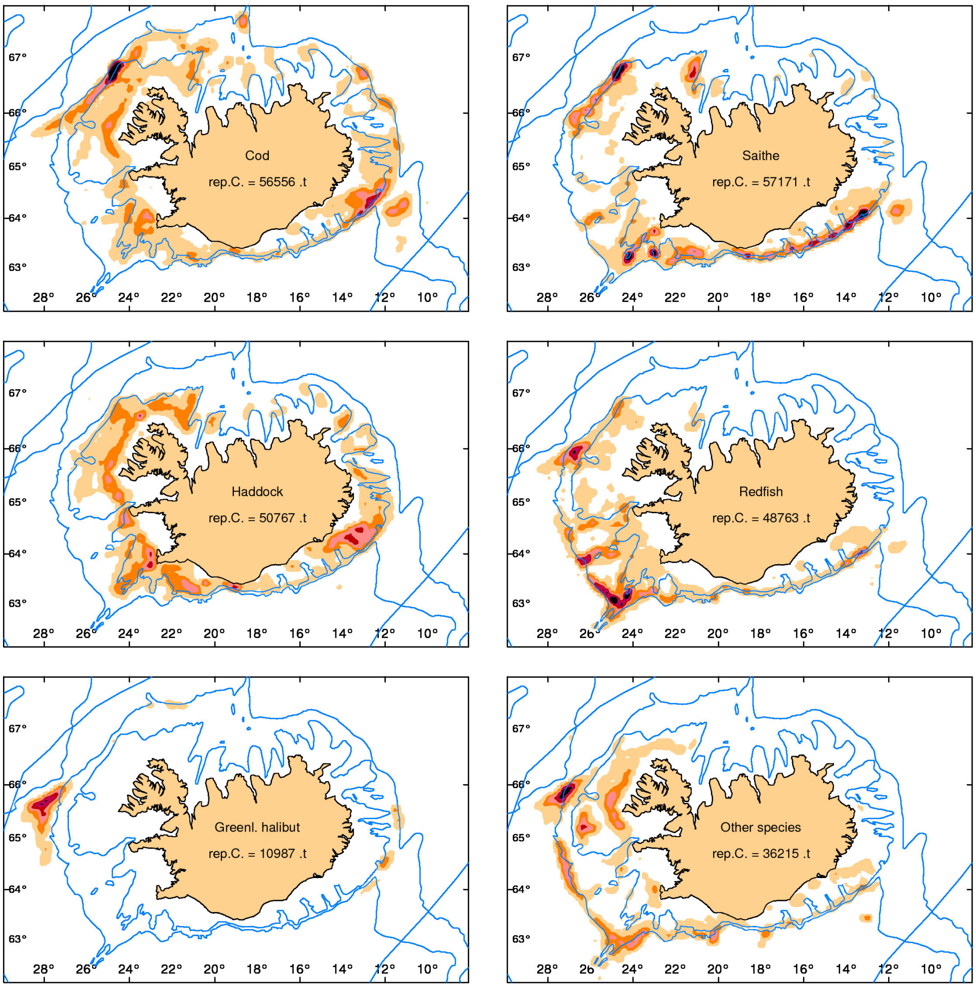


Figure 7.4.2. Location of catches of cod, saithe, haddock, redfish, Greenland halibut and others caught with bottom trawl 2008.

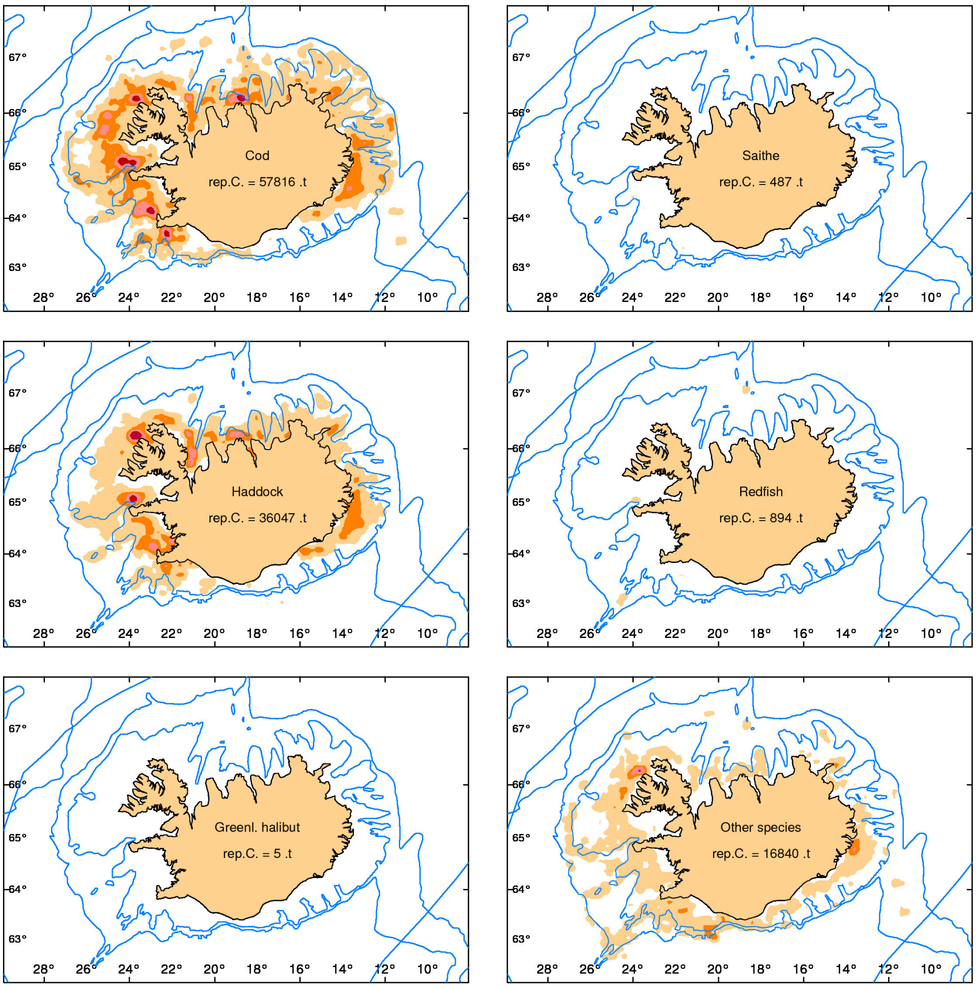


Figure 7.4.3. Location of catches of cod, saithe, haddock, redfish, Greenland halibut and others caught with long-line in 2008.

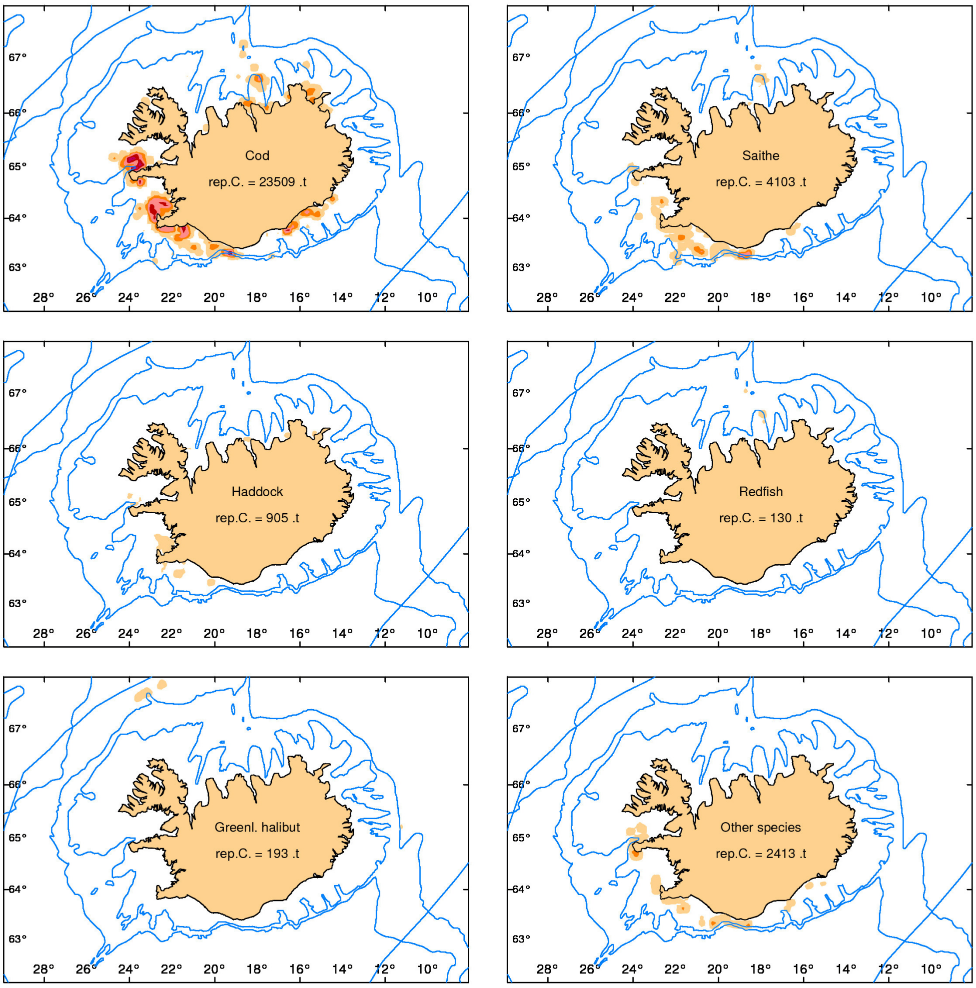


Figure 7.4.4. Location of catches of cod, saithe, haddock, redfish, Greenland halibut and others caught with gillnets in 2008.

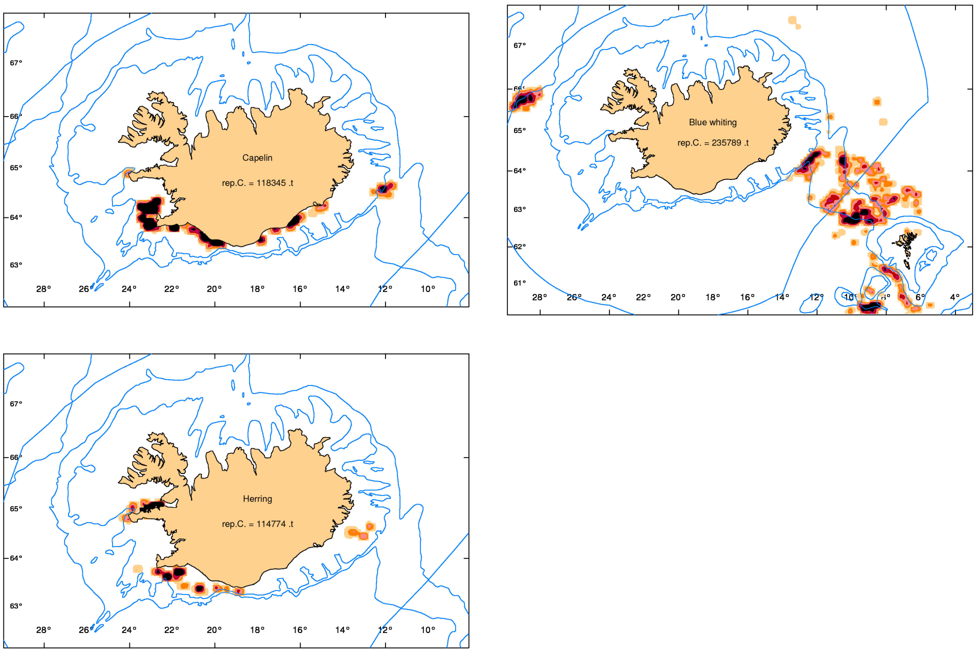


Figure 7.4.5. Location of catches of capelin, Icelandic summer spawning herring and blue whiting with purse seine and pelagic trawls in 2008.

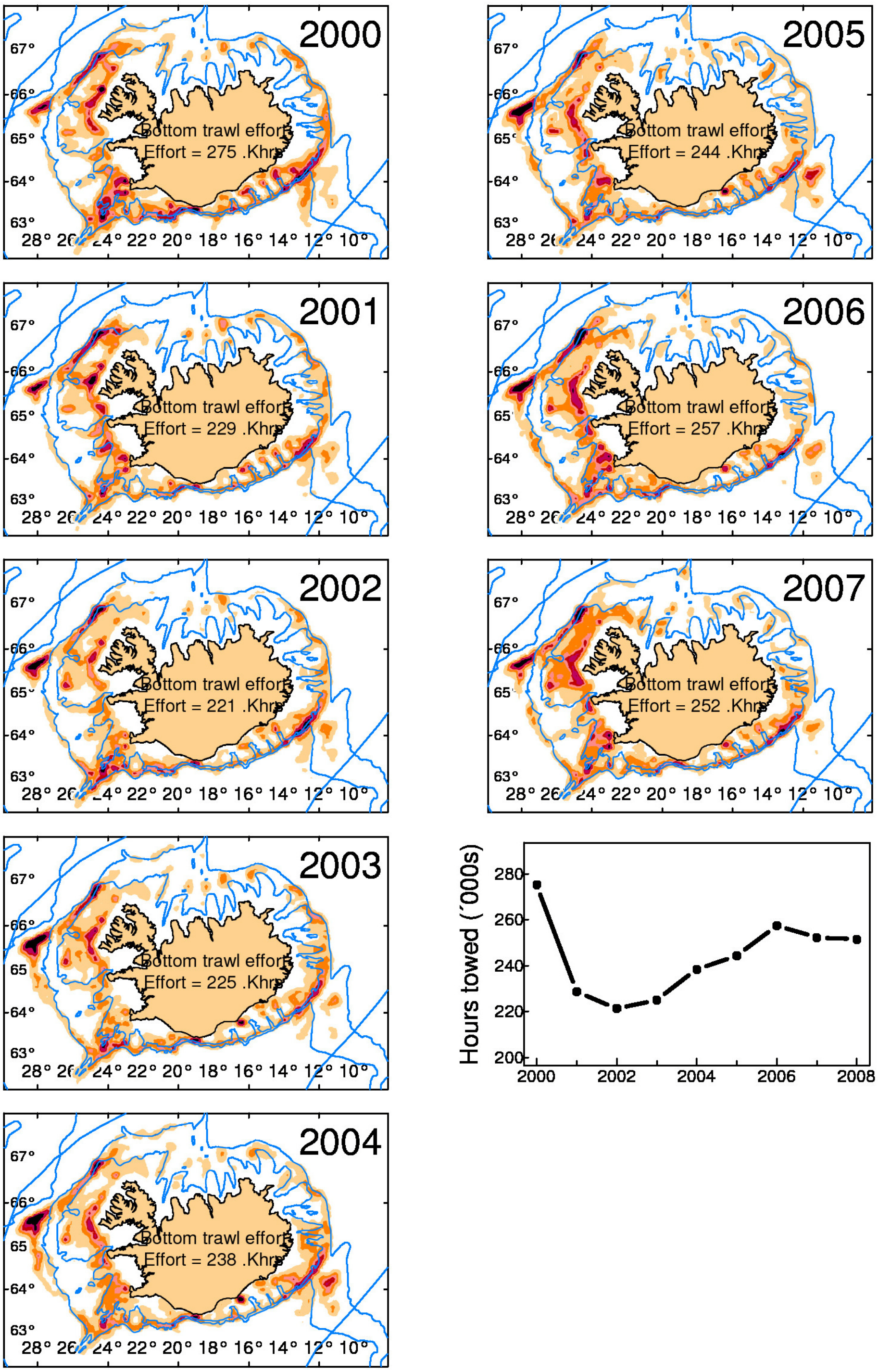


Figure 7.4.6 Spatial distribution of the trawler fleet effort (in hours trawled) in 2000-2008.

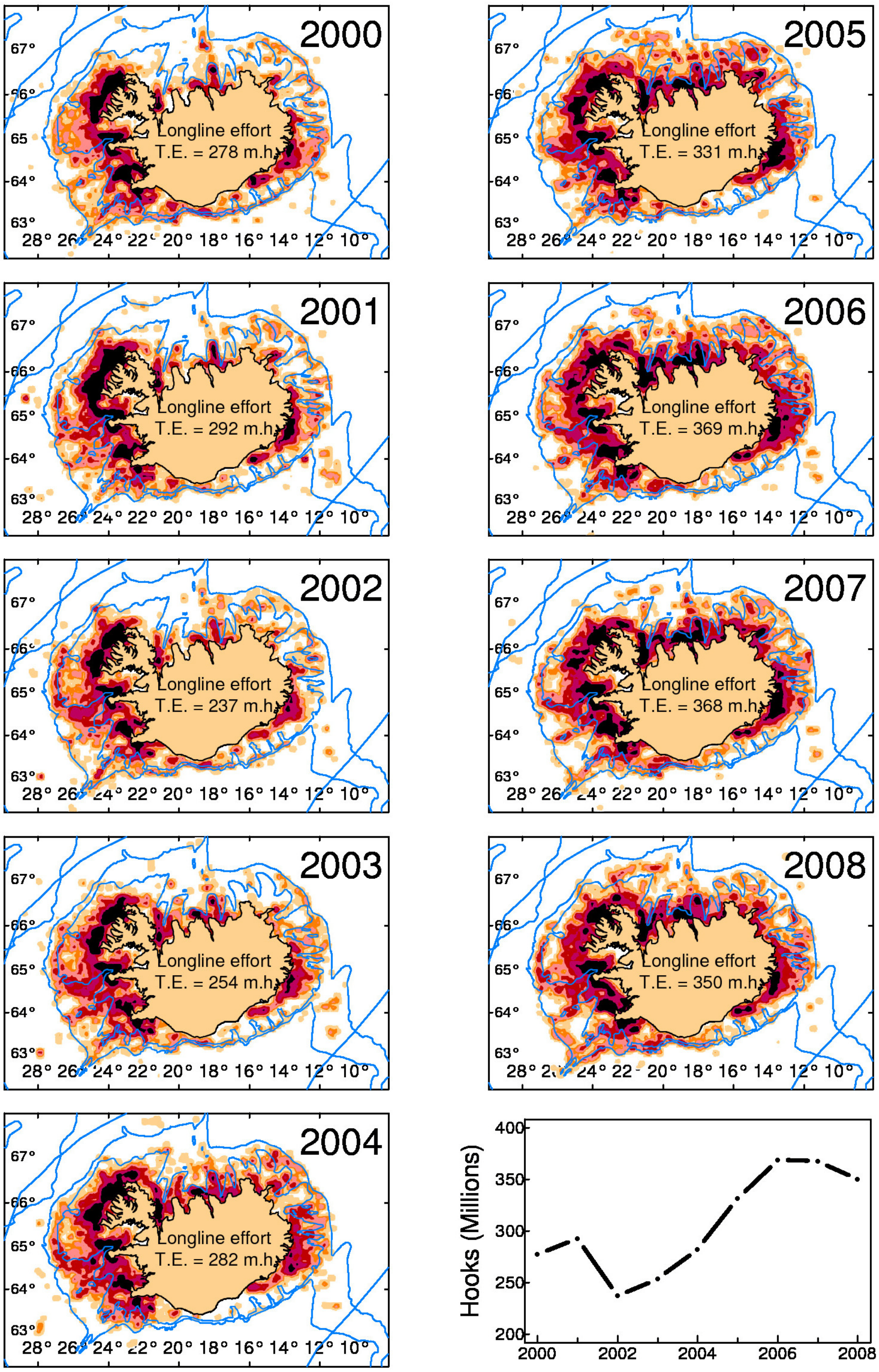


Figure 7.4.7. Spatial distribution of the longlinefleet effort (in number of hooks) in 2000-2008. The main targeted species for longline fishing are cod, haddock, catfish and tusk.

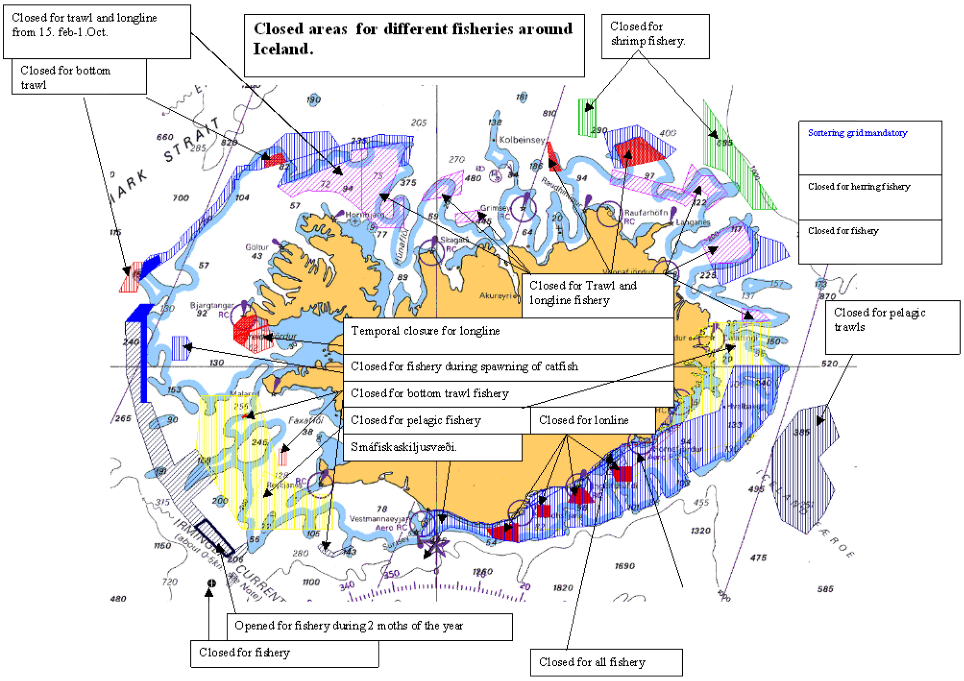


Figure 7.5.1. Overview of closed areas around Iceland in 2006 . The boxes are of different nature and can be closed for different time period and gear type.

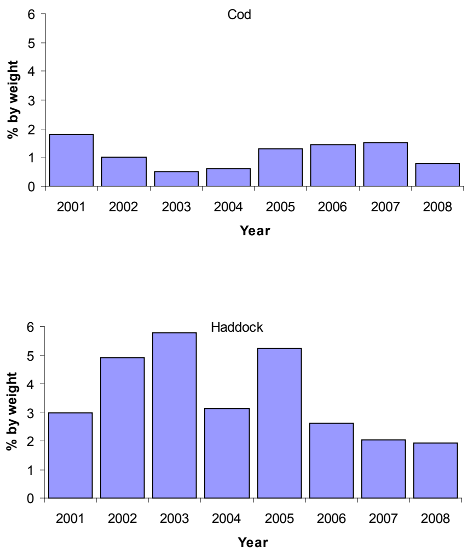


Figure 7.5.2. Estimates of discard percentage by weight for cod and haddock. Source: Ólafur K. Pálsson, Höskuldur Björnsson, Ari Arason, Eyþór Björnsson, Guðmundur Jóhannesson , og Þórhallur Ottesen 2008. Discards in demersal Icelandic fisheries 2008. Marine Research Institute, report series (manuscript for printing).

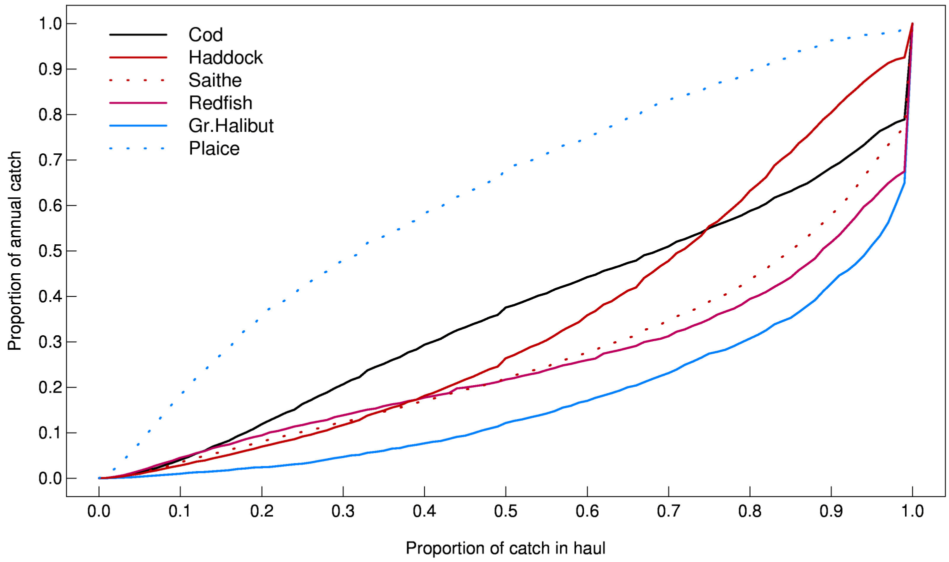


Figure 7.6.1. Cumulative plot for bottom trawl in 2008. An example describes this probably best. Looking at the figure above it can be seen from the dashed lines that 30% of the catch of haddock comes from hauls where haddock is less than 60% of the total catch while only 4% of the catch of greenland 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

8.1 Summary

- The model used is a separable statistical catch-age model implemented in ADMB as selected in the benchmark assessment (WKROUND, ICES-2010). Selectivity is estimated to be constant by age over time through the time period 1980-1995 and then is allowed to change to a different set of selectivities by age for the remaining time period 1996-2009.
- A clear decline in Icelandic saithe stock biomass is evident in estimates for years since 2005 along with an associated rise in fishing mortality since about 2001.
- Year classes 1998-2000 and 2002 are strong but the year classes after 2003 considerably smaller, fluctuating around the long term geometric mean.
- The stock size (B4+ and SSB) is below the long term average.
- In the benchmark assessment Markov chain Monte Carlo algorithm for projections were used for estimating biological reference points and for MSY consideration. Resulting in Fmsy estimates of 0.28, Btrigger/Bpa at 80 kt and Bloss of 65 kt as candidate for Blim.
- The NWWG recommends that the advice for 2011 is based on the estimated Fmsy corresponding to landings of 40 kt.

8.1 Stock description and management units

Description of the stock and management units is provided in the stock annex.

8.2 Fisheries dependent data

8.2.1 Landings, advice and TAC

Landings of saithe in Icelandic waters in 2009 are estimated to have been 61,391 tonnes (Table 8.1 and Figure 8.1). Of the landings 46,407 tonnes were caught by trawl, 9, 365 tonnes caught by gillnets, and 5, 619 tonnes caught by other means. The domestic as well as ICES advice for the fishing year 2009/2010 was based on Fishing on fishing mortality corresponding to Fpa resulting in 35,000 tonnes. The TAC issued was 50,000 tonnes.

The gear used for catching saithe is mainly bottom trawl (~85% in 2006-2008), gillnet, jiggers and Danish seine taking the majority of the rest (Figure 8.1). 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 and its proportion of the domestic landings has now increased from 5% to around 15%.

8.2.2 Landings by age

Catch in numbers by age based on landings are shown in table 8.2. 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 the last two years, as it has been in most years since 2000. The sea-samples constitute about 60-70% of the length samples used in the calculation of the catch in number. Since the amount of discard is likely to be small, not taking discards into account in the total catches and catch in numbers is not considered to have major effect on the stock dynamics estimated.

The sampling program and sampling intensity in 2009 as well as the approach used for calculating catch in numbers is the same as has been done in preceding years. The sampling level in 2009 is indicated in the text table below:

GEAR/NATION	LANDINGS (T)	NO. OF OTOLITH SAMPLES	NO. OF OTOLITHS READ	NO. OF LENGTH SAMPLES	NO OF LENGTH MEASUREMENTS
Gillnets	9365	16	797	49	6946
Jiggers	2955	4	200	19	1785
Danish seine	1406	15	113	27	1901
Bottom trawl	46407	145	4458	314	29373
Other gear	984	-	-	-	-
Foreign landings	269	-	-	-	-
Total	61386	180	5568	409	40008

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.

8.2.3 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 recent years have been below average but some increase is observed in 2008 and 2009 (Table 8.3 and Figure 8.3). Weight at age in the landings is also used as weight at age in the stock.

Predicted weights for 2010 (Table 8.3 and Table 8.12 and Figure 8.3) are estimated by applying a model using survey weights and weight of yearclass in previous year as explanatory variables including a year factor. For future weights the 2010 estimate is applied (WD-iSaitheWDweights).

A model using maturity at age data from the Icelandic groundfish Spring survey (IGFS) (Table 8.4 and Figure 8.4) was used to derive smoothed trends in maturity by age and year. The model is fit to data over ages 3 through 9 using a generalized linear model:

$$logit(P_{a,t}) = \alpha + \beta\ s(age,df{=}4) + \gamma\ ns(year,df{=}6)$$

where P is the proportion mature at age a in year t and *S* and *ns* are smoothing splines used to increase the flexibility of the model.

The following maturity values were applied for spawning stock biomass calculations by time period Table 8.5 and Figure 8.4:

- 1980-1985 are the mean model values from 1985-1998
- 1985-2010 are the values from the model
- Projections forward use the 2010 model values.
- Maturity is set to 1 for fish older than age 9 and set to 0 for fish younger than age 3.

8.2.4 Log book data

Commercial cpue indices are not used for tuning in this assessment. Although these indices have been explored for inclusion in the past, they were not considered for inclusion in the Benchmark workshop (WKROUND 2010) as the trends in cpue are considered not to be a reliable indicator of abundance.

8.3 Scientific surveys

In the benchmark workshop Data from the spring survey were considered superior the autumn survey for calibrating the assessment. The autumn survey index was also examined but not used in the final benchmark assessment.

Saithe is among the most difficult demersal fishes to get reliable information on from bottom trawl surveys. In the Spring survey (IGFS) which has 500-600 stations large proportion of the saithe is caught in relatively few hauls and there seems to be considerable inter-annual variability in the number of these hauls.

The survey biomass indices were high in the beginning of the period, low in the period 1995-2001, high in the period around 2005, but declining to a low level in the most recent years (Figure 8.5)

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 age groups much lower for some other. Despite these poor diagnostic the retrospective pattern are surprisingly good, when using these noisy spring survey data for tuning (Figure 8.9). This may be pure coincidence or it may have origin in that the inter-annual variability is higher in the period prior to 1999 as is apparent in the high variability in the biomass estimator in Figure 8.8.

Small saithe tends to live very close to shore, near piers so survey indices for ages 1 and 2 are nonsurprisingly poor measures of recruitment and the number of those saithe caught in the survey is very low.

8.2 Assessment method

In accordance with the recommendation from the last benchmark workshop (WKROUND-2010) a separable, forward projection, statistical catch-age model developed in ADModel Builder was used to fit the catch at age data from the commercial fleets (ages 3-14, years 1980-2009) and using the Spring bottom-trawl survey index (ages 1-10, year 1985-2010) as a tuning series. Natural mortality is set at 0.2 for all age groups. Selectivity is estimated to be constant by age over time through the time period 1980-1995 and then is allowed to change to a different set of selectivities by age for the remaining time period 1996-2009. This was supported by patterns in catch residuals indicating change in selection around 1995 and that gillnet fisheries reduced substantially in that period.

THE SEPARABLE MODEL RESULTS: The main characteristics of the survey residuals (Table 8.8, Figure 8.6) are year blocks with all residuals being only negative or only positive in a given year. The survey residuals are modelled as multivariate normal distribution with the correlation estimated (one coefficient). In the catch residuals (Table 8.7 and Figure 8.7) a positive blocks for age 3 and 4 are observed in recent years. This reflects relatively high landings of young saithe in recent years.

The retrospective pattern from the 2period separable model (Figure 8.9) indicates more inner consistency in recent years compared to that in the nineties.

The results of the principal stock parameters (Table 8.11 and Figure 8.8) show that the fishing mortality has been increasing in recent years and the estimated fishing mortality in 2008 and 2009 are highest in the time series, 0.48 and 0.47 respectively. A sharp decline in biomass is observed since 2004 and the B4+ biomass in the beginning of 2010 is estimated about 200 kt in (Figure 8.8). The details of the fishing mortality and stock in numbers by are presented in Tables 8.9 and 8.10.

8.4 Reference points and MSY considerations

Reference points for Icelandic saithe were defined in 1998. Fpa (mean F of ages 4 - 9) was set as 0.3 that was close to the mean value sustained in recent decades. The estimated value of Fmed was on the other hand 0.22 that was considered unrealistically low. That conclusion might on the other hand have been wrong.

Blim was set to the lowest value of SSB or 90 000 tonnes and Bpa to 150 000 taking into account relatively uncertain assessment. There has been a discrepancy between the Fpa and the Bpa values used in recent years. One reason for the discrepancy is substantial autocorrelation of recruitment that is characterized with 5-10 poor yearclasses followed by 2-5 good ones. It must though be remembered that the data series is rather short for this kind of inference. The discrepancy between Fpa and the Bpa in recent years would not have been so large if the estimated value of Fmed (0.22) had been used.

The following text describes the work conducted in the benchmark workshop (WKROUND, ICES-2010).

Yield per recruit was calculated using the same model as recommended for stock assessment. First the assessment model was run million time saving every 500th parameter set in the Markov chain. The model was then run forward for number of different fishing motalities, including factors like assessment error, stochastcity of weights at age and stochasticity in recruitment. CV and autocorrelation of residuals from the stock-recruitment function are estimated in the model and the recruitment residuals in the future simulations are lognormally distributed with the estimated parameter values. The model was run using two different stock-recrutment functions.

- Segmented regression with the breakpoint estimated (Figure 8.10).
- No ssb-recruitment relationship. Gives an indication of yield per recruit.

The stochastic factor multiplying the weights was common for all age groups in the same year, lognormal with standard deviation of 13% and autocorrelation of 0.5. The values are close to the average for the most important age groups (4-8). There is substantial correlation in the changes in mean weight at age (correlation between adjacent age groups in the best observed ages 0.75). The common year factor used is therefore more realistic than white noise but the model does not allow the in between approach. The approach selected does therefore exaggerate the effects of stochcaticity in mean weight at age. The mean weight at age in the future simulations are centered around the 2009 values that are 87% of the mean since 1980 though 5% higher observed in 2007-2008.

The error in the assessment is assumed to be lognmormal with standard deviation of 0.25 and autocorrelation of 0.45. No implementation error is assumed nor bias in the assessment except the 4% bias implicit in the lognormal distribution. In the model implementation the estimated fishing mortalities are multiplied by the assessment error in the model. With a catch constraint applied in the year following the assessment year the estimated CV of the mean fishing mortality is 0.26 but 0.22 in the assessment year. The advisory fishing year is in between. Estimated CV on reference biomass is lower or 18-20%.

In the mcmc runs the 5percentile, 10percentile, median and mean of the landings in the last year were plotted against intended fishing mortality (Figure 8.12 and 8.13).

Looking at the estimated parameters the breakpoint was estimated at 80kt with standard error in the estimate 12 kt. (Bloss is 65 kt)

The yield per recruit curves are very flat (Figure 8.12) but the model like all age based models ignores the fact that size selective fishing mortality of recruiting age groups lead to lower mean weight at age when heavy fishing on recruits occurs. $F_{0.1}$ in this curve is around 0.19 or very close to M.

The curves for the segmented regression (Figure 8.13) look quite different. They have a relatively well defined maximum and Fmsy is 0.28 and $F_{0.1}$ 0.19.

The reason for this difference is that when intended fishing mortality is much above 0.3 some of the stochastic runs will lead to spawning stock being below the estimated breakpoint so recruitment and subsequent landing will be reduced.

The assessment error included in the simulation is substantial. The intended fishing mortality deviates substantially from the resulting one and with lognormal distribution with CV of 0.25 a 4% bias is included in those simulations. In addition the assessment errors have autocorrelation of 0.45.

The benchmark workshop concluded (wkround, ICES 2010) the simulations include enough uncertainty for the estimated Fmsy of 0.28 can be used as a target fishing mortality and that the estimated breakpoint of 80 kt is a candidate for Btrigger the point at when the fishing mortality should be start to be recuced. This could also be a candidate for Bpa. The estimated value of Bloss of 65 kt was regarded as a candidate for Blim.

The benchmark workshop also concluded that a harvest control rule will probably not be F based but rather set up as a proportion of stock biomass provided it will lead to the same F that is considered appropriate as Ftarget here.

8.5 Harvest control rule candidates

In most recent years the domestic advice for Icelandic saithe has been based on fishing at F_{4-9}=0.3 except when the spawningstock has been below 150 thous tonnes, then the ICES advice has been 0. Last year the advice was based on F_{4-9}=0.22 taking into account reduced growth, ignoring that the stock was below 150 kt. In the benchmark meeting the maturity at age matrix was revised and based on survey observations instead of using data from landings samples resulting in substantially lower SSB values.

As shown in last section 0.3 is above stochastic Fmsy that is estimated to be around 0.28. A HCR will have to lead to fishing mortality below that value.

The MSY approach calls for a definition of trigger SSB beoynd which the intended fishing mortality will be reduced linearly to 0. For Icelandic saithe the estimated breakpoint in hockey stick regression is 80kt which is a natural candidate for Btrigger.

SSB_{break} in stochastic simulation of the icelandic saithe was estimated at 80 kt (B_{loss}=65kt). The estimated SSB_{break} seems like a reasonable candidate for $B_{trigger}$. F_{msy}

in simulations taking into account most sources of uncertainty was estimated as 0.28 a candidate for F_{msy} and F_{target}. Figure 8.15 shows the cumulative probability of the spawning stock in 2069 with intented F = 0.28, with and without reduction below the trigger point of 80kt. Uncertainty in the estimation of the trigger point is taken into account so when F is overestimated SSB is underestimated by the same amount.

The figure show that there is a minor change in the profile at low SSB but inclusion of the trigger point leads to probability of being below $B_{trigger}$ being around 10% instead of 15%. The mean fishing mortality in the stohastic simulations is 0.289 without the trigger but 0.283 with the trigger. The intended fishing mortality is 0.28.

As F based rules are difficult to present to managers, stakeholders and the public. Therefore managers in Iceland have been more interested in applying biomass based HCR rather than F rules and as saithe and cod grow similarly testing the HCR agreed for cod was considered appropriate first step.

The rule is $Tac_{y/y+1}$=($Tac_{y-1/y}$+0.2B_y)2 where B_y is biomass 4+ using Catch weights.

The rule was both tested with and without reduction of harvest rate below $B_{trigger}$. When the SSB is estimated below $B_{trigger}$ the weight of earlier Tac is reduced so the rule becomes.

$$\alpha = min(\frac{SSB}{B_{trigger}}, 1)$$

$$Tac_{y/y+1} = \alpha 0.5 Tac_{y-1/y} + (1-\alpha)0.5\alpha 0.2 B_y$$

In this equation the weight of last years Tac reduces gradually from 0.5 to 0 as the spawning stock reduces from $B_{trigger}$ to 0 and the effect of reference biomass changes from 0.5 to 1 at the same time.

One of the criteria with the gradual changes of the effect of lastyears TAC and harvest ratio is to avoid discontinuities in the HCR but all HCR where 1% change in stock size can lead to much higher changein TAC are problematic.

The rule without trigger leads to mean fishing mortality of 0.275 but 54.3kt with trigger the mean f is 0.265.

Figure 8.16 shows the cumulative probability profile of the spawning stock in 2069 for the 2 biomass rules compared to F rules.

The biomass rule with stabilizer and trigger has similar probability profile at low spawning stock a F based rule with trigger. The mean SSB is on the other hand higher in the biomass based rule as F is on the average lower. Lower F should lead to lower probability of being below Bloss or $B_{trigger}$ but the stabilizer works against that.

8.6 State of the stock

The spawning stock in the beginning of 2010 is estimated to be 86, 000 tonnes, which is just above the B_{pa} candidate or $B_{trigger}$. Year classes 1998-2000 and 2002 are strong but the year classes after 2003 considerably smaller, fluctuating around the long term geometric mean.

8.7 Short term forecast

The input for the short term forecast is shown in Table 8.12. Predicted weights for 2010 are estimated by applying a model using survey weights and weight of yearclass in previous year as explanatory variables including a year factor. For future weights the 2010 estimate is applied (WD-iSaitheWDweights). For forward projections of maturity ogive the 2010 model values are used. The selection pattern are the average of the years 2007-09. Stock in numbers for age groups 3-14 in 2010 were those estimated in the 2period separable model. The assumed recruitment of around 30 million fish for year classes 2008 onward are the estimate of the assessment modal. A "TAC-constraint" of 45 kt landings is applied in the assessment year based on best estimates of catches in 2010. This results in a fishing mortality somewhat lower than the terminal value (F_{2010}=0.33 compared with F_{2009}=0.47).

Results from short term prediction are shown in Table 8.13. They indicate that the SSB in 2012 will be well above the $B_{trigger}$ if fished at Fmsy =0.28 in 2011. By applying the HCR candidate the F is estimated to be somewhat higher (0.32) but the SSB will still be well above Btrigger in 2012.

As For the calendar year 2011 the NWWG recommends that advice is based on F4-9 = 0.28 which is the the estimated Fmsy corresponding landings of 40 kt.

8.8 Uncertainties in assessment and forecast

The assessment of Icelandic saithe is relatively uncertain due to lack of good tuning data. The internal consistency in the survey that is used for the assessment is very low. These things are not surprising considering the nature of the species that is partly pelagic, schooling and relatively widely migrating. The retrospective pattern is however surprisingly good, giving credence for using the survey data rather than just the catch at age matrix.

Landings in recent 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. Increased proportion of gillnets landing in most recent years might violate the assumption of applying three years average for projected selection pattern.

8.9 Comparison with previous assessment and forecast

The estimated biomass (B4+) in 2010 as estimated by NWWG2009 was 181 kt compared to present estimate of 198 kt. The fishing mortality estimates in 2009 are now estimated to have been 0.47 compared to 0.36 in last years assessment. SSB estimates are not comparable between assessments as different methods for estimating maturity at age have been applied.

8.10 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 descending 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.

8.11 Changes in fishing technology and fishing patterns

There are indications that the fleet may be increasingly targeting younger fish in recent years.

The proportion of saithe landings taken in gillnets increased slightly in recent years (from 5% in 2005 to 15% in 2009) in spite of the fact that in recent years the total effort of gillnetters has gone down around Iceland.

References:

ICES 2010. Report of the Benchmark Workshop on Roundfish (WKROUND). ICES CM 2010/ACOM:36.

Table 8.1 Nominal catch (tonnes) of SAITHE in Division Va by countries, 1997-2009, as officially reported to ICES with working group estimates.

Country	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Faroe Islands	716	997	700	228	128	366	143	214	322	415	392	196	269
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	64,008	69,992	61,391*
Norway	-	-	6	1	44	3*	164	1	2	2	3	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	64,433	70190	61663
Bycatch							403	1,700	1,000				
WG estimate				33,146	32,063	42,071	52,494	64,791	69,143				

*Preliminary.

Table 8.2. Saithe in division Va. Catch in numbers (thousands) 1980-2009.

Year\age	3	4	5	6	7	8	9	10	11	12	13	14
1980	0.275	2.540	5.214	2.596	2.169	1.341	0.387	0.262	0.155	0.112	0.064	0.033
1981	0.203	1.325	3.503	5.404	1.457	1.415	0.578	0.242	0.061	0.154	0.135	0.128
1982	0.508	1.092	2.804	4.845	4.293	1.215	0.975	0.306	0.059	0.035	0.048	0.046
1983	0.107	1.750	1.065	2.455	4.454	2.311	0.501	0.251	0.038	0.012	0.002	0.004
1984	0.053	0.657	0.800	1.825	2.184	3.610	0.844	0.376	0.291	0.135	0.185	0.226
1985	0.376	4.014	3.366	1.958	1.536	1.172	0.747	0.479	0.074	0.023	0.072	0.071
1986	3.108	1.400	4.170	2.665	1.550	1.116	0.628	1.549	0.216	0.051	0.030	0.014
1987	0.956	5.135	4.428	5.409	2.915	1.348	0.661	0.496	0.498	0.058	0.027	0.048
1988	1.318	5.067	6.619	3.678	2.859	1.775	0.845	0.226	0.270	0.107	0.024	0.001
1989	0.315	4.313	8.471	7.309	1.794	1.928	0.848	0.270	0.191	0.135	0.076	0.010
1990	0.143	1.692	5.471	10.112	6.174	1.816	1.087	0.380	0.151	0.055	0.076	0.037
1991	0.198	0.874	3.613	6.844	10.772	3.223	0.858	0.838	0.228	0.040	0.006	0.005
1992	0.242	2.928	3.844	4.355	3.884	4.046	1.290	0.350	0.196	0.056	0.054	0.015
1993	0.657	1.083	2.841	2.252	2.247	2.314	3.671	0.830	0.223	0.188	0.081	0.012
1994	0.702	2.955	1.770	2.603	1.377	1.243	1.263	2.009	0.454	0.158	0.188	0.082
1995	1.573	1.853	2.661	1.807	2.370	0.905	0.574	0.482	0.521	0.106	0.035	0.013
1996	1.102	2.608	1.868	1.649	0.835	1.233	0.385	0.267	0.210	0.232	0.141	0.074
1997	0.603	2.960	2.766	1.651	1.178	0.599	0.454	0.125	0.095	0.114	0.077	0.043
1998	0.183	1.289	1.767	1.545	1.114	0.658	0.351	0.265	0.120	0.081	0.085	0.085
1999	0.989	0.732	1.564	2.176	1.934	0.669	0.324	0.140	0.072	0.025	0.028	0.022
2000	0.850	2.383	0.896	1.511	1.612	1.806	0.335	0.173	0.057	0.033	0.017	0.007
2001	1.223	2.619	2.184	0.591	0.977	0.943	0.819	0.186	0.094	0.028	0.028	0.013
2002	1.187	4.190	3.147	2.970	0.519	0.820	0.570	0.309	0.101	0.027	0.015	0.011
2003	2.262	4.320	5.973	2.448	1.924	0.282	0.434	0.287	0.195	0.027	0.029	0.015
2004	0.952	7.841	7.195	5.363	1.563	1.057	0.211	0.224	0.157	0.074	0.039	0.011
2005	2.607	3.089	7.333	6.876	3.592	0.978	0.642	0.119	0.149	0.089	0.046	0.012
2006	1.380	10.051	2.616	5.840	4.514	1.989	0.667	0.485	0.118	0.112	0.086	0.031
2007	1.244	6.552	8.751	2.124	2.935	1.817	0.964	0.395	0.190	0.043	0.036	0.020
2008	1.432	3.602	5.874	6.706	1.155	1.894	1.248	0.803	0.262	0.176	0.087	0.044
2009	2.820	5.166	2.084	2.734	2.883	0.777	1.101	0.847	0.555	0.203	0.134	0.036

Table 8.3 Saithe in Division Va. Mean weight at age in the catches and in the spawning stock 1980-2009 with predicted weights for 2010-2012.

Year\age	3	4	5	6	7	8	9	10	11	12	13	14
1980	1.428	1.983	2.667	3.689	5.409	6.321	7.213	8.565	9.147	9.617	10.066	11.041
1981	1.585	2.037	2.696	3.525	4.541	6.247	6.991	8.202	9.537	9.089	9.351	10.225
1982	1.547	2.194	3.015	3.183	5.114	6.202	7.256	7.922	8.924	10.134	9.447	10.535
1983	1.530	2.221	3.171	4.270	4.107	5.984	7.565	8.673	8.801	9.039	11.138	9.818
1984	1.653	2.432	3.330	4.681	5.466	4.973	7.407	8.179	8.770	8.831	11.010	11.127
1985	1.609	2.172	3.169	3.922	4.697	6.411	6.492	8.346	9.401	10.335	11.027	10.644
1986	1.450	2.190	2.959	4.402	5.488	6.406	7.570	6.487	9.616	10.462	11.747	11.902
1987	1.516	1.715	2.670	3.839	5.081	6.185	7.330	8.025	7.974	9.615	12.246	11.656
1988	1.261	2.017	2.513	3.476	4.719	5.932	7.523	8.439	8.748	9.559	10.824	14.099
1989	1.403	2.021	2.194	3.047	4.505	5.889	7.172	8.852	10.170	10.392	12.522	11.923
1990	1.647	1.983	2.566	3.021	4.077	5.744	7.038	7.564	8.854	10.645	11.674	11.431
1991	1.224	1.939	2.432	3.160	3.634	4.967	6.629	7.704	9.061	9.117	10.922	11.342
1992	1.269	1.909	2.578	3.288	4.150	4.865	6.168	7.926	8.349	9.029	11.574	9.466
1993	1.381	2.143	2.742	3.636	4.398	5.421	5.319	7.006	8.070	10.048	9.106	11.591
1994	1.444	1.836	2.649	3.512	4.906	5.539	6.818	6.374	8.341	9.770	10.528	11.257
1995	1.370	1.977	2.769	3.722	4.621	5.854	6.416	7.356	6.815	8.312	9.119	11.910
1996	1.229	1.755	2.670	3.802	4.902	5.681	7.182	7.734	9.256	8.322	10.501	11.894
1997	1.325	1.936	2.409	3.906	5.032	6.171	7.202	7.883	8.856	9.649	9.621	10.877
1998	1.347	1.972	2.943	3.419	4.850	5.962	6.933	7.781	8.695	9.564	10.164	10.379
1999	1.279	2.106	2.752	3.497	3.831	5.819	7.072	8.078	8.865	10.550	10.823	11.300
2000	1.367	1.929	2.751	3.274	4.171	4.447	6.790	8.216	9.369	9.817	10.932	12.204
2001	1.280	1.882	2.599	3.697	4.420	5.538	5.639	7.985	9.059	9.942	10.632	10.988
2002	1.308	1.946	2.569	3.266	4.872	5.365	6.830	7.067	9.240	9.659	10.088	11.632
2003	1.310	1.908	2.545	3.336	4.069	5.792	7.156	8.131	8.051	10.186	10.948	11.780
2004	1.467	1.847	2.181	2.918	4.017	5.135	7.125	7.732	8.420	8.927	10.420	10.622
2005	1.287	1.888	2.307	2.619	3.516	5.080	6.060	8.052	8.292	8.342	8.567	10.256
2006	1.164	1.722	2.369	2.808	3.235	4.361	6.007	7.166	8.459	9.324	9.902	9.636
2007	1.140	1.578	2.122	2.719	3.495	4.114	5.402	6.995	7.792	9.331	9.970	10.738
2008	1.306	1.805	2.295	2.749	3.515	4.530	5.132	6.394	7.694	9.170	9.594	11.258
2009	1.412	1.862	2.561	3.023	3.676	4.596	5.651	6.074	7.356	8.608	9.812	10.639
2010	1.412	2.009	2.591	3.363	3.940	4.709	6.017	6.074	7.356	8.608	9.812	10.639
2011	1.412	2.009	2.591	3.363	3.940	4.709	6.017	6.074	7.356	8.608	9.812	10.639
2012	1.412	2.009	2.591	3.363	3.940	4.709	6.017	6.074	7.356	8.608	9.812	10.639

Table 8.4. Saithe in Division Va. Sexual maturity at age as observed in the Spring survey (IGFS) in 1985-2010.

Year/age	3	4	5	6	7	8	9	10
1985	0.02	0.05	0.16	0.51	0.67	0.80	0.66	0.91
1986	0.00	0.03	0.23	0.57	0.76	0.84	0.93	0.93
1987	0.00	0.06	0.23	0.63	0.73	0.93	0.97	1.00
1988	0.00	0.01	0.10	0.43	0.68	0.69	0.88	1.00
1989	0.01	0.03	0.12	0.45	0.41	0.61	0.52	NA
1990	0.00	0.02	0.21	0.34	0.71	0.89	0.86	1.00
1991	0.00	0.02	0.08	0.29	0.21	0.45	0.50	1.00
1992	0.00	0.02	0.21	0.51	0.65	0.71	0.79	0.83
1993	0.00	0.06	0.12	0.36	0.55	0.71	0.54	0.53
1994	0.01	0.09	0.49	0.65	0.79	0.73	0.58	0.35
1995	0.00	0.03	0.13	0.46	0.72	0.81	0.48	0.61
1996	0.00	0.02	0.12	0.42	0.56	0.53	1.00	1.00
1997	0.03	0.09	0.15	0.46	0.68	0.79	0.92	1.00
1998	0.00	0.00	0.17	0.37	0.69	0.62	0.80	1.00
1999	0.00	0.23	0.28	0.37	0.43	0.75	1.00	1.00
2000	0.01	0.16	0.55	0.55	0.71	0.91	0.83	1.00
2001	0.00	0.18	0.51	0.63	0.94	0.87	1.00	1.00
2002	0.01	0.05	0.53	0.85	0.91	0.96	0.94	1.00
2003	0.01	0.03	0.26	0.48	0.64	1.00	1.00	1.00
2004	0.09	0.03	0.34	0.60	0.85	0.95	1.00	0.92
2005	0.01	0.13	0.28	0.59	0.71	0.96	0.96	1.00
2006	0.00	0.05	0.31	0.59	0.61	0.80	0.93	1.00
2007	0.00	0.05	0.30	0.54	0.77	0.79	0.81	1.00
2008	0.00	0.06	0.29	0.51	0.74	0.91	0.96	1.00
2009	0.01	0.03	0.30	0.49	0.77	0.80	0.86	0.86
2010	0.00	0.06	0.49	0.82	0.93	0.98	1.00	1.00

Table 8.5. Saithe in Division Va. Modelled maturity at age used for calculating the SSB. 1980-1985 are the mean model values from 1985-1998.

Year\age	3	4	5	6	7	8	9	10	11	12	13	14
1980	0.000	0.071	0.179	0.384	0.641	0.836	0.936	1.000	1.000	1.000	1.000	1.000
1981	0.000	0.071	0.179	0.384	0.641	0.836	0.936	1.000	1.000	1.000	1.000	1.000
1982	0.000	0.071	0.179	0.384	0.641	0.836	0.936	1.000	1.000	1.000	1.000	1.000
1983	0.000	0.071	0.179	0.384	0.641	0.836	0.936	1.000	1.000	1.000	1.000	1.000
1984	0.000	0.071	0.179	0.384	0.641	0.836	0.936	1.000	1.000	1.000	1.000	1.000
1985	0.000	0.071	0.179	0.384	0.641	0.836	0.936	1.000	1.000	1.000	1.000	1.000
1986	0.000	0.075	0.188	0.398	0.654	0.844	0.939	1.000	1.000	1.000	1.000	1.000
1987	0.000	0.078	0.194	0.407	0.663	0.849	0.941	1.000	1.000	1.000	1.000	1.000
1988	0.000	0.077	0.193	0.407	0.662	0.849	0.941	1.000	1.000	1.000	1.000	1.000
1989	0.000	0.073	0.184	0.391	0.647	0.840	0.938	1.000	1.000	1.000	1.000	1.000
1990	0.000	0.064	0.164	0.359	0.616	0.821	0.929	1.000	1.000	1.000	1.000	1.000
1991	0.000	0.055	0.142	0.321	0.575	0.795	0.917	1.000	1.000	1.000	1.000	1.000
1992	0.000	0.047	0.124	0.288	0.536	0.768	0.904	1.000	1.000	1.000	1.000	1.000
1993	0.000	0.043	0.114	0.268	0.512	0.750	0.895	1.000	1.000	1.000	1.000	1.000
1994	0.000	0.043	0.114	0.268	0.511	0.749	0.895	1.000	1.000	1.000	1.000	1.000
1995	0.000	0.046	0.122	0.285	0.532	0.765	0.903	1.000	1.000	1.000	1.000	1.000
1996	0.000	0.053	0.139	0.316	0.569	0.790	0.915	1.000	1.000	1.000	1.000	1.000
1997	0.000	0.064	0.163	0.358	0.614	0.820	0.929	1.000	1.000	1.000	1.000	1.000
1998	0.000	0.078	0.194	0.407	0.662	0.849	0.941	1.000	1.000	1.000	1.000	1.000
1999	0.000	0.094	0.228	0.457	0.707	0.873	0.952	1.000	1.000	1.000	1.000	1.000
2000	0.000	0.110	0.261	0.502	0.743	0.892	0.959	1.000	1.000	1.000	1.000	1.000
2001	0.000	0.124	0.287	0.535	0.767	0.904	0.964	1.000	1.000	1.000	1.000	1.000
2002	0.000	0.130	0.300	0.551	0.778	0.909	0.966	1.000	1.000	1.000	1.000	1.000
2003	0.000	0.128	0.296	0.545	0.774	0.907	0.966	1.000	1.000	1.000	1.000	1.000
2004	0.000	0.120	0.281	0.527	0.761	0.901	0.963	1.000	1.000	1.000	1.000	1.000
2005	0.000	0.112	0.264	0.506	0.746	0.893	0.960	1.000	1.000	1.000	1.000	1.000
2006	0.000	0.106	0.254	0.493	0.735	0.888	0.958	1.000	1.000	1.000	1.000	1.000
2007	0.000	0.107	0.255	0.495	0.737	0.889	0.958	1.000	1.000	1.000	1.000	1.000
2008	0.000	0.113	0.267	0.510	0.748	0.895	0.960	1.000	1.000	1.000	1.000	1.000
2009	0.000	0.123	0.286	0.534	0.766	0.903	0.964	1.000	1.000	1.000	1.000	1.000
2010	0.000	0.123	0.286	0.534	0.766	0.903	0.964	1.000	1.000	1.000	1.000	1.000
2011	0.000	0.123	0.286	0.534	0.766	0.903	0.964	1.000	1.000	1.000	1.000	1.000
2012	0.000	0.123	0.286	0.534	0.766	0.903	0.964	1.000	1.000	1.000	1.000	1.000

Table 8.6. Saithe in Division Va. IGFS indices of numbers at age 1985-2010 used for tuning .

Year\age	1.00	2.00	3.00	4.00	5.00	6.00	7.00	8.00	9.00	10.00
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
2009	0.01	0.21	2.42	1.79	0.65	0.84	0.75	0.11	0.25	0.14
2010	0.00	0.07	1.23	4.99	2.48	0.62	0.59	0.45	0.07	0.11

Table 8.7. Saithe in Division Va. Log catch residuals from the separable model .

Year\age	3	4	5	6	7	8	9	10	11	12	13	14
1980	-0.281	-0.302	0.127	0.075	-0.039	0.104	-0.016	0.072	-0.083	-0.097	-0.124	-0.004
1981	-0.165	-0.118	-0.290	0.183	-0.077	0.031	0.047	0.088	-0.154	0.219	0.251	0.344
1982	0.318	-0.113	0.066	-0.191	0.120	-0.007	0.164	-0.128	-0.210	-0.138	-0.072	-0.013
1983	-0.797	0.449	-0.322	0.057	0.226	0.104	-0.006	-0.300	-0.462	-0.250	-0.194	-0.178
1984	-1.285	-0.775	-0.618	0.100	0.230	0.389	-0.216	0.162	0.328	0.251	0.734	0.958
1985	-0.116	0.622	0.276	0.042	0.129	-0.082	-0.536	-0.317	-0.323	-0.451	0.100	0.279
1986	1.093	-0.352	0.128	-0.170	-0.037	0.049	-0.169	0.424	-0.365	-0.228	-0.224	-0.114
1987	-0.451	0.089	0.146	0.118	0.034	0.038	0.024	-0.062	-0.036	-0.562	-0.175	-0.026
1988	0.404	-0.165	0.044	0.013	-0.055	0.088	0.317	-0.186	0.130	-0.378	-0.360	-0.146
1989	-0.279	0.307	-0.007	0.129	-0.278	0.032	0.101	-0.049	0.140	0.062	-0.173	-0.206
1990	-0.438	-0.265	0.047	-0.004	0.184	0.025	0.056	-0.125	0.013	-0.083	0.017	-0.151
1991	-0.577	-0.482	0.016	0.180	0.013	-0.018	0.000	0.276	0.047	-0.126	-0.136	-0.116
1992	-0.077	0.261	0.504	0.205	0.049	-0.407	-0.092	-0.139	-0.067	-0.166	0.047	-0.038
1993	0.371	-0.089	-0.181	-0.073	-0.104	-0.019	0.198	0.031	0.091	0.193	0.096	-0.063
1994	0.435	0.477	-0.064	-0.350	-0.209	-0.221	0.107	0.190	0.202	0.189	0.432	0.242
1995	0.768	0.156	0.070	-0.001	0.023	-0.035	-0.094	-0.071	-0.116	-0.223	-0.090	-0.136
1996	0.714	0.143	-0.027	-0.232	-0.165	0.071	0.082	-0.021	0.118	-0.079	0.332	0.342
1997	0.023	-0.021	-0.235	-0.042	0.009	0.218	0.084	-0.037	0.035	0.211	-0.151	0.096
1998	-0.186	-0.166	-0.274	-0.414	0.151	0.091	0.399	0.254	0.388	0.278	0.371	0.228
1999	0.162	-0.108	-0.029	0.010	0.076	0.007	-0.118	0.025	-0.222	-0.114	-0.008	-0.016
2000	-0.057	-0.195	0.029	0.023	0.002	0.351	-0.172	-0.215	-0.133	-0.278	-0.074	-0.112
2001	-0.095	0.008	-0.128	-0.079	0.077	0.031	0.227	-0.094	-0.095	-0.112	-0.095	-0.009
2002	-0.350	-0.166	0.092	0.205	0.016	0.186	-0.044	-0.225	-0.122	-0.275	-0.094	-0.110
2003	0.121	-0.278	0.192	0.000	0.128	-0.099	0.084	-0.136	-0.091	-0.235	-0.093	-0.019
2004	0.215	0.058	0.119	0.131	-0.170	-0.107	-0.007	-0.057	-0.137	-0.239	-0.062	-0.087
2005	0.071	0.159	-0.058	0.173	0.049	-0.219	-0.093	-0.032	0.013	-0.141	-0.178	-0.091
2006	-0.080	0.145	-0.024	-0.150	0.106	-0.089	-0.076	0.078	0.123	0.057	-0.008	-0.107
2007	0.350	0.319	0.133	0.056	-0.296	-0.162	-0.080	0.050	-0.014	0.017	-0.041	-0.095
2008	-0.171	0.169	0.159	-0.007	-0.161	-0.280	-0.003	0.195	0.137	0.137	0.220	0.051
2009	0.056	-0.001	-0.158	-0.201	-0.208	0.110	-0.010	0.339	0.512	0.318	0.260	0.113

Table 8.8. Saithe in Division Va. Log survey residuals from the separable model

Year\age	1	2	3	4	5	6	7	8	9	10
1985	0.00	-0.24	-0.93	-0.26	0.46	0.13	0.18	-0.15	0.47	-0.44
1986	0.00	0.30	-0.46	-0.44	-0.53	-0.34	-0.26	-0.27	-0.35	-0.22
1987	0.00	-0.25	0.64	0.65	0.58	0.28	0.73	0.35	0.17	0.07
1988	0.00	-0.14	-1.31	-1.10	-0.70	-0.24	-0.39	-0.31	-0.38	-0.18
1989	0.00	0.60	0.56	0.01	-0.26	-0.45	0.29	0.16	0.12	-0.35
1990	0.00	-0.09	0.17	0.37	0.28	0.69	0.31	0.46	0.24	-0.18
1991	0.00	-0.02	-0.24	-0.17	-0.26	-0.80	-0.57	-0.85	-0.64	-0.46
1992	0.00	-0.15	-0.06	0.57	0.90	0.29	0.43	-0.08	-0.39	-0.27
1993	0.00	0.56	1.85	0.22	0.81	0.50	0.66	0.24	1.17	0.49
1994	0.00	0.20	-0.31	-0.06	0.17	0.08	-0.14	0.41	0.69	1.56
1995	0.00	0.03	-0.01	-0.38	-0.84	-0.56	-0.62	-0.38	-0.14	-0.04
1996	0.00	-0.12	-0.79	0.16	-0.29	-0.11	0.17	0.60	-0.20	-0.03
1997	0.00	0.15	-0.13	0.50	0.28	-0.11	-0.30	-0.13	-0.22	-0.06
1998	0.00	-0.27	0.71	0.26	0.06	-0.32	0.06	-0.07	-0.12	-0.14
1999	0.00	0.18	0.59	0.05	-0.15	0.02	-0.51	-0.35	-0.47	-0.18
2000	0.00	-0.26	0.07	-0.09	-0.13	-0.13	-0.42	-0.22	-0.34	-0.28
2001	0.00	-0.01	-0.42	-0.07	-0.36	-0.37	-0.55	-0.18	-0.46	-0.17
2002	0.00	0.01	-0.42	-0.44	0.15	0.18	0.16	0.18	-0.03	-0.05
2003	0.00	-0.23	0.79	-0.10	-0.35	-0.19	-0.21	0.07	-0.37	-0.24
2004	0.00	-0.03	0.05	0.35	0.15	0.33	0.30	0.28	0.16	0.07
2005	0.00	-0.22	0.11	0.15	0.23	0.26	0.27	0.36	0.19	0.15
2006	0.00	-0.25	0.03	0.14	0.13	0.86	0.62	0.31	0.01	0.15
2007	0.00	-0.36	-0.71	-0.50	-0.37	-0.18	-0.12	-0.13	-0.21	0.00
2008	0.00	-0.51	0.09	0.05	0.06	0.25	0.07	-0.07	-0.13	-0.15
2009	0.00	-0.16	-0.22	-0.40	-0.45	-0.36	-0.42	-0.21	-0.18	-0.11
2010	0.00	-0.33	-0.23	0.06	0.04	-0.12	-0.11	-0.15	-0.08	-0.17

Table 8.9. Saithe in Division Va. Fishing mortality as estimated from the separable model calibrated with IGFS survey age disaggregated indices 1985-2010.

Year\age	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1980			0.02	0.09	0.18	0.29	0.36	0.43	0.40	0.43	0.36	0.36	0.36	0.36
1981			0.01	0.08	0.16	0.26	0.32	0.39	0.36	0.39	0.32	0.32	0.32	0.32
1982			0.02	0.09	0.18	0.30	0.37	0.45	0.42	0.45	0.37	0.37	0.37	0.37
1983			0.01	0.07	0.15	0.24	0.30	0.36	0.33	0.36	0.29	0.29	0.29	0.29
1984			0.01	0.07	0.14	0.23	0.29	0.34	0.32	0.34	0.28	0.28	0.28	0.28
1985			0.01	0.07	0.15	0.25	0.30	0.36	0.34	0.36	0.30	0.30	0.30	0.30
1986			0.02	0.08	0.17	0.28	0.35	0.42	0.39	0.42	0.34	0.34	0.34	0.34
1987			0.02	0.10	0.21	0.35	0.43	0.52	0.48	0.52	0.43	0.43	0.43	0.43
1988			0.02	0.09	0.19	0.32	0.40	0.48	0.44	0.48	0.39	0.39	0.39	0.39
1989			0.02	0.09	0.19	0.31	0.38	0.45	0.42	0.45	0.37	0.37	0.37	0.37
1990			0.02	0.10	0.21	0.35	0.43	0.52	0.48	0.52	0.42	0.42	0.42	0.42
1991			0.02	0.11	0.22	0.37	0.46	0.55	0.51	0.55	0.45	0.45	0.45	0.45
1992			0.02	0.10	0.22	0.36	0.44	0.53	0.49	0.53	0.43	0.43	0.43	0.43
1993			0.02	0.11	0.23	0.39	0.48	0.57	0.53	0.57	0.47	0.47	0.47	0.47
1994			0.02	0.12	0.26	0.43	0.53	0.63	0.59	0.63	0.52	0.52	0.52	0.52
1995			0.02	0.12	0.25	0.42	0.52	0.62	0.58	0.62	0.51	0.51	0.51	0.51
1996			0.02	0.10	0.22	0.36	0.44	0.53	0.49	0.53	0.43	0.43	0.43	0.43
1997			0.04	0.16	0.23	0.31	0.34	0.37	0.36	0.35	0.32	0.32	0.32	0.32
1998			0.03	0.13	0.19	0.24	0.27	0.29	0.29	0.28	0.25	0.25	0.25	0.25
1999			0.03	0.14	0.20	0.26	0.29	0.31	0.31	0.30	0.27	0.27	0.27	0.27
2000			0.03	0.15	0.21	0.28	0.31	0.34	0.33	0.32	0.29	0.29	0.29	0.29
2001			0.03	0.13	0.19	0.24	0.27	0.29	0.29	0.28	0.25	0.25	0.25	0.25
2002			0.03	0.15	0.21	0.27	0.31	0.33	0.32	0.32	0.28	0.28	0.28	0.28
2003			0.03	0.15	0.21	0.28	0.31	0.33	0.33	0.32	0.29	0.29	0.29	0.29
2004			0.04	0.17	0.24	0.32	0.36	0.38	0.38	0.37	0.33	0.33	0.33	0.33
2005			0.04	0.19	0.27	0.36	0.40	0.44	0.43	0.42	0.37	0.37	0.37	0.37
2006			0.05	0.22	0.31	0.41	0.46	0.50	0.49	0.48	0.43	0.43	0.43	0.43
2007			0.05	0.22	0.31	0.41	0.46	0.49	0.48	0.47	0.42	0.42	0.42	0.42
2008			0.06	0.27	0.38	0.50	0.56	0.60	0.59	0.58	0.52	0.52	0.52	0.52
2009			0.06	0.26	0.37	0.48	0.54	0.59	0.57	0.56	0.50	0.50	0.50	0.50
2010			0.04	0.18	0.26	0.34	0.39	0.42	0.41	0.40	0.36	0.36	0.36	0.36
2011			0.03	0.15	0.21	0.28	0.31	0.34	0.33	0.32	0.29	0.29	0.29	0.29
2012			0.03	0.15	0.21	0.28	0.31	0.34	0.33	0.32	0.29	0.29	0.29	0.29

Table 8.10. Saithe in Division Va. Stock in numbers from the separable model calibrated with IGFS survey age disaggregated indices 1985-2012.

Year\age	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1980	22	20	28	47	31	10	8	4	1	1	0.7	0.5	0.3	0.1
1981	33	22	20	23	35	21	6	5	2	1	0.4	0.4	0.3	0.2
1982	41	33	22	16	17	25	13	4	3	1	0.4	0.2	0.2	0.2
1983	36	41	33	17	12	12	15	8	2	1	0.6	0.2	0.1	0.1
1984	66	36	41	26	13	9	8	9	4	1	0.8	0.4	0.1	0.1
1985	93	66	36	34	20	9	6	5	5	3	0.7	0.5	0.2	0.1
1986	50	93	66	29	26	14	6	3	3	3	1.5	0.4	0.3	0.1
1987	33	50	93	53	22	18	9	3	2	1	1.7	0.8	0.2	0.2
1988	21	33	50	74	39	14	10	5	2	1	0.7	0.9	0.5	0.1
1989	31	21	33	40	56	27	9	6	2	1	0.5	0.4	0.5	0.3
1990	16	31	21	26	30	38	16	5	3	1	0.5	0.3	0.2	0.3
1991	21	16	31	17	19	20	32	9	2	1	0.6	0.2	0.1	0.1
1992	19	21	16	25	13	13	11	16	4	1	0.7	0.3	0.1	0.1
1993	32	19	21	12	18	8	7	6	8	2	0.6	0.4	0.2	0.1
1994	27	32	19	17	9	12	5	4	3	4	0.9	0.3	0.2	0.1
1995	17	27	32	15	12	6	6	2	2	1	1.7	0.5	0.1	0.1
1996	9	17	27	25	11	8	3	3	1	1	0.5	0.8	0.2	0.1
1997	29	9	17	22	19	7	4	2	1	0	0.4	0.3	0.4	0.1
1998	30	29	9	14	15	12	4	3	1	1	0.3	0.2	0.2	0.3
1999	51	30	29	7	10	10	8	3	2	1	0.5	0.2	0.1	0.1
2000	58	51	30	23	5	7	7	5	2	1	0.3	0.3	0.1	0.1
2001	65	58	51	23	16	3	4	4	3	1	0.6	0.2	0.2	0.1
2002	21	65	58	40	17	11	2	3	2	2	0.6	0.4	0.1	0.1
2003	61	21	65	46	28	11	7	1	2	1	1.0	0.4	0.2	0.1
2004	34	61	21	52	32	19	7	4	1	1	0.8	0.6	0.2	0.1
2005	18	34	61	16	36	21	11	4	2	0	0.5	0.5	0.4	0.1
2006	32	18	34	48	11	22	12	6	2	1	0.2	0.3	0.3	0.2
2007	50	32	18	26	31	7	12	6	3	1	0.6	0.1	0.2	0.1
2008	27	50	32	14	17	19	4	6	3	2	0.5	0.3	0.1	0.1
2009	32	27	50	25	9	10	9	2	3	1	0.7	0.3	0.2	0.0
2010	33	32	27	39	16	5	5	4	1	1	0.7	0.4	0.1	0.1
2011	33	33	32	21	26	10	3	3	2	0	0.7	0.4	0.2	0.1
2012	33	33	33	25	15	18	6	2	2	1	0.2	0.4	0.2	0.1

Table 8.11 Saithe in Division Va. Main population estimates from the separable model calibrated with IGFS survey age disaggregated indices 1985-2010.

Year\age	Landings	F4-9	SSB	N3	B4+	Hratio
1980	58	0.29	115	28	313	0.18
1981	58	0.26	122	20	306	0.19
1982	68	0.30	141	22	295	0.23
1983	57	0.24	142	33	271	0.21
1984	60	0.23	144	41	288	0.21
1985	54	0.25	140	36	300	0.18
1986	65	0.28	146	66	319	0.20
1987	80	0.35	144	93	335	0.24
1988	77	0.32	147	50	416	0.19
1989	82	0.31	154	33	398	0.21
1990	98	0.35	161	21	379	0.26
1991	102	0.37	165	31	339	0.30
1992	80	0.36	147	16	293	0.27
1993	72	0.39	118	21	237	0.30
1994	64	0.43	97	19	196	0.32
1995	48	0.42	73	32	164	0.30
1996	39	0.35	65	27	163	0.24
1997	37	0.30	67	17	174	0.21
1998	31	0.24	76	9	172	0.18
1999	31	0.25	83	29	149	0.21
2000	33	0.27	86	30	156	0.21
2001	32	0.24	90	51	172	0.18
2002	42	0.26	103	58	222	0.19
2003	52	0.27	119	65	270	0.19
2004	65	0.31	129	21	299	0.22
2005	69	0.35	130	61	257	0.27
2006	75	0.40	128	34	267	0.28
2007	64	0.39	116	18	226	0.28
2008	69	0.48	108	32	192	0.36
2009	60	0.47	94	50	174	0.35
2010	45	0.33	86	27	198	0.23
Average	**60**	**0.32**	**117**	**35**	**256**	**0.24**
Units	1000 tons		1000 tons	Millions	1000 tons	

Table 8.12. Saithe in Division Va. Input values for the short term predictions.

Mean weights in the stock and the catch

age\year	2009	2010	2011	2012	2013
3	1.412	1.412	1.412	1.412	1.412
4	1.862	2.009	2.009	2.009	2.009
5	2.561	2.591	2.591	2.591	2.591
6	3.023	3.363	3.363	3.363	3.363
7	3.676	3.940	3.940	3.940	3.940
8	4.596	4.709	4.709	4.709	4.709
9	5.651	6.017	6.017	6.017	6.017
10	6.074	6.074	6.074	6.074	6.074
11	7.356	7.356	7.356	7.356	7.356
12	8.608	8.608	8.608	8.608	8.608
13	9.812	9.812	9.812	9.812	9.812
14	10.639	10.639	10.639	10.639	10.639

Mean weights in the SSB

age\year	2009	2010	2011	2012	2013
3	1.412	1.412	1.412	1.412	1.412
4	1.862	2.009	2.009	2.009	2.009
5	2.561	2.591	2.591	2.591	2.591
6	3.023	3.363	3.363	3.363	3.363
7	3.676	3.940	3.940	3.940	3.940
8	4.596	4.709	4.709	4.709	4.709
9	5.651	6.017	6.017	6.017	6.017
10	6.074	6.074	6.074	6.074	6.074
11	7.356	7.356	7.356	7.356	7.356
12	8.608	8.608	8.608	8.608	8.608
13	9.812	9.812	9.812	9.812	9.812
14	10.639	10.639	10.639	10.639	10.639

Sexual maturity at spawning time:

age\year	2009	2010	2011	2012	2013
3	0.000	0.000	0.000	0.000	0.000
4	0.123	0.123	0.123	0.123	0.123
5	0.286	0.286	0.286	0.286	0.286
6	0.534	0.534	0.534	0.534	0.534
7	0.766	0.766	0.766	0.766	0.766
8	0.903	0.903	0.903	0.903	0.903
9	0.964	0.964	0.964	0.964	0.964
10	1.000	1.000	1.000	1.000	1.000
11	1.000	1.000	1.000	1.000	1.000
12	1.000	1.000	1.000	1.000	1.000
13	1.000	1.000	1.000	1.000	1.000
14	1.000	1.000	1.000	1.000	1.000

Selection pattern

age\year	2009	2010	2011	2012	2013
3	0.127	0.127	0.127	0.127	0.127
4	0.555	0.555	0.555	0.555	0.555
5	0.786	0.786	0.786	0.786	0.786
6	1.031	1.031	1.031	1.031	1.031
7	1.159	1.159	1.159	1.159	1.159
8	1.248	1.248	1.248	1.248	1.248
9	1.221	1.221	1.221	1.221	1.221
10	1.198	1.198	1.198	1.198	1.198
11	1.069	1.069	1.069	1.069	1.069
12	1.069	1.069	1.069	1.069	1.069
13	1.069	1.069	1.069	1.069	1.069
14	1.069	1.069	1.069	1.069	1.069

Natural Mortality

age\year	2009	2010	2011	2012	2013
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	2009	2010	2011	2012	2013
3	50.487	26.762	31.514	32.646	32.774
4	24.792	38.938			
5	8.795	15.646			
6	9.665	4.980			
7	9.375	4.879			
8	1.667	4.457			
9	2.792	0.760			
10	1.394	1.289			
11	0.708	0.651			
12	0.263	0.351			
13	0.164	0.131			
14	0.032	0.081			

Prop. mort. before spawning

age\year	F	M
3	0.000	0.000
4	0.000	0.000
5	0.000	0.000
6	0.000	0.000
7	0.000	0.000
8	0.000	0.000
9	0.000	0.000
10	0.000	0.000
11	0.000	0.000
12	0.000	0.000
13	0.000	0.000
14	0.000	0.000

Table 8.13 Saithe in Division Va. Output of the short term predictions.

2010 B4+	Fbar	SSB	Landings
198	0.33	86	45

2011 B4+	Fmult	Fbar	SSB2011	Landings	2012 B4+	SSB	%SSB change[1)]	% TAC change[2)]	Rational
196	0.00	0.000	90	0	250	130	43%	-100%	Zero catch
	0.18	0.060	90	9	239	123	36%	-79%	
	0.21	0.070	90	11	238	121	34%	-76%	
	0.24	0.080	90	13	236	120	33%	-72%	
	0.27	0.090	90	14	234	119	32%	-69%	
	0.30	0.100	90	16	233	118	31%	-65%	
	0.33	0.110	90	17	231	117	30%	-62%	
	0.36	0.120	90	18	229	116	28%	-59%	
	0.39	0.130	90	20	228	115	27%	-56%	
	0.42	0.140	90	21	226	114	26%	-53%	
	0.45	0.150	90	23	225	113	25%	-49%	
	0.48	0.160	90	24	223	112	24%	-46%	
	0.51	0.170	90	26	222	111	23%	-43%	
	0.54	0.180	90	27	220	110	22%	-40%	
	0.57	0.190	90	28	219	109	20%	-37%	$F_{0.1}$
	0.60	0.200	90	30	217	108	19%	-34%	
	0.63	0.210	90	31	216	107	18%	-31%	
	0.66	0.220	90	32	214	106	17%	-28%	
	0.69	0.230	90	34	213	105	16%	-25%	
	0.72	0.240	90	35	211	104	15%	-22%	
	0.75	0.250	90	36	210	103	14%	-19%	
	0.78	0.260	90	38	208	102	13%	-16%	
	0.81	0.270	90	39	207	101	12%	-13%	
	0.84	0.280	90	40	205	100	11%	-11%	Fmsy
	0.87	0.290	90	42	204	99	10%	-8%	
	0.90	0.300	90	43	203	99	9%	-5%	
	0.93	0.310	90	44	201	98	8%	-2%	
	0.96	0.320	90	45	200	97	7%	1%	((20% $B_{4+,10}$ + $TAC0_{9/10}$)/2)[3)]
	0.99	0.330	90	46	199	96	6%	3%	Fsq
	1.02	0.340	90	48	197	95	5%	6%	
	1.05	0.350	90	49	196	94	4%	9%	
	1.08	0.360	90	50	195	93	3%	11%	
	1.11	0.370	90	51	193	93	2%	14%	
	1.14	0.380	90	52	192	92	2%	16%	
	1.17	0.390	90	54	191	91	1%	19%	
	1.20	0.400	90	55	190	90	0%	22%	
	1.23	0.410	90	56	188	89	-1%	24%	
	1.26	0.420	90	57	187	89	-2%	27%	
	1.29	0.430	90	58	186	88	-3%	29%	
	1.32	0.440	90	59	185	87	-4%	32%	
	1.35	0.450	90	60	183	86	-5%	34%	
	1.38	0.460	90	61	182	86	-5%	37%	

3) HCR candidate

1) SSB 2012 relative to SSB 2011

2) TAC 2011 relative to TAC 2010

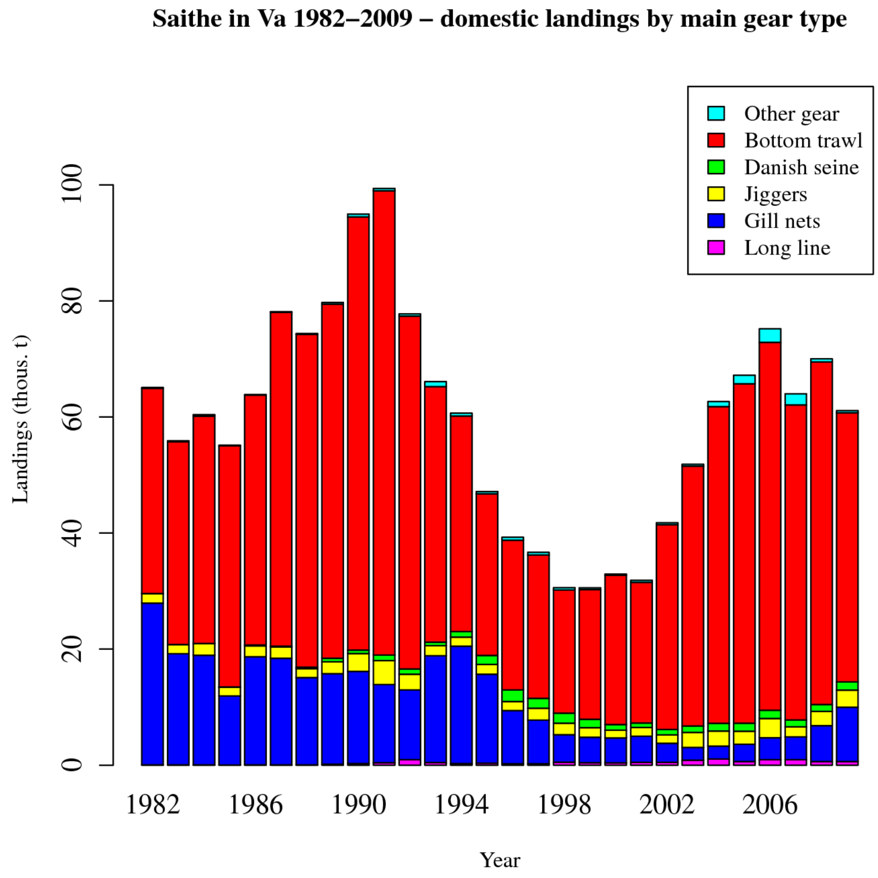


Figure 8.1 Saithe in Division Va. Total landings by gear from 1982 – 2009

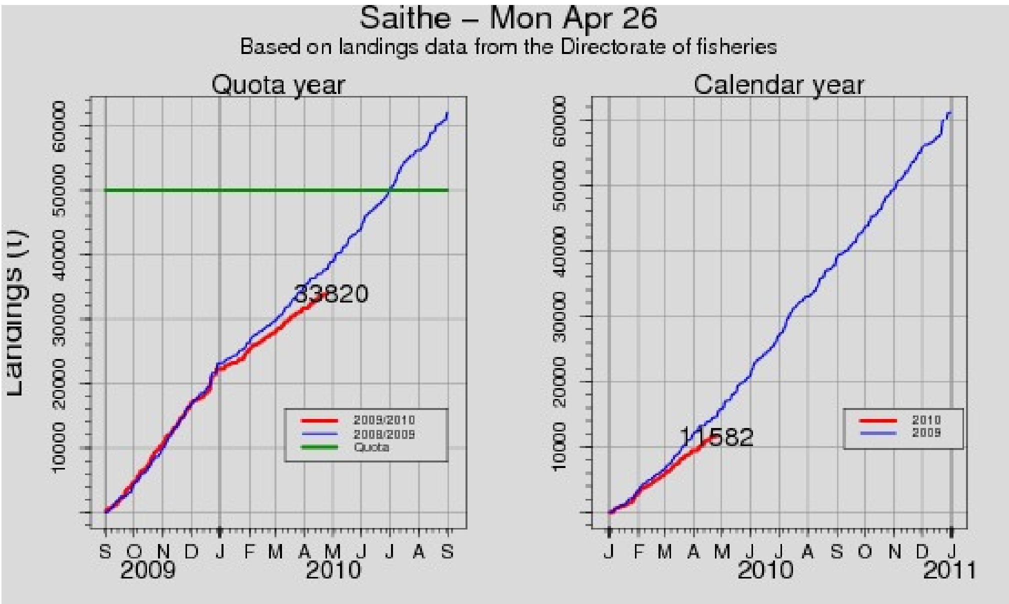


Figure 8.2 Saithe in Division Va. Cumulative landings in the last two fishing years (left) and calendar years (right). The vertical (green line) in the left figure shows the 50 kt quota for the current fishing year (2009/2010), the quota for the fishing 2008/2009 having been set at 65 kt.

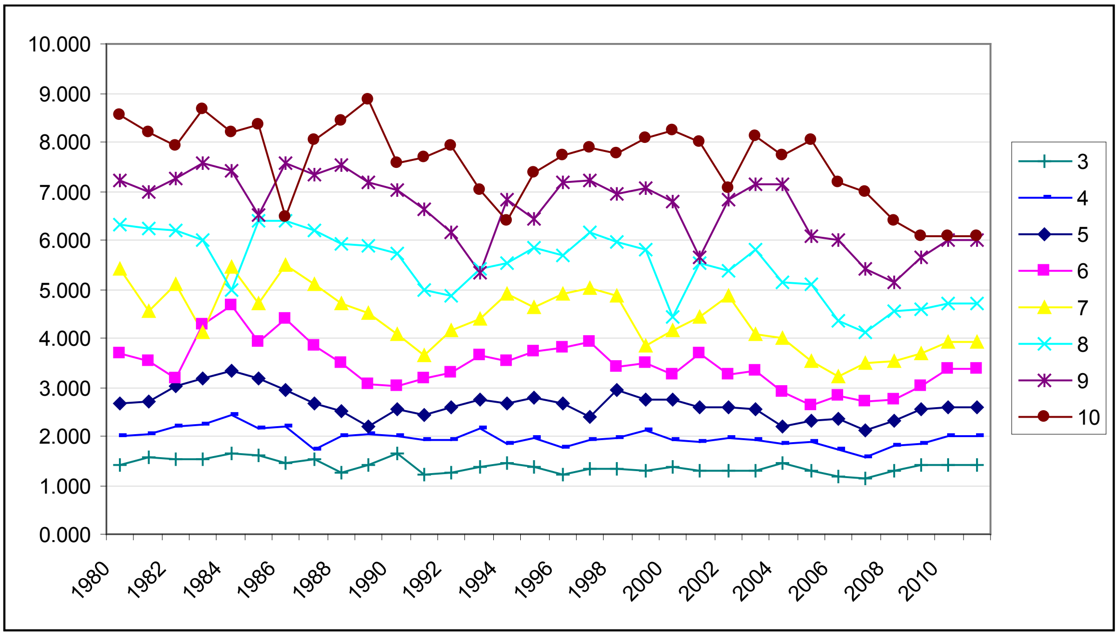
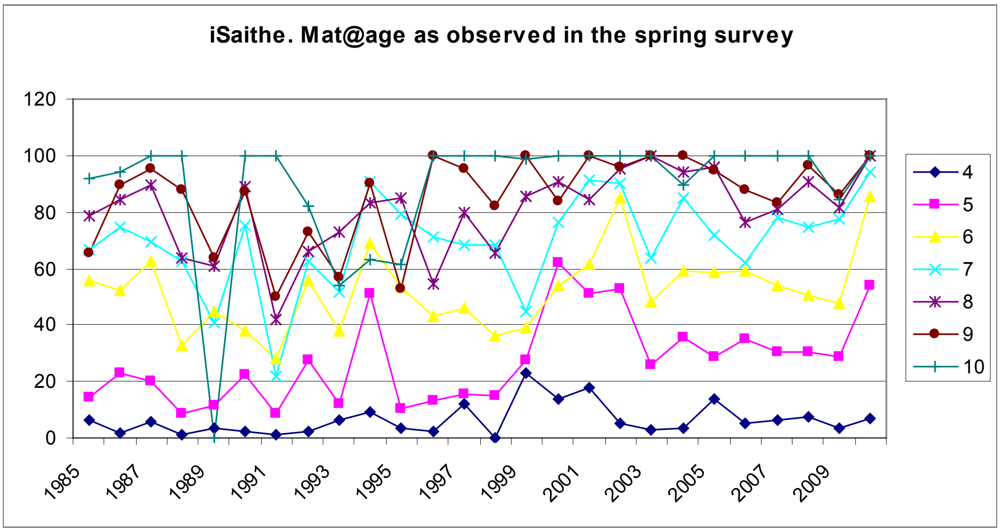


Figure 8.3 Saithe in Division Va. Weight at age in the catches for the period 1980-2009 and predictions for 2010 and 2011.



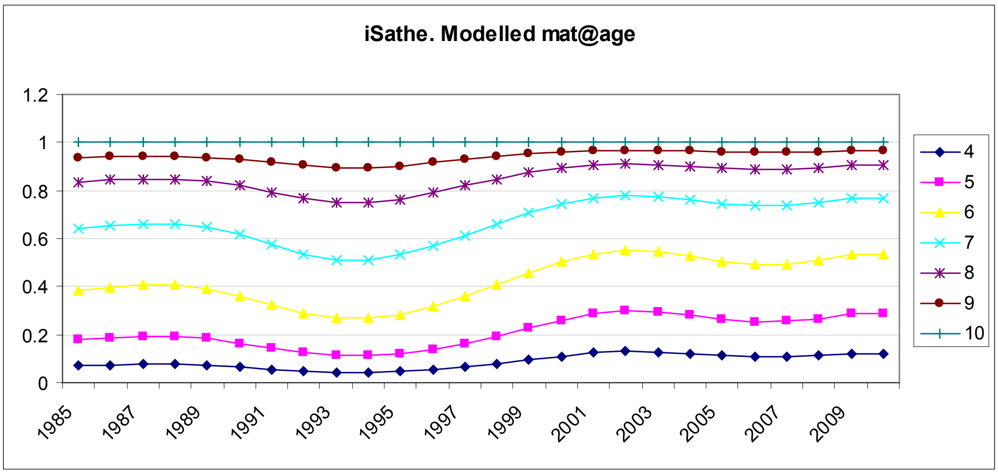


Figure 8.4 Saithe in Division Va. Maturity at age in the spring survey for the period 1985-2010 (upper figure) results from the applied model (lower figure).

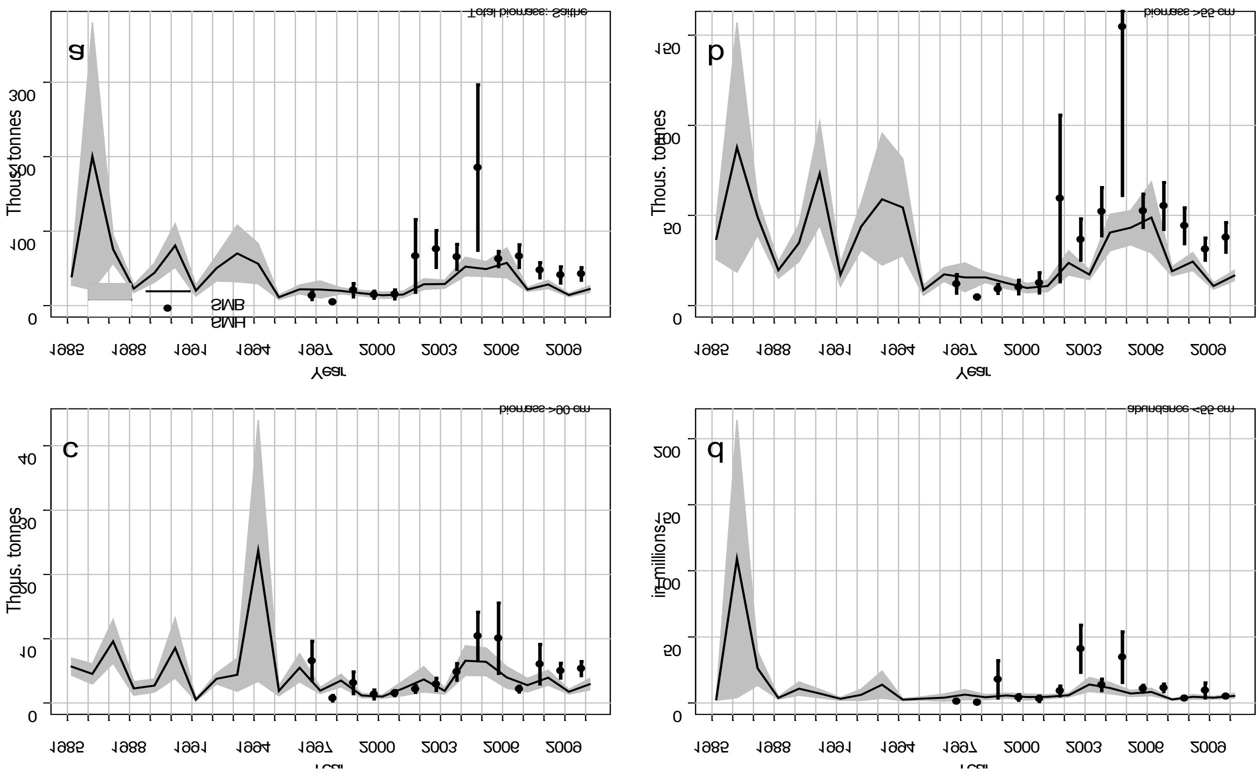


Figure 8.5 Saithe in Division Va. Shown are a) total biomass indices, b) biomass indices larger than 55 cm, biomass indices smaller than 90 cm and d) abundance indices smaller than 55 cm. The lines with the shades show the spring survey indices from 1985 (SMB) and the points with the vertical line she fall survey indices from 1997. The shades and the vertical lines indicate +/- 1 standard error.

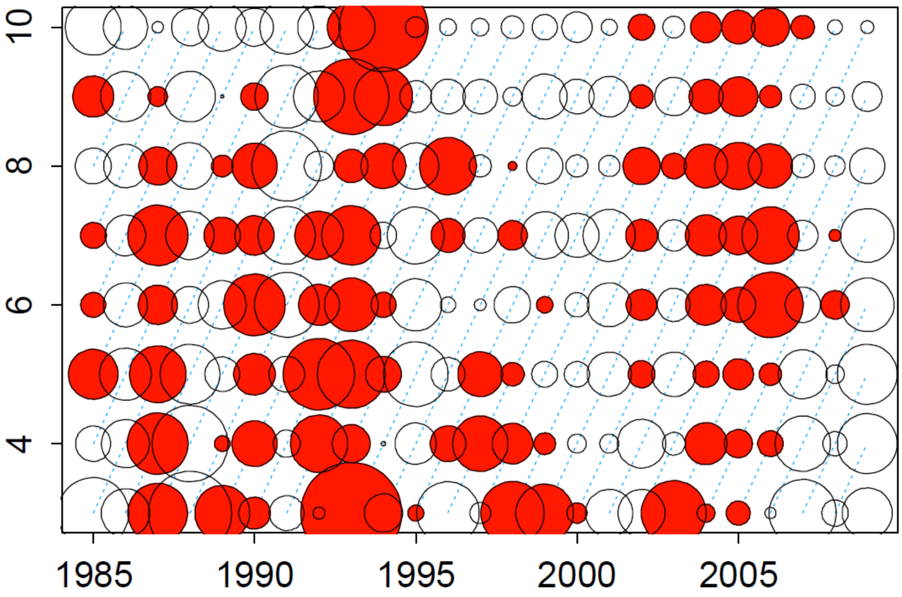


Figure 8.6. Saithe in Division Va. Survey residuals at age from the separable model.

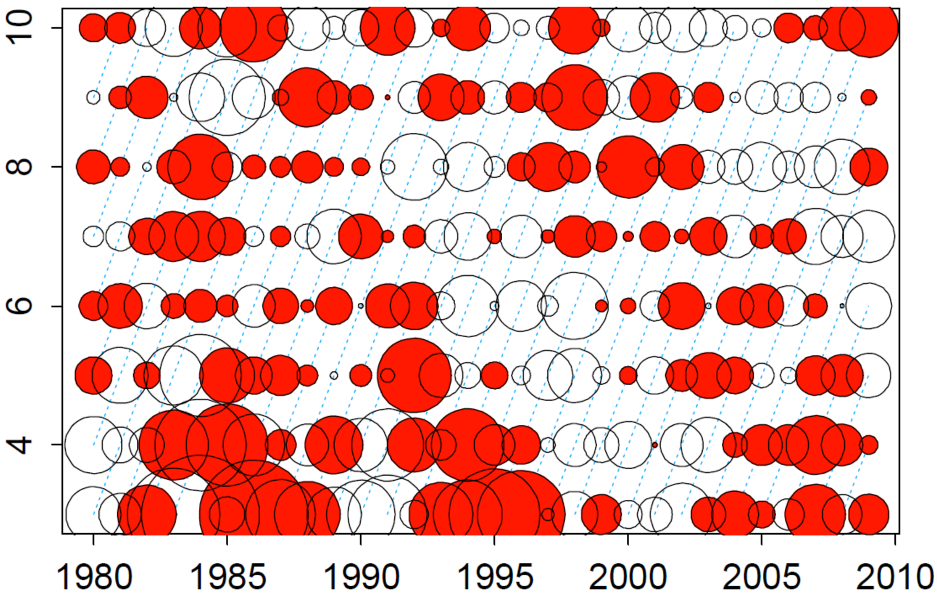


Figure 8.7. Saithe in Division Va. Catch residuals at age from the separable model.

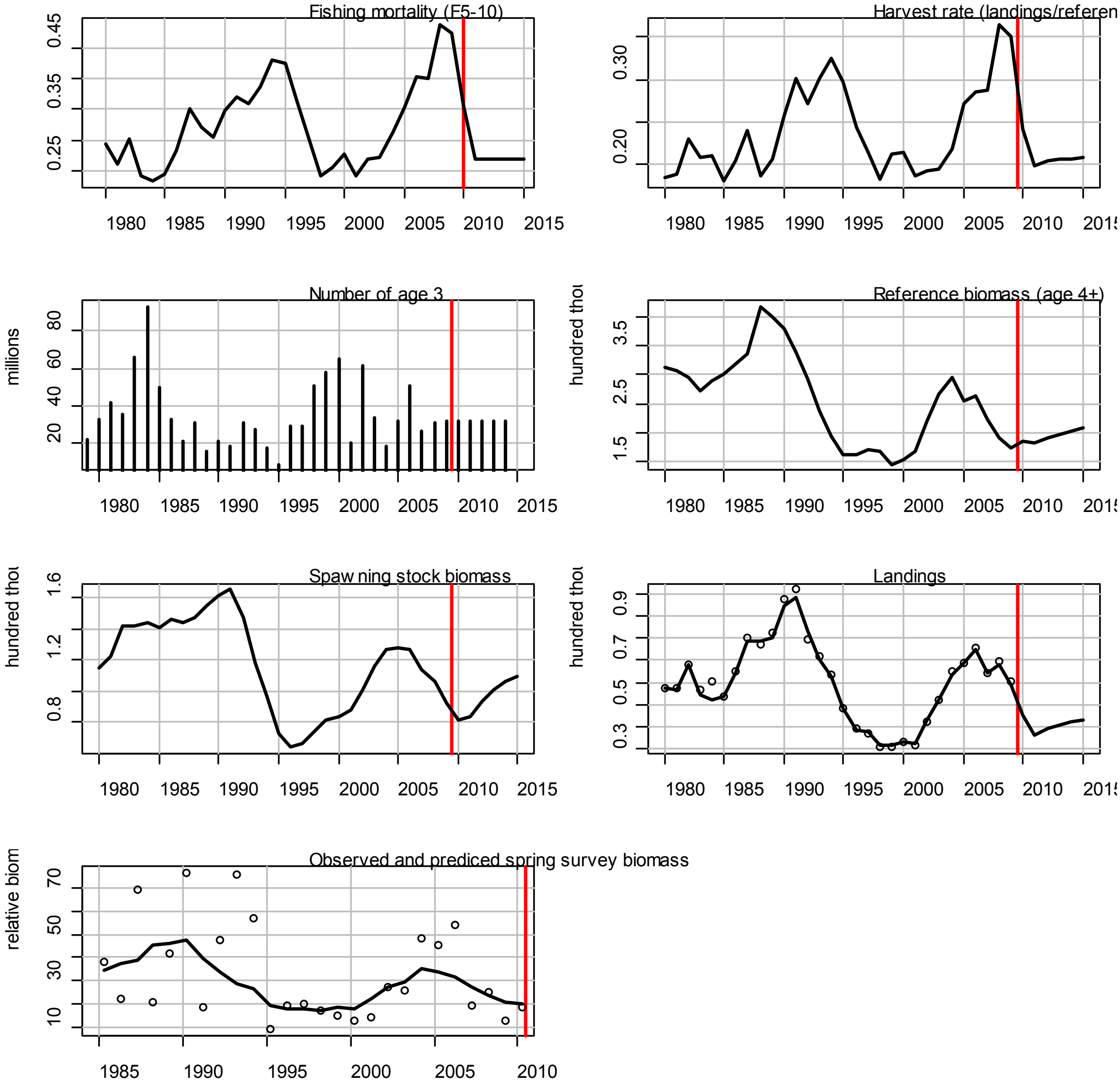


Figure 8.8. Saithe in Division Va. Results from the separable model and short term forecast.

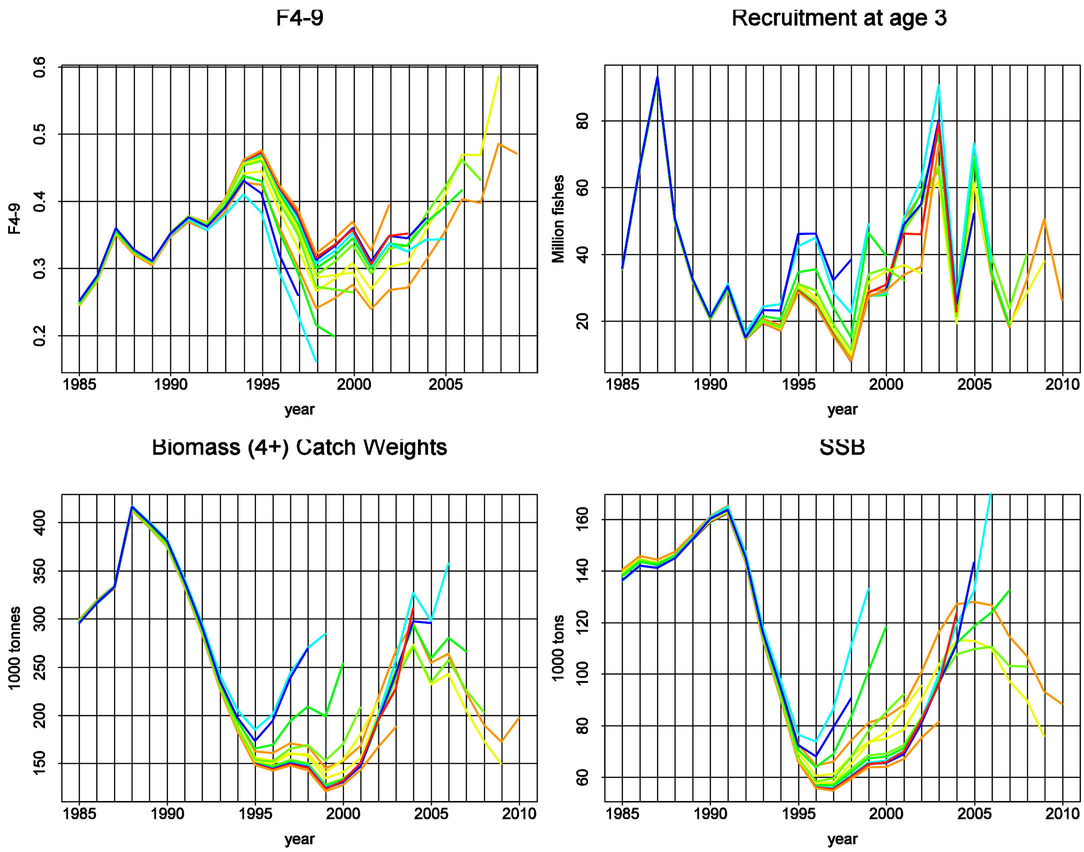


Figure 8.9: Saithe in Division Va. Retrospective pattern from the separable model where selection is allowed to change in 1996, calibrated with IGFS survey age disaggregated indices 1985-2010.

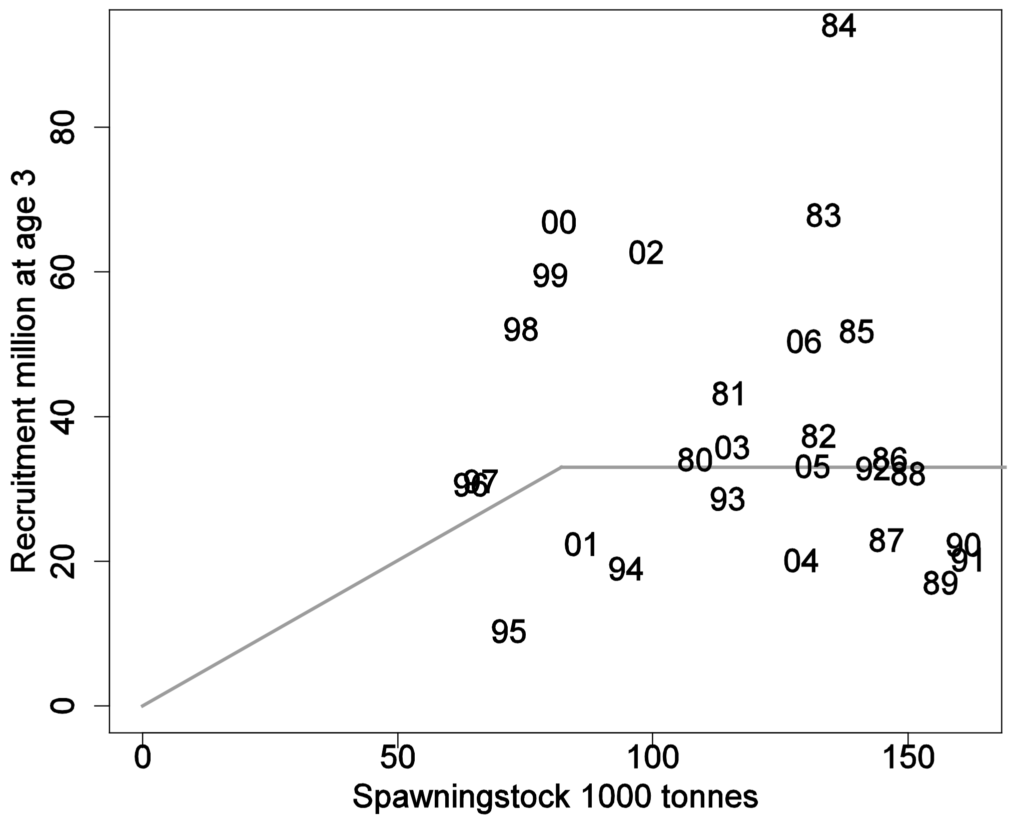


Figure 8.10. Saithe in Division Va. The hockey-stick SSB-Recruitment. Numbers represent yearclasses. SSB break is at 80 kt.

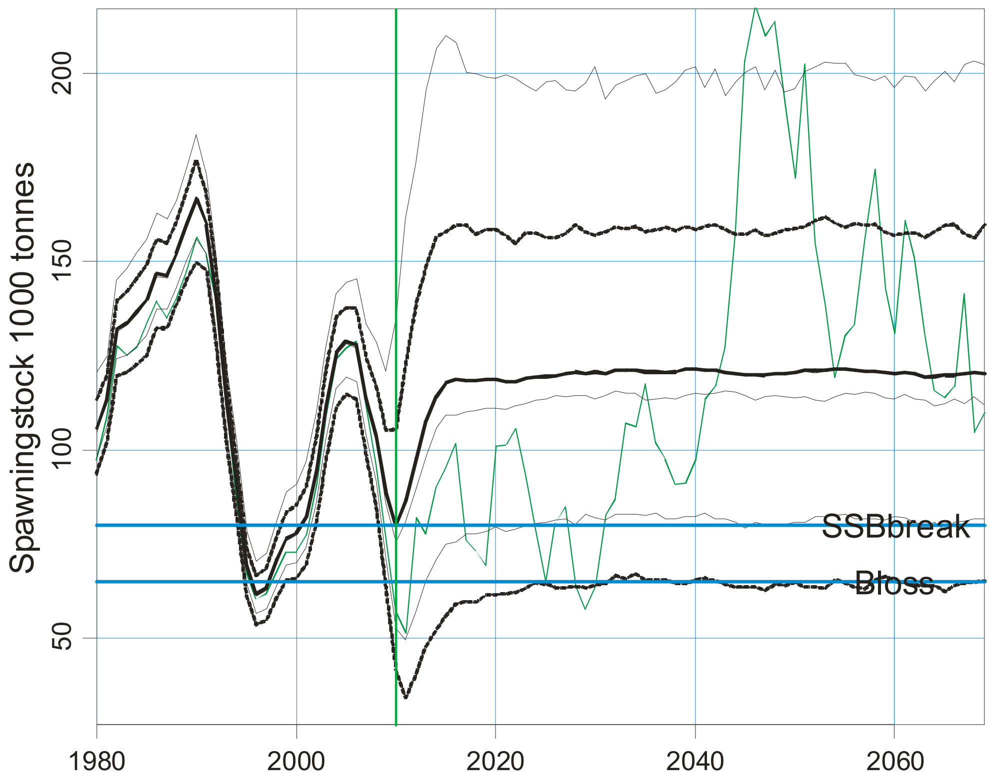


Figure 8.11. Saithe in Division Va. Development of the spawning stock from the benchmark assessment statistical catch-age model with split periods of constant selectivity and Spring survey tunning index. The lines are 5th percentile, 16th percentile, median, mean, 84th percentile and 95th percentile.

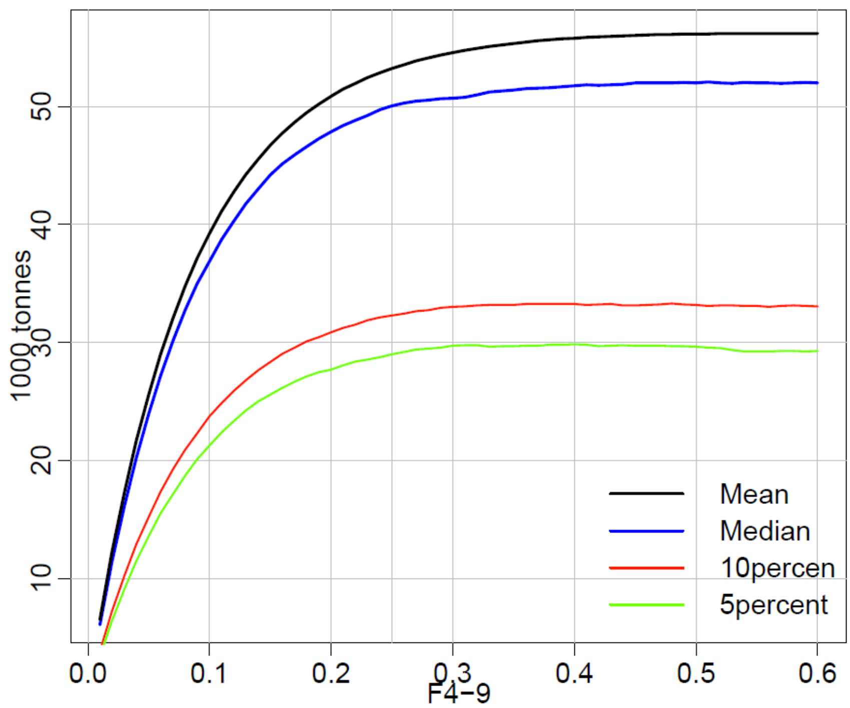


Figure 8.12. Saithe in Division Va. Estimated yield against intended fishing mortality with no SSB-Recruitment function. The figure shows mean, median, 10th percentile and 5th percentile.

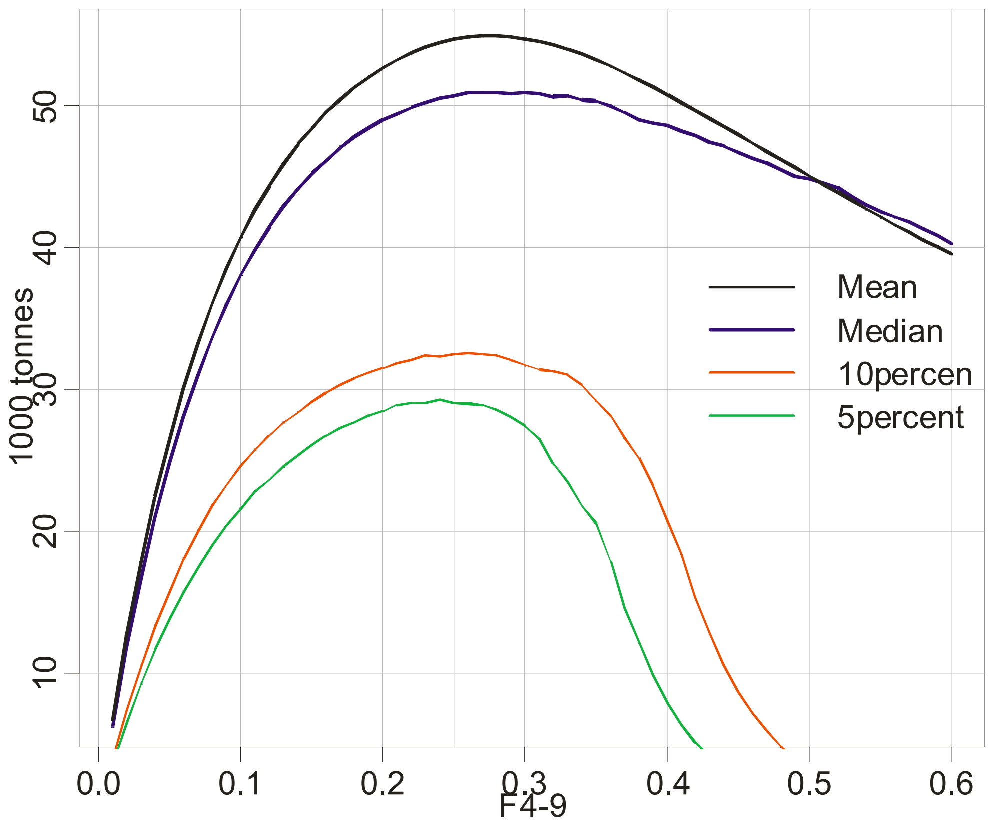


Figure 8.13. Saithe in Division Va. Estimated yield against intended fishing mortality with the assumption of a hockeystick SSB-Recruitment function. The figure shows mean, median, 10th percentile and 5th percentile.

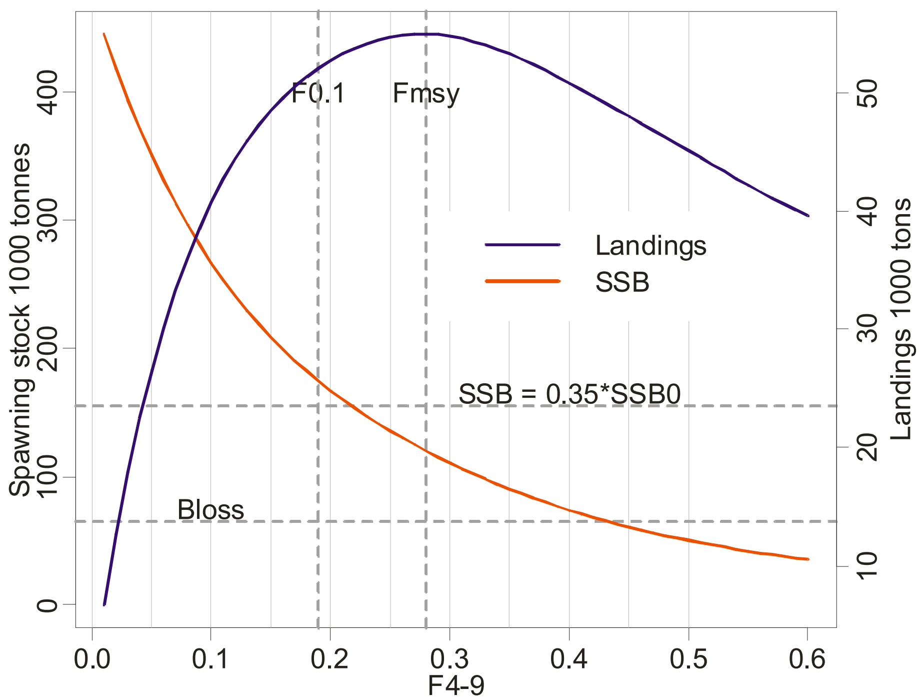


Figure 8.14. Saithe in Division Va. Yield and SSB as function of intended fishing mortality.

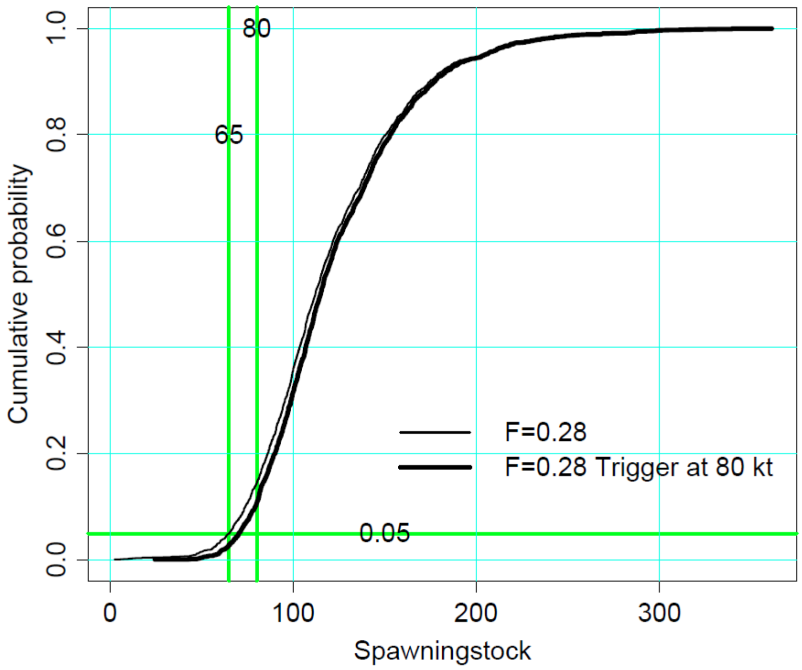


Figure 8.15. Saithe in Division Va. Cumulative probability distribution of the SSB in 2069 when fishing at 0.28, with and without a trigger of 80 kt.

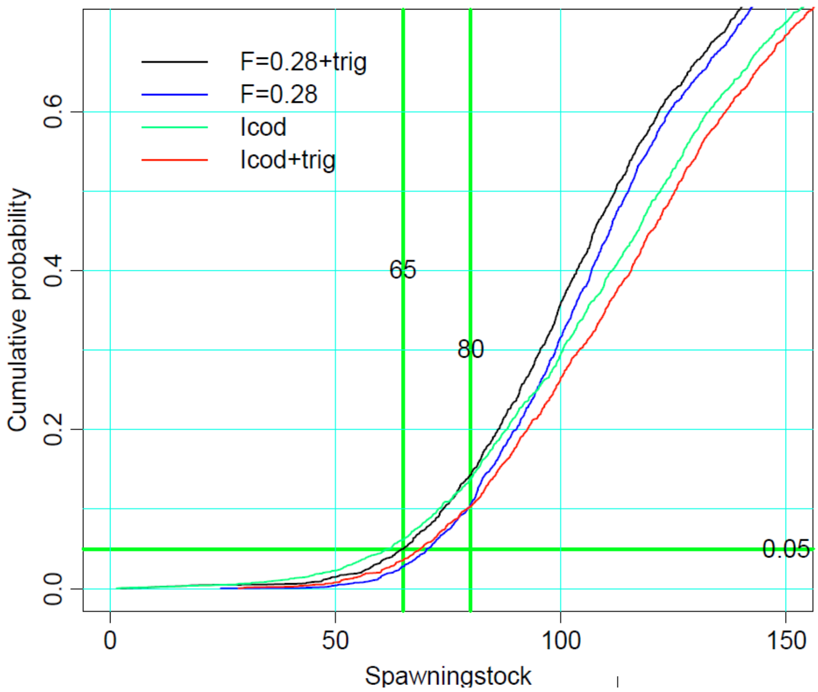


Figure 8.16. Saithe in Division Va. Cumulative probability distribution of the SSB in 2069 when fishing at 0.28 and applying the Icelandic cod HCR, with and without a trigger of 80 kt.

9 Icelandic cod

Summary

INPUT DATA: The total reported landings in 2009 were 183 kt. Total landings in the last 5 fishing year have been relatively close to the set TAC for the Icelandic fleet. In the last fishing (2008/2009) the TAC was set to 160 kt and the landings were 168 kt.

Mean weight at age in landings have been declining in the last 6-7 years and are in 20098 about 9 to 18 % below the long term average in 1985-2009. Weights at age in the spring survey have also been declining over the same period and are generally very low in the 2019 spring survey.

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 first measurements of the 2008 and 2009 year classes indicates that it may be at or above average. These year class will however not contribute significantly to the fisheries until after 2012.

ASSESSMENT MODELS: Several assessment models were applied as in recent years. The results from the AD-Model builder statistical Catch at Age Model (ADCAM) as was used as the final run, as done in the previous years. This year both the spring and the fall survey were used in the tuning, compared with last year when only the spring survey was used in the final run.

COMPARISON WITH 2009 ASSESSMENT: The estimates of reference fishing mortality in 2008 is now 0.38 compared with 0.42 estimated last year. The B4+ in 2009 is now estimated to have been 793 kt compared with 702 kt estimate last year.

STATE OF THE STOCK: The spawning stock has been relatively small in the last 40 year compared with the time before that. It reached a historical low in 1993 (120 kt) but has since then increased and is estimated to be about 300 kt at present. In spite of major drawback around the year 2000 exploitation rate and fishing mortality have on the been lower after the implementation of the catch rule in 1995 compared with period 1980-1993. Fishing mortality has declined significantly in recent years, the present estimate of about 0.4 not seen since the early 1960's. First measurement of the 2008 and 2009 year classes indicate that they may at or above medium size.

9.1 Stock description and management units

The Icelandic cod stock is distributed all around Iceland and in the assessment cod within Icelandic EEZ waters it is assumed to be a single homogenous unit in the assessment. Spawning takes place in late winter mainly off the southwest coast but smaller, variable regional spawning components have also been observed all around Iceland. A slight but significant genetic difference has been observed between the cod spawning in the northern waters vs cod spawning in the southern waters (Pampoulie *et al* 2007). There are indications that different behavioural type (shallow vs. deep migration) may be found within cod spawning in the same areas (Pampoulie *et al* 2008). Both these information indicate that management measurements operating on a finer scale may be warranted, although appropriate non-abiguous management measure in addition to maintaining low fishing mortality have not yet been identified.

The pelagic eggs and larvae from the main spawning grounds off the southwest coast 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 which are considered to be of Icelandic origin have been observed in some years. This pattern was quite prevalent prior to 1970, while condition in Greenlandic waters are thought to have been favourable for cod productivity. The latest of such migration was from the 1984 year class in 1990, the number estimated around 30 millions. Recent tagging experiments as well as abnominal decline in survey indices in West Greenlandic waters indicate that part of the 2003 and to some extent the 2002 year classes may have migrated from Greenland to Icelandic waters (see section 14 in this report).

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.

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 2009 are estimated to have been 183 kt (Table 9.2.1 and Figure 9.2.1). Of the total landings 181.3 kt were taken by Icelandic fleet but 1.3 kt by other nations. The latter includes around 0.5 kt of cod taken by the Faroese bottom trawl fleet inside the Faroese EEZ close to the line separating the Icelandic and Faroese EEZ.

Historically the landings of bottom trawlers constituted a larger portion of the total catches than today, in some years prior to 1990 reaching 60% of the total landings. In the 1990's the landings from bottom trawlers declined significantly, and have been just above 40% of the total landings in the last decade. (Figure 9.2.1). The share of long line has tripled over the last 20 years and is now on par with bottom trawl. The share of gill net has over the same time period declined and is now only half of what it was in the 1980's. Since the size of cod caught by the gillnet fleet is generally much larger than caught by other fleet, this change in fishing pattern is likely to have caused a significant reduction in the fishing mortality of older fish.

The trend in landings in recent years is largely a reflection of the set TAC (Figure 9.2.2) that is set for the fishing year (starting 1. September and ending 31 august). The TAC for the fishing year 2008/2009 was set at 160 kt while the landings where 168 kt.. The TAC for the fishing year 2009/2010 is set at 150 kt. This was done in accordance with a HCR that has now been evaluated by ICES (see section 9.11) The catches in the first four months of the fishing year (September – December 2009) were 58 kt or around 40% of the allocated quota. Hence it is estimated that landings by the ITQ fleet in January to September 2010 may be around 92 thousand tonnes. Allowance for some additional catches (6 kt for jiggers outside the ITQ and 5 kt for other and then catches in the first four months of the next fishing year) it is estimated that the catches in for the whole calendar year 2010 may amount to some 152 kt.

Estimates of annual cod discards (Pálsson *et al* 2006, Pálsson *et al* 2009) since 2001 are in the range of 1.4-4.3% of numbers landed and 0.4-1.8% of weight landed. Mean annual discard of cod over the period 2001-2008 was around 2 kt,or just over 1% of landings. In 2008 estimates of cod discards amounted to 1.1 kt, 0.8% of landings, the third lowest value int the period 2001-2008. The method used for deriving these estimates assumes that discarding only occurs as high grading but larger fish is usually higher priced.

In recent years misreporting has not been regarded as a major problem in the fishery of this stock. No study is though available to support that general perspective. Production figures from processing plants do though 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 2009 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 recent years there are indications that the share of the catches coming from older age groups has been increasing. In 2009 the number of 5 year old in the catches is low, confirming the prior estimates from the survey that the 2004 year class is small. 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). There are indications of an anomaly high value in the catch at age matrix of age 6 in 2009 in the Icelandic fisheries (based on TSA analysis, Guðmundur Guðmundsson, personal communication).

MEAN WEIGHT AT AGE IN THE LANDINGS: The mean weight age in the landings (Table 9.2.3 and Figure 9.2.4) declined from 2001 to 2007, reaching then a historical low in many age groups. The weight at age in 2009 for age groups 3-9 is around 7-18% lower than the average weights in 1985-2009. 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) but also change in fishing pattern. In recent years gillnet fisheries in the south have decreased (section 9.2.1). Mean weights at age of cod caught by gillnets is usually higher than of cod caught by other gears.

The reference biomass (B_{4+}) upon which the TAC in the fishing year is set (based on the HCR) is derived from population numbers and catch weights in the beginning of the assessment year. In recent years the estimates of mean weights in the landings of age groups 3-9 in the assessment years have been based on a prediction from the spring survey measurements in that year using the relationship between survey and landings weights in preceding year. Using this procedure last year gave slight underestimate of the predicted weight at age in the catches in 2009. The biomass estimates for the start of 2009 was last year estimated being 702 kt based on the predicted 2009 catch weights but would have been 729 kt based on the observed 2009 catch weights.

The same approach was used this year for predicting weight at age in the catches for 2010. The catch weights in 2010 were estimated from the weights in the spring survey 2010 using the relationship between survey and landings weight in 2009. Since the survey weights are higher for some age groups in 2010 compared with 2009 (Figure 9.2.5), mean weights at age in the catches are predicted to increase from 2009 to 2010 (Figure 9.2.4). The reference biomass of age groups four and older (B4+) in 2010 is based on those predicted weights.

9.2.3 Surveys

BIOMASS INDICES: The total biomass indices from the spring and the fall survey (Figure 9.2.6) indicate that the decline in total stock size observed in recent years has halted with the most recent observations indicating an increase in stock size. Indices of large fish is among the highest over the time series but indices of small fish relatively low, as would be expected in a situation where recruitment is poor and fishing mortality relatively low, as is considered to be the case for Icelandic cod.

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 the year classes 2005 and younger are larger than the record low 2001 and 2004 year classes. The age 1 abundance indices of year classes 2008 and 2009 are among of the highest observed. However, the measurement of the 2008 year class at age 2 in spring 2010 is only around average. This conforms to the pattern seen in recent years as explored using the following model:

$$U_{a+1,y+1} = a + bU_{a,y} + \varepsilon$$

A residual plot of the spring survey indices by age and year ($U_{a,y}$) from consecutive years based on this model shows that in recent years later observed values (ages 1 vs 2 and to some extent ages 2 vs 3) of the incoming year classes are smaller than expected on average (Figure 9.2.7, Table 9.2.8). 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 analytical assessments in recent years. The difference would be even larger if the estimates of *a* and *b* in the equation above were only based on data until the year 2001. The positive anomaly in recent years in the residuals of the older age groups that have entered the fishery are most likely a result of reduced fishing mortality in recent years, compared with the average over the whole time period.

9.3 Commercial cpue and effort

Unstandardised CPUE and effort indices, based on log book records were not considered during this meeting. In previous reports it has been concluded that changes in these parameters, although to some extent a reflection of the dynamics in the stock they are confounded by other factors.

9.4 Assessment

The structure of this chapter is kind of upside down. First an overview of the procedures used and assessment issues that have been raised in previous reports are presented ending with describing the decisiont reached by the NWWG 2010 this year. (OVERVIEW). This is then followed by a discussion on the comparison between the setting last year and the final run adopted this year (THE SPALY (NWWG 2009 SETTINGS) AND THE NWWG FINAL 2010 RUN). Following that is a summary of the independent analysis by Guðmundur Guðmundsson using the TSA framework (EXPLORATOINS IN THE TSA FRAMEWORK).

Overview:

The final assessment upon which point estimates have been used for management decisions in recent years have been based on catch at age **tuned with the spring survey indices only** using a statistical catch as age framework implemented in AD-Model Builder (acronym used by NWWG has been ADCAM). This model will be referred to as SPALY settings in the following text.

In additions to using the spring survey, assessments have also been done annually within the NWWG using the fall survey (SMH). Use of the available indices have also been explored in the TSA framework, using a Time Series Analysis developed and run by Guðmundur Guðmundsson (1994, 2004, model description and details of numerous runs are given in WD 15, NWWG 2010). Models where the catch/fishing mortality is not modelled (ADAPT) have also been explored as well as models using models where the fishing pattern is considered not to change each year (SEPARABLE). All these annual exercise have the principal objectives of exploring patterns in the measurements, plausibility of alternative hypothesis and sensitivity of model assumption on the assessment results. Hence there is no "Update assessment framework" in place for the Icelandic cod.

Using the above procedure, issues that have affect the assessment results have been identified in the most recent NWWG reports as:

- Spring vs. Fall survey estimates: Tuning with the fall survey has shown a persistent higher stock estimates than tuning with the spring survey. Although the cause is not exactly known, a change reflected in change in catchability of the spring survey can not be ruled out. This pattern is also observed this year.
- Estimation of incoming recruits: A pattern has been observed where the first survey estimates available for each cohort at age 1 is more optimistic than what later survey estimates show. This pattern is also observed this year with the addition of one more year in the spring survey.
- It has been hypothesised that the 2003 year class found in Greenlandic waters may in part be of Icelandic origin. Given that this hypothesis is true it has been anticipated in recent NWWG reports that a significant migration to Iceland may occur once these fish reach maturity.

All the above consideration were explored in this years assessment cycle. It was concluded by the NWWG that changes in the model setting from the SPALY settings are warranted. The working group concluded:

- Instead of using only the spring survey indices in the tuning adding the available measurement of the fall survey in the tuning is warranted.
- In addition, that spring survey q for age 1 should be estimated separately for the time period 1985-2001 and 2002-2010.
- Indication from tagging studies (section 14) and from the catch at age matrix in 2009 indicate that portion of the 2003 year class may have started to migrate from Greenlandic to Icelandic waters. Hence in the modelling framework an allowance for an estimation of immigration of age 6 in 2009 may be warranted. This is the same procedure as has been done on previous occations when such event have been suspected (most recently for year class 1984, at age 6 in 1990). Effectively, this is thus not a real change to the "SPALY" concept.

The SPALY setting (although not allowing for immigration at age 6 in 2009) gives a reference biomass (B4+) in 2010 of 764 kt. The proposed final run gave a 11% higher estimate or 846 kt. The effect on the ICES advice given the harvest control rule is however minimal. I.e. instead of advising on limiting catches to 151 kt the advice would be 160 kt. The difference in terms of estimated resulting fishing mortality in 2010 by applying these two target landings are 0.27 vs 0.29, respectively.

The SPALY (NWWG 2009 settings) and the NWWG FINAL 2010 run

The population numbers in 2010 from various model runs (spring (SMB) only, fall only (SMH) or both (SMB & SMH) are presented in Table 9.4.5. The stock in numbers as estimated in the NWWG 2010 final run (both spring and fall survey) are plotted against the survey measurements in figures 9.4.3 a and b. Included in the plot is also the stock in number as estimated using the SPALY setting (spring survey only). The values are plotted on a log scale, which is the same scale as “the model sees it”. The population estimates in 2010 fall reasonable well within that expected from the long term relationship for most age groups. This includes the estimates of age group 7, for which migration was allowed to occur at age 6 in 2009. Estimates of age group 4 in 2010 shows slight discrepancy from that expected when using both surveys, it being overestimated relative to the spring survey measurements but underestimated relative to the fall survey measurement. Using both survey in the tuning results in a compromise between the two conflicting survey measurements of year class 2006. This is the largest contributor to the discrepancy in the reference biomass estimates (B4+) of the SPALY vs FINAL. The estimates of the 2009 year class (only observed in the spring survey at age 1 in 2010) from the FINAL run is somewhat lower than would be expected, this being driven by estimating q at age 1 separately for the period 1985-2000 and 2001-2010. Inclusions of this feature is however warranted since it corrects for the large positive block of residuals observed in the SPALY setting (see spring survey residuals at age 1 in Figure 9.4.1a vs Figure 9.4.1b). Effectively we are assuming that the pattern observed since 2000 is still in place for the most recent year classes, most notable year class 2009.

Exploratoins in the TSA framework:

What follows is a summary of the independent analysis by Guðmundur Guðmundsson using the TSA framework. Further details of the model including equation and residual patterns are provided in NWWG 2010 WD 15. The principal population metrics from the TSA model are given in the overview table (Table 9.4.5).

The stock size of 4-11 years old fish is estimated 733 kt with a standard deviation of 47 kt by the Spring-survey and 951 kt., s.d.82 kt, by the Fall survey. Examined separately, the results with both surveys appear fairly satisfactory and acceptable with the estimated accuracy. But the estimates of the total biomass differ by 218 kt and there is a corresponding difference in the fishing mortality rate. This is a significant difference and strengthened by the fact that the estimates are partly based on the same observations and thus positively correlated.

The most important sources of systematic errors in stock assessment by catch-at-age and CPUE data are probably wrong assumptions about natural mortality, unreported catches and discards and permanent variations in catchability in the survey or fleets where the CPUE is calculated. The same M and same catch-at-age data are employed in both estimates so that only the catchability needs consideration here.

There is no indication of random walk (equation (4)) in catchability in either survey. Estimation of linear trend was negligible and insignificant in the fall survey, but negative by 0.0102 year^{-1} (ln-scale) with a standard deviation of 0.0062. The null hypothesis of no trend is rejected at 10% risk against the alternative of trend, but 5% against the alternative of a negative trend. This takes only into account the stochastic uncertainty. Actual uncertainty is bigger because of the uncertainty about model specification. However, combined with the results from the fall survey, the evidence for decreased catchability in the spring survey is not negligible.

The assessment of the total stock 2010 from ages 4-11 years is 830 kt when using the spring survey where decreased catchability trend is included. The calculation of the standard deviation of this estimate is rather uncertain, but it is certainly much bigger than in estimates where no permanent variations in catchability are estimated. Preliminary value is 123 kt. but this awaits further simulation studies.

The residuals from the spring survey from 2-4 years age in 2006-2010 are all negative and this feature remains when trend in catchability is included. This implies that predictions of the stock estimate obtained by the spring-, (but not fall), survey at 4 years by the values of respective year class at 1-3 years are too high. Possible explanations of this are that catchability in the youngest ages has increased, or remained constant while catchability of older fish decreased. Another explanation could be that natural mortality has increased in the youngest ages. There is no evidence of this in the fall survey.

The standard deviations, obtained by the Kalman filter, refer to stock size at respective time. They can be regarded as predictions of recruitment from the year class, but then the random variations in natural mortality until the age at recruitment is reached, represented by $\delta_{n,at}$ in our models, must be added to the variance at the time of the survey. This is also presented in the following table. The year class strength is in million fish, standard deviations in ln-values. The adjustment in the table below refers to predictions of estimates by the March survey. The standard deviations apply to ln-values, "s.d" in 2010 and "s.d.pred" to estimates at 3 years of age.

Conclusions

The reference biomass in 2010 (upon which the advice is based on) ranges from 733-830 in models calibrated with the Spring survey only and 804-951 kt in models calibrated with the fall survey (Table 9.4.5). When both surveys are used in the tuning the estimates based on the ADCAM framework is somewhere between the extremes or 846 kt.

The TSA analysis concludes that there may be a negative catchability trend in the spring survey and that this explains in part the discrepancy obtained in the stock trajectory estimated. Reasonable causative factor for this have however not been identified. Nor the difference that still remains in the stock estimates when the two surveys are treated independently.

Hence the WG concludes that basing the advice on one or the other of the survey indices may be a little premature and hard to defend at this time. Since the ADCAM tuning using both the spring and the fall survey gives estimates that are somewhere between the extreme ranges, the working group concluded that that may the most pragmatic compromise as an advice basis this year. What is the most likely scenario is than whatever the final point that is selected is most definitively the wrong one. It should be emphasized that the difference in the population estimates between the

SPALY and the FINAL run are only 11%, and given the HCR result in insignificant difference in the fishing mortalities exerted during the advisory year.

The estimating fishing mortalities and stock in numbers by age are from the FINAL run (ADCAM, spring and fall survey) are presented in Tables 9.4.3 and 9.4.4.

9.5 Reference points

Reference points are dealt with in the section on Mangement Plan Evaluation.

9.6 State of the stock

The spawning stock reached a historical low in 1993 (120 kt) but has since then increased and is estimated to be above 300 kt at present (Figure 9.6.1). With the exception of a brief period around the 1980´s when a large immigration of the 1973 year class from Greenland influence the stock dynamics in Icelandic waters, a spawning stock biomass above the current estimates has not been observed since around the 1970's. This increase in biomass of older fish occurs despite productivity being relative poor in recent years, both in terms of recruitment and growth. The driving factor is hence attributed to a significant decline in fishing mortality/exploitation rate over the past 20 years, being at present within the same order as observed in the beginning of the time series. First measurements of the 2008 and 2009 year classes indicate that they may be at or above average.

9.7 Short term forecast

INPUT : Given the current harvest control rule, the only additional prediction needed is the estimates of catch weight in 2010. These were described in section 9.2.2. Additional assumptions used in the predictions are: Weights and proportion mature in the spawning stock 2011 and onwards were assumed to be the same as measured in the mature fish in the spring survey in 2010 (Tables 9.2.4 and 9.2.5). The fishing pattern used is the average of the years 2007-2009. The estimated landings for the calendar year 2010 are 152 kt as discussed in section 9.2.1. Details of the inputs values are provided in Table 9.7.1.

OUTPUT: The estimated reference biomass in 2010 is 846 kt. The TAC in the current fishing year is 150 kt. According to the harvest control rule the TAC in the next fishing year is:

$$
\begin{aligned}
TAC_{2010/2011} &= \left(TAC_{2009/2010} + 0.2B_{4+,2010}\right)/2 \\
&= \left(150 + 0.2*846\right)/2 \\
&= \left(150.0 + 169.2\right)/2 \\
&= 159.6 \approx 160 \text{ kt}
\end{aligned}
$$

Fishing mortality is expected to decline further from a point estimate of just under 0.4 in 2009 to 0.3 in 2010 and beyond. The deterministic estimates of the reference biomass and the spawning stock are predicted to increase somewhat from the present level by 2012.

An advice based on fishing at Fmax =0.32 in 2011, as has been the basis by ICES in the last two year would result in 181 kt. However, since ICES has evaluated the HCR to be in conformity with the ICES MSY framework, the MSY based advice should be set accordingly, i.e. 160 kt.

9.8 Medium term forecasts

No medium term simulation (up to 2016) were done this year. See however long term simulations in section 9.11.

9.9 Uncertainties in assessment and forecast

As discussed in section 9.4 and shown in Table 9.4.5 there is some difference between results of assessment models calibrated with the autumn survey and those calibrated with the March survey. The exact cause of this has not been identified although it is unlikely to be because significant changes in the quality of the landings statistics or changes in M.

The ratio B4+,y / B4+,2010 (Figure 9.9.1) where B4+,y refers to the contemporaneous estimates in year y gives an indication of the bias, cv and autocorrelation in the historical performance of the MRI stock assessors. There cv is roughly 0.14, the autocorrelation around 0.45 and the bias is on the order of 1.05. These estimates are much lower in the analytical retrospectives using the current modelling framework.

The above values, in addition to autocorrelation in predicted weight at age in the implementation year were included in the evaluation of the HCR (ICES 2009).

9.10 Comparison with previous assessment and forecast

The reference stock (B_{4+}) in 2009 is now estimated to be 793 kt compared to 702 kt last year. 23 kt of the difference is caused by higher than predicted mean weight at age in the catches and 27 kt by the changes in stock numbers estimates. The remainder is a result of estimation of immigration of the year class 2003.

The SSB in 2009 is now estimated to be 254 kt compared to 224 kt estimated last year.

Fishing mortality in 2008 is now estimated 0.38 compared to 0.42 estimated last year.

Estimate of year classes 2008 is now 27% lower than estimated in 2009. Other incoming year classes (2004-2007) are estimated to be 0-10% larger than in last years assessment.

9.11 Management plans and evaluations

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 implemented was:

$$TAC_{y/y+1} = 0.25\frac{B_y + B_{y+1}}{2}$$

Where the $TAC_{y/y+1}$ refers to the fishing year starting in september in year y and ending in august in year y+1 and the biomass estimates refer to start of calendar year y and calendar year y+1. The rule followed work of a group (xxx 1994) set up by the minister of fisheries. The suggestions of the group were somewhat different from what was in the implemented or

$$TAC_{y/y+1} = \frac{TAC_{y-1/y} + 0.22B_y}{2}$$

The HCR that was set in place in 2009 to be effective from the fishing year 2009/2010 onwards is similar to the original proposed HCR except the harvest rate is now set lower, or 0.2 instead of originally proposed rate of 0.22.

The current HCR has been evaluated by ICES (Ad hoc Group on Iceland Cod HCR Evaluation, ICES 2009). The following are excerpts from the original request by the managers and ICES response:

Managers 2009 request

"Since the mid 1990's the Government of Iceland has attempted through its management scheme for the Icelandic cod fishery to increase the size of the cod stock towards the size that generates maximum sustainable yield. To that end, progress has been made, reflected in lower fishing mortality and increase in spawning stock biomass from historical low of 120 thousand tons in 1993 to 220thousand tons at present.

In accordance with this general aim, the Government has adopted a management plan for the Icelandic cod stock for the next five fishing years, starting by the 2009/2010 fishing season. The main objective of the management plan is to ensure that the spawning stock biomass (SSB) will with high probability (>95%) be above the present size of 220 thousand tons by the year 2015. According to a medium-term simulation conducted by the ICES North West Working Group this spring (Draft NWWG Report 2009), this will be achieved by applying the following harvest control rule (HCR) to calculate the total allowable catch (TAC):

TACy+1 = (0.2 B4+,y + TACy)/2, where y refers to the assessment year and B4+ to biomass of 4 year and older cod.

This HCR formulation is based on recommendation from national committee of experts that re-evaluated the performance of the initial catch rule adopted in 1995. The Marine Research Institute, Reykjavik has used this HCR as a basis for advice the last two years.

The Government 0f Iceland will determine the TAC for the next five fishing years according to this harvest control (HCR) and informs hereby the General Secretary of this harvest strategy.

The Government of Iceland requests the Council to evaluate this management plan at its earliest convenience."

Ices 2009 response

(http://www.ices.dk/committe/acom/comwork/report/2010/Special%20Requests/Icelandic%20cod%20management%20plan.pdf)

"… the plan is consistent with the precautionary approach (low probability of the stock declining to a level where future productivity of the stock may be impaired) and the medium-term projected fishing mortality is consistent with international commitments to achieve maximum sustainable yield (high long-term average yield, Fmax=~0.3)"

"Biological reference points have not been defined for this stock. The latest ICES' assessment and advice, indicates that the SSB in 1993 was the lowest in the time series. This gives an estimated Bloss at ~123 kt. The estimated SSB for 2009 is ~220 kt (~1.8 x Bloss) which is the reference biomass for the management plan. ICES' evaluation of the management plan indicates a projected SSB in 2015 that has a high probability (> 95%) of being above the estimated SSB for 2009. This statement implies a low probability (< 5%) that the projected SSB for 2015 will be below Bloss (a candidate value of Blim) and hence, ICES' evaluates the management plan to be precautionary."

"The exact conditions leading to MSY are not well known, and may depend on external conditions. The expected decrease in fishing mortality should increase stock biomass closer to that producing maximum sustainable yield. The projected management plan catch fraction of ~0.2 on average is similar to common proxies for FMSY."

Reference points

As indicated in the ICES response above, hockey stick regression based on the low recruitment scenario observed since 1985 gives an estimate of Bbreak that is not significantly from Bloss of around ~123 kt (Figure 9.11.1). The scientific basis and the methods used in the calculation are extentively described in the AGICOD (ICES 2009). The NWWG recommends that Blim be defined based this approach and that ICES sets it formally at 125 kt. Using the default formula used by ICES for many other stocks a Bpa of ~180 kt can be calculated.

Since no Btrigger is set in the current HCR, it is not in full conformity with newly established ICES MSY framework. An objective of the management plan is that there is a high probability that the SSB will be above 220 kt in 2015. By applying the HCR, simulation indicate that there is low probability that the stock will go below 220 kt in the long term (Figure 9.11.2). In order that the HCR is in full compliance with the newly established ICES MSY framework NWWG recommends that the management authorities consider setting Btrigger=220 kt as a part of the current HCR with a proportional reduction in fishing morality if the stock goes below that point.

9.12 Management considerations

See paragraph above on recommendation of Btrigger.

Prior to allocating quota to the Icelandic fleet that is under the ITQ control, the managers should ensure subtracting all estimated catches from other sources. The amount is not known precisely in advance but is likely to be of the similar order of magnitude as in recent years.

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. The pressure to open closed areas could be an indication that fishing effort was too high

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 cannot 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 fish. 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 in relative to other species (due to restrictive TAC),the fleet has shifted to somewhat shallower water. It has been hypothesised that this may lead to increased targeting of small cod. This hypothesis has not been supported 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 in 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.

9.17 Response to 2009 review and technical minutes

Comment 1: "However, the report was not finalized before review. A lot of marked and uncompleted text and data still." taken care of in the current report.

Response: Every effort has been made in this report to correct that.

Comment 2: Table 9.2.1. Missing landings data for Iceland I don't understood. Have to be put or explained.

Response: The table heading states "Nominal catches (tonnes) by countries 1973-2008 as **officially reported to ICES** and WG best estimates of landings"

Comment 3: Table 9.2.6. "Data for the age 1 in 2009 is very high – almost highest from 1985. Is it cannot be overestimated?"

Response: The table show survey index estimates. The estimates are based on standard scientific calculation of a standard stratified scientific survey. In the analytical modelling framework used in the assessment the estimates of the 2008 year class was far lower than what is implied by the measurement alone. In addition the size estimate at age 1 in this stock/fishery has no influence on the short term predictions and advice, since the fishery effectively only start fishing on sizes that are equivalent to age 4.

Comment 4: "Figure 9.2.7. Seems that residuals for some ages and years are very high. It's difficult to analyse because cannot to see exact value."

Response: Residuals have been provided this year in a table.

Comment 5: The assessment has been performed correctly, although it is uncertain due to the survey indices used. There is an urgent need for a benchmark in the short time. The present management has led to an increase in F and a de-crease in SSB below Bpa. A management plan is needed that ensures sustainable harvest rates (e.g., MSY) in the future.

Response: The NWWG does not consider that there is an urgent need for a benchmark for this stock. A harvest control rule is in place and has been evaluated by ICES. The rule is in accordance with the MSY concept.

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Table 9.2.1. Icelandic cod in division Va. Nominal catches (tonnes) by countries 1973-2009 as officially reported to ICES and WG best estimates of landings.

Year	Belgium	Faeroe Islands	France	Germany	Germany, Fed. Rep	Greenland	Iceland	Norway	Poland	UK - Eng+Wales+N	UK - England & Wa	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
2008															148000	

Table 9.2.2. Icelandic cod in Division Va. Observed catch in numbers by year and age in millions of fish in 1955-2008. The 2009 catches are estimates based on a landing estimates of 160 kt, the 2010 and beyond 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	2.616	4.850	12.585	11.973	5.238	4.582	2.040	0.831	0.308	0.053	0.037	0.004
2009	3.660	8.150	9.480	17.330	10.060	3.910	2.290	0.770	0.310	0.090	0.020	0.010
2010	1.990	6.078	10.008	6.504	9.220	5.113	1.190	1.283	0.455	0.172	0.068	0.011
2011	2.634	5.958	9.495	10.395	5.088	6.226	2.924	0.728	0.702	0.253	0.091	0.038
2012	2.637	7.848	9.278	9.854	8.142	3.445	3.572	1.796	0.400	0.393	0.135	0.051
2013	2.244	8.031	12.509	9.872	7.926	5.668	2.034	2.258	1.016	0.230	0.216	0.078
2014	2.297	6.939	12.995	13.514	8.064	5.604	3.400	1.306	1.298	0.595	0.129	0.126
2015	2.337	7.063	11.162	13.954	10.971	5.666	3.340	2.170	0.746	0.755	0.330	0.075

Table 9.2.3. Icelandic cod in Division Va. Observed mean weight at age in the landings (kg) in period the 1955-2009. The weights for age groups 3 to 9 in 2010 are based on predictions from the 2010 spring survey measurements, weight for 2010 onwards are set equal to those in 2010. 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	1.162	1.627	2.318	3.120	3.846	5.367	6.771	7.648	8.282	11.181	14.266	17.320
2009	1.109	1.680	2.204	3.206	4.098	4.884	6.744	8.505	10.126	12.108	12.471	15.264
2010	1.057	1.662	2.335	3.190	4.610	5.481	6.656	8.499	10.119	12.100	12.463	15.254
2011	1.058	1.662	2.336	3.190	4.611	5.482	6.658	8.501	10.121	12.102	12.465	15.257
2012	1.058	1.663	2.337	3.191	4.612	5.484	6.660	8.504	10.124	12.106	12.469	15.262
2013	1.058	1.663	2.337	3.192	4.613	5.485	6.661	8.505	10.125	12.107	12.470	15.263
2014	1.058	1.663	2.337	3.192	4.613	5.485	6.661	8.505	10.126	12.108	12.471	15.264
2015	1.058	1.663	2.337	3.192	4.613	5.485	6.661	8.505	10.126	12.108	12.471	15.264

Table 9.2.4. Icelandic cod in Division Va. Estimated weight at age in the spawning stock (kg) in period the 1955-2010. The weights for the period 2011 onward are set equal to those in 2010. 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	1.017	1.841	2.227	2.924	3.920	5.367	6.771	7.648	8.282	11.181	14.266	17.320
2009	1.017	1.440	2.027	2.871	3.909	4.884	6.744	8.505	10.126	12.108	12.471	15.264
2010	1.017	1.587	2.150	3.128	4.169	5.484	6.659	8.503	10.124	12.105	12.468	15.260
2011	1.017	1.587	2.151	3.128	4.169	5.484	6.660	8.504	10.124	12.106	12.469	15.262
2012	1.017	1.587	2.151	3.129	4.170	5.485	6.661	8.505	10.125	12.107	12.470	15.263
2013	1.017	1.587	2.151	3.129	4.170	5.485	6.661	8.505	10.126	12.108	12.471	15.264
2014	1.017	1.587	2.151	3.129	4.170	5.485	6.661	8.505	10.126	12.108	12.471	15.264
2015	1.017	1.587	2.151	3.129	4.170	5.485	6.661	8.505	10.126	12.108	12.471	15.264

Table 9.2.5. Icelandic cod in Division Va. Estimated maturity at age in period the 1955-2010. The maturity for the period 2011 onward are set equal to those in 2010.

Year\age	3	4	5	6	7	8	9	10	11	12	13	14
1955	0.019	0.022	0.033	0.181	0.577	0.782	0.834	0.960	1.000	1.000	1.000	1.000
1956	0.019	0.025	0.033	0.111	0.577	0.782	0.818	0.980	0.980	1.000	1.000	1.000
1957	0.019	0.026	0.043	0.100	0.549	0.801	0.842	0.990	1.000	1.000	1.000	1.000
1958	0.019	0.028	0.086	0.520	0.682	0.801	0.834	1.000	1.000	1.000	1.000	1.000
1959	0.019	0.029	0.070	0.535	0.772	0.818	0.834	0.990	1.000	1.000	1.000	1.000
1960	0.019	0.026	0.066	0.577	0.782	0.826	0.834	0.990	1.000	1.000	1.000	1.000
1961	0.019	0.025	0.053	0.450	0.772	0.818	0.834	0.990	0.990	1.000	1.000	1.000
1962	0.019	0.025	0.048	0.281	0.791	0.834	0.834	0.990	0.990	1.000	1.000	1.000
1963	0.019	0.025	0.048	0.237	0.706	0.834	0.849	1.000	1.000	1.000	1.000	1.000
1964	0.019	0.026	0.048	0.329	0.762	0.826	0.849	1.000	1.000	1.000	1.000	1.000
1965	0.019	0.025	0.045	0.354	0.751	0.826	0.842	1.000	1.000	1.000	1.000	1.000
1966	0.019	0.026	0.045	0.394	0.791	0.849	0.849	1.000	1.000	1.000	1.000	1.000
1967	0.019	0.028	0.051	0.341	0.772	0.842	0.849	1.000	1.000	1.000	1.000	1.000
1968	0.019	0.025	0.051	0.292	0.682	0.801	0.842	1.000	1.000	1.000	1.000	1.000
1969	0.019	0.028	0.043	0.227	0.682	0.801	0.842	1.000	1.000	1.000	1.000	1.000
1970	0.019	0.023	0.041	0.227	0.644	0.772	0.818	1.000	1.000	1.000	1.000	1.000
1971	0.019	0.025	0.037	0.074	0.657	0.706	0.772	0.979	0.994	0.982	0.993	1.000
1972	0.019	0.023	0.035	0.106	0.450	0.772	0.809	0.979	0.994	0.982	0.993	1.000
1973	0.022	0.028	0.163	0.382	0.697	0.801	0.834	0.996	0.996	1.000	1.000	1.000
1974	0.020	0.031	0.085	0.346	0.636	0.790	0.818	0.989	1.000	1.000	1.000	1.000
1975	0.020	0.035	0.118	0.287	0.715	0.809	0.839	1.000	1.000	1.000	1.000	1.000
1976	0.025	0.026	0.086	0.253	0.406	0.797	0.841	1.000	1.000	1.000	1.000	1.000
1977	0.019	0.024	0.060	0.382	0.742	0.817	0.842	1.000	1.000	1.000	1.000	1.000
1978	0.025	0.025	0.052	0.192	0.737	0.820	0.836	1.000	1.000	1.000	1.000	1.000
1979	0.019	0.021	0.053	0.282	0.635	0.790	0.836	0.919	1.000	1.000	1.000	1.000
1980	0.026	0.021	0.047	0.225	0.653	0.777	0.834	0.977	1.000	0.964	1.000	1.000
1981	0.019	0.022	0.030	0.090	0.448	0.751	0.811	0.962	0.988	1.000	1.000	1.000
1982	0.021	0.025	0.038	0.065	0.297	0.705	0.815	0.967	1.000	1.000	1.000	1.000
1983	0.019	0.030	0.047	0.116	0.264	0.530	0.715	0.979	0.985	1.000	1.000	1.000
1984	0.019	0.024	0.053	0.169	0.444	0.620	0.716	0.949	0.969	0.948	1.000	1.000
1985	0.000	0.021	0.185	0.412	0.495	0.735	0.572	1.000	1.000	1.000	1.000	1.000
1986	0.001	0.023	0.149	0.395	0.682	0.734	0.941	0.962	0.988	1.000	1.000	1.000
1987	0.002	0.033	0.093	0.360	0.490	0.885	0.782	1.000	0.979	1.000	1.000	1.000
1988	0.006	0.029	0.225	0.511	0.448	0.683	0.937	0.946	0.974	0.821	1.000	1.000
1989	0.008	0.025	0.142	0.372	0.645	0.652	0.634	0.991	1.000	0.903	0.859	1.000
1990	0.006	0.012	0.155	0.437	0.581	0.796	0.814	0.986	1.000	1.000	1.000	1.000
1991	0.000	0.055	0.149	0.369	0.637	0.790	0.682	0.842	1.000	1.000	1.000	1.000
1992	0.002	0.062	0.265	0.402	0.813	0.917	0.894	1.000	1.000	1.000	1.000	1.000
1993	0.006	0.085	0.267	0.464	0.693	0.801	0.843	0.968	1.000	1.000	1.000	1.000
1994	0.008	0.110	0.339	0.591	0.702	0.917	0.698	0.852	0.985	1.000	1.000	1.000
1995	0.005	0.109	0.384	0.528	0.752	0.787	0.859	1.000	1.000	1.000	1.000	1.000
1996	0.002	0.031	0.186	0.499	0.650	0.733	0.812	1.000	1.000	0.986	0.971	1.000
1997	0.006	0.037	0.246	0.424	0.685	0.787	0.804	0.932	1.000	0.913	1.000	1.000
1998	0.000	0.061	0.209	0.491	0.782	0.814	0.810	0.925	0.998	1.000	1.000	1.000
1999	0.012	0.044	0.239	0.516	0.649	0.835	0.687	0.988	1.000	1.000	1.000	1.000
2000	0.001	0.065	0.248	0.512	0.611	0.867	0.998	0.980	1.000	1.000	1.000	1.000
2001	0.004	0.043	0.261	0.589	0.750	0.742	0.862	0.987	1.000	1.000	1.000	1.000
2002	0.008	0.086	0.322	0.656	0.759	0.920	0.550	0.979	1.000	1.000	1.000	1.000
2003	0.005	0.046	0.218	0.524	0.870	0.798	0.860	0.998	1.000	1.000	1.000	1.000
2004	0.000	0.038	0.246	0.549	0.626	0.843	0.816	0.990	1.000	1.000	1.000	1.000
2005	0.006	0.109	0.282	0.495	0.791	0.814	0.951	0.990	1.000	1.000	1.000	1.000
2006	0.002	0.023	0.294	0.448	0.751	0.869	0.743	1.000	1.000	1.000	1.000	1.000
2007	0.012	0.032	0.159	0.500	0.693	0.795	0.862	0.960	0.924	1.000	1.000	1.000
2008	0.001	0.041	0.275	0.550	0.730	0.826	0.846	0.954	0.736	1.000	1.000	1.000
2009	0.002	0.015	0.132	0.455	0.688	0.883	0.741	0.631	0.892	1.000	1.000	1.000
2010	0.000	0.016	0.057	0.380	0.820	0.869	0.928	0.818	0.583	1.000	1.000	1.000
2011	0.000	0.016	0.057	0.380	0.820	0.869	0.928	0.818	0.583	1.000	1.000	1.000
2012	0.000	0.016	0.057	0.380	0.820	0.869	0.928	0.818	0.583	1.000	1.000	1.000
2013	0.000	0.016	0.057	0.380	0.820	0.869	0.928	0.818	0.583	1.000	1.000	1.000
2014	0.000	0.016	0.057	0.380	0.820	0.869	0.928	0.818	0.583	1.000	1.000	1.000
2015	0.000	0.016	0.057	0.380	0.820	0.869	0.928	0.818	0.583	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	111.11	34.86	48.14	64.74	22.94	15.28	5.04	3.39	1.60
1986	15.10	60.90	95.61	22.47	21.52	27.46	7.18	2.80	0.93	0.82
1987	3.65	28.92	103.80	82.71	21.43	12.78	12.95	2.80	0.99	0.43
1988	3.45	7.45	72.11	103.77	69.71	8.39	6.41	6.94	0.68	0.28
1989	4.04	16.47	22.06	79.80	74.16	39.11	4.85	1.72	1.42	0.27
1990	5.56	11.80	26.17	14.18	27.83	35.22	16.74	1.76	0.59	0.48
1991	3.95	16.29	17.94	30.24	15.49	18.94	22.45	4.90	0.94	0.34
1992	0.72	17.24	33.32	18.94	16.58	6.87	6.35	5.76	1.48	0.23
1993	3.57	4.84	30.85	36.71	13.55	10.64	2.43	2.04	1.40	0.38
1994	14.40	15.03	9.00	26.91	22.43	6.09	3.96	0.80	0.54	0.49
1995	1.18	29.21	24.82	9.07	24.53	18.44	4.02	1.87	0.38	0.20
1996	3.72	5.52	42.74	29.71	13.17	15.34	15.09	4.20	1.16	0.22
1997	1.21	22.47	13.60	56.69	29.80	9.94	9.41	7.29	0.62	0.42
1998	8.07	5.58	30.05	16.21	63.36	29.72	7.02	5.73	3.37	0.76
1999	7.40	33.10	7.03	42.66	13.35	24.82	12.01	2.60	1.48	0.79
2000	18.84	28.02	54.90	7.00	30.79	8.69	8.83	4.58	0.56	0.35
2001	12.32	23.53	36.94	37.94	5.04	15.99	3.59	2.17	0.87	0.27
2002	0.92	38.85	41.36	40.70	37.16	7.45	9.01	1.67	0.82	0.35
2003	11.18	4.54	46.29	36.95	29.18	17.72	4.11	4.72	1.13	0.24
2004	7.01	26.61	8.16	64.43	38.37	27.79	15.92	3.03	3.21	0.51
2005	2.69	17.89	42.07	10.00	46.25	24.97	12.14	6.36	1.01	0.93
2006	9.11	7.59	24.94	40.60	11.75	31.57	11.63	4.07	1.62	0.25
2007	5.61	19.14	8.99	22.94	30.15	10.14	11.43	6.05	2.38	0.77
2008	6.75	12.41	23.02	9.86	22.38	22.99	9.46	7.97	3.05	0.78
2009	21.97	12.60	16.57	22.76	15.68	26.06	16.72	4.86	3.15	1.15
2010	18.78	21.46	18.92	18.12	24.64	14.13	18.35	9.91	3.27	1.98

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										
1996	6.69	3.57	20.00	13.98	5.40	7.44	6.26	1.60	0.31	0.09
1997	0.67	16.89	6.83	29.57	15.76	4.09	3.62	2.36	0.25	0.17
1998	5.92	2.63	15.62	7.36	16.01	16.03	5.20	2.24	1.27	0.20
1999	8.61	14.54	5.68	23.38	7.42	9.94	4.05	0.59	0.34	0.36
2000	4.60	13.17	15.25	3.71	11.15	3.49	2.61	1.11	0.34	0.28
2001	7.11	11.51	19.53	21.13	3.30	6.73	1.60	0.76	0.17	0.03
2002	0.92	13.72	16.11	23.39	15.94	5.41	4.77	1.11	0.61	0.08
2003	5.16	2.68	25.66	16.98	13.22	8.99	1.89	2.55	0.38	0.10
2004	3.67	16.28	6.92	29.86	18.85	11.73	7.38	1.88	1.65	0.23
2005	2.15	9.03	20.37	6.82	25.62	10.88	3.86	1.91	0.29	0.31
2006	4.51	4.52	16.28	23.04	7.67	13.93	6.12	2.05	1.02	0.16
2007	3.73	9.82	4.93	11.73	15.68	6.34	5.91	3.14	0.76	0.50
2008	5.30	11.88	15.19	7.68	17.54	18.51	5.67	5.61	1.50	0.79
2009	8.83	8.02	16.19	19.50	9.54	16.28	8.45	2.73	1.92	0.76

Table 9.2.8. Icelandic cod in Division Va. Internal consistency in the spring survey. Residuals of observed vs predicted indices based on model described in section 9.2.3.

Year/age	1	2	3	4	5	6	7	8	9	10
1985										
1986		1.24	-0.75	-0.36	-0.46	-0.28	-0.51	-0.86	-0.67	-0.69
1987		-0.07	0.93	-0.28	0.05	-0.12	-0.10	-0.14	-0.04	0.12
1988		-0.26	0.92	0.07	0.41	-0.37	-0.09	0.39	-0.31	-0.24
1989		0.16	0.10	0.22	0.05	0.11	-0.06	-0.39	-0.75	-0.06
1990		-0.09	-0.04	-0.25	-0.86	-0.01	-0.24	-0.23	-0.07	-0.04
1991		0.01	-0.15	0.09	0.02	0.08	0.59	-0.32	0.12	0.14
1992		0.15	0.17	-0.01	-0.27	-0.31	-0.40	-0.65	-0.17	-0.24
1993		-0.18	0.07	0.08	-0.15	-0.14	-0.23	-0.29	-0.48	-0.30
1994		0.09	-0.21	-0.13	-0.21	-0.31	-0.23	-0.27	-0.18	-0.03
1995		-0.01	-0.04	-0.05	0.06	0.17	-0.01	-0.11	-0.03	-0.14
1996		-0.18	0.07	0.10	0.04	-0.05	0.54	0.44	0.25	-0.01
1997		0.40	-0.10	0.38	0.18	-0.09	0.10	0.35	-0.62	-0.11
1998		-0.18	-0.10	0.02	0.76	0.61	0.11	0.41	0.59	0.84
1999		0.58	-0.29	0.32	-0.10	-0.37	-0.30	-0.19	-0.38	-0.76
2000		0.40	0.31	-0.06	-0.05	-0.16	-0.39	-0.09	-0.31	-0.41
2001		-0.63	-0.06	-0.45	-0.19	-0.15	-0.18	-0.44	-0.53	-0.03
2002		0.54	0.24	0.09	0.26	-0.05	0.03	-0.16	-0.06	-0.06
2003		-0.21	-0.08	-0.07	0.05	-0.07	-0.04	0.31	0.33	-0.17
2004		0.00	-0.23	0.46	0.18	0.31	0.54	0.11	1.06	0.17
2005		-0.20	0.12	-0.01	0.01	0.19	-0.11	0.03	-0.07	-0.39
2006		-0.22	-0.06	-0.04	-0.05	0.25	-0.16	-0.24	-0.45	-0.31
2007		-0.11	-0.27	-0.07	-0.05	-0.07	-0.41	0.25	0.58	0.32
2008		-0.19	-0.21	-0.04	0.06	0.19	0.31	0.70	0.49	-0.24
2009		-0.25	-0.21	-0.04	0.09	0.52	0.48	0.17	0.35	0.41
2010		-0.81	-0.12	0.02	0.18	0.13	0.74	1.21	1.34	2.24

Table 9.4.1. Icelandic cod in Division Va. Catch at age residuals from the ADCAM model tuned with the spring (SMB) and the fall (SMH) surveys.

Year\age	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	0.19	-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	0.24
1977	-0.40	-0.06	0.05	-0.09	0.13	0.05	0.31	0.03	-0.70	-0.48	-1.23	-2.49
1978	0.08	-0.01	0.04	-0.10	0.04	-0.21	0.12	-0.19	0.02	-0.05	0.53	1.20
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	0.10	0.15	-1.09
1981	-0.30	-0.21	0.08	-0.13	0.07	0.09	0.02	0.33	-0.08	0.60	-0.02	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	-0.86
1983	-0.32	-0.36	0.11	0.14	0.04	0.01	-0.04	-0.03	0.00	0.37	-0.20	0.59
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	0.04	0.18	-0.10	0.12	-0.10	-0.02	-0.14	0.14	0.03	-0.34	0.47	0.48
1986	0.15	-0.11	0.02	-0.02	0.18	-0.05	0.11	-0.21	0.09	0.06	-0.60	0.19
1987	-0.15	0.12	0.02	-0.17	0.06	0.03	-0.03	0.11	-0.38	-0.11	0.12	-0.29
1988	-0.09	-0.06	-0.05	0.14	-0.09	0.06	0.15	0.03	0.48	0.02	0.54	0.13
1989	-0.21	0.04	0.15	-0.07	-0.00	-0.16	-0.33	-0.10	-0.03	0.51	-0.03	-1.40
1990	-0.00	-0.13	-0.10	0.00	0.04	0.09	-0.09	-0.24	0.28	0.11	-0.23	0.08
1991	0.08	0.04	-0.12	-0.07	0.09	-0.08	0.12	-0.08	-0.32	0.39	-0.58	0.12
1992	-0.22	0.09	0.05	0.03	0.10	-0.01	-0.05	-0.07	-0.76	-0.78	-0.58	-0.15
1993	0.26	0.05	-0.19	-0.06	-0.07	-0.13	0.06	0.49	0.51	-0.21	-0.99	0.44
1994	0.04	0.25	-0.13	-0.18	-0.05	0.06	-0.20	-0.14	0.44	0.54	0.52	-0.37
1995	0.28	-0.03	0.09	-0.03	-0.04	-0.13	-0.13	-0.30	-0.21	0.74	1.13	0.64
1996	0.00	-0.05	-0.17	0.08	0.04	0.02	0.12	0.16	-0.39	-0.40	0.61	-0.03
1997	-0.15	0.03	-0.02	-0.11	-0.10	0.20	0.17	0.22	0.38	-0.76	-0.25	0.18
1998	-0.18	-0.17	0.07	0.08	0.02	-0.17	0.23	0.02	0.05	0.24	0.11	-0.74
1999	-0.10	0.03	0.04	0.03	0.09	-0.04	-0.25	-0.21	-0.28	-0.44	-0.52	-0.91
2000	0.17	-0.24	0.11	-0.03	0.01	0.11	0.04	-0.13	-0.02	0.13	-0.17	-0.07
2001	0.18	0.19	-0.15	-0.00	0.03	-0.18	0.10	0.27	-0.05	0.14	-0.52	0.01
2002	-0.02	0.08	0.03	-0.06	-0.03	-0.01	-0.15	0.27	0.28	-0.31	0.39	-1.06
2003	-0.23	0.02	-0.02	-0.02	0.18	0.00	0.23	-0.33	0.05	0.17	0.17	0.55
2004	-0.20	0.09	0.09	-0.07	-0.06	0.24	0.03	0.22	-0.50	0.01	0.26	-0.26
2005	0.19	-0.29	0.13	-0.04	-0.13	-0.09	0.34	0.08	0.32	0.10	0.07	-0.72
2006	-0.05	0.00	-0.14	0.08	0.04	-0.08	-0.06	0.16	-0.02	0.12	-0.16	-1.54
2007	-0.02	0.16	-0.09	0.02	-0.17	0.05	-0.01	0.14	0.74	0.35	0.80	-0.24
2008	0.03	-0.10	0.05	-0.09	0.10	-0.17	0.06	0.05	-0.01	0.11	0.07	-0.36
2009	0.11	-0.09	0.08	0.07	-0.07	0.28	-0.14	-0.25	-0.07	-0.40	0.10	-0.37

Table 9.4.2a. 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	-0.38	0.06	0.18	0.43	0.15	0.29	0.44	0.22	0.33	0.55
1986	0.46	-0.05	-0.44	-0.23	-0.08	0.03	-0.13	-0.24	-0.24	-0.04
1987	0.58	0.01	0.07	-0.44	-0.02	-0.05	0.07	-0.05	-0.08	0.02
1988	-0.22	0.03	0.45	0.16	-0.09	-0.31	0.12	0.48	-0.10	-0.10
1989	0.34	0.05	0.50	0.55	0.26	0.22	-0.09	-0.07	0.22	0.11
1990	-0.45	0.11	0.03	0.04	-0.15	-0.12	0.11	-0.11	-0.02	0.16
1991	-0.18	-0.45	0.07	0.14	0.25	0.07	0.17	-0.11	0.24	0.26
1992	-0.30	0.02	-0.24	0.11	-0.10	-0.10	-0.11	-0.11	-0.10	0.00
1993	-0.50	-0.05	0.15	-0.06	0.05	-0.01	-0.18	-0.12	-0.21	-0.26
1994	0.56	-0.26	0.00	0.10	-0.19	-0.29	-0.14	-0.19	-0.16	-0.09
1995	-0.23	0.13	-0.25	-0.06	0.17	0.01	-0.19	-0.08	-0.06	-0.20
1996	-0.62	-0.12	0.06	-0.12	0.20	-0.01	0.29	0.43	0.22	0.08
1997	0.13	-0.06	0.11	0.27	-0.02	-0.01	-0.01	0.28	-0.33	0.07
1998	-0.07	0.13	-0.22	0.12	0.52	0.32	0.13	0.23	0.45	0.51
1999	-0.02	0.17	-0.05	0.04	-0.04	0.12	0.07	0.02	-0.00	0.10
2000	0.89	0.13	0.24	-0.18	-0.07	-0.17	-0.16	0.04	-0.23	-0.20
2001	0.22	0.00	-0.02	-0.11	-0.46	-0.18	-0.33	-0.51	-0.33	0.08
2002	-0.21	0.23	0.10	0.06	0.06	-0.11	-0.14	-0.23	-0.38	-0.10
2003	-0.08	-0.10	-0.02	-0.05	-0.11	-0.17	-0.15	-0.03	0.19	-0.48
2004	-0.14	0.15	-0.11	0.25	0.11	0.26	0.23	0.19	0.44	0.30
2005	-0.05	0.09	0.15	-0.11	0.09	0.13	0.04	0.07	0.05	0.16
2006	0.08	0.08	-0.04	0.04	-0.07	0.19	-0.07	-0.29	-0.33	-0.28
2007	-0.25	0.13	-0.18	-0.21	-0.16	-0.13	-0.28	-0.03	0.02	-0.18
2008	-0.06	-0.12	-0.13	-0.27	-0.23	-0.07	0.18	-0.02	0.10	-0.20
2009	0.35	-0.10	-0.32	-0.25	-0.02	-0.07	-0.03	0.09	-0.20	-0.16
2010	0.12	-0.19	-0.20	-0.36	-0.21	-0.05	-0.07	-0.01	0.37	-0.03

Table 9.4.2b. Icelandic cod in Division Va. Fall survey (SMH) at age residuals from the ADCAM model.

Year\age	1	2	3	4	5	6	7	8	9	10
1985										
1986										
1987										
1988										
1989										
1990										
1991										
1992										
1993										
1994										
1995										
1996	0.04	-0.08	0.01	-0.21	-0.02	-0.07	0.19	0.22	-0.11	-0.04
1997	-0.19	0.15	-0.03	0.23	0.05	-0.16	-0.11	-0.00	-0.25	-0.05
1998	-0.20	-0.02	-0.17	0.02	-0.04	0.36	0.53	0.15	0.37	0.06
1999	0.27	-0.05	0.09	0.08	0.07	-0.00	-0.08	-0.26	-0.24	0.13
2000	-0.27	-0.04	-0.25	-0.09	-0.23	-0.21	-0.35	-0.27	0.10	0.24
2001	-0.13	-0.12	0.05	-0.04	-0.22	-0.24	-0.21	-0.45	-0.45	-0.30
2002	-0.18	-0.16	-0.12	0.13	-0.01	0.13	0.02	0.05	0.10	-0.34
2003	-0.12	-0.10	0.10	-0.18	-0.12	-0.15	-0.10	0.11	0.03	-0.40
2004	-0.08	0.18	0.09	0.09	0.15	0.10	0.25	0.36	0.55	0.21
2005	0.24	-0.03	0.10	0.08	0.23	-0.01	-0.24	-0.25	-0.15	-0.11
2006	0.07	0.04	0.13	0.06	0.08	0.04	0.05	-0.18	0.02	-0.06
2007	0.01	0.02	-0.22	-0.25	-0.11	-0.01	-0.17	0.06	-0.18	0.08
2008	0.32	0.21	0.05	0.00	0.12	0.23	0.31	0.27	0.12	0.32
2009	0.17	-0.04	0.17	0.11	0.07	0.02	-0.01	0.16	0.01	-0.01
2010										

Table 9.4.3. Icelandic cod in Division Va. Estimates of fishing mortality 1955-2009 based on ACAM using catch at age and spring and fall bottom survey indices. Estimates for 2010 are based on catch constraint; the prediction for 2011 is based on the harvest control rule.

Year\age	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1955			0.04	0.17	0.25	0.27	0.30	0.30	0.28	0.33	0.33	0.31	0.33	0.33
1956			0.05	0.18	0.25	0.26	0.29	0.30	0.30	0.34	0.36	0.34	0.33	0.33
1957			0.08	0.21	0.27	0.27	0.30	0.33	0.33	0.36	0.37	0.33	0.30	0.30
1958			0.11	0.25	0.30	0.29	0.32	0.37	0.40	0.44	0.45	0.39	0.33	0.33
1959			0.09	0.23	0.28	0.26	0.30	0.34	0.35	0.40	0.38	0.32	0.23	0.23
1960			0.10	0.23	0.29	0.29	0.34	0.40	0.43	0.48	0.48	0.39	0.27	0.27
1961			0.09	0.23	0.26	0.26	0.33	0.40	0.42	0.46	0.44	0.35	0.23	0.23
1962			0.11	0.25	0.28	0.26	0.35	0.42	0.47	0.51	0.49	0.38	0.24	0.24
1963			0.13	0.28	0.33	0.31	0.38	0.49	0.59	0.65	0.63	0.46	0.29	0.29
1964			0.13	0.29	0.37	0.36	0.43	0.57	0.74	0.81	0.84	0.61	0.39	0.39
1965			0.12	0.28	0.38	0.40	0.47	0.60	0.74	0.85	0.88	0.66	0.43	0.43
1966			0.09	0.25	0.34	0.38	0.49	0.62	0.78	0.92	1.01	0.79	0.53	0.53
1967			0.08	0.23	0.30	0.34	0.48	0.61	0.75	0.88	0.93	0.73	0.46	0.46
1968			0.08	0.25	0.34	0.41	0.58	0.77	1.04	1.20	1.36	1.08	0.74	0.74
1969			0.06	0.23	0.32	0.35	0.50	0.61	0.72	0.84	0.87	0.72	0.45	0.45
1970			0.07	0.27	0.39	0.43	0.55	0.65	0.76	0.89	0.95	0.80	0.52	0.52
1971			0.09	0.31	0.48	0.53	0.62	0.72	0.80	0.96	1.04	0.88	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	1.03	0.70	0.70
1975			0.11	0.31	0.50	0.60	0.72	0.88	1.02	1.13	1.26	1.11	0.78	0.78
1976			0.07	0.26	0.43	0.55	0.70	0.85	0.95	1.01	1.07	0.95	0.66	0.66
1977			0.03	0.20	0.33	0.43	0.61	0.72	0.73	0.74	0.70	0.63	0.41	0.41
1978			0.03	0.17	0.28	0.35	0.53	0.60	0.55	0.55	0.49	0.45	0.28	0.28
1979			0.03	0.17	0.27	0.34	0.50	0.57	0.50	0.49	0.42	0.39	0.25	0.25
1980			0.03	0.17	0.31	0.39	0.54	0.62	0.56	0.55	0.47	0.44	0.30	0.30
1981			0.02	0.18	0.35	0.49	0.65	0.82	0.85	0.82	0.75	0.70	0.53	0.53
1982			0.03	0.19	0.39	0.56	0.70	0.90	0.96	0.87	0.75	0.68	0.52	0.52
1983			0.02	0.18	0.38	0.55	0.71	0.88	0.92	0.86	0.74	0.68	0.53	0.53
1984			0.04	0.20	0.38	0.53	0.67	0.81	0.76	0.71	0.60	0.57	0.44	0.44
1985			0.05	0.23	0.42	0.58	0.71	0.83	0.77	0.70	0.60	0.57	0.45	0.45
1986			0.06	0.26	0.51	0.71	0.82	0.95	0.87	0.77	0.66	0.62	0.50	0.50
1987			0.06	0.27	0.55	0.81	0.90	1.06	0.99	0.85	0.75	0.70	0.58	0.58
1988			0.05	0.26	0.52	0.79	0.92	1.10	1.08	0.94	0.88	0.84	0.73	0.73
1989			0.04	0.24	0.46	0.65	0.79	0.89	0.80	0.72	0.65	0.63	0.52	0.52
1990			0.05	0.25	0.47	0.66	0.79	0.86	0.75	0.69	0.62	0.60	0.50	0.50
1991			0.09	0.30	0.56	0.81	0.88	0.95	0.84	0.77	0.71	0.69	0.59	0.59
1992			0.10	0.32	0.60	0.87	0.92	1.00	0.89	0.80	0.74	0.72	0.62	0.62
1993			0.14	0.31	0.55	0.80	0.89	1.03	1.02	0.93	0.90	0.86	0.79	0.79
1994			0.09	0.24	0.38	0.53	0.67	0.76	0.71	0.69	0.65	0.64	0.56	0.56
1995			0.06	0.20	0.32	0.42	0.57	0.62	0.55	0.56	0.52	0.52	0.45	0.45
1996			0.04	0.16	0.28	0.41	0.55	0.62	0.56	0.59	0.54	0.54	0.47	0.47
1997			0.03	0.15	0.27	0.42	0.58	0.66	0.65	0.67	0.63	0.63	0.56	0.56
1998			0.03	0.15	0.33	0.52	0.66	0.78	0.81	0.82	0.80	0.78	0.74	0.74
1999			0.04	0.18	0.39	0.65	0.75	0.87	0.92	0.90	0.89	0.86	0.83	0.83
2000			0.06	0.18	0.39	0.63	0.75	0.89	0.96	0.96	0.97	0.94	0.94	0.94
2001			0.07	0.19	0.38	0.58	0.70	0.86	0.98	1.02	1.05	1.01	1.04	1.04
2002			0.04	0.16	0.34	0.48	0.60	0.71	0.81	0.88	0.89	0.87	0.87	0.87
2003			0.03	0.15	0.33	0.49	0.57	0.65	0.69	0.77	0.76	0.77	0.76	0.76
2004			0.03	0.14	0.33	0.52	0.58	0.65	0.68	0.75	0.75	0.76	0.75	0.75
2005			0.03	0.13	0.29	0.47	0.55	0.62	0.65	0.72	0.73	0.74	0.74	0.74
2006			0.03	0.12	0.27	0.45	0.53	0.62	0.66	0.73	0.75	0.76	0.76	0.76
2007			0.03	0.11	0.24	0.38	0.49	0.59	0.65	0.73	0.78	0.80	0.81	0.81
2008			0.02	0.09	0.19	0.29	0.40	0.46	0.45	0.50	0.49	0.50	0.46	0.46
2009			0.03	0.10	0.21	0.31	0.41	0.47	0.42	0.44	0.41	0.40	0.36	0.36
2010			0.02	0.07	0.15	0.23	0.30	0.34	0.35	0.38	0.38	0.38	0.37	0.37
2011			0.02	0.07	0.15	0.23	0.29	0.33	0.34	0.37	0.37	0.37	0.36	0.36
2012			0.02	0.06	0.14	0.22	0.28	0.32	0.33	0.36	0.35	0.36	0.35	0.35
2013			0.02	0.06	0.14	0.22	0.28	0.32	0.32	0.35	0.35	0.36	0.34	0.34
2014			0.02	0.06	0.14	0.22	0.28	0.32	0.32	0.36	0.35	0.36	0.35	0.35
2015			0.02	0.06	0.14	0.22	0.28	0.32	0.32	0.36	0.35	0.36	0.35	0.35

Table 9.4.4. Icelandic cod in Division Va. Estimates of numbers at age in the stock 1955-2010 based on ACAM using catch at age and spring and fall bottom survey indices. Estimates for 2011 are based on catch constraint for the year 2010; the predictions are based on the 20% catch rule.

Year\age	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1955	171	153	152	218	212	115	36	25	13	87	9.2	7.8	8.1	2.6
1956	221	171	153	120	150	135	72	22	15	8	51.6	5.4	4.7	4.8
1957	289	221	171	119	82	96	85	44	13	9	4.6	29.6	3.2	2.7
1958	154	289	221	129	79	51	60	52	35	8	5.1	2.6	17.3	1.9
1959	193	154	289	161	82	48	31	35	52	19	4.1	2.7	1.5	10.2
1960	129	193	154	216	105	51	30	19	21	37	10.6	2.3	1.6	0.9
1961	178	129	193	114	140	64	31	18	10	11	19.0	5.4	1.3	1.0
1962	204	178	129	144	75	89	40	18	24	6	5.7	10.0	3.1	0.8
1963	216	204	178	94	92	46	56	23	10	12	2.7	2.9	5.6	2.0
1964	229	216	204	128	58	54	28	31	12	4	5.2	1.2	1.5	3.4
1965	320	229	216	147	78	33	31	15	14	5	1.6	1.8	0.5	0.8
1966	172	320	229	157	91	44	18	16	7	6	1.6	0.5	0.8	0.3
1967	248	172	320	171	100	53	24	9	7	2	1.8	0.5	0.2	0.4
1968	181	248	172	243	111	60	31	12	4	3	0.8	0.6	0.2	0.1
1969	189	181	248	130	155	65	33	41	5	1	0.7	0.2	0.2	0.1
1970	139	189	181	192	85	92	37	33	18	2	0.4	0.2	0.1	0.1
1971	273	139	189	138	120	47	49	18	14	7	0.6	0.1	0.1	0.0
1972	179	273	139	141	83	61	23	22	23	5	2.2	0.2	0.0	0.0
1973	261	179	273	104	86	42	29	10	9	9	1.6	0.6	0.1	0.0
1974	368	261	179	199	62	43	20	12	4	3	2.7	0.5	0.2	0.0
1975	143	368	261	131	118	31	20	8	4	1	0.9	0.7	0.1	0.1
1976	227	143	368	192	79	58	14	8	3	1	0.3	0.2	0.2	0.1
1977	244	227	143	282	121	42	27	6	3	1	0.4	0.1	0.1	0.1
1978	140	244	227	114	190	71	22	12	2	1	0.3	0.2	0.0	0.0
1979	140	140	244	181	78	117	41	11	5	1	0.5	0.2	0.1	0.0
1980	132	140	140	194	125	49	72	20	5	3	0.5	0.3	0.1	0.1
1981	233	132	140	111	133	75	27	47	9	2	1.3	0.3	0.1	0.1
1982	139	233	132	112	77	77	38	12	17	3	0.8	0.5	0.1	0.1
1983	140	139	233	105	76	42	36	15	4	5	1.1	0.3	0.2	0.1
1984	330	140	139	187	72	43	20	15	5	1	1.8	0.4	0.1	0.1
1985	261	330	140	110	125	40	21	8	5	2	0.5	0.8	0.2	0.1
1986	176	261	330	109	71	67	19	8	3	2	0.8	0.2	0.4	0.1
1987	89	176	261	254	69	35	27	7	3	1	0.8	0.3	0.1	0.2
1988	131	89	176	202	158	32	13	9	2	1	0.4	0.3	0.1	0.0
1989	106	131	89	137	128	77	12	4	2	1	0.3	0.1	0.1	0.1
1990	175	106	131	70	88	100	33	4	1	1	0.2	0.1	0.1	0.1
1991	135	175	106	102	45	45	42	12	2	1	0.4	0.1	0.0	0.0
1992	77	135	175	80	62	21	16	14	4	1	0.2	0.1	0.0	0.0
1993	151	77	135	129	47	28	7	5	4	1	0.2	0.1	0.1	0.0
1994	165	151	77	97	77	22	10	2	2	1	0.4	0.1	0.0	0.0
1995	88	165	151	58	62	43	11	4	1	1	0.5	0.2	0.0	0.0
1996	161	88	165	116	39	37	23	5	2	0	0.3	0.3	0.1	0.0
1997	70	161	88	131	81	24	20	11	2	1	0.2	0.1	0.1	0.0
1998	172	70	161	70	92	50	13	9	5	1	0.4	0.1	0.1	0.1
1999	162	172	70	128	49	54	24	5	3	2	0.3	0.1	0.0	0.0
2000	160	162	172	55	88	27	23	9	2	1	0.6	0.1	0.0	0.0
2001	180	160	162	133	38	49	12	9	3	1	0.4	0.2	0.0	0.0
2002	79	180	160	124	90	21	22	5	3	1	0.2	0.1	0.1	0.0
2003	156	79	180	125	86	52	11	10	2	1	0.3	0.1	0.0	0.0
2004	132	156	79	143	88	50	26	5	4	1	0.4	0.1	0.0	0.0
2005	87	132	156	63	101	52	25	12	2	2	0.3	0.2	0.0	0.0
2006	133	87	132	124	45	62	27	12	5	1	0.7	0.1	0.1	0.0
2007	127	133	87	105	90	28	32	13	5	2	0.4	0.3	0.0	0.0
2008	126	127	133	69	77	58	16	16	6	2	0.9	0.1	0.1	0.0
2009	171	126	127	107	52	66	35	9	8	3	1.1	0.4	0.1	0.1
2010	177	171	126	101	80	34	39	19	4	4	1.6	0.6	0.2	0.0
2011	152	177	171	102	77	56	22	24	11	3	2.5	0.9	0.3	0.1
2012	155	152	177	138	78	55	37	14	14	7	1.5	1.4	0.5	0.2
2013	157	155	152	142	106	55	36	23	8	8	3.8	0.8	0.8	0.3
2014	158	157	155	122	109	75	36	22	13	5	4.8	2.2	0.5	0.5
2015	158	158	157	125	94	78	50	23	13	8	2.7	2.7	1.2	0.3

Table 9.4.5. 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 TSA SMH and ADCAM SMH, where the fall survey is used. 2008 estimate refers to the estimates from the result from the ADCAM framework that was the basis for advice last year.

a)

Estimated fishing mortality rate in 2009:

Age	NWWG 2009	ADCAM spaly (SMB only)	ADCAM SMH only	Adcam final SMB & SMH	TSA SMB no trend	TSA SMB trend	TSA SMH
3	0.02	0.04	0.03	0.03			
4	0.09	0.10	0.10	0.10	0.10	0.09	0.07
5	0.21	0.22	0.21	0.21	0.25	0.23	0.20
6	0.33	0.38	0.34	0.31	0.40	0.35	0.32
7	0.40	0.44	0.42	0.41	0.43	0.38	0.39
8	0.44	0.53	0.48	0.47	0.49	0.44	0.39
9	0.49	0.45	0.44	0.42	0.51	0.45	0.38
10	0.56	0.41	0.46	0.44	0.51	0.46	0.38
11	0.59	0.37	0.42	0.41	0.51	0.46	0.38
12	0.63	0.35	0.42	0.40			
13	0.65	0.31	0.37	0.36			
14	0.65	0.31	0.37	0.36			
F(5-10)	**0.40**	**0.40**	**0.39**	**0.38**	**0.43**	**0.38**	**0.35**

b)

Estimated stock in numbers (millions) in 2010:

Age	NWWG 2009	ADCAM spaly (SMB only)	ADCAM SMH only	Adcam final SMB & SMH	TSA SMB no trend	TSA SMB trend	TSA SMH
0							145
1		198	177	177	203	219	132
2	218	165	172	171	166	181	202
3	121	119	126	126	112	123	149
4	92	89	101	101	81	89	135
5	80	77	79	80	69	77	95
6	32	33	34	34	31	35	38
7	31	31	32	39	34	38	43
8	19	18	19	19	17	20	18
9	4	4	4	4	6.0	6.9	7.6
10	4	4	4	4	3.8	4.5	4.6
11	1	2	2	2	1.7	2.1	2.1
12	0	1	1	1			
13	0	0	0	0			
14	0	0	0	0			

Estimated Biomass age 4-11 in 2010:

Age	NWWG 2009	ADCAM spaly (SMB only)	ADCAM SMH only	Adcam final SMB & SMH	TSA SMB no trend	TSA SMB trend	TSA SMH
1							
2							
3							
4	153	149	168	168	134	148	224
5	186	179	186	186	162	180	222
6	104	106	108	110	98	111	122
7	145	143	147	182	155	177	196
8	106	98	103	106	94	109	100
9	27	26	29	30	40	46	51
10	34	35	37	38	32	38	39
11	14	16	16	16	18	21	21
B4-11	769	752	794	836	733	830	975

c)

Estimated stock size (B4+)

Year	NWWG 2009	ADCAM spaly (SMB only)	ADCAM SMH only	Adcam final SMB & SMH	TSA SMB no trend	TSA SMB trend	TSA SMH
1992	547	547	550	550	554	549	
1993	590	590	595	595	555	552	
1994	574	574	576	576	580	578	
1995	553	554	557	557	567	566	533
1996	668	669	670	670	655	657	697
1997	782	783	783	783	805	810	801
1998	718	718	720	720	747	752	723
1999	731	731	731	730	748	756	762
2000	591	592	589	589	585	594	623
2001	696	698	687	686	698	714	729
2002	732	735	728	728	751	772	832
2003	746	748	740	739	764	789	857
2004	805	804	802	801	838	870	952
2005	714	719	723	723	737	770	839
2006	687	690	700	701	722	763	837
2007	663	675	683	679	675	725	735
2008	663	677	689	685	654	713	741
2009	702	736	753	793	737	815	871
2010	719	764	804	846	733	830	975

d)

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.

Year\age	Landings	F5-10	SSB	N3	B4+	Hratio
1955	545	0.29	938	152	2357	0.23
1956	487	0.29	793	153	2082	0.23
1957	455	0.31	773	171	1878	0.24
1958	517	0.35	873	221	1865	0.28
1959	459	0.32	852	289	1827	0.25
1960	470	0.37	708	154	1753	0.27
1961	377	0.36	467	193	1496	0.25
1962	389	0.38	568	129	1492	0.26
1963	409	0.46	507	178	1315	0.31
1964	437	0.55	451	204	1219	0.36
1965	387	0.58	318	216	1023	0.38
1966	353	0.59	277	229	1032	0.34
1967	336	0.56	256	320	1103	0.30
1968	382	0.72	222	172	1223	0.31
1969	403	0.56	314	248	1326	0.30
1970	475	0.61	331	181	1337	0.36
1971	444	0.68	242	189	1098	0.40
1972	395	0.69	222	139	997	0.40
1973	369	0.70	245	273	844	0.44
1974	368	0.76	187	179	918	0.40
1975	365	0.81	168	261	895	0.41
1976	346	0.75	138	368	955	0.36
1977	340	0.59	198	143	1289	0.26
1978	330	0.48	212	227	1297	0.25
1979	366	0.45	304	244	1396	0.26
1980	432	0.49	356	140	1489	0.29
1981	465	0.66	264	140	1242	0.37
1982	380	0.73	167	132	970	0.39
1983	298	0.72	130	233	791	0.38
1984	282	0.64	141	139	914	0.31
1985	323	0.67	172	140	928	0.35
1986	365	0.77	198	330	854	0.43
1987	390	0.86	150	261	1030	0.38
1988	378	0.89	172	176	1033	0.37
1989	363	0.72	171	89	1004	0.36
1990	335	0.70	214	131	842	0.40
1991	308	0.80	161	106	699	0.44
1992	265	0.85	153	175	550	0.48
1993	251	0.87	124	135	595	0.42
1994	178	0.62	154	77	576	0.31
1995	169	0.51	179	151	557	0.30
1996	181	0.50	160	165	670	0.27
1997	203	0.54	191	88	783	0.26
1998	244	0.65	212	161	720	0.34
1999	260	0.75	184	70	730	0.36
2000	235	0.77	167	172	589	0.40
2001	234	0.75	161	162	686	0.34
2002	208	0.63	196	160	728	0.29
2003	208	0.58	186	180	739	0.28
2004	227	0.59	202	79	801	0.28
2005	213	0.55	232	156	723	0.30
2006	196	0.54	222	132	701	0.28
2007	170	0.51	205	87	679	0.25
2008	146	0.38	266	133	685	0.21
2009	181	0.38	254	127	793	0.23
2010	153	0.29	300	126	846	0.18
2011	163	0.28	325	171	902	0.18
2012	176	0.27	366	177	1020	0.17
2013	194	0.27	393	152	1138	0.17
2014	213	0.27	438	155	1208	0.18
2015	229	0.27	496	157	1264	0.18

Table 9.7.1. Icelandic cod in Division Va. Inputs in the short term predictions

Mean weights in the stock and the catch

age\year	2009	2010	2011	2012	2013
3	1.109	1.057	1.058	1.058	1.058
4	1.680	1.662	1.662	1.663	1.663
5	2.204	2.335	2.336	2.337	2.337
6	3.206	3.190	3.190	3.191	3.192
7	4.098	4.610	4.611	4.612	4.613
8	4.884	5.481	5.482	5.484	5.485
9	6.744	6.656	6.658	6.660	6.661
10	8.505	8.499	8.501	8.504	8.505
11	10.126	10.119	10.121	10.124	10.125
12	12.108	12.100	12.102	12.106	12.107
13	12.471	12.463	12.465	12.469	12.470
14	15.264	15.254	15.257	15.262	15.263

Mean weights in the SSB

age\year	2009	2010	2011	2012	2013
3	1.017	1.016	1.017	1.017	1.017
4	1.440	1.586	1.586	1.587	1.587
5	2.027	2.150	2.150	2.151	2.151
6	2.871	3.127	3.128	3.128	3.129
7	3.909	4.167	4.168	4.169	4.170
8	4.884	5.481	5.482	5.484	5.485
9	6.744	6.656	6.658	6.660	6.661
10	8.505	8.499	8.501	8.504	8.505
11	10.126	10.119	10.121	10.124	10.125
12	12.108	12.100	12.102	12.106	12.107
13	12.471	12.463	12.465	12.469	12.470
14	15.264	15.254	15.257	15.262	15.263

Sexual maturity at spawning time:

age\year	2009	2010	2011	2012	2013
3	0.002	0.000	0.000	0.000	0.000
4	0.015	0.016	0.016	0.016	0.016
5	0.132	0.057	0.057	0.057	0.057
6	0.455	0.380	0.380	0.380	0.380
7	0.688	0.820	0.820	0.820	0.820
8	0.883	0.869	0.869	0.869	0.869
9	0.741	0.928	0.928	0.928	0.928
10	0.631	0.818	0.818	0.818	0.818
11	0.892	0.583	0.583	0.583	0.583
12	1.000	1.000	1.000	1.000	1.000
13	1.000	1.000	1.000	1.000	1.000
14	1.000	1.000	1.000	1.000	1.000

Selection pattern

age\year	2009	2010	2011	2012	2013
3	0.077	0.061	0.061	0.061	0.061
4	0.255	0.236	0.236	0.236	0.236
5	0.549	0.500	0.500	0.500	0.500
6	0.829	0.770	0.770	0.770	0.770
7	1.083	1.020	1.020	1.020	1.020
8	1.239	1.193	1.193	1.193	1.193
9	1.127	1.198	1.198	1.198	1.198
10	1.171	1.318	1.318	1.318	1.318
11	1.076	1.307	1.307	1.307	1.307
12	1.074	1.307	1.307	1.307	1.307
13	0.954	1.307	1.307	1.307	1.307
14	0.954	1.307	1.307	1.307	1.307

Natural Mortality

age\year	2009	2010	2011	2012	2013
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	2009	2010	2011	2012	2013
3	127.111	126.212	171.287	176.844	151.971
4	107.005	101.098			
5	51.583	79.575			
6	65.881	34.339			
7	35.475	39.469			
8	8.707	19.316			
9	8.352	4.470			
10	3.022	4.473			
11	1.091	1.592			
12	0.442	0.596			
13	0.066	0.241			
14	0.053	0.038			

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 9.7.2a. Icelandic cod in Division Va. Output of the short term predictions, domestic format

2010				2011				2012				2013			
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)
152	846	301	0.289	100	904	344	0.166	100	1096	437	0.135	100	1303	529	0.109
				169	904	324	0.297	181	1015	361	0.288	203	1127	384	0.293
				161	904	327	0.280	171	1025	371	0.266	187	1149	402	0.259
				219	904	309	0.401	240	958	308	0.438	268	999	286	0.494
				300	904	284	0.595	300	864	232	0.692	200	831	205	0.473

Table 9.7.2b. Icelandic cod in Division Va. Output of the short term predictions, ICES format

2010 B4+	Fbar	SSB	Landings
846	0.29	301	152

2011 B4+	Fmult	Fbar	SSB2011	Landings	2012 B4+	SSB	%SSB change[1)]	% TAC change[2)]
904	0.00	0.000	371	0	1212	543	46%	-100%
	0.21	0.060	361	38	1168	499	38%	-76%
	0.24	0.070	359	44	1161	492	37%	-72%
	0.28	0.080	357	50	1154	485	36%	-69%
	0.31	0.090	356	56	1147	478	34%	-65%
	0.35	0.100	354	62	1140	472	33%	-61%
	0.38	0.110	353	68	1133	465	32%	-58%
	0.41	0.120	351	74	1126	459	31%	-54%
	0.45	0.130	349	80	1119	452	30%	-50%
	0.48	0.140	348	85	1113	446	28%	-47%
	0.52	0.150	346	91	1106	440	27%	-43%
	0.55	0.160	345	97	1099	434	26%	-40%
	0.59	0.170	343	102	1093	428	25%	-36%
	0.62	0.180	342	108	1086	422	24%	-33%
	0.66	0.190	340	113	1080	416	22%	-29%
	0.69	0.200	338	119	1074	411	21%	-26%
	0.73	0.210	337	124	1067	405	20%	-22%
	0.76	0.220	335	130	1061	400	19%	-19%
	0.79	0.230	334	135	1055	394	18%	-16%
	0.83	0.240	332	140	1049	389	17%	-12%
	0.86	0.250	331	145	1043	384	16%	-9%
	0.90	0.260	329	151	1037	378	15%	-6%
	0.93	0.270	328	156	1031	373	14%	-3%
	0.97	0.280	327	161	1025	368	13%	0%
	1.00	0.290	325	166	1019	363	12%	4%
	1.04	0.300	324	171	1013	358	11%	7%
	1.07	0.310	322	176	1008	353	10%	10%
	1.11	0.320	321	181	1002	349	9%	13%
	1.14	0.330	319	185	996	344	8%	16%
	1.18	0.340	318	190	991	339	7%	19%
	1.21	0.350	316	195	985	335	6%	22%
	1.24	0.360	315	200	980	330	5%	25%
	1.28	0.370	314	205	974	326	4%	28%
	1.31	0.380	312	209	969	322	3%	31%
	1.35	0.390	311	214	963	317	2%	34%
	1.38	0.400	309	218	958	313	1%	36%
	1.42	0.410	308	223	953	309	0%	39%
	1.45	0.420	307	227	948	305	-1%	42%
	1.49	0.430	305	232	943	301	-1%	45%
	1.52	0.440	304	236	937	297	-2%	48%
	1.56	0.450	303	241	932	293	-3%	50%
	1.59	0.460	301	245	927	289	-4%	53%

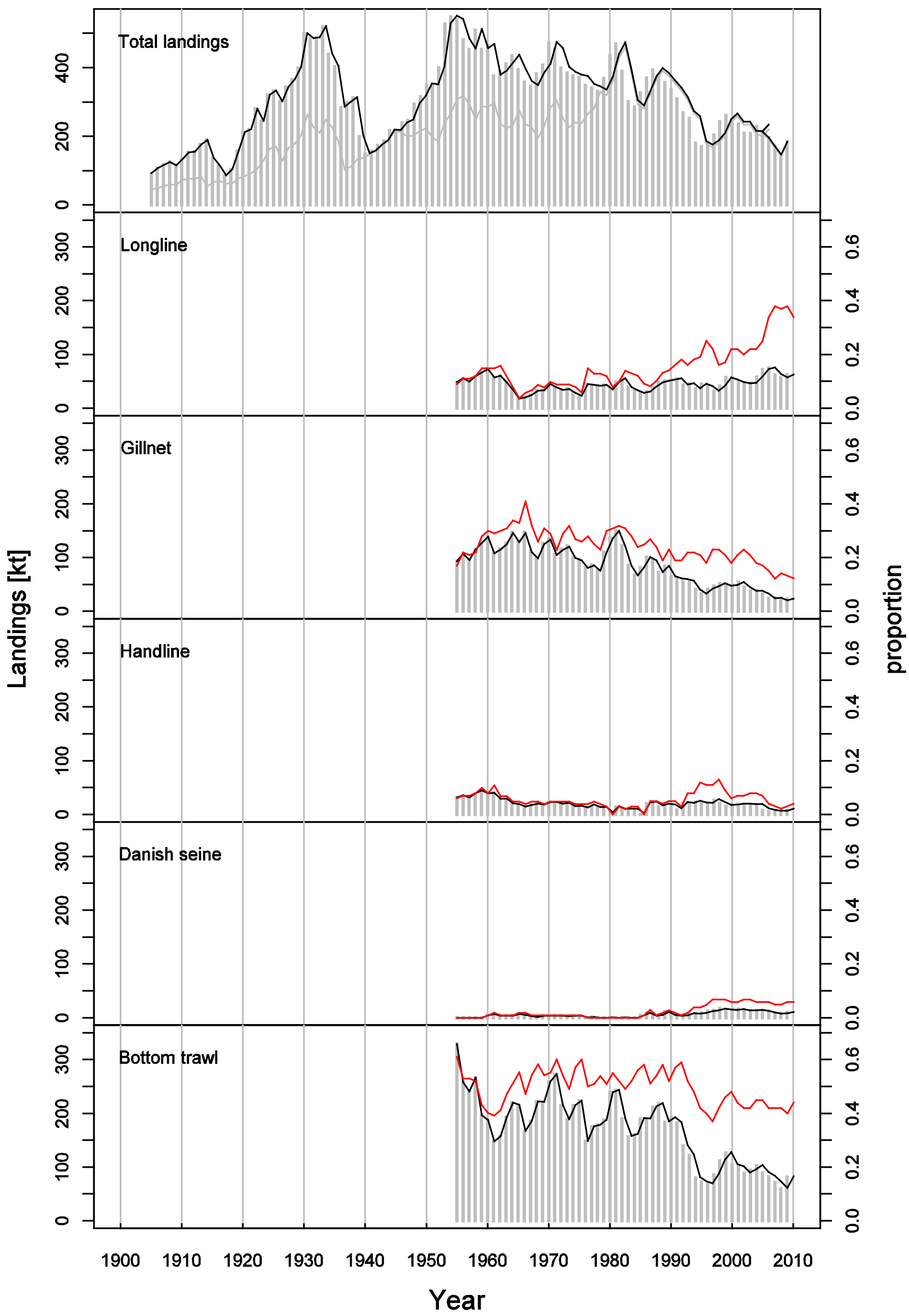


Figure 9.2.1 Icelandic cod division Va. Total landings from 1905 to 2009 and landings by principal gear from 1955 to 2009. The proportion of landings by each gear are shown by the red line.

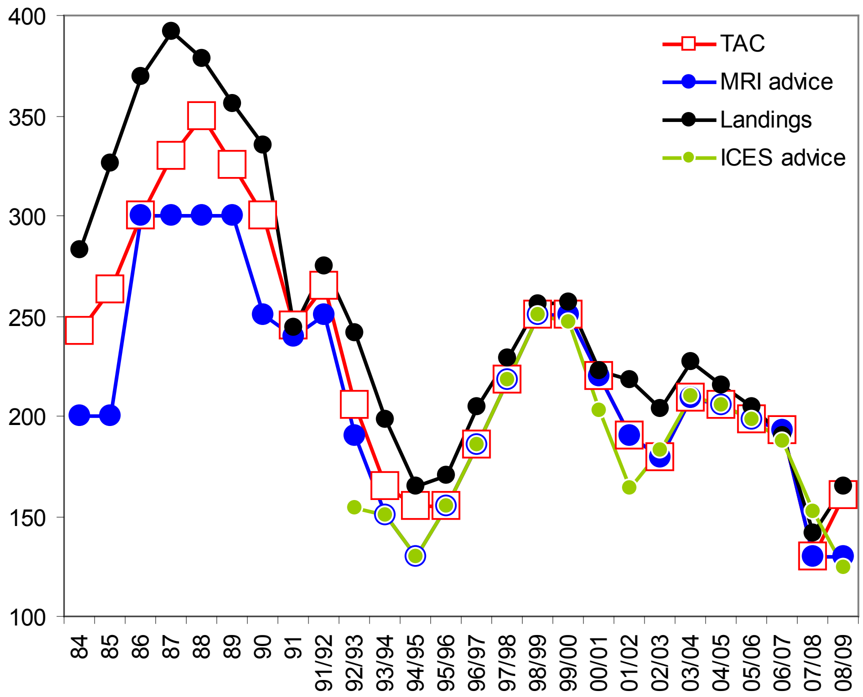


Figure 9.2.2. Icelandic cod division Va. ICES advice, domestic advice (MRI advice), the set TAC and reported landings for the fishing year (September through August).

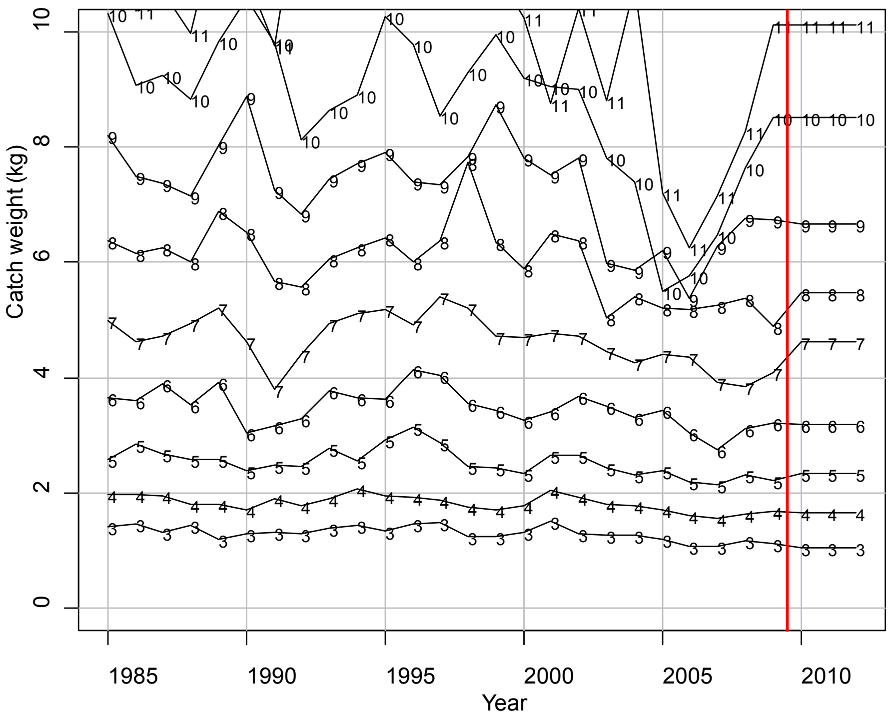


Figure 9.2.4. Icelandic cod division Va. Mean observed weight at age (numbers indicate age classes) in the catches 1974-2009, with predicted and assumed mean weight at age for 2010 and beyond.

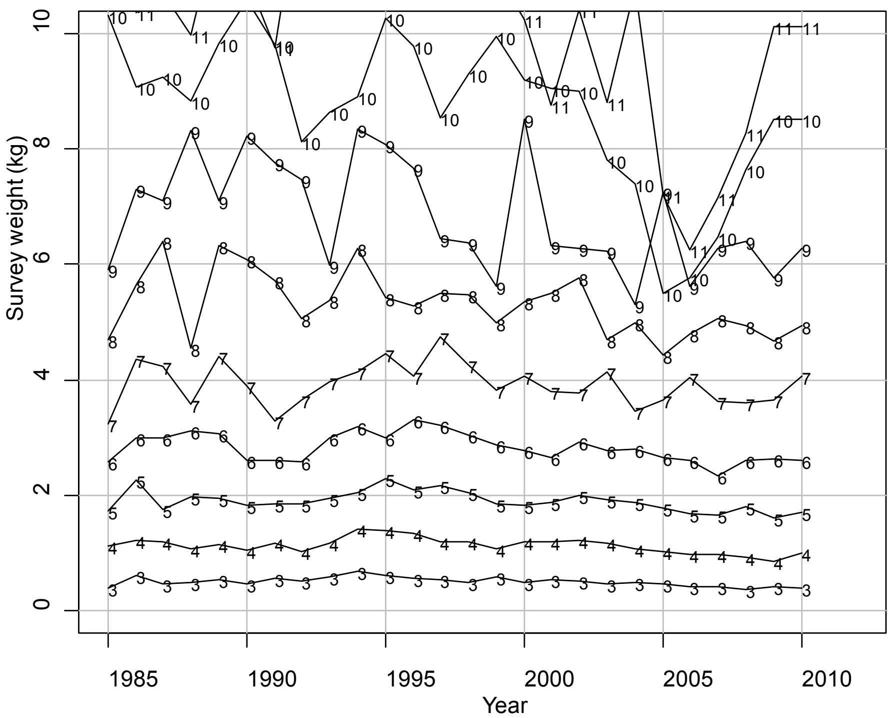


Figure 9.2.5. Icelandic cod division Va. Mean observed weight at age (numbers indicate age classes) in the March groundfish survey 1985-2010.

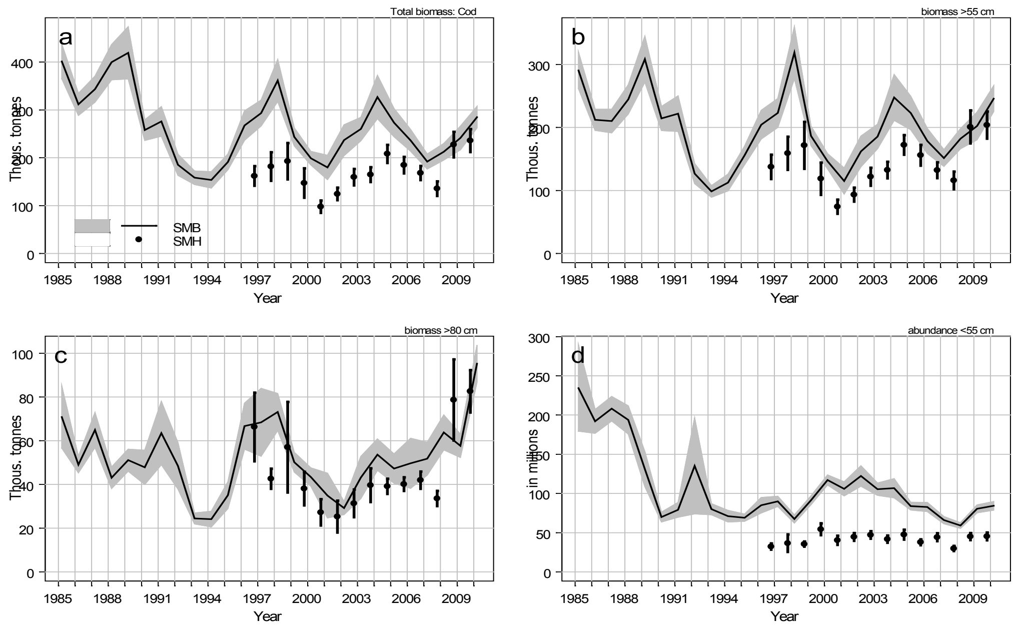


Figure 9.2.6. Icelandic cod division Va. Abundance indices of cod in the groundfish survey in spring 1985-2010 (SMB, line, shaded area) and fall 1996-2009 (SMH, points, vertical lines). a) Total biomass index, b) Biomass index of 55 cm and larger, c) Biomass index 90 cm and larger, d) Abundance index of < 55 cm. The shaded area and the vertical bar show ± 1 standard error of the estimate.

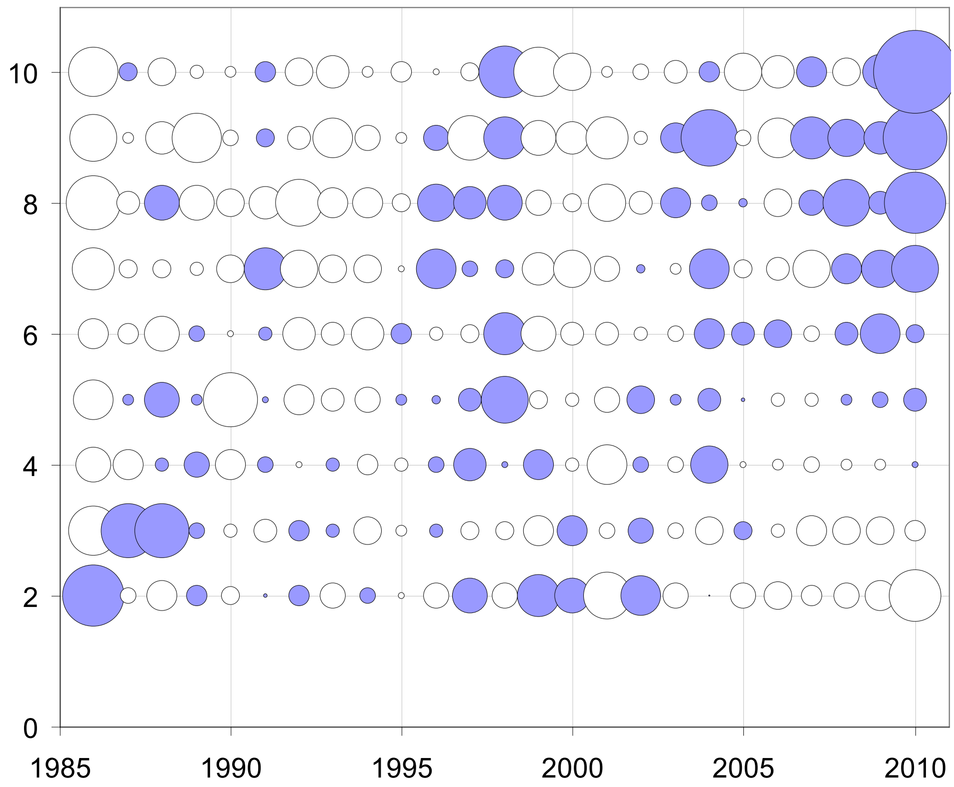


Figure 9.2.7. Icelandic cod division Va. Residual pattern of the observed vs. predicted spring survey indices by age and year from consecutive years. For further explanation see section 9.2.3.

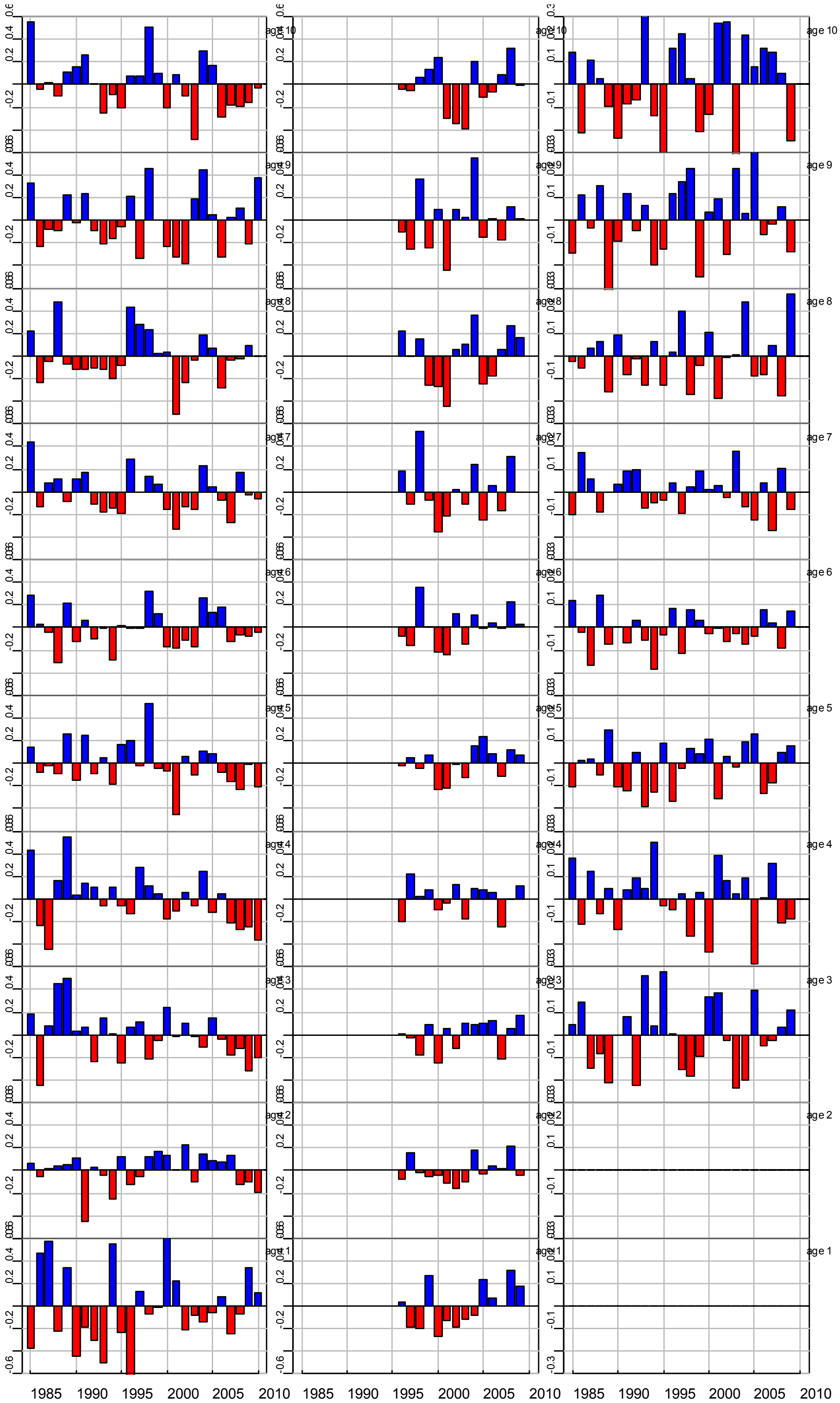


Figure 9.4.1.a Spring survey residuals (left), fall survey residuals (middle) and catch residuals (right) by year and age from the final ADCAM run.

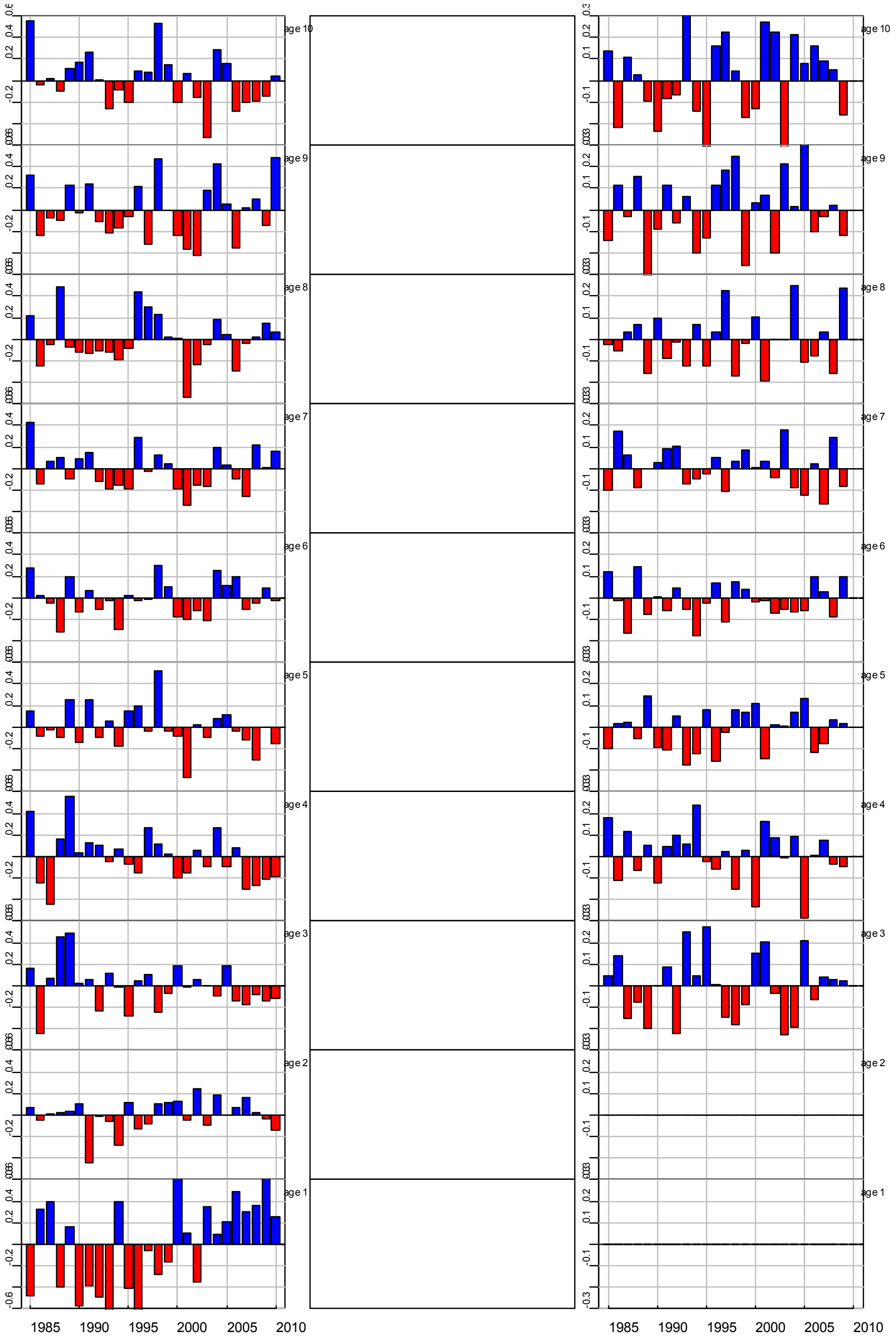


Figure 9.4.1.b Spring survey residuals (left) and catch residuals (right) by year and age from the spaly ADCAM run.

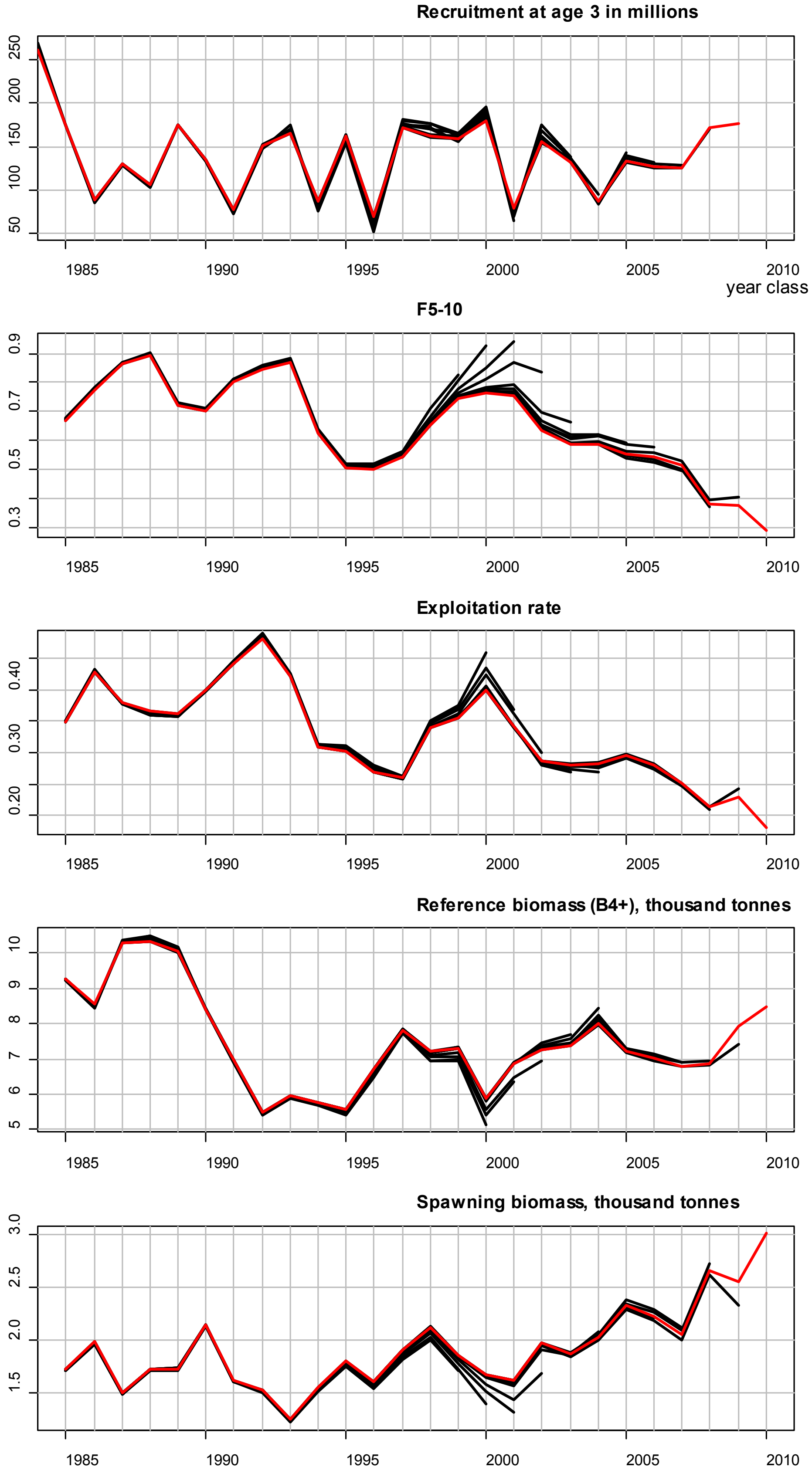


Figure 9.4.2. Icelandic cod in division Va. Retrospective pattern from the final ADCAM run. Note that the intercept of the y-axis on the x-axis is not set to zero.

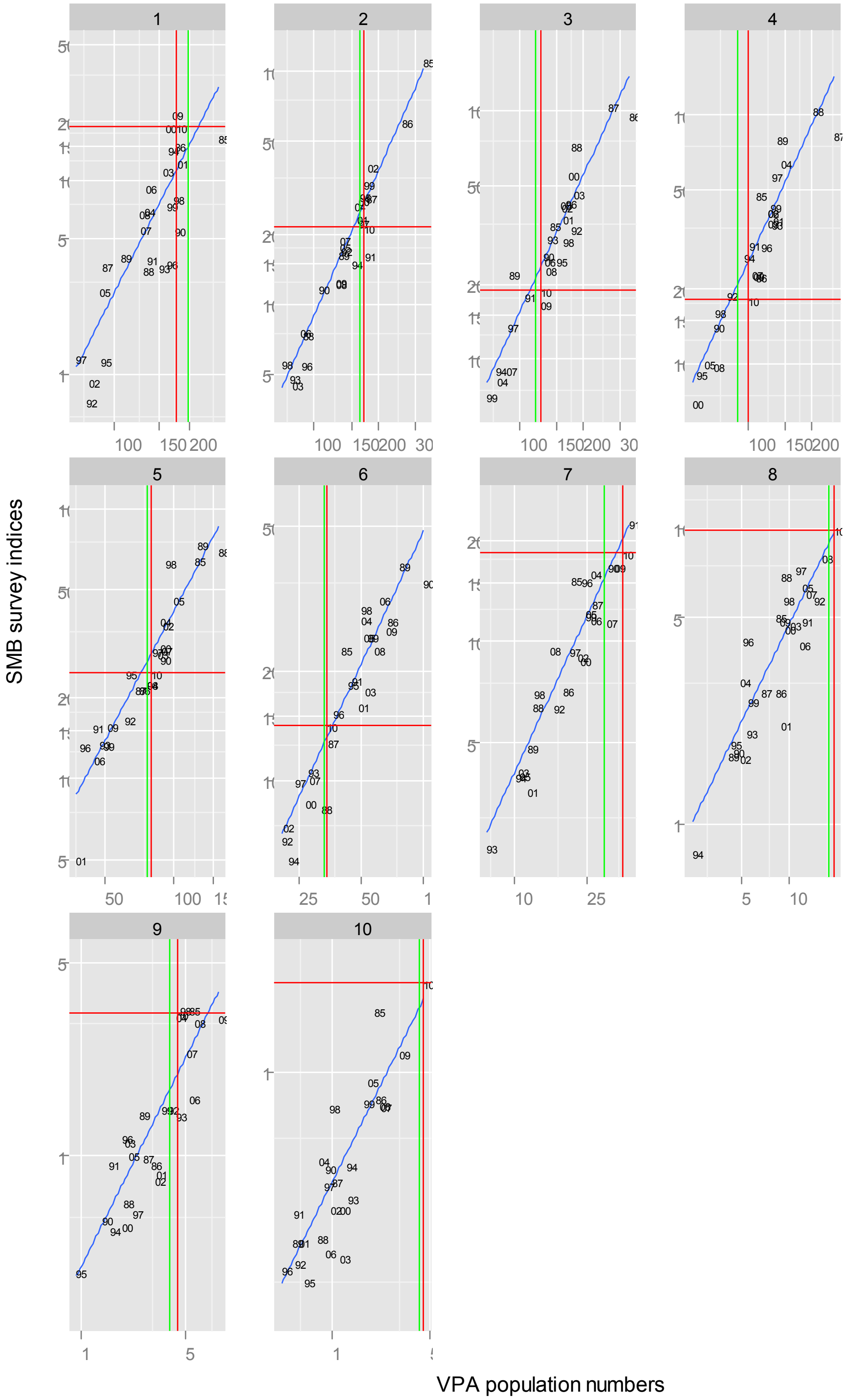


Figure 9.4.3a. Icelandic cod in division Va. Log Indices from the spring groundfish survey vs. log number in stock. The horizontal red line shows the spring survey measurements in 2010. The red vertical line shows the population estimates using both the spring and the fall survey in the tuning, the green horizontal line if only the spring survey is used in the tuning. The population estimates of age 1 and age 2 are scaled to population numbers at age 3 (recruiting age).

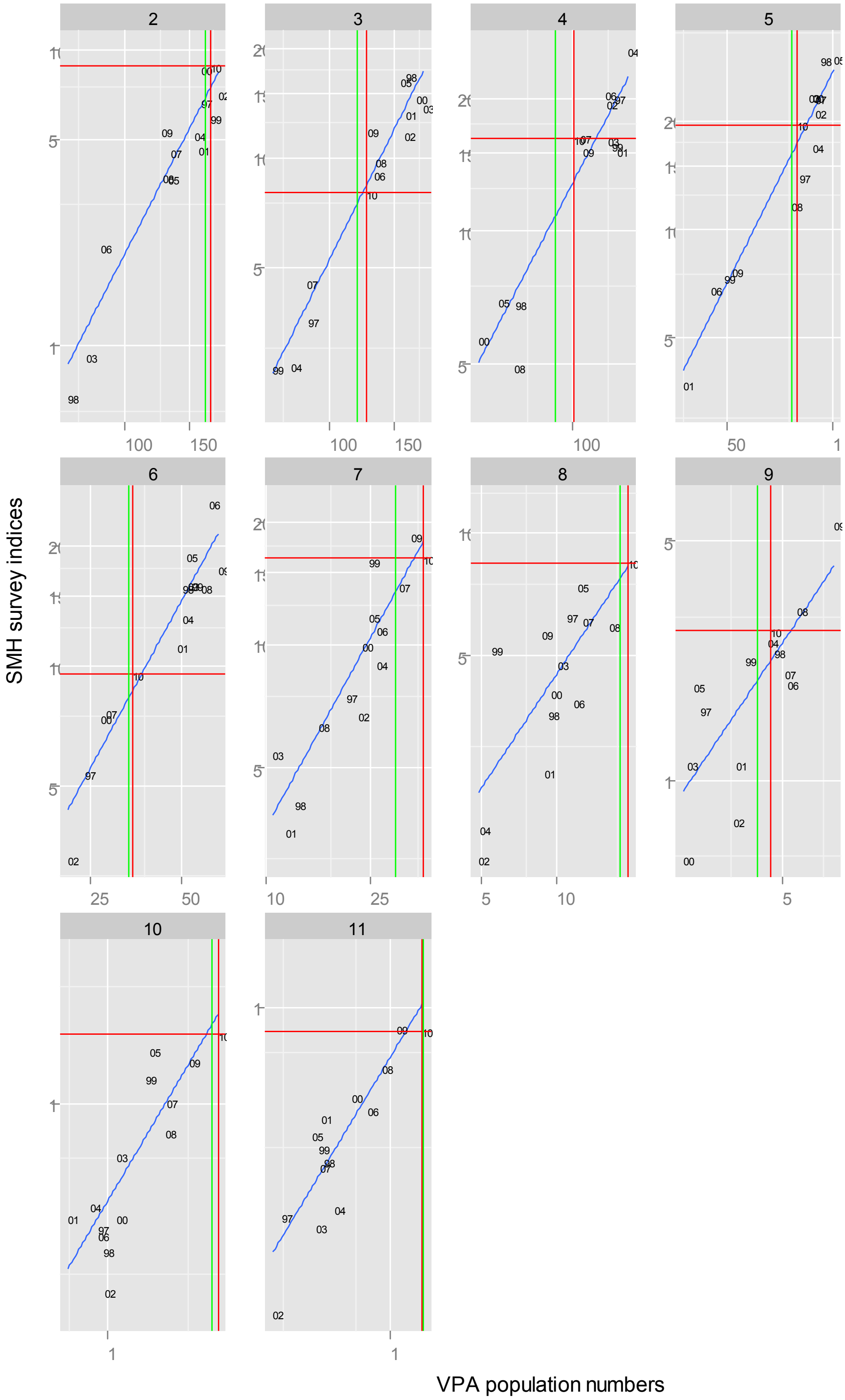


Figure 9.4.3b. Icelandic cod in division Va. Icelandic cod in division Va. Log Indices from the fall groundfish survey vs. log number in stock. The horizontal red line shows the fall survey measurements in 2009 (at age one year younger than here indicated). The red vertical line shows the population estimates using both the spring and the fall survey in the tuning, the green horizontal line if only the spring survey is used in the tuning. The population estimates of age 1 and age 2 are scaled to population numbers at age 3 (recruiting age).

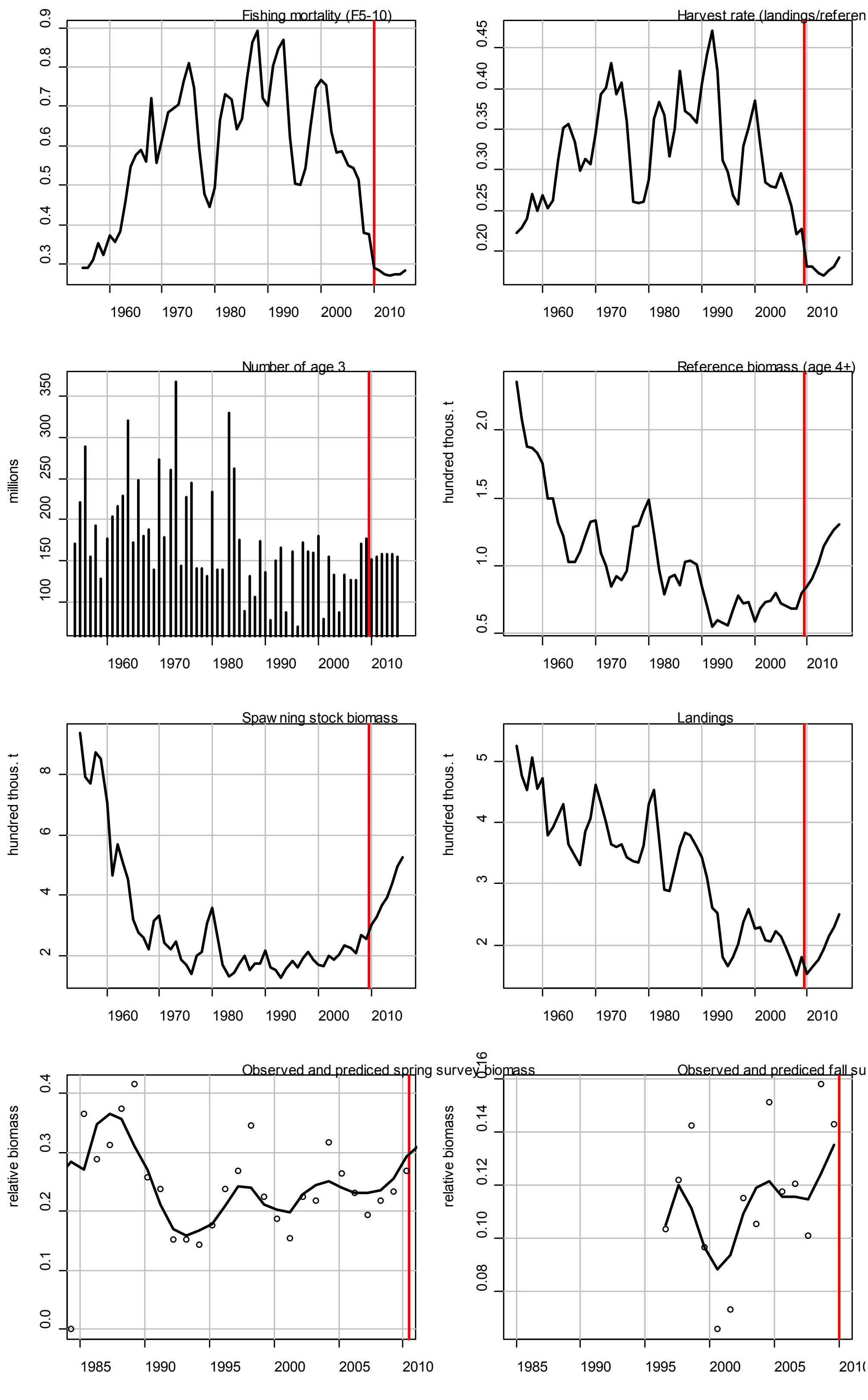


Figure 9.6.1. Icelandic cod in division Va. Summary plot. The x-axis on the recruitment plot refers to year class.

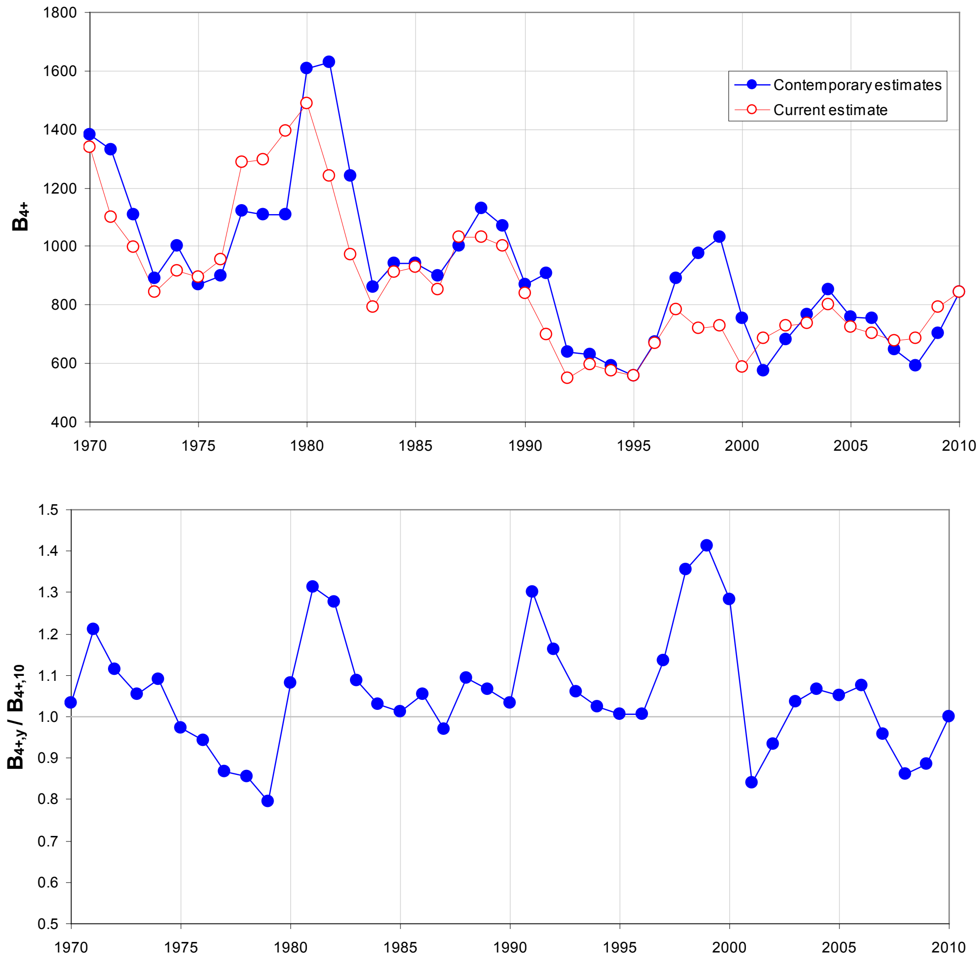


Figure 9.1.1. Contemporary (historical) and current estimates of the reference biomass (B4+, upper panel) and the ratio between them (lower panel).

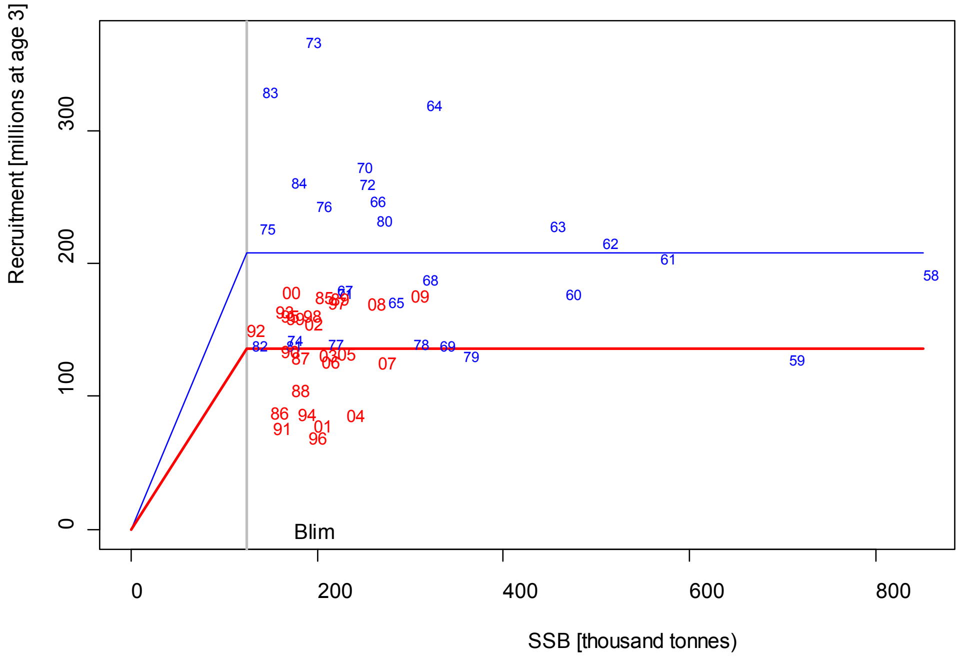


Figure 9.11.1. Icelandic cod in division Va. Spawning stock size and recruitment. Text in figure refers to year class. A segmented regression lines for the year classes 1958 to 1984 (blue) and year classes 2009 (red) are drawn.

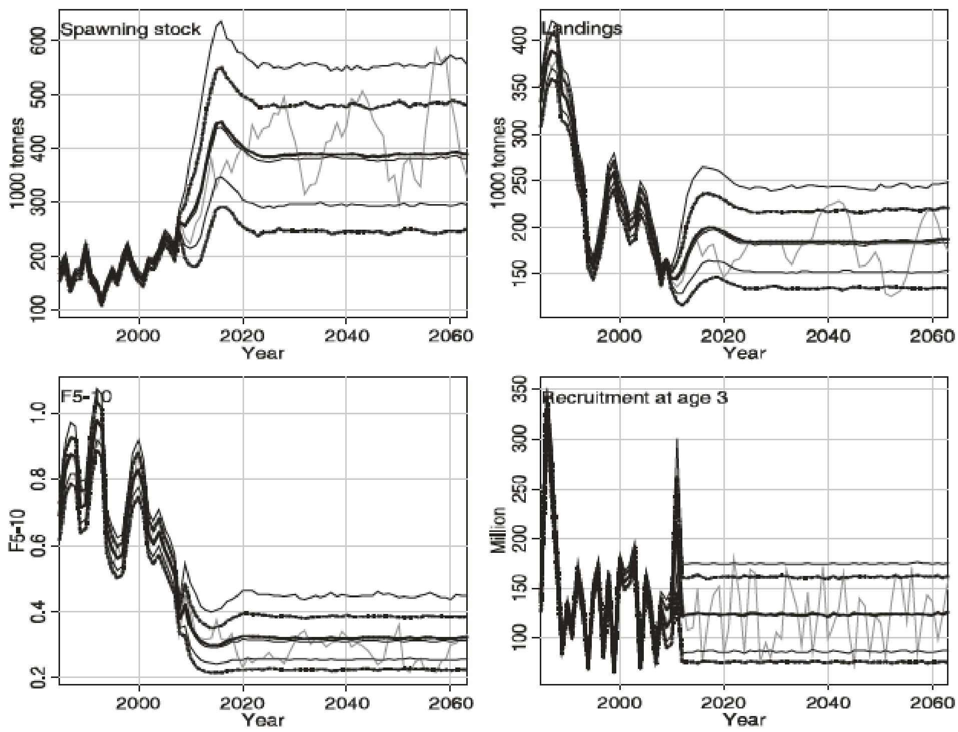


Figure 9.11.2. Icelandic cod in division Va. Simulation scenario based on the HCR and assuming a recruitment scenario representing the low recruits observed after 1984. Future values show the mean, the median value (thick line) ± 1 standard deviation and the 5th and 95th percentile using harvest rate of 0.2. One randomly drawn iteration is displayed.

10 Icelandic haddock

The main points in this section are.

- Current assessment gives similar indication of development of the stock as last years assessment.
- Year classes entering the fishable stock much smaller than those disappearing so the stock is rapidly decreasing. Year classes 2008 and 2009 very small.
- Catch (or landings) in numbers in age recalculated to include ages 10-12. Reason is that the large year class from 2003 is getting close to maximum age in data (age 9) but VPA models have to be based on assumptions about the oldest age group. Prognosis after 2012 will require inclusion of the 2003 year class.
- Same (similar) 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. Still no indications of improved growth in spite of smaller year classes.
- Risk of the spawning stock going below Bloss in 2015 Lower fishing mortality to 0.3 or lower to reduce that risk to less than 5%.

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 section xx.

10.2.1 Landings

Landings of Icelandic haddock in 2009 are estimated to have been 82043 tonnes , see Figure 10.2.1 and Table 10.2.1 Of the landings 81418 tonnes are by Iceland but 625tonnes by other nations. For comparison the landings in 2008 were 103 thous. tonnes. The share of different gear in the haddock catches have been varying with time, with the share of longlines and Danish seine increasing in recent years 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. Catch in numbers was recompiled this year to include ages 10-12. The calculations were done in the same way as before. Figure 10.2.6a shows the difference between the old and new catch in numbers, showing reasonable comparison except for age 2 where there is much more catch according to the new numbers.

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. The discrepancy between the new and old landings by age is that in some years fish below certain size (discard size) was not included when compiling the data.

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 landed and 22% of landings in 1997 (Pálsson 2003). Comparison of sea and harbour samples indicate that discard was small in 2009 (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 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=1 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. The index of total biomass from the groundfish survey in March 2010 is the lowest since 2001 .

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. After 2008 the abundance of year classes 2003 and earlier is substantially reduced. Later year classes are much smaller but year class 2007 is the largest of those and well above the mean. Year classes 2008 and 2009 seem to be small. 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 adjacent years, indicating a reasonably good consistency for the most important age groups. At age 7 the abundance of the large 2003 year class looks normal compared to what it was at age 6 (Figure 10.2.12). 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 6 to 7 seems near average. This might indicate average fishing mortality of age 6 in 2009 pointing indicating average effort compared to the period 1985-2008. The abundance of older age groups is than expected, indicating that the mortality of those age groups in 2009 was higher than the average for the period 1985-2007.

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 1985–2010 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 1993–2009. 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 2010 at or near historic low. From history increased growth should be expected when the stock size reduces and smaller year classes enter the stock. Improved growth has though not been observed yet.

The catch weights show similar trends as the stock weights. In 2009 mean weight at age of the 2003 year class that accounted for over 50% of the landings was 15% below what was predicted from the mean weight at age of the same year class in the 2009 survey. The reason is not clear but has caused catch of larger number of fishes than expected. In March 2010 the mean weight of the year class was on the other hand similar to what would have been expected from the mean weight in March 2009.

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 lower than in the late nineties. Mean weight at age has on the other hand been low so maturity by size is currently relatively high.

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 information 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 as in recent years 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). The rapid decrease seen in the surveys recently (Figure 10.2.7) has not yet been seen in the CPUE. The total biomass of the stock has been reducing but at the same time the size distribution of haddock has become more suitable for the commercial fisheries (older fish). 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

In 2007 to 2009 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. 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. This year things have changed and models calibrated with the October survey indicate better state of the stock.

The SPALY method used this year was the same as in last year i.e Adapt type model tuned with both the surveys. As before this was not done without reference to results from the other models and it can therefore be stated that the assessment was based on 3 different models (TSA, XSA and Adapt) or 3 little different models as all are age disaggregated models assuming M=0.2 using more or less the same data.

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 more than one year behind what was normal. This has affected the selection pattern of the fisheries but also changed the reference F as F_{4-7} should now be compared to F_{3-6} in earlier years. Those factors have been taken into account since 2007 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 still relatively large but rapidly decreasing because 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. This could be an indication that the current assessment was an overestimate and the retrospective pattern (Figure 10.6.5) shows that adding one year from last year's assessment leads to downward revision of the stock size.

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 2008,

The table below show estimated fishing mortality in 2009 and biomass in 2010 from a number of models. It shows that models based only on the March survey indicate smaller stock than models tuned with the autumn survey or both the surveys. The difference is though not much but it must again be born in mind that model results do not follow the rapid decrease in the March survey leading to mostly negative residuals in 2010.

Model and data	*F4-7 2009*	*Bio 3+ 2010*
XSA March survey	*0.511*	*144*
TSA Autumn survey	*0.531*	*163*
TSA March survey	*0.537*	*145*
Adapt March survey	*0.514*	*160*
Adapt both surveys (Spaly)	*0.534*	*166*

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 2009. Growth is predicted as a function of weight at age multiplied by a year effect.

$$\log \frac{W_{a+1,t+1}}{W_{a,t}} = \alpha + \beta \log W_{a,t} + \delta_{year}$$

Model including year class effect did not fit the data as well for the low mean weight at age of large year classes can already be seen at age 2.

Figure 10.7.1 shows the estimated year effect indicating slow growth in 3 years. Last year the year factor for the year 2008 was used as basis for prediction of growth in 2009 and 2019, leading to reasonably correct estimation of stock weight at age in 2010 as growth in 2009 is estimated to be a little better than in 2008 (Figure 10.7.1) . This year the procedure is repeated i.e the slow 2009 growth was used for the years

2010 and later. As discussed earlier this might a pessimistic assumption as slow growth is possibly a density dependent phenomena and density of haddock is predicted to decrease in coming years.

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.

Catch weights of the older age groups were unusually low in 2009 relative to stock weights as shown in figure 10.7.2. The default procedure is to base the prediction of catch weight on the period from 2000 but prediction based on only the 2009 data will lead to approximately 6% lower catch in 2011 using the same fishing mortality.

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 2010 and recruitment in 2011 – 2012 were obtained from the Adapt type model calibrated with both the surveys and the same model was used for prediction as for assessment.

F_{4-7}= 0.35 has in recent years been used as basis for advice as described in working paper #19 2006 and in the section on reference point (section 10.5). This value corresponds to F_{4-7}= 0.47 in the period that the reference point was based on.

A TAC constraint of 55 000 tonnes was used for the year 2009. The estimate was the sum of the TAC for the fishing year starting September 1st 2009 that was remaining in the beginning of 2009 and 33% of the estimated TAC for the fishing year 2010-2011

The result of short term prediction is shown in Table 10.7.1 and Figure 10.6.1. They show that both stock size and landings will decrease in coming years when the large year classes disappear, how rapidly depends on fishing mortality and growth. Prediction based on F4-7=0.35 lead to landings of 51 000 tonnes in 2011 (47 000 tonnes if the relationship between catch and stock weights from 2009 is used).

10.8 Reference points and medium term forecasts

This year the plan was to evaluate MSY points and subsequently to develop a harvest control rule for Icelandic haddock similar to what has been done for cod and saithe. In the MSY framework would B_{loss} be a candidate for B_{lim} a value that should be avoided with high probability. Avoiding B_{lim} will be one of the criteria in selection of target fishing mortality (or harvest ratio) and $B_{trigger}$. Most likely Btrigger will higher than Bloss although that does not have to be the case if the harvest ration is very low. But in any case the fisheries will not be close if the stock is at Blim, the targe fishing mortality will only be by the ratio between SSB and Btrigger when SSB is below Btrigger.

The stock of Icelandic haddock is predicted to decrease in coming year and stochastic simulations were conducted to see how much risk there was of going below B_{loss} in 2015. This goal could be looked at as a first step towards the MSY rule, although thi

The premises in the stochastic prognosis were.

1. Mean weight at age compiled as in the stochastic simulations. Mean weight at at age after 2013 same as in 2013. Random error lognormal with CV = 0.15 and autocorrelation = 0.35 added to the weight.
2. Assessment error lognormal with CV = 0.15.
3. Size of year classes 2010 and later lognormal with mean and CV estimated from historical data. Lognormal does though not describe well the probability distribution of recruitment of Icelandic haddock.
4. Runs were done with fishing mortality of ages 4 – 7 was 0.3 and 0.35.

Figure 10.8.1 shows the cumulative probability distribution of the spawning stock in 2015 There is over 10% probability being below B_{pa} when fishing with F=0.35 but around 5% when fishing at F=0.3. 10% is rather high probability considering that Bl_{oss} has only been reached once in 30 years and for most of those 30 years fishing mortality has been high.

There are number of uncertainties in the simulations and difficult to estimate if they are all contained within the assumed stochasticity.

- Mean weight at age should improve when stock size decreases
- Current assessment might be an over estimate (negative residuals in current year)

In addition to increasing the probability of the spawning stock being above Bloss lowering of F would lead to better balance between the effort towards cod and haddock as well as leading to the large year class from 2003 to last longer in the fisheries. This value of F would then be increased if mean weight at age increases but hopefully a carefully thought out HCR will be available by that time. But this year base advice on F=0.3 leading to landings of 45 000 tonnes in 2011, hoping that a HCR will be "ready for use" next year.

10.9 Uncertainties in assessment and forecast

The state of the stock today is reasonably well known but there is though some difference beween model results tuned with different surveys with the autumn survey indicating 10-20% larger stock than the March survey. There is on the other hand considerable uncertainty in prediction of growth and therefore in short and medium term forecast. Currently mean weight of all age groups are at historical minimum. On the other side growth of haddock is to some degree density dependent and is expected to improve with reduced stock size.

Low mean weight at age in landings last year compared to mean weight at age in the stock are not well understood.

10.10 Comparison with previous assessment and forecast

Figure 10.10.1 shows a comparison of this years and last year's assessment. The weights compare reasonably well but there is some downward revision of stock numbers. Comparison with the 2008 assessment may also be seen in figure 10.6.1 where the 2008 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 further in next year's assessment.

Looking at the last 7 years prediction of numbers in stock has succeeded reasonably well but mean weight at was 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 then, some underestimation of 2006 growth, overestimation for 2007 and correct estimate for 2008.

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 2009 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 are 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 reference landing size of haddock has been 45 cm and areas where more than 25% of the catch were below this size were closed temporarily. In 2007-2008 large part of the very large 2003 year class was below reference landing size but younger year classes are much smaller so nearly all haddock close to the reference landing size was of the 2003 year class. Keeping the reference landing size unchanged meant trying to take the largest individuals of the same year class so it was decided to change the reference landings size to follow the size of the 2003 year class. The reference landings size was changed back to 45 cm in 2009 when most of the 2003 year class had reached that size.

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.

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	2008	2009
Belgium							
Faroe Islands	833	1035	1372	1499	1780	828	625
Iceland	59970	83791	95859	96115	108175	101651	81418
Norway	30	9			11	11	
UK	51						
Total	60884	84835	97231	97614	109966	102490	82043

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	10
1979	149	1908	3762	6057	9022	1743	438	56	0
1980	595	1385	11481	4298	3798	3732	544	91	32
1981	10	514	4911	16900	5999	2825	1803	168	43
1982	107	245	3149	10851	14049	2068	1000	725	169
1983	34	1010	1589	4596	9850	8839	766	207	263
1984	241	1069	4946	1341	4772	3742	4076	238	58
1985	1320	1728	4562	6796	855	1682	1914	1903	212
1986	1012	4223	4068	4686	5139	494	796	897	344
1987	1939	8308	6965	2728	2042	1094	132	165	220
1988	237	9831	15164	5824	1304	1084	609	66	89
1989	188	2474	22560	9571	3196	513	556	144	34
1990	1857	2415	8628	23611	6331	816	150	67	45
1991	8617	2145	5397	7342	14103	2648	338	40	10
1992	5405	10693	5721	4610	3691	5209	999	120	10
1993	769	12333	12815	2968	1722	1425	2239	343	19
1994	3198	3343	28258	10682	1469	726	358	647	93
1995	4015	7323	5744	23927	5769	615	290	187	268
1996	3090	10552	7639	4468	12896	2346	208	79	60
1997	1364	3939	10915	4895	2610	5035	719	64	12
1998	279	8257	5667	7856	2418	1422	1897	261	17
1999	1434	1550	17243	4516	4837	915	620	481	63
2000	2659	6317	2352	13615	1945	1706	324	222	176
2001	2515	11098	6954	1446	6262	675	478	105	42
2002	1082	10434	15998	5099	1131	3149	262	169	42
2003	401	6352	16265	12548	2968	748	1236	91	48
2004	1597	4063	17652	19358	8871	1940	471	489	92
2005	2405	9450	6929	25421	13778	4584	809	251	212
2006	241	10038	21246	6646	18840	7600	2180	323	93
2007	782	3884	42224	22239	3354	9952	2740	519	62
2008	2316	4508	9706	53022	11014	1717	3033	815	167
2009	1066	3185	4886	8892	35011	5733	726	1381	395

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	0.07
2008	88.53	68.49	71.9	75.17	222.62	29.91	3.53	7.47	1.67	0.27
2009	10.52	111.32	54.16	41.45	41.94	105.19	12.98	2.24	3.17	0.5
2010	15.15	27.72	138.72	30.03	18.06	20.38	31.58	2.88	0.47	0.74

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
1996	16.1	460.87	109.75	85.78	18.49	7.8	18.24	1.55	0.08	0
1997	52.85	32.39	212.86	54.46	38.68	7.04	5.79	6.05	0.23	0
1998	209.09	81.08	32.49	133.4	19.83	15.75	5.36	5.36	1.91	0
1999	178.59	397.44	66.87	28.61	97.12	11.88	10.35	0.56	2.1	0.33
2000	56.19	162.34	260.1	45.84	8.24	28.71	1.97	3.45	0.08	0.27
2001	46.95	386.99	282.1	170.25	35.69	4.06	13.92	0.85	0.96	0
2002	150.58	85.19	237.78	197.49	98.45	19.33	2.96	2.51	0.87	0.07
2003	316.54	343.8	147.83	252.45	169.19	56.68	9.49	2.5	0.63	0
2004	189.43	713.02	348.5	51.24	160.31	70.57	17.04	4.03	0.85	0.5
2005	91.14	74.2	560.35	182.1	27.3	96.52	26.73	10.18	2.07	0
2006	85.88	124.13	117.57	510.38	108.53	13.82	40.39	9.76	3.94	1.51
2007	203.44	93.77	78.47	92.82	340.57	58.67	8.46	12.39	3.85	0.57
2008	95.34	201.84	93.9	68.36	87.88	198.94	16.79	2.87	3.35	0.34
2009	54.9	59.25	265.28	91.58	19.91	37.08	88.31	8.24	0.32	2.69

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	10
1979	37	185	481	910	1409	1968	2496	3077	3300	4000
1980	37	185	481	910	1409	1968	2496	3077	3300	4615
1981	37	185	481	910	1409	1968	2496	3077	3300	4898
1982	37	185	481	910	1409	1968	2496	3077	3300	3952
1983	37	185	481	910	1409	1968	2496	3077	3300	4463
1984	37	185	481	910	1409	1968	2496	3077	3300	3941
1985	36	244	568	1187	1673	2371	2766	3197	3331	4564
1986	35	239	671	1134	1943	2399	3190	3293	3728	4436
1987	31	162	550	1216	1825	2605	3030	3642	3837	3653
1988	37	176	457	974	1830	2695	3102	3481	3318	4169
1989	26	182	441	887	1510	2380	3009	3499	3195	5039
1990	29	184	457	840	1234	1965	2675	3052	3267	4115
1991	31	176	501	1003	1406	1884	2496	3755	3653	5243
1992	28	157	503	894	1365	1891	2325	2936	3682	4674
1993	41	168	384	878	1492	1785	2562	2573	3266	4047
1994	33	181	392	680	1235	1766	1717	2977	2131	3154
1995	37	167	440	755	1065	1857	2689	5377	1306	3119
1996	41	174	453	813	1076	1477	2171	2426	4847	3686
1997	50	174	424	817	1221	1425	1915	2390	3692	3508
1998	41	203	415	753	1241	1747	1996	2342	3076	3275
1999	33	206	480	715	1189	1956	2366	2782	2922	3534
2000	29	179	552	889	1159	1767	2612	2917	3132	3734
2001	36	190	490	1056	1437	1509	2169	2765	3300	4715
2002	67	172	475	889	1460	1949	2137	1990	3709	4078
2003	40	230	412	801	1268	1873	3139	2343	3301	3289
2004	34	176	556	807	1282	1690	2454	3236	2942	3957
2005	40	153	448	920	1188	1564	2128	2808	2550	2755
2006	33	127	333	736	1145	1512	1944	2232	3272	3617
2007	48	170	350	615	1053	1514	1786	2073	2198	2408
2008	27	179	382	595	868	1295	1828	2201	2340	2568
2009	29	139	442	687	882	1141	1495	1920	2574	3070
2010	32	150	392	773	942	1190	1468	1829	2086	3070
2011	31	152	373	692	1112	1285	1525	1778	2087	2294
2012	31	152	374	694	1116	1288	1529	1784	2093	2301

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	10
1979	620	960	1410	2030	2910	3800	4560	4720	4000
1980	837	831	1306	2207	2738	3188	3843	4506	4615
1981	584	693	1081	1656	2283	3214	3409	4046	4898
1982	289	959	1455	1674	2351	3031	3481	3874	3952
1983	320	1006	1496	1921	2371	2873	3678	4265	4463
1984	691	1007	1544	2120	2514	3027	2940	3906	3941
1985	652	1125	1811	2260	2924	3547	3733	4039	4564
1986	336	1227	1780	2431	2771	3689	3820	4258	4436
1987	452	1064	1692	2408	3000	3565	4215	4502	3653
1988	362	780	1474	2217	2931	3529	3781	4467	4169
1989	323	857	1185	1996	2893	4066	3866	4734	5039
1990	269	700	1054	1562	2364	3414	4134	4946	4115
1991	288	699	979	1412	1887	2674	3135	4341	5243
1992	313	806	1167	1524	1950	2357	3075	4053	4674
1993	303	705	1333	1875	2386	2996	3059	3363	4047
1994	337	668	1019	1717	2391	2717	3280	3156	3154
1995	351	746	1096	1318	2044	2893	3049	3675	3119
1996	311	787	1187	1560	1849	2670	3510	3567	3686
1997	379	764	1163	1649	1943	2342	3020	3337	3508
1998	445	724	1147	1683	2250	2475	2834	3333	3275
1999	555	908	1101	1658	2216	2659	2928	3209	3534
2000	495	978	1333	1481	2119	2696	3307	3597	3734
2001	541	945	1456	1731	1832	2243	3020	3328	4715
2002	564	928	1253	1737	2219	2230	2911	3365	4078
2003	498	922	1283	1704	2274	2744	2635	2819	3289
2004	559	1006	1258	1579	2044	2809	3123	2945	3957
2005	339	886	1265	1506	1916	2323	3028	3211	2755
2006	402	749	1093	1495	1758	2163	2555	3054	3617
2007	510	748	988	1346	1840	2062	2350	2525	2408
2008	383	636	857	1125	1575	2149	2417	2802	2568
2009	452	841	960	1131	1352	1757	2364	2497	3070
2010	405	755	1172	1332	1549	1775	2046	2228	2651
2011	412	736	1098	1491	1637	1828	2020	2240	2381
2012	413	738	1101	1496	1641	1833	2026	2246	2388

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	10
1979	0.08	0.301	0.539	0.722	0.821	0.868	0.904	0.963	1
1980	0.08	0.301	0.539	0.722	0.821	0.868	0.904	0.963	1
1981	0.08	0.301	0.539	0.722	0.821	0.868	0.904	0.963	1
1982	0.08	0.301	0.539	0.722	0.821	0.868	0.904	0.963	1
1983	0.08	0.301	0.539	0.722	0.821	0.868	0.904	0.963	1
1984	0.08	0.301	0.539	0.722	0.821	0.868	0.904	0.963	1
1985	0.016	0.144	0.536	0.577	0.765	0.766	0.961	0.934	1
1986	0.021	0.205	0.413	0.673	0.845	0.884	0.952	0.986	1
1987	0.022	0.137	0.426	0.535	0.778	0.776	1	0.969	1
1988	0.013	0.221	0.394	0.767	0.793	0.928	0.914	1	1
1989	0.041	0.202	0.532	0.727	0.818	0.998	1	1	1
1990	0.114	0.334	0.634	0.814	0.843	0.918	0.882	1	1
1991	0.063	0.224	0.592	0.739	0.817	0.894	0.495	1	1
1992	0.05	0.227	0.419	0.799	0.901	0.901	0.858	1	1
1993	0.124	0.362	0.481	0.67	0.904	0.977	0.908	0.867	1
1994	0.248	0.312	0.573	0.762	0.846	1	0.907	1	1
1995	0.124	0.479	0.382	0.75	0.753	0.606	0.985	1	1
1996	0.191	0.362	0.59	0.648	0.787	0.739	0.949	0.908	1
1997	0.093	0.436	0.587	0.683	0.75	0.783	0.88	1	1
1998	0.026	0.454	0.668	0.77	0.733	0.849	0.899	1	1
1999	0.05	0.397	0.683	0.724	0.749	0.892	0.761	0.92	1
2000	0.107	0.261	0.632	0.808	0.868	0.873	1	0.78	1
2001	0.091	0.377	0.522	0.753	0.895	0.916	0.918	1	1
2002	0.047	0.286	0.633	0.8	0.934	0.928	1	1	1
2003	0.062	0.347	0.685	0.867	0.922	0.946	1	1	1
2004	0.037	0.361	0.57	0.831	0.91	1	1	1	1
2005	0.024	0.23	0.562	0.753	0.927	0.936	0.968	1	1
2006	0.027	0.117	0.462	0.621	0.739	0.918	1	1	1
2007	0.078	0.208	0.418	0.68	0.77	0.875	0.959	1	1
2008	0.027	0.263	0.418	0.621	0.828	0.87	0.904	0.975	1
2009	0.017	0.301	0.47	0.576	0.847	0.891	1	0.968	1
2010	0.029	0.187	0.618	0.778	0.787	0.887	0.934	1	1
2011	0.027	0.193	0.512	0.765	0.821	0.874	0.909	0.936	1
2012	0.027	0.198	0.495	0.731	0.861	0.889	0.915	0.934	1

Table 10.6.1 Haddock in division Va. Summary table from the SPALY run using the surveys in March and October for tuning.

Year	Recruitment thousand at age 2	Biomass 3+ tons	SSB tons	Landings tons	Yield/SSB	F4-7
1979	80655	160668	94822	55330	0.584	0.529
1980	37182	190644	115206	51110	0.444	0.402
1981	10303	205305	140228	63558	0.453	0.551
1982	42595	178682	135366	69428	0.513	0.45
1983	29179	146380	111092	65942	0.594	0.513
1984	20428	111093	81470	48282	0.593	0.523
1985	42664	100527	65072	51102	0.785	0.55
1986	86320	94631	58214	48859	0.839	0.762
1987	163773	103601	44787	40760	0.91	0.597
1988	48602	151952	67876	54204	0.799	0.692
1989	29658	166499	98030	62885	0.641	0.705
1990	26978	143979	109358	67198	0.614	0.621
1991	92128	121281	88623	54692	0.617	0.671
1992	174872	104972	65203	47121	0.723	0.736
1993	38292	129164	69873	48123	0.689	0.683
1994	46684	126725	82303	59502	0.723	0.657
1995	72690	122904	84099	60884	0.724	0.678
1996	36115	106840	68990	56890	0.825	0.683
1997	102248	86006	58028	43764	0.754	0.631
1998	17824	95902	63162	41192	0.652	0.638
1999	51652	89746	63387	45411	0.716	0.701
2000	122141	90067	62628	42105	0.672	0.653
2001	155800	116793	70491	39654	0.563	0.473
2002	187443	171015	100890	50498	0.501	0.456
2003	48487	222907	150206	60883	0.405	0.388
2004	150136	255629	184379	84828	0.46	0.442
2005	388177	261313	179939	97225	0.54	0.488
2006	77719	301486	145964	97614	0.669	0.595
2007	47804	295807	163626	109966	0.672	0.576
2008	53535	248433	158670	102872	0.648	0.533
2009	124272	194789	143415	82045	0.572	0.525
2010	22195	173221	115724			
Mean 79-09	84076	157927	100819	61417	0.642	0.584

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	10
1979	45.41	80.66	117.03	27.6	19.45	20.33	3.34	0.73	0.12	0.02
1980	12.58	37.18	65.9	94.09	19.2	10.45	8.48	1.16	0.2	0.04
1981	52.03	10.3	29.9	52.7	66.65	11.83	5.12	3.56	0.46	0.08
1982	35.64	42.59	8.43	24.02	38.7	39.28	4.26	1.63	1.29	0.22
1983	24.95	29.18	34.78	6.68	16.81	21.87	19.44	1.61	0.43	0.4
1984	52.11	20.43	23.86	27.56	4.03	9.61	8.99	7.92	0.63	0.17
1985	105.43	42.66	16.51	18.57	18.09	2.09	3.55	3.98	2.8	0.3
1986	200.03	86.32	33.74	11.95	11.07	8.66	0.93	1.38	1.52	0.57
1987	59.36	163.77	69.76	23.8	6.1	4.83	2.44	0.32	0.41	0.44
1988	36.22	48.6	132.33	49.59	13.18	2.53	2.1	1.01	0.14	0.19
1989	32.95	29.66	39.58	99.45	26.88	5.52	0.89	0.74	0.27	0.06
1990	112.52	26.98	24.11	30.16	61.01	13.35	1.63	0.27	0.1	0.09
1991	213.59	92.13	20.41	17.56	16.89	28.59	5.2	0.6	0.08	0.02
1992	46.77	174.87	67.63	14.77	9.49	7.18	10.64	1.86	0.18	0.03
1993	57.02	38.29	138.28	45.7	6.91	3.6	2.54	4	0.62	0.04
1994	88.78	46.68	30.66	102.06	25.82	2.98	1.39	0.79	1.25	0.2
1995	44.11	72.69	35.33	22.07	57.99	11.47	1.11	0.48	0.32	0.44
1996	124.89	36.11	55.88	22.3	12.87	25.83	4.17	0.35	0.13	0.1
1997	21.77	102.25	26.77	36.2	11.34	6.5	9.48	1.29	0.1	0.04
1998	63.09	17.82	82.48	18.36	19.76	4.86	2.96	3.2	0.41	0.02
1999	149.18	51.65	14.34	60.06	9.9	9.07	1.79	1.14	0.91	0.1
2000	190.3	122.14	40.99	10.34	33.57	4.02	3.05	0.64	0.37	0.31
2001	228.94	155.8	97.6	27.84	6.34	15.16	1.53	0.96	0.23	0.1
2002	59.22	187.44	125.28	69.86	16.51	3.88	6.75	0.64	0.35	0.09
2003	183.38	48.49	152.49	93.13	42.72	8.9	2.15	2.68	0.29	0.13
2004	474.12	150.14	39.33	119.1	61.53	23.62	4.6	1.09	1.07	0.15
2005	94.93	388.18	121.48	28.53	81.54	32.86	11.32	2.01	0.46	0.44
2006	58.39	77.72	315.64	90.91	17.09	43.75	14.44	5.12	0.91	0.15
2007	65.39	47.8	63.41	249.34	55.2	7.98	18.78	4.94	2.22	0.46
2008	151.79	53.53	38.43	48.4	165.94	25.07	3.5	6.37	1.57	1.35
2009	27.11	124.27	41.74	27.39	30.85	87.88	10.56	1.31	2.47	0.55
2010	32.3	22.19	100.78	31.29	18	17.21	40.27	3.46	0.41	0.77
2011	71.58	26.45	17.97	76.87	20.4	10.93	9.55	20.51	1.6	0.18
2012	71.58	58.6	21.41	13.84	52.33	11.81	5.99	4.9	9.87	0.73

Table 10.6.3 Haddock in division Va. Fishing mortality from the SPALY run using the March and October surveys for tuning.

Year/Age	2	3	4	5	6	7	8	9	10
1979	0.002	0.018	0.163	0.422	0.674	0.858	1.087	0.768	0
1980	0.018	0.024	0.145	0.284	0.514	0.667	0.73	0.69	1.644
1981	0.001	0.019	0.109	0.329	0.822	0.942	0.819	0.52	0.853
1982	0.003	0.033	0.157	0.371	0.503	0.77	1.13	0.975	1.819
1983	0.001	0.033	0.305	0.36	0.689	0.698	0.744	0.755	1.315
1984	0.013	0.051	0.221	0.459	0.796	0.616	0.841	0.544	0.488
1985	0.035	0.123	0.317	0.537	0.603	0.742	0.759	1.394	1.542
1986	0.013	0.149	0.472	0.631	1.067	0.879	1.01	1.051	1.106
1987	0.013	0.141	0.391	0.681	0.63	0.684	0.615	0.584	0.815
1988	0.005	0.086	0.412	0.67	0.844	0.843	1.102	0.732	0.739
1989	0.007	0.072	0.289	0.5	1.02	1.012	1.766	0.868	1.136
1990	0.079	0.117	0.38	0.558	0.743	0.805	0.982	1.249	0.75
1991	0.109	0.123	0.415	0.655	0.788	0.827	0.984	0.784	0.604
1992	0.035	0.192	0.559	0.77	0.839	0.779	0.898	1.294	0.452
1993	0.022	0.104	0.371	0.643	0.753	0.966	0.964	0.942	0.717
1994	0.079	0.128	0.365	0.611	0.789	0.863	0.692	0.85	0.73
1995	0.063	0.26	0.339	0.609	0.811	0.952	1.104	1.011	1.131
1996	0.099	0.234	0.476	0.484	0.803	0.971	1.072	1.111	1.157
1997	0.015	0.177	0.405	0.648	0.587	0.885	0.953	1.28	0.475
1998	0.017	0.117	0.417	0.579	0.799	0.758	1.063	1.226	1.846
1999	0.031	0.127	0.382	0.701	0.89	0.832	0.925	0.884	1.236
2000	0.024	0.187	0.29	0.595	0.765	0.962	0.825	1.094	1.008
2001	0.018	0.134	0.323	0.291	0.609	0.668	0.805	0.708	0.615
2002	0.006	0.097	0.292	0.418	0.389	0.725	0.599	0.765	0.699
2003	0.009	0.047	0.214	0.392	0.46	0.485	0.714	0.428	0.508
2004	0.012	0.121	0.179	0.427	0.536	0.627	0.653	0.7	1.076
2005	0.007	0.09	0.313	0.422	0.622	0.594	0.588	0.915	0.771
2006	0.003	0.036	0.299	0.562	0.646	0.872	0.637	0.495	1.131
2007	0.018	0.07	0.207	0.589	0.625	0.881	0.948	0.299	0.163
2008	0.049	0.139	0.251	0.436	0.664	0.783	0.747	0.853	0.148
2009	0.01	0.088	0.22	0.384	0.58	0.916	0.95	0.963	1.597
2010	0.011	0.071	0.228	0.299	0.389	0.475	0.569	0.611	0.611
2011	0.011	0.062	0.185	0.347	0.401	0.468	0.531	0.58	0.58
2012	0.011	0.062	0.172	0.311	0.438	0.479	0.531	0.566	0.566

Table 10.7.1. Output from short term prediction.

F_{4-7} 2009 = 0.52

2010				
Bio 3+	SSB	Fmult	F4-7	Landings
173	116	0.662	0.348	55

	2011				2012	
Fmult	F4-7	Bio 3+	SSB	Landings	Bio 3+	SSB
0.1	0.052	154	109	9	170	133
0.2	0.105	154	109	17	163	126
0.3	0.157	154	109	25	156	120
0.4	0.21	154	109	33	149	115
0.5	0.262	154	109	40	143	109
0.6	0.315	154	109	47	137	104
0.7	0.367	154	109	53	131	99
0.8	0.42	154	109	60	126	95
0.9	0.472	154	109	65	121	90
1	0.525	154	109	71	116	86
1.1	0.577	154	109	76	111	83
1.2	0.63	154	109	81	107	79
1.3	0.682	154	109	86	103	76
1.4	0.735	154	109	90	99	72
1.5	0.787	154	109	94	96	69
1.6	0.84	154	109	98	92	67
1.7	0.892	154	109	102	89	64
1.8	0.945	154	109	106	86	61
1.9	0.997	154	109	109	83	59
2	1.05	154	109	113	80	56

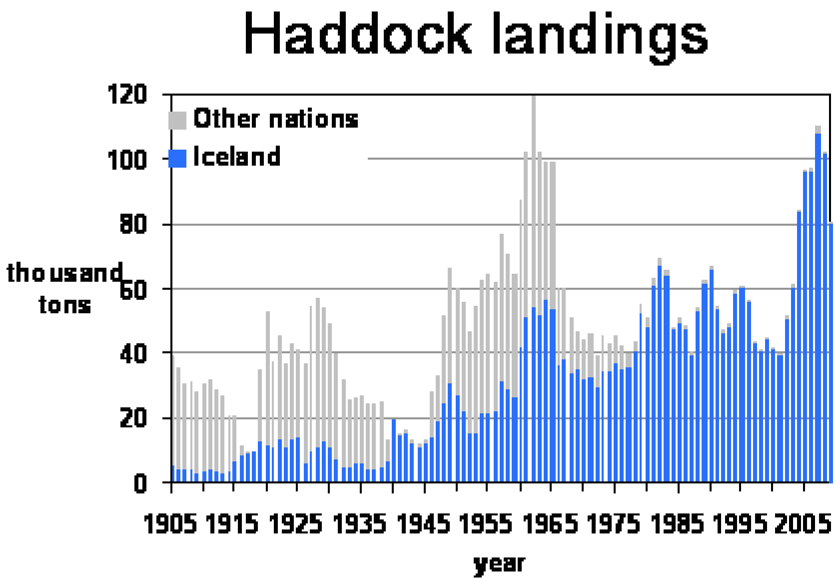


Figure 10.2.1 Haddock in division Va. Landings 1905 – 2009.

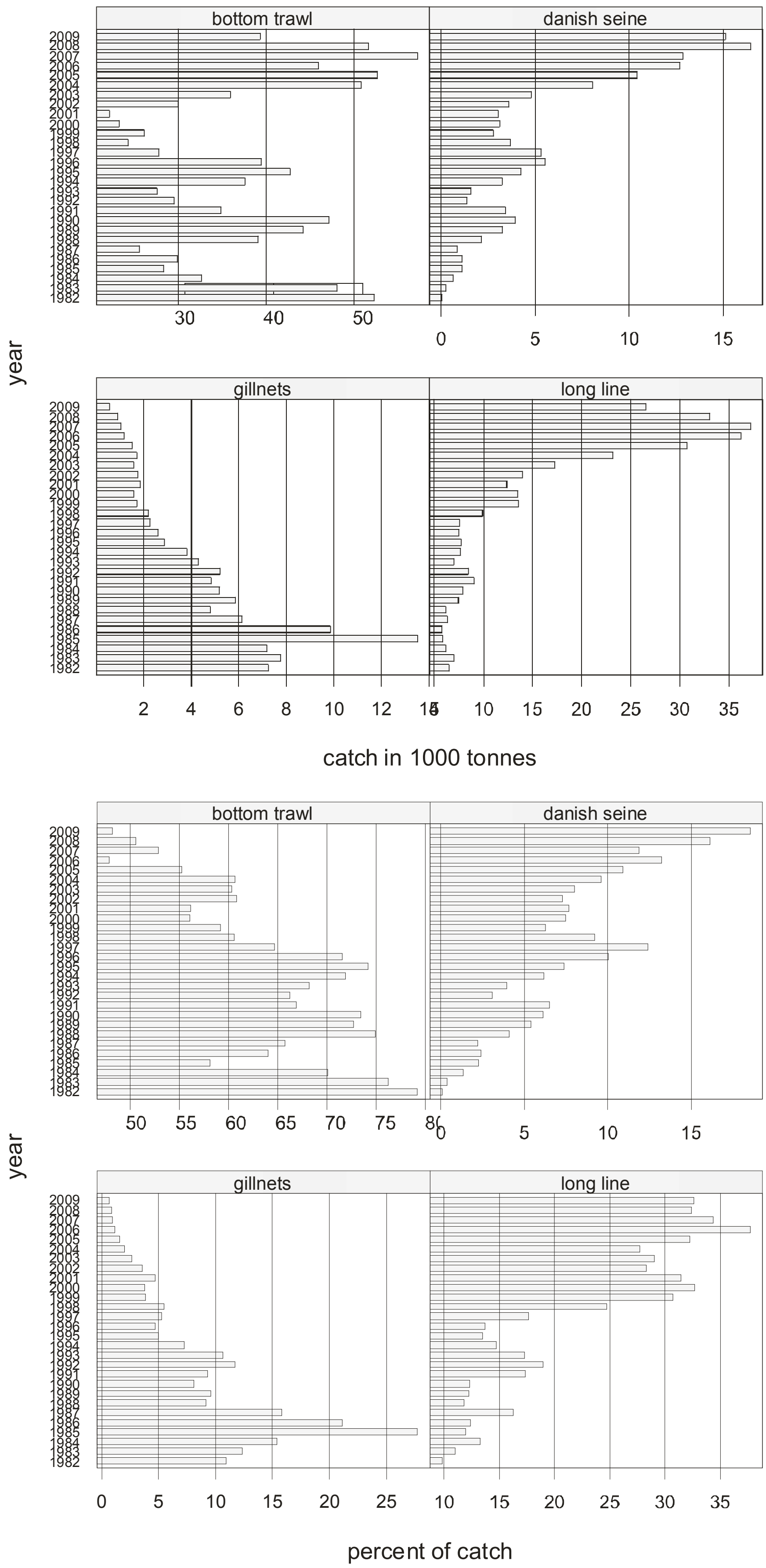


Figure 10.2.2 Haddock Division VA. Landings in tons and percent of total by gear and year.

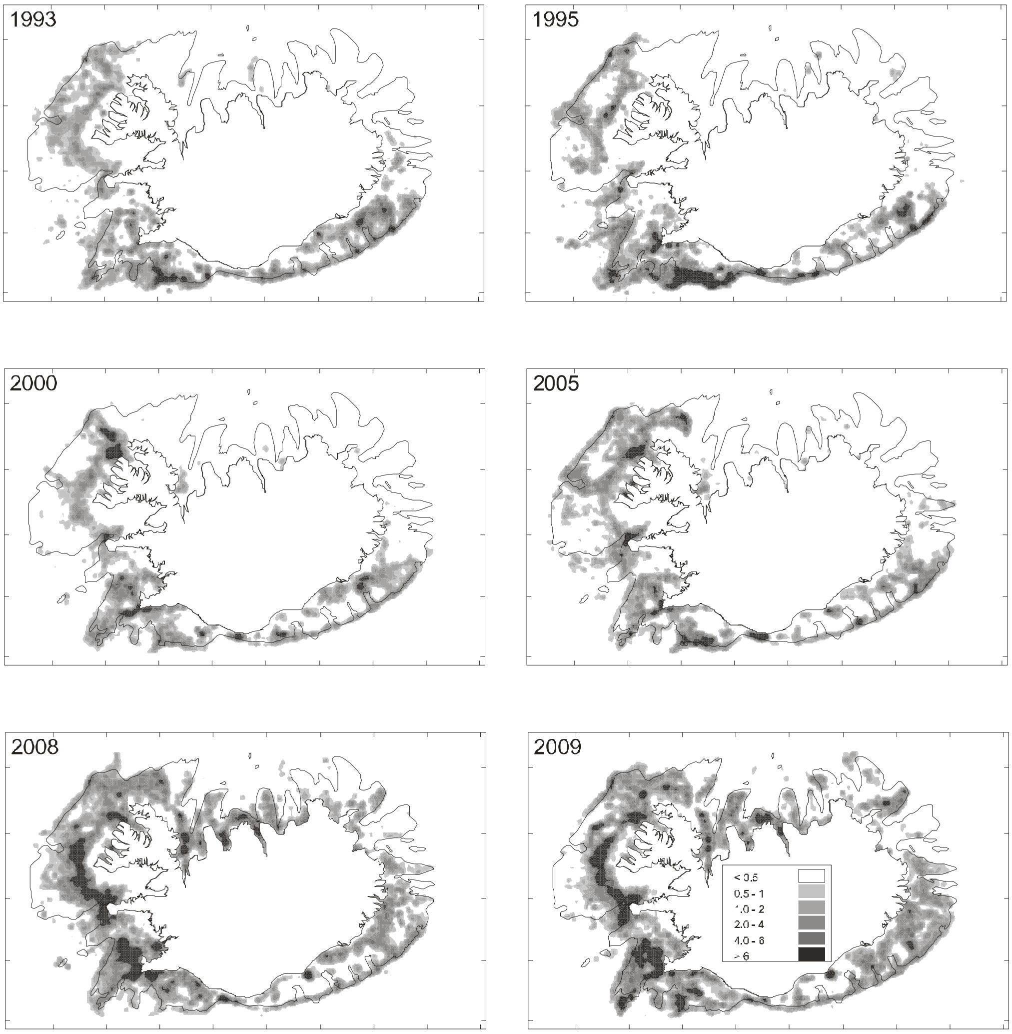


Figure 10.2.3 Haddock Division VA. Spatial distribution af landings. The legend show tonnes per square mile.

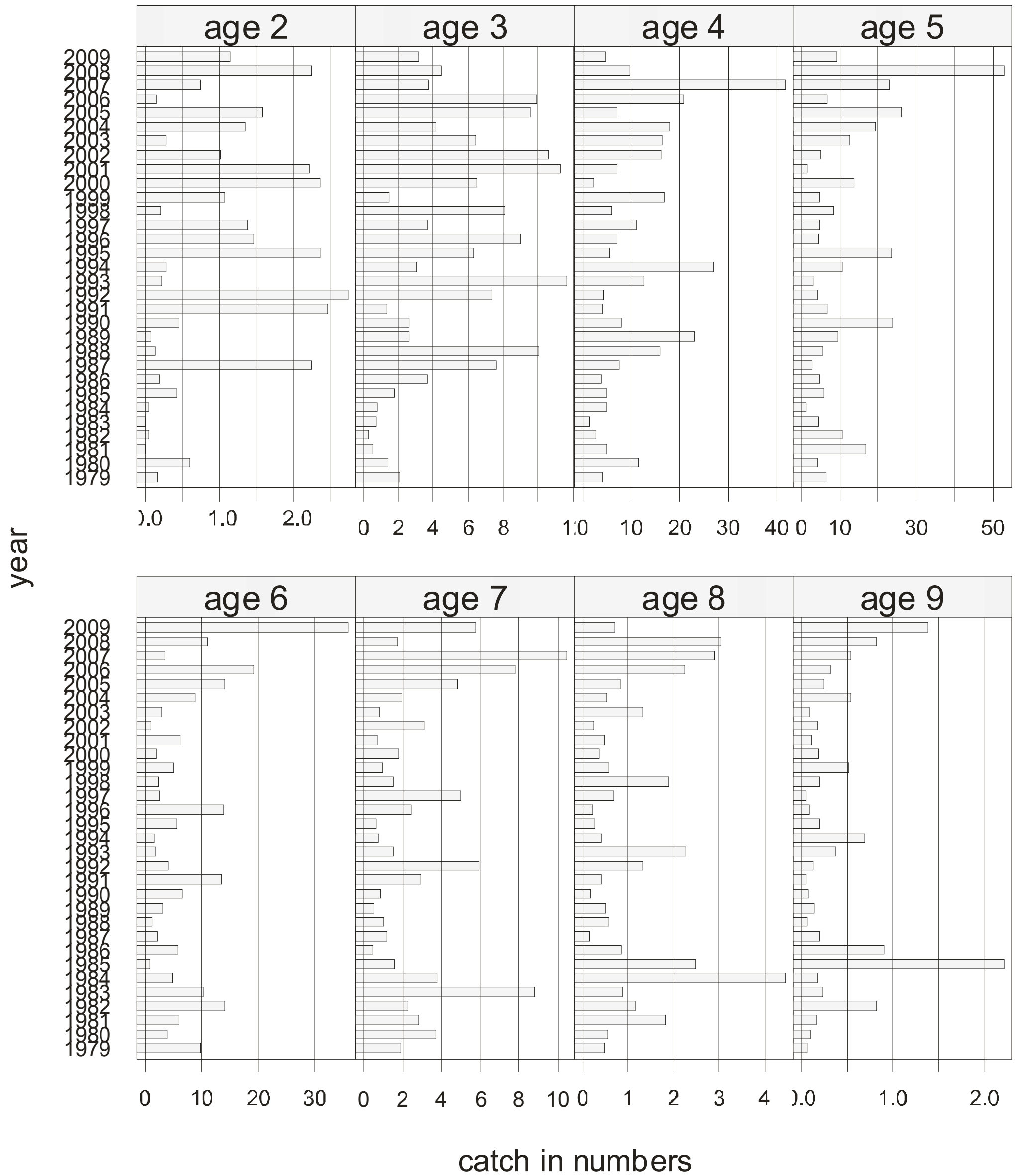


Figure 10.2.4 Haddock in division Va. Age disaggregated catch in numbers.

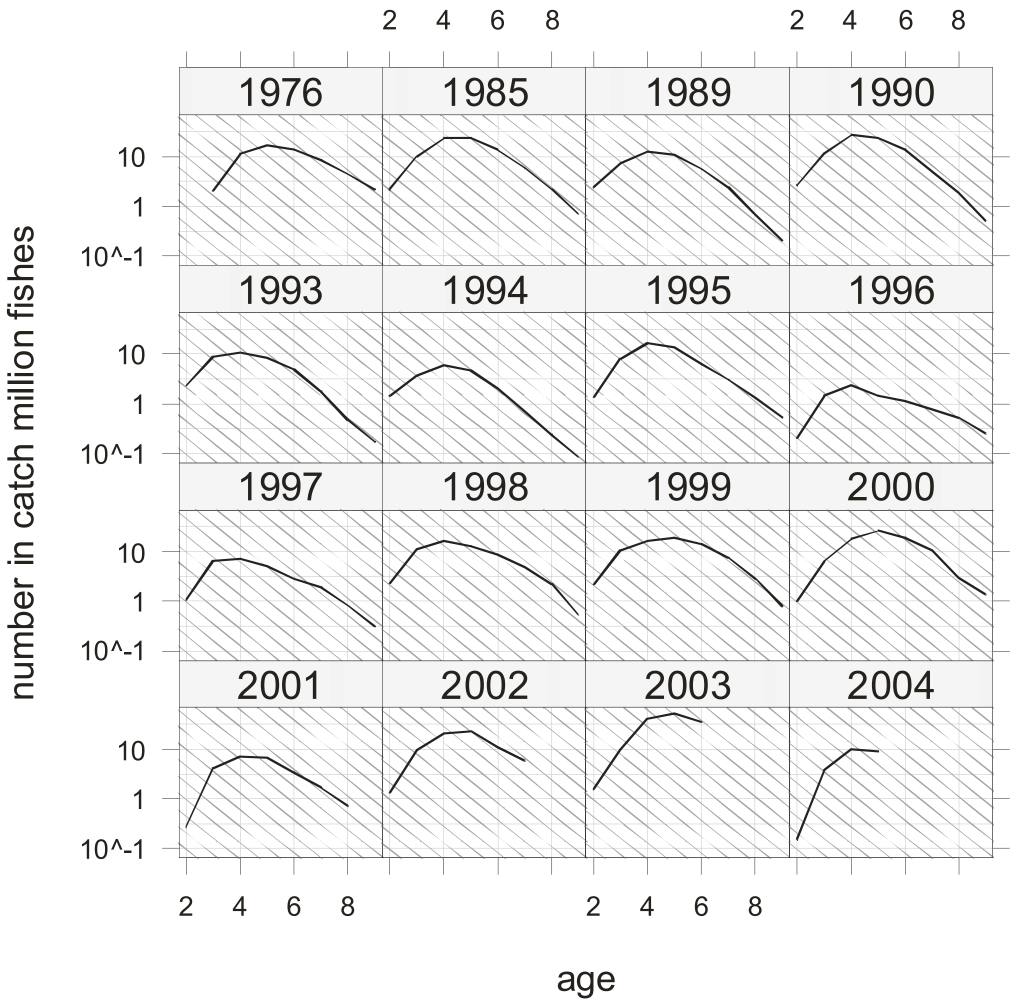


Figure 10.2.5. Haddock in division Va. Age disaggregated catch in numbers plotted on log scale. The grey lines show Z = 1.

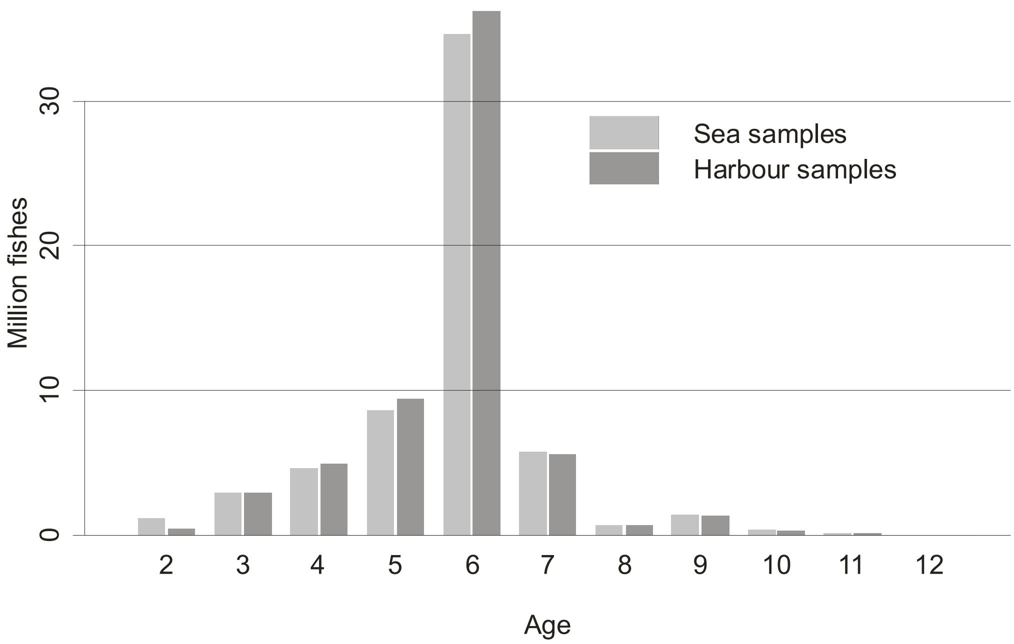


Figure 10.2.6 Comparison of catch in numers in 2008 based on port samples and shore samples.

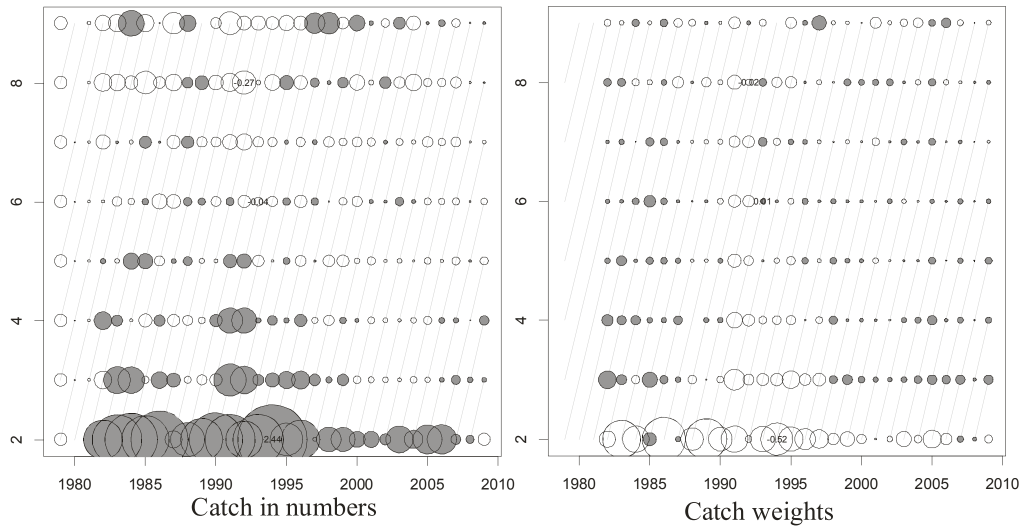


Figure 10.2.6a. Comparison of old and new catch in numbers and catch weights.

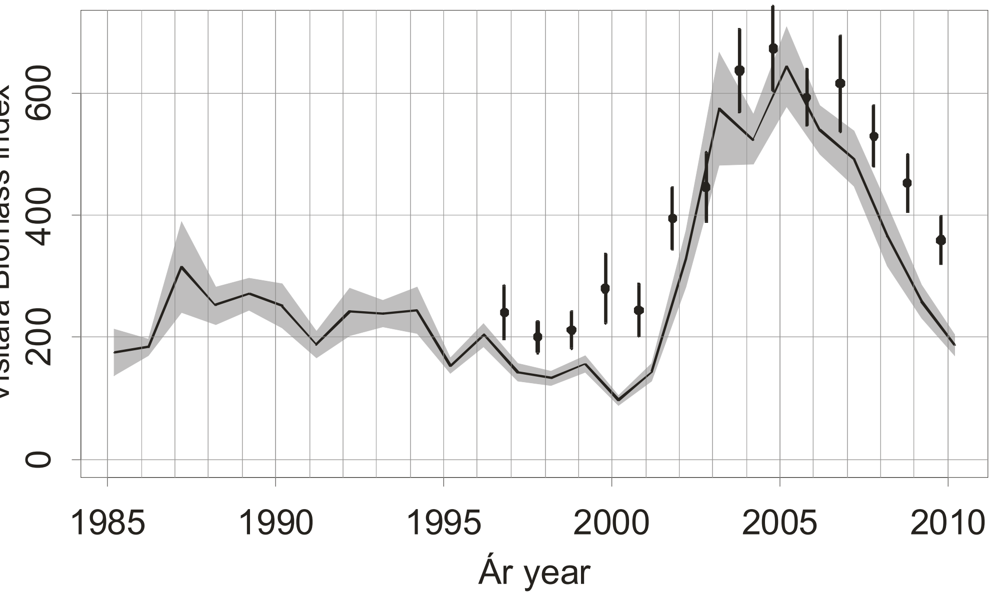


Figure 10.2.7 Icelandic haddock. Total biomass indices from the groundfish surveys in March (lines and shading) and the groundfish survey in October vertical segments. The standard error in the estimate of the indices is shown in the figure.

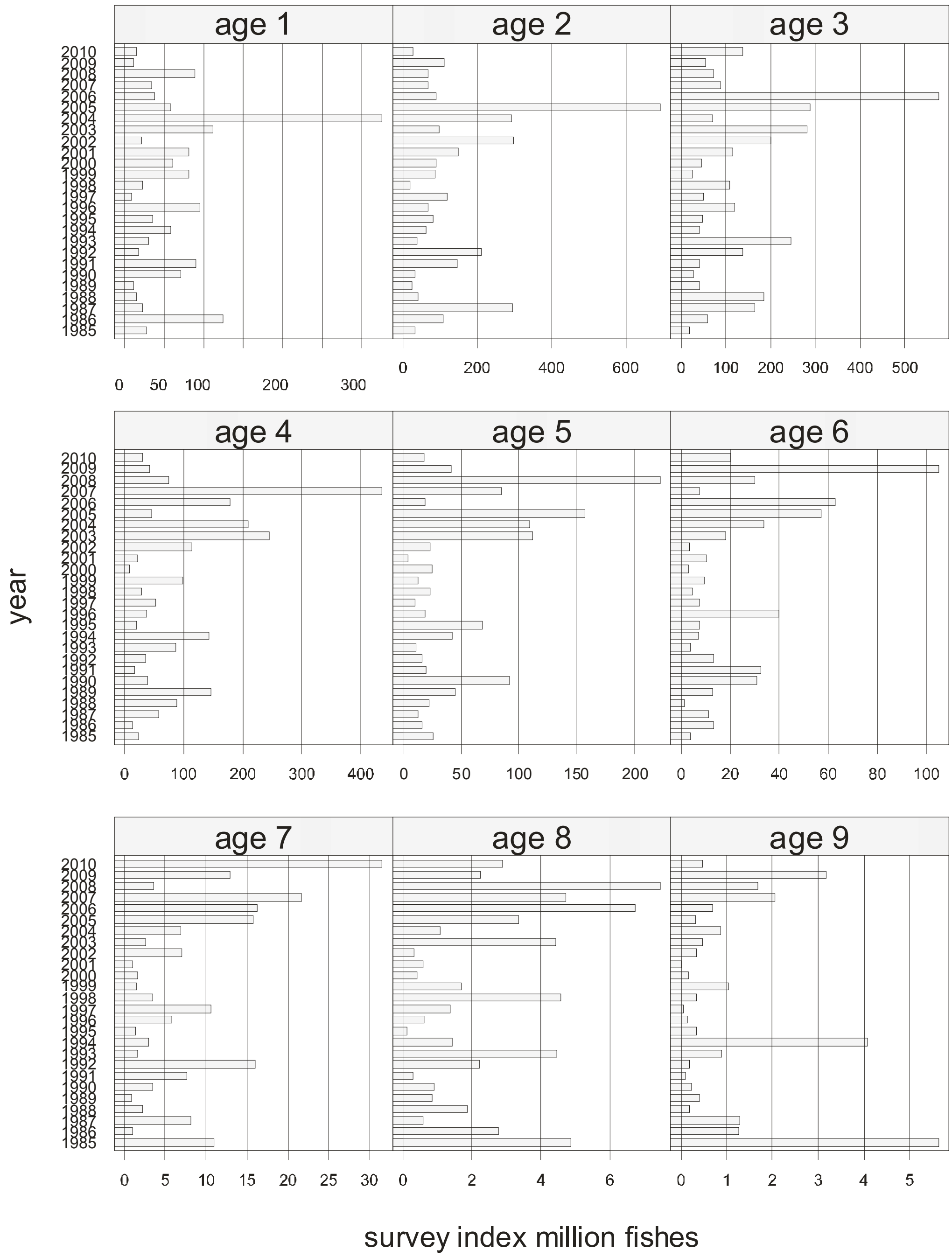


Figure 10.2.8. Age disaggregated indices from the groundfish survey in March.

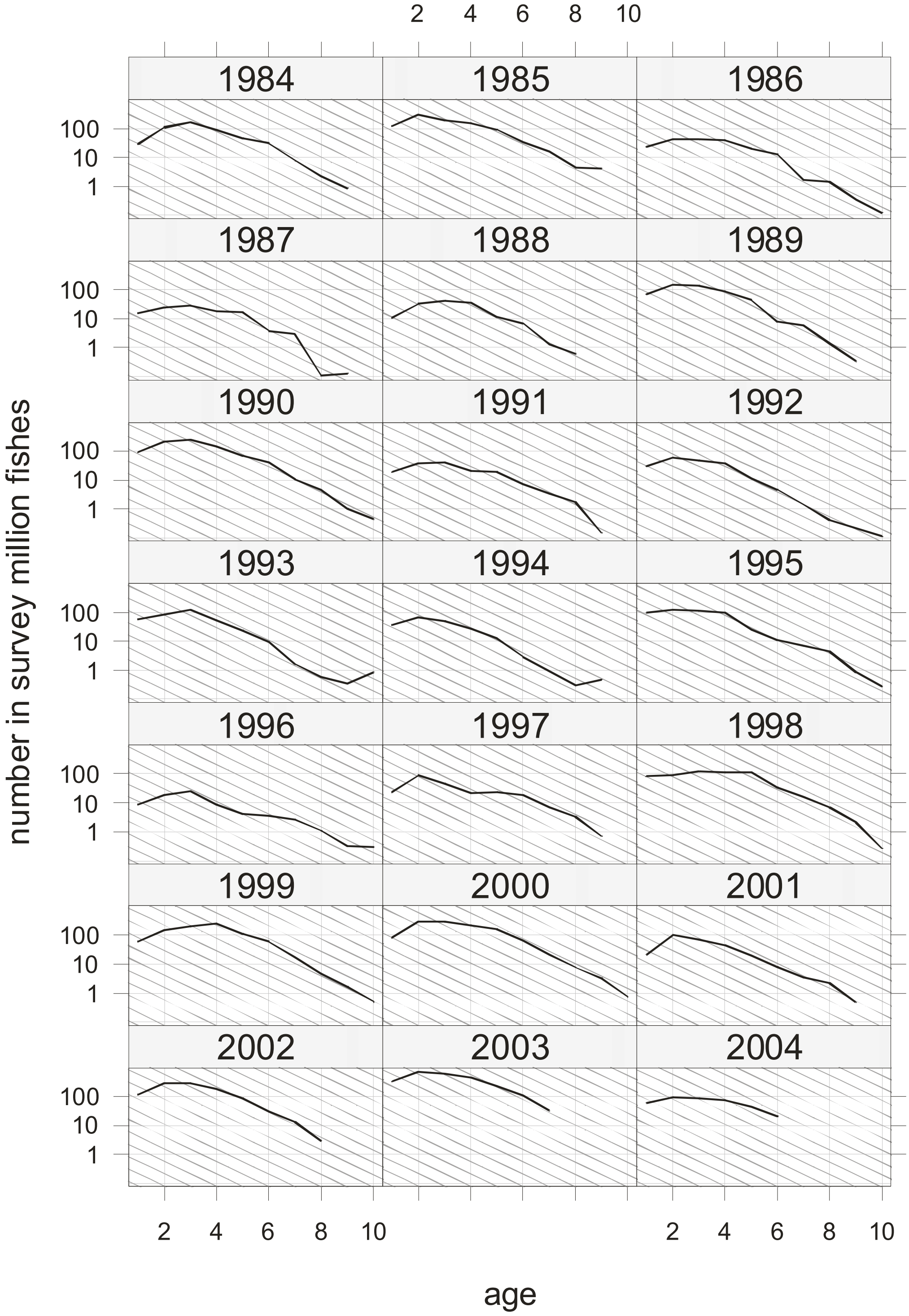


Figure 10.2.9. Age disaggregated indices from the groundfish survey in March plotted on logscale . Grey lines show Z=1.

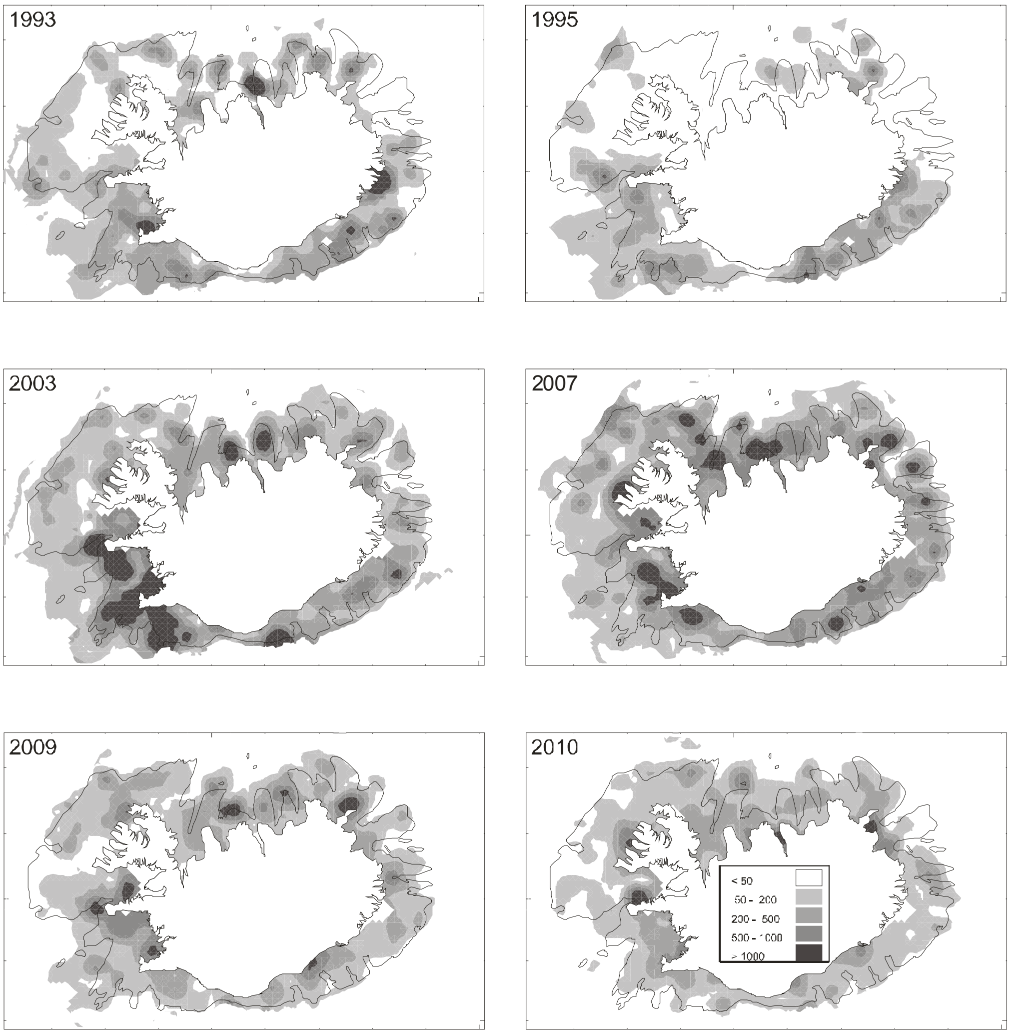


***Figure 10.2.10. Spatial distribution of haddock in the groundfish survey in March. The legend show kg per hour towed.**

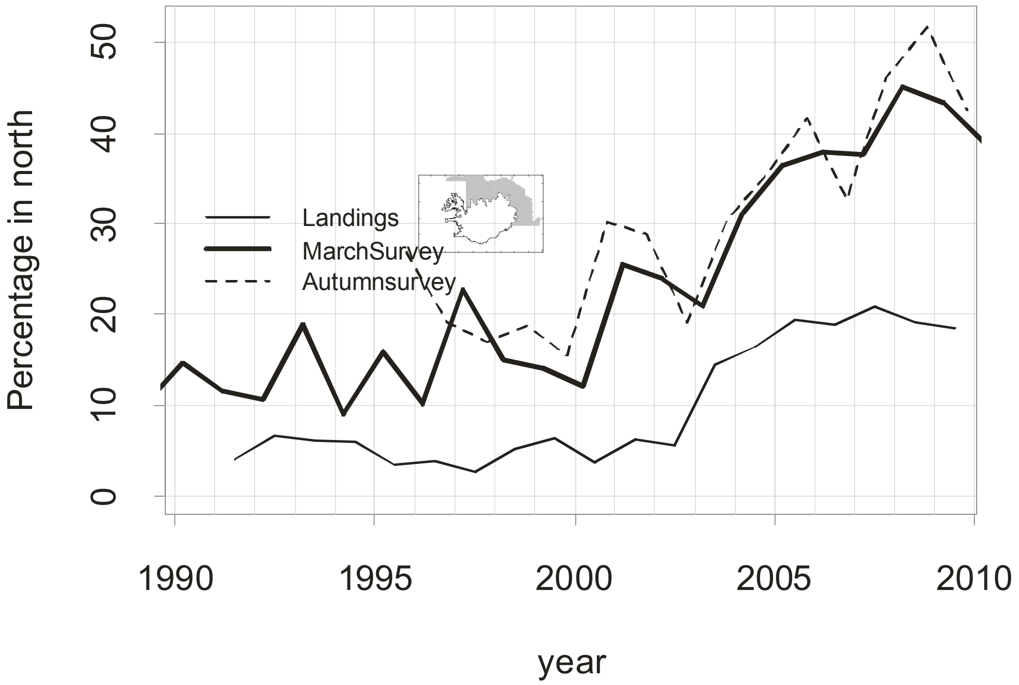


Figure 10.2.11. Proportion of the landings and the biomass of 42cm and older haddock that is in the north area. The small figure shows the northern area

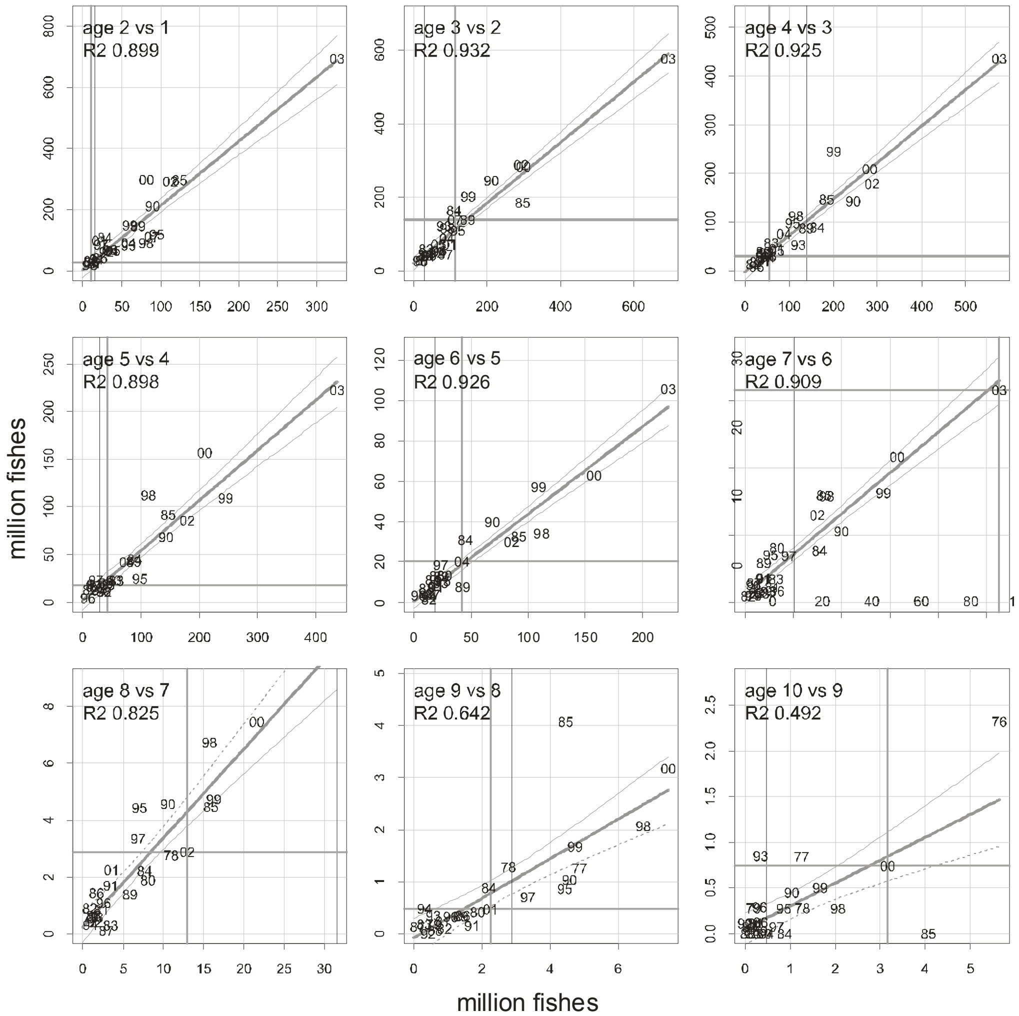


Figure 10.2.12. Haddock in division Va. Indices from March survey plotted against indices of the same year class one year earlier. The letters in the figure are year classes. The dashed vertical lines show the most recent values and the intersection of the gray lines the most recent pair.

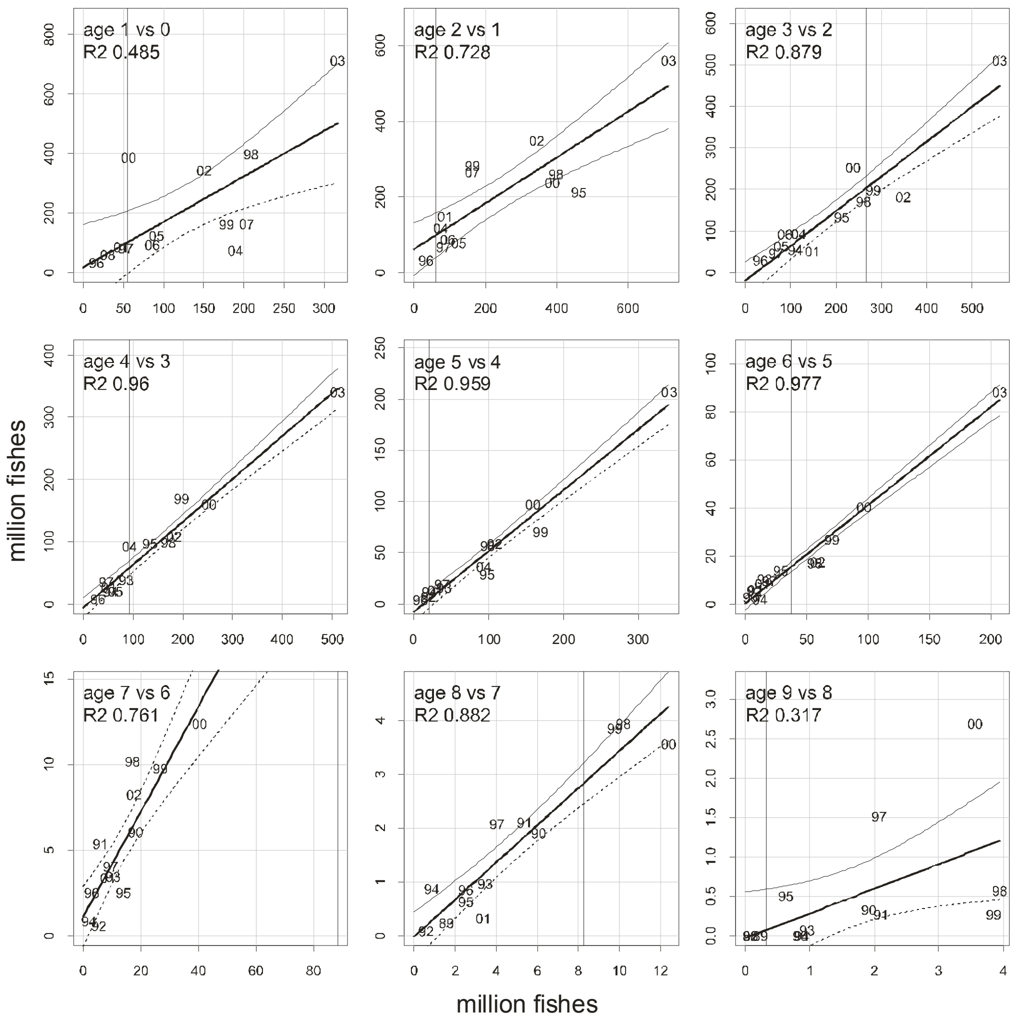
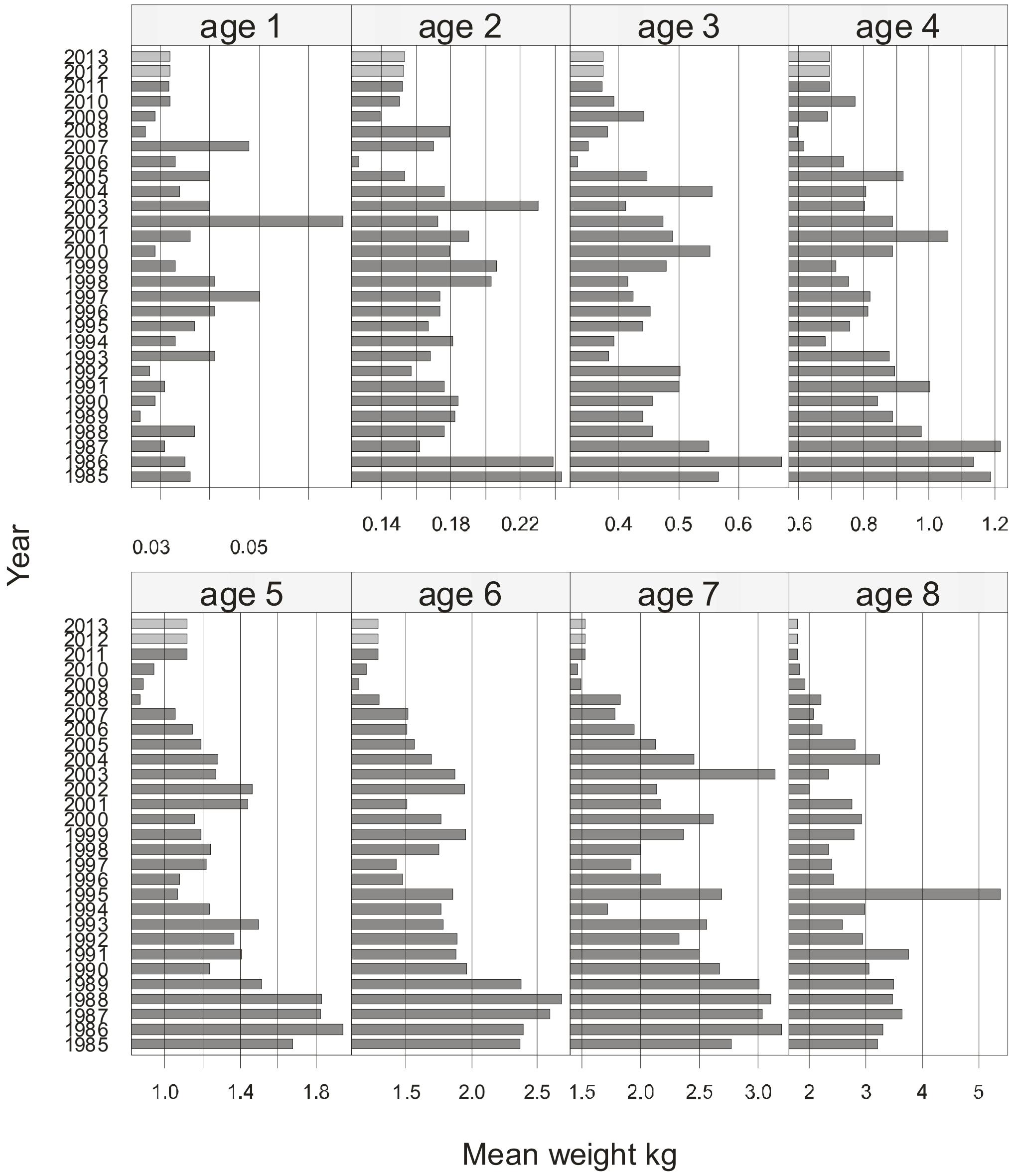


Figure 10.2.13. Indices from October survey plotted against indices of the same year class one year earlier. The letters in the figure are year classes. The dashed vertical lines show the most recent values and the intersection of the gray lines the most recent pair.



age 1
age 2
age 3
age 4
age 5
age 6
age 7
age 8
Year
Mean weight kg
2013
2012
2011
2010
2009
2008
2007
2006
2005
2004
2003
2002
2001
2000
1999
1998
1997
1996
1995
1994
1993
1992
1991
1990
1989
1988
1987
1986
1985
0.03
0.05
0.14
0.18
0.22
0.4
0.5
0.6
0.8
1.0
1.2
1.4
1.8
1.5
2.0
2.5
3.0
2
3
4
5

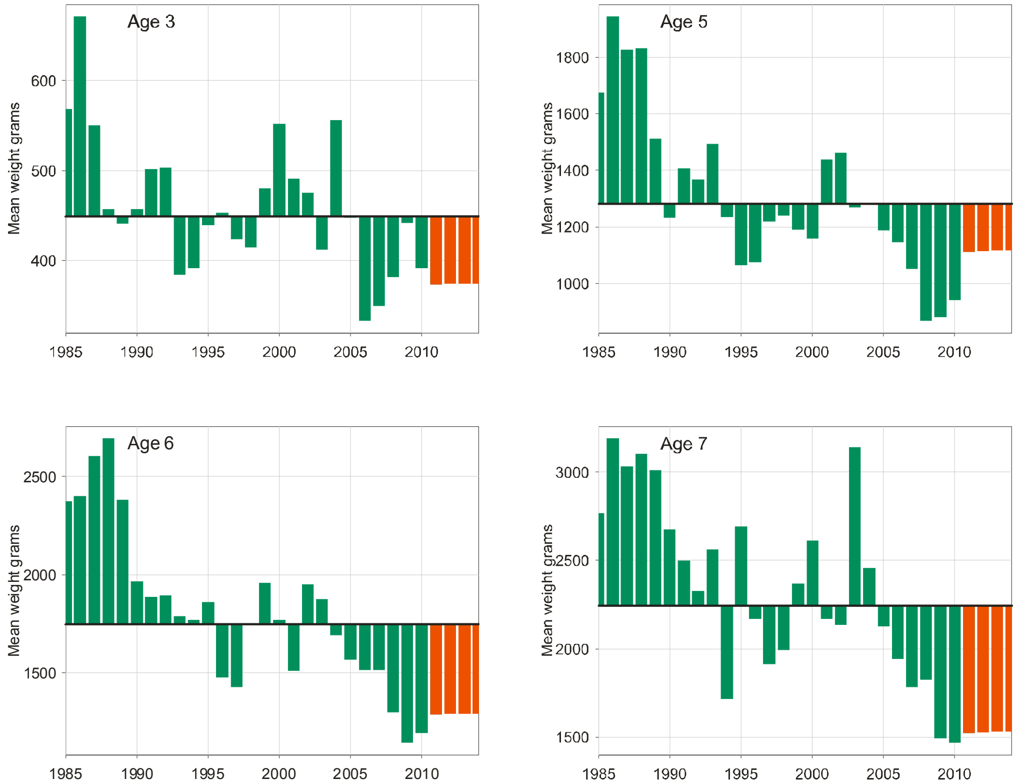


Figure 10.2.15 Haddock in division Va. Mean weight at age in the survey. Predictions are shown as light grey. The values shown are used as weight at age in the stock and spawning stock.

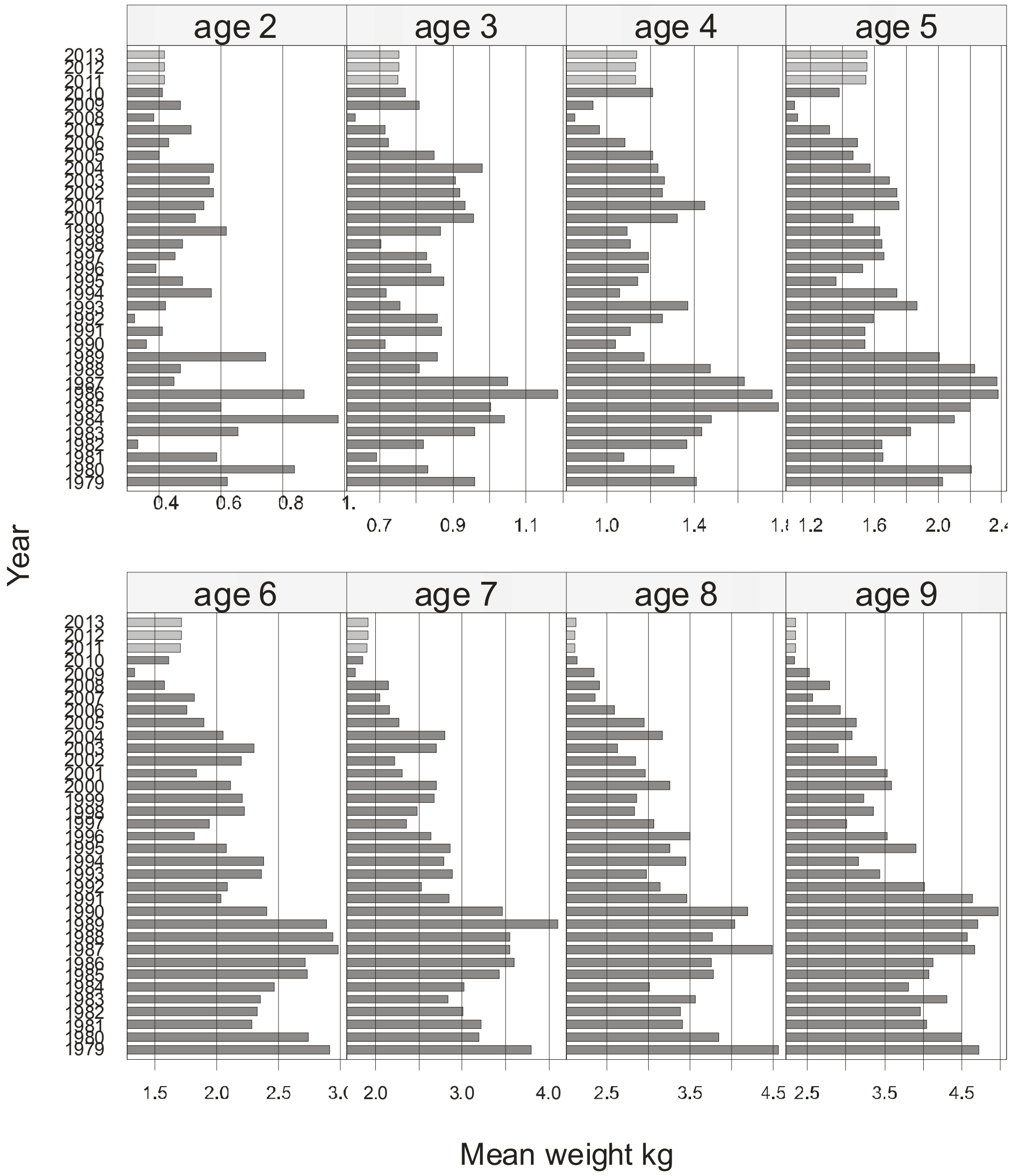


Figure 10.2.16 Haddock in division Va. Mean weight at age in the catches. Perdictions are shown as light grey. Note the very low mean weight of age 6 in 2009.

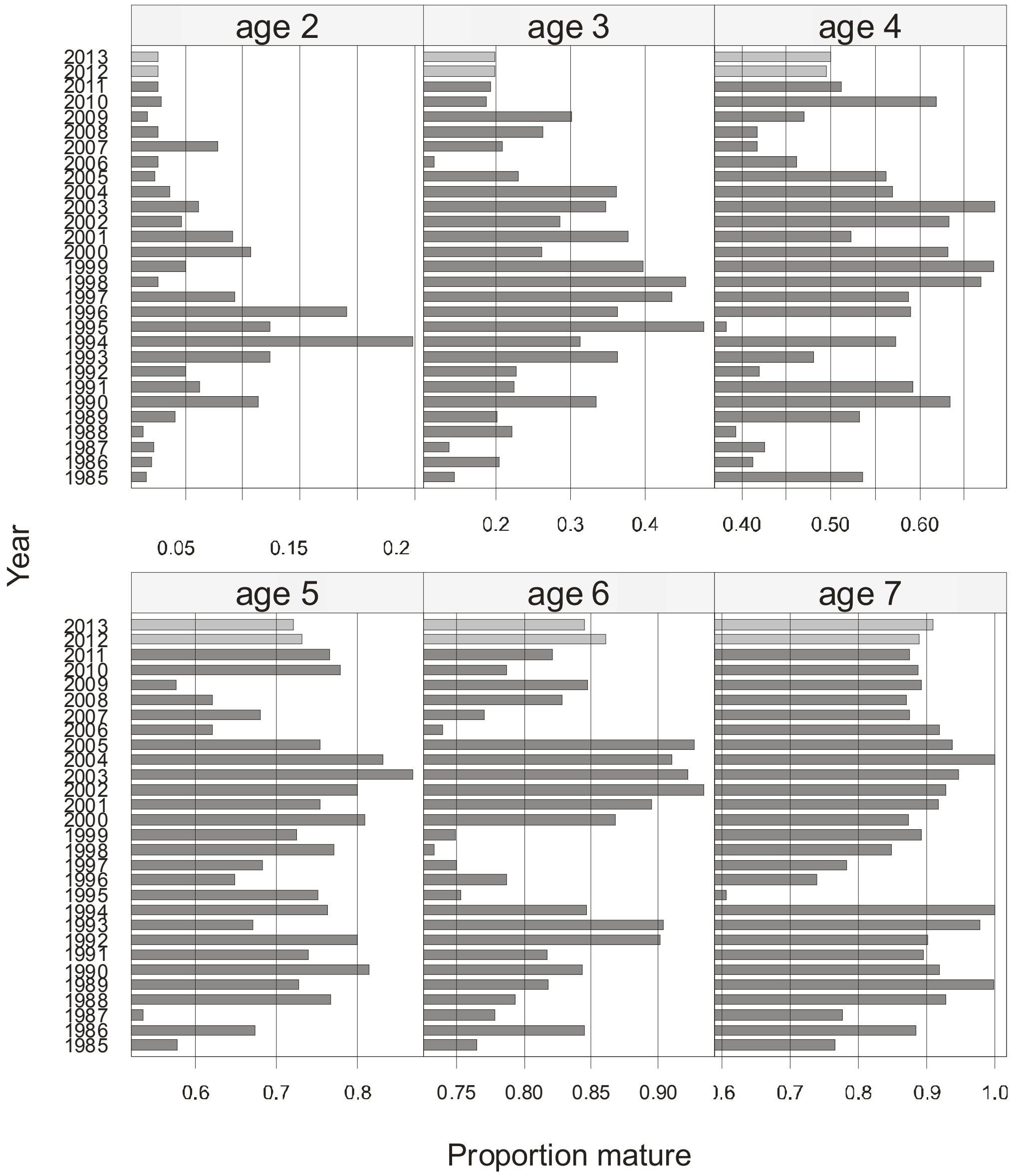


Figure 10.2.17 Haddock in division Va. Maturity at age in the survey. The light grey bars indicate prediction. The values are used to calculate the spawning stock.

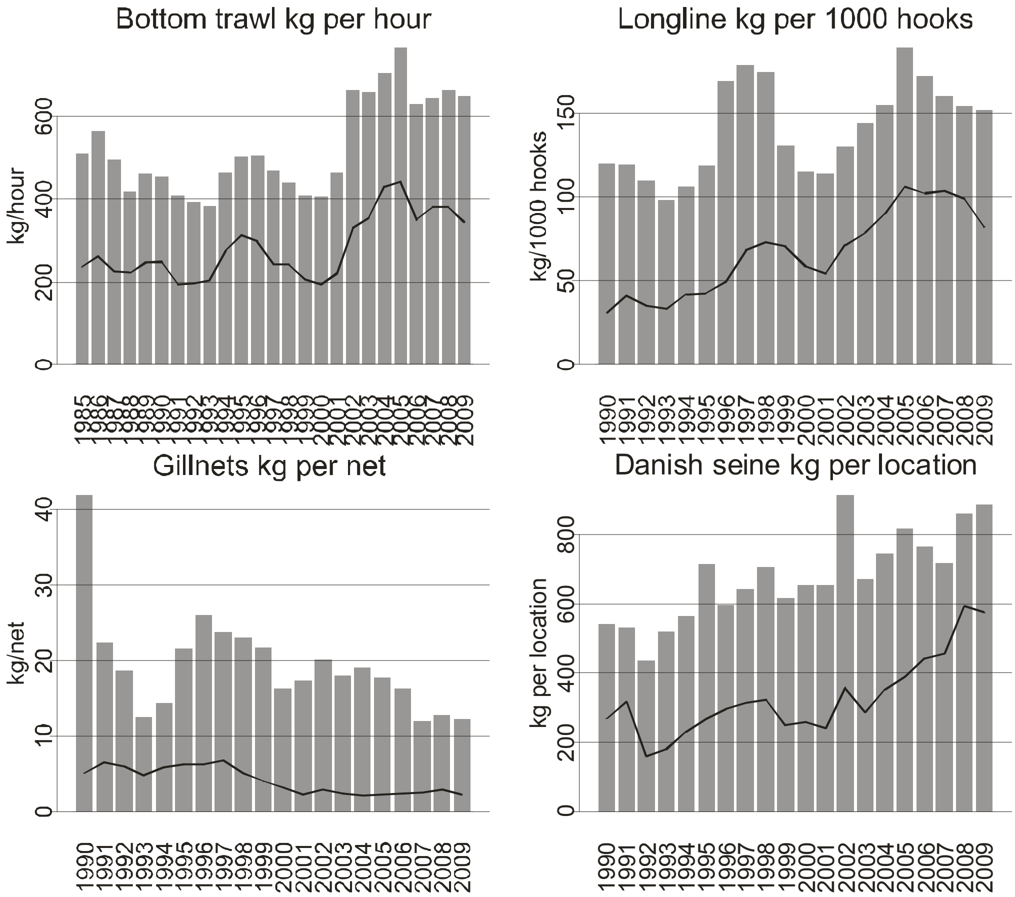


Figure 10.3.1. Catch per unit effort in the most important gear types. The bars are based on locations where more than 50% of the catch is haddock and the lines on all records where haddock is caught. A change occurred in the longline fleet starting September 1999. Earlier only vessels larger than 10 BRT were required to return logbooks but later all vessels were required to return logbooks.

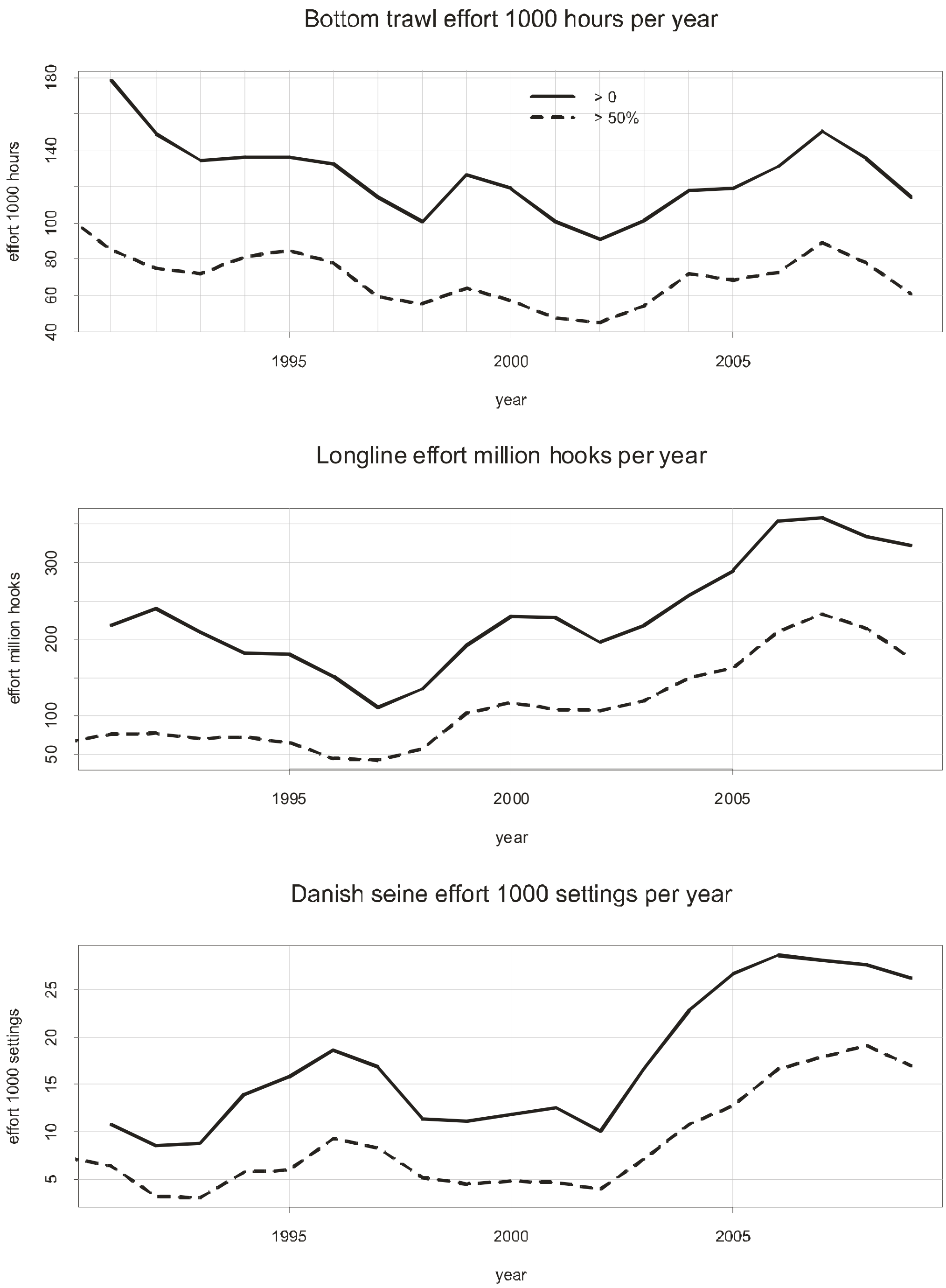
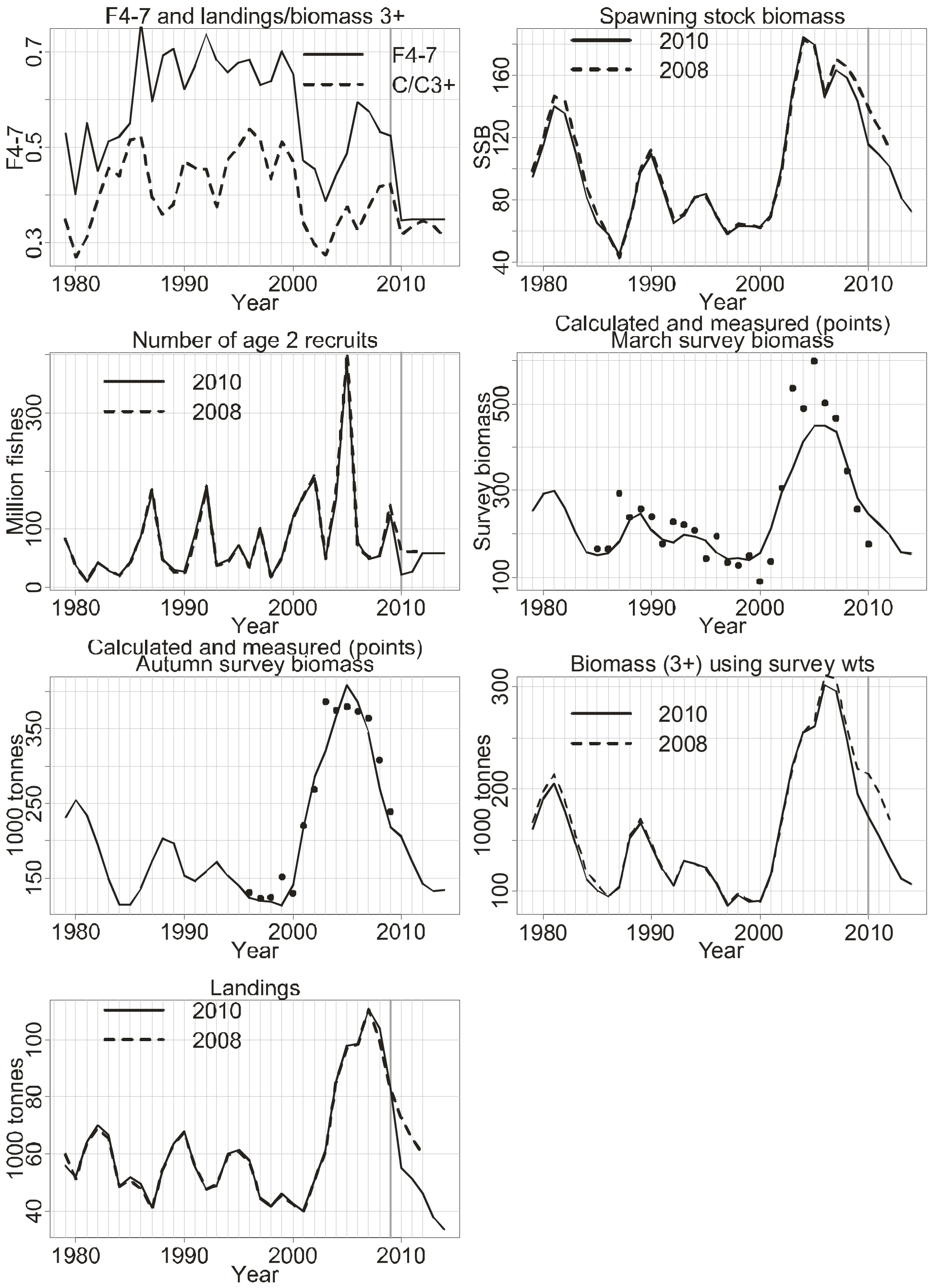


Figure 10.3.2. Effort towards haddock. The effort is calculated as the ratio of the total landings for the gear and the CPUE based on records where haddock was more than 50% of the registered catch


F4-7 and landings/biomass 3+
F4-7
C/C3+
F4-7
Year
Spawning stock biomass
2010
2008
SSB
Year
Number of age 2 recruits
2010
2008
Million fishes
Year
Calculated and measured (points)
March survey biomass
Survey biomass
Year
Calculated and measured (points)
Autumn survey biomass
1000 tonnes
Year
Biomass (3+) using survey wts
2010
2008
1000 tonnes
Year
Landings
2010
2008
1000 tonnes
Year

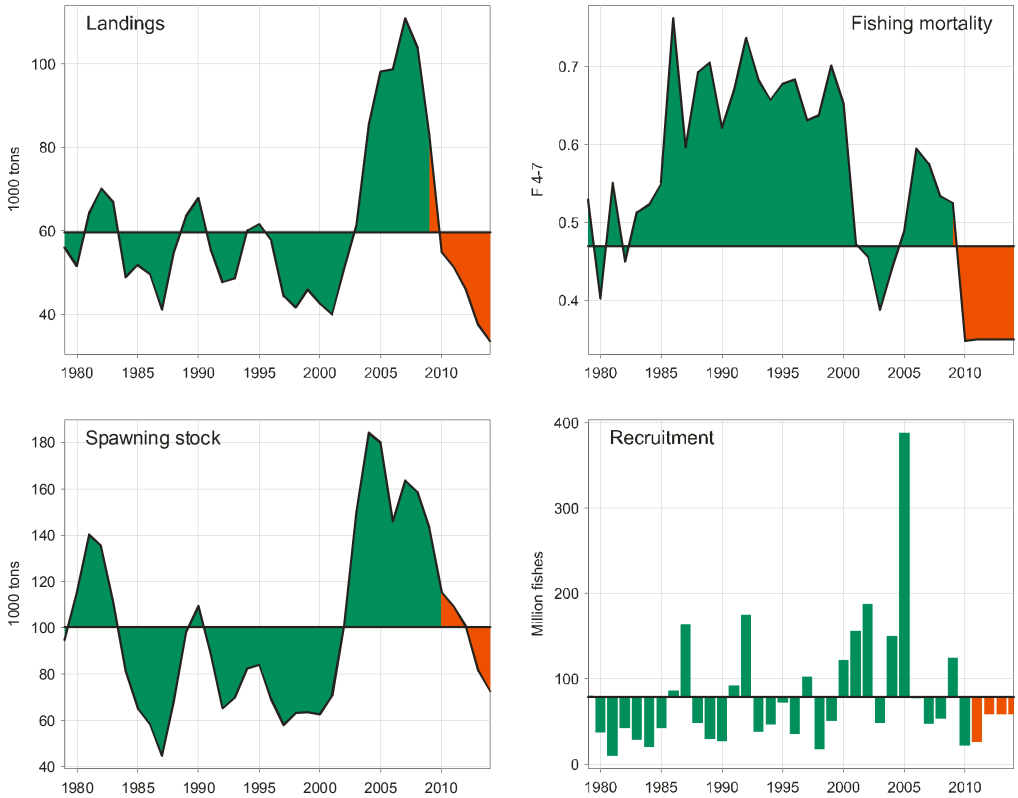


Figure 10.6.1. Haddock in division Va. Summary plots from the model run using the March survey. The dashed lines in the figure of SSB and Biomass(3+) show results from the 2008 assessment.

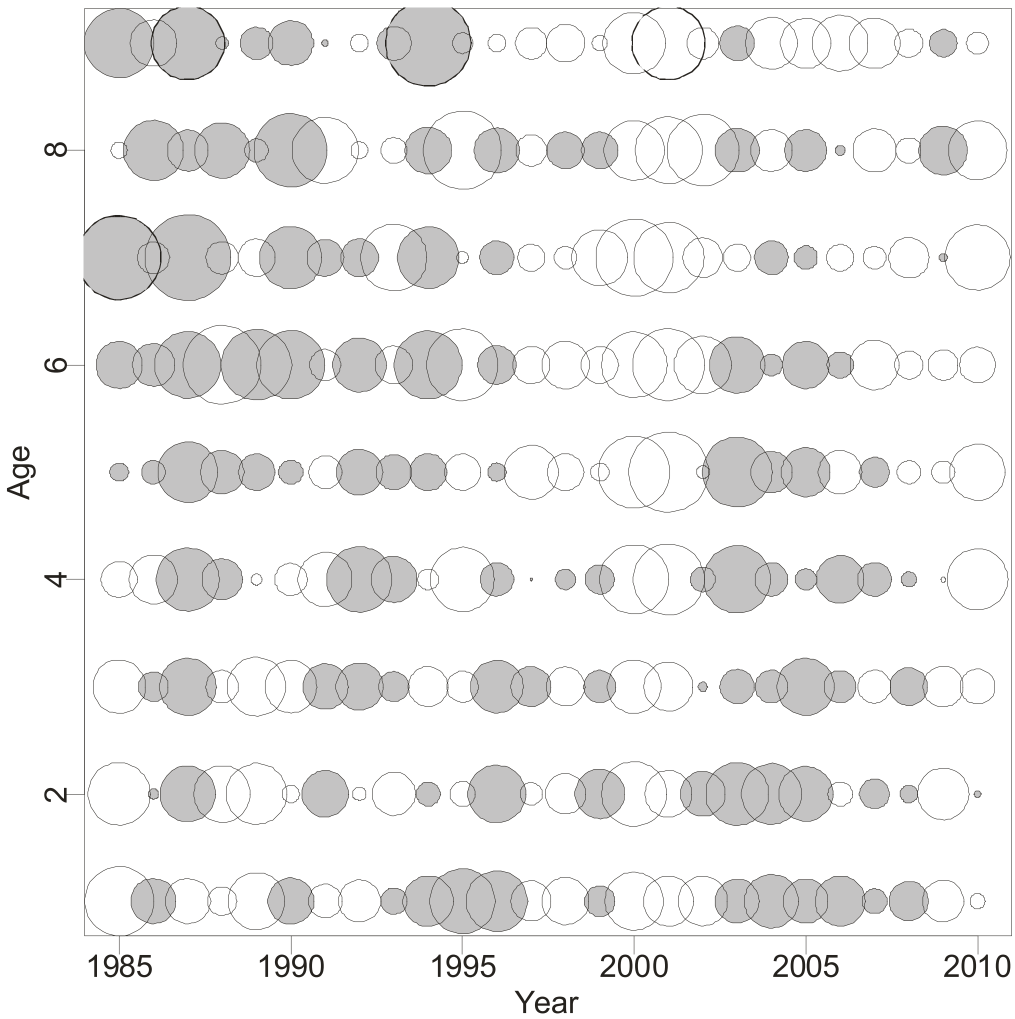


Figure 10.6.2. Haddock in division Va. Residuals from the fit to March survey data . from Adapt run based on the both the surveys. Coloured circles indicate positive residuals (observed > modelled). The largest circle corresponds to a value of 0.87. Residuals are proportional to the area of the circles.

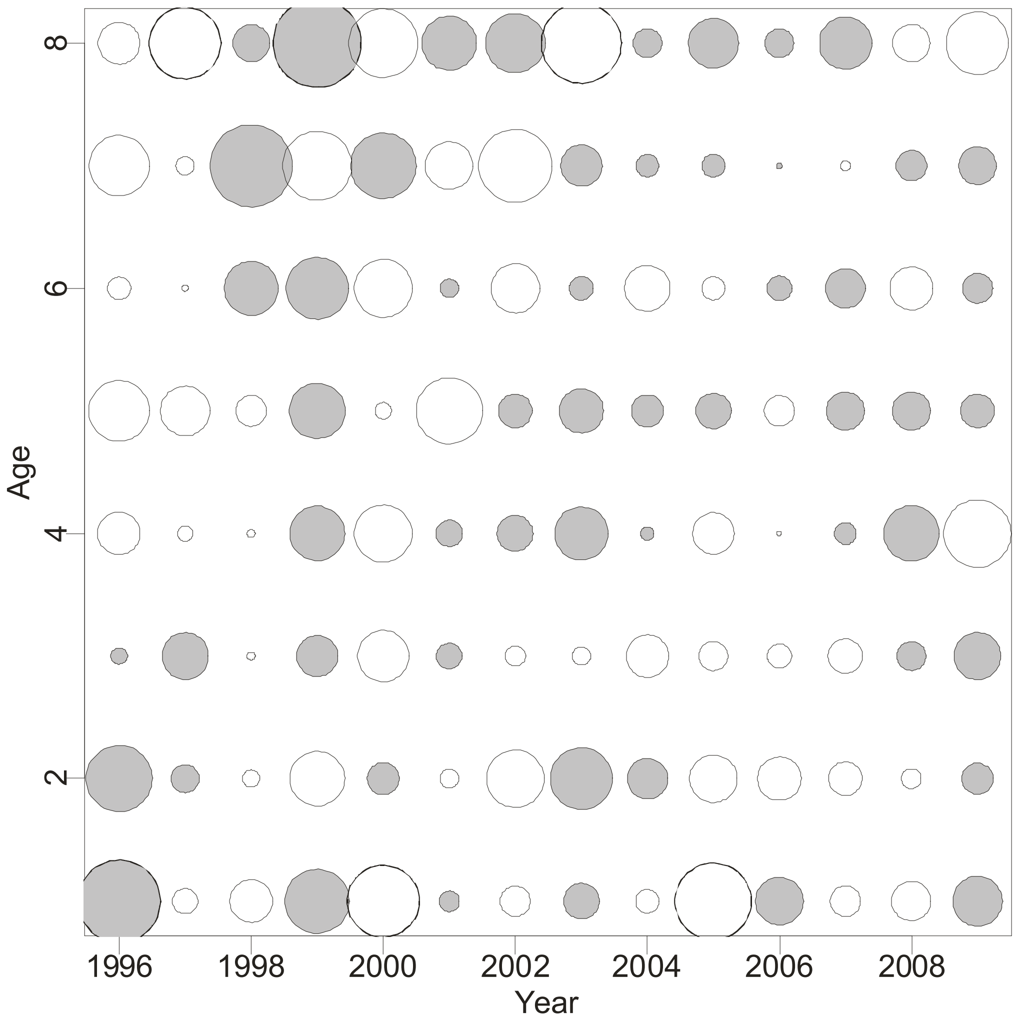


Figure 10.6.3. Haddock in division Va. Residuals from the fit to October survey data from Adapt run based on the both the surveys. Coloured circles indicate positive residuals (observed > modelled). The largest circle for corresponds to a value of 0.89. residuals are proportional to the area of the circles.

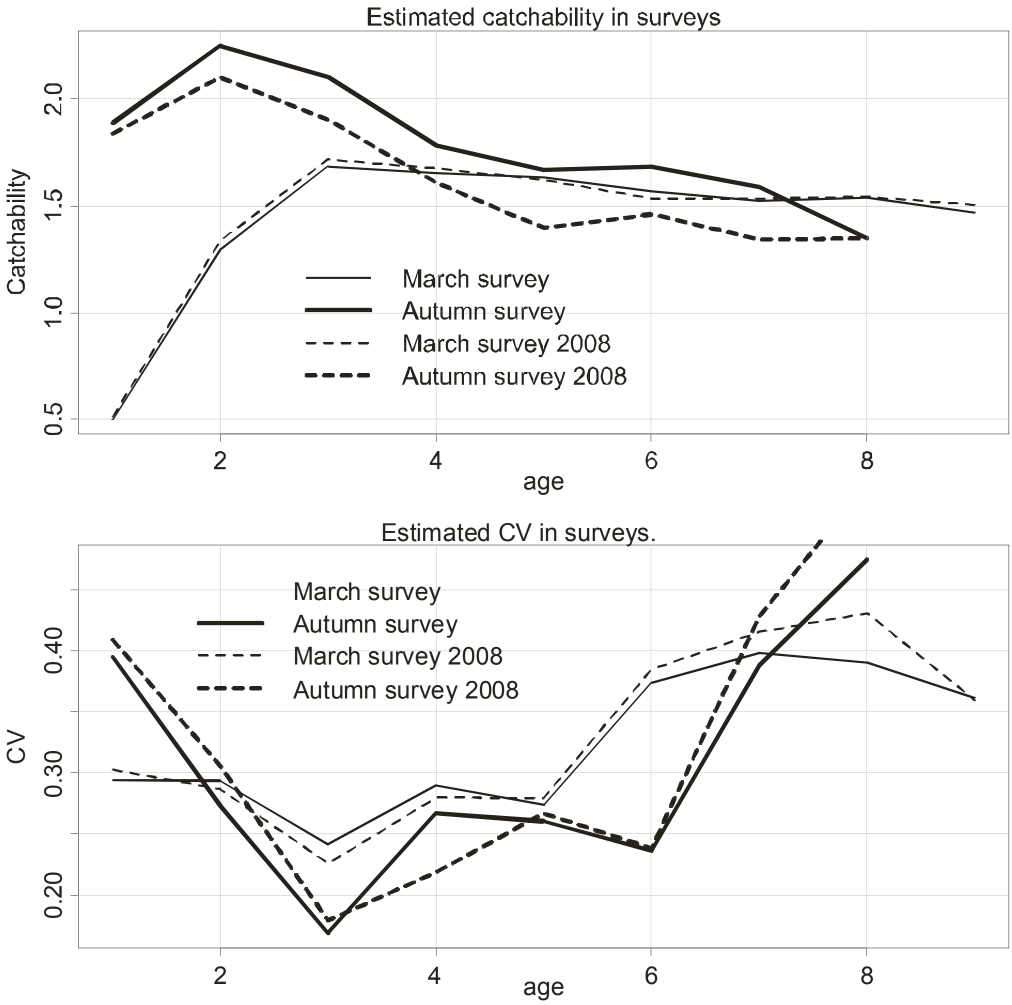


Figure 10.6.4. Haddock in division Va . Results from the spaly run. Catchability and CV from the autumn survey (wide lines) and March survey (thinner lines) . Estimates from 2008 shown dashed.

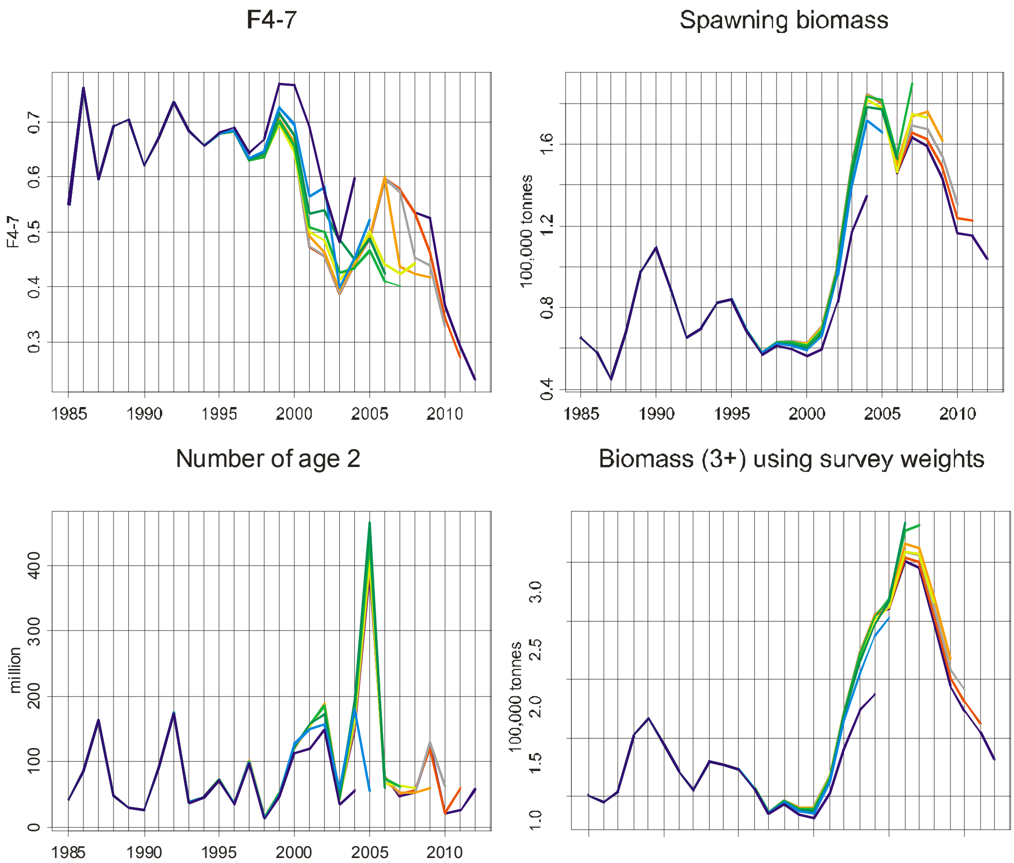


Figure 10.6.5. Haddock in division Va . Retrospective pattern from the SPALY run.

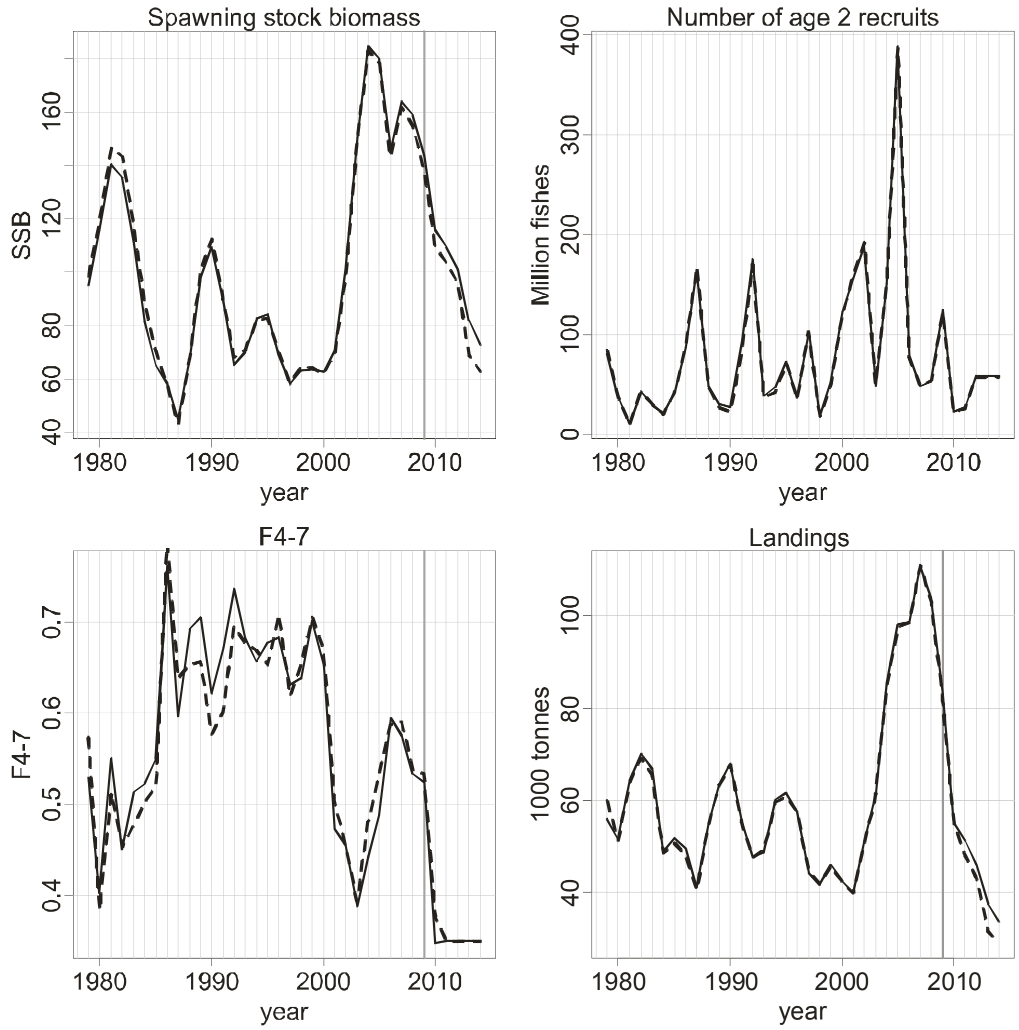


Figure 10.6.6. Haddock in division Va . Comparison of assessment based on the old (dashed lines) and new (solid lines) catch in numbers by age.

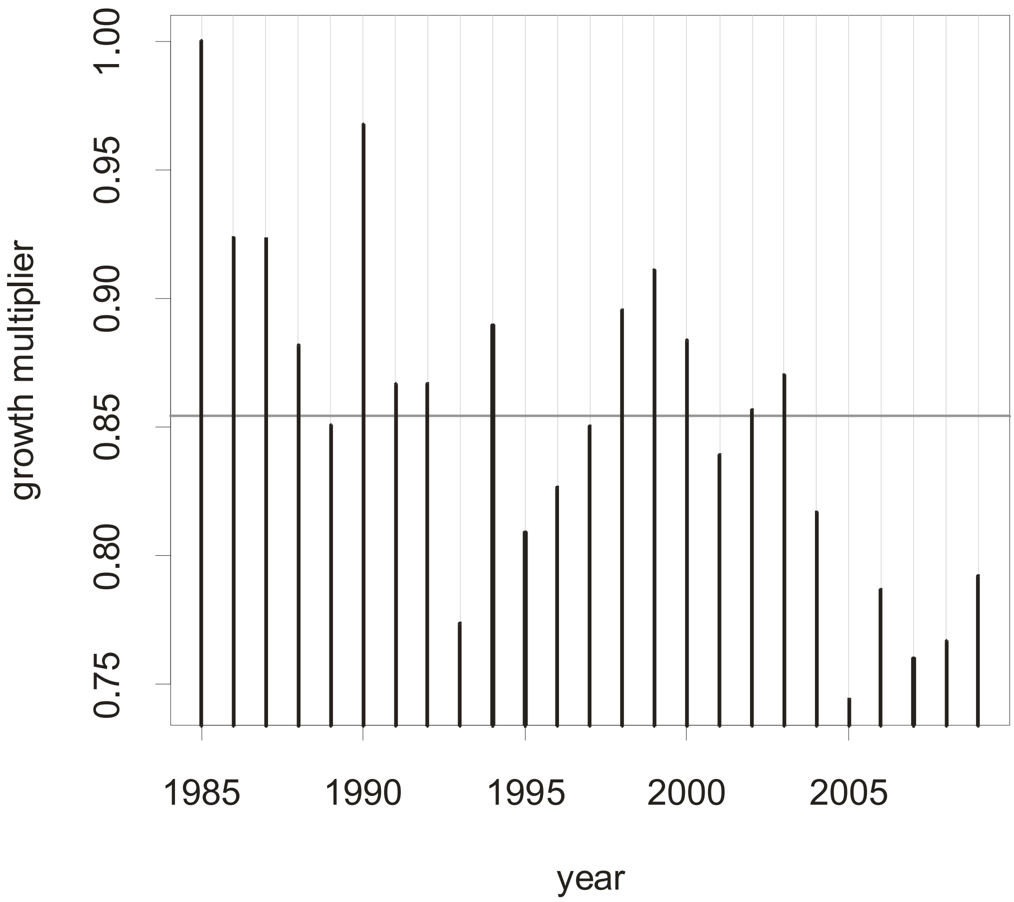


Figure 10.7.1. Haddock in division Va. Exponential of the yearfactor (growth multiplier) in the equation $\log\frac{W_{a+1,t+1}}{W_{a,t}} = \alpha + \beta \log W_{a,t} + \delta_{year}$

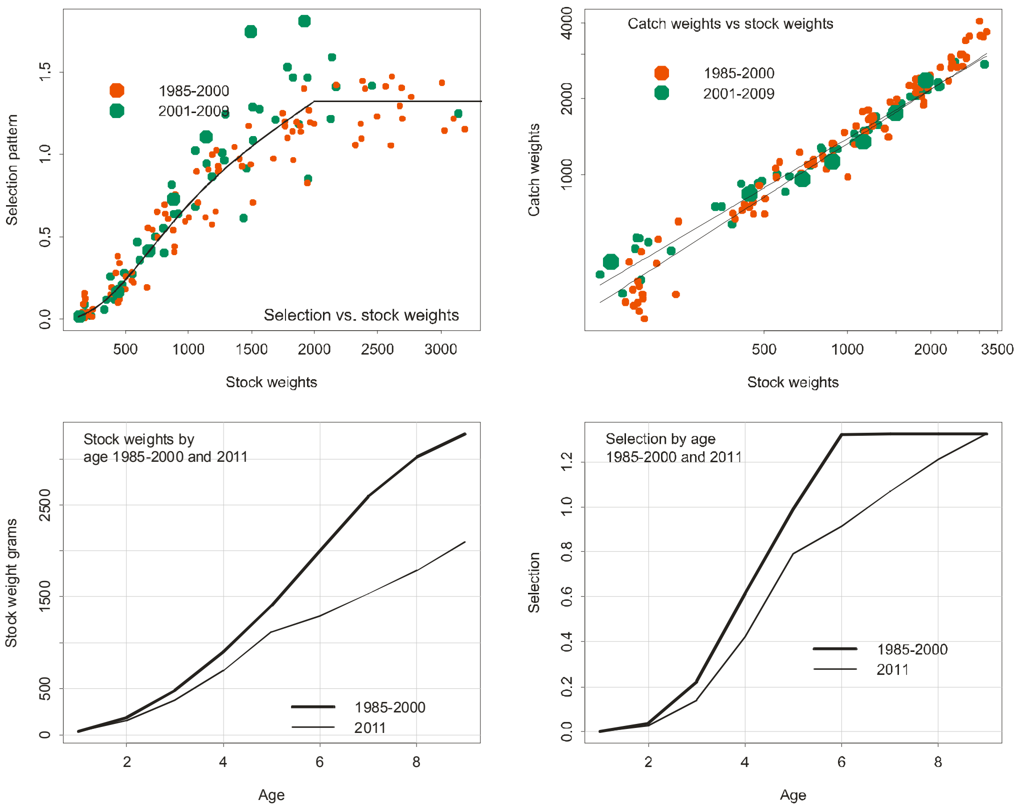
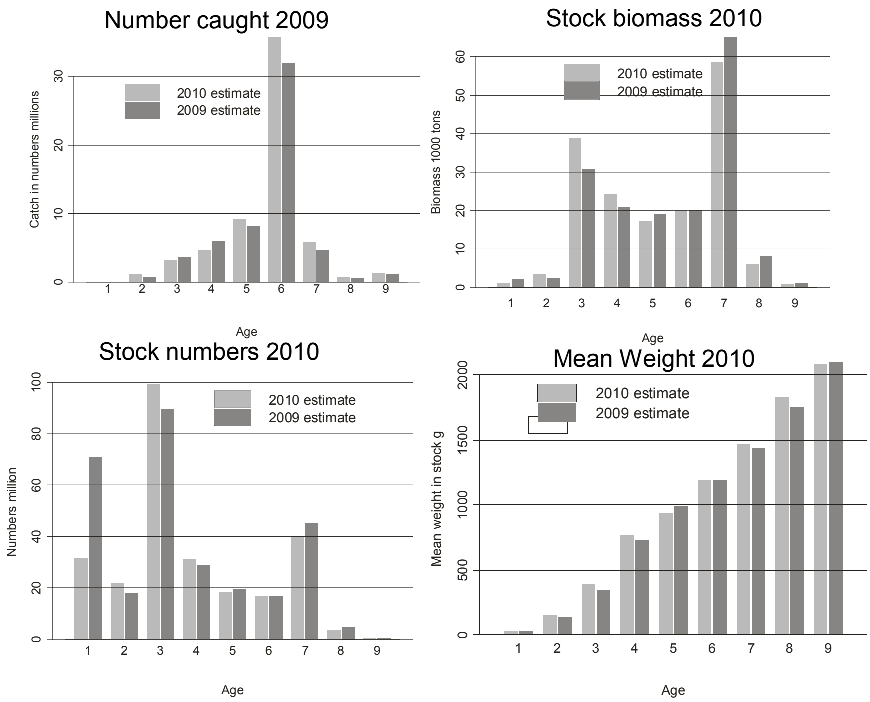


Figure 10.7.2 Haddock in division Va. Input data to prediction. 2009 values shown with larger symbols. The lower figure shows fitted lines to the data for the whole period, 2000-2009 and only 2009.



10.10.1 Haddock in division Va. Comparison of some of the results of the 2008 and 2007 assessment.

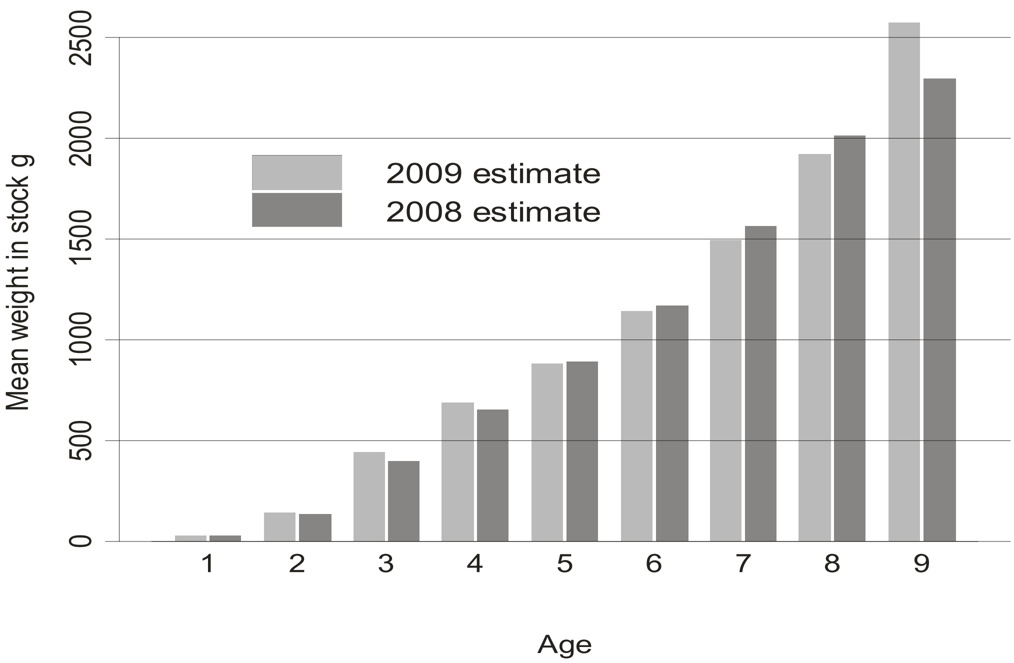
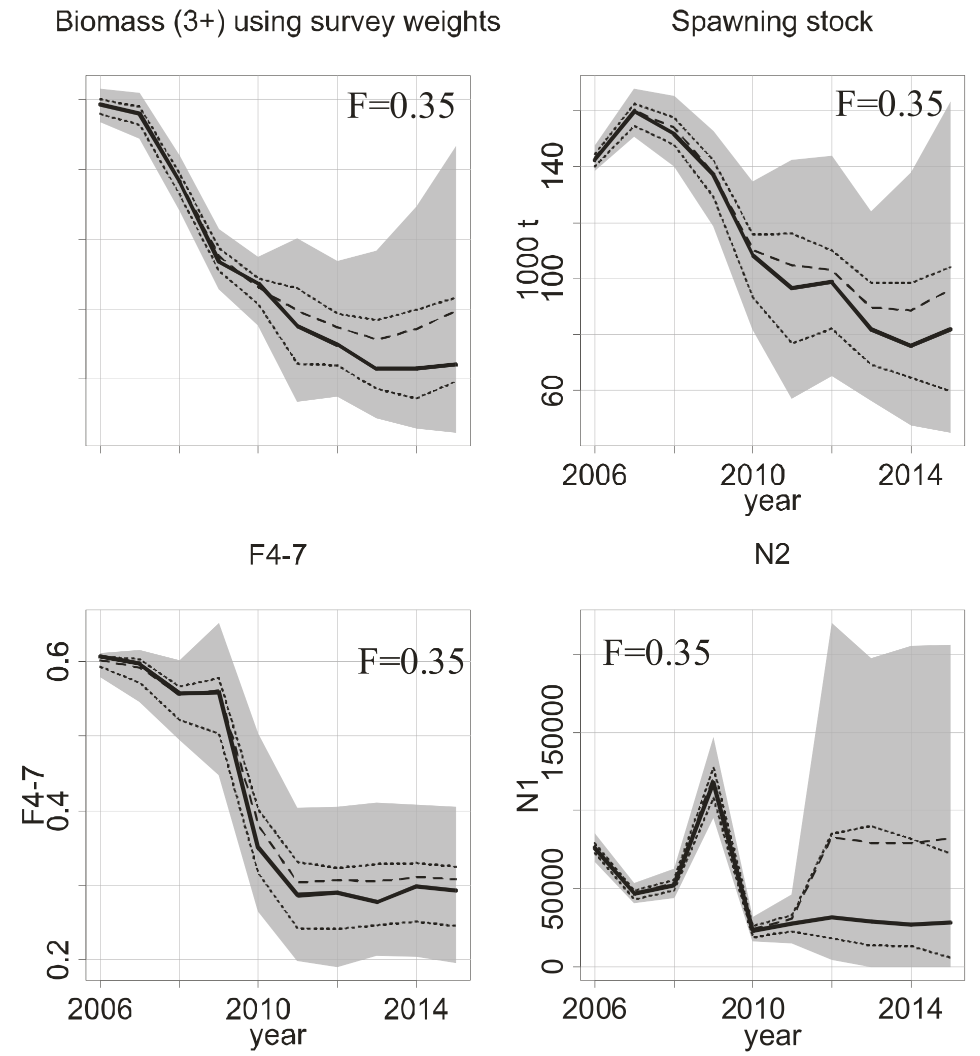


Figure 10.10.2 Mean weight at age in the stock in 2009 as predicted in 2009 and measured in 2009.



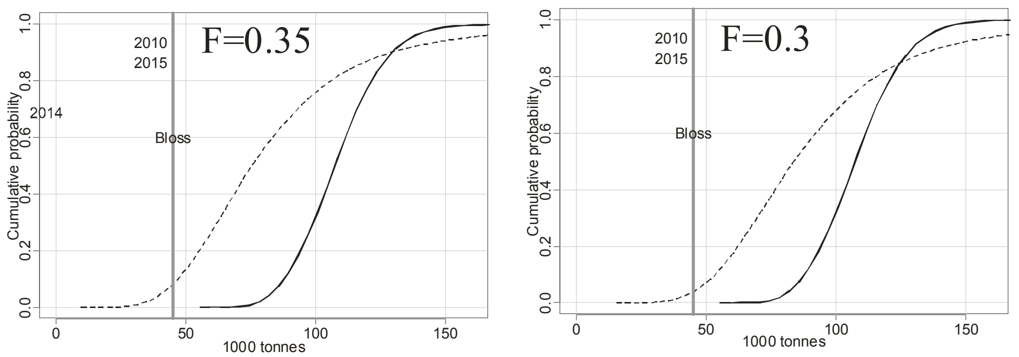


Figure 10.8.1 Haddock in division Va. Stochastic simulations. Cumulative distribution of spawning stock in 2010 and 2015. The dashed line shows B_{loss} (45 000 tonnes). The lower figure compare the spawningstock if when F=0.35 compared to F=0.3.

11 Icelandic summer spawning herring

Executive summary

Input data

- The total reported landings in 2009/10 were 46 kt, the recommended TAC was 40 kt but additionally 7 kt were allocated to a research quota. TAC was 47 kt.
- Around 44 kt of the catch in 2009/10 was taken in a relatively small area in Breiðafjörður, in W Iceland, similar to the two preceding fishing seasons.
- The total estimate of the adult stock (age 4+) in the herring acoustic surveys in October 2009 was 610 kt, or 50 kt higher than in the January 2009 survey.
- Higher prevalence of *Ichthyophonus* infection was observed in the fishable stock now than in last year or on average 43% compared to 32% in last year. Thus, 43% of the fishable stock is considered to die in the winter/spring 2010 because of the infections, which corresponds to $M_{infection}$=0.56 with respect to results of the acoustic measurements 2009/10.
- Different from last year, the prevalence of infection in 2009/10 was age and length dependent, where younger and smaller herring had higher infection rate. This must be accounted for in the current and future assessment.
- Resurrect herring juvenile survey indicates that the 2008 year class (age 1 in 2009) is not seriously infected by *Ichthyophonus* and it could be above average size. Corresponding survey in 2008 indicated that the 2007 year class could be around average size, but since then the *Ichthyophonus* infection has harmed him by an uncertain level.

Assessment

- This is an update assessment and no revisions of last year's data, only the 2009 data have been added to the input data.
- The final analytical assessment model, NFT-Adapt, indicate that the biomass of age 3+ is 507 kt and SSB is 430 kt in the beginning of year 2010. Accounting for the observed *Ichthyophonus* infection (on average 43%) in that period gives estimates of surviving fish, or 294 kt of age 3+ and SSB of 246 kt in the beginning of fishing season 2010/11.

Predictions

- There is an uncertainty in the assessment and the development of the *Ichthyophonus* infection in the stock. Under those circumstances it was neither considered appropriate nor beneficial to provide stock prognosis.

Comments

- The WG recommends that a limited preliminary TAC of around 10 kt will be given for the fishing season 2010/2011 that can sustain a necessary sampling from purse seiners to get an estimation of the *Ichthyophonus* infection and get information of the stock composition.
- Due to the uncertainty regarding the development of the *Ichthyophonus* infection in the summer 2010, the WG consider it necessary to postpone a

recommendation of final TAC until the results of a planned survey early next autumn and more information about the infection rates become available.

- The MSY based reference points have not been established for this stock. Because of uncertainty in this year's assessment due to the *Ichthyophonus* infection and because there is a plan to take the stock to a benchmark assessment in 2011, the WG decided that it would be the most appropriate place to deal with it.

General description of the stock's definition, the stock's life-history and the management unit is given in the stock annex (Her-Vasu).

11.1 Scientific data

11.1.1 Surveys description

The scientific data used for assessment of the Icelandic summer-spawning herring stock are based on annual acoustic surveys, which have been ongoing since 1974 (Table 11.1.1.1). These surveys have been conducted in October-December or January. The surveyed area each year is decided on the basis of available information on the distribution of the stock in previous and the current year, which include information from the fishery. Thus, the survey area varies spatially as the survey is focused on the adult and incoming year classes.

The acoustic estimate for 2009/10 is based on two acoustic surveys (Table 11.1.1.2). During October 23-27, the research vessel Dröfn measured herring in Breiðafjörður, which is the main over wintering areas of the stock in last three winters. Commercial vessels and the research vessel Bjarni Sæmundsson covered simultaneously other areas of the west and south coast and obtained only few registrations. It was only in Breiðamerkurdjúp off the south coast where considerable registrations were observed outside of Breiðafjörður. Three additional acoustic surveys took place in Breiðafjörður, in November, January and March. All of them gave lower acoustic values than the October measurement, and the values actually decreased throughout the season. Following a thorough examination and verification of the four measurements, the October measurement was considered the most reliable and recommended for the analytical assessment (Óskarsson *et al*. 2010b).

Like last winter, but different from other recent years, the nursery grounds of the stock were covered this winter on RV Dröfn in a survey during November 20 to 28. The objective was to get an acoustic estimate of juveniles and estimate their prevalence of *Ichthyophonus* infection (see Óskarsson *et al.* 2010a).

The instrument and methods in the surveys were the same as in previous years and described in the stock annex.

11.1.2 The surveys results

The fishery was not started when the October survey took place because no quota had been given at that point for the fishing season. The highest abundance of the adult stock (age 4+) was in a single inlet, Breiðasund in inner Breiðafjörður (Fig. 11.1.1), a total of 567 kt. In addition 49 kt were measure in Breiðamerkurdjúp off the south coast. Other areas gave insignificant amount. The total estimate of the adult stock was therefore 616 kt. Figure 11.1.2 shows the total estimated biomass of age 4+ in the acoustic survey since 1973, and how the eastern part of the stock has been decreasing in size and the western part increasing since 1995.

The 2004 and 2005 year classes were most numerous in the survey or 22% and 19%, respectively, of the total number of herring (Table 11.1.1.1).

The results of the juvenile acoustic measurements took account of the *Ichthyophonus* infection. The total estimates of the 2008 and 2007 year classes west and north of Iceland, were 757×10⁶ and 62×10⁶ individuals, respectively, when fish infected by *Ichthyophonus* has been subtracted (see Óskarsson *et al.* 2010a). The year class strength of age-2 year old herring (2007 year class here) has been found to be poorly determined by acoustical measurements of the stock (Gudmundsdottir *et al.* 2007), while acoustic estimates of age-1 year old herring provide a reliable estimate of year class strength. Considering Gudmundsdottir *et al.* (2007) finding and using their obtained relationship between acoustic measurements of age-1 year old and number of individuals at age-2 in the stock as obtained from analytical stock assessments, the predicted number of the 2008 year class at age-2 is 635×10⁶. It means that the 2008 year class can be just above average size. Most of the 2008 year class, or around 73%, derives from the fjord Eyjafjörður off N Iceland (Fig. 11.1.1) where only 4.5% *Ichthyophonus* infection was observed (Óskarsson *et al*. 2010a).

The length composition of the adult part of the stock in the acoustic estimation in 2009/10 is based on total 11 samples, 5 taken in Breiðafjörður and 6 taken in other areas (total 2292 herring), while the composition of the juvenile part was based on total 9 samples (total 829 herring). The age composition was then derived from length-at-age key from a total of 17 samples (Table 11.1.2). The total number of aged scales from these samples was 667.

11.1.3 Prevalence of *Ichthyophonus* infection in 2009/10

As detailed in a WD 11 (Óskarsson *et al*. 2010a), the prevalence of the *Ichthyophonus* infection in the Icelandic herring stock was estimated from catch samples and the mean values for the stock weighed by results of the acoustic surveys. The main findings are that the prevalence of infection was observed to be higher in the fishable stock now than in previous winter (2008/09), or on average 43% compared to 32% in last winter. Since the infection is considered to cause a 100% mortality, it indicates that 43% of the fishable stock is considered to die in the winter/spring 2010 because of the infections, which corresponds to $M_{infection}$=0.56 with respect to results of the acoustic measurements 2009/10. Different from last year, the prevalence of the infection in 2009/10 was age and length dependent, where younger and smaller herring had higher infection rate (Table 11.1.3.1). This must be accounted for in the current and future assessment.

11.2 Information from the fishing industry

The total landings in 2009/2010 season were about 46 kt with no discards reported (Table 11.2.1 and in Figure 11.2.1). 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 and in the Her-Vasu stock annex. Because of uncertainty about the stock size due to the *Ichthyophonus* infection of the stock during the preceding summer, no recommendation of TAC had been given prior to the acoustic survey in October 2009. Following an analytical assessment based on the acoustic results, a TAC of 40 kt was recommended and adopted in the beginning of November. At that time preliminary research quota of 15 kt had been given, which was subtracted from the TAC. The fishery started right after that and took place almost entirely in Breiðafjörður with most of the catches taken in November (Fig. 11.2.2). An additional research quota of 7 kt was then given with the restrictions of a weekly sampling by purse seiners in Breiðafjörður in January and February to monitor the development of the *Ichthyophonus* infection. Only 2.6 kt were caught outside of Breiðafjörður and it consist both of by-catch in the summer fishery for the Norwegian spring-spawning herring, NSSH, (0.6 kt) and fishery connected to the acoustic measurements by the commercial vessels in the autumn (see section 11.1.1).

Unlike in the fishing seasons of 2004/05, 2005/06 and 2006/07, NSSH was neither found mixed with the Icelandic summer-spawning herring stock this season nor the previous two seasons. This is probably because the mixing has been almost exclusively connected to the areas east of Iceland where no fishery took place this winter season. However, as stated above, in the summer fishery for NSSH, 0.6 kt was allocated to Icelandic summer-spawning herring and was added to the total catch in the 2009/10 fishing season.

11.2.1 Fleets and fishing grounds

The herring fishing season has taken minor changes in the last three decades. Until 1990, the herring fishery took place during the last three months of the calendar year. During 1990-2008 the autumn fishery extended into 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 kt each year was conducted at the south coast. All seasonal restricted landings, catches and recommended TACs since 1984 are given in thousands tonnes (kt) in Table 11.2.1.

Almost all of the catch in 2009/10 was taken with purse-seines and only around 0.8 kt were taken with pelagic trawls, which is amongst the lowest proportion in pelagic trawls since 1995/96 (see Figure 11.2.1.1). The proportion of the herring fishery off the west coast has been increasing since 2002/03 and was particularly high last season and now, where only 1.7% and 1.5%, respectively, of the total catches were taken off the east coast. We need to go back to 1948 to see some similarities or the fishery in Hvalfjörður, off west Iceland, in the winter 1947/48 with total catch of 180 kt (Jakobsson 1980).

To protect juveniles herring (27 cm and smaller) in the fishery, area closures are enforced based on a regulation of the herring fishery set by the Icelandic Ministry of Fisheries (no. 376, 8. October 1992). No closures were enforced in this herring fishery in 2009/10. However, three closures were enforced in the summer fishery of Norwegian spring-spawning herring off the east coast because of high proportion of Icelandic summer-spawning herring in the fishery and no catch quota for it.

11.2.2 Catch in numbers, weight at age and maturity

Catch at age in 2010:

The procedure for the catch at age estimations, as described in the Stock Annex, was followed for the 2009/10 fishing season. It involves calculations from catch data collected at the harbours by the research personnel or at sea by fishermen (Table 11.2.2.1). This year, the calculations were accomplished by dividing the total catch into 3 cells confined by area (Breiðafjörður vs. catches of the south and east coast, 2.6 kt), and two periods in Breiðafjörður (Oct-Dec, 37.4 kt vs. Jan-Feb, 6.4), as the catch- and sample sizes allowed. One weight-at-length relationship 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 as well as back to 1982 are given in Table 11.2.2.2. The geographical location of the sampling is shown on Figure 11.2.2.1.

Weight at age:

The mean weight at age of the stock is derived from the same catch samples (Table 11.2.2.3) by fitting the equation: ln(whole body weight) = a + b • ln(total length), and link the weights to age-at-length key derived from the same data. The total number of fish weighed from the catch in 2009/10 was 10731 and 3754 of them were aged from their fish scales. This unusual high number of measured fish is due to increased sampling effort to get a good estimation of the *Ichthyophonus* infection (Óskarsson *et al.* 2010a).

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 11.2.2.4). 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 classes from 2004 and 2005 were in highest quantity in the total catch weight (19% and 18%, respectively) and then the 2002 year class followed (16%; Figure 11.2.2.2). The proportions in number were similar (19%, 20% and 13%, respectively). The main difference in the catch composition from what was proposed from last years assessment (Figure 11.2.2.2), is that the 1999 year class (at age 10) was expected to provide much more to the catch biomass and the 2005 year class much less. This relates to how strong the 1999 year class has been measured in the acoustic measurements and poor estimate of the strength of the 2005 year class. On the opposite, this is the fourth season that the 2002 year class dominates the catches and in all cases, the total weight of the year class was higher than predicted.

Like in last year, there is no indication that the fishery in 2009/10 was concentrated more on certain year classes than others, like observed in some fishing season (see previous Assessment reports). It is related to the fact that the big herring schools in Breiðafjörður were very assessable to the fleet and fishing elsewhere was not feasible for the fleet.

11.3 Analytical assessment

11.3.1 Analysis of input data

Examination of catch curves for the year classes from 1975 to 2005 (Figure 11.3.1.1) indicates, in general, that the total mortality signal (Z) in the fully recruited age groups is around 0.4. It is under the assumption that the effort has been the same the whole time. There are obvious indications that the fishing effort in some year classes has varied, for example there is a jump in the curves for the two last points in year classes 1997 to 2000. This can be explained by high fishing effort in relative young herring off the south coast in the fishing season 2006/07 (had difficulties to find larger herring), but concentrated on older fish the next two seasons thereafter in Breiðafjörður. There is also an apparent drop in the curves for the last year in the series for year classes 1996 to 2004, which can simply be explained by lower fishing effort and small catches in 2009/10.

Catch curves were also plotted using the age disaggregated survey indices for each year class from 1973-2004 (Figure 11.3.1.2). Even if the total mortalities look at bit noisy in general, they seem to be fairly close to 0.4. There is an indication that the fish is fully assessable to the survey at age 3, but apparently a year later occasionally. Further exploration of the survey data include a linear fitting of number at age x against number at age x+1 (Figure 11.3.1.3) for different age groups. The slope of the regression lines for the most abundant age classes (age 3 to 7) varied non-systematically from 0.5 to 0.9, which corresponds to 50% and 10%, respectively, mortality between adjoining age classes (r^2 varied from 0.81 to 0.94). The results imply that those age classes (age 3 to 7) 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, even if the survey data are 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 11.3.1.4). The 1999 year class is apparently the largest in the time series, but according to cumulative fishing of the year classes from 1978-1996 (Figure 11.3.1.5), around 97% can be expected to be already fished of that year class. The 2002 year class is still getting stronger in the estimations (Figure 11.3.1.4), but only around 13% of it can be expected to remain to be fished (Figure 11.3.1.5), under normal circumstances.

11.3.2 Exploration of different assessment models

In order to explore the data this year, two assessments tools were used, namely NFT-ADAPT (VPA/ADPAT version 2.8.0 NOAA Fisheries Toolbox) and a new version of TSA (older version see Gudmundsson, G. 1994). It should be noted that the NFT-Adapt was the basis for the last year's assessments. NFT-Adapt used catch data from 1986/87-2009/10 (Table 11.2.2.2) and survey data from 1987/88-2009/10 (Table 11.1.1.1), while TSA used three years less catch data, 1989/90-2009/10. Other input data consist of (i) mean weight at age (Table 11.2.2.3), (ii) maturity ogive (Table 11.2.2.4), (iii) natural mortality, M, that was set to 0.1 for all age groups except for 2009 where it was set 0.49 because of the *Ichthyophonus* infection (see Óskarsson *et al*. 2009), (iv) proportion of M before spawning was set to 0.5 and (v) proportion of F before spawning was set to 0.

NFT-Adapt:

The estimated parameters in NFT Adapt 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 2009, but stock numbers at age 3 were set to the geometric mean from 1986-2005. Like in last year's assessment, the *input partial recruitment* was set to 1 for ages 4 and older and the *classic* method was used to calculate the value of fully-recruited fishing mortality in the terminal year.

The catchability at age in the survey, as estimated by the NFT Adapt, and the CV is shown in Figure 11.3.2.1. Like in the four last years assessments (2006 to 2009) the final Adapt run was tuned with age groups 3-9 (i.e. age in autumns) and 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 11.3.2.1. Stock numbers and fishing mortalities derived from the run are shown in Table 11.3.2.2 and Table 11.3.2.3, respectively, and summarized in Table 11.3.2.4 and Figure 11.3.2.2.

Residuals of the model fit are shown in Figure 11.3.2.3 and Table 11.3.2.5. The strongest cohort effect is seen for the year class 1999, where the model estimates it smaller than seen in the survey, for all age groups, except for the last one. Year effects are observed where 1988 and 2009 (i.e. moved to 1st January winter) had generally negative residuals (smaller in the survey than estimated in the model) and 1997, 2003, and 2010 (i.e. the survey in October 2009) had positive residuals.

Retrospective analysis (Figure 11.3.2.4) shows that the estimate of SSB is lower for 2001-2007 when the 2009 data are included (referring to the end of the year), and the retrospective pattern have worsen since the last assessment. The main reason for the pattern seems to be the lower estimation on the 1999 year class when including the most recent data.

TSA:

Two TSA run were done in 2010, with a fixed natural mortality (comparable to NFT_Adapt; M=0.49 in 2009 but M=0.1 in other years) and allowing the model to estimate the M in the most recent year (Guðmundsson 2010). Estimated standard deviations indicated poor accuracy and the specification was rather uncertain for both of the runs. In the latter run, M was estimated 0.15 but the standard deviations were so wide that it gave not a reason to reject that it was 0.49. The former run was used for a comparison to the NFT-Adapt results.

Comparisons of models:

The estimations of recruitment, spawning stock biomass, and N weighed average $F_{5\text{-}10}$ from the two models (NFT-Adapt and TSA with a fixed M) were compared (Figure 11.3.2.2). There is clear indication that the stock estimates of TSA are lower from around 2003 to present. Similar observations were made in last two years assessments and it was explained by that TSA estimates the 1999 and 2000 year classes weaker than NFT Adapt did, and it is even more apparent now (Figure 11.3.2.2). The estimated 3+ biomass in the beginning of year 2010 is 388 kt from TSA and 507 kt from NFT Adapt.

Because this is an update assessment and 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.

11.3.3 Final assessment

The model settings and outputs of the adopted final model (NFT-Adapt run in 2010) are shown in Table 11.3.2.1 to Table 11.3.2.4 and Figure 11.3.2.2.

The assessment (Table 11.3.2.4 and Figure 11.3.2.2) indicates that the fishing mortality (weighed average) was high during 1986 to 2003 and fluctuated between 0.25 and 0.42, which is above F_{pa}=0.22. Since then, F has declined even if it was above F_{pa} in most years. The spawning stock reached maximum in 2006 but is decreasing fast because of the *Ichthyophonus* outburst. 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.

The stock estimates on Jan. 1st 2010 include the *Ichthyophonus* infected part of the stock, which is assumed to die in the first few months of the year 2010 (Óskarsson *et al*. 2010a). When the infected part is subtracted from the stock estimates according to the estimated infection rate (Table 11.1.3.1) and 50% of M (i.e. 0.05 in the middle of the year), the surviving biomass of age 3+ is 294 kt and SSB 246 kt at the spawning time in the year 2010.

11.4 Reference points

The Working Group has pointed 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, as stated in the Stock Annex, 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}.

The MSY based reference points have not been established for this stock. Because of uncertainty in this year's assessment due to the Ichthyophonus infection and because there is a plan to take the stock to a benchmark assessment in 2011, the WG decided that it would be the most appropriate place to deal with it.

11.5 State of the stock

The stock was considered at high levels until 2007 (Table 11.3.2.4). However there has been a substantial reduction since then mainly due to *Ichthyophonus* infection. and there are concerns about stock's development in next years because of the continued *Ichthyophonus* infection (see in sections 11.1.3, 11.8.2, 11.12 and Óskarsson *et al*. 2010a).

11.6 Short term forecast

As clearly indicated above, there is an uncertainty in the assessment due to the development of the *Ichthyophonus* infection in the stock. Under these extreme circumstances, the WG did consider it neither appropriate nor beneficial to provide stock prognosis at the May 2010 meeting that could be a basis for an advice for the next fishing season (2010/11). However, just for an illustration purpose, traditional preliminary prognosis was done for the stock and it is introduced below. Instead of base the recommendation of TAC on this stock prognosis, the WG suggests that recommendation of TAC should be postponed until results of acoustic surveys in the autumn 2010 are available. The TAC should then be given following an analytical assessment with those additional data.

11.6.1 The input data

The final adopted model, NFT-Adapt, which gave the number at age on January 1st, 2010, was used for the illustrative prognosis. Because of the *Ichthyophonus* infection in the stock that was age dependent (Óskarsson *et al.* 2010a), the number at age for age groups 3 to 14 from the NFT-Adapt model output were reduced according to the infection ratios. The reason for the approach is that all of the infected herring observed in the winter 2009/10 are expected to die in the first 3-5 months of the year (Óskarsson *et al.* 2010a). All input values for the prognosis are given in Table 11.6.1.1. The weights estimates used in the prognoses were the mean weight at age from the catch during the last three fishing seasons (2007/08-2009/10) (Figure 11.6.1.1). The selection pattern used in the prognosis was determined from the fishing mortality at age ($F_{age\ i}/WF_{age\ 5\text{-}10}$), averaged over 2007 to 2009 from the final run. As traditionally, M was set 0.1, proportion M before spawning was set 0.5 and proportion F before spawning was set 0. The numbers of recruits in the prognosis were determined as follows:

<u>The 2007 year class:</u> An abundance index for the year class was obtained in an acoustic survey on the nursery grounds in November 2008 when it was at age 1 (Óskarsson *et al.* 2009). According to a linear-regression provided by Gudmundsdottir *et al.* (2007), the year class could be around average size. Thus, the year class size was set to the geometrical mean for age-3 over 1986-2009, which gives 570 millions from the NFT-Adapt run in 2010.

<u>The 2008 year class:</u> The number at age 3 in 2011 was set to the geometrical mean for age-3 over 1986-2009, which give 570 millions. There are indications from a juvenile survey in November 2009 that the year class is just above average size (Óskarsson *et al.* 2010a), thus geometric mean is considered a reasonable estimate.

11.6.2 Prognosis results

As stated above, the reason for providing this preliminary prognosis was only for an illustrative purpose but not to base an advice on. SSB and biomass of age 3+ are estimated to be 246 kt and 294 kt, respectively, in the beginning of the fishing season 2010/11. The results of the prognosis from the final NFT-Adapt run indicate that fishing at 0.22 (= $F_{0.1}$; the stock is managed at F=0.22) would correspond to TAC in 2010/11 of 52 kt and SSB in 2011/12 would be 254 kt. Using last years TAC of 40 kt would results in F=0.18 and SSB in 2011/12 of 263 kt. In the same way TAC of 10 kt means F=0.04 and SSB in 2011/12 of 295 kt.

The proposed composition of the catch in the season 2010/11 would mainly consist of the 2004 year class with 16% of the weight while the year classes from 2002, 2003 and 2005-2007 would contribute to 10-12%.

11.7 Medium term predictions

No medium term predictions were performed.

11.8 Uncertainties in assessment and forecast

11.8.1 Assessment

There are several things that could lead to uncertainty in the assessment. One of the main factor is the effects of the *Ichthyophonus* infection on the stock. That is the infection rate, and the assumptions whether that all infected fish die and the number of infection's generations per year

The reinstate of the juvenile survey in the winter 2008/09 (the last one was in 2003) is seen as a very positive step in reducing uncertainty in determining year class strength of recruits. It is important that these juvenile surveys will take place every year as they provide a reliable estimate of year class strength of one year old herring (Gudmundsdottir *et al.* 2007).

11.8.2 Forecast

As stated above, the WG did consider it neither appropriate nor beneficial to provide stock prognosis that could be a basis for an advice for the next fishing season (2010/11). It was because of the uncertainty in the assessment due to the development of the *Ichthyophonus* infection in the stock. The preliminary prognosis presented above was therefore only done for an illustrative purpose.

11.8.3 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 three year assessments (2007, 2008 and 2009) there was observed an improvement in the pattern from NFT-Adapt. In this years assessment, the retrospective pattern seems to be reoccurring, which decrease the quality of the assessment. The uncertainty in the assessment related to the *Ichthyophonus* infection decrease the quality of the assessment further and adds uncertainty to the forecast.

11.9 Comparison with previous assessment and forecast

In the 2009 assessment, the estimated spawning stock biomass at spawning time in 2009 was 370 kt while in the present assessment it is estimated as 246 kt at the spawning time in 2010. The reason for this difference is due to the above mentioned *Ichthyophonus* infection in present assessment where M was set 0.49 in 2009.

The recommendation of TAC for the fishing season 2009/10 was not given until a survey had been conducted on the fishing grounds in the autumn 2009 because of uncertainty in the forecast related to the infection in the herring stock. Similar approach is suggested by the WG for the next fishing season, i.e. postpone the recommendation of TAC until a survey results from autumn 2010 becomes available. The reason is the same, uncertainty in the forecast.

11.10 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.

11.11 Management consideration

There are several points to address:

Retrospective pattern shows that there has been a tendancy to overestimate stock size in recent years, which has been less pronounced for the last four years.

The estimated prevalence of the *Ichthyophonus* infection in the stock during the winter 2008/09 was 32%, which corresponded to $M_{infection} = 0.39$ (Óskarsson *et al*. 2009). All the infected fish was considered to die in the spring months 2009 and was not considered to spawn in July 2009. Thus, in this years assessment, M in 2009 was set equal to $M_{infected} + M_{fixed}$, or 0.39 + 0.1= 0.49. This value should be used in the future analytical assessments of the stock, unless the assumptions that all infected herring dies because of it and the infections estimates for the stock are true, will be shown to be incorrect.

In same way as in the winter 2008/09, the estimated prevalence of the *Ichthyophonus* infection in the winter 2009/10 of 43% (Óskarsson *et al*. 2010a) should be considered to represent the mortality due to the infection in the spring 2010. This prevalence of infection corresponds to $M_{infection} = 0.56$, but since the infection this year was found to be age and length dependent (Óskarsson *et al*. 2010a), the future estimates of $M_{infection}$ should reflect the variation, as also done in the prognosis in this year's assessment.

The WG recommends that a limited catch quota of around 10 kt will be given for the fishing season 2010/2011 that can sustain a necessary sampling from purse seiners to get an estimation of the Ichthyophonus infection and get information of the stock composition. Purse seiner samples have been shown to be necessary to get a significant estimate on the prevalence of the *Ichthyophonus* infection (Óskarsson *et al*. 2009; 2010a).

11.12 Ecosystem considerations

The reason for the outbreak of *Ichthyophonus* infection in the herring stock is not known but is probably the effect of interaction between environmental factors and distribution of the stock (Óskarsson *et al.* 2009). It includes that outbreak of *Ichthyophonus* spores in the environment, which infect the herring via oral intake (Jones and Dawe 2002), could be linked to the observed increased temperature off the southwest coast. Further researches on the causes of such an outbreak are needed and how the herring get infected, i.e. through intake of free floating spores or through zooplankton that contain spores.

It is unknown how long the current *Ichthyophonus* outbreak in the stock will last. Similar outbreaks in other herring stock have lasted from 1-3 years (see Óskarsson and Pálsson 2009).

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; Óskarsson and

Taggart 2010). It is manifest in higher number of recruits per SSB during warm years. 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 (MRI, 2008), has therefore probably positive effects on the stock.

11.13 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. October 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.

11.14 Changes in fishing technology and fishing patterns

There are no recent changes in fishing technology which may lead to different catch compositions. The fishing pattern in 2009/10 was similar to the last two seasons' pattern, which differed from previous seasons because most of the catches in the three most recent seasons were taken from a small area off the west coast. It is emphasized that the fishing pattern does varies annually as noted in section 11.2 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.

11.15 Comments on the PA reference points

The WG have not dealt with this issue recently.

11.16 Comments on the assessment

The acoustic measurements in 2009/10 gave a higher stock estimate than the measurements the year before, despite the high infection rate with the associated mortality in the period between them. This might reflects the uncertainty in acoustic survey or the stock size may have been underestimated.

The cautious allowed TAC in recent years that is based on $F_{0.22}$, has probably facilitated continuous increase in stock size in the last decade. The recent decrease in stock size is considered to be mainly related to the *Ichthyophonus* outburst.

11.17 Response to comments made be RG, ACOM

Several technical comments were given on the 2009 assessment report by the Review Group of NWWG (ICES 2009). They have been dealt with here in the report as adequate. Some notations such as that the surveys are carried out in an unusual way will be dealt with in benchmark of the stock in 2011. It is, however, emphasized that the survey methodology has not changed over the last decades.

11.18 References

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Table 11.1.1.1. Icelandic summer-spawning herring. Acoustic estimates (in millions) in the seasons 1973/74-2008/09 (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	Total
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	[illegible]
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	186
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	322
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	0
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	886
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	967
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	1004
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	1390
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	666
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	0
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	1419
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	689
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	1688
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	0
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	1965
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	1795
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	2094
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	1733
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	2850
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	2395
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	2525
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	0
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	2197
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	2022
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	1924
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	2001
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	2823
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	3284
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	2586
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	5372
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	5268
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	5539
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	4005
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	3576
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	3376
2008/09	149.466	196.127	416.862	288.156	457.659	266.975	225.747	168.960	29.922	26.281	17.790	9.881	0.974	3.195	2258
2009/10	151.066	315.941	490.653	554.818	271.445	327.275	149.143	83.875	156.920	36.666	13.649	8.507	1.458	5.590	2567

*** 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 (ICES, 2006).**

**** No survey**

11.1.1.2. Overview of acoustic surveys conducted in the winter 2009/10 that contributed to the abundance estimates of the fishable stock and juveniles (age-1) of Icelandic summer-spawning herring.

Survey, vessel	Survey duration	Area covered	Contributed to abundance index of:
RV Dröfn	October 23-27th	Breiðafjörður	The fishable stock
RV ®Bjarni Sæmundsson and fishing vessels	The end of October and early November	East, south, and west of Iceland	The fishable stock
Rv Dröfn	November 20th to December 2nd	The nuresery grounds in fjords and bays of the west and north coast	Year class strength of age-1

Table 11.1.2. Icelandic summers-spawning herring. Number of scales by ages and number of samples taken in the annual acoustic surveys in the seasons 1987/88-2009/10 (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.

	Number of scales															Number 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
2008/09	274	208	213	136	204	123	125	97	18	13	9	7	4	17	1448	29	19	10
2009/10	104	100	105	116	60	74	34	19	36	8	3	4	2	2	667	17	10	7

*** No survey**

Table 11.1.3.1. The total acoustic estimate (N_{total}) of Icelandic summer-spawning herring in the winter 2009/10 for age groups 3 to 11, the number of infected herring ($N_{infected}$) and estimates of prevalence of *Ichthyophonus* infection ($P_{infected}$) of the whole stock when weighed with the herring quantity of the different locations , and finally the corresponding estimate of natural mortality caused by the infection ($M_{infected}$).

Age (years)	Acoustic estimate N_{total} (´10^6)	$N_{infected}$ (´10^6)	Weighed $P_{infected}$ %)	$M_{infected}$
3	337.3	160.2	47.5	0.64
4	525.4	248.6	47.3	0.64
5	466.9	207.8	44.5	0.59
6	273.6	113.3	41.4	0.53
7	335.3	132.1	39.4	0.50
8	156.5	60.1	38.4	0.48
9	140.7	52.6	37.4	0.47
10	149.3	54.6	36.6	0.46
11	36.9	13.2	35.7	0.44
Total	2421.8	1042.6	43.0	0.56

Table 11.2.1. Icelandic summer spawners. Landings, catches, recommended TACs, and set National TACs in thousand tonnes.

Year	Landings	Catches	Recommended TACs	National 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	50	50
1986	65.5	65.5	65	65
1987	75	75	70	73
1988	92.8	92.8	90	90
1989	97.3	101	90	90
1990/1991	101.6	105.1	80	110
1991/1992	98.5	109.5	80	110
1992/1993	106.7	108.5	90	110
1993/1994	101.5	102.7	90	100
1994/1995	132	134	120	120
1995/1996	125	125.9	110	110
1996/1997	95.9	95.9	100	100
1997/1998	64.7	64.7	100	100
1998/1999**	87	87	90	70
1999/2000	92.9	92.9	100	100
2000/2001	100.3	100.3	110	110
2001/2002	95.7	95.7	125	125
2002/2003*	96.1	96.1	105	105
2003/2004*	130.7	130.7	110	110
2004/2005	114.2	114.2	110	110
2005/2006	103	103	110	110
2006/2007	135	135	130	130
2007/2008	158.9	158.9	130	150
2008/2009	151.8	151.8	130	150
2009/2010	46.3	46.3	40	47

***Summer fishery in 2002 and 2003 included**

**** TAC was decided 70 thous. tonnes but because of transfers from the previous quota year the national TAC became 90 thous. tonnes.**

Table 11.2.2.1. Overview of the catch data for Icelandic summer-spawning herring 2009/10.

	BREIÐAFJÖRÐUR	OTHER AREAS	TOTAL
Total catch (thousands tonnes)	43755	2577	46332
Number of samplings for ageing	71	9	80
Number of aged fish	3314	440	3754
Number of weighed fish	10040	691	10731
Number of fish taken for *Ichthyophonus* infection estimate	7012	691	7703
Number of samplings for length determinations	73	11	84
Number of fish length measured	9897	974	10871

Table 11.2.2.2. 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
2008	10.427	38.830	90.932	79.745	107.644	59.656	62.194	54.345	18.130	8.240	5.157	2.680	2.630	1.178	151.780
2009	5.431	21.856	35.221	31.914	18.826	22.725	10.425	9.213	9.549	2.238	1.033	0.768	0.406	0.298	46.332

Table 11.2.2.3. 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
2008	105	174	232	275	292	307	315	327	345	366	377	372	403	434
2009	113	190	237	274	304	318	326	335	342	360	372	394	409	421

Table 11.2.2.4. 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
2008	0	0.2	0.85	1	1	1	1	1	1	1	1	1	1	1
2009	0	0.2	0.85	1	1	1	1	1	1	1	1	1	1	1

Table 11.3.2.1. Model settings and results of model parameters from the NFT-Adapt run in 2009 for Icelandic summer spawning herring.

```
VPA Version 3.0.1
 Model ID: SPALY from 2009
 Input File: C:\ASTA\NFT\VPA\2010\RUN2\RUN2.DAT
 Date of Run: 13-APR-2010                         Time of Run: 15:38
 Levenburg-Marquardt Algorithm Completed    13 Iterations
 Residual Sum of Squares =     32.4496
 Number of Residuals     =    140
 Number of Parameters    =      7
 Degrees of Freedom      =    133
 Mean Squared Residual   =     0.243982
 Standard Deviation      =     0.493946
 Number of Years =    24
 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 (2010)
 Age    Stock Predicted     Std. Error      CV

   4        290054.943   0.147256E+06   0.507684E+00
   5        223515.177   0.829805E+05   0.371252E+00
   6        258123.462   0.835637E+05   0.323735E+00
   7        146354.579   0.453143E+05   0.309620E+00
   8        185251.989   0.565224E+05   0.305111E+00
   9        100381.710   0.287291E+05   0.286198E+00
  10         93718.407   0.273145E+05   0.291453E+00

 Catchability Values for Each Survey Used in Estimate
 INDEX     Catchability    Std. Error      CV

   1       0.108926E+01   0.121599E+00   0.111635E+00
   2       0.142937E+01   0.164968E+00   0.115413E+00
   3       0.135994E+01   0.117225E+00   0.861985E-01
   4       0.135916E+01   0.120245E+00   0.884697E-01
   5       0.143950E+01   0.143435E+00   0.996426E-01
   6       0.167961E+01   0.207044E+00   0.123270E+00
   7       0.181252E+01   0.251347E+00   0.138673E+00
```

Table 11.3.2.1.,continues:

```
-- Non-Linear Least Squares Fit --
Default Tolerances Used
Scaled Gradient Tolerance      =    6.055454E-06
Scaled Step Tolerance          =    3.666853E-11
Relative Function Tolerance    =    3.666853E-11
Absolute Function Tolerance    =    4.930381E-32
Reported Machine Precision     =    2.220446E-16
VPA Method Options

- Catchability Values Estimated as an Analytic Function of N
- Catch Equation 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 2010
  =  Geometric Mean of First Age Populations
     Year Range Applied =  1986 to  2005

Stock Estimates
Age   4
Age   5
Age   6
Age   7
Age   8
Age   9
Age  10

Full F in Terminal Year               =   0.0902
F in Oldest True Age in Terminal Year =   0.0802
Full F Calculated Using Classic Method
F in Oldest True Age in Terminal Year has been
Calculated in Same Manner as in All Other Years
```

Age	Input Partial Recruitment	Calc Partial Recruitment	Fishing Mortality	Used In Full F	Comments
3	0.700	0.494	0.0566	NO	Stock Estimate in T+1
4	1.000	1.000	0.1147	YES	Stock Estimate in T+1
5	1.000	0.795	0.0912	YES	Stock Estimate in T+1
6	1.000	0.825	0.0947	YES	Stock Estimate in T+1
7	1.000	0.789	0.0905	YES	Stock Estimate in T+1
8	1.000	0.673	0.0772	YES	Stock Estimate in T+1
9	1.000	0.638	0.0732	YES	Stock Estimate in T+1
10	1.000	0.787	0.0902	NO	Input PR * Full F
11	1.000	0.699	0.0802		F-Oldest

Table 11.3.2.2. Icelandic summer spawners stock estimates (from NFT-Adapt in 2010) in numbers (thousands) during 1986-2010.

Age \ Year	1986	1987	1988	1989	1990	1991	1992	1993	1994
3	1120888	547493	281822	433754	291952	833134	1044093	625122	680083
4	377824	1006451	492403	250481	370971	250023	669611	854614	517032
5	117747	309626	868294	406276	201331	281555	179652	489499	604593
6	97585	84287	222949	691285	293754	148386	172976	126139	354956
7	199160	68676	56706	136026	446624	190175	101261	100993	94398
8	72000	106715	43416	29582	82224	255196	119722	65151	64306
9	52335	47838	52812	20248	19072	45754	126712	71922	46318
10	38736	36931	28851	17420	12731	9511	31838	64392	46478
11	42313	26896	20195	14421	8862	7378	4675	17830	43783
12+	68098	75954	58376	41117	39979	37657	35046	32132	40171
Total	2186685	2310866	2125824	2040610	1767499	2058769	2485586	2447795	2492118

Age \ Year	1995	1996	1997	1998	1999	2000	2001	2002	2003
3	207087	195237	772910	313895	557535	404346	489416	1474584	1150684
4	487615	167440	161486	662064	240924	450983	311474	402650	1257409
5	360344	311105	113269	117511	432612	166030	278897	199895	297127
6	411529	243659	199784	77535	84794	257922	103509	163681	137606
7	238463	268873	155125	145902	61975	61451	160756	64902	96749
8	61790	143014	163056	108384	93243	43263	44645	93834	38628
9	38946	35675	91798	118097	73461	54558	31275	30554	44990
10	26470	20826	18324	61933	76473	47653	33852	19991	18277
11	27185	15858	10876	8514	42145	48310	33749	19035	13624
12+	57488	57843	50813	38480	33879	47974	64648	63429	41808
Total	1916917	1459530	1737440	1652314	1697041	1582488	1552220	2532554	3096902

Age \ Year	2004	2005	2006	2007	2008	2009	2010
3	660785	1130698	676294	767550	493002	501044	565315
4	840443	537716	998295	499428	605519	409192	290055
5	866412	627994	446529	696771	373861	461559	223515
6	213694	610842	456324	351990	478708	262619	258123
7	97961	154931	426111	367007	258160	331030	146355
8	63274	75604	114023	331203	247097	177000	185252
9	21501	48382	56946	90252	211102	164597	100382
10	30329	13985	35044	45833	59452	139475	93718
11	14420	20782	7756	27626	30319	36611	78073
12+	37677	36023	41213	39065	42678	47196	43870
Total	2846496	3256958	3258535	3216728	2799899	2530324	1984658

Table 11.3.2.3. Estimated fishing mortality at age of Icelandic summer-spawning herring (from NFT-Adapt in 2010) during 1986-2009 and weighed average F by numbers (WF 5-10 and WF 4-8).

Age \ Year	1986	1987	1988	1989	1990	1991	1992	1993
3	0.008	0.006	0.018	0.056	0.055	0.119	0.100	0.090
4	0.099	0.048	0.092	0.118	0.176	0.231	0.213	0.246
5	0.234	0.228	0.128	0.224	0.205	0.387	0.254	0.221
6	0.251	0.296	0.394	0.337	0.335	0.282	0.438	0.190
7	0.524	0.359	0.551	0.403	0.460	0.363	0.341	0.351
8	0.309	0.603	0.663	0.339	0.486	0.600	0.410	0.241
9	0.249	0.406	1.009	0.364	0.596	0.263	0.577	0.337
10	0.265	0.504	0.593	0.576	0.446	0.610	0.480	0.286
11	0.274	0.504	0.755	0.426	0.509	0.491	0.489	0.288
12+	0.274	0.453	0.485	0.168	0.097	0.096	0.071	0.035
WF 5-10	0.350	0.341	0.259	0.312	0.381	0.420	0.401	0.246
WF 4-8	0.250	0.148	0.181	0.276	0.323	0.383	0.280	0.241

Age \ Year	1994	1995	1996	1997	1998	1999	2000	2001
3	0.233	0.113	0.090	0.055	0.165	0.112	0.161	0.095
4	0.261	0.349	0.291	0.218	0.326	0.272	0.381	0.344
5	0.285	0.291	0.343	0.279	0.226	0.417	0.373	0.433
6	0.298	0.326	0.352	0.214	0.124	0.222	0.373	0.367
7	0.324	0.411	0.400	0.259	0.348	0.259	0.220	0.438
8	0.402	0.449	0.343	0.223	0.289	0.436	0.225	0.279
9	0.460	0.526	0.566	0.294	0.335	0.333	0.377	0.348
10	0.436	0.412	0.550	0.667	0.285	0.359	0.245	0.476
11	0.432	0.463	0.486	0.394	0.303	0.376	0.282	0.368
12+	0.134	0.206	0.220	0.367	0.211	0.341	0.315	0.325
WF 5-10	0.310	0.348	0.372	0.256	0.279	0.374	0.338	0.411
WF 4-8	0.287	0.343	0.351	0.235	0.300	0.352	0.360	0.388

Age \ Year	2002	2003	2004	2005	2006	2007	2008	2009
3	0.059	0.214	0.106	0.025	0.203	0.137	0.086	0.057
4	0.204	0.272	0.191	0.086	0.260	0.190	0.172	0.115
5	0.273	0.230	0.250	0.219	0.138	0.275	0.253	0.091
6	0.426	0.240	0.222	0.260	0.118	0.210	0.269	0.095
7	0.419	0.325	0.159	0.207	0.152	0.296	0.277	0.091
8	0.635	0.486	0.168	0.183	0.134	0.350	0.306	0.077
9	0.414	0.294	0.330	0.223	0.117	0.317	0.315	0.073
10	0.284	0.137	0.278	0.490	0.138	0.313	0.385	0.090
11	0.444	0.306	0.259	0.299	0.130	0.327	0.335	0.080
12+	0.624	0.280	0.273	0.179	0.125	0.360	0.337	0.069
WF 5-10	0.401	0.264	0.236	0.235	0.135	0.283	0.282	0.088
WF 4-8	0.317	0.270	0.216	0.194	0.186	0.260	0.242	0.096

Table 11.3.2.4. Summary table from NFT-Adapt run in 2010 for Icelandic summer spawning herring.

Year	Recruits $_{age\ 3}$ (millions)	Biomass age 3+ (kt)	SSB (kt)	Landings age 3+ (kt)	Yield/SSB	WF 5-10
1986	1121	448	296	66	0.22	0.35
1987	547	517	393	75	0.19	0.34
1988	282	510	436	93	0.21	0.26
1989	434	472	399	101	0.25	0.31
1990	292	420	361	104	0.29	0.38
1991	833	432	319	107	0.34	0.42
1992	1044	512	352	107	0.31	0.40
1993	625	554	432	103	0.24	0.25
1994	680	558	447	134	0.30	0.31
1995	207	466	411	125	0.31	0.35
1996	195	353	311	96	0.31	0.37
1997	773	373	274	65	0.24	0.26
1998	314	371	303	86	0.28	0.28
1999	558	377	293	93	0.32	0.37
2000	404	393	311	100	0.32	0.34
2001	489	357	278	94	0.34	0.41
2002	1475	526	307	96	0.31	0.40
2003	1151	603	403	129	0.32	0.26
2004	661	643	511	112	0.22	0.24
2005	1131	758	558	102	0.18	0.24
2006	676	833	662	130	0.20	0.13
2007	768	757	612	158	0.26	0.28
2008	493	743	622	151	0.24	0.28
2009	501	696	474	46	0.10	0.09
2010	565	507*	430*			

*** The expected mortality because of the observed infection in 2009/10 has not been accounted for.**

Table 11.3.2.5. The residuals from survey observations and NFT-Adapt 2010 results for Icelandic summer spawning herring (no surveys in 1994, 1997, and 2001) on 1st January.

Year\Age	4	5	6	7	8	9	10
1988	-0.29	-0.37	0.02	-0.30	-0.65	-0.23	-0.35
1989	-0.30	-0.91	-0.90	0.02	0.09	-0.28	0.04
1990	0.48	-0.47	-0.36	-0.02	0.42	-0.37	-0.06
1991	-0.72	-0.44	-0.76	-0.30	0.34	0.03	0.78
1992	0.36	0.32	0.31	-0.43	-0.22	0.19	-1.00
1993	-0.11	0.04	-0.08	-0.05	-0.55	-0.23	-0.19
1994	-0.11	0.02	0.03	-0.65	-0.46	0.31	-0.54
1995							
1996	-0.31	0.54	-0.18	0.05	-0.15	0.49	0.25
1997	0.43	-0.19	0.55	0.25	0.33	0.34	1.03
1998							
1999	-0.03	0.56	-0.11	-0.49	0.01	-0.56	-0.31
2000	0.54	0.01	0.55	0.05	-0.36	0.59	0.04
2001	1.05	1.19	0.31	0.79	-0.63	-1.21	-0.48
2002							
2003	0.34	0.26	0.09	0.69	1.01	1.30	1.10
2004	0.45	0.51	0.13	-0.20	0.10	0.07	-0.19
2005	0.20	0.13	0.23	-0.21	-0.56	-0.61	-0.84
2006	-0.90	-0.62	0.28	0.75	0.54	0.24	0.71
2007	0.11	0.06	-0.15	-0.16	0.37	-0.46	0.40
2008	-0.37	-0.61	-0.18	-0.13	0.12	0.68	0.72
2009	-0.82	-0.46	-0.21	0.02	0.05	-0.20	-0.40
2010	0.00	0.43	0.46	0.31	0.20	-0.12	-0.71

Table 11.6.1.1. The input data used for prognosis of the Icelandic summer-spawning herring. The mean weights and the selection pattern are the age specific average values over the last three years (2007-09), M is set 0.1 (as traditionally), proportion of M before spawning is set 0.5, and number at age derives from NFT-Adapt run but are reduced according to the estimated *Ichthyophonus* infection rate in the stock in January 2010 as shown.

Age	Mean weights (kg)	M	Maturity ogive	Selection pattern	Mortality prop. before spawn.		Proportion infected (%)	Number at age
					F	M		Jan. 1st 2010
3	0.187	0.1	0.2	0.48	0	0.5	47.5	296.8
4	0.237	0.1	0.85	0.86	0	0.5	47.3	152.9
5	0.276	0.1	1.00	1.00	0	0.5	44.5	124.1
6	0.299	0.1	1.00	1.00	0	0.5	41.4	151.3
7	0.32	0.1	1.00	1.00	0	0.5	39.4	88.7
8	0.336	0.1	1.00	1.00	0	0.5	38.4	114.1
9	0.334	0.1	1.00	1.00	0	0.5	37.4	62.8
10	0.348	0.1	1.00	1.00	0	0.5	36.6	59.4
11	0.357	0.1	1.00	1.00	0	0.5	35.7	50.2
12+	0.403	0.1	1.00	1.00	0	0.5	35.7	28.2

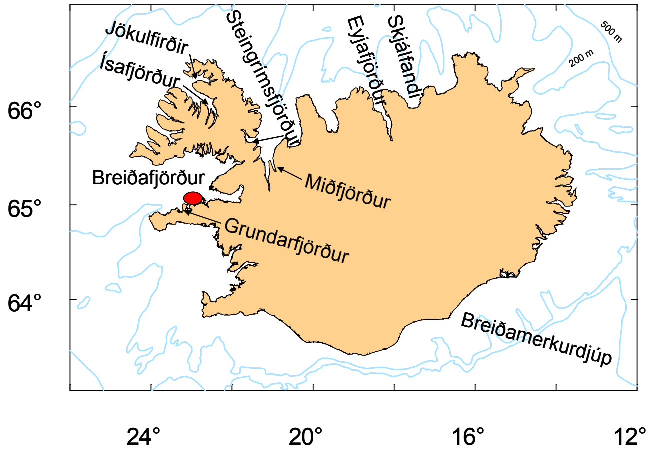

Figure 11.1.1. The locations of the areas that are referred to in the text. The circle denotes the main overwintering area of the Icelandic summer-spawning herring in the winter 2009/10 in Breiðafjörður.

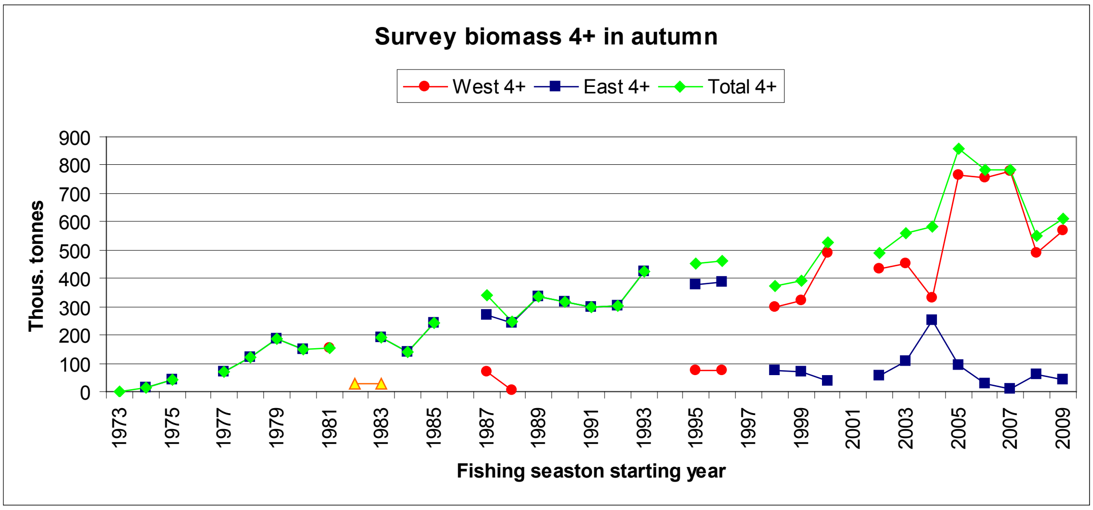

Figure 11.1.2 Total biomass index for Icelandic summer-spawning herring from the acoustic surveys for ages 4+ in the areas east and west of 18°W and then combined. The years in the plot (1973-2009) refer to the autumn of the fishing seasons.

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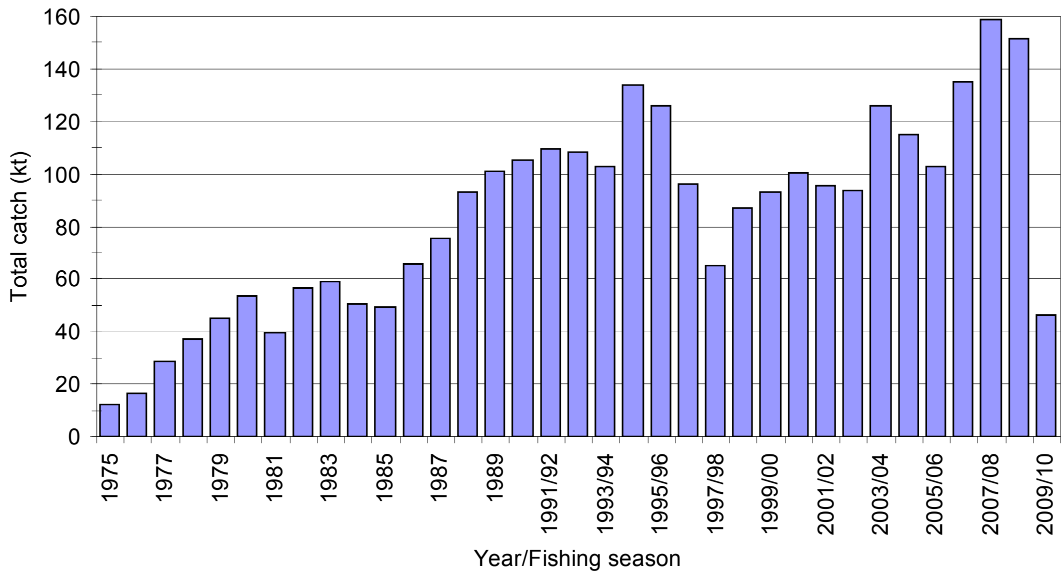

Figure 11.2.1. Icelandic summer spawning herring. Total catch (in thousand tonnes) in 1975-2009/10.

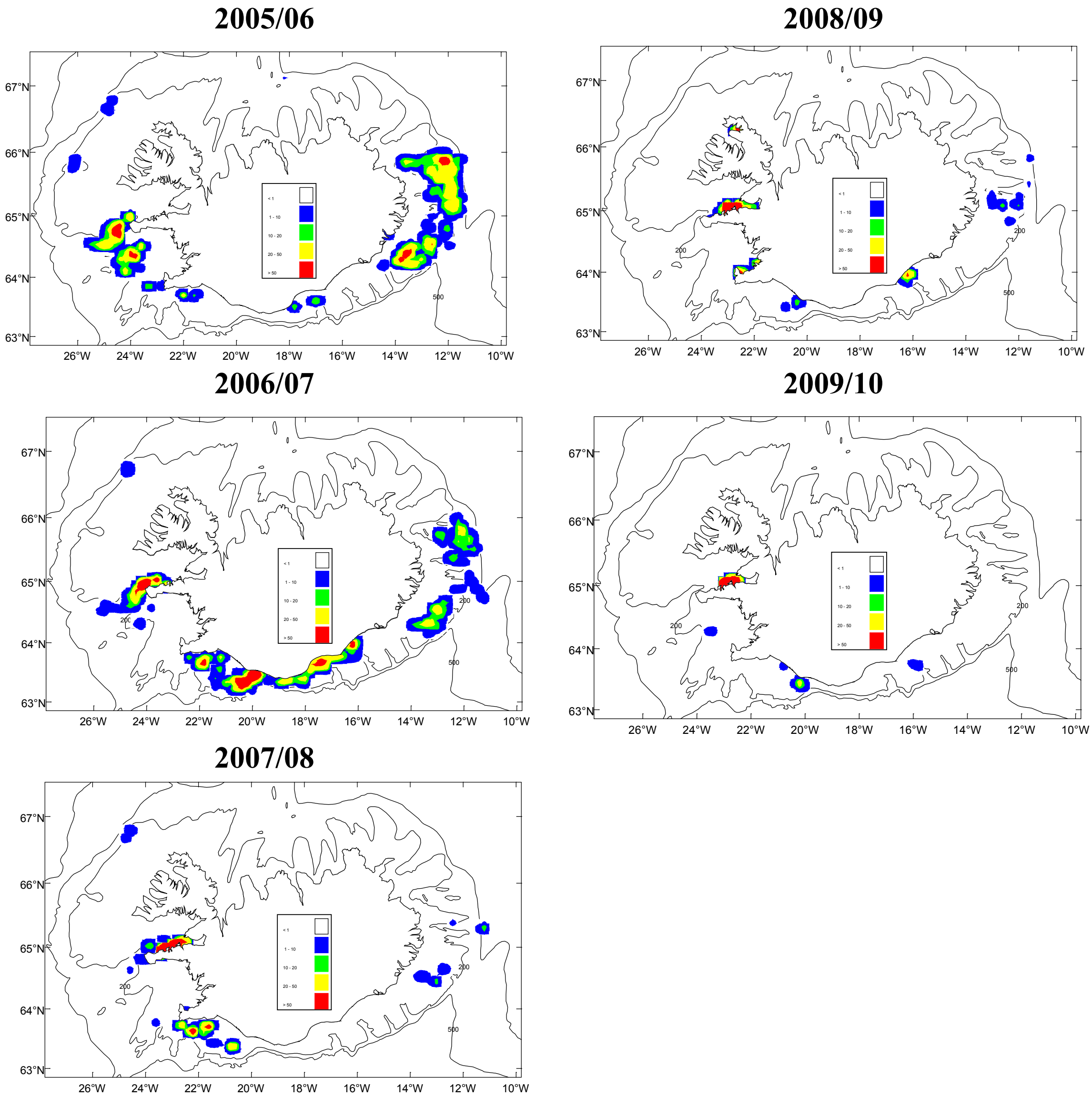

Figure 11.2.2. The distribution of the fishery of Icelandic summer spawning herring during the fishing season 2009/10 in comparison to previous four seasons.

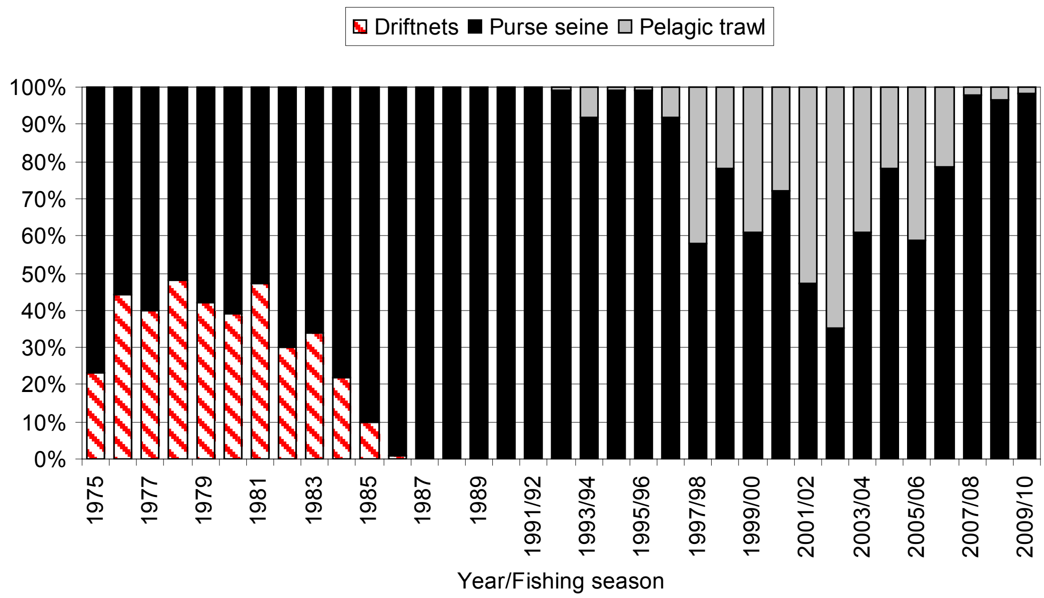

Figure 11.2.1.1. Icelandic summer spawning herring. Proportion of the total catches of the Icelandic summer-spawning herring in 1975/76-2009/10 taken by different gears.

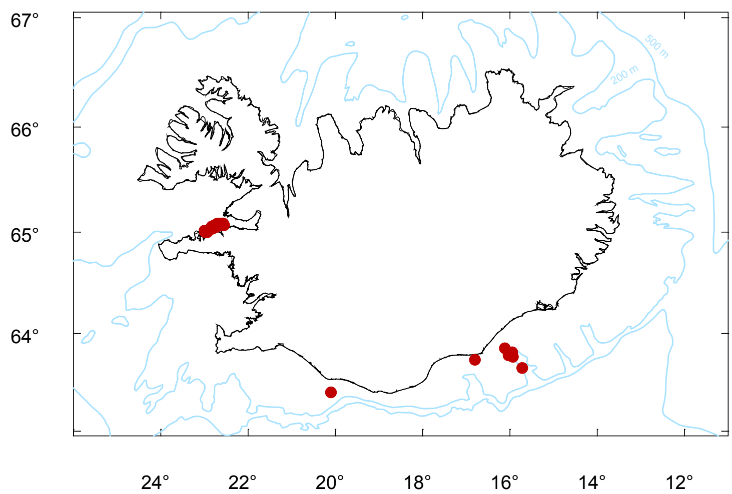

Figure 11.2.2.1. The locations of the Icelandic summer-spawning herring catch samples in 2009/10 (red dots).

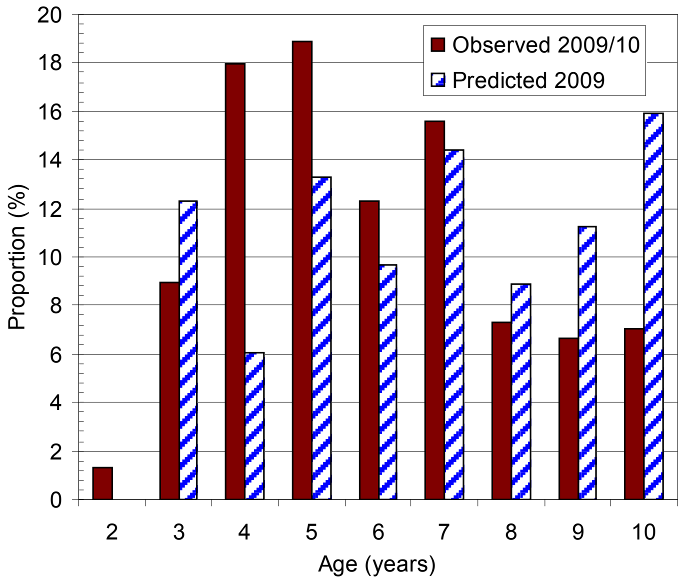

Figure 11.2.2.2. Icelandic summer spawning herring. Predicted catch in weight (%) in the assessment 2009 and observed catch in the season 2009/10.

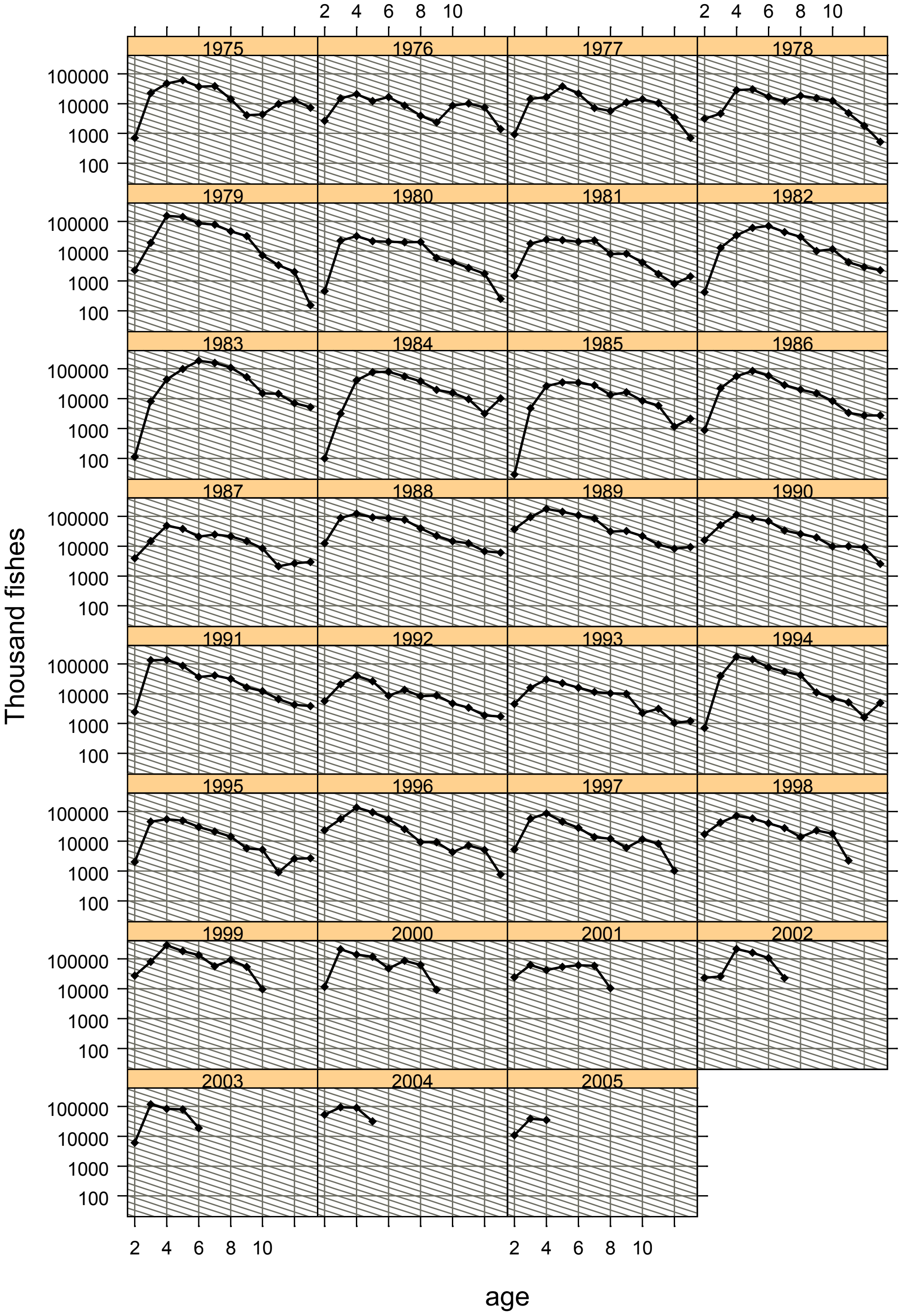

Figure 11.3.1.1. Icelandic summer-spawning herring. Catch curves by year classes 1973-2005. Grey lines correspond to Z=0.4.

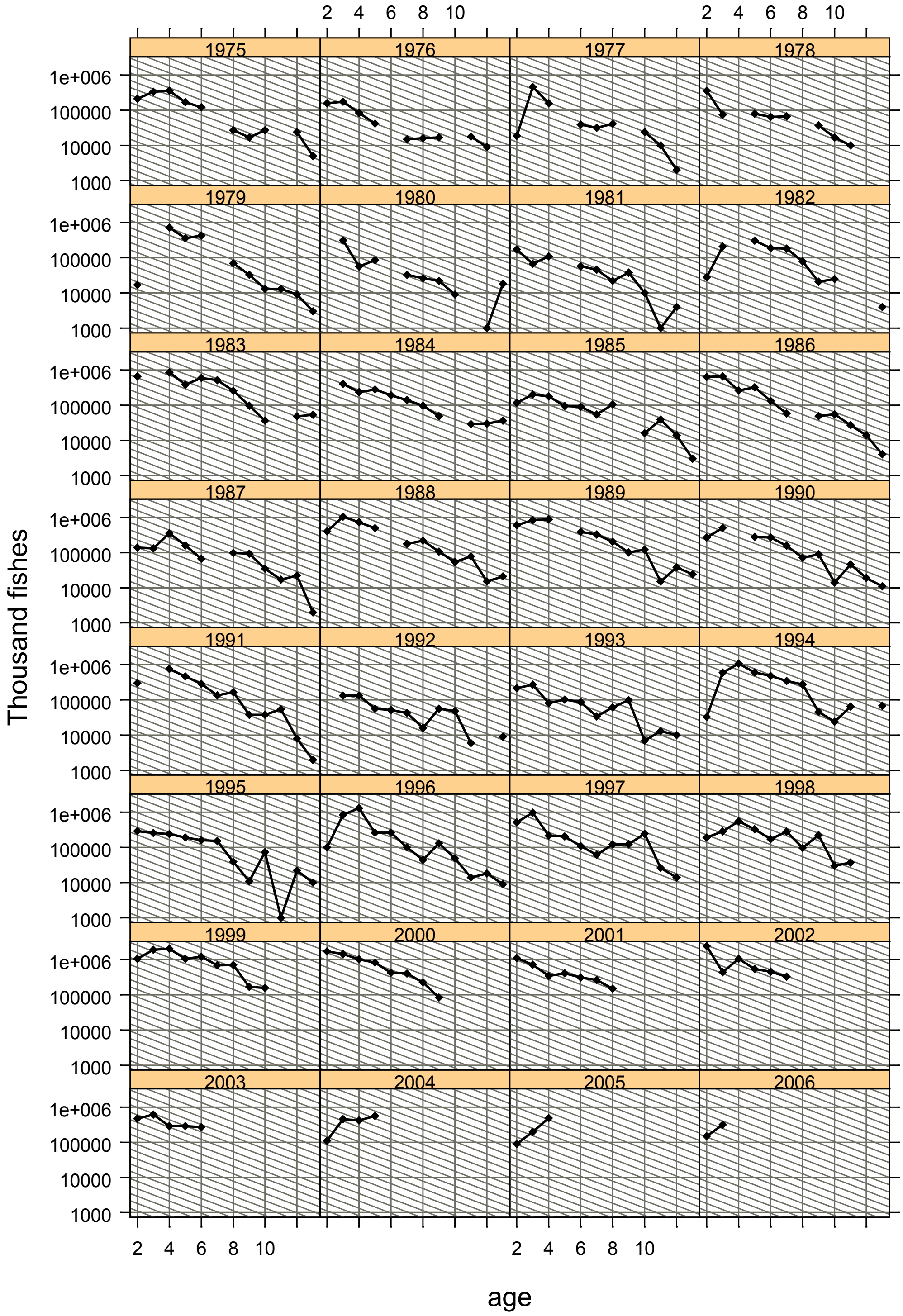

Figure 11.3.1.2. Icelandic summer spawning herring. Catch curves from survey data by year classes 1973-2006. Grey lines correspond to Z=0.4.

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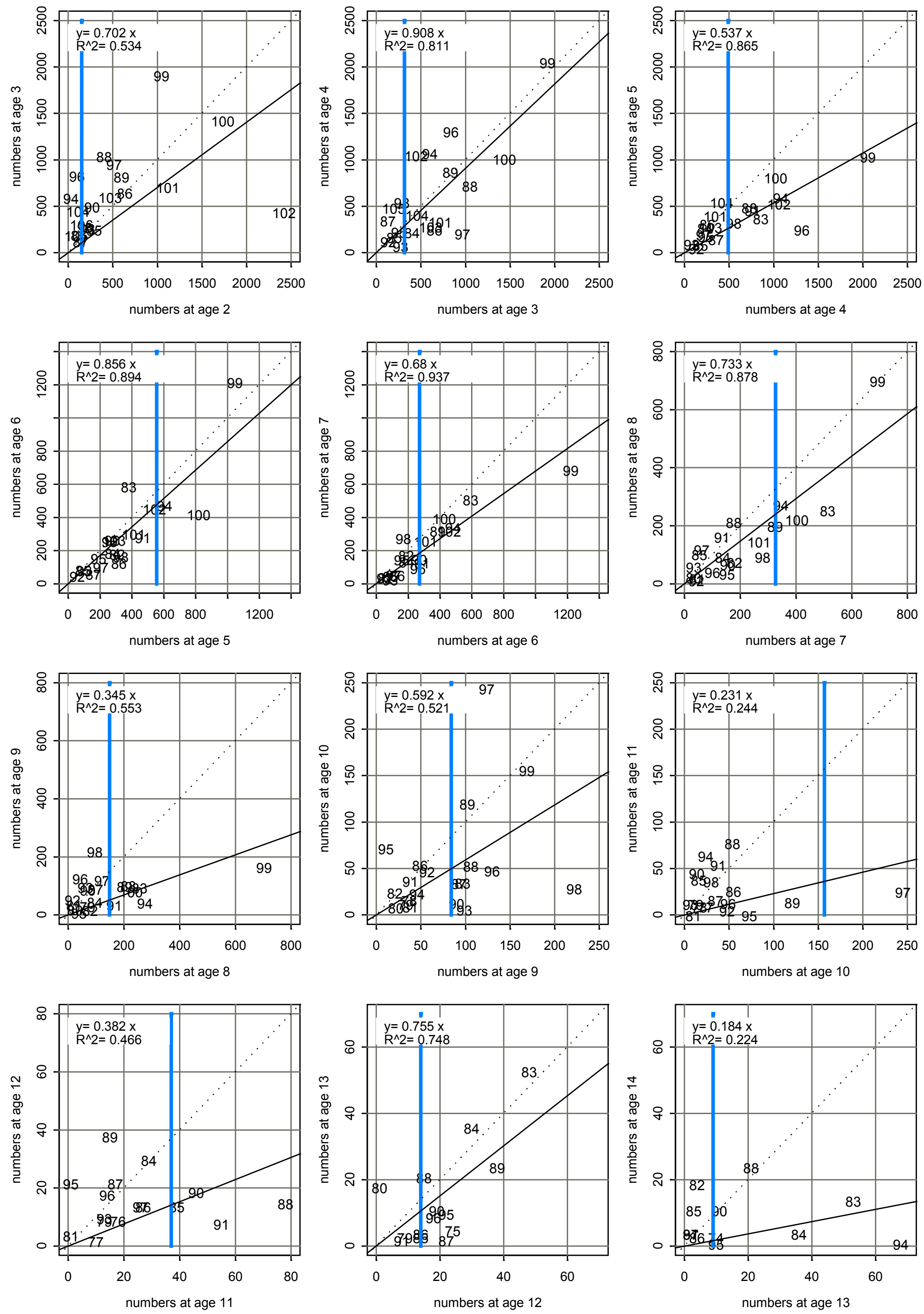

Figure 11.3.1.3. The relationship between acoustic survey indices for age groups 2 to 13 and the same year classes (indicate on graphs) a year later for Icelandic summer-spawning herring. The bolded vertical line represent the acoustic indices in October 2009.

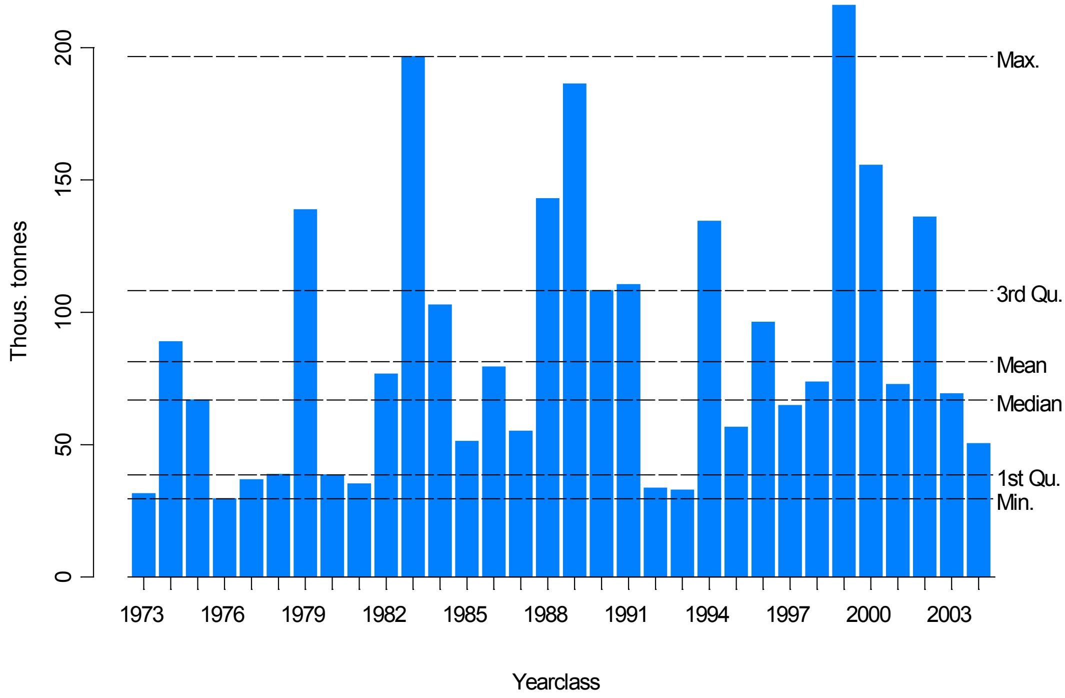

Figure 11.3.1.4. The sum of total catch of each year class of Icelandic summer-spawning herring from 1973 to 2004. The provided summary statistic is based on yearclasses from 1973 to 1997.

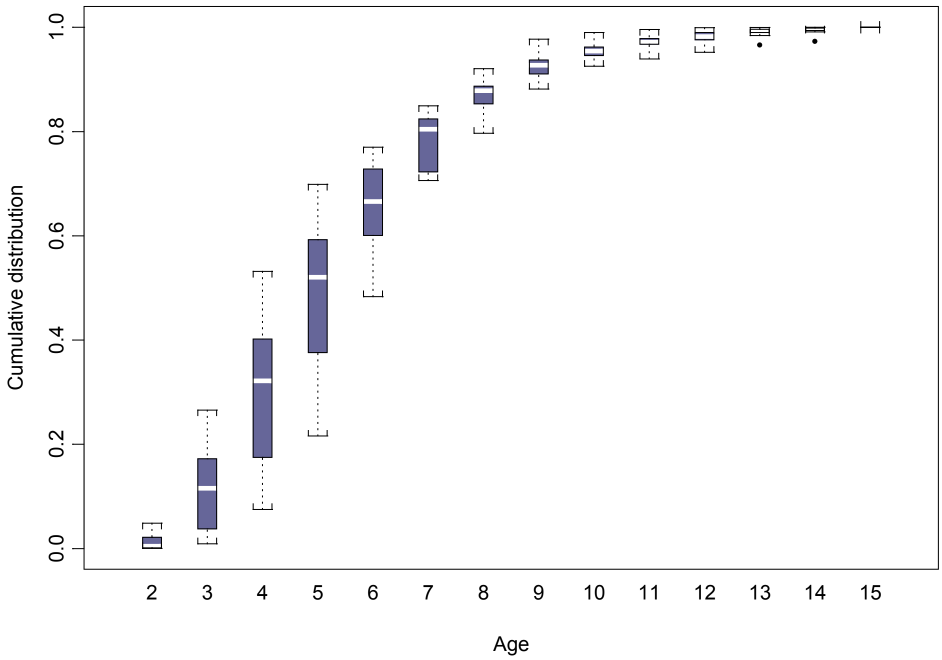

Figure 11.3.1.5. The cumulative total biomass in the catch (in proportion) of Icelandic summer-spawning herring for different age group for the year classes 1978 to 1996.

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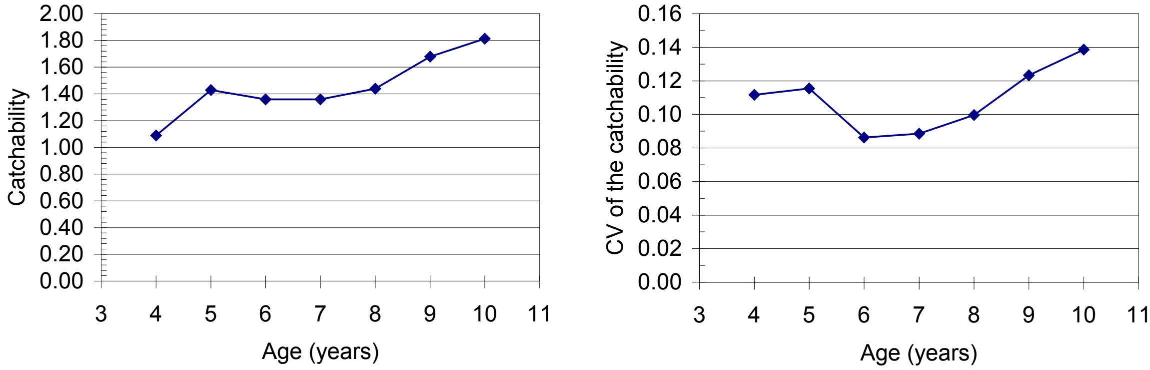

Figure 11.3.2.1. Icelandic summer-spawning herring. The catchability and its CV for the acoustic surveys used in the final Adapt run in 2010.

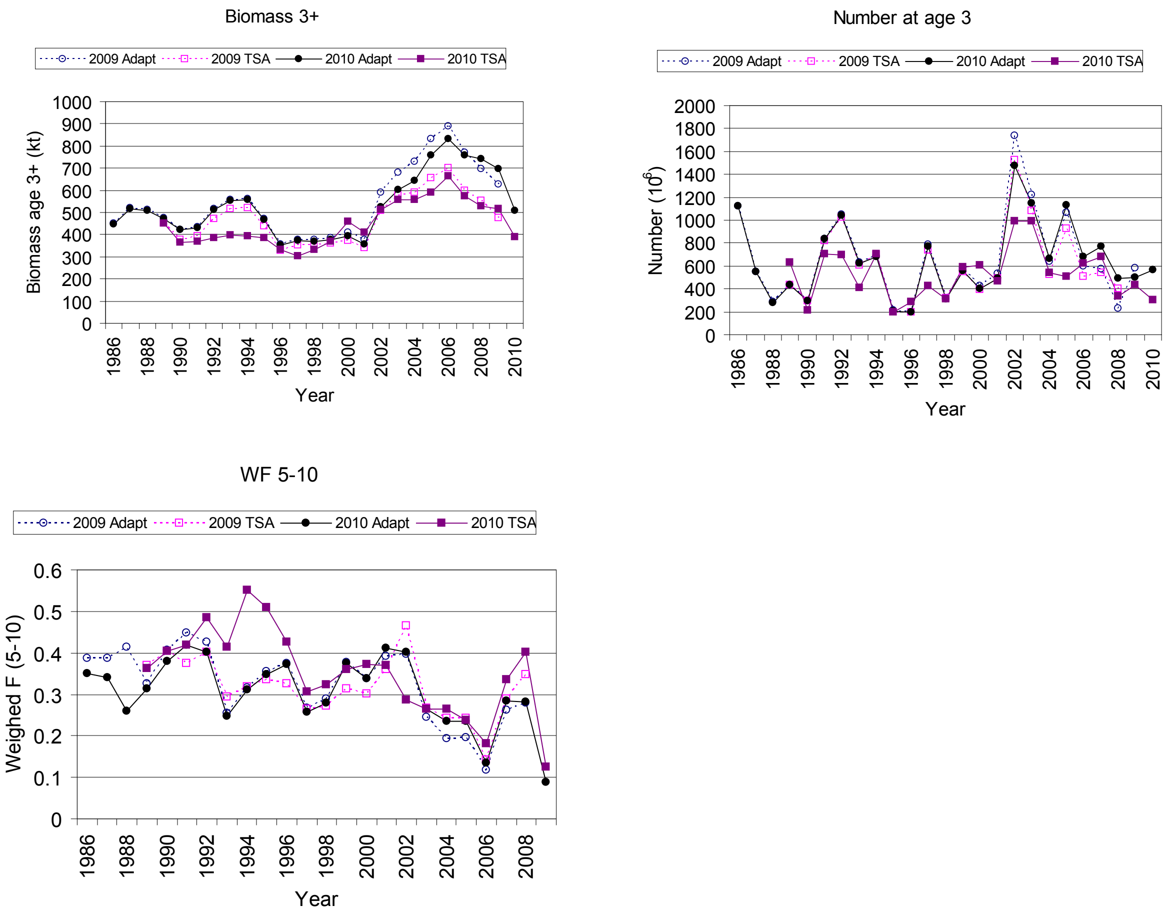

Figure 11.3.2.2. Icelandic summer-spawning herring. Comparisons of NFT-Adapt and TSA runs in 2009 and in 2010.

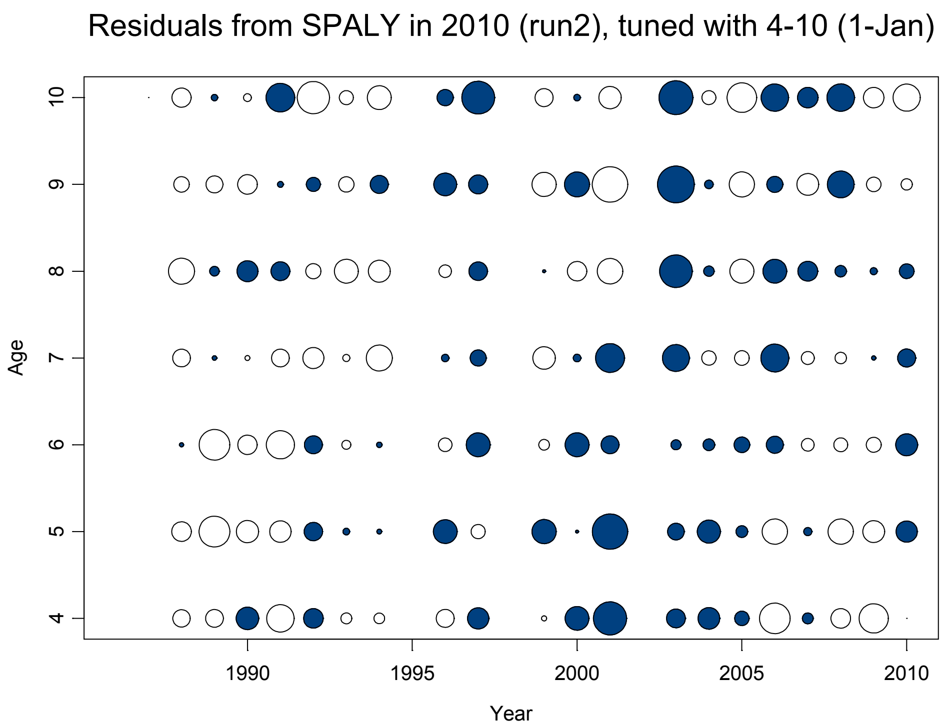

Figure 11.3.2.3. Icelandic summer spawning herring. Residuals of NFT-Adapt run in 2010 from survey observations (moved to 1st January). Filled bubbles are positive and open negative. Max bubble = 1.30.

Figure 11.3.2.4. Icelandic summer spawning herring. Retrospective pattern in spawning stock biomass, N weighted F and recruitment (N at age 3) from NFT-Adapt in 2010.

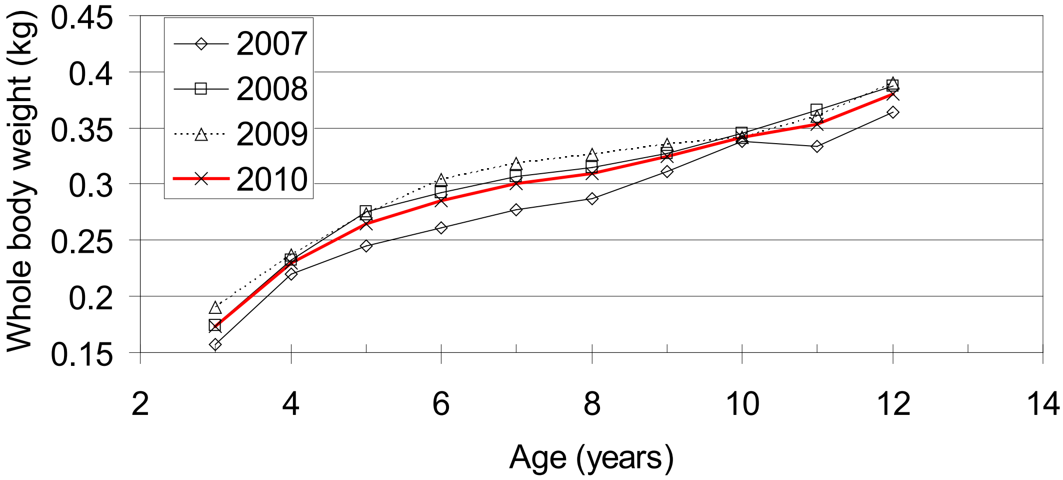

Figure 11.6.1.1. Icelandic summer spawning herring. The mean weight at age for age groups 3 to 12 (+ group) during 2007 to 2009 and the average across the three years that represents 2010 in the stock prognosis.

12 Capelin in the Iceland–East Greenland–Jan Mayen area

Summary

- Last year (2009) no inital quota was issued.
- Acoustic biomass assessments prior to the spawning gave SSB of 550 000 t and a catch of 150 000 t was allocated in February. The stock has been at low levels the last 5 years.
- Only very low abundance of 1 year old capelin was measured in November- December 2009.
- The advice is therefore not to open the fishery in the season 2010/11 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 in March 2011 after accounting for the natural mortality.
- The Icelandic capelin stock was on the agenda in the Benchmark Workshop WKSHORT 31 August – 4 September 2009. The WKSHORT was unable to approve the assessment of the Icelandic capelin stock. This was primarily because there are reasons to believe that the value of M (natural mortality) used in the assessment and in the predictions (value of 0.035) is too low. The workshop recommended further work. That work is ongoing.
- In the absence of an accepted assessment methodology the WG decided to use the old assessment method to assess the state of the stock.

12.1 Stock description and management units

The capelin is a small pelagic shooling fish. It is 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-east, south and west coast of Iceland. Spawning peaks in March. Although capelin spawn at the age of 2-4 years a great majority spawns at 3 years of age and the males and most of the females die after spawning. Capelin is a migratory fish. Changes in distribution and migrations of both the adult and juvenile parts of the stock around 2002 are discussed in section 7 (see Figure 7.3.4 and Figure 7.3.5). Capelin is a very important forage species for several commercial fish species and especially 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 assess the size of the fishable stock and on its basis to set a final TAC for the season.

Surveys on 0-group and 1-group in August discontinued in 2004 (ICES 2009a) and are therefore not mentioned further here.

Surveys on immature 1 and 2 capelin in autumn

The surveys, aimed at young capelin in October to December, have been the basis for the starting quota in many years. But in the years 2001 to 2005 and 2007-2009 these surveys have measured low levels of juvenile abundance and therefore no starting quota has been given.

In November-December 2008, 0-group capelin was observed in large numbers, in historical perspective, over the Greenland and Iceland shelf all the way to East Iceland. However, only small number of age 1 capelin was measured in the 2009 survey (Table 12.2.1 and Figures 12.2.1). So preliminary quota cannot be set for the fishing season 2010/11.

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 71-72°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 areas of the Greenland plateau. Capelin was encountered fairly widely in the survey area but in low abundance.

In August 2007 two year old capelin was found along the continental slope at East Greenland between 68°-70°30'N but the abundance was very low.

In August 2008 the stock had a more southerly distribution in the Denmark Strait and over the Greenland shelf but still 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-December and/or in January/February in the fishing season. The survey in November-December 2009 resulted in total biomass of 207 000 t. and the spawning stock biomass was only estimated as 140 000 t (Table 12.2.1 and Figure 12.2.1). The resulting biomass estimate was too low to recommend a quota.

In the beginning of January an acoustic assessments of the stock were made off NW, N, NE and E-Iceland by two research vessels (R/V Arni Fridriksson and R/V Bjarni Saemundsson). The size of the maturing part of the migration was estimated as 354 000 t. The distribution of the SA-values in the survey is shown in Figure 12.2.2. The leading part of the migration off the east coast was well separated from the rest and was estimated about 180 000 t. The following migration off the northeast coast was estimated 118 00 tonnes and a small migration off the western north coast was estimated 56 00 t. From 12-17 January another attempt at estimating the first two migrations was made with one R/V and the aid of a scouting vessel. This survey failed because of adverse weather conditions. During 22-29 January yet another survey was conducted by the R/V Arni Fridriksson with the aid of a scouting vessel on the part of the migration off the east and northeast coast of Iceland. The total biomass estimate was 388 000 t of which 350 000 t were maturing to spawn (Fig. 12.2.3). The first migration had by that time entered and dispersed in the warm waters off the southeast coast and consequently inaccessible to an acoustic assessment. A few days later on the 3rd of January a part of this migration entered the coastal waters at SE Iceland (Myrarbugur). This migration had previously been estimated at 180 000 t and when added to the estimate 22-29 January the total estimate of mature capelin was 530 000 t. Based on this estimate the Marine Research Institute recommended a capelin TAC of 130 000 t to the Ministry of Fisheries and Agriculture which followed this advice.

On the 8.February the M/V Borkur, equipped with calibrated echo-sounders measured, under the guidance of the MRI, the first part of the spawning migration that had entered the coastal waters at SE Iceland on 3rd of February. This migration was then situated west of Vest-mannaeyjar at the south west coast. The resulting estimate was 113 000 t (Fig. 12.2.4). At the same time the R/V Arni Fridriksson started a new acoustic assessment at NE Iceland and followed the migration to SE Iceland (Fig. 12.2.5). This assessment finished on the 14th of February. The total assessment in this area was 277 000 t of which 222 000 t were maturing to spawn. The following days (14th-18th February) the research vessel surveyed the area from SE Iceland to Reykjanes at SW Iceland. In this area all the capelin were mature. By that time the first migration measured by M/V Borkur had entered Faxabay at the west coast. At the SE coast the assessment gave 143 000 t (Fig. 12.2.6) and at the SW coast 27 500 t (Fig. 12.2.7). When the survey finished a catch of 40 000 t had been removed from the stock. Based on this new estimate the Ministry of Fisheries and Agriculture added 20 000 t to the TAC previously set giving a total TAC for the 2009/2010 season of 150 000 t. The result of the surveys conducted 8 - 18 February by the R/V Arni Fridriksson and the M/V Borkur was considered the final assessment and further attempts at assessing the stock did not result in any changes in the TAC for the 2009/2010 season (Table 12.2.2).

12.3 Fishery dependent data

A starting quota for a fishing season is allocated to Iceland, Norway, Faroe Islands and Greenland, based on an assessment of juvenile capelin the year before, by an existing agreement between the nations. No preliminary catch quota was recommended for the 2009/2010 season as the autumn survey in 2008 failed to record enough juvenile capelin. Usually the first spawning migration enters the warm Atlantic water off the southeast coast in the first or the beginning of the second week of February. From there they migrate fairly fast westward in near-shore areas. This was the case in February 2010 and acoustic assessments in both oceanic and coastal waters resulted in a final quota of 150 000 t. About 28 000 t were caught in the first half of February off the east coast and the rest was caught at the south coast (23 000 t) and in Faxafloi at West-Iceland (99 000 t) from the first half of February to the first half of March. The distribution of the catches for the Icelandic fleet is shown in Figure 12.3.1.

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 and Figure 12.3.2.

No summer fishery took place in 2006 - 2009 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 2010 are given in Table 12.3.3 and the total catches in numbers by age during the winter seasons 1986–2010 are in Table 12.3.4.

Preliminary and recommended TAC as well as landings for the fishing seasons 1994/95 – 2009/10 are given in Table 12.3.5.

12.4 Methods

The Icelandic capelin stock was on the agenda in the Benchmark Workshop WKSHORT 31 August – 4 September 2009 in Bergen, Norway. Regarding the Icelandic capelin the WKSHORT came to the following conclusion:

"The WKSHORT was unable to approve the assessment of Icelandic capelin. This was primarily because there are reasons to believe that that the value of natural mortality used in the assessment (0.035 per month) is too low. Also, the description of the first stage of quota setting was inadequate, in the sense that it would not be sufficient to allow someone else to conduct the assessment given the data". More detailed description can be found in the WKSHORT report, chapter 4.13 (ICES 2009b).

The WKSHORT recommended further work (see chapter 4.14 in the WKSHORT report). That work is still ongoing, but will be delivered to ICES soon. In the absence of an accepted assessment methodology the WG decided to use the old assessment method to assess the state of the stock.

Stock projections

To calculate the stock numbers at age on 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 stock numbers. Let I_a=abundance at age a (a=2, 3 and 4) in the survey and C_a=the total number caught at age a prior to the survey. Assuming that there is no survival of spawners, we are practically calculating the number of mature capelin at age 3 and 4.

The stock number N_a at age a on the 1 January is $N_a = I_a\, e^{iM} + C_a\, e^{i1/2M}$, where i=the number of months between 1 January and the acoustic survey and M=0.035 (a monthly natural mortality).

Further details can be found in Gudmundsdottir, A., and Vilhjálmsson, H. 2002.

Stock prognosis

Historically the fishable stock consists primarily 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 2009 if one has the abundance of 1 and 2 year old in autumn 2008.

An account is taken of 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 have to be left to spawn. 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 even more problematic.

12.6 State of the stock

The state of the stock is very uncertain. The SSB is highly variable because it is primarily dependent on only one age group. It is estimated that 410 000 t were left for spawning in spring 2010 (Table 12.6.1). It is clear that the stock has been at low level the last five fishing seasons. Only few 1 year old capelin were measured in autumn 2009 and immature 2 year old were hardly seen, both of which should be in the SSB in spring 2011.

The number of 4 years old capelin in the catches has been declining since the eighties and were at very low level in the fishing seasons 2005/06-2007/08. This seemed 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 years 2005/06-2007/08. In 2009 and 2010 the proportion of 4 year old capelin in the spawning stock increased again (> 14%) but this can be explained by the fact that the stock numbers of younger age groups are very low.

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 1978/79–2009/10 seasons. The results are shown in Table 12.6.1 and also the remaining spawning stock by number and biomass in March/April 1979–2010.

An overview of stock development during 1978–2010 is given in Table 12.6.2.

12.7 Short term forecast

As stated above, in the absence of an accepted assessment methodology, the WG decided to use the old assessment method to assess the state of the stock.. It is also used as the basis for the forecast.

To predict the abundance of the fishable stock in the 2010/11 season knowledge of the amount of immature capelin at age 1 and 2 from the autumn 2009 are needed. As the measurement of 1 year old capelin is so low (corresponding to a SSB of less than 100 000 t) and the numbers of immature capelin at age 2 were practically zero then a starting quota cannot be given for the fishing season 2010/11.

There should be no fishery until new acoustic measurements on stock size confirm a SSB in excess of 400 000 t in March 2011 after accounting for the natural mortality..

12.8 (Medium term forecasts)

12.9 Uncertainties in assessment and forecast

In January 2010 the stock was acoustically assessed in deep waters off East-Iceland and survey conditions were good. A few weeks later acoustic surveys were also conducted in shallow water south of Iceland. A survey conducted both in deep waters off East–Iceland and in shallow waters from Southeast-Iceland to Southwest-Iceland 8-18 February gave slightly larger spawning stock biomass than the assessments off the east coast in January. Comparisons between acoustic biomass assessments in deep and shallow water do not exist. It is known that it is more difficult to separate other species and the bottom from the targeted species in shallow water when the shoal is very dense and surface schooling may sometimes be a problem. This year, however, conditions for surveying in the shallow waters at the south coast were quite favourable.

The practice of increasing searching time when the acoustic measurements of capelin are low, as the tendency has been in recent years, should be considered more carefully as it may result in a biased assessment of stock size compared to previous assessments when the stock was larger.

12.10 Comparison with previous assessment and forecast

Last year there was no predicted quota (for 1 November 2009) and the state of the stock was considered uncertain. The final TAC set for the fishing season 2009/10 was 150 000 t leaving a spawning stock biomass of about 410 000 t which is in accordance with the management target. Like last year no starting quota can be set for the fishing season 2010/11 due to low abundance of juvenile capelin.

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 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 due to small TAC 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 on 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 and again there was a ban on fishing in the season 2008/09. 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 developed long ago, and since skippers of purse-seine vessels generally operate in groups due to the behaviour of the fish, 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 (1965-1973). 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 a small part of the catch was taken with pelagic trawl in the fishing season 2007/08 and in the fishing season 2009/2010 less than 200 t was taken with pelagic trawl. 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, as well as on the spawning grounds at South- and Southwest Iceland. The temperature increase is so great that it may have led to displacements of the juvenile part and the spawning areas of the capelin stock. Changes in spawning locations may on the other hand influence the drift of the larvae to the nursery areas in the Iceland Sea. 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.

ICES. 2009a. Report of the North Western Working Group (NWWG), 29 April - 5 May 2009, ICES Headquarters, Copenhagen. Diane Lindemann. 14 pp.

ICES 2009b. Report of the Benchmark Workshop on Short-lived Species (WKSHORT). 31 August-4 September 2009, Bergen, Norway. ICES CM 2009/ACOM:34

Table 12.2.1 Assessment of young capelin in the Iceland/Greenland/Jan Mayen area, by r/v Arni Fridriksson 24/11-16/12 2009. (Numbers in billions, biomass in thousand tonnes)

		Age/Year class					
Length	Mean weight	1	2	3	Numbers	Biomass	Total
(cm)	(g)	2008	2007	2006	(10^9)	(10^3 t)	
9	2.33	0.036	0.000	0.000	0.036	0.084	
9.5	3.10	0.479	0.000	0.000	0.479	1.484	
10	3.69	0.855	0.000	0.000	0.855	3.155	
10.5	4.19	2.860	0.000	0.000	2.860	11.996	
11	5.01	3.442	0.000	0.000	3.442	17.256	
11.5	5.71	3.531	0.000	0.000	3.531	20.150	
12	6.70	1.835	0.000	0.000	1.835	12.284	
12.5	7.83	1.120	0.000	0.000	1.120	8.772	
13	9.30	0.481	0.003	0.000	0.484	4.505	
13.5	10.33	0.374	0.039	0.000	0.413	4.270	
14	12.29	0.215	0.227	0.000	0.442	5.435	
14.5	14.64	0.103	0.403	0.000	0.506	7.405	
15	15.84	0.015	0.664	0.012	0.691	10.946	
15.5	17.95	0.015	0.945	0.042	1.002	17.991	
16	19.97	0.003	1.057	0.165	1.225	24.467	
16.5	22.58	0.000	0.618	0.119	0.737	16.638	
17	24.62	0.067	0.640	0.172	0.878	21.630	
17.5	28.51	0.000	0.283	0.101	0.383	10.934	
18	31.32	0.000	0.149	0.064	0.213	6.667	
18.5	36.45	0.000	0.012	0.000	0.012	0.440	
19	34.50	0.000	0.006	0.000	0.006	0.000	
TSN (10^9)		15.432	5.046	0.674	21.152	0.000	
TSB (10^3)		89.892	100.802	16.023		206.509	
Mean weight (g)		5.8	20	23.8			9.8
Mean length (cm)		11.4	15.9	16.7			12.6
% N		73	23.9	3.2			100
SSN (10^9)		2.394	5.046	0.674	8.114		
SSB (10^3)		23.484	100.802	16.023		140.309	

Table 12.2.2 Capelin. Final assessment of capelin in the Iceland/Greenland/Jan Mayen area, by r/v Arni Fridriksson February 2010. (Numbers in billions, biomass in thousand tonnes)

		Age/Year class					
Length	Mean weight	2	3	4	Numbers	Biomass	Total
(cm)	(g)	2008	2007	2006	(10^9)	(10^3 t)	
10.5	4.10	0.010	0.000	0.000	0.010	0.043	
11	4.98	0.071	0.000	0.000	0.071	0.353	
11.5	6.13	0.206	0.000	0.000	0.206	1.264	
12	6.56	0.401	0.003	0.000	0.404	2.653	
12.5	7.80	0.726	0.000	0.000	0.726	5.659	
13	9.29	1.122	0.170	0.000	1.292	12.003	
13.5	10.63	1.861	0.170	0.000	2.031	21.595	
14	13.18	2.150	0.417	0.000	2.567	33.822	
14.5	13.37	1.827	1.433	0.047	3.308	44.219	
15	15.51	1.337	1.947	0.020	3.304	51.255	
15.5	18.04	1.305	2.806	0.233	4.344	78.385	
16	19.98	0.590	2.805	0.267	3.662	73.158	
16.5	22.62	0.059	2.295	0.461	2.816	63.702	
17	25.33	0.074	1.715	0.753	2.542	64.388	
17.5	28.46	0.000	1.601	0.711	2.312	65.809	
18	29.59	0.000	0.611	0.267	0.878	25.971	
18.5	34.17	0.000	0.302	0.182	0.484	16.533	
19	42.75	0.000	0.000	0.055	0.055	2.360	
TSN (10^9)		11.740	16.276	2.997	31.012		
TSB (10^3)		152.219	334.252	76.700	0.000	563.171	
Mean weight (g)		13.0	20.5	25.6			18.2
Mean length (cm)		14.1	16.0	17.0			15.4
% N		37.9	52.5	9.7			100.0
SSN (10^9)		8.060	15.162	2.997	26.218		
SSB (10^3)		113.669	318.256	76.700		508.625	

Table 12.3.1 The international capelin catch 1964–2010 (thousand tonnes).

	Winter season					Summer and autumn season						
Year	Iceland	Nor-way	Faroes	Green-land	Season total	Iceland	Nor-way	Faroes	Green-land	EU	Season total	Total
1964	8.6	-	-		8.6	-	-	-		-	-	8.6
1965	49.7	-	-		49.7	-	-	-		-	-	49.7
1966	124.5	-	-		124.5	-	-	-		-	-	124.5
1967	97.2	-	-		97.2	-	-	-		-	-	97.2
1968	78.1	-	-		78.1	-	-	-		-	-	78.1
1969	170.6	-	-		170.6	-	-	-		-	-	170.6
1970	190.8	-	-		190.8	-	-	-		-	-	190.8
1971	182.9	-	-		182.9	-	-	-		-	-	182.9
1972	276.5	-	-		276.5		-	-		-	-	276.5
1973	440.9	-	-		440.9	-	-	-		-	-	440.9
1974	461.9	-	-		461.9	-	-	-		-	-	461.9
1975	457.1	-	-		457.1	3.1	-	-		-	3.1	460.2
1976	338.7	-	-		338.7	114.4	-	-		-	114.4	453.1
1977	549.2	-	24.3		573.5	259.7	-	-		-	259.7	833.2
1978	468.4	-	36.2		504.6	497.5	154.1	3.4		-	655.0	1,159.6
1979	521.7	-	18.2		539.9	442.0	124.0	22.0		-	588.0	1,127.9
1980	392.1	-	-		392.1	367.4	118.7	24.2		17.3	527.6	919.7
1981	156.0	-	-		156.0	484.6	91.4	16.2		20.8	613.0	769.0
1982	13.2	-	-		13.2	-	-	-		-	-	13.2
1983	-	-	-		-	133.4	-	-		-	133.4	133.4
1984	439.6	-	-		439.6	425.2	104.6	10.2		8.5	548.5	988.1
1985	348.5	-	-		348.5	644.8	193.0	65.9		16.0	919.7	1,268.2
1986	341.8	50.0	-		391.8	552.5	149.7	65.4		5.3	772.9	1,164.7
1987	500.6	59.9	-		560.5	311.3	82.1	65.2		-	458.6	1,019.1
1988	600.6	56.6	-		657.2	311.4	11.5	48.5		-	371.4	1,028.6
1989	609.1	56.0	-		665.1	53.9	52.7	14.4		-	121.0	786,1
1990	612.0	62.5	12.3		686,8	83.7	21.9	5.6		-	111.2	798.0
1991	202.4	-	-		202.4	56.0	-	-		-	56.0	258.4
1992	573.5	47.6	-		621.1	213.4	65.3	18.9	0.5	-	298.1	919.2
1993	489.1	-	-	0.5	489.6	450.0	127.5	23.9	10.2	-	611.6	1,101.2
1994	550.3	15.0	-	1.8	567.1	210.7	99.0	12.3	2.1	-	324.1	891.2
1995	539.4	-	-	0.4	539.8	175.5	28.0	-	2.2	-	205.7	745.5
1996	707.9	-	10.0	5.7	723.6	474.3	206.0	17.6	15.0	60.9	773.8	1,497.4
1997	774.9	-	16.1	6.1	797.1	536.0	153.6	20.5	6.5	47.1	763.6	1,561.5
1998	457.0	-	14.7	9.6	481.3	290.8	72.9	26.9	8.0	41.9	440.5	921.8
1999	607.8	14.8	13.8	22.5	658.9	83.0	11.4	6.0	2.0	-	102.4	761.3
2000	761.4	14.9	32.0	22.0	830.3	126.5	80.1	30.0	7.5	21.0	265.1	1,095.4
2001	767.2	-	10.0	29.0	806.2	150.0	106.0	12.0	9.0	17.0	294.0	1,061.2
2002	901.0	-	28.0	26.0	955.0	180.0	118.7	-	13.0	28.0	339.7	1,294.7
2003	585.0	-	40.0	23.0	648.0	96.5	78.0	3.5	2.5	18.0	198.5	846.5
2004	478.8	15.8	30.8	17.5	542.9	46.0	34.0	-	12.0		92.0	634.9
2005	594.1	69.0	19.0	10.0	692.0	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	149.0	37.6	10.1	6.7	203.4	-	-	-	-	-	-	203.4
2009	15.1	-	-	-	15.1	-	-	-	-	-	-	15.1
2010*	110.6	28.3	7.7	4.7	150.7							

*** 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 since 2005.**

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 2010 by age and length, and the catch in weight (thousand tonnes) by age group.

TOTAL LENGTH (CM)	AGE 2	AGE 3	AGE 4	TOTAL	PERCENTAGE
12.5	0.015	0.000	0.000	0.000	0.015
13	0.038	0.000	0.000	0.000	0.038
13.5	0.082	0.023	0.000	0.000	0.105
14	0.150	0.114	0.000	0.000	0.263
14.5	0.132	0.288	0.005	0.000	0.425
15	0.108	0.744	0.044	0.000	0.896
15.5	0.117	0.911	0.063	0.000	1.092
16	0.074	0.871	0.172	0.000	1.117
16.5	0.014	1.007	0.197	0.005	1.223
17	0.005	0.782	0.153	0.008	0.948
17.5	0.000	0.421	0.135	0.000	0.556
18	0.000	0.120	0.073	0.000	0.193
18.5	0.000	0.010	0.014	0.000	0.024
19	0.000	0.000	0.000	0.000	0.000
Total number (billions)	0.735	5.292	0.856	0.013	6.897
Percentage	10.7	76.7	12.4	0.2	100.0
Total weight ('000 t)	11.8	117.7	20.9	0.3	150.7

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) 1986–2010.

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
2009	0.1	0.6	0.1	-	0.7	15.1
2010	0.7	5.3	0.9	0.01	6.9	150.7

Table12.3.5 Preliminary TACs for the summer/autumn fishery, recommended TACs for the entire season and landings (000 tonnes) in the 1994/95–2008/09 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
2008/09*	0	0	15
2009/10	0	150	151

*** landings from scouting vessels**

Table 12.6.1 The estimated number (billions) of capelin on 1 January 1979–2010 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 (March) 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	48.0	2.9	86.6	7.5	+	50.9	72.5	570	1450	36.3	602
2006	81.7	2.1	29.4	1.9		83.8	31.3	761	639	18.8	400
2007	55.8	1.1	52.5	1.4		56.9	53.9	515	997	19.1	410
2008	26.1	4.0	32.5	0.7		30.1	33.2	283	619	22.2	406
2009	35.1*	6.4	14.5	2.6	+	41.5*	17.1	393*	343	17.3	328
2010	13.0*	1.5*	21.5	4.2		14.5*	25.2	158*	548	21.5	410

*** preliminary**

Table 12.6.2 Capelin in the Iceland-East Greenland-Jan Mayen area 1978-2009. 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	124	238	400
2006/07	66	377	410
2007/08	31	202	406
2008/09	42*	15	328
2009/10	15*	151	410

*** preliminary**

Table 12.4.1 Capelin. The data used in comparisons between abundance of age groups (numbers) when predicting fishable stock abundance for calculations of preliminary TACs.

	AGE 1 - ACOUSTICS	BACK-CALCULATED	BACK-CALCULATED	BACK-CALCULATED
YEAR CLASS	(MEASURED AUTUMN)	AGE 2 MATURE (AUGUST)	TOTAL AGE 2 (AUGUST)	AGE 3 MATURE (AUGUST)
1980	23.7	17.1	32.1	9.8
1981	68	53.7	96.2	27.9
1982	44.1	40.7	81.6	27
1983	73.8	64.6	164.6	65.8
1984	33.8	35.6	65	20.1
1985	58.6	65.4	102.6	24.5
1986	70.2	70.3	94.8	15.8
1987	43.9	42.8	58.6	6.8
1988	29.2	31.9	42	6.7
1989	39.2[1)]	67.7	77.4	6.4
1990	60	70.7	87.3	10.9
1991	104.6	86.9	107	13.2
1992	100.4	59.8	95	23
1993	119	102.2	147.3	29.6
1994	165	100.7	129.4	19
1995	111.9	90.3	125.5	23.2
1996	128.5	89.5	108.7	12.6
1997	121	85.9	110.3	16
1998	89.8	65.7	90.7	16.9
1999	103	86.7	95.7	5.9
2000	100.3	68	91.9	15.7
2001	74.4[2)]	82.1	93.5	7.5
2002	86.4	86.6	89.3	2.3
2003	*	37.2	38.9	1.1
2004	*	62.5	63.8	0.8
2005	44.7	38.7	43.4	3.1
2006	5	17.2	23.3	4.0
2007	7.5	20.8		
2008	13.0			

1) invalid due to ice conditions

2) Calculated from acoustic estimate in April 2003

***) No information available**

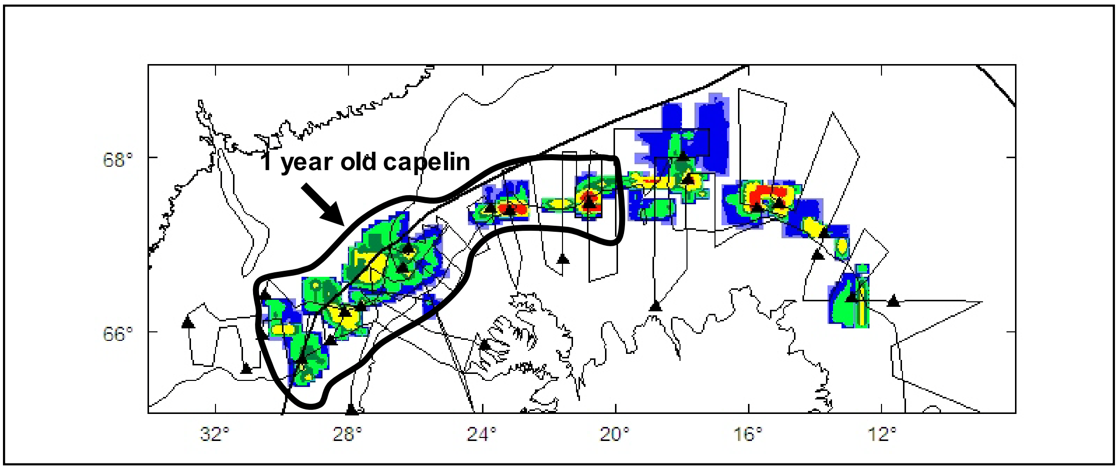

Figure 12.2.1. Capelin. Cruise tracks and trawl stations (upper figure), distribution of 1-3 year old capelin (lower figure) and the ice edge during an acoustic survey by r/v Arni Fridriksson in November/December 2009.

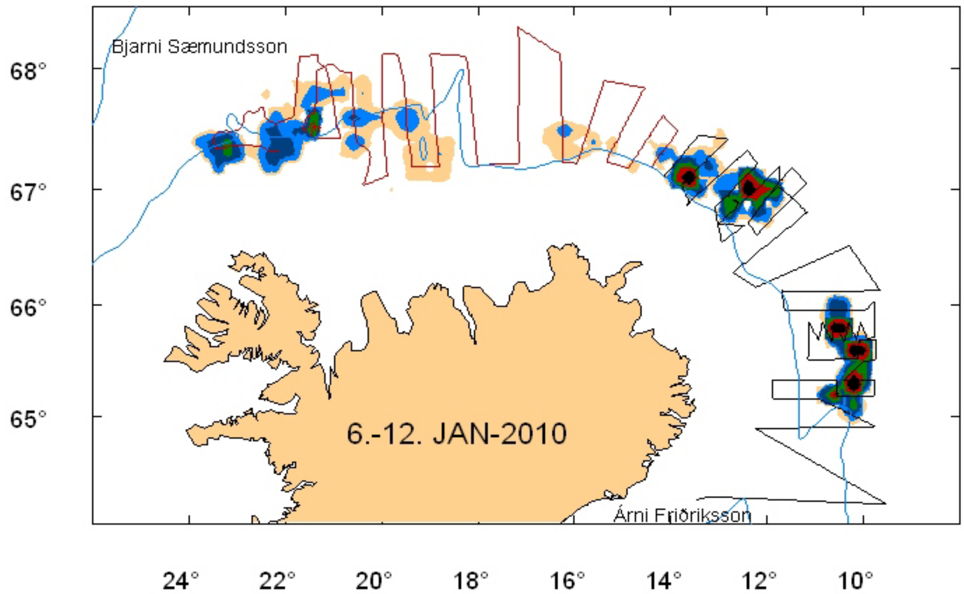

Figure 12.2.2. Capelin. The distribution of SA-values from an assessment survey carried out with r/v Arni Fridriksson in January 6-12, 2010.

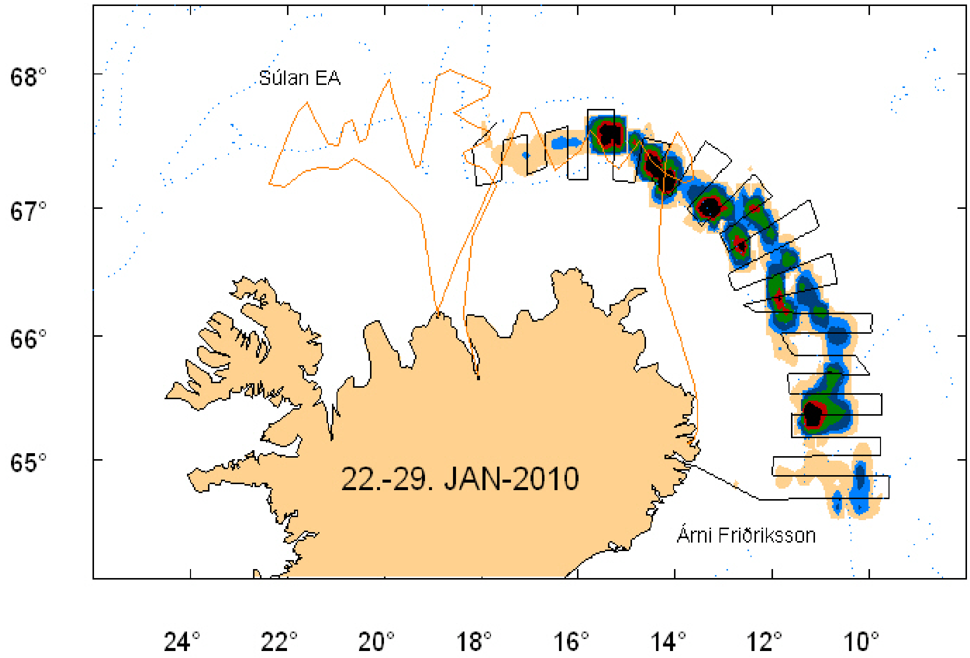

Figure 12.2.3. Capelin. The distribution of SA-values from an assessment survey carried out with r/v Arni Fridriksson in January 22-29, 2010.

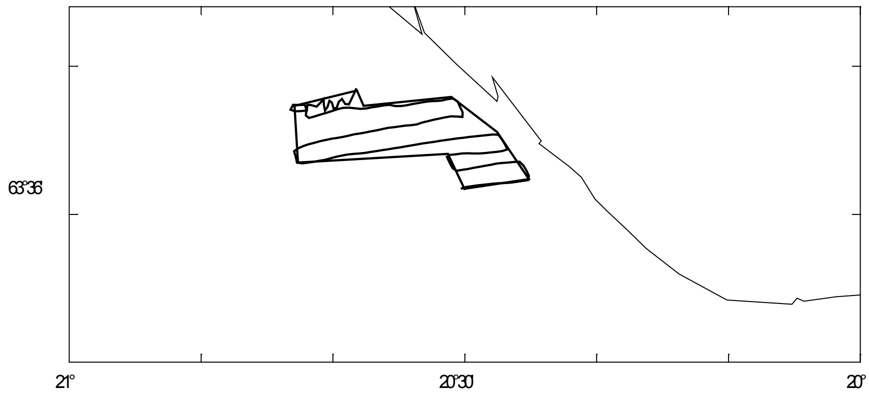

Figure 12.2.4 Capelin. The distribution of SA-values, cruiselines and trawl stations from an assessment survey carried out with M/V Börkur February 8, 2010.

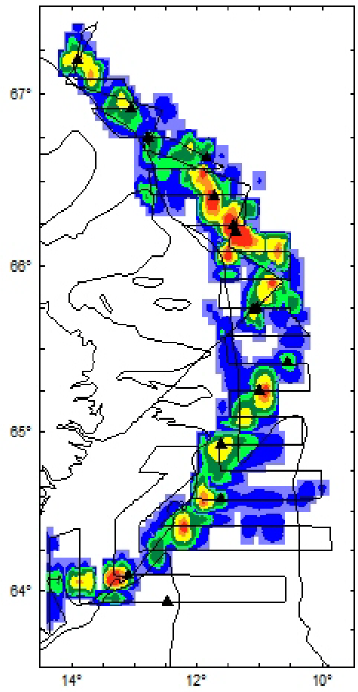

Figure 12.2.5 Capelin. The distribution of SA-values, cruiselines and trawl stations from an assessment survey carried out with r/s Arni Fridriksson, February 8-14, 2010.

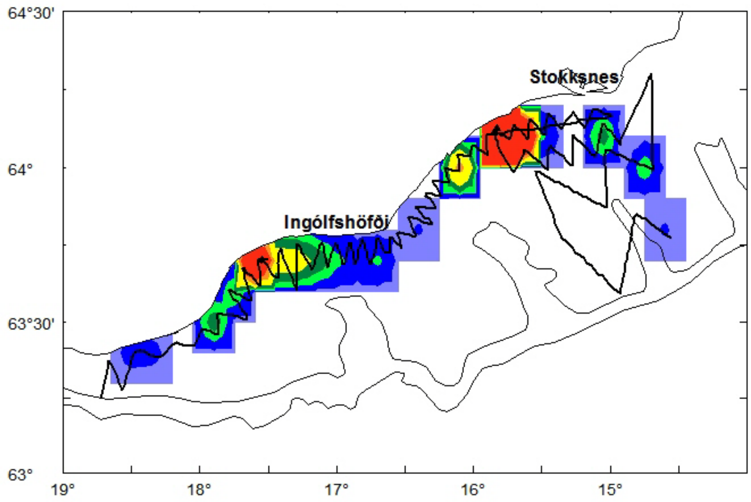

Figure 12.2.6 Capelin. The distribution of SA-values from an assessment survey carried out with r/s Arni Fridriksson, February 14-17, 2010. Black lines show the cruise lines.

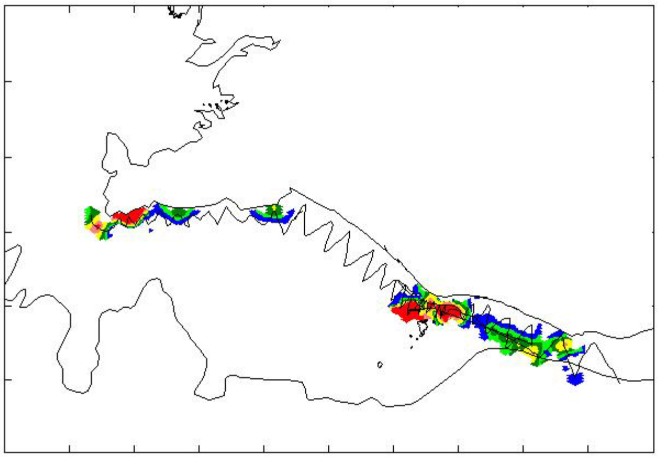

Figure 12.2.7 Capelin. The distribution of SA-values from an assessment survey carried out with r/s Arni Fridriksson, February 17-18, 2010. Black lines show the cruise lines.

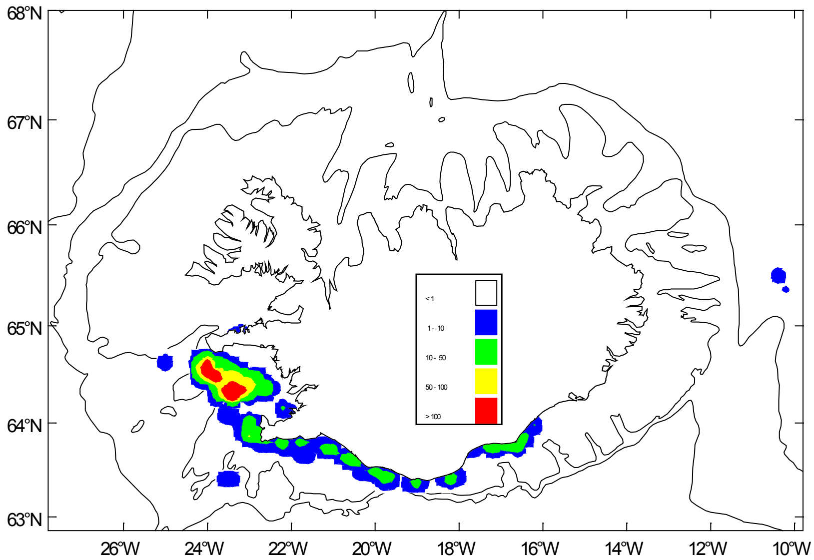

Figure 12.3.1. Distribution of the catches of the Icelandic capelin in the fishing season 2009/10 based on data from logbooks.

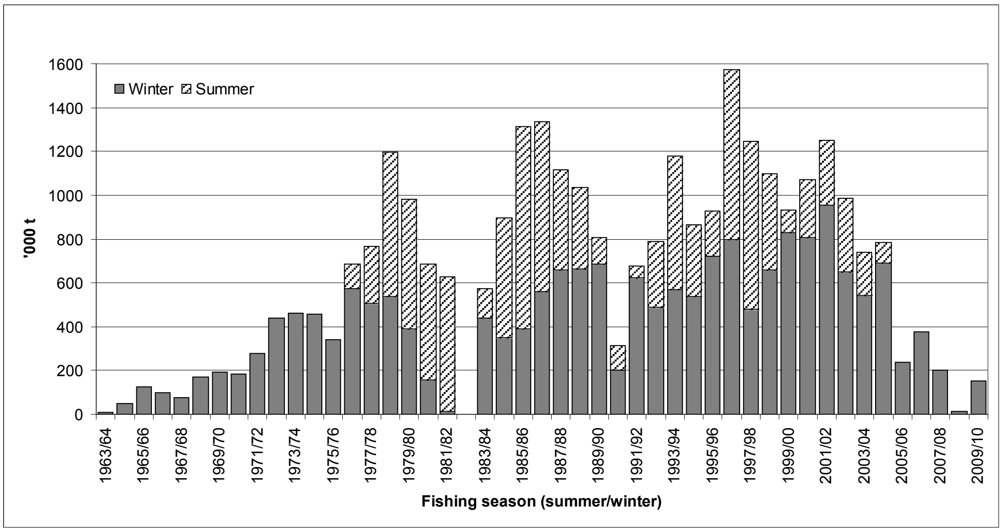

Figure 12.3.2. Total catch (in thousand tonnes) of the Icelandic capelin since 1963/64.

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 (Figure 1). 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 (Figure 2).

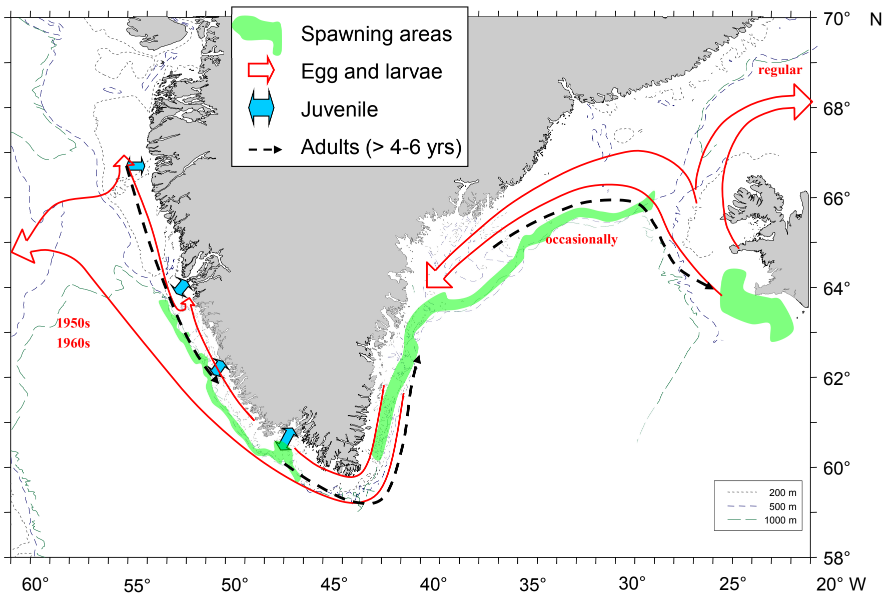

Figure 1: Spawning areas, egg and larval transport of Atlantic cod (*Gadus morhus*) in Greenlandic and Icelandic waters.

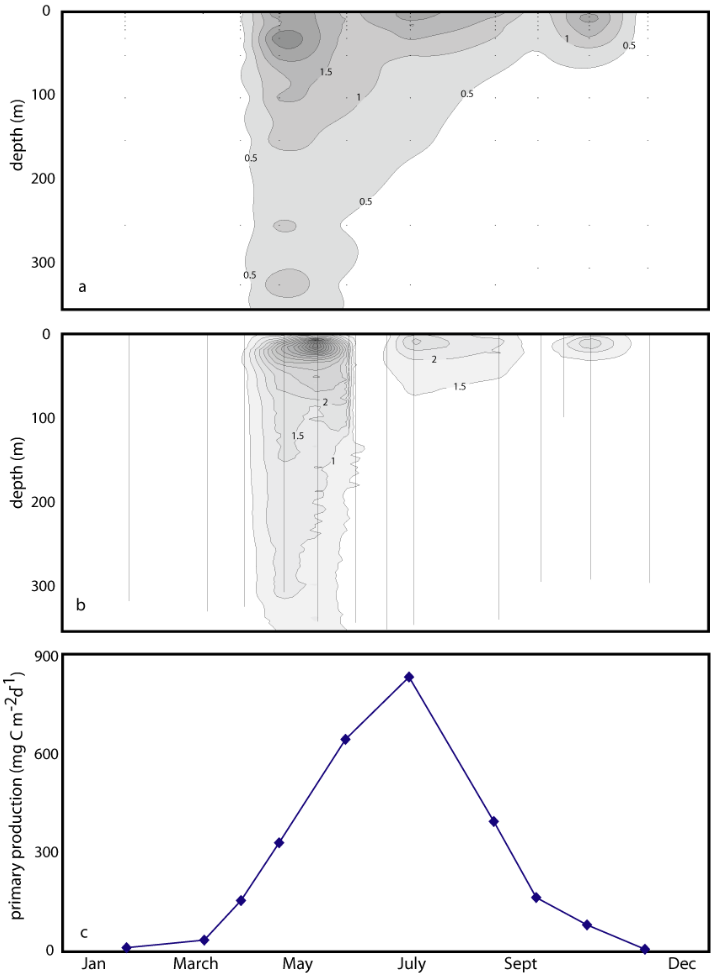

Figure 2. Annual variation in algal biomass and productivity at the inlet of Nuuk Fjord. a: chlorophyll (μg l^{-1}), b: fluorescence, c: primary production (mg C m^{-2} d^{-1}). Dots represent sampling points. From Mikkelsen et al. (2008).

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. 3). 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.

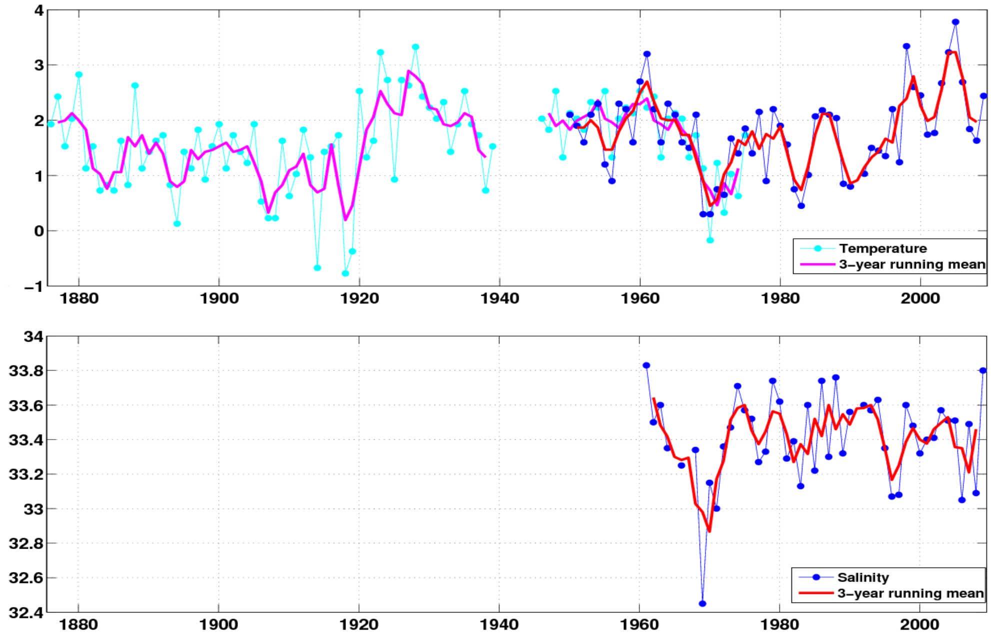

Figure 3. Timeseries of mean temperature (top) and mean salinity (bottom) on top of Fylla Bank (located outside Nuuk Fjord) (0–40 m) in the middle of June for the period 1950–2009. The red curve is the 3 year running mean value. From Ribergaard (2010).

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 is 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 Atlantic cod, snow crab, scallops, salmon and shrimp. Fishery for Greenland 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 targeted 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, but started again in the 00ies. In 2010 the fishery was closed off West Greenland. In East Greenland the fishery has been closed north of 62°N since 2008 in order to protect cod spawning grounds. 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 round-nose 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 has been negligible, but increased in the late 00s due to incoming cod from Iceland (2003 YC). Since 2010 the cod biomass has been concentrated in the spawning grounds off East Greenland. 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 2009, total landings of cod were reported as 12600 t where 5000 t were reported from the offshore areas. The landings were the highest in 2008 with 24900 t where 12600 t were taken in the offshore areas. Although the landings are the highest in a 10-years period it is still only a fraction of the landings caught in 1990. Recruitment has been negligible since the 1984 and 1985 year class was observed. The information on spawning offshore is limited as the survey takes place well after the spawning period. However offshore spawning has been inferred of East Greenland since 2004 and in spring 2007 dense concentrations of unusual large cod were actively spawning off East Greenland. The inshore fishery was regulated in 2009 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

In 2009 a quota of 6000 t where given for the demersal *Sebastes mentella* in East Greenland.

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 is, that 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.

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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 (Fig. 14.1). It is not feasible to sample and asses stock status of the various stock components separately, and they are therefore assessed together. The Stock Annex provides more details on the stock identities including the references to primary works. Some recent/ongoing activities on spawning and migrations are included below.

14.2 Information from the fisheries

14.2.1 The emergence and collapse of the Greenland cod fisheries

The Greenland commercial cod fishery in West Greenland started in the 1920s The fishery gradually developed culminating with catch levels above 400,000 tons annually in the 1960s. Due to over fishing and deteriorating environmental conditions the stock size declined and the fishery completely collapsed in the early 1990’s (Fig 14.2). In the 2000s catches have gradually increased with maximum catches in 2007/2008. Since 2008 offshore areal closures have been implemented in order to protect the spawning stock. More details on the historical development in the fisheries are provided in the stock annex.

14.2.2 The Fishery in 2009

The catch statistics differentiates between a *coastal fleet* (smaller vessels mainly) and an international *offshore fleet*, mainly large trawlers (cf. stock annex). The coastal fleet almost exclusively takes its catch in West Greenland.

The inshore fishery by the coastal fleet was until 2009 under no restrictions other than minimum landing size of 40 cm. In 2009 a TAC of 10,000 tons was allotted to the inshore fisheries. In 2009 the catches from the coastal fleet amounted to 7,672, which is 35% below lasts years catches (Table 14.4). Relative to 2008 catches decreased in all areas except in Mid Greenland, NAFO division 1E. Largest decrease by 60% occurred in the northern divisions 1AB and by 50% in the southern division 1F. The coastal fleet catches peaks during summer where the dominant pound net fishery takes place.

In 2009 the offshore area north of the 62° parallel off East Greenland and north of 61° parallel off West Greenland was closed for directed cod fisheries and the 2009 offshore catches was therefore found exclusively off south Greenland (65% in NAFO 1F; 35% in ICES XIVb). Total offshore catches in 2009 amounted to 5,000 tons. EU took 50% and Norway took 80% of their quotas. Of the Greenland quotas of 5,400 tons only 2,100 tons was taken.

14.2.3 Length and age distributions in 2009

There is limited landing sample information from the 1990's where the cod fishery was very low. For that period length frequency information is generally lacking for the offshore fisheries where cod was taken as a by-catch only. For the inshore fisheries length frequency information is lacking for 1997-1998 and 2000-2001. Sampling intensities have been considerably increased in the later years, although sampling is often impeded by the logistic difficulties found in Greenland (see Stock Anex).

Catch-at-age and weight-at-age is not used in assessment and is not provided in this report. The time series presented in NWWG report 2008 need to be recompiled as the data until 2005 only covers the catches from the coastal fleet.

Length frequencies sample information from the fisheries

AREA	SAMPLE NUMBER	NUMBER MEASURED
Inshore area	48	10,000
Offshore West Longliner	29	5,500
Offshore East Longliner	1	1,100
Offshore West Trawler	11	1,700
Offshore East Trawler	2+7*	300 + 3138*

*From German observer on a German vessel.

The pound net are operated on shallow depth (0-20m) with catches dominated of small cod ~ 40-55 cm. The 2004 YC and 2005 YC dominates in the coastal fishery (Fig. 14.3 and 14.4). The length of cod in the offshore trawl fisheries were similar (Fig 14.6) and dominated by the same year classes 2004 and 2005 (Fig. 14.5). The catch of the German trawler comprised mainly YC 2003 specimens of a mean size of 60-65 cm resembling the mean size-at-age from NAFO-1F (NWWG WD 16, 2010). The Longliners offshore caught larger cod (55-75 cm) than the trawlers (Fig. 14.6) and their catches were dominated by the 2003 YC (fig. 14.5).

14.2.4 Information on spawning

Offshore Spawning.

The recent offshore fishery has shown dense concentrations of large spawning cod off East Greenland at least since 2004. In 2007 GINR carried out an observer program onboard two Greenland trawler to document that spawning takes place off East Greenland. 14,000 cod were measured and 1000 examined for maturity/spawning. The average length was 70 cm. Cod was maturity staged according to Tomkiewicz et al, (2002). All maturity stages were recorded (non-mature 27%; maturing 23%; active spawning 36% and spent 14% spent).

In april-may 2009 an Icelandic survey in East Greenland found dense concentrations of spawning cod north of 62° at the banks between "Skjoldungen" (62°30') and "Kleine Banke" (64°30'). The major yearclass contributing to the spawning biomass was the 2003 YC (fig. 14.21). Length at 50% maturity was ap. 60 cm.

In 2007, the East Greenland offshore cod reached 50% maturity at a length of 58 cm (NWWG, WD19, 2008).

Inshore spawning

Inshore spawning has been documented since 1926 and spawning is known to have occurred in several Greenland fiords. An ongoing program attempts to map the extent of spawning. Based on the criteria that a spawning ground is documented when actively spawning females occur spawning areas has been located off Ilulissat (Disko Bay, Div. 1A), Aasiat (Northern Div. 1B) and in several of the Fjords around Nuuk (Div. 1D). Samplings in 2009, just prior to the actual spawning time, indicate that spawning most likely occur also in Fiskenæsset (southern Div. 1D). The cod reached 50% maturity at a length of 45 cm (ICES, 2008).

Tagging experiments

Tagging of cod has been resumed since 2003 in the inshore area and since 2007 in the offshore area, primarily during summer. Inshore tagged cod totaled 3795 fish. Offshore tagged off West and East Greenland totaled 1927 and 2511 respectively.

A preliminary compilation (April 2010) indicates that all inshore-tagged cod have been recorded in inshore areas with the majority taken in the same area where they were tagged (326 ind.), 3 tagged in South Greenland were however recaptured of Iceland. Offshore returns were similarly generally taken in the vicinity of the tagging area (34 ind.). However, 29 individuals tagged in South and East Greenland were caught off Iceland (table 14.5, figure 14.8). Of the 32 cod recaptured in Iceland 19 were age determined. Of the 19 individuals 10 were 2003 YC, 8 were 2002 YC and 1 was 2004 YC (table 14.6).

The interpretation of the tag-return pattern need to take into account the closure of the areas north of the 62° parallel and tags returns need to be analysed with an effort based recapture model.

14.3 Surveys

At present, the surveys - two offshore trawl surveys and an inshore gill-net surveys- provide the core information relevant for stock assessment purposes.

On the NWWG meeting in 2008 it was recommended that issues in surveys concerning 1) trawlable areas in East Greenland, 2) few stations taken due to weather conditions and 3) high leverage hauls, should be analysed further on a designated survey workshop.

Despite the outstanding difficulties described in the report of 2008 and the fact that the surveys have different focuses they also complement each other. The German survey being designed for cod research have covered the main cod grounds off both South East and West Greenland since 1982, i.e. stretching the period where cod were abundant and later very scarce. The Greenland survey target shrimp off West Greenland between 60° and 72° N latitude down to 600 m and hereby extending the coverage into the adjacent areas where large cod concentrations is not expected. Although most of the effort is allocated for shrimp the high number of hauls (ca. 260) and a recent addition of extra "cod" stations implies a fair coverage of the areas were cod exist. In 2008 the Greenland survey was extended to cover East Greenland (52 hauls in 2008 and 97 hauls in 2009).

14.3.1 Results of the German groundfish survey off West and East Greenland

Both abundance and biomass indices declined in 2009 by 62% and 54%, respectively, compared to the 2008 estimates (Table14.7). This decrease is mainly due the decay of the strong 2003-2005 year-classes.

The 2009 survey confirm previous findings of a strong 2003 year-class being the strongest year class since the 1985 year-class. The high mortality rate on this yc also compares to that of the 1984 yc. (Table 14.8 -14.10). In 2009 this yc has its highest abundance at East Greenland (Table 14.11). Year-classes since 2003 are all about or below average. Only the 2005 yc appeared above average in West Greenland as ages 1-3, but are at older ages only observed at average numbers.

Older cod (year classes 1999-2002) are almost exclusively taken in East Greenland (Table 14.11 ; Fig 14.9).

The survey time series (Fig 14.10) outline the pronounced two peaks in abundance; 1987 to 1989 caused by the 1984 and 1985 year-classes and from 2005 caused by the good 2003-2005 yc.

Mean length at age have fluctuated over the time series without any trends (Figures 14.12 and 14.13). In 2009 both for West and East Greenland, a decline was observed for the older age groups.

Due to weather conditions survey effort decreased considerably in 2009 (67 hauls vs 90 hauls in 2008), so that area coverage was less than in previous years (NWWG WD 16, 2010).

14.3.2 Results of the Greenland survey in West Greenland

Both survey biomass and abundance declined in 2009 with 85% and 70% respectively compared to 2008 in West Greenland. This decline was caused by the disappearance of two year classes, the 2003 and 2005 YC. The survey biomass was estimated at 4 Kt and survey abundance at 15 million individuals (Tables 14.12 and 14.13). Abundance per Km2 and Biomass per Km2 is shown in Figs. 14.14 and 14.15 respectively.

The stock in West Greenland was dominated by the 2007 YC that accounts for 70% of the total abundance (Table 14.14). Since the commencement of the time series in 1992 the 2003 YC was the largest observed. The size of the 2007 YC is estimated at 27% of the 2003 YC, based on comparing survey abundance as age 2. The 2009 survey confirmed that the 2006 YC is very small.

The survey has in previous years consistently found the 2003 YC concentrated in southern West Greenland. In 2009 this YC is absent. The 2007 YC show a more northerly distribution pattern compared to the 2003 YC, and is in 2009 dispersed over Div. 1BCD (Table 14.15 and Figs. 14.16 and 14.18).

14.3.3 Results of the Greenland survey in East Greenland

In 2008 the trawl survey was extended to cover the East Greenland area with 52 hauls. In 2009 the trawl survey covered the East Greenland area with twice as many hauls (97) including non-shelf area (Fig. 14.14). One small shallow water strata (0.2% of the survey area) could not be fished and had to be covered by the density found in the adjacent 200-400 m strata.

The survey stock biomass was estimated at 59 Kt and the abundance at 56 million individuals, an incline of 20% and 45% respectively compared to 2008. Cod of the year classes 2002-2005 was found abundant in the northern part of the survey area, especially concentrated in the Kleine Bank area (Q3). Considerable number of older cod are found in the northern areas (Q1-Q3) ~ the area between Kleine Bank and Dohrn Bank. In addition high numbers of 0-class cod were caught in this area as well (Table 14.15, Fig. 14.18). The length distribution by strata is shown in Fig. 14.17.

As the two Greenland surveys are carried out in succession and uses the same trawl the Greenland survey now provides an estimate of the total stock distribution. The overall pattern estimated from the Greenland surveys are that the abundance and the biomass is found in East Greenland. This covers that: a) Old and large cod are found off East Greenland in combination with recruits b) that the once large 2003 and smaller 2005 year class has disappeared in West Greenland offshore area. This pattern is reflected in the distribution of the Spawning Stock that is only found in East Greenland (Fig. 14.19).

14.3.4 West Greenland young cod survey

The inshore survey provides information on mainly pre recruit abundance in inshore areas. Gangs of nets with different mesh-sizes are used, as the inshore areas are not trawlable. The change of the nets fishing power associated with a change in the twine thickness for some mesh-sizes in 2004 is estimated as limited (Stock Anex.). The survey has been conducted since 1985.

The 2009 catches in Div. 1D was dominated by the 2005 and 2007 year classes and the 2006 YC is found very weak (Table 14.16). In south Greenland (Div. 1F) catches was dominated by the 2007 year class. Due to the breakdown of R/V Adolf Jensen no survey was carried out in Div 1B in 2009 and only 2 days were used to cover South Greenland.

Seen over its entire history, the survey demonstrates considerable differences between the three areas. For south Greenland (Div. 1F) high recruitment indices are found only for year-classes that have been estimated as strong by the offshore surveys, i.e.1984, 1985 and 2005. However, after the 1988-1995 period with practically no catches of young cod, the southern coverage was dropped in many years. For the central Nuuk area (Div. 1D) recruitment is high for the 1984-1991 year-classes but low for the 1992-2002 year-classes. The northern area (Div. 1B) is in contrast characterised by a stable high recruitment. All areas show high recruitment indices for the strong 1984 and 1985 yearclasses (fig. 14.20, Tab. 14.16).

14.3.5 State of the stock

The offshore component has been severely depleted since 1990. The surveys indicate an improvement in recruitment with all year classes since 2002 (except the 2006 YC) estimated at sizes above the very small year classes seen in the 1990s. These good YC's has lead the stock increase during the 00s, but the levels are far below historical levels. The total offshore stock has however declined in 2009 compared to 2008 (fig. 14.22). This was mainly caused by a decrease in the abundance of the 2003 and 2005 YC in West Greenland.

The spawning in East Greenland that was first observed in 2007 by an exploratory fishery was confirmed by an Icelandic survey in 2009. Nearly only ages 6 and 7 comprised this spawning stock (2002-2003 yc's). This could imply a spawning migration of the strong 2003 YC from its previous main distribution in West Greenland to the spawning location in East Greenland. Tag-returns data supports such an eastward migration.

In the West Greenland inshore areas (NAFO Div. 1DE) two strong year classes are recognized, the 2005 and 2007 YC. In the southern inshore areas only the YC 2007 is recognized at a relatively weak level. Thus the 2005 YC is mainly observed in inshore areas of NAFO Divs 1D and 1E.

14.4 Implemented management measures for 2010

The offshore quota for the total international fishery is sat at 5,000 tons for 2010. The quota for 2009 was 10,000 tons. An area closure of the offshore area north of the 62° latitude off East Greenland and the offshore area in West Greenland west of the 44° longitude has been closed for all directed cod fisheries in 2009.

For the coastal fisheries a TAC, sat at 5,000 tons, has been introduced for the coastal fleets for 2010. The TAC for 2009 was 10,000 tons. Until 2009 the coastal fleets have had a free access fishery.

14.5 Management considerations.

No sustainable offshore cod fishery at Greenland can be based on the infrequent inflow of cod from Iceland waters. Presently no management objectives have been set for this stock. A main management objective should therefore be to establish a robust offshore spawning stock comprised of several yearclasses that may improve the likelihood of future good recruitment. Such an objective could be a basis for a biomass reference point and thus determine reopening of the fishery in the future. In addition spatial criteria on distribution of spawning grounds could be included in the definition of such a reference point/basis, e.g. requirements of established spawning stocks at both East and West Greenland.

All management effort should therefore be given to secure the rebuilding of the indigenous Greenland offshore cod stock. This implies that no offshore fishery should take place in 2011.

The inshore stocks have until 2009 not been subjected to catch constraints and is expected to yield far less that their maximum sustainable yield. The catch is predominantly taken at shallow water (pound net) and is dominated by 0.6-1 kg cod impeding a full utilisation of the cods growth potential. An increase in the minimum landing size (presently at 40 cm) and low catch ceilings is expected to increase stock size and landings in the medium term.

Table 14.1 Nominal catch (t) of Cod in NAFO Sub-area 1, 1988-2008 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	2008	2009
Faroe Islands				
Germany				
Greenland				
Japan				
Norway				
UK				
Togo				
Total				
WG estimate	7769	13313	21921	10956

[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, 1988-2008 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	2008	2009
Faroe Islands		305		
Germany	775	772		5
Greenland				
Iceland				
Norway	479	613		8
Portugal				
UK (E/W/NI)				544
United Kingdom		180		
Total				
EG estimate	1981	3221	2997	1720

Table 14.3. Cod off Greenland (inshore and offshore components). Catches (t) from 1924 – 2009 as used by the Working Group, inshore and offshore by NAFO division 1B and 1D, offshore divided into East and West Greenland. Until 1995, based on Horsted (1994, 2000). * indicates preliminary results.

Cod		Offshore			Total
Year	Total inshore	East	West	Total offshore	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 *continued*. Cod off Greenland (inshore and offshore components). Catches (t) from 1924 – 2007 as used by the Working Group, inshore and offshore by NAFO division 1B and 1D, offshore divided into East and West Greenland. Until 1995, based on Horsted (1994, 2000). * indicates preliminary results.

Cod		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	5508
2004	4948*	369	27	396*	5344
2005	6043	773	75	847*	6890*
2006	7388*	1981	408	2389	9777*
2007	11693	3221	1620	4841	16533
2008	12270	2997	9651	12648	24918
2009	7672	1720	3286	5006	12678

Table 14.4. Cod catches (t) divided to NAFO –divisions, caught by the coastal fleets (Horsted 2000, Statistic Greenland 2007, Greenland Fisheries License Control). [1]Including 1258t tran-shipped from local inshore fishers to foreign vessels.[2] Including landings fished in unknown waters.

	NAFO Division						
Year	1A	1B	1C	1D	1E	1F	Total
1984	175	3,908	1,889	5,414	1,149	1,333	19,958
1985	149	2,936	957	1,976	1,178	1,245	8,441
1986	76	1,038	255	1,209	1,456	1,268	5,302
1987	97	2,995	536	8,110	4,560	1,678	18,486
1988	333	6,294	1,342	2,992	3,346	4,484	18,791
1989	634	8,491	5,671	8,212	10,845	4,676	38,529
1990	476	9,857	1,482	9,826	1,917	5,241	28799
1991	876	8,641	917	2,782	1,089	4,007	18,311
1992	695	2,710	563	1,070	239	450	5,723
1993	333	323	173	968	18	109	1,924
1994	209	332	589	914	11	62	2,115
1995	53	521	710	332	4	81	1,710
1996	41	211	471	164	11	46	948
1997	18	446	198	99	13	130	1,186
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	1,183	245	54	0	81	1,680
2002	263	1,803	505	214	24	813	3,622
2003	1,109	1,522	334	274	3	479	5,215 [1]
2004	535	1,316	242	116	47	84	4,948 [1]
2005	650	2,351	1,137	1,162	278	382	6,043 [1]
2006	922	1,682	577	943	630	1,461	7,388 [1]
2007	417	2,547	1,197	1,843	660	4,988	11,693 [2]
2008	870	3,067	1,538	3,171	224	3,395	12,270 [2]
2009	325	1288	1189	2009	1142	1717	7672

Table 14.5. Tag and recoveries from cod tagging in 2003-2010.

Tagging area	Tagged	Recaptured innshore	Recaptured offshore	Recaptured Iceland
Innshore West	3795	326	0	3
Offshore West	1927	1	26	10
Offshore East	2511	1	8	19

Table 14.6. Age information from cod tag-recovered in Iceland. Yellow indicate 2003 YC.

Year/age	5	6	7	8
2008	2	3		
2009	1	5	4	
2010			3	1

Table 14.7 German survey. Cod off Greenland. Abundance (1000) and biomass indices (t) for West, East Greenland and total by stratum, 1982-2008. 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, 1982-2008, and historical maturity data from Horsted et al, 1984.

	Abundance					Biomass				
Year	West	East	Total	CI	SSN	West	East	Total	CI	SSB
1982	100553	12214	112767	40	16661	145419	32552	177971	35	47868
1983	55453	9819	65272	34	14392	93296	40103	133399	29	48114
1984	18540	7822	26362	41	6255	28496	23610	52106	38	21463
1985	58531	12014	70545	35	9191	38012	32464	70476	47	29168
1986	130176	22838	153014	33	9499	77830	38246	116076	28	40878
1987	778042	43992	822034	47	23131	633071	55087	688158	48	55727
1988	652220	25133	677353	51	30004	646733	56815	703548	49	48997
1989	422763	101758	524521	52	60244	404602	259793	664395	44	127083
1990	41358	33473	74831	38	20654	42167	83753	125920	29	35871
1991	5874	11592	17466	26	8100	6809	35970	42779	29	19400
1992	2298	937	3235	42	123	723	1425	2148	51	685
1993	1798	4112	5910	38	103	440	6385	6825	42	2560
1994	578	1103	1681	27	191	137	3674	3811	62	1009
1995	339	7600	7939	75	29	85	17375	17460	92	6761
1996	851	1578	2429	34	155	388	3860	4248	45	1237
1997	301	5559	5860	57	114	275	16073	16348	67	3485
1998	1799	1722	3521	39	76	141	4450	4591	69	1674
1999	1014	3201	4215	43	121	290	4728	5018	55	1747
2000	2133	5255	7388	60	62	638	5154	5792	41	2208
2001	7990	8608	16598	48	356	2602	16328	18930	38	3879
2002	4724	10952	15676	50	150	2446	22318	24764	59	8049
2003	6539	20111	26650	44	3052	2576	51701	54277	71	9279
2004	32572	19607	52179	54	3932	6588	36276	42864	32	12311
2005	67543	91915	159458	34	7163	27191	124417	151608	33	36932
2006	248920	153196	402116	99	8773	162125	145796	307921	67	34020
2007	173095	38803	211898	90	12037	173178	89971	263149	72	37369
2008	46714	142034	188748	92	37561	41113	427304	468417	122	181490
2009	10605	61422	72030	44	25497	4010	213744	217754	46	118027

Table 14.8 ***German survey***, **West Greenland. Age disaggregate abundance indices), 1982-2008, ('1000).**

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	205	6	42	2359	1702	10736	986	2178	106	185	30	.	18535
1985	828	37494	1401	895	6243	2793	7673	426	737	18	25	.	58533
1986	.	9151	102390	4823	837	6767	1932	3726	108	386	22	.	130142
1987	.	296	55472	670795	29299	6249	10404	1517	3619	.	337	28	778016
1988	.	266	3225	103181	535793	5785	698	1184	699	1315	32	.	652178
1989	-24	339	2718	8921	201787	205439	3172	.	228	37	141	.	422758
1990	137	62	1227	3339	1589	26427	8494	50	0	0	.	.	41325
1991	.	252	237	493	1319	175	2845	504	8	.	.	.	5833
1992	.	196	1644	264	52	87	.	54	.	.	.	.	2297
1993	.	15	1061	651	26	44	.	.	.	.	.	.	1797
1994	.	290	46	196	36	5	.	5	.	.	.	.	578
1995	.	.	274	14	51	.	.	.	.	.	.	.	339
1996	.	154	12	665	9	.	10	.	.	.	.	.	850
1997	.	11	25	13	250	.	.	.	.	.	.	.	299
1998	49	1712	.	6	6	25	.	.	.	.	.	.	1798
1999	29	405	460	107	7	.	6	.	.	.	.	.	1014
2000	.	182	1108	696	140	.	.	.	.	.	.	.	2126
2001	.	663	5992	1118	140	41	.	.	.	.	.	.	7954
2002	12	13	1166	3441	82	.	.	.	.	.	.	.	4714
2003	96	3768	430	1263	849	102	28	.	.	.	.	.	6536
2004	823	24172	5290	814	641	636	171	11	.	.	.	.	32558
2005	236	1108	57596	6760	464	628	509	41	27	.	.	.	67369
2006	477	4587	18549	206716	13749	656	2483	1325	116	.	.	.	248658
2007	370	564	22211	12739	127222	9210	542	167	70	.	.	.	173095
2008	53	2806	4796	15385	4792	18232	533	22	87	0	0	0	46706
2009	127	1192	6441	927	1342	244	306	28	.	.	.		10607

***) calculated proportionally using age compositions reported by the ICES Working Group on Cod Stocks off East Greenland (ICES, 1984).**

Table 14.9 ***German survey,*** **East Greenland. Age disaggregate abundance indices 1982-2008, (1000),. *). () incomplete sampling. In 2007, stratum 5.1 was not completely sampled.**

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)	.	29	136	1786	701	1468	931	1887	498	219	26	.	7681
1985	209	1864	543	120	2492	1959	1772	738	1907	275	54	82	12015
1986	.	5119	7987	2184	574	2131	1006	1834	467	1275	87	100	22764
1987	.	8	13367	19261	4635	1186	1909	458	1641	200	1111	113	43889
1988	12	27	196	7378	11417	2385	551	1705	166	693	95	477	25102
1989	.	9	252	776	20785	68832	3188	334	5026	419	1647	446	101714
1990	.	41	113	798	702	6589	24034	347	44	253	.	379	33300
1991	.	132	462	446	767	170	3952	5482	98	44	12	.	11565
(1992)	.	.	73	111	80	54	106	64	79	.	.	.	567
1993	.	18	53	2487	455	306	306	98	279	100	.	.	4102
(1994)	.	153	.	37	377	182	103	177	.	36	.	.	1065
1995	.	7	2514	1133	398	1922	508	163	525	42	248	.	7460
1996	.	.	.	574	273	310	275	67	82	.	.	.	1581
1997	.	.	60	84	2577	1793	602	248	149	.	.	.	5513
1998	93	246	192	22	46	467	449	156	42	.	.	.	1713
1999	259	631	773	490	146	372	230	223	.	45	30	.	3199
2000	.	889	1174	1458	871	170	311	77	148	128	33	.	5259
2001	.	402	1205	1723	2473	1449	742	213	195	73	39	.	8514
2002	106	9	466	2052	2296	2367	2206	1001	265	93	40	.	10901
2003	1426	426	149	989	4361	4354	4652	2452	1086	185	.	.	20080
2004	361	4606	2256	797	1140	4416	2836	2145	822	141	52	.	19572
2005	155	3677	53513	14918	2855	6866	6544	2300	607	111	.	.	91546
(2006)	.	372	4863	124917	14430	2882	3242	1964	307	91	24	.	153092
(2007)	182	300	913	1344	23104	9193	1147	1278	1211	122	.	.	38794
2008	38	355	296	2853	9104	94922	24954	3989	2039	2050	929		141529
2009	199	144	1074	920	4311	9169	37837	6638	364	465	227		61348

***) calculated proportionally using age compositions reported by the ICES Working Group on Cod Stocks off East Greenland (ICES, 1984).**

Table 14.10 *German survey*. Greenland (total). Age disaggregate abundance indices (1000), 1982-2005. () incomplete sampling. Minor differences between previous tables due to rounding.

YEAR	Age0	Age1	Age2	Age3	Age4	Age5	Age6	Age7	Age8	Age9	Age10	Age11+	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	114	58198
-1984		35	178	4145	2403	12204	1917	4065	604	404	56	0	26216
1985	1037	39358	1944	1015	8735	4752	9445	1164	2644	293	79	0	70548
1986		14270	110377	7007	1411	8898	2938	5560	575	1661	109	0	152906
1987		304	68839	690056	33934	7435	12313	1975	5260	0	1448	141	821905
1988		293	3421	110559	547210	8170	1249	2889	865	2008	127	0	677280
1989		348	2970	9697	222572	274271	6360	0	5254	456	1788	0	524472
1990		103	1340	4137	2291	33016	32528	397	44	253	0	0	74625
1991		384	699	939	2086	345	6797	5986	106	0	0	0	17398
-1992			1717	375	132	141	0	118	0	0	0	0	2864
1993		33	1114	3138	481	350	0	0	0	0	0	0	5899
-1994		443		233	413	187	0	182	0	0	0	0	1643
1995			2788	1147	449	0	0	0	0	0	0	0	7799
1996				1239	282	0	285	0	0	0	0	0	2431
1997			85	97	2827	0	0	0	0	0	0	0	5812
1998	142	1958		28	52	492	0	0	0	0	0	0	3511
1999	288	1036	1233	597	153	0	236	0	0	0	0	0	4213
2000		1071	2282	2154	1011	0	0	0	0	0	0	0	7385
2001		1065	7197	2841	2613	1490	0	0	0	0	0	0	16468
2002	118	22	1632	5493	2378	0	0	0	0	0	0	0	15615
2003	1522	4194	579	2252	5210	4456	4680	0	0	0	0	0	26616
2004	1184	28778	7546	1611	1781	5052	3007	2156	0	0	0	0	52130
2005	391	4785	111109	21678	3319	7494	7053	2341	634	0	0	0	158915
-2006		4959	23412	331633	28179	3538	5725	3289	423	0	0	0	401750
-2007	552	864	23124	14083	150326	18403	1689	1445	1281	0	0	0	211889
2008	91	3161	5092	18238	13896	113154	25487	4011	2126	2050	929	0	188235
2009	326	1336	7515	1847	5653	9413	38143	6666	364	465	227	0	71955

***) calculated proportionally using age compositions reported by the ICES Working Group on Cod Stocks off East Greenland (ICES, 1984).**

Table 14.11 . ***German survey.*** **Age-disaggregated abundance estimates by stratum 2009 ('000). Stratas shown in fig. 14.7.**

Year	Stratum	Age0	Age1	Age2	Age3	Age4	Age5	Age6	Age7	Age8	Age9	Age10		
2009	1.1	0	0	126	17	0	0	0	0	.	.	.	.	.
2009	2.1	37	389	1815	272	218	6	3	0	.	.	.	.	.
2009	2.2	0	86	1173	151	198	44	48	0	.	.	.	.	.
2009	3.1	29	159	1518	172	201	10	18	28	.	.	.	.	.
2009	3.2	6	19	389	116	194	14	13	0	.	.	.	.	.
2009	4.1	40	536	1275	162	306	102	151	0	.	.	.	.	.
2009	4.2	15	3	145	37	225	68	73	0	.	.	.	.	.
2009	5.1	0	78	931	478	568	546	557	54	3	0	0	.	.
2009	5.2	0	14	57	81	380	241	384	33	2	0	0	.	.
2009	6.1	0	0	0	121	1285	3604	15908	2254	86	185	39	.	.
2009	6.2	128	28	31	147	1469	3405	14073	2165	98	122	135	.	.
2009	7.2	71	24	55	93	609	1373	6915	2132	175	158	53	.	.

Table 14.12 Cod abundance indices ('000) from the West Greenland Shrimp and Fish survey by year and NAFO divisions. The survey gear was changed in 2005. The new gear is estimated as ca. 50% more efficient than the old gear.

Year	0A	1A	1B	1C	1D	1E	1F	Total	CV
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
2008	1209	886	4129	4107	9521	11905	21651	53408	23
2009	891	869	4174	3218	2832	1400	1735	15119	11

Table 14.13. Cod biomass indices (tons) from the West Greenland Shrimp and Fish survey by year and NAFO divisions. The survey gear was changed in 2005. The new gear is estimated as ca. 50% more efficient compared to the old gear.

	0A	1A	1B	1C	1D	1E	1F	Total	CV
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
2008	421	372	2012	923	1730	3321	19702	28481	37
2009	212	226	1245	688	453	282	499	3604	13

Table 14.14 : Abundance indices ('000) by age from the West Greenland Shrimp and Fish survey. The survey gear was changed in 2005. The new gear is estimated as ca. 50% more efficient compared to the old gear.

Year/age	0	1	2	3	4	5	6	7	8+
1992		0	221	126	123	63	10	3	1
1993		0	39	170	73	16	7	1	2
1994		0	10	126	22	8	1	0	0
1995		19	345	101	157	40	0	0	0
1996		0	14	203	78	3	0	0	0
1997		0	0	10	3	24	8	1	0
1998		0	17	25	20	0	0	0	0
1999		7	144	66	23	6	1	1	1
2000		90	711	363	92	13	52	0	0
2001		97	540	546	376	0	0	0	0
2002		0	603	2323	1078	245	0	4	0
2003		81	1416	1037	433	135	18	0	0
2004		1215	2812	1205	786	382	71	33	4
New Survey gear Introduced									
2005	3284	1348	38177	44685	10490	5595	4596	113	30
2006	244	6804	5826	42612	9722	1956	532	72	0
2007	224	295	12835	6348	29856	2708	166	69	16
2008	35	3516	2880	20921	8337	16047	1530	150	0
2009	0	308	10203	2295	1928	365	16	5	0

Table 14.15: Greenland Survey. The 2009 abundance indices ('000) by year class/age . The areas are shown in fig. 14.14.

Year-class	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000	<2000
Age	0	1	2	3	4	5	6	7	8	9	10+
Div. 0A	0	0	677	94	120	0	0	0	0	0	0
Div. 1A	0	0	649	137	56	28	0	0	0	0	0
Div. 1B	0	50	2779	692	418	229	6	0	0	0	0
Div. 1C	0	0	2467	197	511	44	0	0	0	0	0
Div. 1D	0	76	2107	216	414	18	0	0	0	0	0
Div. 1E	0	0	816	379	190	14	0	0	0	0	0
Div. 1F	0	183	707	580	220	32	10	5	0	0	0
ICES Q6	0	432	913	1501	991	615	304	0	0	0	0
ICES Q5	0	160	157	137	16	70	4	0	0	0	0
ICES Q4	201	545	583	327	262	338	589	440	38	149	74
ICES Q3	4417	6211	4500	1567	4338	3962	3490	1344	41	94	109
ICES Q2	151	96	6	20	54	83	915	344	96	131	94
ICES Q1	10244	848	197	255	353	695	1251	460	52	154	96

Table 14.16 : NAFO Div. 1B. Cod abundance indices (numbers of cod caught per 100 hours net settings) by age in the West Greenland inshore gill-net survey. na= data not available. The strong (and only) year classes of any importance offshore are indicated with yellow.

Year/Age	1	2	3	4	5	6	7	8+	All
1985	26	23	0	6	0	0	0	0	54
1986	4	245	16	8	2	2	0	0	278
1987	0	122	233	25	1	0	0	0	381
1988	0	33	130	111	2	0	0	0	276
1989	1	110	83	57	32	1	0	0	283
1990	0	109	108	62	53	12	0	0	344
1991	0	3	131	53	11	3	0	0	202
1992	0	43	10	18	3	0	0	0	74
1993	0	22	22	2	1	0	0	0	47
1994	4	8	19	12	0	0	0	0	43
1995	2	115	19	7	1	0	0	0	143
1996	0	28	40	7	1	0	0	0	77
1997	0	14	8	3	1	0	0	0	26
1998	2	7	4	6	3	0	0	0	23
1999	na	na	na	na	na	na	na	na	na
2000	na	na	na	na	na	na	na	na	na
2001	na	na	na	na	na	na	na	na	na
2002	31	207	72	21	9	1	0	0	340
2003	1	68	69	21	3	0	0	0	163
2004	32	28	29	9	5	0		0	102
2005	47	123	35	7	5	1	3	0	221
2006	32	148	60	24	1	1	0	0	170
2007	7	170	82	15	1	0	0	0	275
2008	na	na	na	na	na	na	na	na	na
2009	na	na	na	na	na	na	na	na	na

Table 14.16, *continued* : NAFO Div. 1D. Cod abundance indices (numbers of cod caught per 100 hours net settings) by age in the West Greenland inshore gill-net survey. The strong (and only) year classes of any importance offshore are indicated with yellow.

Year/Age	1	2	3	4	5	6	7	8+	All
1985	68	77	0	3	3	3	0	1	155
1986	0	96	15	0	0	1	2	0	114
1987	1	16	68	5	0	0	0	0	90
1988	0	20	48	30	1	0	0	0	99
1989	0	78	47	13	13	0	0	0	152
1990	0	14	35	4	4	3	0	0	60
1991	124	3	17	6	2	1	0	0	154
1992	0	61	22	10	7	1	0	0	100
1993	0	4	57	20	2	0	0	0	83
1994	0	0	6	5	1	0	0	0	12
1995	0	3	2	4	4	0	0	0	12
1996	0	1	1	0	2	0	0	0	4
1997	3	3	1	0	0	1	0	0	8
1998	0	10	17	1	0	0	0	0	28
1999	0	0	1	3	0	0	0	0	5
2000	0	2	2	1	1	0	0	0	6
2001	na	na	na	na	na	na	na	na	na
2002	0	7	4	3	0	0	0	0	14
2003	0	6	4	2	1	0	0	0	13
2004	3	43	6	3	1	1	0	0	57
2005	9	27	7	2	0	0	0	0	45
2006	2	114	37	13	4	0	0	0	170
2007	na	na	na	na	na	na	na	na	na
2008	4	4	47	63	7	0	0	0	124
2009	4	52	14	72	23	1	0	0	166

Table 14.16, *continued*: NAFO Div. 1F. Cod abundance indices (numbers of cod caught per 100 hours net settings) by age in the West Greenland inshore gill-net survey. The strong (and only) year classes of any importance offshore are indicated with yellow.

Year/Age	1	2	3	4	5	6	7	8+	All
1985	204	8	1	1	1	1	1	0	217
1986	17	112	5	0	2	0	0	0	136
1987	0	143	147	1	0	0	0	0	291
1988	0	1	83	6	0	0	0	0	89
1989	0	5	2	19	2	0	0	0	29
1990	0	0	3	2	13	1	0	0	18
1991	2	2	0	2	0	1	0	0	7
1992	0	3	1	0	1	0	1	0	6
1993	0	5	2	1	0	0	0	0	8
1994	0	0	1	1	0	0	0	0	3
1995	0	0	0	0	0	0	0	0	0
1996	na	na	na	na	na	na	na	na	na
1997	na	na	na	na	na	na	na	na	na
1998	0	4	12	0	0	0	0	0	17
1999	na	na	na	na	na	na	na	na	na
2000	0	14	8	0	2	0	1	0	24
2001	na	na	na	na	na	na	na	na	na
2002	na	na	na	na	na	na	na	na	na
2003	na	na	na	na	na	na	na	na	na
2004	na	na	na	na	na	na	na	na	na
2005	na	na	na	na	na	na	na	na	na
2006	na	na	na	na	na	na	na	na	na
2007	6	90	9	21	1	0	0	0	108
2008	8	17	30	4	2	0	0	0	62
2009	3	39	14	15	0	0	0	0	71

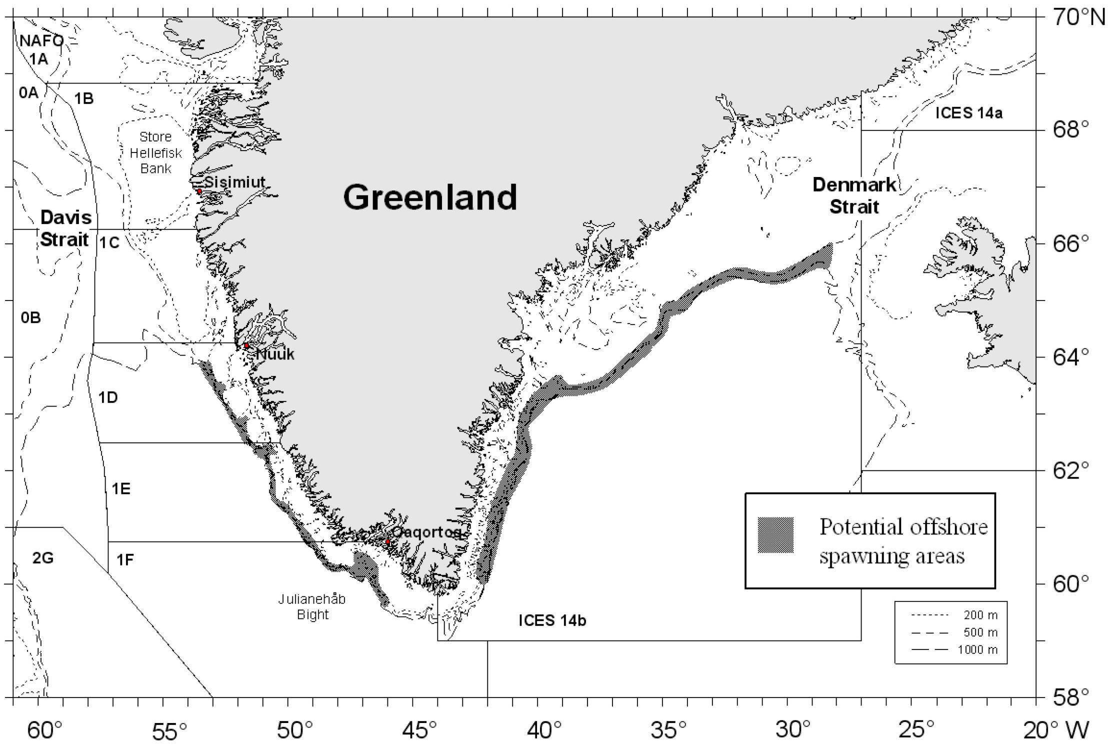

Figure. 14.1 Historical offshore spawning areas of cod in Greenland.

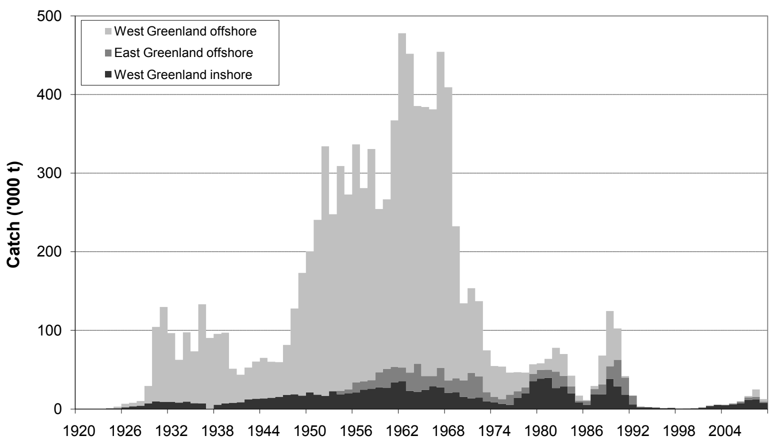

Figure 14.2. Cod off Greenland. Catches 1920-2009 as used by the Working Group, inshore and offshore by West and offshore by East Greenland (Horsted 1994,2000). Columns are stacked.

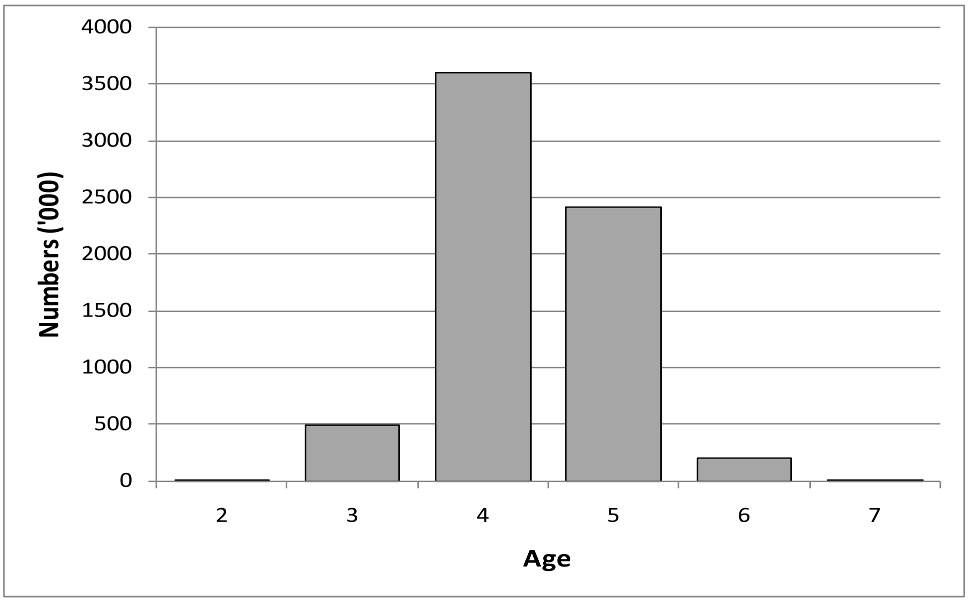

Figure:14.3 Estimated catch in numbers by age from the Coastal vessels, 2009.

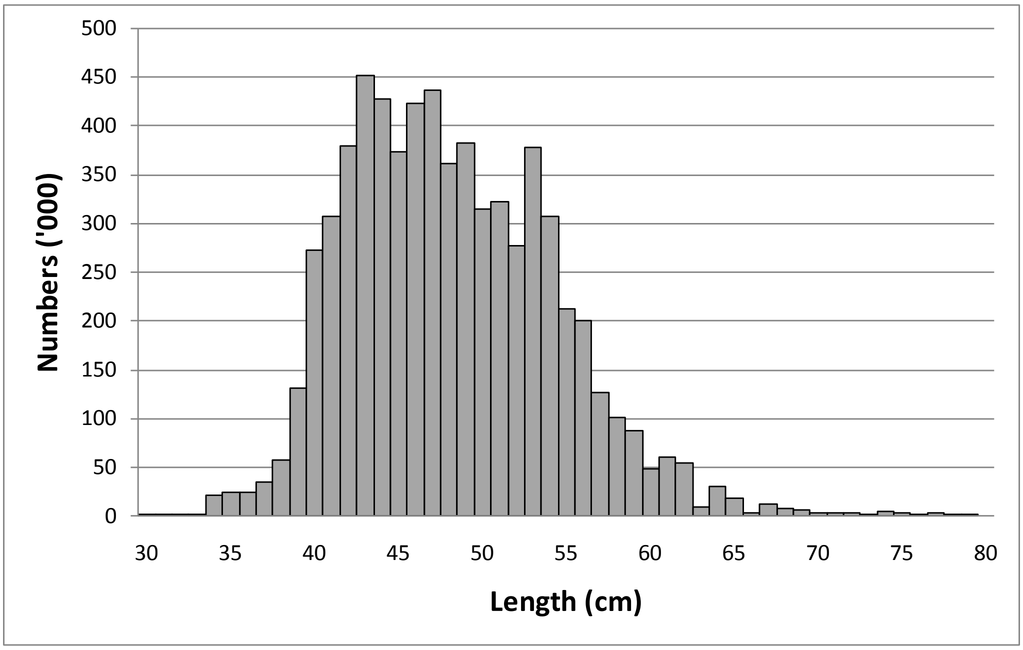

Figure 14.4 Estimated LFQ from the Coastal vessels, 2009.

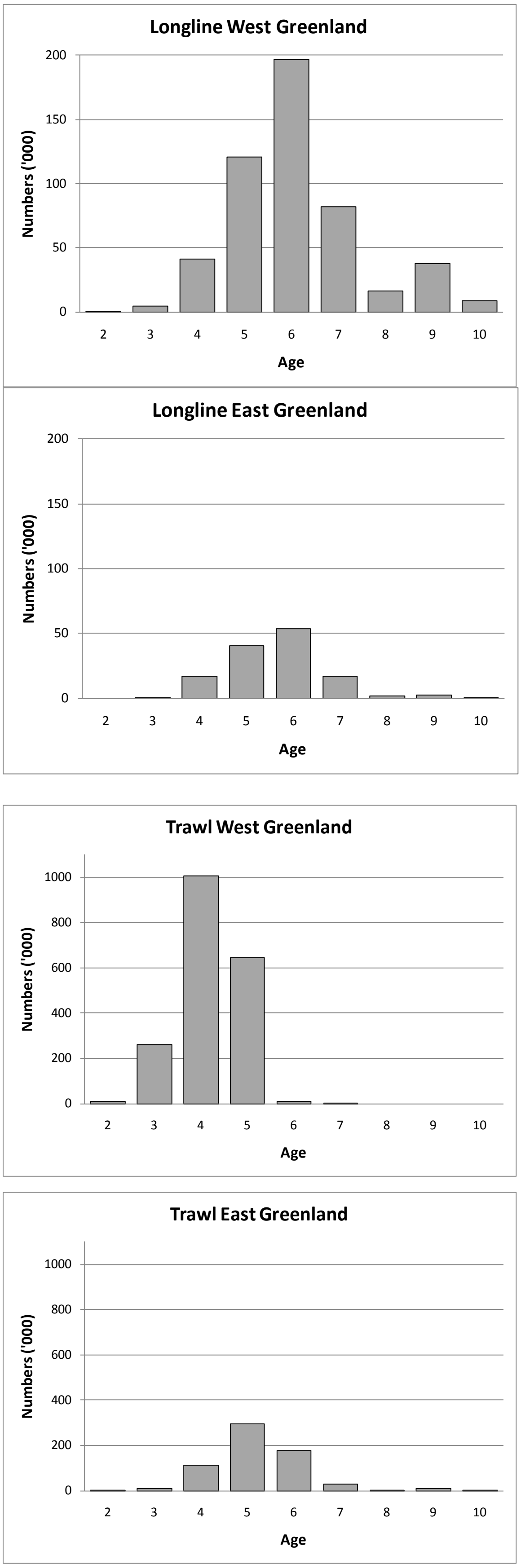

Figure14.5 : Estimated catch in numbers and age from the offshore vessels, 2009.

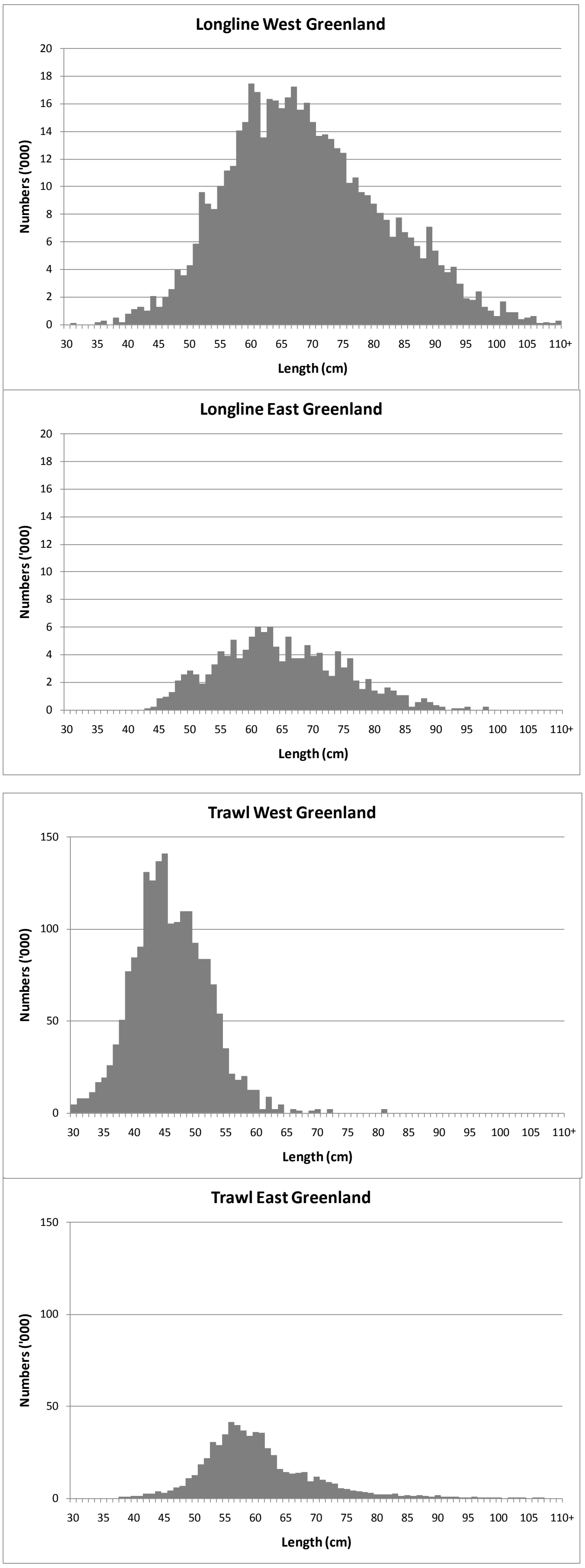

Figure 14.6 Estimated LFQ distribution from the offshore vessels, 2009.

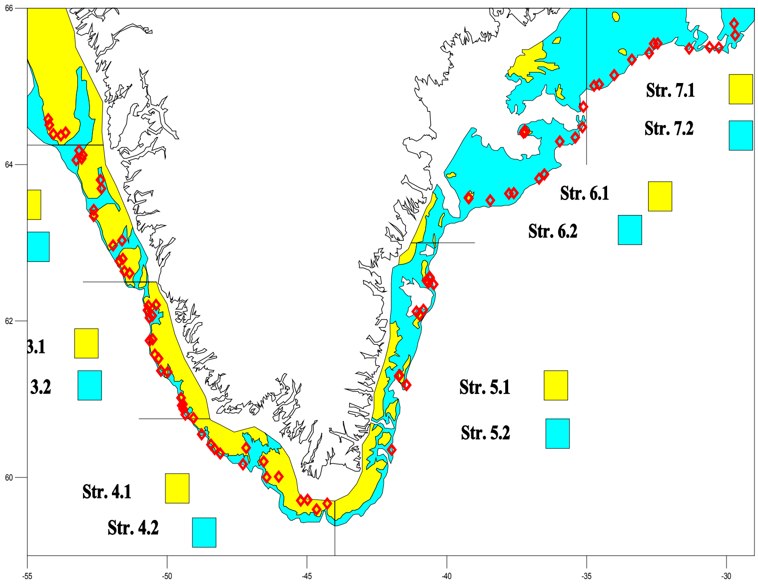

Figure 14.7 German survey, 2009. Strata and haul positions. At East Greenland hauls generally restricted to the shelf area.

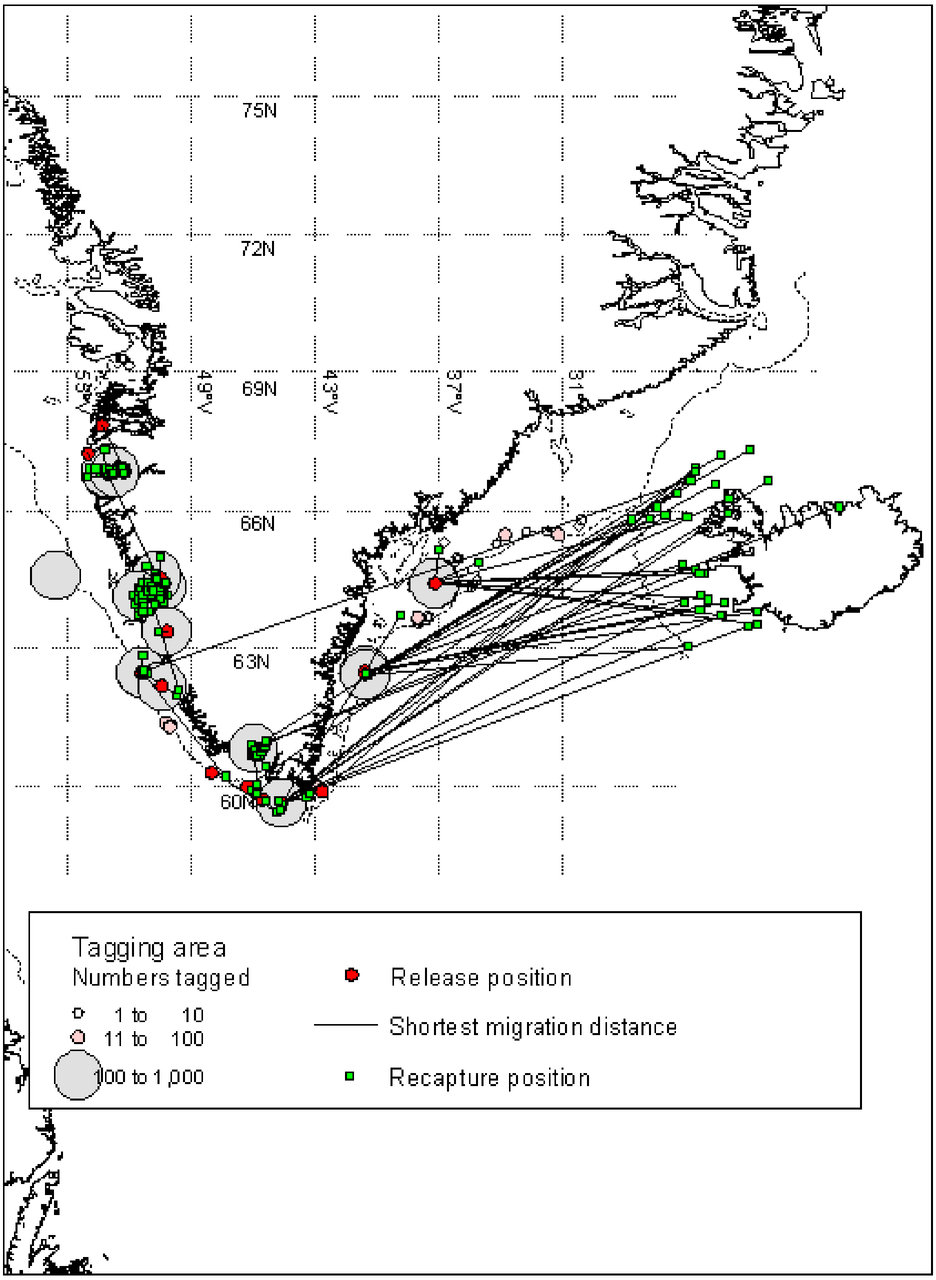

Figure 14.8: Tag-recapture areas.

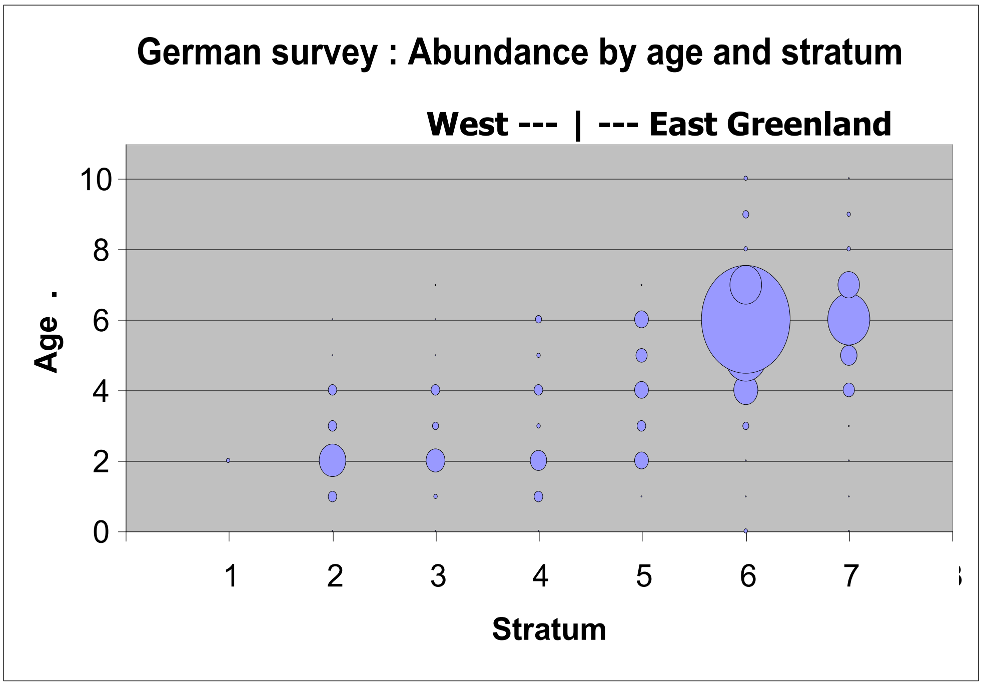

Figure 14.9 German survey, Abundance per age group and strata. Strata 1 –4 is West Greenland from north to south; strata 5-7 is East Greenland from south to north.

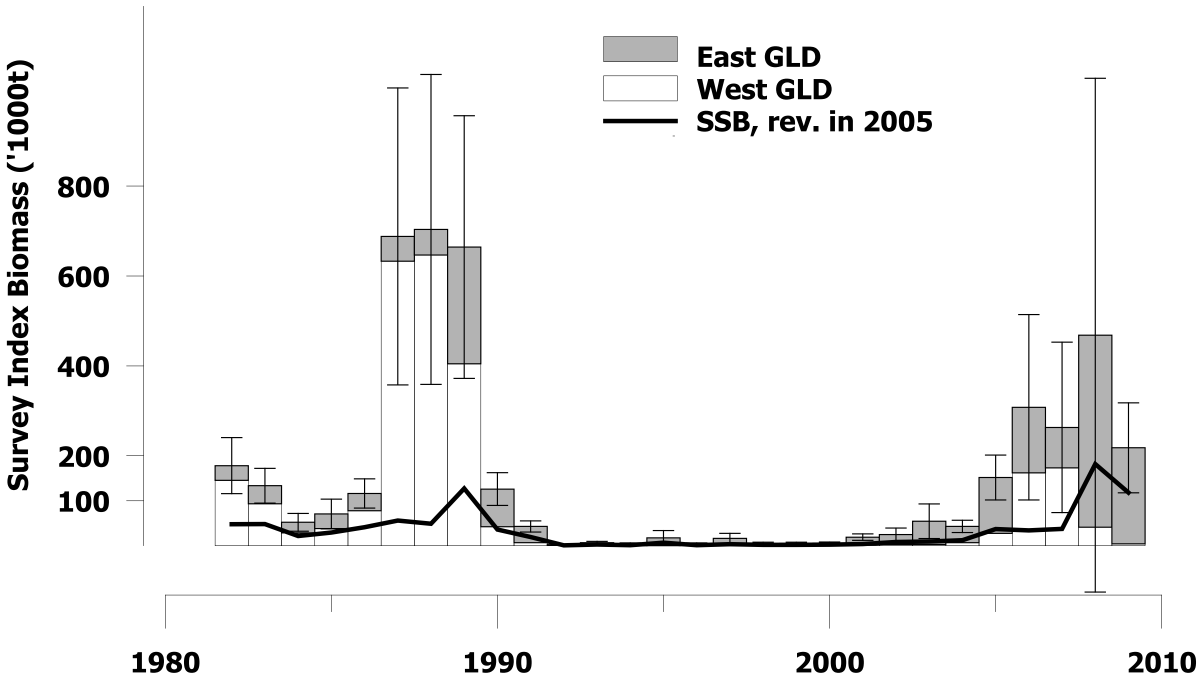

Figure 14.10 German survey, Cod off Greenland. Aggregated survey biomass indices for West and East Greenland and revised spawning stock biomass, 1982-2008. Error bars indicate 95% confidence intervals on the total biomass. Incomplete survey coverage in 1984, 1992, 1994, 2006 and 2007.

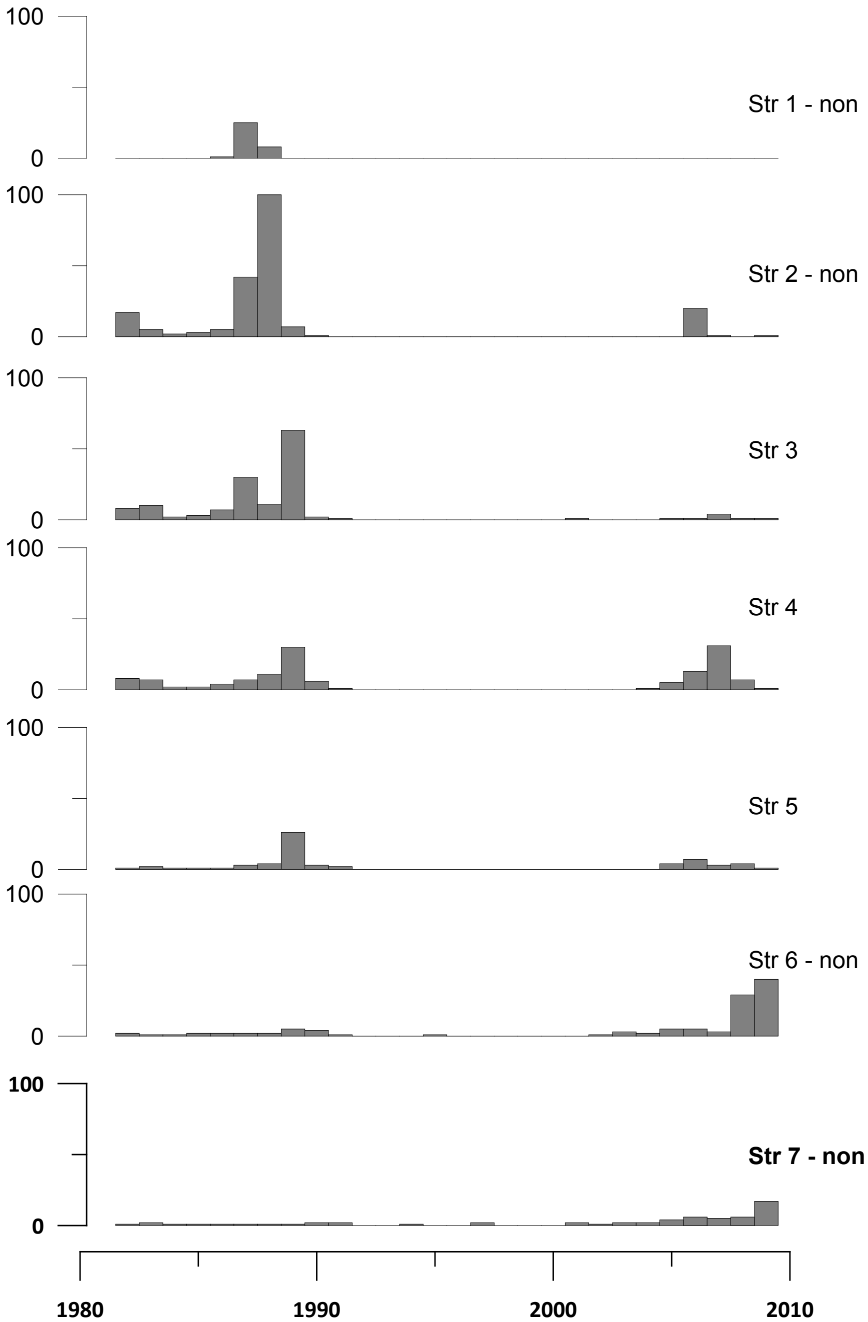

Figure 14.11 German survey. Mean CPUEs in weight by stratum, depth strata 0-200 and 200-400 combined. CPUEs standardized to maximum=100 in stratum 2, 1988. The value in stratum 6 in 2008 driven by one exceptional large haul. 'NON'- no commercial fisheries in 2009

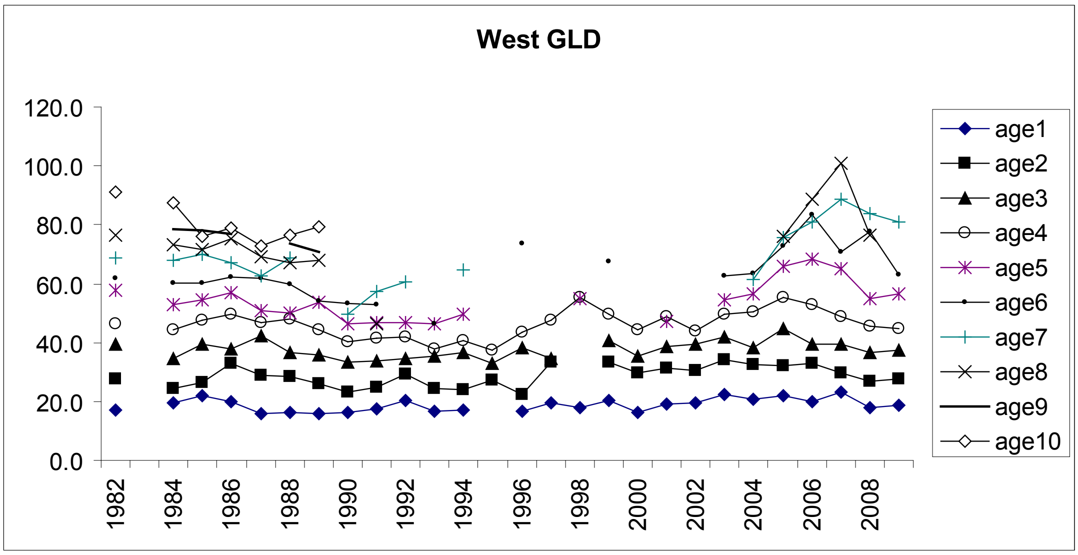

Figure 14:12 Mean length at age 1-10 years 1982, 1984-2009 sampled in West Greenland. Data derived from German survey.

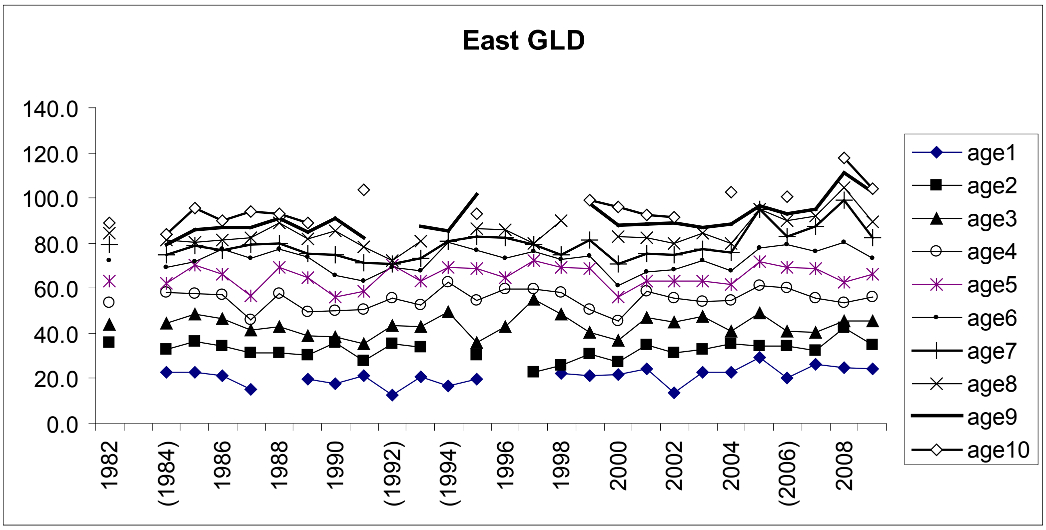

Figure 14 :13 mean length at age 1-10 years 1982, 1984-2009 sampled in East Greenland. Data derived from German survey.

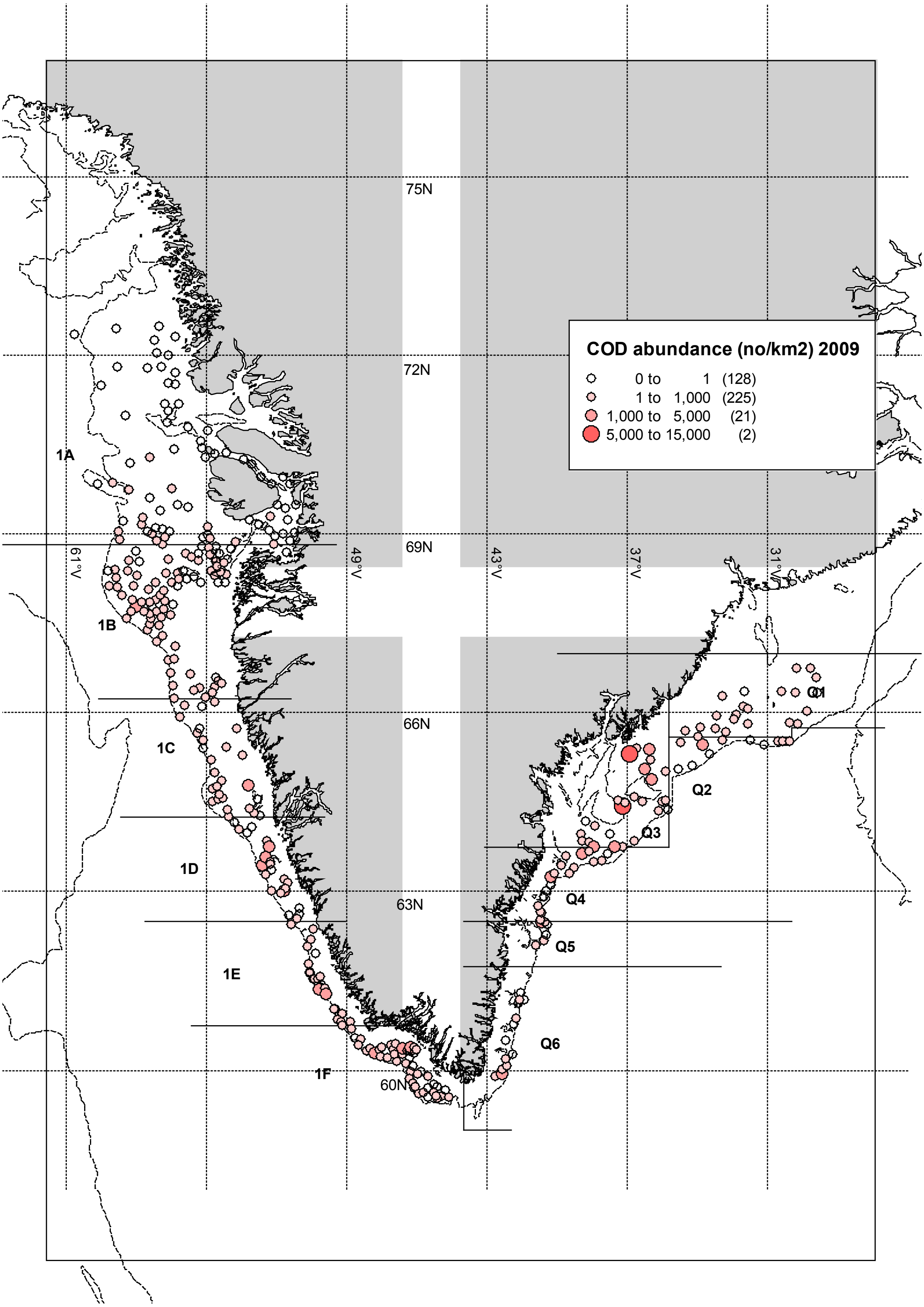

Figure14.14. Greenland survey 2009. Abundance per Km²

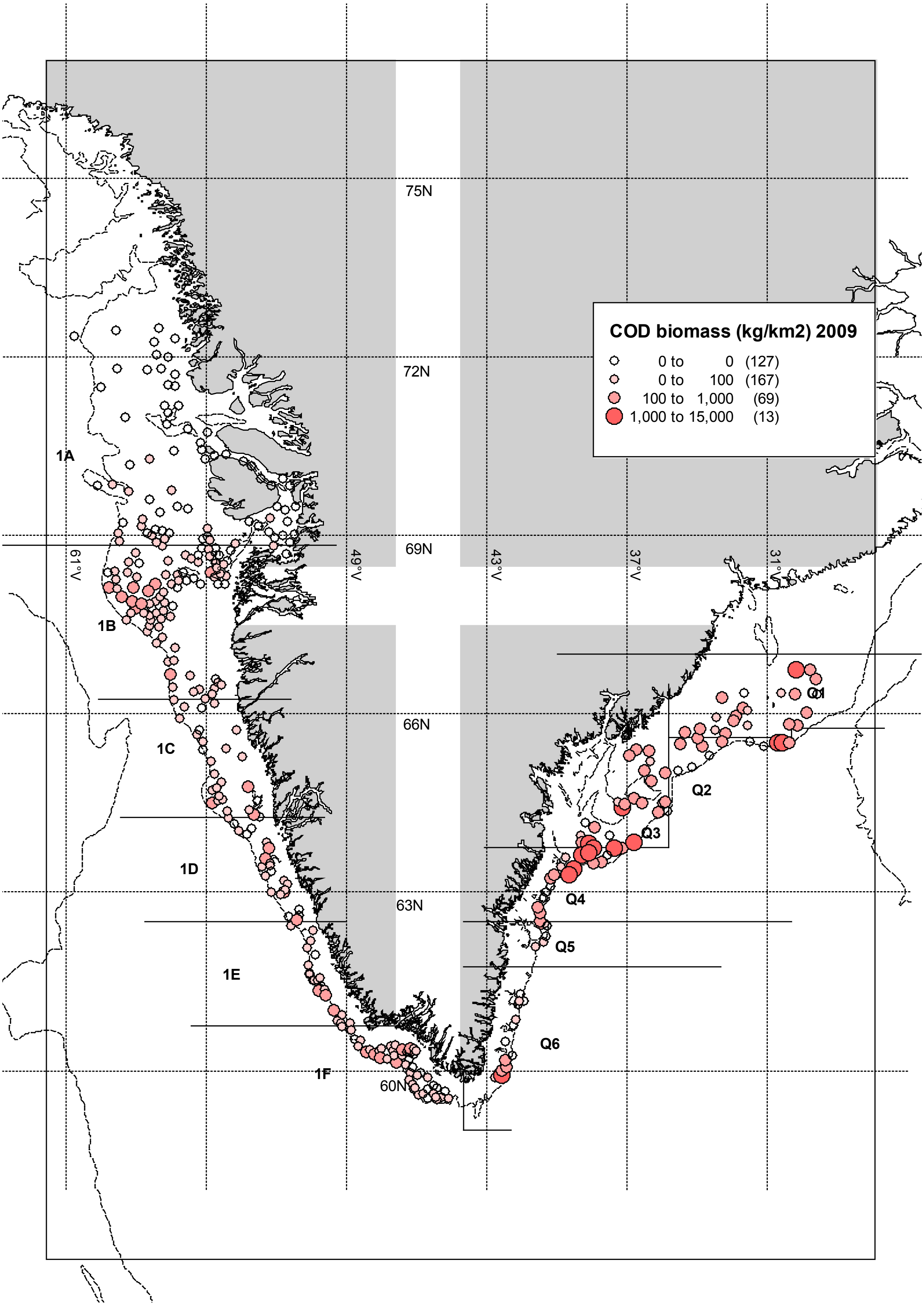

Figure 14.15 Greenland survey 2009. Catch weight kg per Km²

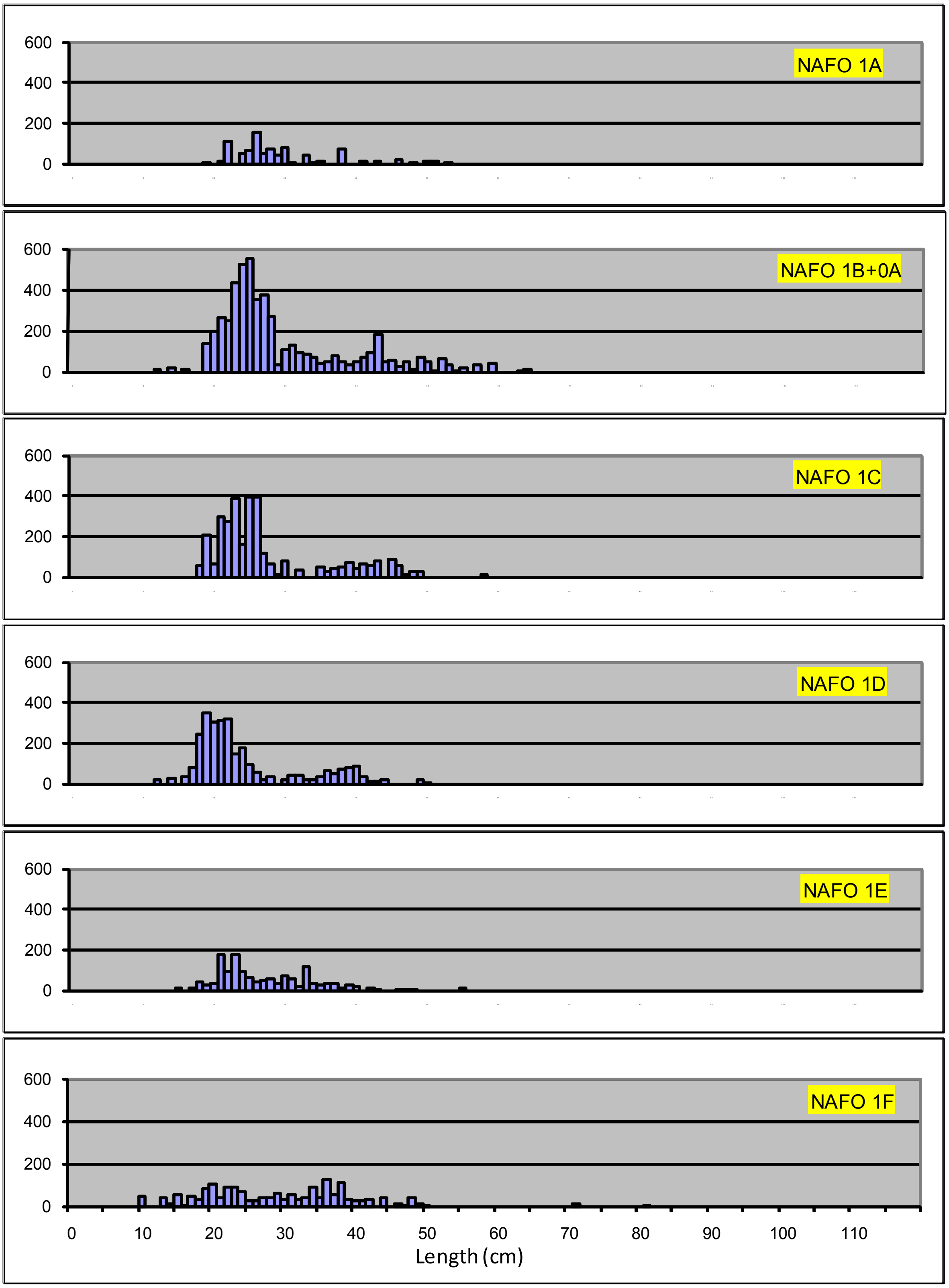

Figure 14.16: Greenland survey 2009 West Greenland. Length distribution from NAFO Div. 1A (top) to 1F (bottom).

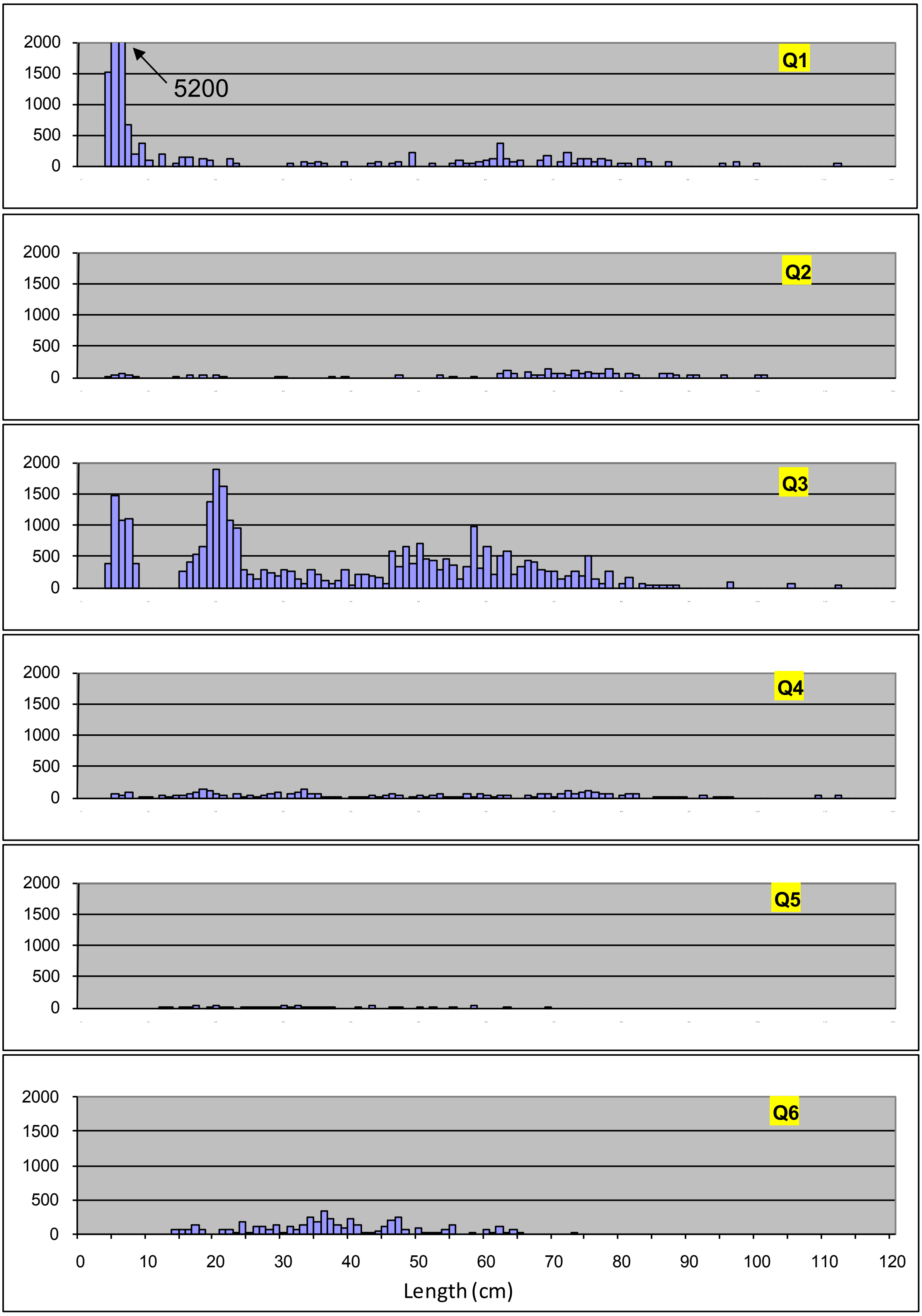

Figure 14.17 : Greenland survey 2009 East Greenland. Length distribution from the northern area Q1 (top) to the southernmost area Q6 (bottom).Areas shown in fig. 14.14.

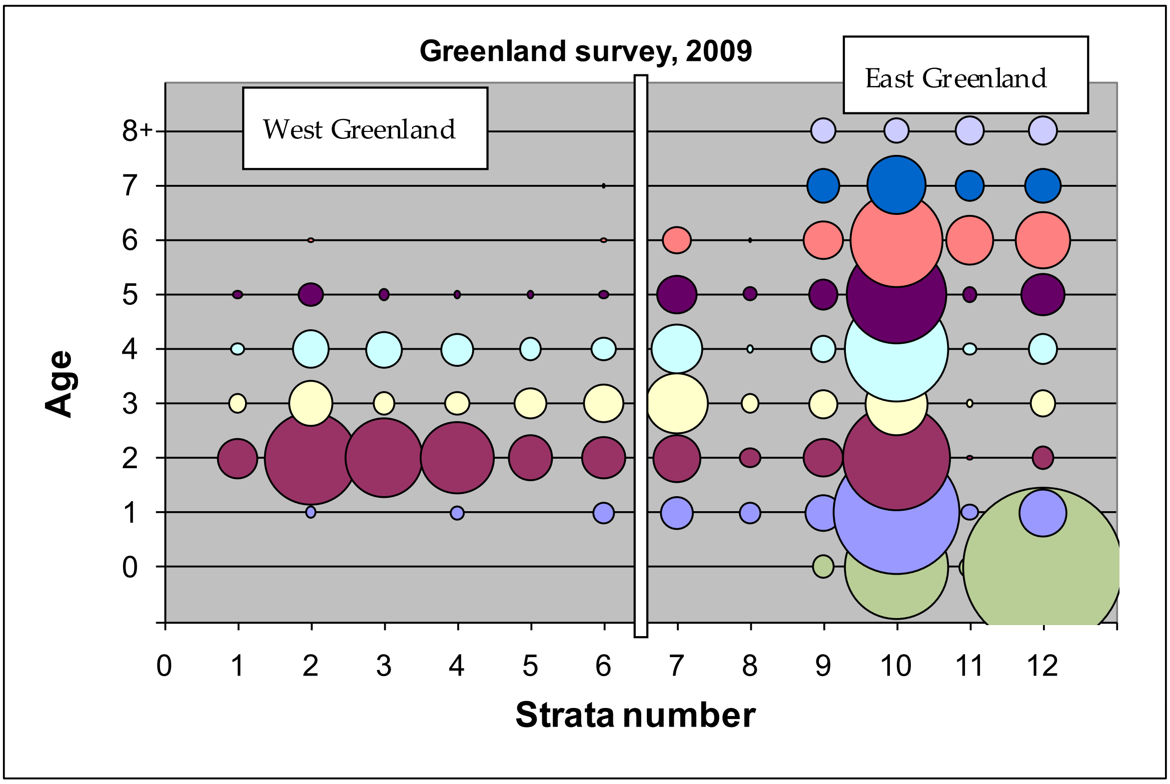

Figure 14.18 Abundance indices from the Greenland Survey, by strata and age. Strata's from NAFO Div. 1A, numbered=1 (left) to the East Greenland northernmost strata Q1 numbered 12 (right). The separation between West and East Greenland at Cape Farewell is indicated by the line between strata no. 6 and 7.

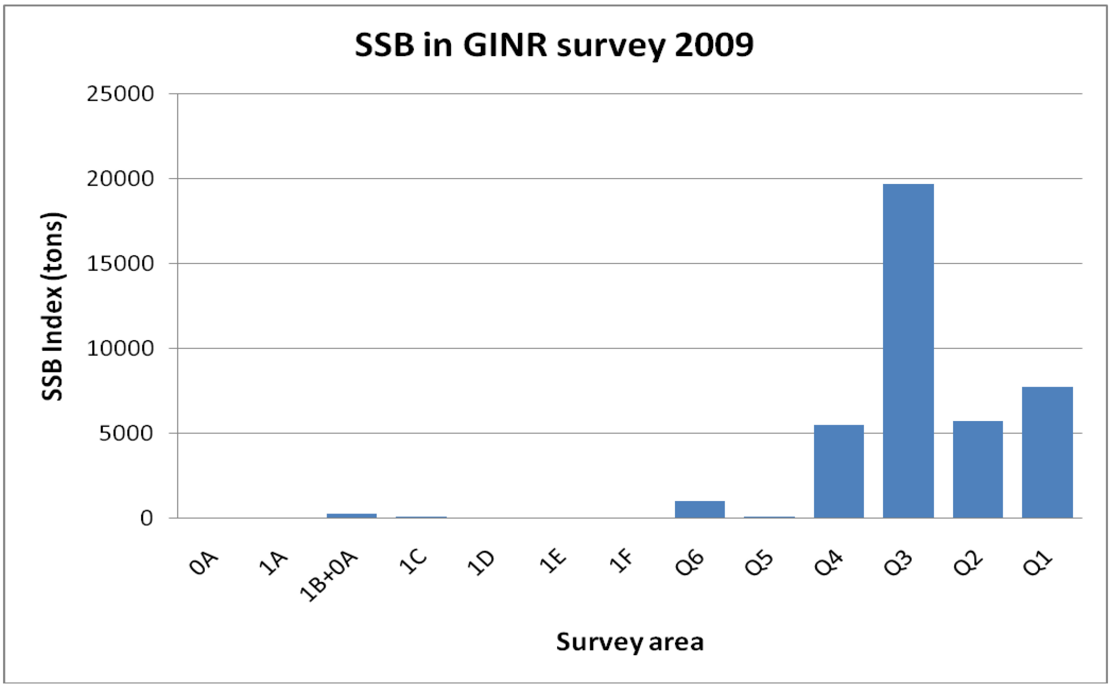

Figure 14.19 The Spawning stock biomass from the Greenland surveys, 2009. Maturity taken from proportion mature by length as recorded on observer trips off East Greenland in 2007.

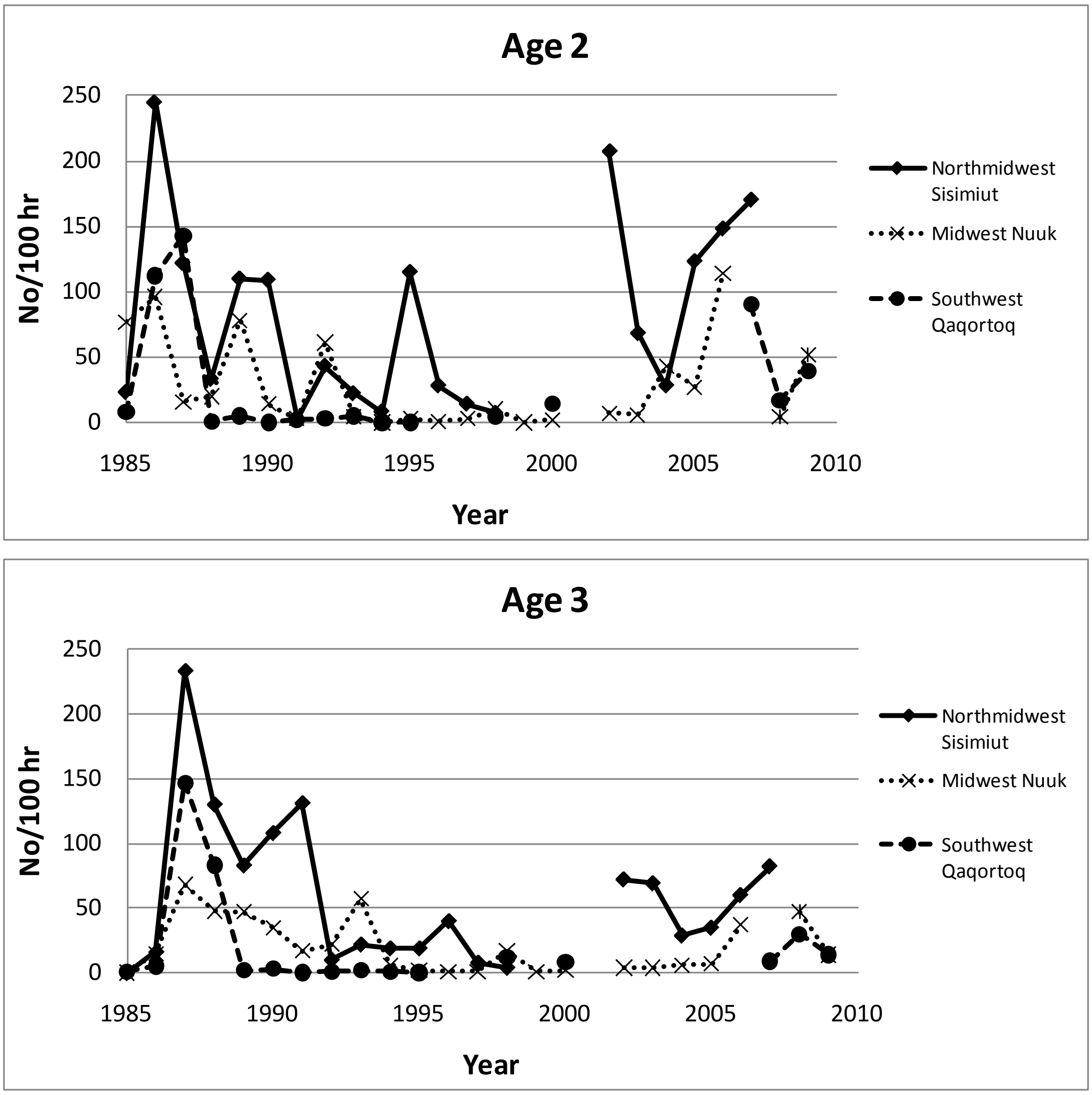

Figure 14.20. Recruitment indices (numbers caught/100 hr. Net settings) from the inshore Gill-net survey, by Year class and area. Indices given for age 2 and age 3.

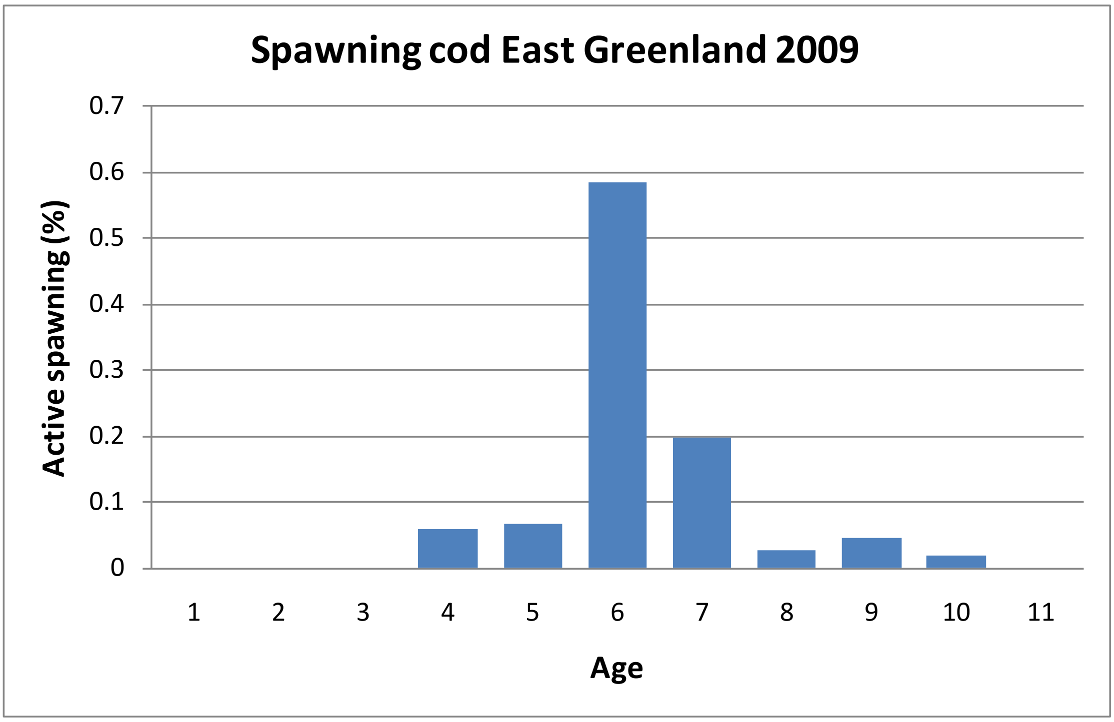

Figure 14.21. Age composition of actively spawning cod (running) in East Greenland 2009. Data from Icelandic survey in april-may 2009.

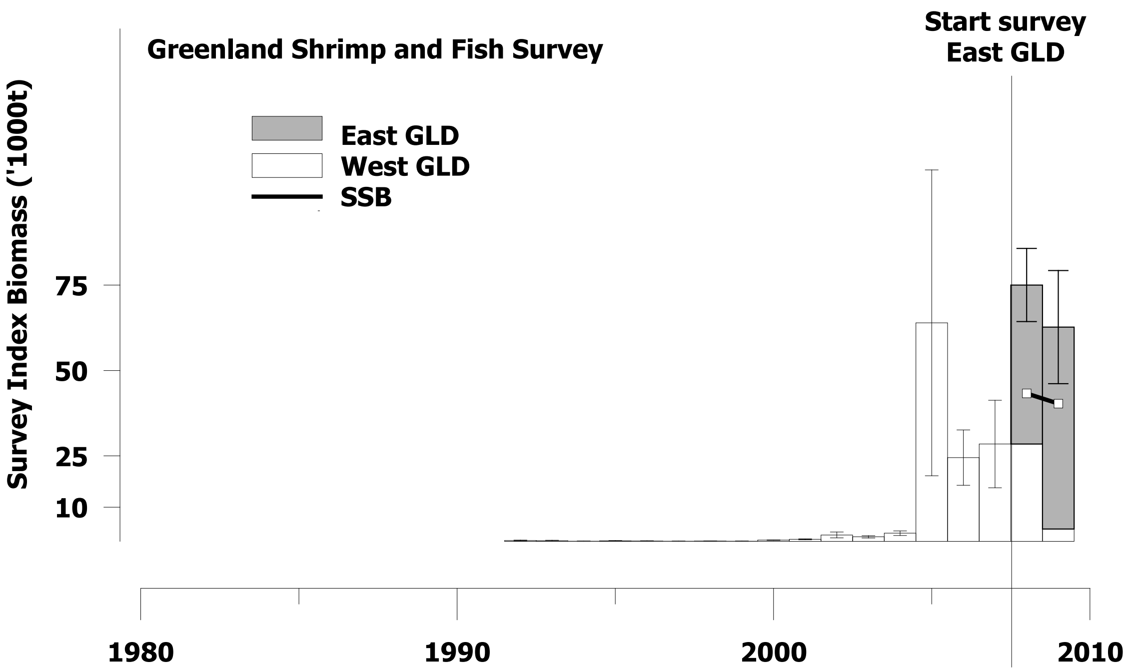

Figure 14.22 Greenland survey, Cod off Greenland. Aggregated survey biomass indices for West and East Greenland and spawning stock biomass. New gear introduced in 2005. Start of East Greenland survey in 2008.

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: current surveys have continued and sampling intensity and coverage remains also unchanged. Logbooks from the fishery are available as haul by haul data. Since 2001 no age readings of otoliths were available from the main fishing areas.

From 2007 a logistic production model in a Bayesian framework was used to assess stock status and for making predictions. The model includes 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 fishing mortality by far exceeds the value that maximizes yield (F_{msy}).

Stock status 2009-2010

Stock size:

Stock biomass 0.4B_{msy} (median)

100% probability of being below B_{msy}

6-33% risk of being below B_{lim} (30%B_{msy})

Stock production:

MSY = 16 – 30 ktons (inter-quartile range)

Actual ≈ 0.6MSY (median)

Exploitation:

28 ktons

3.5F_{msy} (median)

≈90% risk of exceeding F_{lim}

Predictions 2011 onwards

Risk of exceeding Blim (B<30%Bmsy)

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.

Catch option of 10 ktons/yr

Stock biomass is projected to increase slowly to about 0.5B_{msy} within a decade.

F is projected to decrease to about F_{msy}.

Catch option of 5 ktons/yr

Stock biomass is likely to increase slowly to about 0.6B_{msy} within a decade.

Fishing mortality is projected to decrease below F_{msy}.

Moratorium

In the order of 10 years or more to rebuild to B_{msy}

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 1981–2009 in Tables 15.2.1–15.2.6 and since 1961 in Figure 15.2.1.

Landings in Icelandic waters have historically predominated the total landings in areas V+XIV, but since the mid 1990s also fisheries in XIV and Vb have developed.

Fisheries and fleets

In 2009 quotas in Greenland EEZ were utilised by most of the principal fleets. Within the Iceland EEZ, quotas in the fishing year 2008/2009 were fully utilized as in the preceding fishing years. 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.

Most of the fishery for Greenland halibut in Divisions Va, Vb and XIVb is a directed trawl fishery, and only minor catches in Va by Iceland, and in XIVb by Germany and the UK comes partly from a redfish fishery.

Spatial distribution of 2009 fishery and historic effort and catch in the trawl fishery in XIV and V is provided in Figures 15.2.2-5. 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 2009 the distribution of the fishery covered all areas but was discontinuous in its distribution. 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 1 000 m) also stretching into Div. XIIb. Landings in Divisions XII and VIb in Tables 15.2.5-15.2.6 derive from the Hatton Bank area.

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). No information has since been available.

Only little information is presently available on discard in the Greenland halibut fishery, but the fishery in XIVb (logbooks) report discard less than 1%.

15.3 Trends in Effort and CPUE

Division Va

Indices of CPUE for the Icelandic trawl fleet directed at Greenland halibut for the period 1985–2008 (Table 15.3.1, Figures 15.3.1-3.)

Catch rates of Icelandic bottom trawlers decreased for all fishing grounds during 1990–1996 (Figure 15.3.1). Since 1996 catch rates peaked in 2000-2001 and has in recent years been stable and record low. The tendency over time is the same for all fishing grounds in Va (Figure 15.3.2), although the less important fishing grounds in north, east and southeast show a more optimistic view since 2006. Both observed and derived effort has increased in recent three years (Figure 15.3.3).

Division Vb

Information from logbooks from the Faroese otterboard trawl fleet (>1000 hp) was available for the years 1991-2009 (Table 15.3.1, Figure 15.3.4.-5.). The location of the bulk of fishery has changed from the eastern side of the islands in 1995-1998, to the south-western side since 2000. CPUE decreased drastically in the early period by more than 50 % coinciding with a significant increase in effort. Since 1994 CPUE has been variable without any trends.

Division XIVb

CPUE and effort from logbooks in XIV are provided in Table 15.3.1 and Figure 15.3.6. In 2005-2008 catch rates have maintained a high level above the average, but decreased by nearly 20% in 2009 along with a massive increase in effort (84%). A breakdown of the CPUE series into subdivisions, trace the 2009 CPUE decrease to the southernmost areas (Figure. 15.3.7) where most of the catches are taken.

The CPUE series from Divisions Va, Vb and XIVb do show different trends over the time series. This might indicate different population dynamics between the areas, but could also be artefacts, i.e. due to different behaviour of the fleets 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 up to 2007 are insignificant. In 2008 Lithuania caught 968 t and also France and Russia has developed a fishery in this area resulting in total 2008 catches of 1200 t. 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 based on available logbooks do not show any consistent patterns. Greenland halibut has been reported as by-catch from the Spanish fleet since 1998. In addition to the fishery in the Hatton bank area Greenland halibut has also previously been caught in the Reykjanes Ridge area within Subarea XII. (Tables 15.2.5-15.2.6).

15.4 Catch composition

Length compositions of catches from the commercial trawl fishery in Div. Va are rather stable from year to year. In Figure 15.4.1 length distributions are shown since 2000 and compared to average 1985-2009 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,.

15.5 Survey information

The total surveyed area in 2009 for Greenland halibut in Divisions Va, Vb and XIVb is provided in Figure 15.5.1. Most of the areas where commercial fishing takes place (Figure 15.2.2.) are covered by the surveys, although a few areas are not that intensively surveyed.

Division Va

Since 2006 the fishable biomass of Greenland halibut (fish of length equal to or greater than 50 cm) has increased significantly in Icelandic waters (Figures 15.5.2), Length distributions from the survey further suggest higher abundance of smaller fish below 50 cm in recent two years (Figures 15.5.3. – 15.5.4.).

Division Vb

The catch rates from the available time series of the exploratory fisheries/survey (1995-2009) shows fluctuation without any clear trend but suggest an increase since 2007 (Figure 15.5.5).

Division XIVb

Total biomass in the Greenlandic survey (Figure 15.5.6) in 2009 was estimated at 7589 tons (S.E. 914) which is a historic low in the time series (Figure 15.5.7) A GLM analysis performed on the survey catch rates, taking into account different coverage of area and depth between years did show a similar development in catch rates (Figure 15.5.8.).

Survey / Division	No. hauls in 2009 (planned hauls)	Depth range (m)	Coverage (km^2)
Va	219 (219)	400-1500	130 000
XIVb	63 (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 although of varying magnitude. The fall groundfish survey in Va (1996-2009) indicate a strong recovery from a low level in 2004-2006 for all sizes of fish and in all surveyed areas. Icelandic trawl CPUE in 1993-2009 are less than half that observed in 1985-1989. CPUE declined since 2001 to a low in 2004 and have since remained low. Effort has increased considerably in recent two years.

Div. Vb: The Faroese survey/exploratory remained stable in the period 1994-2009.

Div. XIVb: The Greenland survey in XIV has decreased catch rates since 2006, and trawl CPUE's from the various fleets in XIVb have also decreased in 2009.

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. 2008 WD #4). A more detailed formulation of the model and its performance is found in the stock annex.

15.6.2.1 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 15.6.1). The three series of biomass indices were: a standardised series of annual commercial-vessel catch rates for 1985–2009, $CPUE_t$,; and two trawl-survey biomass index for 1996–2009, Ice_t, and 1998-2009, $Green_t$.

Total reported catch in ICES Subareas V, VI, XII and XIV 1961-2009 was used as yield data (Table 15.6.1, Figure. 15.2.1). 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 was therefore not included either.

15.6.2.2 Model performance

Inference were made from samples from the converged part of the MCMC samples as identified by appropriate statistics (Hvingel et al. 2009 WD #4). The model was able to produce a reasonable simulation of the observed data (Figure. 15.6.2). 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 15.6.4). Exceptions are observed for the Greenland survey in 2006 (p=0.96) and for the Iceland survey in the final year (p=0.98) The CPUE series was generally better estimated than the survey series. Since the two surveys have opposite trends in the final year, the model was not able to capture both trends. This discrepancy also caused the high residuals for both surveys in final year.

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.15.6.1). 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_{2009} 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. 15.6.3).[NEEDS UPDATE]

The priors for *MSY* was significantly updated (Figure. 15.6.1). As mentioned above *MSY* was relatively insensitive to changes in prior distributions. The posterior *K* had an inter-quartile range of 777-1093 ktons (Table 15.6.3).

15.6.2.3 Assessment results

The time series of estimated median biomass-ratios starts in 1960 as a virgin stock at K (Figure. 15.6.4 -5). 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 B_{msy} in 2009 is 100% and 6% of being below B_{lim} (Table 15.6.5). The median fishing mortality ratio (*F-ratio*) has exceeded F_{msy} since the 1990s (Figure. 15.6.4 and 15.6.6). 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 16 ktons and 30 ktons (Table 15.6.3). 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 #4) and the low growth rate of the population. Risk associated with five optional catch levels for 2010 are given in Table 15.6.5.

The risk trajectory associated with ten-year projections of stock development assuming a maintained annual catch in the entire period ranging from 0 to 30 ktons were investigated (Figure. 15.6.7).[NEED ZERO OPTION] The calculated risk is a result of the projected development of the stock and the increase in uncertainty as projections are carried forward. It most be noted that a catch scenario of a maintained constant catch over a decade without considering arrival of new biological information and advice is highly unrealistic. [AWAITING SCENARIO WITH CONSTANT F]

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 5 ktons will likely result in stock increase. Taking 20 and higher ktons/yr will increase risk of going below B_{lim} to more than 35% within a 3-year period (Fig 15.6.7).

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. 15.6.8).

15.6.2.4 Conclusions

Stock status 2008–2009

Stock size:

- Stock biomass 0.4B_{msy} (median)
- 100% probability of being below B_{msy}
- 6-33 % risk of being below B_{lim}

Stock production:

- MSY = 16 – 30 ktons (inter-quartile range)
- Actual ≈ 0.6MSY (median)

Exploitation:

- 28 ktons
- 3.5F_{msy} (median)
- ≈90% 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.

Catch option of 20 ktons or more/yr

- Stock biomass is projected to decrease further with a high risk going below B_{lim} and a high risk of collapsing within a 5 year period. F is projected to increase by a factor of 10-90 times F_{msy}.

Catch option of 5 ktons/yr

Stock biomass is likely to increase slowly to about 0.6B_{msy} within a decade.

- Median fishing mortality is projected to be below F_{msy} and is associated with a high risk of being at or above F_{msy}.

15.6.3 Reference points

The previous suggested limit reference points Blim=0.3Bmsy and Flim=1.7Fmsy is by the ICES transition to the MSY approach not any longer candidates. The inherent estimation of msy reference points by the production model requires thus only $B_{trigger}$ to be defined. In order to define $B_{trigger}$ require scenarios of biomass developments at equilibrium when fishing at F_{msy}. The group was not able to perform these analyses presently, however since the present stock biomass must be considered to be below any $B_{trigger}$ candidate, present advice will deviate from an F_{msy} advice.

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 with 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 for a decade 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 a clean fishery with minor bycatches. 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 cpue series of commercial catches due to a contrasting signal to the other indices, although the quality of the Greenland commercial 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%.

15.9 Communication with RG, ACOM

The Review Group on North Western stocks had in its report of May 2009 some comments on the assessment and report structure. Their main issues are commented by NWWG as follows:

"The estimates were compared with those from previously applied ASPIC model. There are some differences in estimates, which could be closer inspected (e.g. present approach shows much sharper increase in stock size near 2000, and biomass from ASPIC at the beginning of time series is close to Bmsy, while in the present approach it is close to carrying capacity)"

- as the present approach includes stochasticity in the estimation of the parameters, it is assumed to behave more dynamic to changes in input data. [EINAR]

Table 15.2.1 GREENLAND HALIBUT. Nominal landings (tonnes) by countries,
in Sub-areas V, VI, XII and XIV 1981-2009, as officially reported to ICES and estimated by WG

Country	1981	1982	1983	1985	1986	1987	1988	1989
Denmark	-	-	-	-	-	6	+	-
Faroe Islands	767	1,532	1,146	1,052	853	1,096	1,378	2,319
France	8	27	236	845	52	19	25	-
Germany	3,007	2,581	1,142	863	858	565	637	493
Greenland	+	1	5	81	177	154	37	11
Iceland	15,457	28,300	28,360	29,231	31,044	44,780	49,040	58,330
Norway	-	-	2	3	+	2	1	3
Russia	-	-	-	-	-	-	-	-
UK (Engl. and Wales)	-	-	-	-	-	-	-	-
UK (Scotland)	-	-	-	-	-	-	-	-
United Kingdom	-	-	-	-	-	-	-	-
Total	19,239	32,441	30,891	32,075	32,984	46,622	51,118	61,156
Working Group estimate	-	-	-	-	-	-	-	61,396

Country	1990	1991	1992	1994	1995	1996	1997	1998
Denmark	-	-	-	-	-	1	-	
Faroe Islands	1,803	1,566	2,128	6,241	3,763	6,148	4,971	3,817
France	-	-	3	-	-	29	11	8
Germany	336	303	382	648	811	3,368	3,342	3,056
Greenland	40	66	437	867	533	1,162	1,129	747
Iceland	36,557	34,883	31,955	27,778	27,383	22,055	18,569	10,728
Norway	50	34	221	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	513	1,436	386	218	190
UK (Scotland)	-	-	19	84	232	25	26	43
United Kingdom								
Total	38,813	36,890	35,259	37,305	36,006	35,762	30,242	20,360
Working Group estimate	39,326	37,950	35,423	36,958	36,300	35,825	30,309	20,382

Country	1999	2000	2001	2003 [1]	2004 [1]	2005 [1]	2006 [1]	2007 [1]
Denmark		-	-	-	-	-	-	-
Estonia		-	-	-	-	5	3	-
Faroe Islands	3,884	-	121	458	338	1,150	855	1,141
France	-	2	32	177	157	-	62	17
Germany	3,082	3,265	2,800	2,948	5,169	5,150	4,299	4,930
Greenland	200	1,740	1,553	1,459	-	-	-	-
Iceland	11,180	14,537	16,590	20,366	15,478	13,023	11,798	-
Ireland		-	56	-	-	-	-	-
Lithuania		-	-	2	1	-	2	3
Norway	1,187	1,750	2,243	1,074	1,233	1,124	1,097	692
Poland		-	2	93	207	-	-	-
Portugal		-	6	-	-	-	1,094	-
Russia	138	183	187	-	262	-	552	501
Spain		779	1,698	3,075	4,721	506	33	-
UK (Engl. and Wales)	261	370	227	40	49	10	1	-
UK (Scotland)	69	121	130	367	367	391	1	-
United Kingdom	-	166	252	841	1,304	220	93	17
Total	20,001	22,913	25,897	30,900	29,286	21,579	19,890	7,301
Working Group estimate	20,371	26,644	27,291	30,891	27,102	24,978	21,466	21,873

Country	2008 [1]	2009 [1]
Denmark	-	-
Estonia	-	-
Faroe Islands	-	270
France	114	-
Germany	4,846	427
Greenland	-	2,819
Iceland	-	-
Ireland	-	-
Lithuania	566	
Norway	639	124
Poland	1,354	988
Portugal	-	-
Russia	799	762
Spain	-	-
United Kingdom	422	581
Total	9,744	5,974
Working Group estimate	24,481	28,197

1) Provisional data

Table 15.2.2 GREENLAND HALIBUT. Nominal landings (tonnes) by countries, in Division Va 1981-2009, 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				
Iceland	36,557	34,883	31,955	33,968	27,696	27,376	22,055	16,766	10,580
Norway									
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 [1]
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 0	945
Working Group estimate		14,607	16,752	19,714	20,415	15,477	13,172	11,817	10,525

Country	2008 [1]	2009 [1]
Faroe Islands		
Germany	4	423
Greenland		
Iceland		
Norway		
Russia	4	
Poland		270
UK	179	
Total	187	693
Working Group estimate	11,859	15,782

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 15.2.3 GREENLAND HALIBUT. Nominal landings (tonnes) by countries, in Division Vb 1981-2009 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]	-	-		-	-	-

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

Country	2008	2009
Denmark		
Faroe Islands		
France	36	
Germany		
Iceland		
Ireland		
Norway	1	1
UK (Engl. and Wales)		
UK (Scotland)		
United Kingdom	32	117
Total	69	118
Working Group estimate	1759	1739

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 15.2.4 GREENLAND HALIBUT. Nominal landings (tonnes) by countries, in Sub-area XIV 1981-2009, 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 0	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

Country	2008 [1]	2009 [1]
Denmark		
Faroe Islands		270
Germany	4,842	4
Greenland		2,819
Iceland		
Ireland		
Norway	637	29
Poland	1,354	718
Portugal		
Russia	763	
Spain		
United Kingdom	131	452
Total	7,727	4,292
Working Group estimate	9,102	9,805

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 15.2.6 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]
Estonia							8		
Faroe Islands									
France							286	165	110
Poland							16	91	1
Spain [2]			22	88	20	350	1367	214	170
UK					159	247	77	42	10
Russia						1			1
Norway					35	317	21	26	
Total	0	0	22	88	214	915	1775	538	292
WG estimate									

Country	2005 [1]	2006 [1]	2007 [1]	2008 [1]	2009 [1]
Estonia	5	1			
Faroe Islands					
France		22	8	114	
Poland					
Spain [2]	3	33			
UK	217	74	15	80	12
Russia		1		32	
Norway		3		1	3
Lithuania				968	
Total	225	134	23	1195	15 0
WG estimate					

[1] Provisional data

[2] Based on estimates by observers onboard vessels

Table 15.3.1. CPUE indices oftrawl fleets in Div Va, Vb and XIVb as derived from GLM multiplicative models.

area	year	cpue	% change in CPUE between years	landings	relative derived effort	relative derived effort	% change in effort between years
Iceland Va	1985	1.00		29,197	29	100	
	1986	1.01	1	31,027	31	106	6
	1987	1.08	7	44,659	41	134	27
	1988	1.11	3	49,379	44	107	-20
	1989	1.06	-5	59,049	56	125	17
	1990	0.72	-32	37,308	52	92	-26
	1991	0.70	-3	35,413	51	98	6
	1992	0.61	-13	31,978	52	103	5
	1993	0.48	-21	34,134	71	136	31
	1994	0.40	-18	28,608	72	102	-25
	1995	0.32	-20	27,391	87	120	18
	1996	0.27	-16	22,073	83	96	-20
	1997	0.28	6	16,792	59	71	-26
	1998	0.44	57	10,595	24	40	-44
	1999	0.51	15	11,138	22	92	128
	2000	0.58	14	14,607	25	115	25
	2001	0.61	5	16,755	28	109	-5
	2002	0.50	-18	19,714	39	143	31
	2003	0.33	-34	20,415	62	156	9
	2004	0.23	-31	15,477	67	110	-30
	2005	0.25	8	13,015	53	78	-29
	2006	0.25	2	11,817	47	89	14
	2007	0.29	15	10,525	36	77	-13
	2008	0.27	-6	9,580	35	96	25
	2009	0.25	-7	15,782	62	177	84
Greenland, XIVb	1991	1.00		875	1	100	0
	1992	0.92	-8	1,176	1	146	46
	1993	2.56	178	2,249	1	69	-53
	1994	3.26	27	3,125	1	109	59
	1995	3.40	4	5,077	1	156	43
	1996	3.43	1	7,283	2	142	-8
	1997	3.58	5	8,558	2	112	-21
	1998	3.44	-4	5,940	2	72	-36
	1999	2.65	-23	5,376	2	117	62
	2000	2.20	-17	6,958	3	156	33
	2001	2.18	-1	7,216	3	105	-33
	2002	2.36	8	6,621	3	85	-19
	2003	2.40	2	8,017	3	119	40
	2004	2.27	-5	9,854	4	130	9
	2005	3.13	37	10,185	3	75	-42
	2006	3.23	3	8590	3	82	9
	2007	3.04	-6	10261	3	127	55
	2008	3.09	2	8,952	3	86	-32
	2009	2.55	-18	10,567	4	143	67
Faroe Islands, Vb	1991	1.00		1,662	2	100	33
	1992	1.60	60	2,269	1	85	-15
	1993	0.93	-42	4,434	5	338	297
	1994	0.67	-28	5,225	8	164	-52
	1995	0.72	7	3,832	5	68	-58
	1996	0.69	-4	6,469	9	176	158
	1997	0.48	-30	4,870	10	107	-39
	1998	0.49	2	3,825	8	77	-28
	1999	0.59	19	4,265	7	94	22
	2000	0.76	29	5,079	7	92	-1
	2001	0.55	-27	3,245	6	88	-5
	2002	0.51	-7	2,694	5	89	2
	2003	0.70	37	2,426	3	66	-26
	2004	0.47	-33	1,771	4	109	66
	2005	0.47	1	892	2	50	-54
	2006	0.66	40	873	1	70	40
	2007	0.52	-21	1,060	2	154	120
	2008	0.66	-21	1735	2	100	-35
	2009	0.66	27	1760	3	129	29

Table 15.6.1. 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	8.030	-	-	-
1967	9.597	-	-	-
1968	8.337	-	-	-
1969	26.200	-	-	-
1970	33.823	-	-	-
1971	28.973	-	-	-
1972	26.473	-	-	-
1973	20.463	-	-	-
1974	36.280	-	-	-
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	1.77	-	-
1987	46.622	1.90	-	-
1988	51.118	1.96	-	-
1989	61.396	1.87	-	-
1990	39.326	1.27	-	-
1991	37.950	1.23	-	-
1992	35.487	1.08	-	-
1993	41.247	0.85	-	-
1994	37.190	0.70	-	-
1995	36.288	0.56	-	-
1996	35.932	0.47	34.44	-
1997	30.309	0.50	42.01	-
1998	20.382	0.78	42.01	50.21
1999	20.371	0.89	52.37	38.66
2000	26.644	1.02	39.63	48.77
2001	27.291	1.07	55.73	-
2002	29.158	0.88	47.15	59.41
2003	30.891	0.58	24.41	36.18
2004	27.102	0.40	16.01	25.22
2005	24.249	0.44	22.31	35.94
2006	21.432	0.44	18.46	43.37
2007	20.957	0.51	21.05	27.30
2008	22.169	0.48	30.15	19.36
2009	27.349	0.45	43.62	19.03
2010	25.000*	-	-	-

*estimated

Table 15.6.2. Priors used in the assessment 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 15.6.3. 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)	23	10	16	23	30
K (ktons)	937	230	777	932	1093
r	0.11	0.06	0.06	0.10	0.15
q_{cpue}	3E-03	8E-04	2E-03	3E-03	3E-03
q_{Ice}	0.15	0.05	0.12	0.14	0.17
q_{Green}	0.16	0.05	0.13	0.16	0.19
P_{1985}	1.46	0.13	1.37	1.46	1.55
P_{2008}	0.39	0.05	0.35	0.39	0.42
σ_{Ice}	0.24	0.05	0.21	0.24	0.27
σ_{cpue}	0.09	0.02	0.08	0.09	0.10
σ_{Green}	0.25	0.05	0.22	0.25	0.28
σ_P	0.20	0.03	0.17	0.19	0.22

Table 15.6.4. Model diagnostics: residuals (% of observed value), probability of getting a more

	CPUE		Survey Ice		Survey Green	
Year	resid (%)	Pr	resid (%)	Pr	resid (%)	Pr
1985	0.46	0.48	-	-	-	-
1986	1.03	0.47	-	-	-	-
1987	-0.52	0.52	-	-	-	-
1988	-2.05	0.56	-	-	-	-
1989	-4.92	0.66	-	-	-	-
1990	3.94	0.37	-	-	-	-
1991	-1.26	0.54	-	-	-	-
1992	-1.97	0.56	-	-	-	-
1993	0.80	0.47	-	-	-	-
1994	0.10	0.50	-	-	-	-
1995	2.91	0.41	-	-	-	-
1996	9.13	0.23	-20.97	0.78	-	-
1997	10.54	0.19	-33.37	0.89	-	-
1998	-3.21	0.61	-2.60	0.54	-12.10	0.68
1999	-3.40	0.61	-11.60	0.67	26.99	0.15
2000	-6.84	0.71	26.57	0.16	14.03	0.29
2001	-5.46	0.67	-1.54	0.52	-0.01	-
2002	-2.76	0.59	-1.69	0.53	-16.38	0.74
2003	-0.42	0.51	24.80	0.18	-6.20	0.60
2004	5.17	0.33	35.48	0.09	-1.71	0.53
2005	2.19	0.43	8.85	0.37	-30.43	0.88
2006	3.83	0.37	29.35	0.14	-47.68	0.96
2007	-5.64	0.68	21.46	0.21	3.90	0.44
2008	-2.49	0.58	-17.19	0.74	35.42	0.09
2009	0.80	0.47	-57.46	0.98	33.93	0.10

extreme observation (p.extreame; see text for explanation).

Table 15.6.5. Upper: stock status for 2009 and predicted to the end of 2010. Lower: predictions for 2010 given catch options ranging from 0 to30 ktons.

Status	2009	2010*
Risk of falling below B_{lim} ($0.3B_{MSY}$)	6%	33%
Risk of falling below B_{MSY}	100%	100%
Risk of exceeding F_{MSY}	100%	99%
Risk of exceeding F_{lim} ($1.7F_{MSY}$)	94%	90%
Stock size (B/Bmsy), median	0.37	0.34
Fishing mortality (F/Fmsy),	3.46	3.58
Productivity (% of MSY)	61%	56%

*Predicted catch = 25ktons

Catch option 2011 (ktons)	0	5	10	15	20	30
Risk of falling below B_{lim} ($0.3B_{MSY}$)	24%	28%	32%	33%	46%	52%
Risk of falling below B_{MSY}	100%	100%	100%	100%	100%	100%
Risk of exceeding F_{MSY}	-	25%	65%	87%	95%	99%
Risk of exceeding F_{lim} ($1.7F_{MSY}$)	-	11%	35%	60%	80%	95%
Stock size (B/Bmsy), median	0.38	0.37	0.35	0.35	0.31	0.29
Fishing mortality (F/Fmsy),	0.00	0.61	1.29	2.00	3.11	5.24
Productivity (% of MSY)	61%	60%	58%	57%	53%	50%

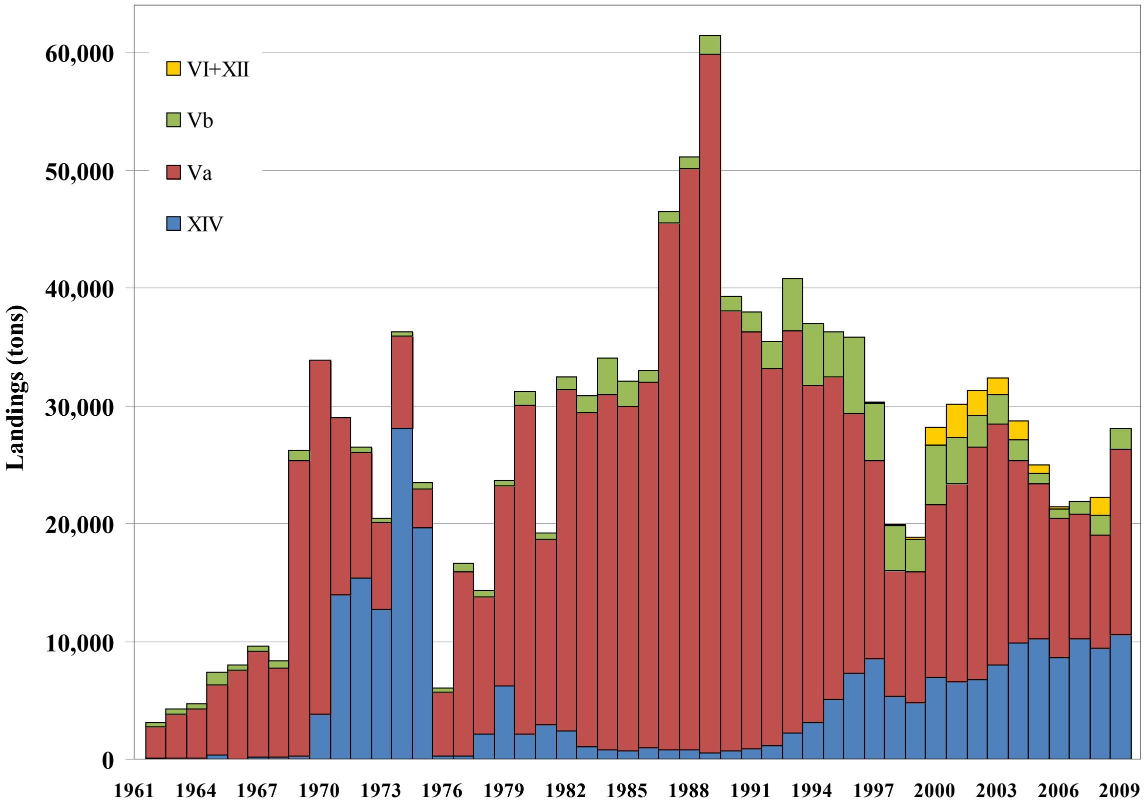

Figure 15.2.1. Landings of Greenland halibut in Divisions V, XI and XIV. As the landings within Icelandic waters, since 1976, have not officially been separated and reported according to the defined ICES statistical areas, they are set under area Va by the North Western Working Group.

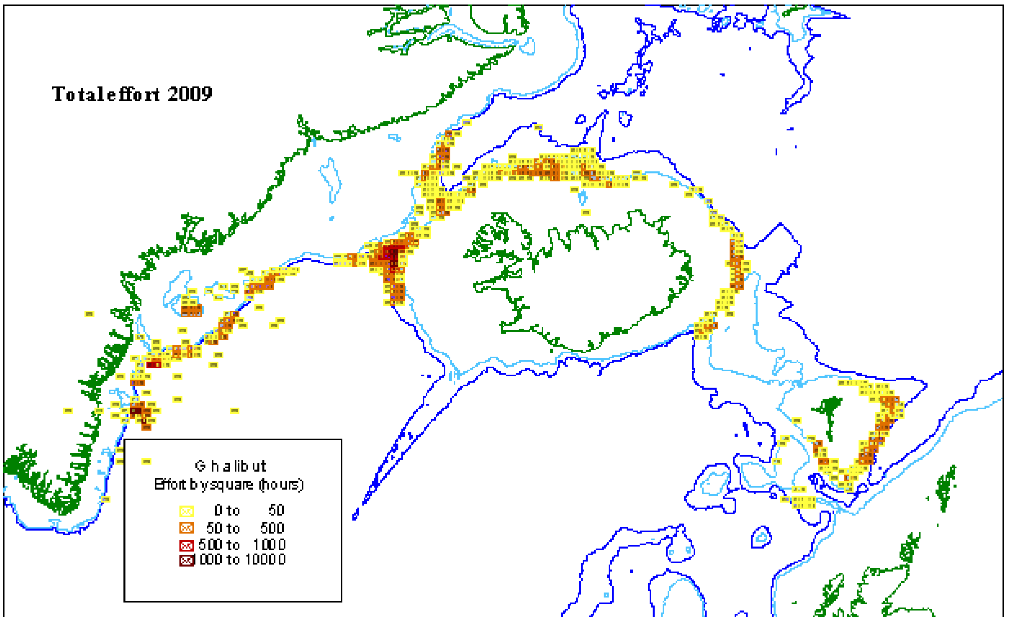

Figure 15.2.2 Greenland halibut V+XIV. Distribution of fishing effort 2009. 500m and 1000 m depth contours are shown.

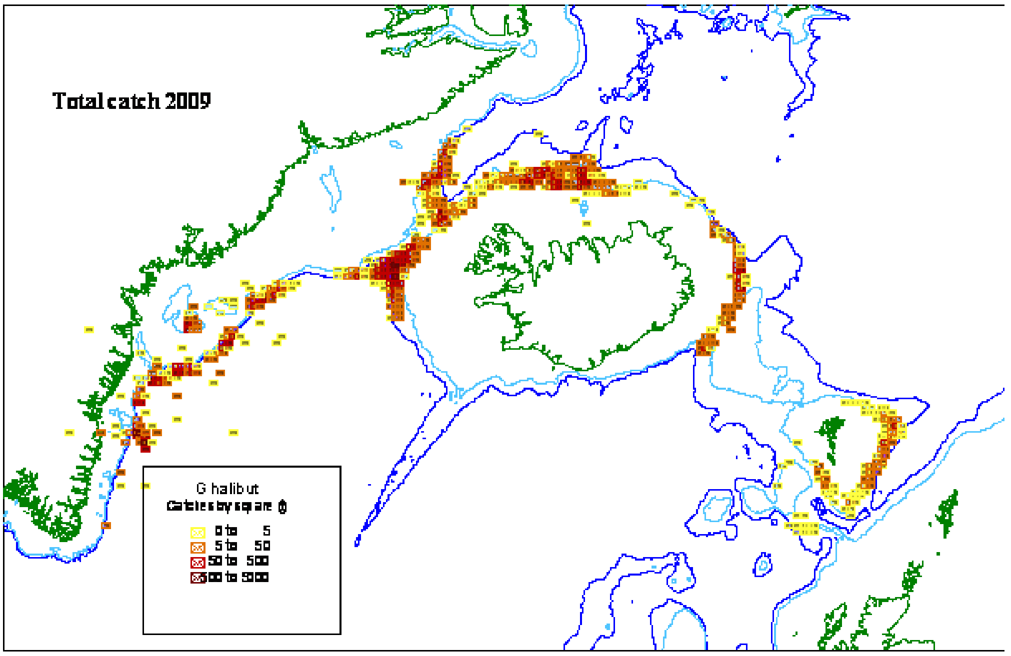

Figure 15.2.3. Greenland halibut V+XIV. Distribution of catches in the fishery in 2009. 500m and 1000 m depth contours are shown

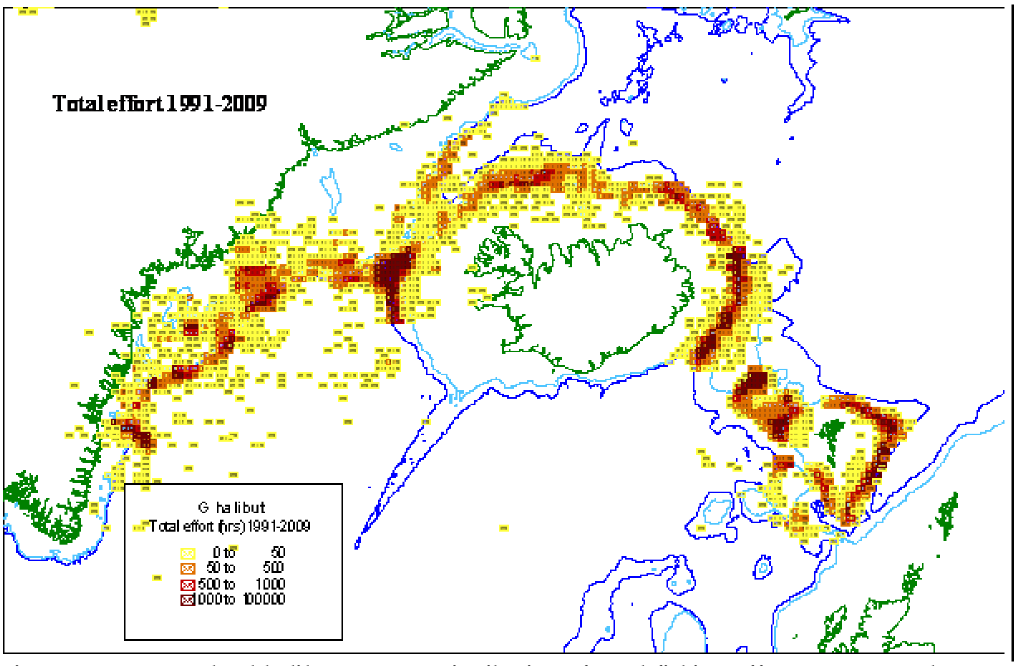

Figure 15.2.4. Greenland halibut V+XIV. Distribution of total fishing effort 1991-2009. The 500m and 1000 m depth contours are shown.

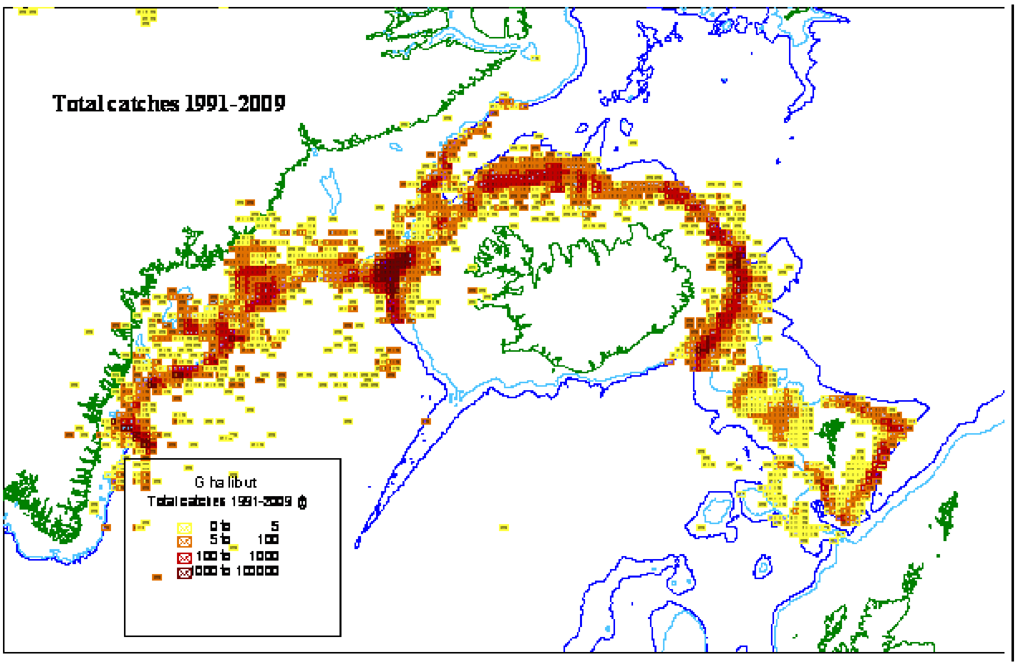

Figure 15.2.5. Greenland halibut V+XIV. Distribution of total catches in the fishery 1991-2009 500m and 1000 m depth contours are shown.

Figure 15.3.1. Standardised CPUE from the Icelandic trawler fleet in Va. 95% CI indicated.

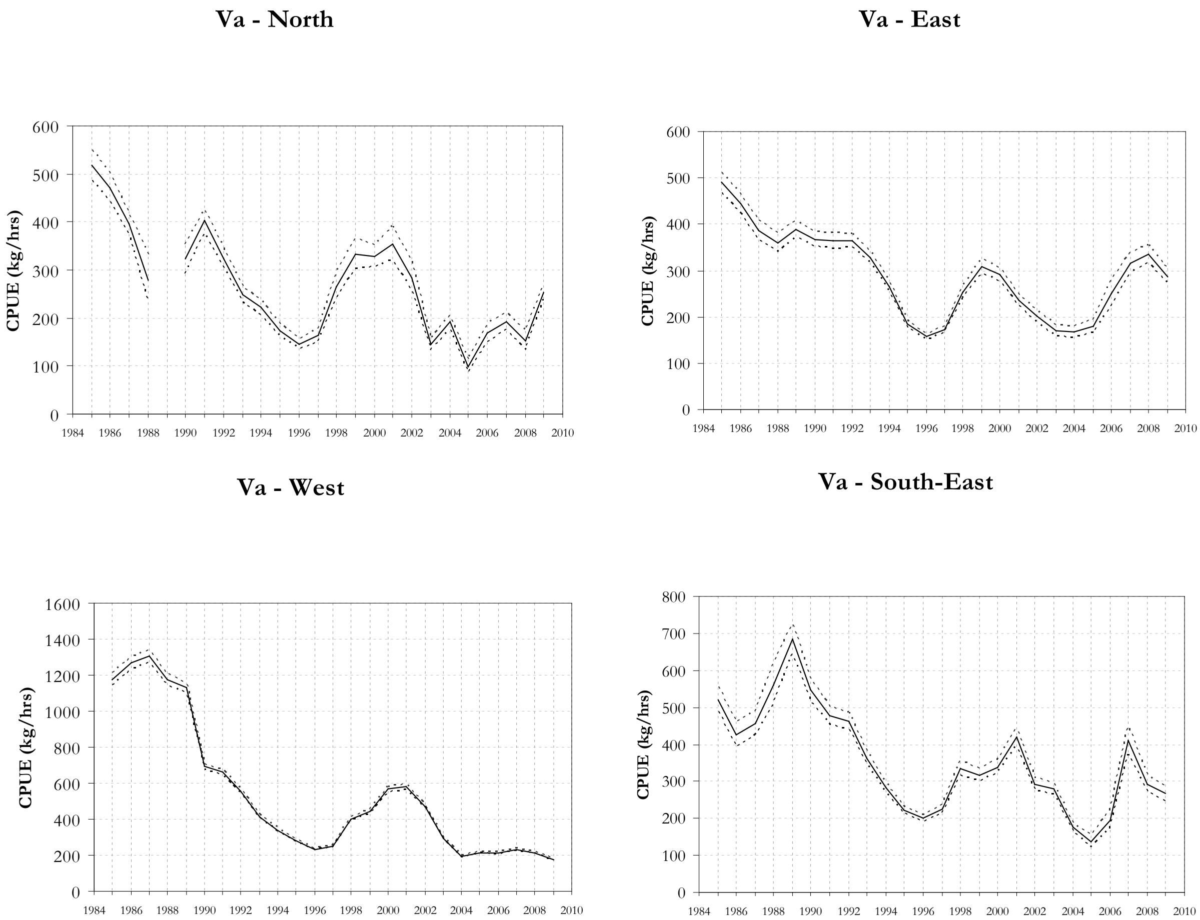

Figure 15.3.2 Standardised CPUE from the Icelandic trawler fleet in Va by four main fishing areas in Va. 95% CI indicated.

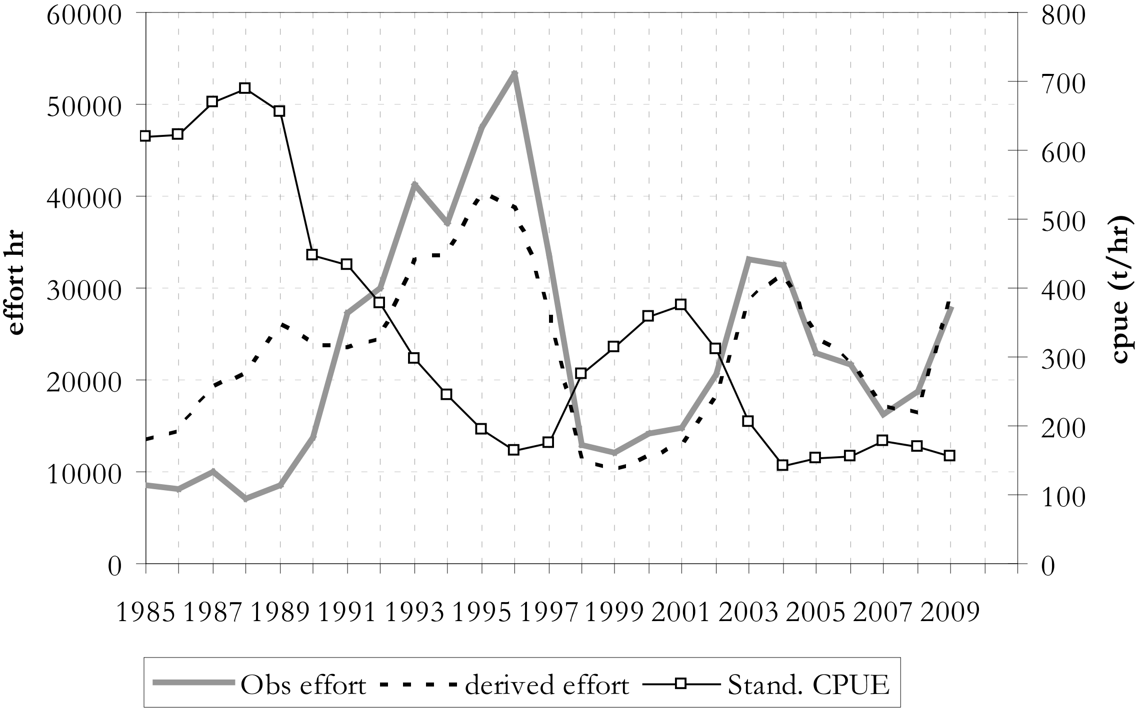

Figure 15.3.3. Standardised CPUE,observed and derived effort from Icelandic trawl fishery.

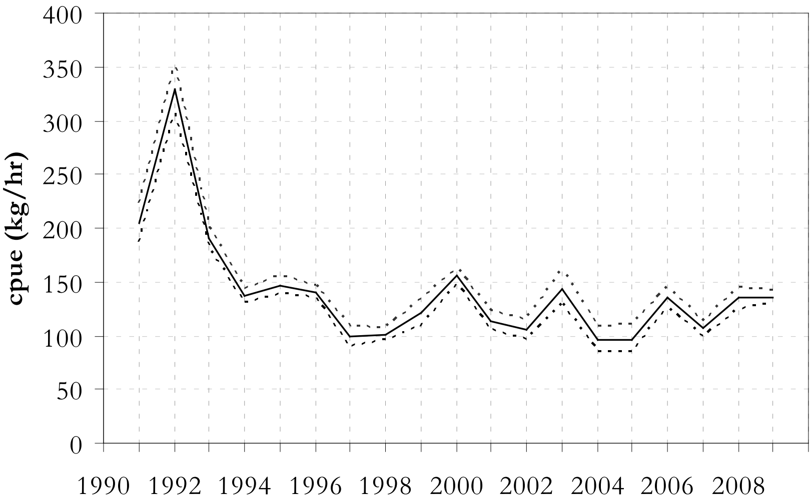

Figure 15.3.4. Standardised CPUE from the Faroese trawler fleet. 95% CI indicated

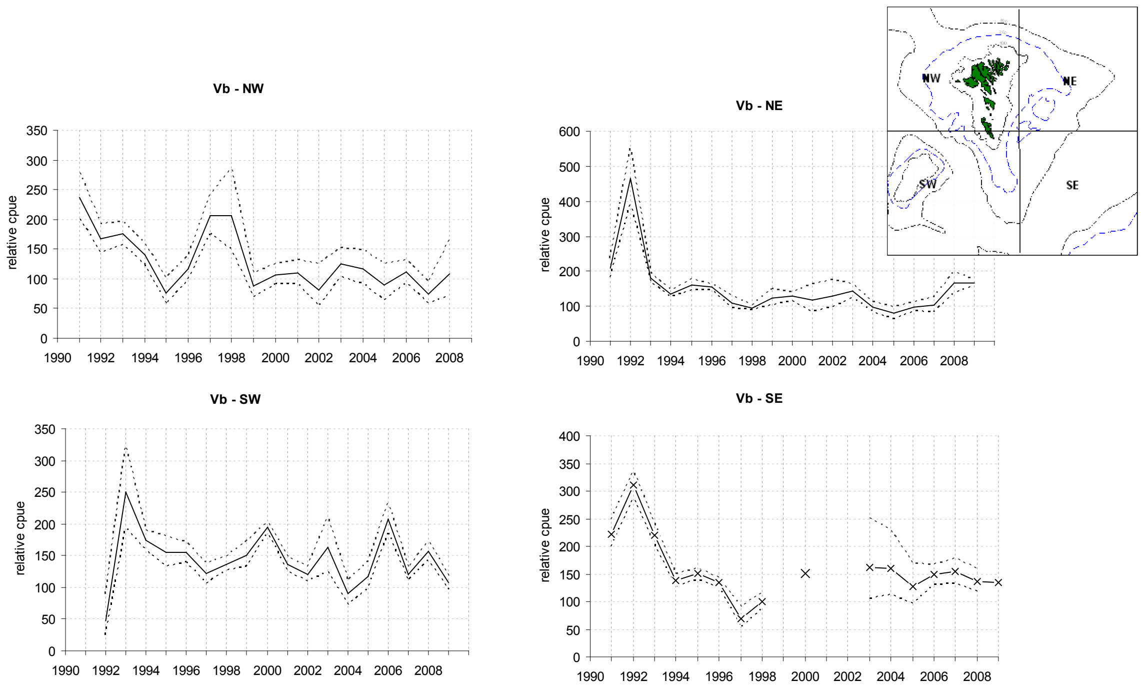

Figure 15.3.5. Standardised CPUE from the Faroese trawler fleet by four fishing areas as indicated on map. 95% CI indicated.

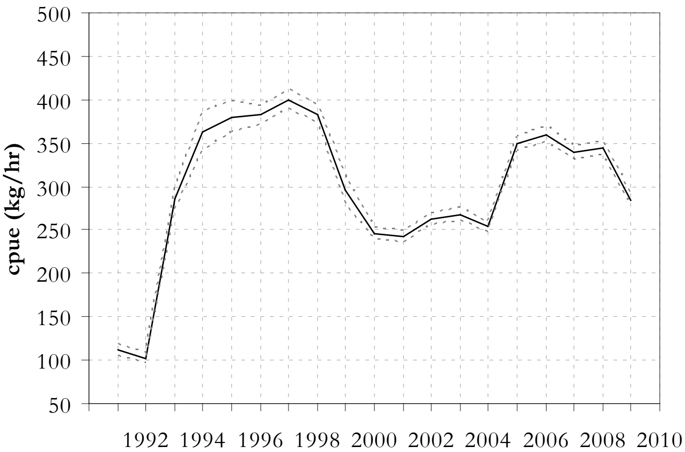

Figure 15.3.6. Standardised CPUE from trawler fleets in XIVb. 95% CI indicated

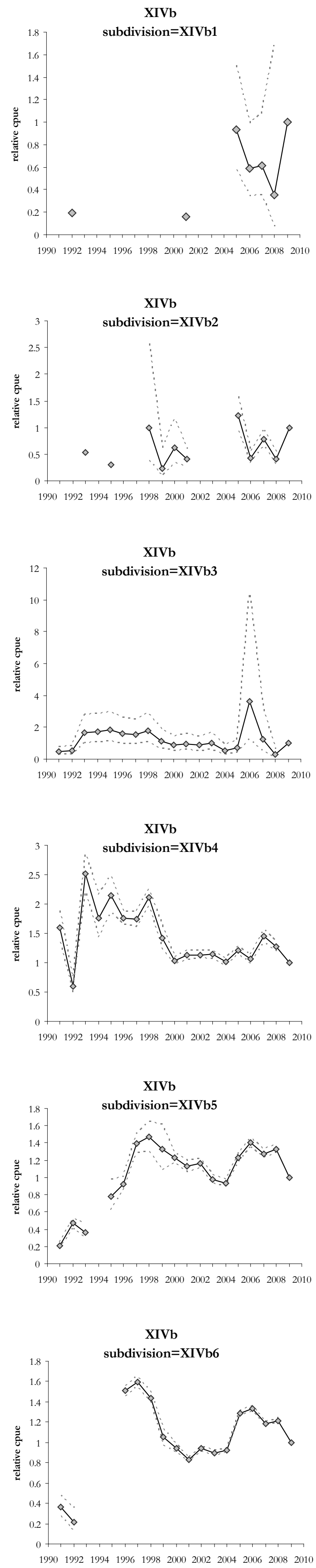

Figure 15.3.7. Standardised CPUE from trawler fleets in XIVb shown by subdivisions in XIVb in a north-south orientation. 95% CI indicated.

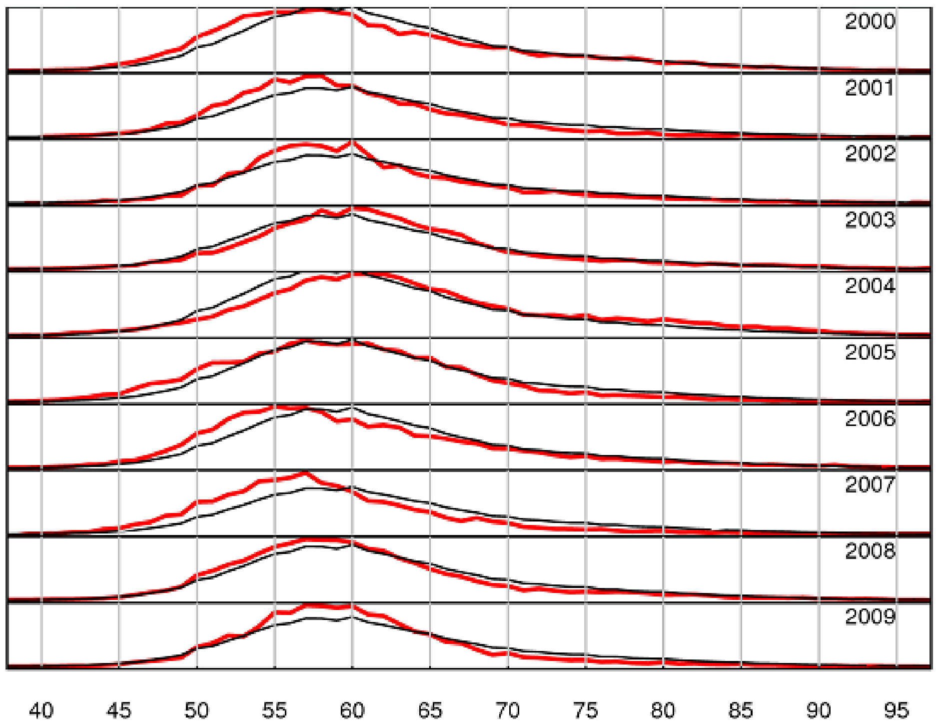

Figure 15.4.1. Length distributions from the commercial trawl fishery in the western fishing grounds of Iceland (Va) in the years 2000 – 2009 The thin solid line is average of 1985-2009 and the thick red solid line is annual distribution.

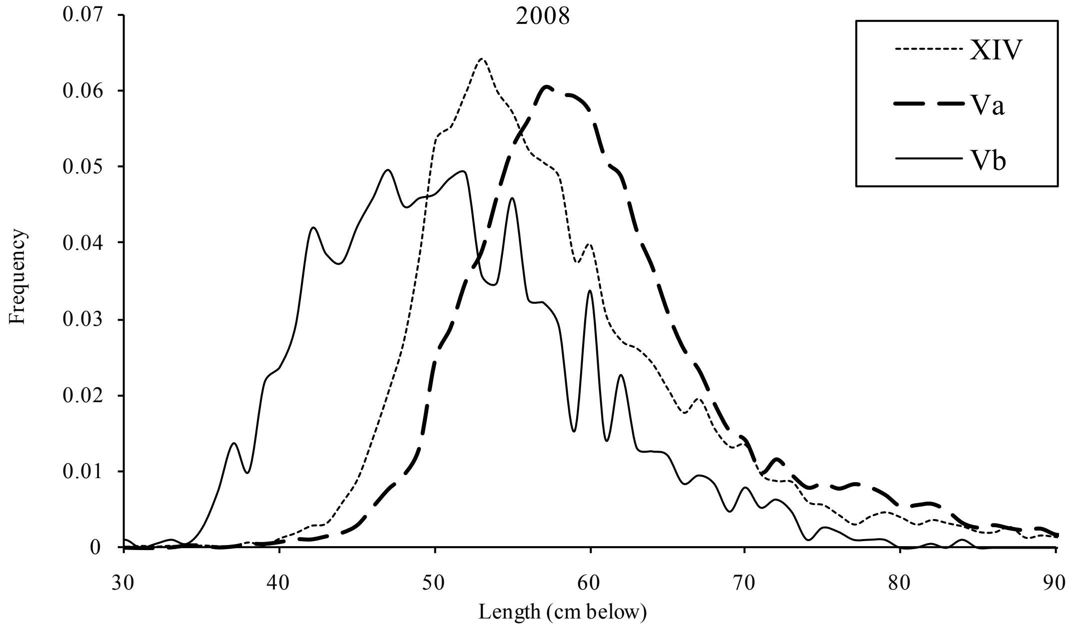

Figure 15.4.2. Length distributions of Greenland halibut caught in the commercial fishery in ICES Va, Vb and XIV in 2008.

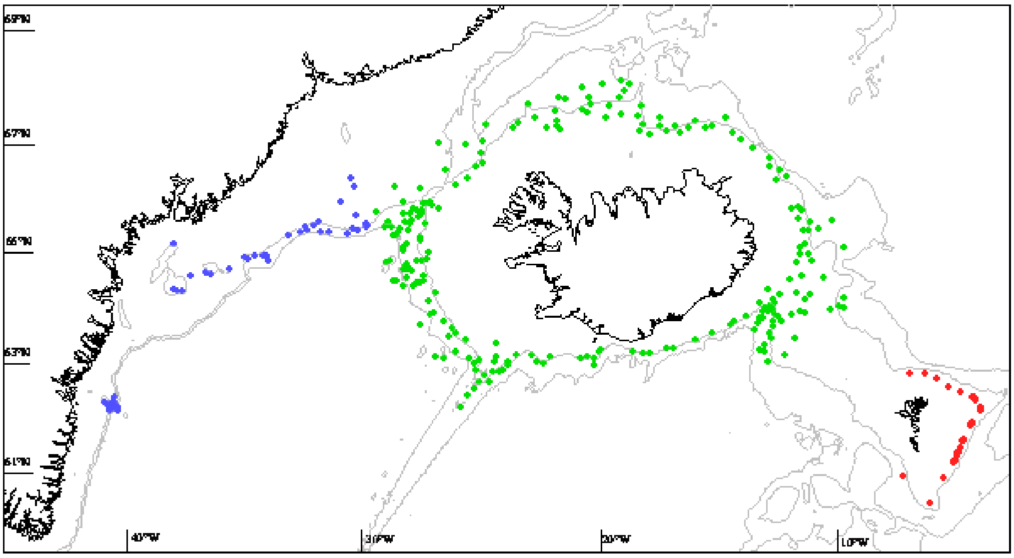

Figure. 15.5.1. Surveyed area in XIV+V indicated as station positions in 2008 by the Greenland (n=46), Iceland (n=219) and Faroese surveys (n=42).

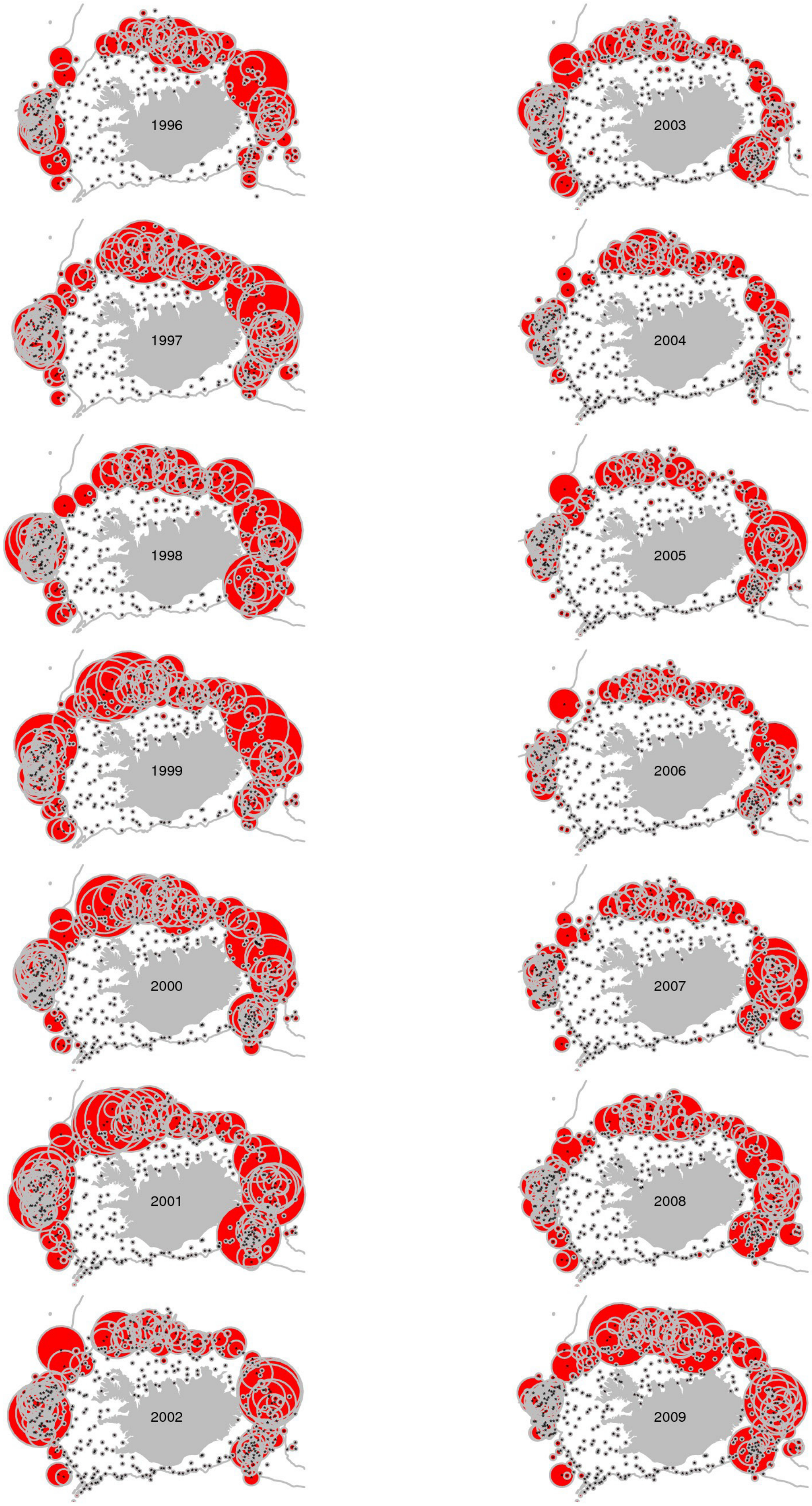

Figure. 15.5.2. Distribution of catches from the Icelandic fall survey 1996-2009.

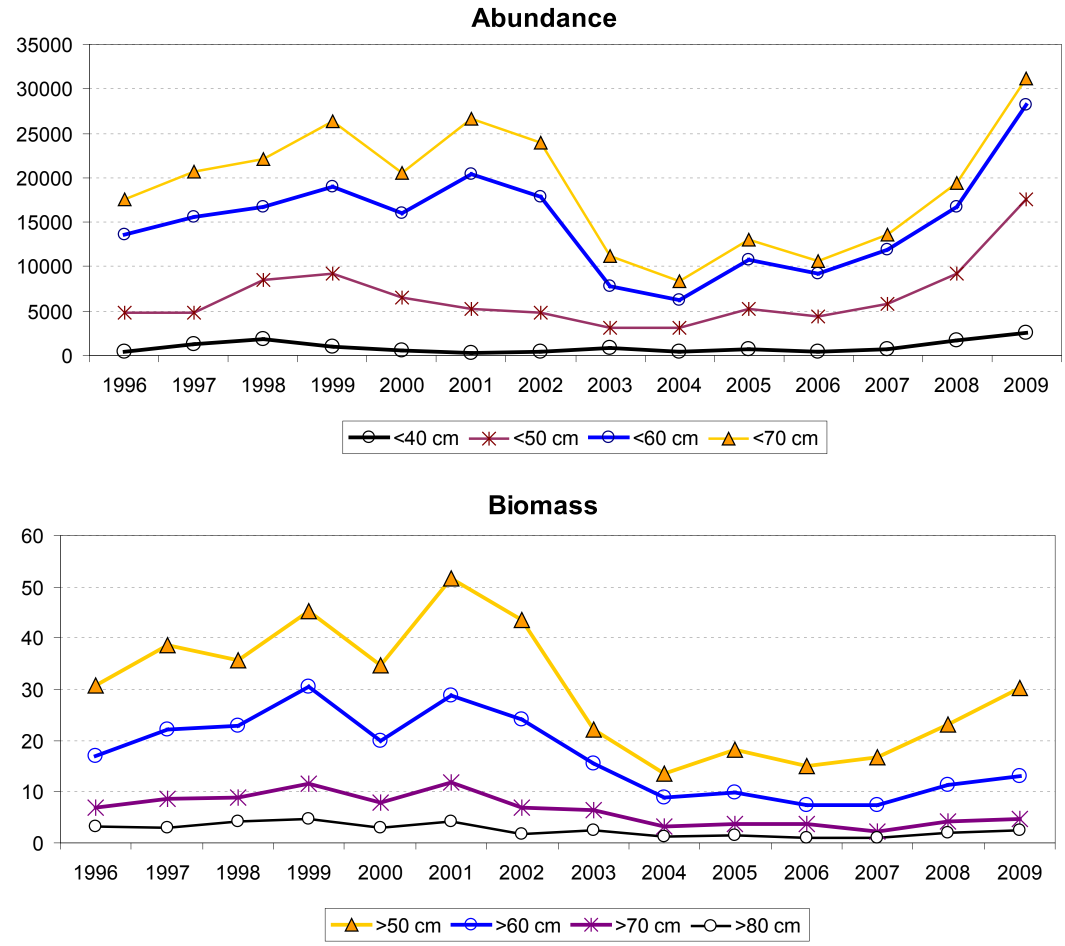

Figure 15.5.3. Greenland halibut in Icelandic fall groundfish survey.

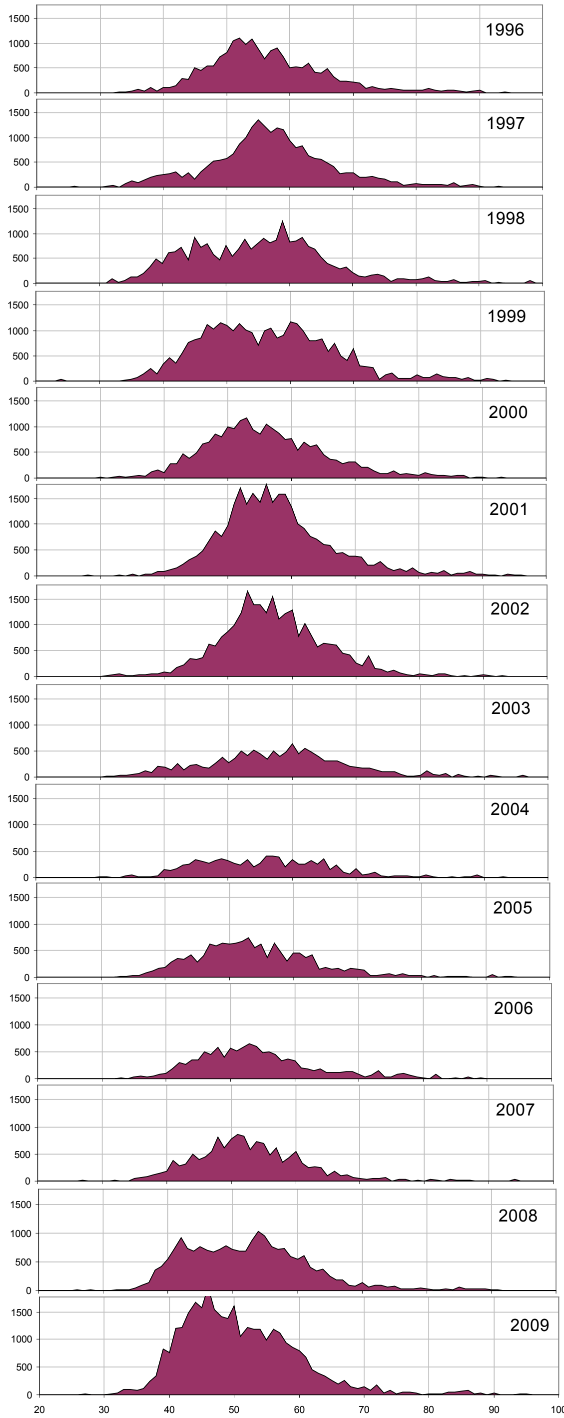

Figure 15.5.4. Abundance indices by length for the Icelandic fall survey 1996-2009.

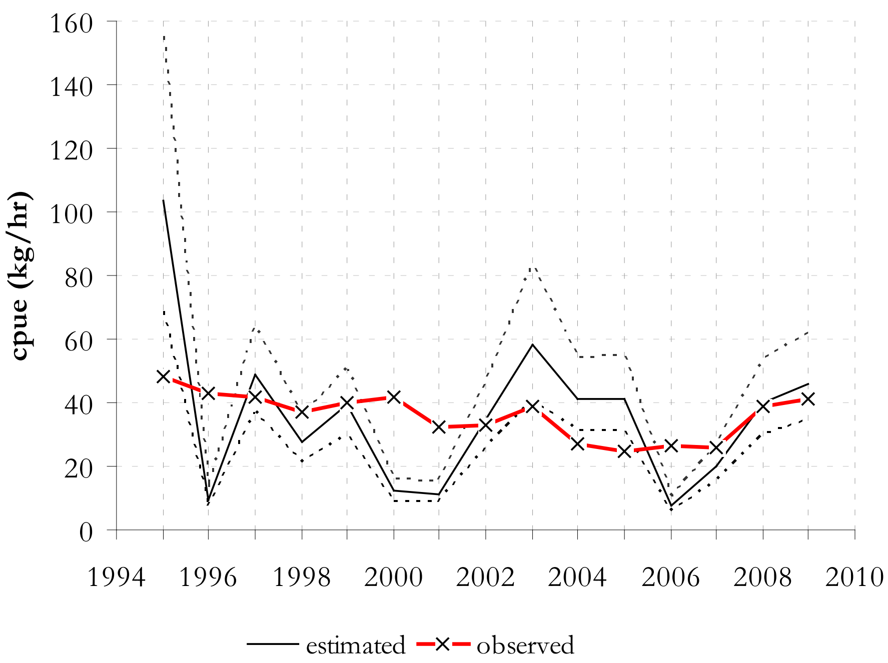

Figure 15.5.5. Catch rates from a combined survey/fishermans survey in Vb. Estimates are from a GLM model.

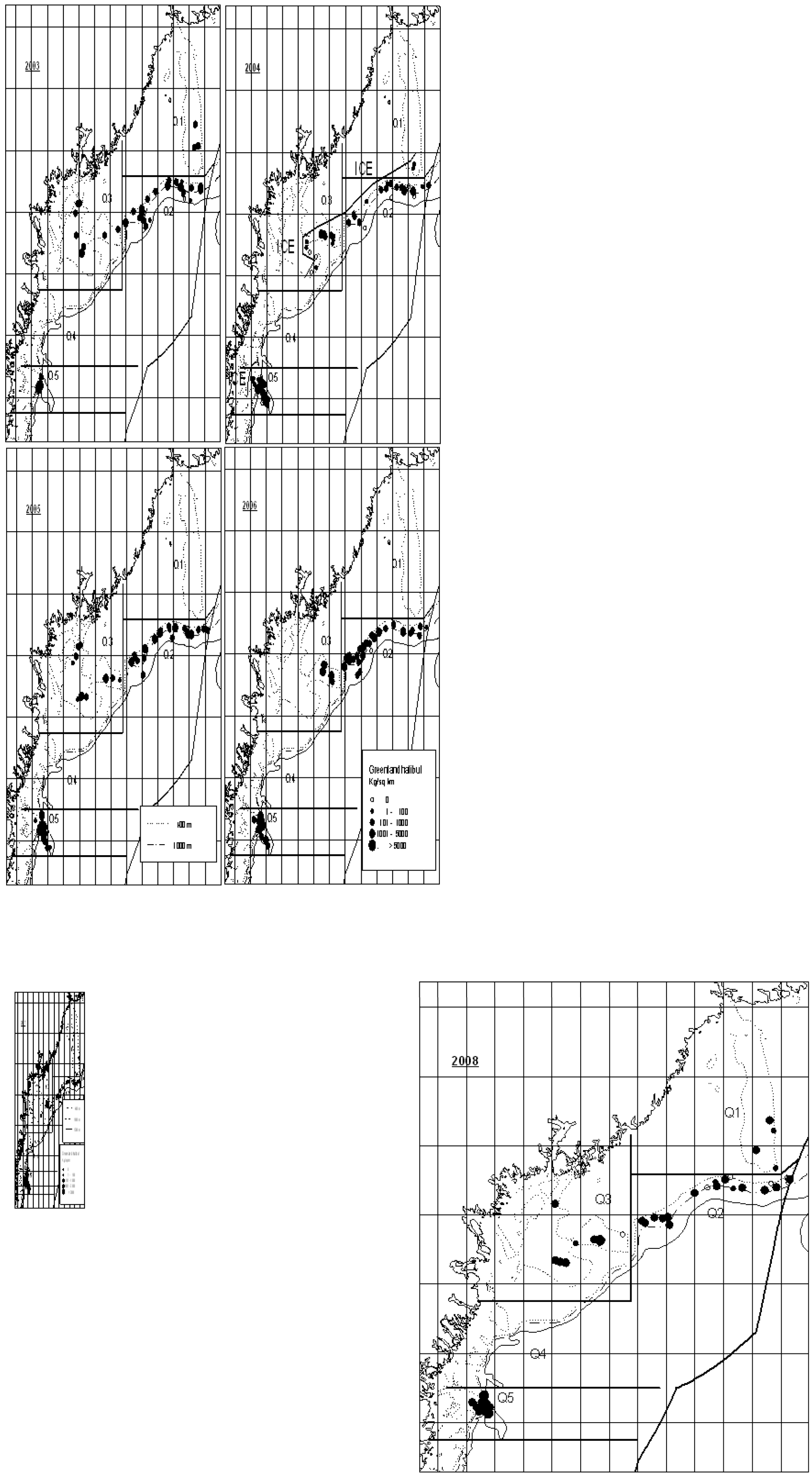

Figure 15.5.6. Distribution of catches of Greenland halibut at East Greenland in 1998 – 2008 in the Greenland deep-water survey.

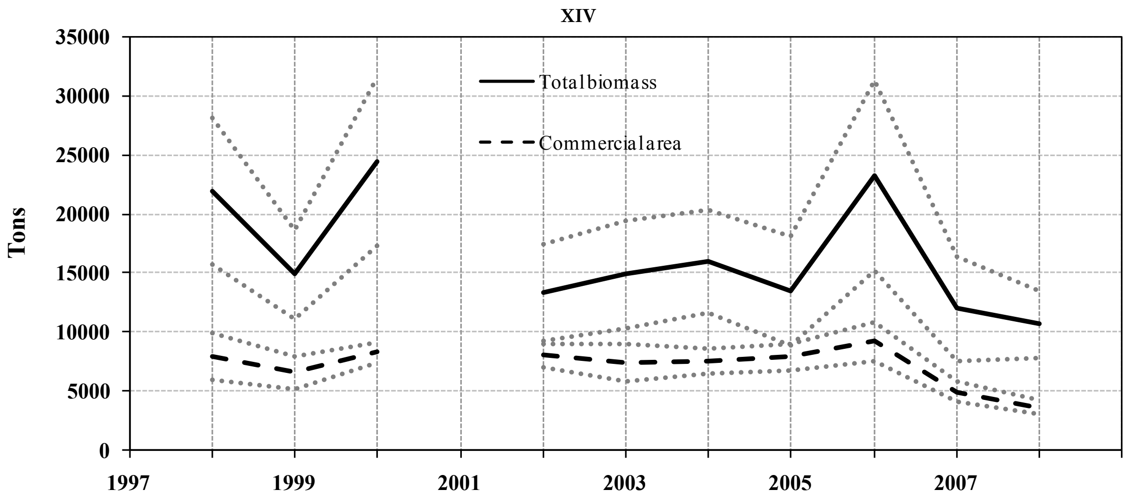

Figure 15.5.7. Estimated Biomass (t) in div. XIVb from the Greenland deep-water trawl survey with 95% CI indicated.Biomass Tot is is swept area estimates for the entire survey area, Biomass Com.is swept area estimates for strata Q2 and Q5 covered all years.

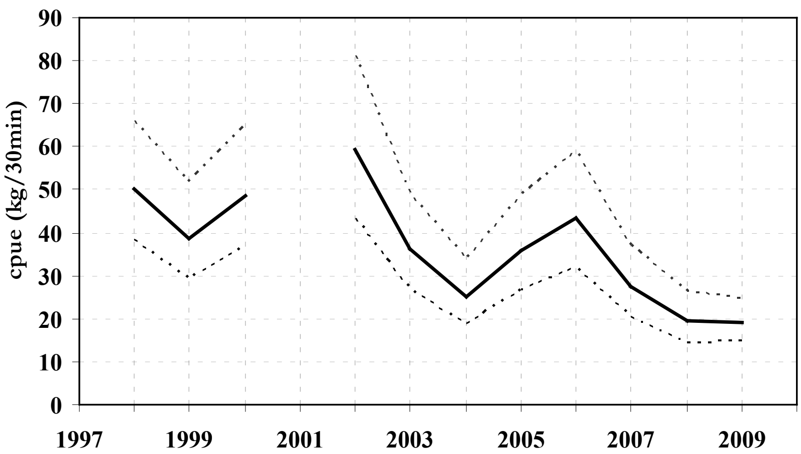

Figure 15.5.8. Standardised catch rates from the Greenland survey.(95% CI indicated.)

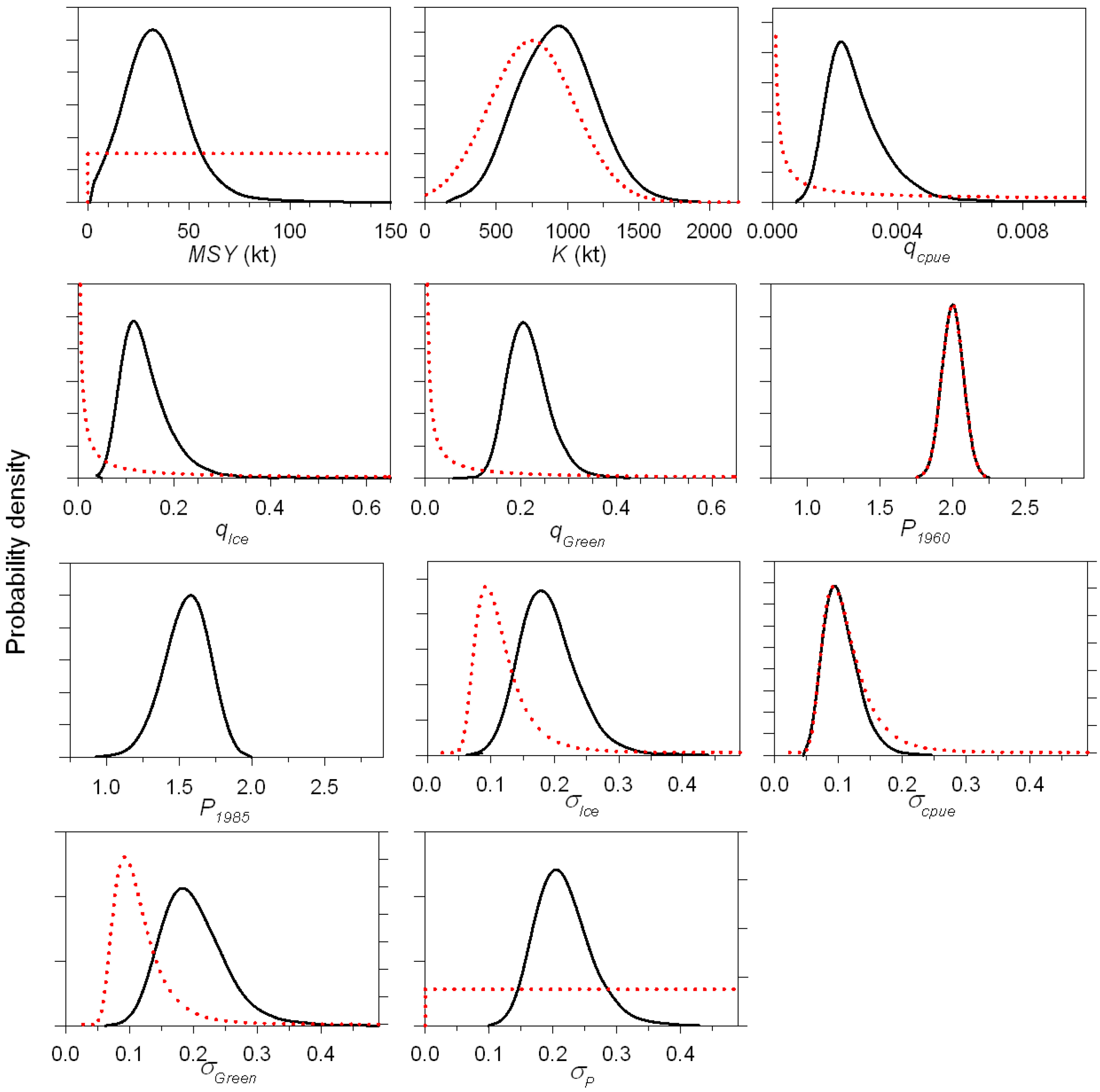

Figure 15.6.1. Probability density distributions of model parameters: estimated posterior (solid line) and prior (broken line) distributions.

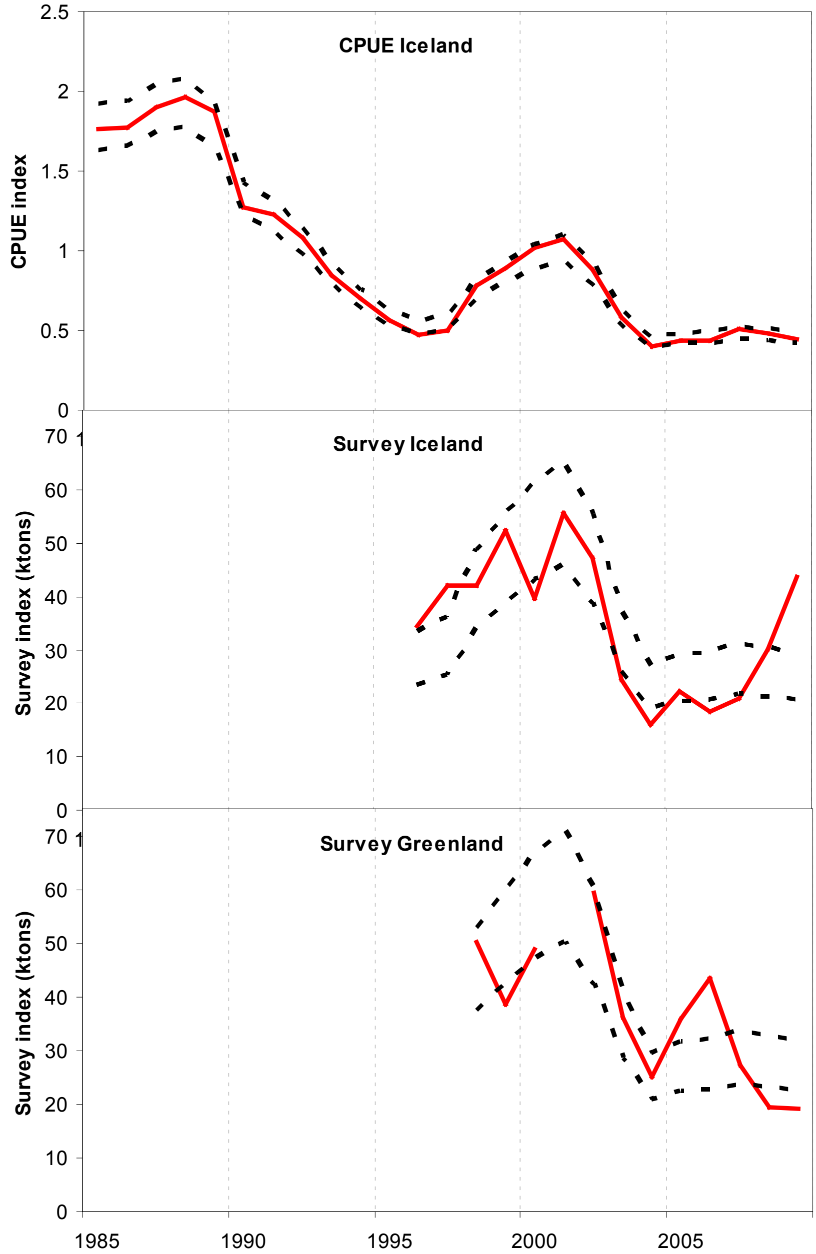

Figure 15.6.2. Observed (red curve) and predicted (dashed lines) series of the biomass indices used as input to the model. Gray shaded areas are inter-quartile range of the posteriors.

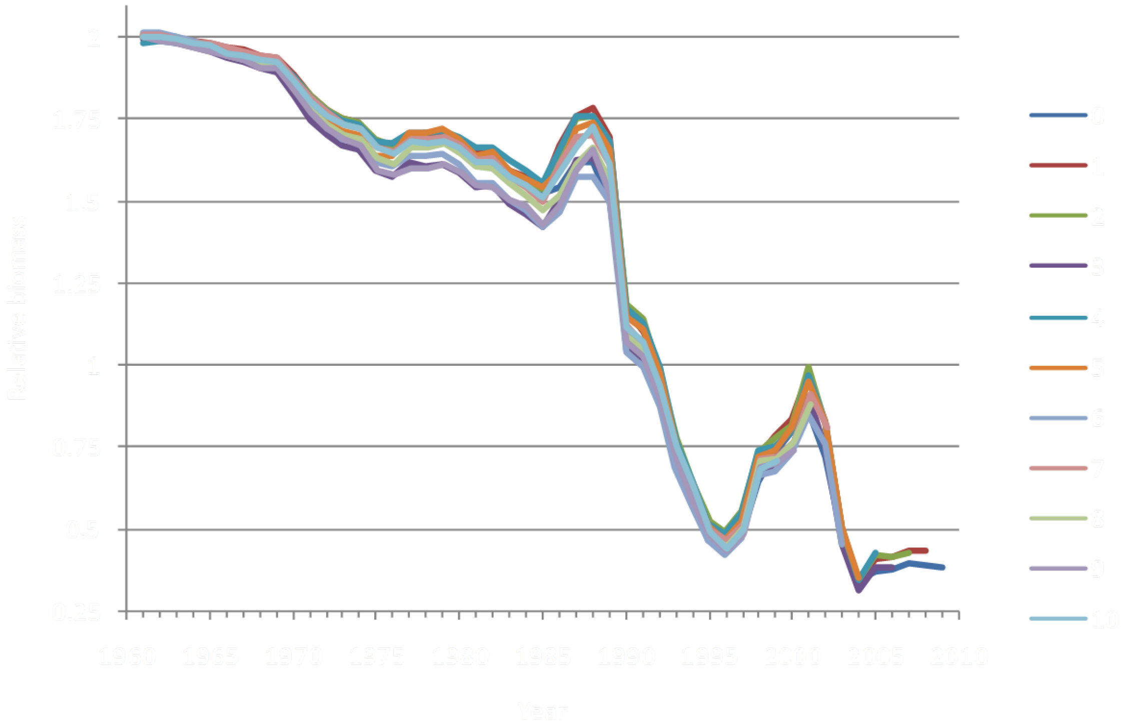

Figure 15.6.3. Retrospective plot of median relative biomass (*B*/B_{msy}). Relative biomass series are estimated by consecutively leaving out from 0 to 9 years of data.

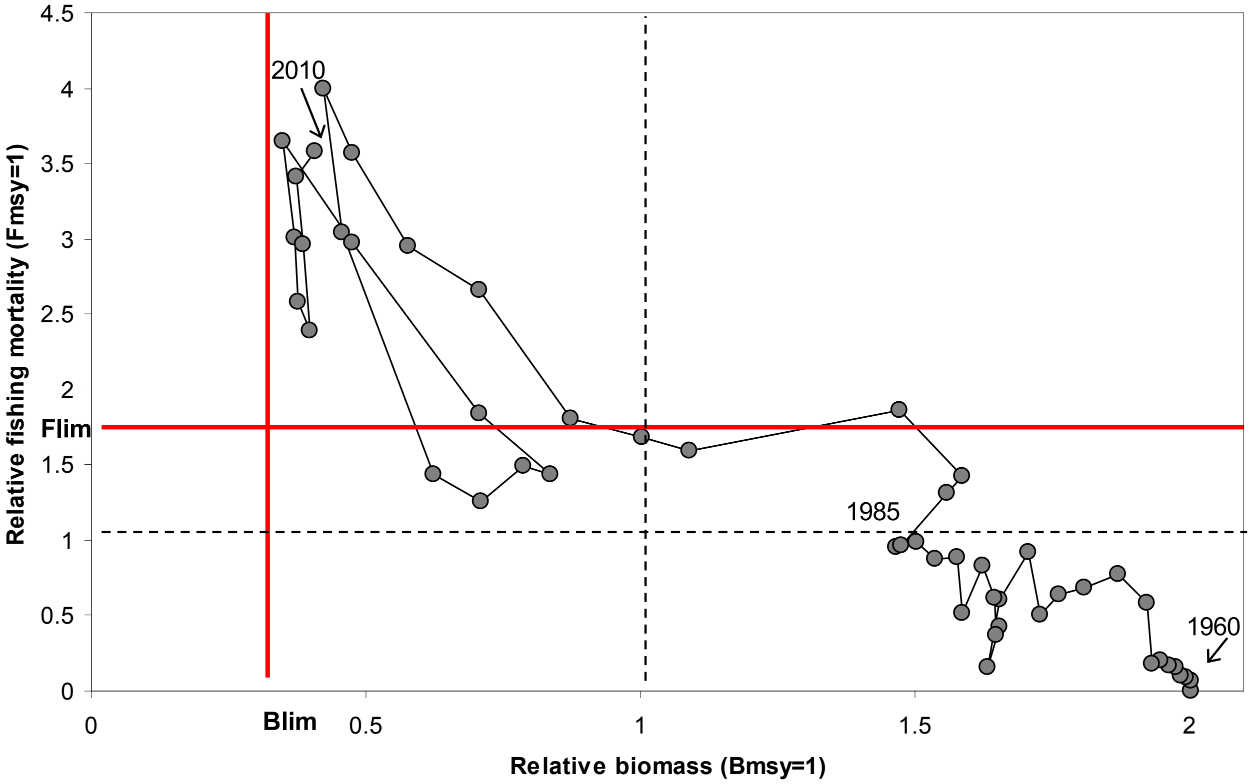

Figure 15.6.4. Estimated annual median biomass-ratio (B/BMSY) and fishing mortality-ratio (F/FMSY) 1985-2010. Previously suggested PA reference points for stock biomass, Blim, and fishing mortality, Flim, are indicated by red lines.

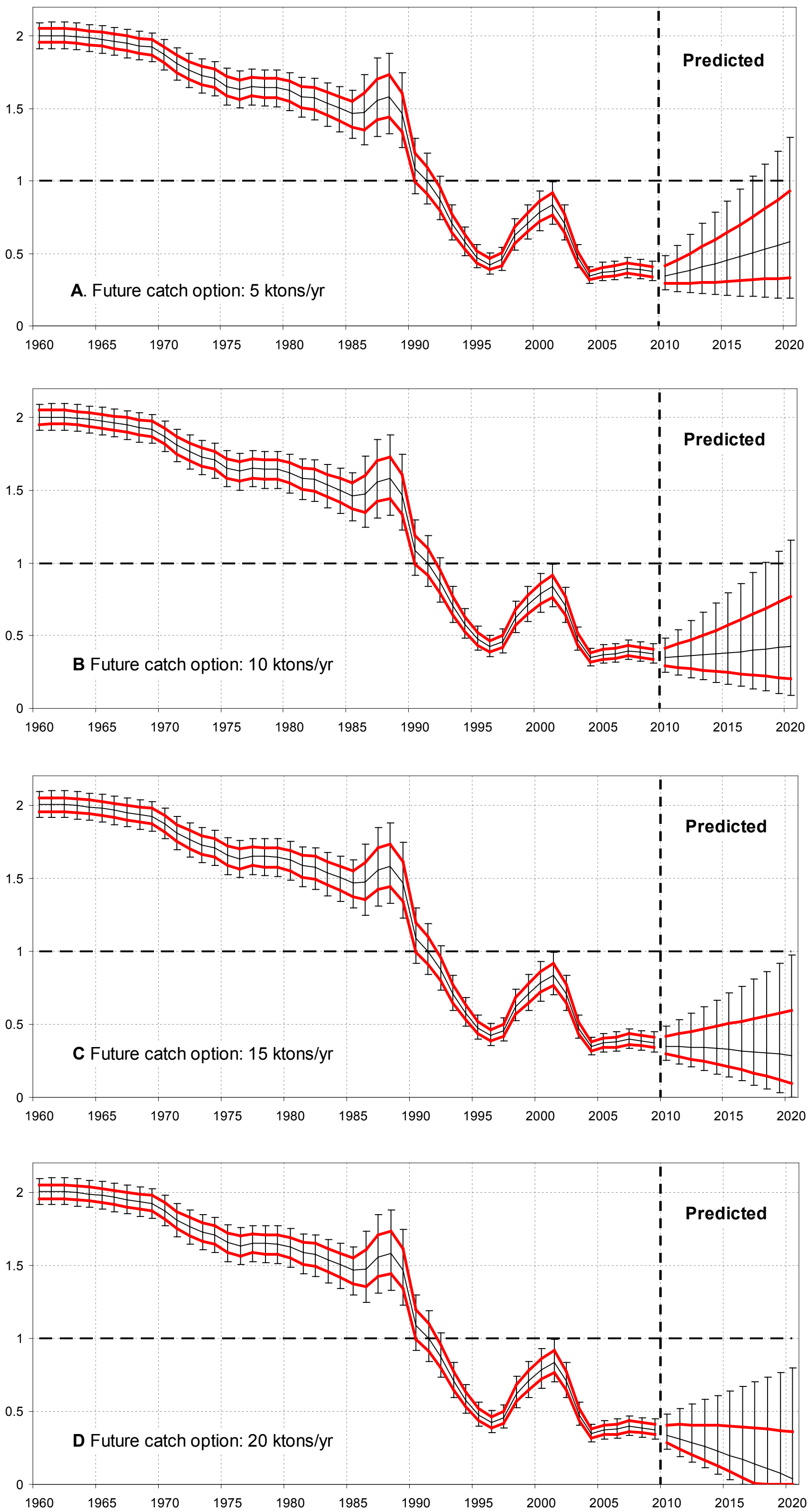

Figure 15.6.5. Estimated time series of relative biomass (B_t/B_{msy}). Bold red lines are inter-quartile ranges and the solid black line is the median; the error bars extend to cover the central 90 per cent of the distribution.

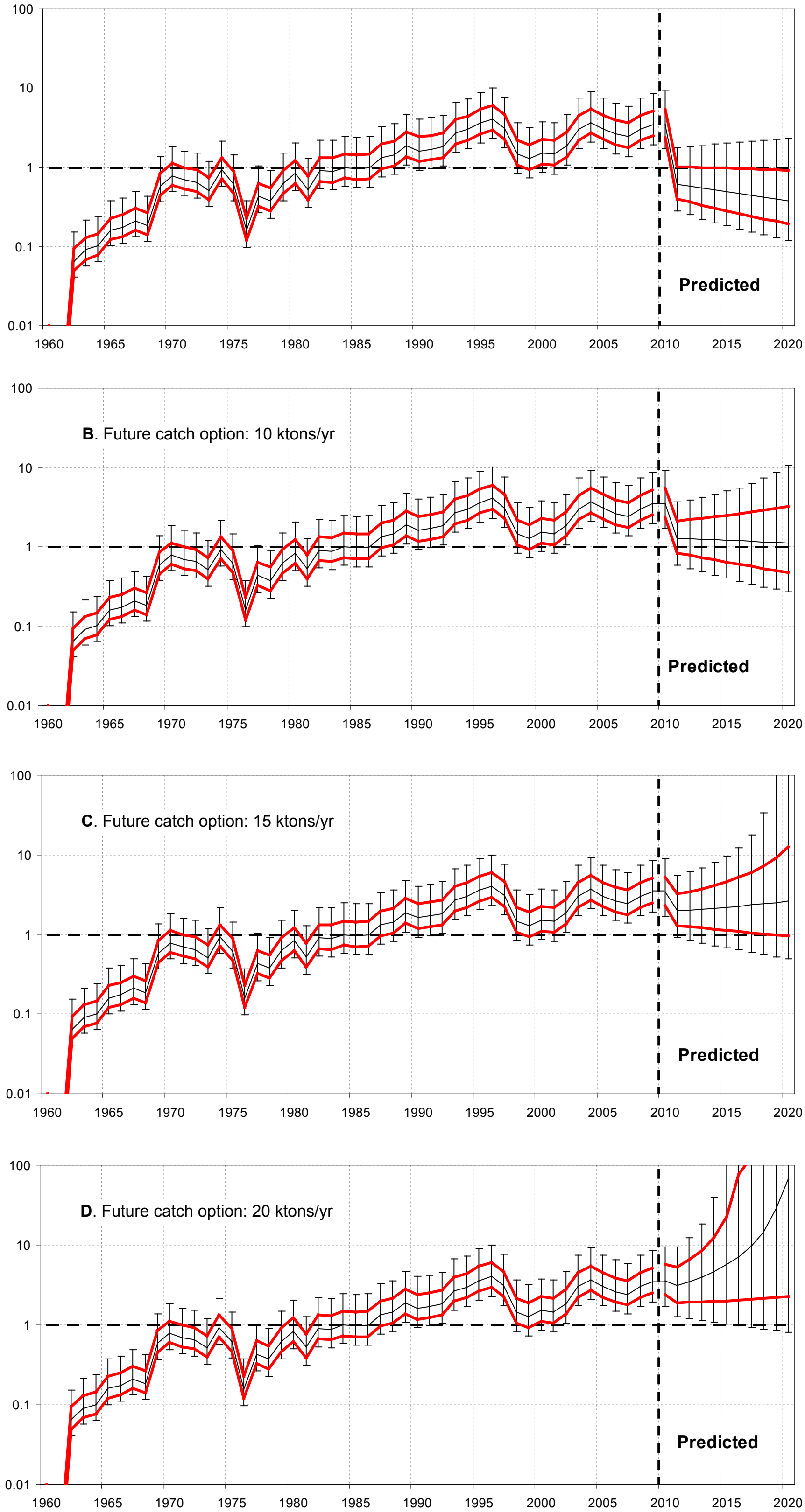

Figure. 15.6.6 Estimated time series of relative biomass (F_t/F_{msy}). Bold red lines are inter-quartile ranges and the solid black line is the median; the error bars extend to cover the central 90 per cent of the distribution.

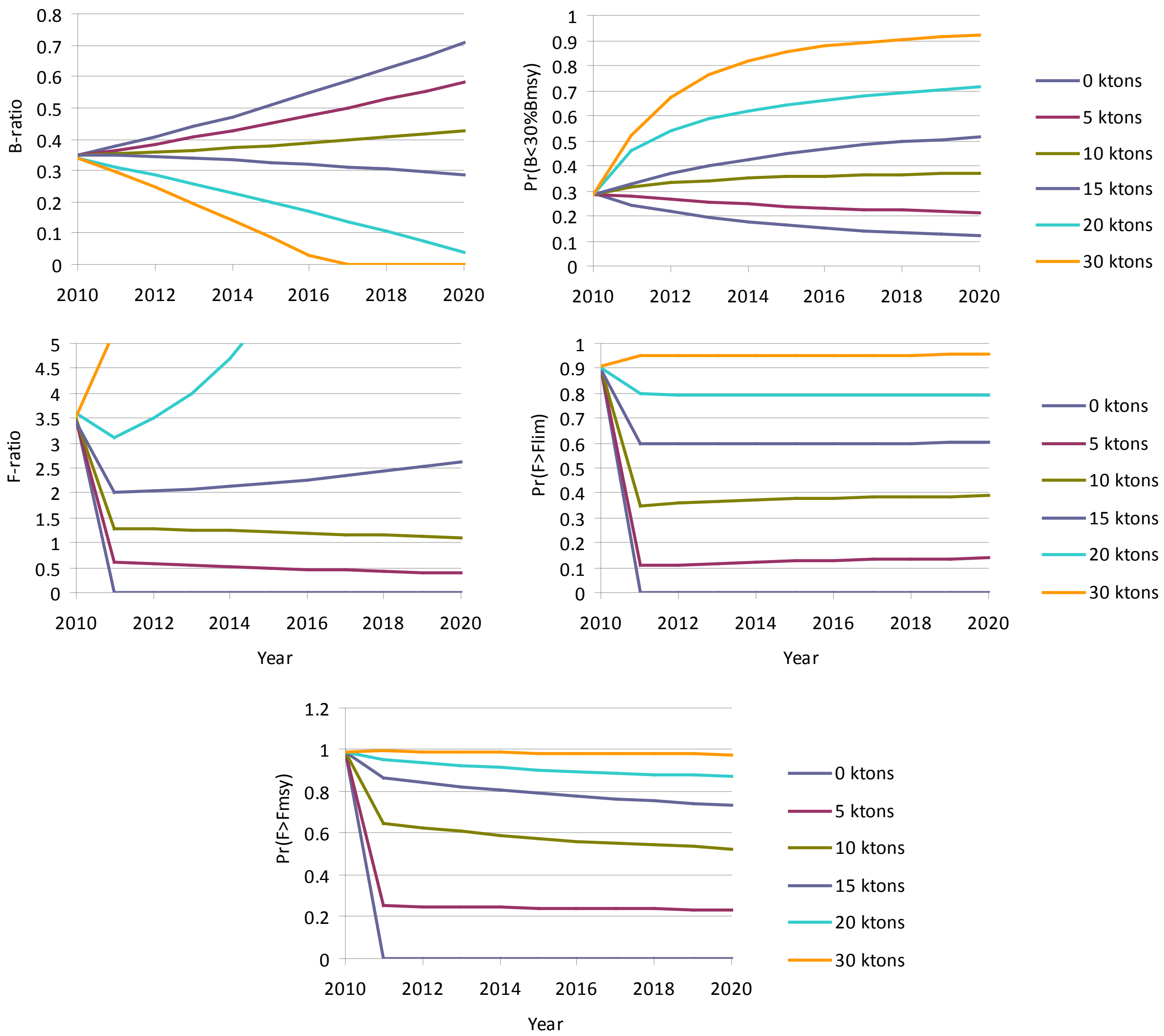

Figure 15.6.7. Projections: Medians of estimated posterior biomass- and fishing mortality ratios; estimated risk of exceeding F_{msy} and F_{lim} (1.7F_{msy}) or going below and B_{lim} given catches at 0, 5,10, 15, 20 and 30 ktons.

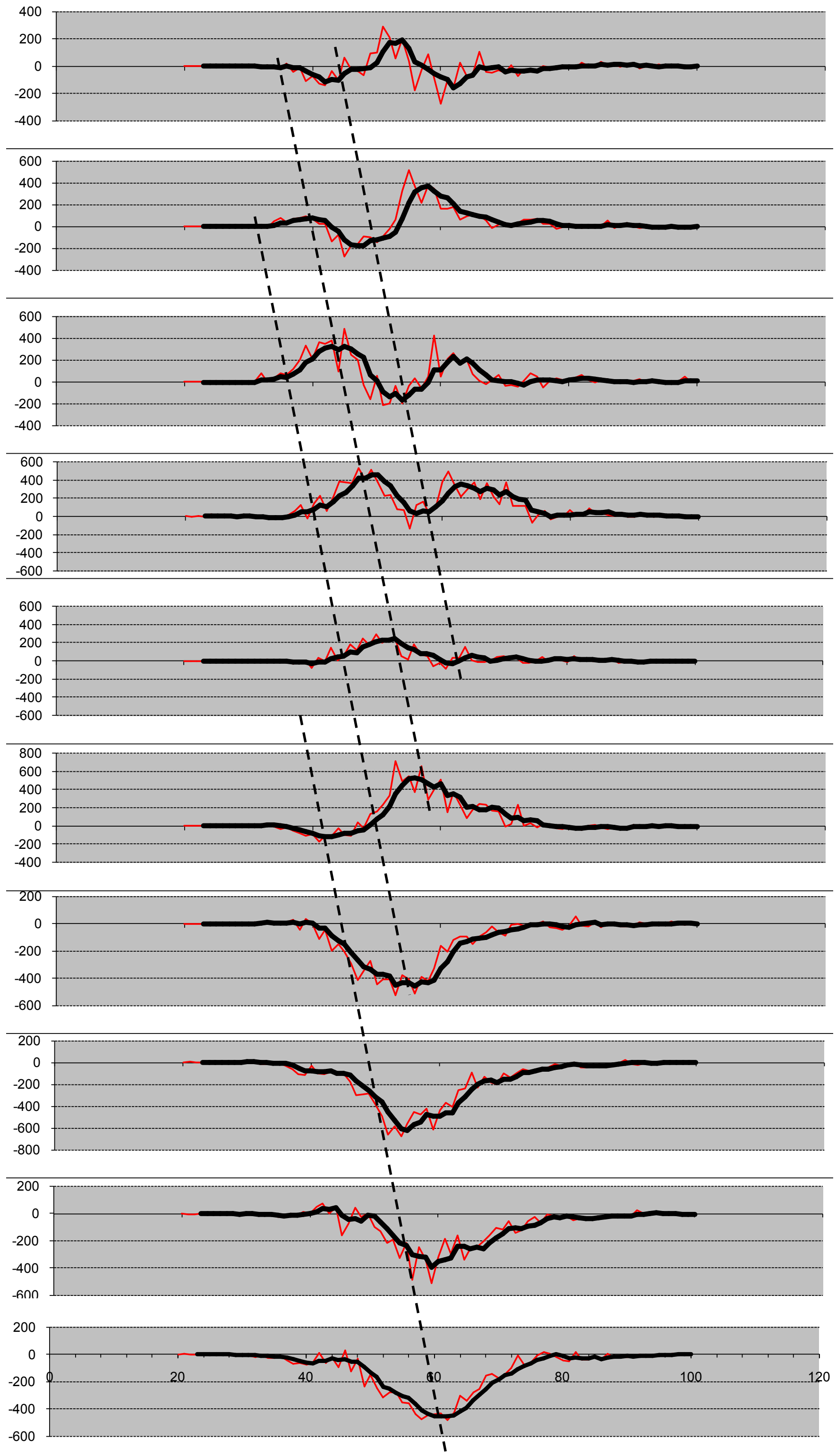

Figure 15.6.8. Length frequencies of GHL from the Icelandic survey 1996 (*top*)-2005(*bottom*) shown as deviations from the mean. Dotted lines indicate traceable recruitment modes consisting of several yearclasses

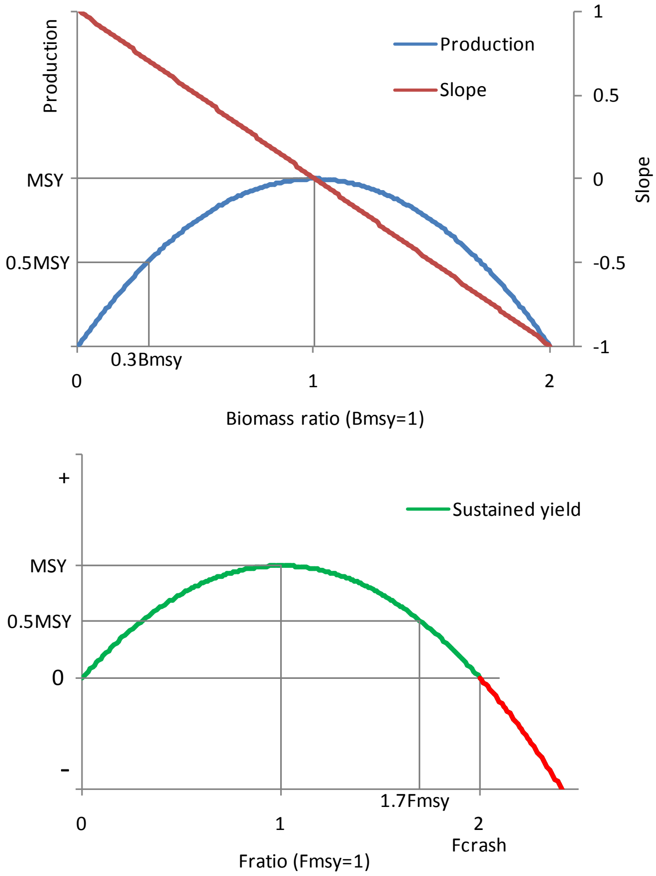

Figure 15.6.9. The logistic production curve in relation to stock biomass (B/Bmsy) (*upper*) and fishing mortality (F/Fmsy) (*lower*). *Upper*: points of maximum sustainable yield (MSY) and corresponding stock size are shown as well as the slope (red line) of the production curve (blue line); *lower*: points of MSY and corresponding fishing mortality and Fcrash (F≥Fcrash do not have stable equilibriums and will drive the stock to zero).

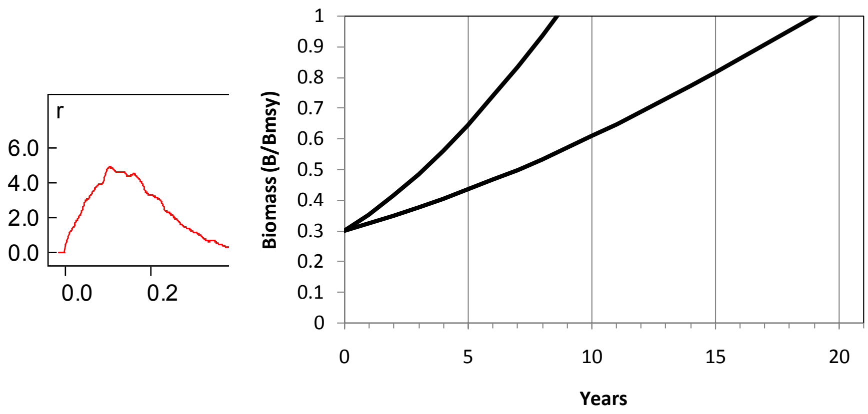

Figure 15.6.10. ***Left:*** **The posterior probability density distribution of *r*, the intrinsic rate of growth. Right: estimated recovery time from Blim (0.3Bmsy) to Bmsy (relative biomass = 1) given *r*-values ranging within the 95% conf. lim. of the posterior (left figure) and no fishing mortality.**

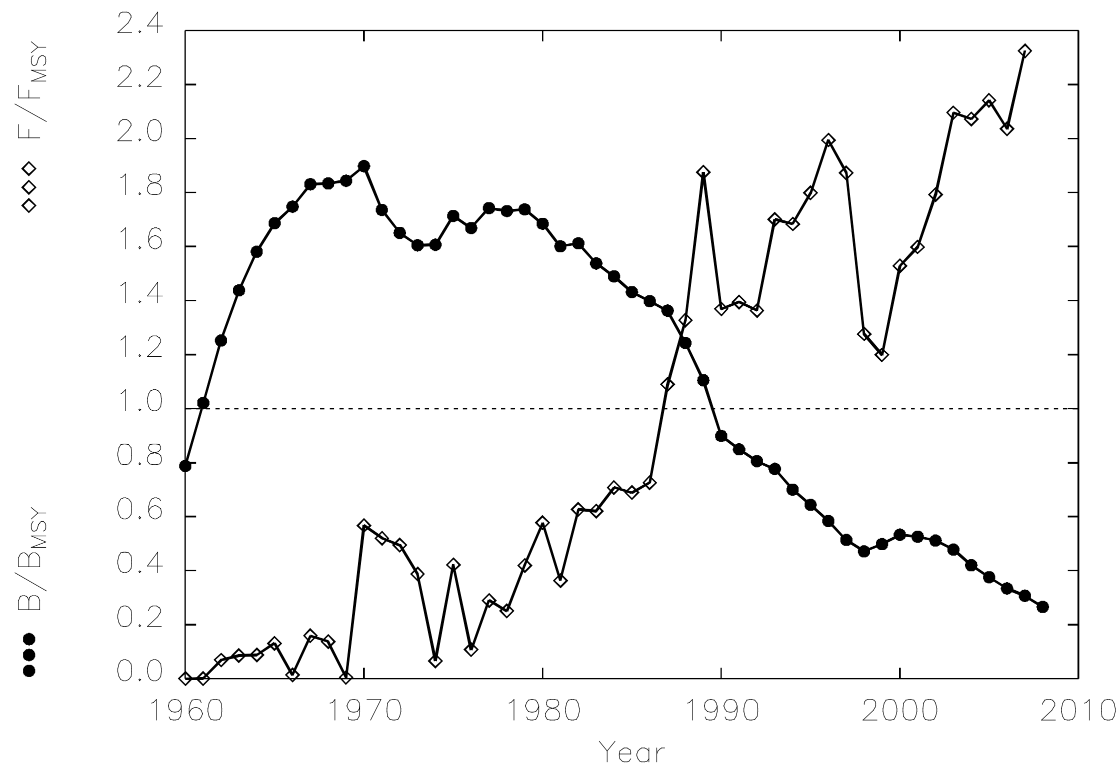

Figure 15.6.11. Relative biomass and fishing mortality from an exploratory ASPIC run with same input series as used in the Bayesian model.

16 Redfish in Subareas V, VI, XII and XIV

This chapter deals with fisheries directed to *Sebastes* species in Subareas V, VI, XII and XIV (chapters 16.4 and 16.6), and the abundance and distribution of juveniles (chapter 16.2.1), among other issues.

The "Workshop on Redfish Stock Structure" (WKREDS, 22-23 January 2009, Copenhagen, Denmark; ICES 2009) reviewed the stock structure of *Sebastes mentella* in the Irminger Sea and adjacent waters. ACOM concluded, based on the outcome of the WKREDS meeting, that there are three biological stocks of *S. mentella* in the Irminger Sea and adjacent waters:

- a 'Deep Pelagic' stock (NAFO 1–2, ICES V, XII, XIV >500 m) – primarily pelagic habitats, and including demersal habitats west of the Faeroe Islands;
- a 'Shallow Pelagic' stock (NAFO 1–2, ICES V, XII, XIV <500 m) – extends to ICES I and II, but primarily pelagic habitats, and includes demersal habitats east of the Faeroe Islands;
- an 'Icelandic Slope' stock (ICES Va, XIV) – primarily demersal habitats.

This conclusion is primarily based on genetic information, i.e. microsatellite information, and supported by analysis of allozymes, fatty acids and other biological information on stock structure, such as some parasite patterns.

The adult redfish on the Greenland shelf has traditionally been attributed to several stocks, and there remains the need to investigate the affinity of adult *S. mentella* in this region. The East-Greenland shelf is most likely a common nursery area for the three biological stocks.

ICES past advice for *S. mentella* fisheries was provided for two distinct management units, i.e. a demersal unit on the continental shelves and slopes and pelagic unit in the Irminger Sea and adjacent waters. However, based on the new stock identification information, ICES recommends three potential management units that are geographic proxies for biological stocks that were partly defined by depth and whose boundaries are based on the spatial distribution pattern of the fishery to minimize mixed stock catches (see Figure 16.1.1):

Management Unit in the northeast Irminger Sea: ICES Areas Va, XII, and XIV.

Management Unit in the southwest Irminger Sea: NAFO Areas 1 and 2, ICES areas Vb, XII and XIV.

Management Unit on the Icelandic slope: ICES Areas Va and XIV, and to the north and east of the boundary proposed in the MU in the northeast Irminger Sea.

The pelagic fishery in the Irminger Sea and adjacent waters shows a clear distinction between two widely separated grounds fished at different seasons and depths. Spatial analysis of the pelagic fishery catch and effort by depth, inside and outside the boundaries proposed for the management units in the northeast Irminger Sea, indicate that the boundaries effectively delineate the pelagic fishery in the northeast Irminger Sea from the pelagic fishery in the southwest Irminger Sea, with a small portion of mixed-stock catches. The northeastern fisheries on the pelagic *S. mentella* occur at the start of the fishing season at depths below 500 m and overlap to some extent with demersal fisheries on the continental slopes of Iceland (Sigurdsson et al., 2006).

A schematic illustration of the relationship between the management units and biological stocks is given in Figure 16.1.2.

For the abovementioned reasons, the Group now provides advice for the following *Sebastes* units:

- the *S. marinus* on the continental shelves of ICES Divisions Va, Vb and Subarea VI and XIV (chapter 17),
- the demersal *S. mentella* on the Icelandic slope (chapter 18),
- the shallow and deep pelagic S. mentella units in the Irminger Sea and adjacent waters (chapters 19 and 20, respectively),
- the Greenland shelf *S. mentella* (chapter 21);

As it has been expressed in previous reports (WKREDS-2009, Annex 4; NWWG-2009, chapter 16.8; ICES ASC Document ICES CM 2009/E: 15; ACOM advice, etc.) there is not a consensus among scientists, neither on the biological stock structure of *S. Mentella* in the Irminger Sea, nor on the approach used in reaching the conclusion with regards to biological stocks and management units.

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. Larvae extrusion 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 Faeroe Islands, Iceland and Greenland is given in chapters 2, 7 and 13 respectively.

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 18), 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 16.2.1). In 2008, the lowest survey index was recorded since 1982. 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 1999-2008 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 commercially exploited redfish in ICES Subarea V, VI, XII, and XIV *S. marinus*, *S. mentella* and *S. viviparus*. This last one has only been of a minor commercial value in Icelandic waters and it 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 16.4.1) due to decreased commercial interest in this species. The landings in 2009 amounted to 37 t, more than a twofold increase in comparison with 2009.

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 previously (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 ranged 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 and in 2008-2009. 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 16.4.1). The pelagic catches of demersal *S. mentella* were taken in similar areas and depths as the bottom trawl catches (Figure 16.4.2). The vertical and horizontal distribution of the pelagic catches focused, however, on smaller areas and shallower depth layers than the bottom trawl catches. The seasonal distribution by depth (Figure 16.4.3) shows that the pelagic catches of demersal *S. mentella* were in general taken in autumn, and overlapped in June with the traditional pelagic fishery only in 2003 and 2007. 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 in Iceland by gear and area are given in Figure 16.4.4. During 1994-1999 and in 2003, the fish taken with pelagic trawls were considerably larger than the fish caught with bottom trawls, but they 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.

Pelagic *S. mentella* fishery data not divided by stock

Data from the Russian fishery for pelagic redfish in 2009 are presented here because they are not disaggregated by depth. Figure 16.4.5 shows the spatial and temporal distribution of Russian catches . The fleet stayed along the Reykjanes Ridge and right outside the Icelandic EEZ, where catches were higher in most months. Russian non-standardized CPUE for the period 1997-2009 in Divisions XII and XIV and NAFO Divisions 1F, 2H and 2J is shown in Figure 16.4.6. Length distribution and age structure disaggregated by sex in Russian catches are shown in Figures 16.4.7 and 16.4.8, respectively. Length for both males and females peaked at 38.1 cm. The predominant ages in catches were 16 and 18 for males and 17 for females , More updated information on the Russian fishery can be found in Popov and Roslkiy (NWWG 2010, WDXX).

16.5 Biological sampling

Biological samples are taken both in national and international surveys and from the commercial catches. They consist of length measurements, otolith collection, stomach contents, sex and maturity stages. The following samples were taken by several nations during 2009:

Country	Area	No. of samples	No. of fish measured
Portugal	XII	5	400
	XIV	27	1240
Russia	XIV	NA	18,147
Spain	XII	14	1483
	XIV	24	3348
Iceland	XIV (deep)	54	7693

16.6 Demersal *S. mentella* in Vb and VI

16.6.1 Demersal *S. mentella* in Vb

16.6.1.1 Surveys

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 are not used to evaluate the stock status.

16.6.1.2 Fisheries

In Division Vb, landings gradually decreased from 15,000 t in 1986 to about 5,000 t in 2001 (Table 16.6.1). Since then the landings have varied between 1,400 and 4,000 t. The landings in 2009 were close to 1,100 t, increasing about 30% respect to 2008.

Length distributions from the landings in 2001-2008 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 16.6.1).

Non-standardized CPUE indices in Division Vb were obtained from the Faroese otter board (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 16.6.1). In 2005, the CPUE decreased to the lowest level in the time series and has since then been close to the Upa level. In 2009 CPUE increased slightly in comparison with the previous three years (Figure 16.6.2).

Fishing effort has decreased since the beginning of the time series and has been the lowest in the time series in 2008 and 2009.

16.6.2 Demersal *S. mentella* in VI

16.6.2.1 Fisheries

In Subarea VI, the annual landings varied between 200 t and 1 100 t in 1978-2000 (Table 16.6.1). The landings from VI in 2004 were negligible (6 t), the lowest recorded since 1978. They increased again to 111 t in 2005 and 179 t in 2006. The reported landings in 2008 were 50 t and no catches were taken in 2009.

16.7 Regulations (TAC, effort control, area closure, mesh size etc.)

Management of redfish differs between stock units and is described in sections 17.14 for *S. marinus*, section 18.7 for demersal *S. mentella*, section 19.10 for shallow pelagic *S. mentella* and section 20.10 for deep 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).

16.8 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,shallow pelagic *S. mentella* in chapter 19.2, deep pelagic *S. mentella* in chapter 20.2 and Greenland slope redfish in chapter 21.3.

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 16.4.1. 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
2008	15
2009	37

Table 16.6.1. Nominal landings (tonnes) of demersal *S. mentella* 1978-2009 by ICES Divisions.

Year	Vb	VI
1978	7 767	18
1979	7 869	819
1980	5 119	1 109
1981	4 607	1 008
1982	7 631	626
1983	5 990	396
1984	7 704	609
1985	10 560	247
1986	15 176	242
1987	11 395	478
1988	10 488	590
1989	10 928	424
1990	9 330	348
1991	12 897	273
1992	12 533	134
1993	7 801	346
1994	6 899	642
1995	5 670	536
1996	5 337	1 048
1997	4 558	419
1998	4 089	298
1999	5 294	243
2000	4 841	885
2001	4 696	36
2002	2 552	20
2003	2 114	197
2004	3 931	6
2005	1 593	111
2006	3 421	179
2007	1 376	1
2008	750	50
2009[1)]	1,077	0

[1)] **Provisional**

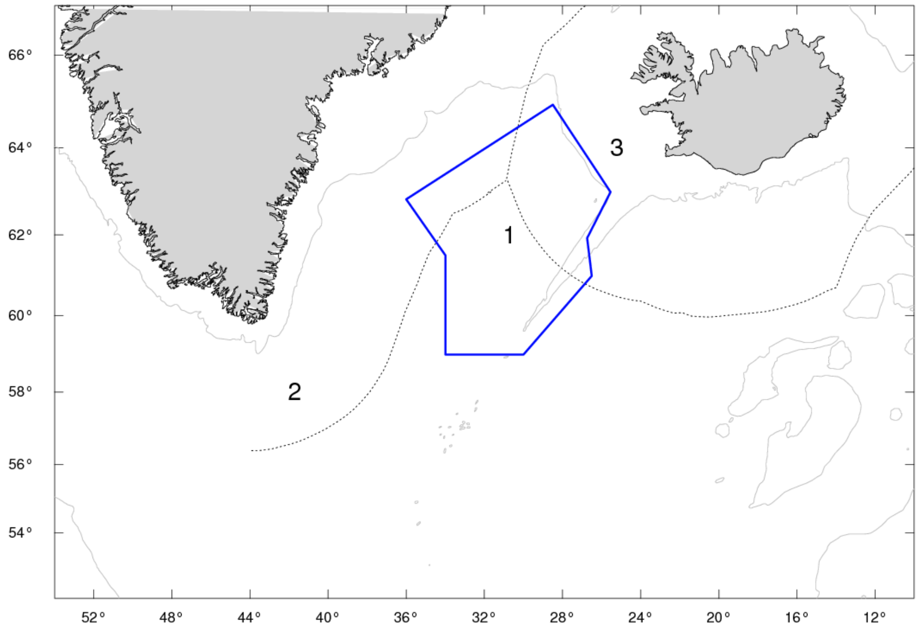

Figure 16.1.1 Potential management unit boundaries. The polygon bounded by blue lines, i.e. 1, indicates the region for the 'deep pelagic' management unit in the northwest Irminger Sea, 2 is the "shallow pelagic" management unit in the southwest Irminger Sea, and 3 is the Icelandic slope management unit.

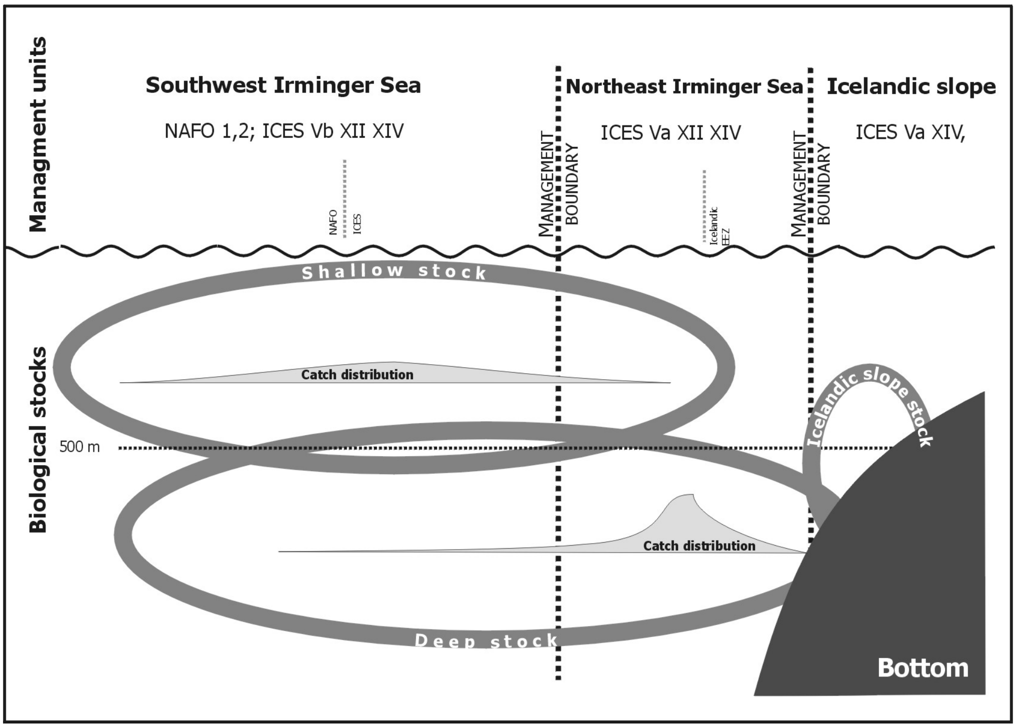

Figure 16.1.2 Schematic representation of biological stocks and potential management units of *S. mentella* in the Irminger Sea and adjacent waters. The management units are shown in Figure 16.1.1. Included is a schematic representation of the geographical catch distribution in recent years. Note that the shallow pelagic stock includes demersal *S. mentella* east of the Faroe Islands and the deep pelagic stock includes demersal *S. mentella* west of the Faroe Islands.

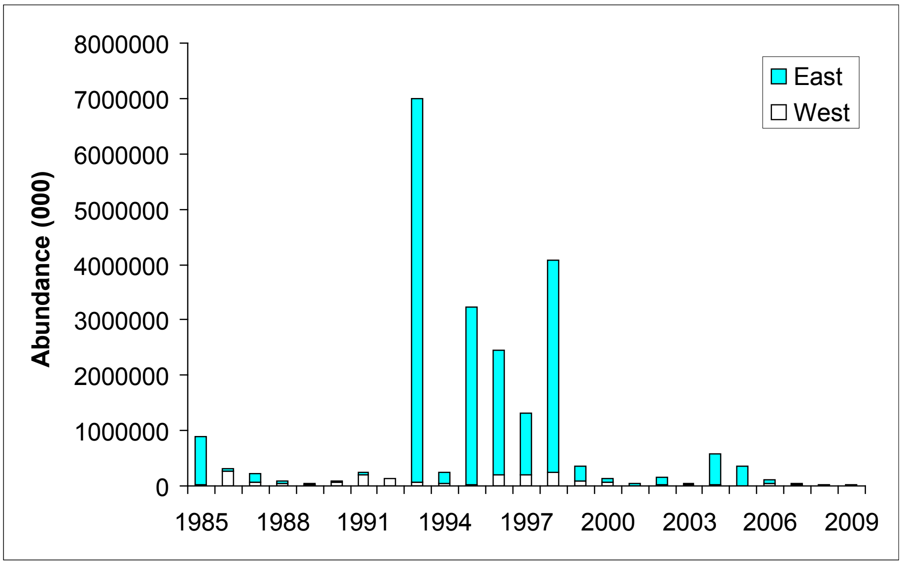

Figure 16.2.1 Survey abundance indices of juvenile *Sebastes* spp. (<17 cm) from the German groundfish survey conducted on the continental shelves off East and West Greenland 1985-2009.

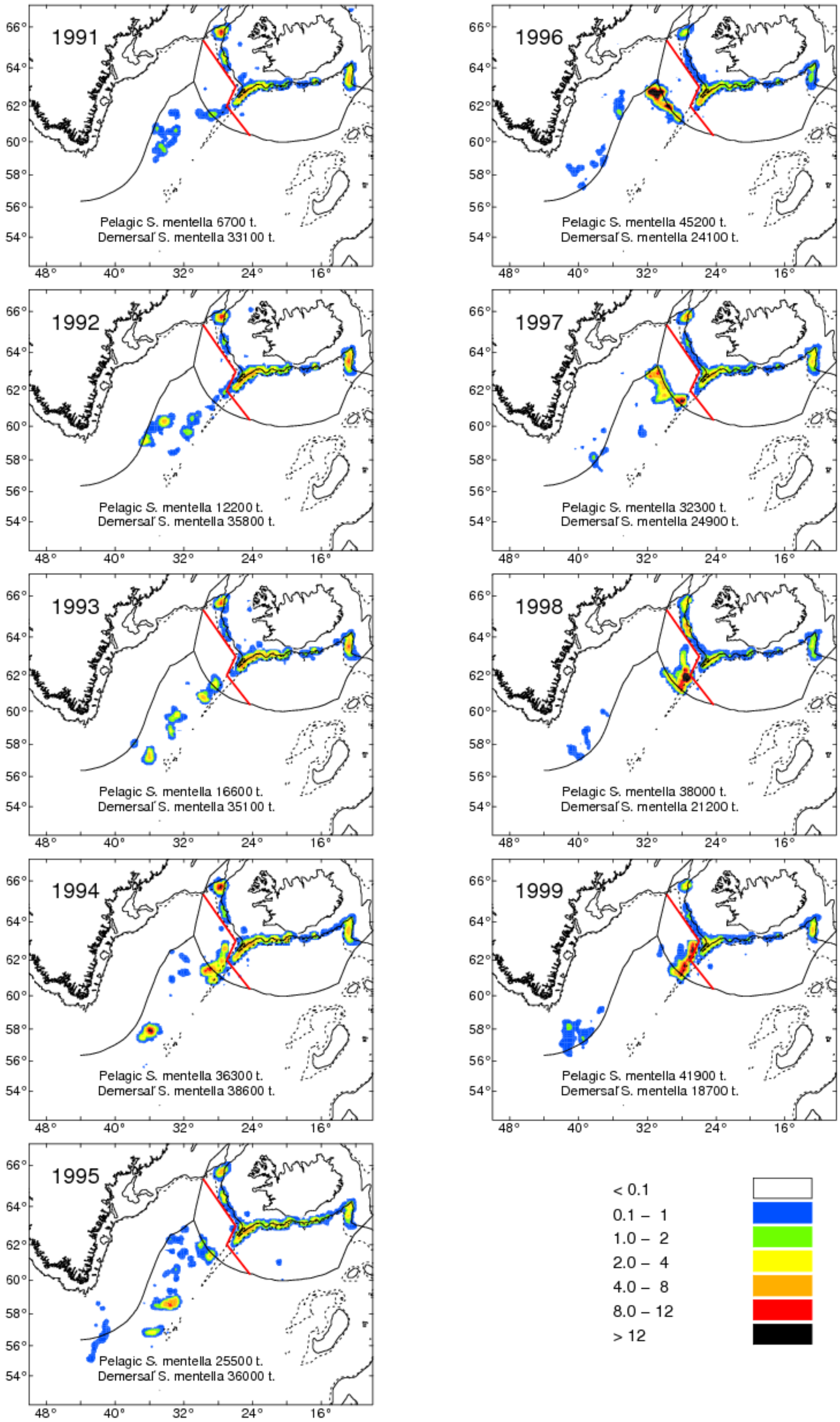

Figure 16.4.1 Geographical distribution of the Icelandic catches of *S. mentella* 1991-1999. The colour scale indicates catches (tonnes per NM²).

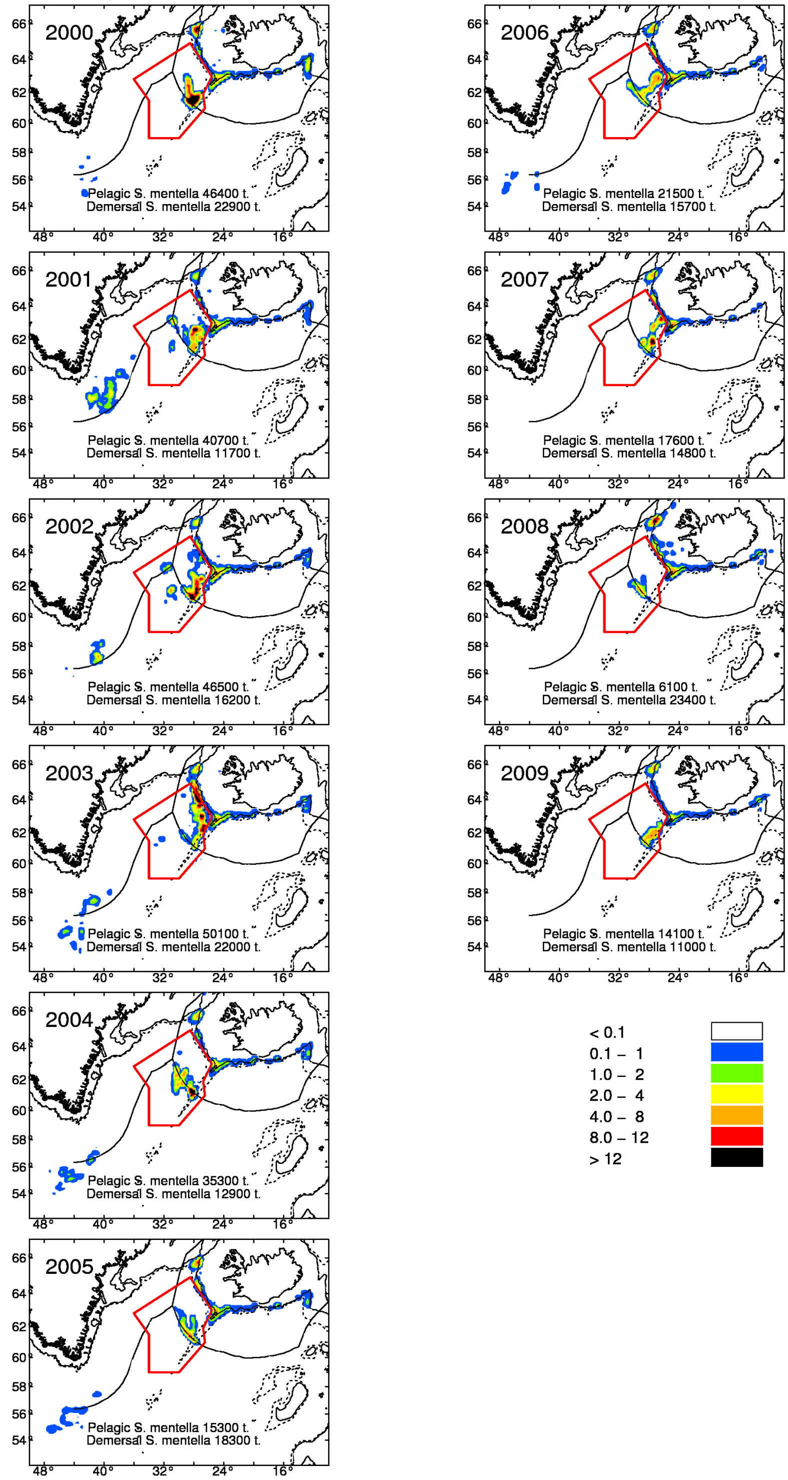

Figure 16.4.1 Geographical distribution of the Icelandic catches of *S. mentella* 2000-2009. The colour scale indicates catches (tonnes per NM²).

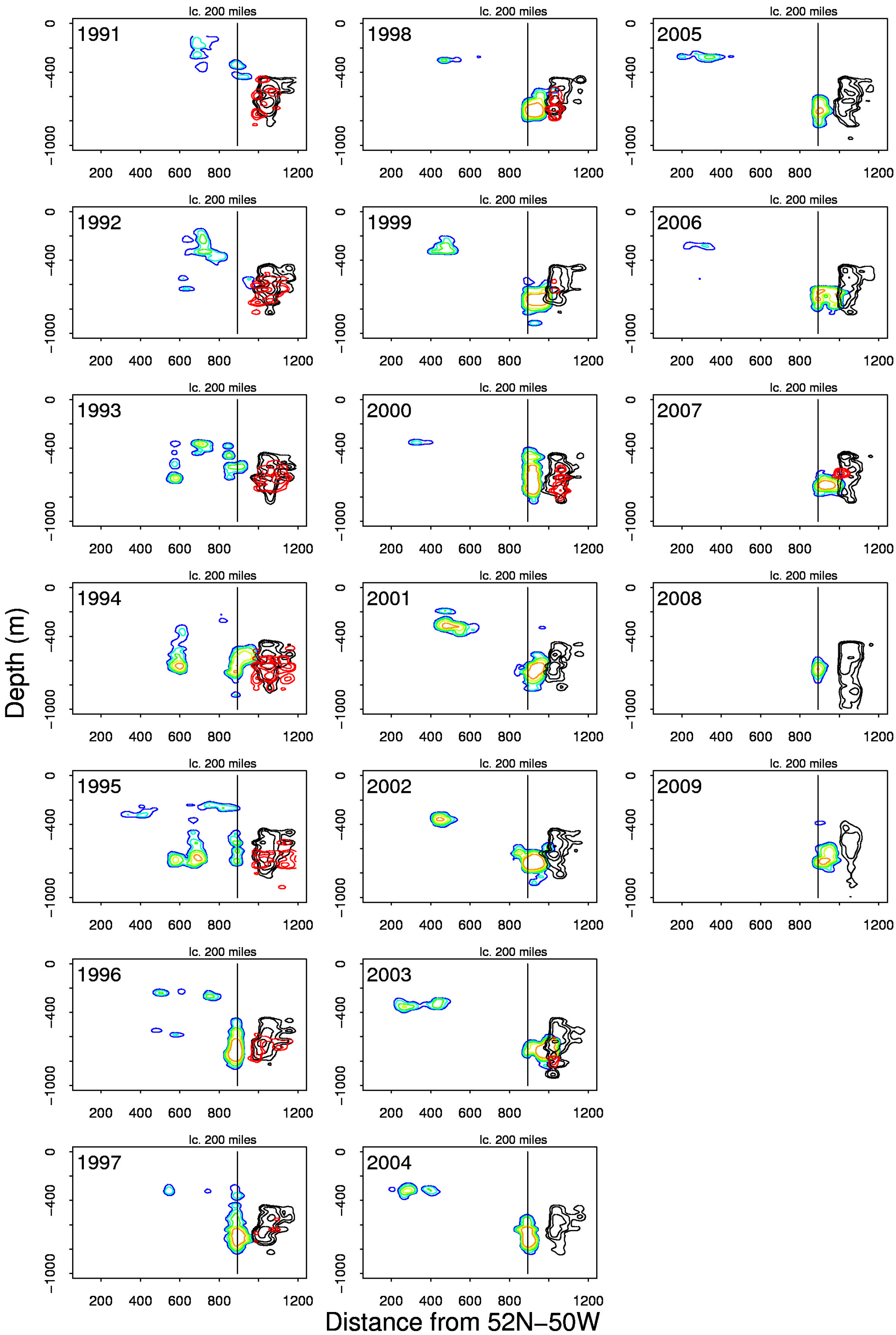

Figure 16.4.2 Distance-depth plot for Icelandic *S. mentella* catches, where distance (in NM) from a fixed position (52°N 50°W) is given. The contour lines indicate catches in a given area and distance. The coloured contours represent the fishery on pelagic *S. mentella*, the black contours indicate bottom trawl catches of demersal *S. mentella*, and the red contours represent catches of demersal *S. mentella* taken with pelagic trawls.

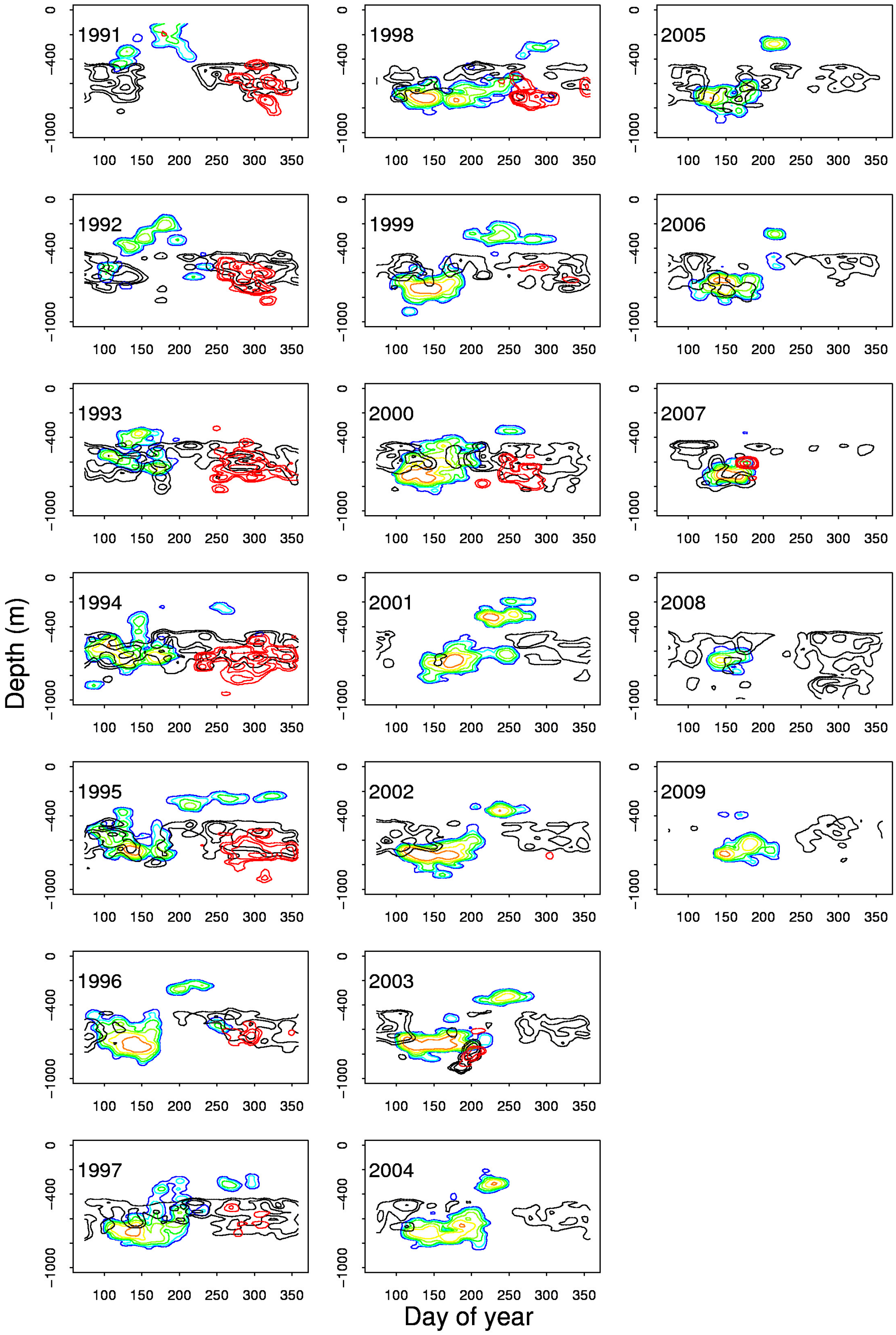

Figure 16.4.3 Depth-time plot for Icelandic *S. mentella* catches 1991-2009, where the y-axis is depth, the x-axis is day of the year and the colour indicates the catches. The coloured contours represent the fishery on pelagic *S. mentella*, the black contours indicate bottom trawl catches of demersal *S. mentella*, and the red contours represent catches of demersal *S. mentella* taken with pelagic trawls.

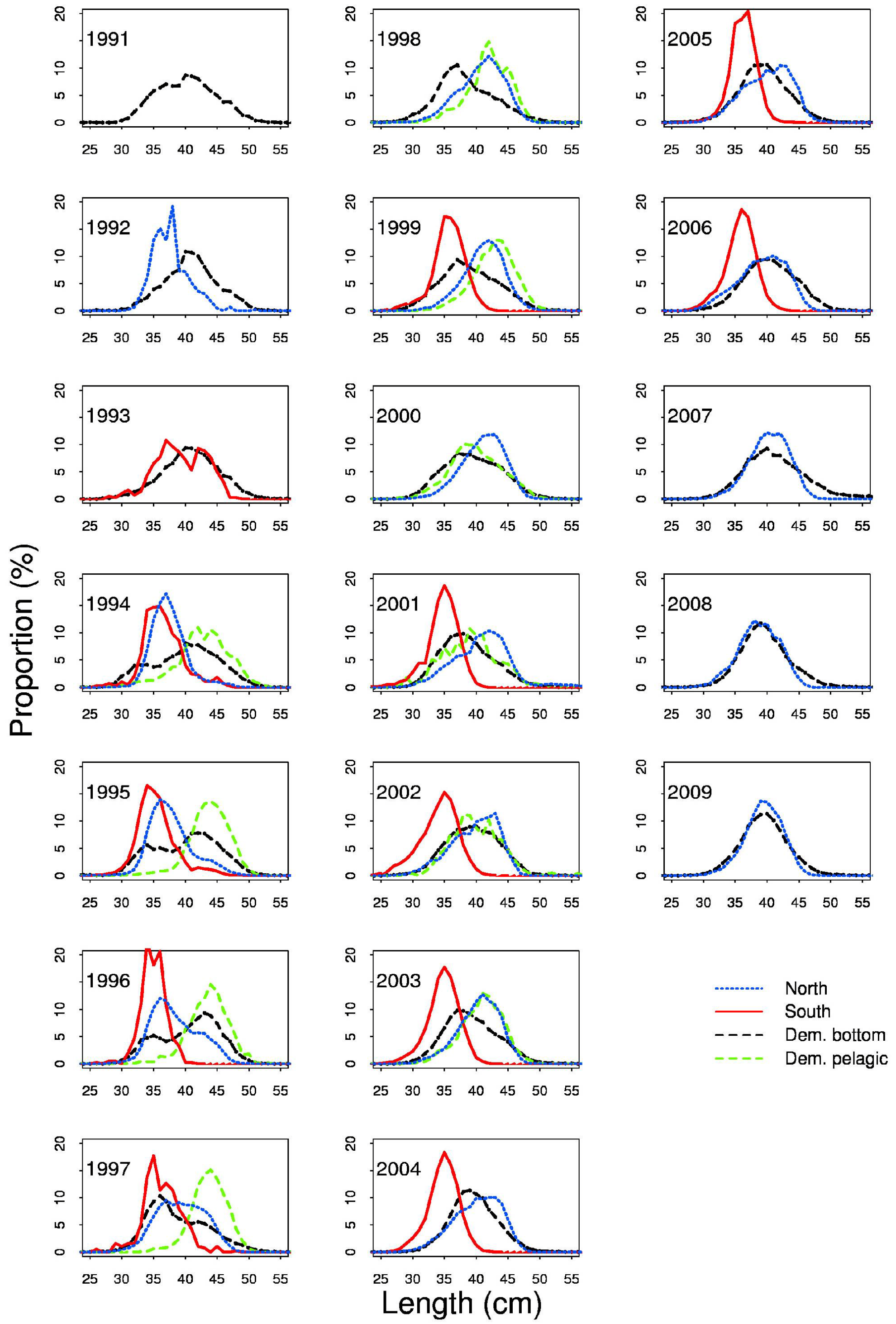

Figure 16.4.4 Length distributions from different Icelandic *S. mentella* fisheries, 1991-2009. The blue lines represent the fishery on pelagic *S. mentella* in the northeastern area, the red lines the pelagic fishery in the southwestern area, the black lines indicate bottom trawl catches of demersal *S. mentella*, and the green lines represent catches of demersal *S. mentella* taken with pelagic trawls.

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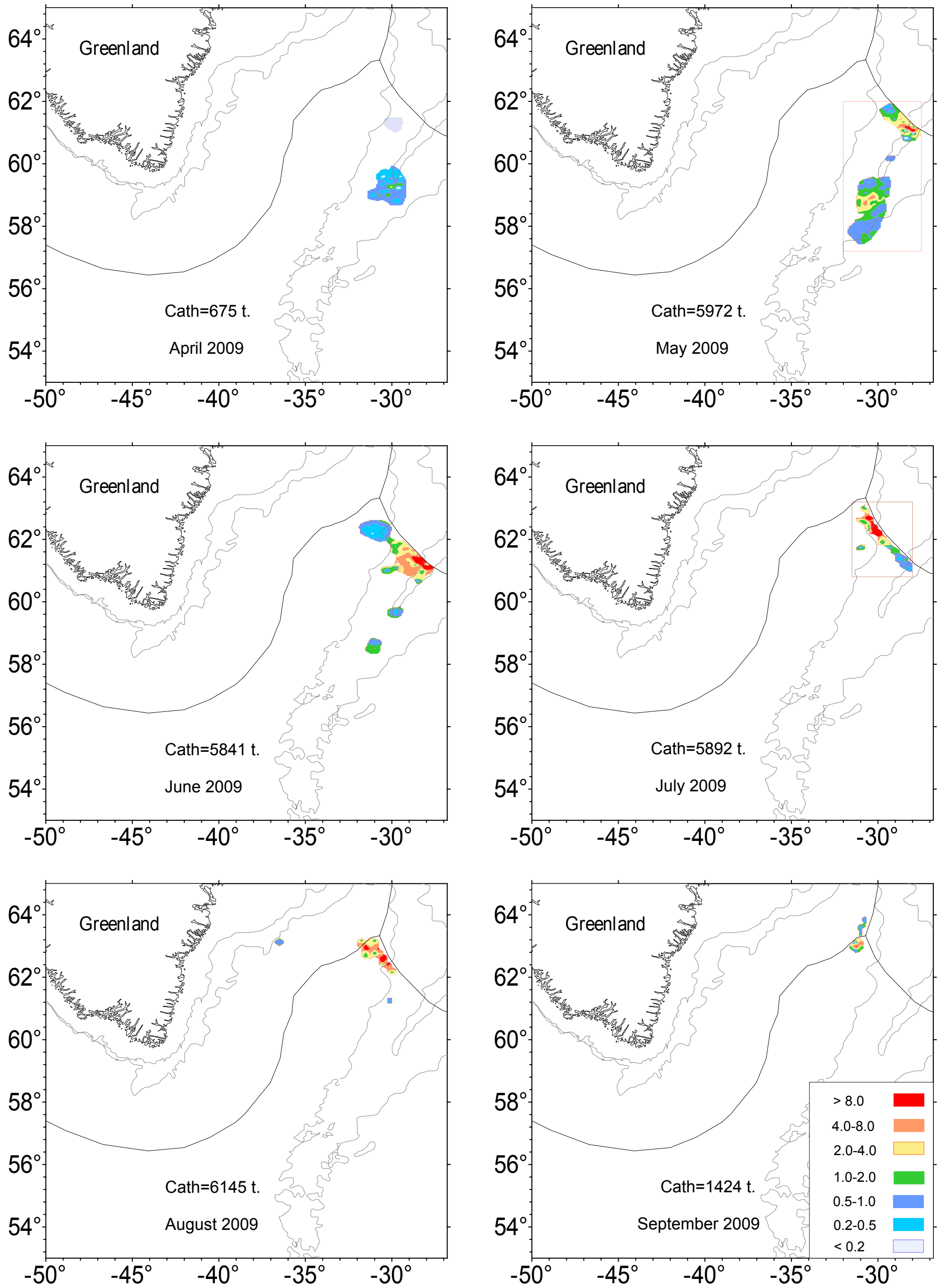

Figure 16.4.5 Fishing areas and total catch of pelagic redfish (*S. mentella*) by month(s) in 2009, derived from catch statistics provided by Russia. The catches in the legend are given as tonnes per square nautical mile.

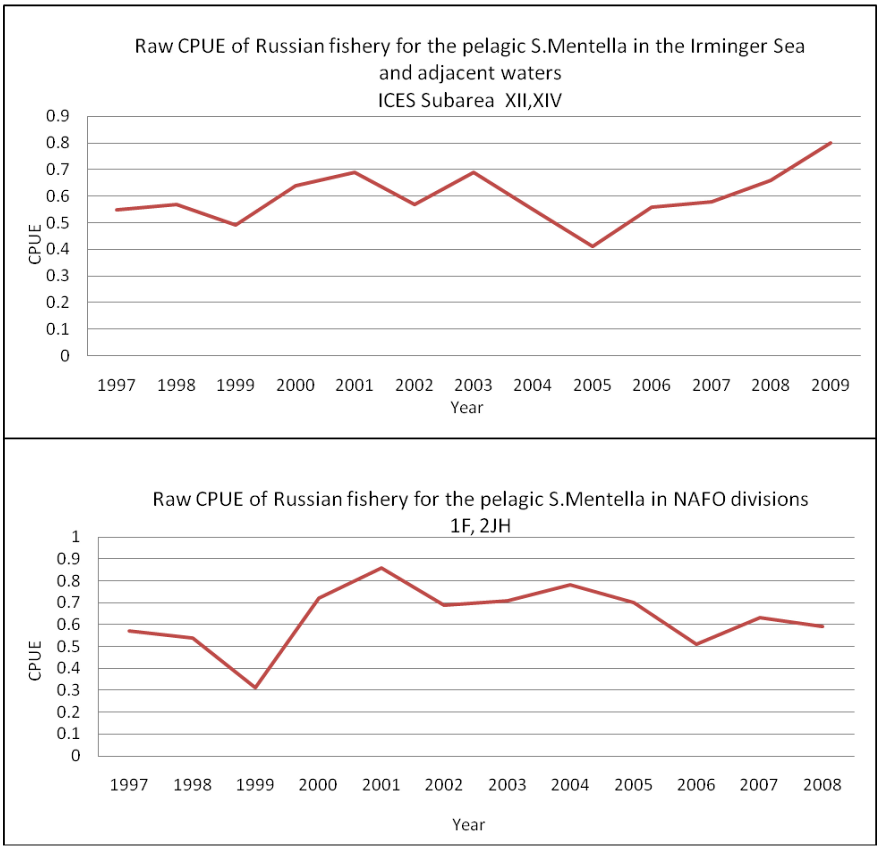

Figure 16.4.6 Non standardized CPUE from the Russian fleet in ICES Divisions XII AND XIV (upper panel) and NAFO Divisions 1F, 2H and 2J (lower panel)

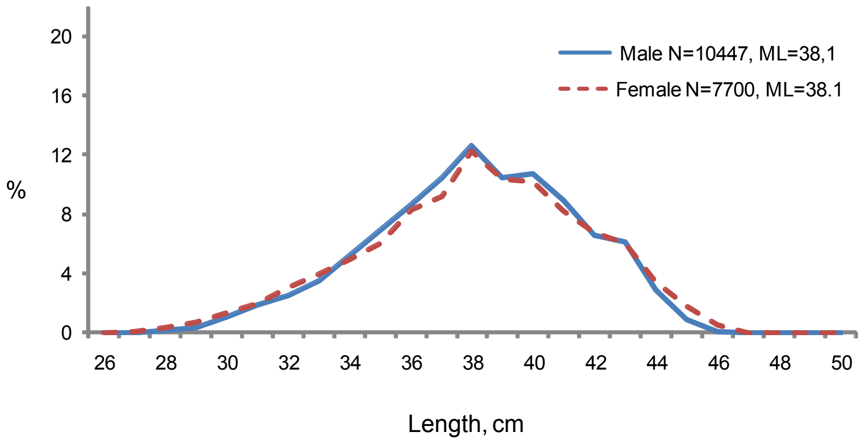

Figure 16.4.7 Redfish length distribution in catches by Russian trawlers in ICES Subareas XIV in 2009,expressed as percentages

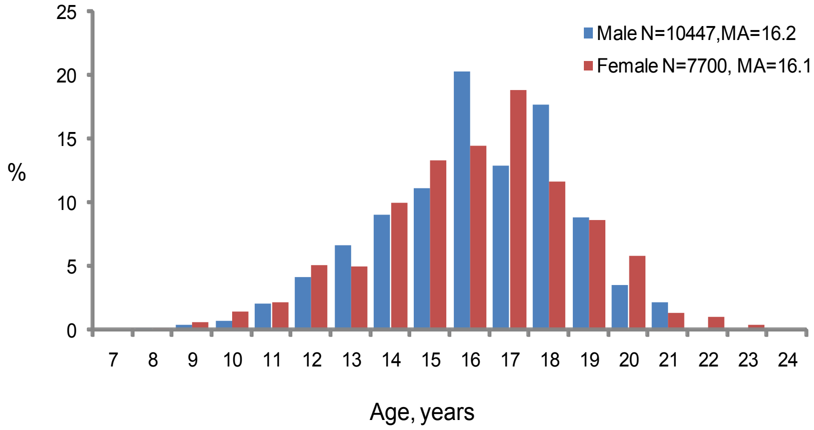

Figure 16.4.8 Redfish age composition in catches by Russian trawlers in ICES Subareas XIV in 2009, expressed as percentages.

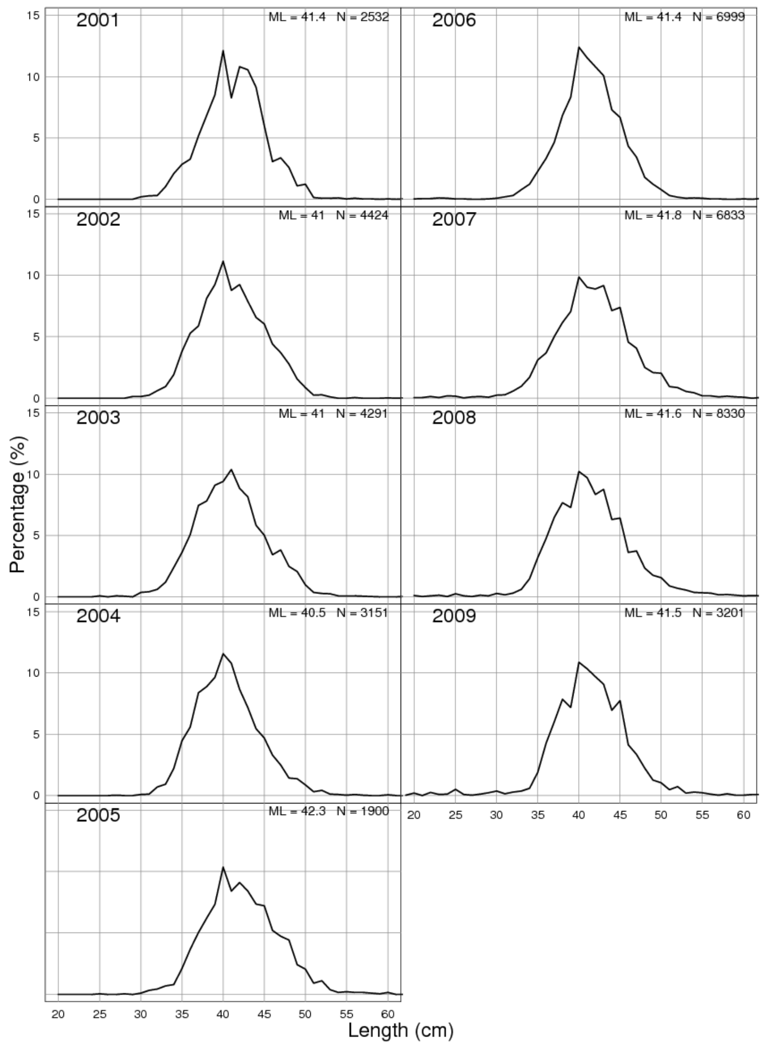

Figure 16.6.1 Length distribution of demersal *S. mentella* from landings of the Faeroese fleet in Division Vb 2001-2009.

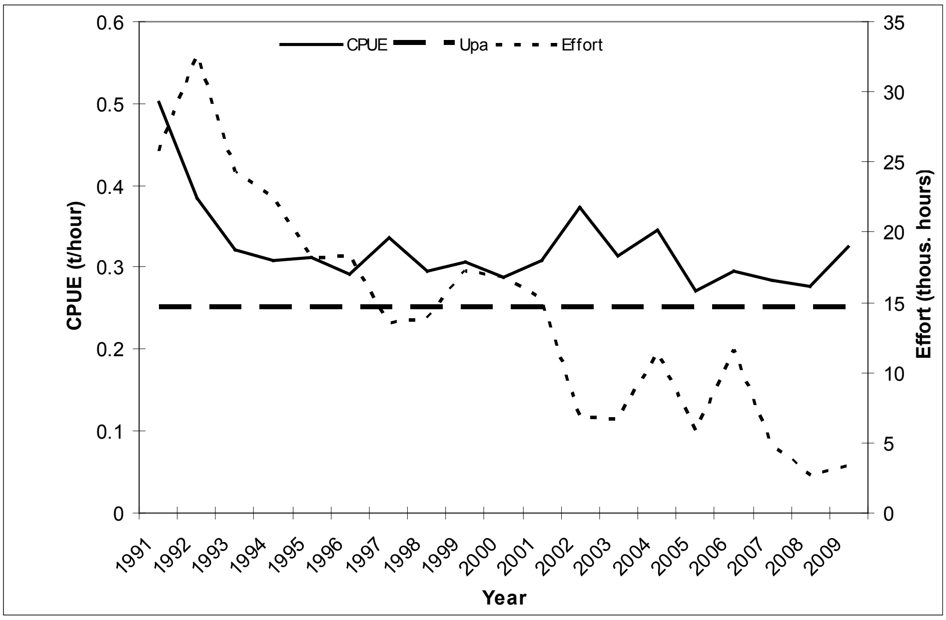

Figure 16.6.2 Demersal *S. mentella*, CPUE (t/hour) and fishing effort (in thousands hours) from the Faeroese CUBA fleet 1991-2009 and where 70% of the total catch was demersal *S. mentella*.

17 Golden redfish (*Sebastes marinus*) in Subareas V, VI and XIV

Executive summary

- Total landings in 2009 were about 40,000 t, about 5,000 t less than in 2008. About 99% 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 Division Va.
- Catch-at-age data from Va shows that the catch is dominated by two strong year classes from 1985 and 1990. 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. The roles of other age classes are increasing.
- Survey indices of the fishable stock in Va is in the vicinity of safe biological limits (Upa). The fishable stock situation in Vb remains at low level, but has improved in XIV.
- Recruitment in Va has been low since 1993 compared to the big 1985- and 1990 year classes, but there is an indication of improving new year classes observed as 8-13 years old fish in the October survey in 2009. There are signs of improved recruitment in XIV as well.
- 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 ICES Subarea 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 in both the March and October surveys, which is caused by relatively few tows accounting for a large part of the total amount of fish caught. This is also reflected in rapid changes of the indices from one year to another that is difficult to interpret.

To get a more stable index, the index of fishable biomass was calculated from the March survey for the area from 0–400 m depth and based on a selection curve rising sharply from 34-36 cm (L_{50} = 35 cm). The survey extends down to 500 m depth but the stations between 400 and 500 m are few and show the largest CV´s. Figure 17.2.2 shows this index of fishable biomass. The index indicates a decrease in the fishable biomass from 1985-1995, and an increasing trend since then. The lowest index was in

1995, only about 30% of the maximum in 1987. The values in 2004-2008 have on average been at 60% of the highest observed value. The index of the fishable biomass decreased gradually from 2003 to 2008 but increased again in 2009 to 2% below the Upa level (Figure 17.2.2). In comparison the total biomass index in both surveys has shown great variability, especially in recent years, without any clear trend (Figure 17.2.1). 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 used in the GADGET model (see below).

The estimate of the fishable biomass can be used as a proxy for the SSB. Figure 17.2.3 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.

Length distribution from the Icelandic groundfish survey in March show that the peaks, which can be seen first in 1987 and then in 1991-1992, reached the fishable stock approximately 10 years later (Figure 17.2.4). The increase in the survey index since 1995, therefore, reflects the recruitment of a relatively strong year classes (1985-year class and then the 1990-year class). This has been confirmed by age readings (Figure 17.2.6). There is an indication of considerable recruitment (fish less than 12 cm) observed in both groundfish surveys in 1998-2000 (Figure 17.2.1*d*) and can be seen as 8-13 years old fish in the 2009 autumn survey (Figure 17.2.6). These year-classes are individually not as large as the 1985 and 1990 year-classes but combined they may be larger than the big year-classes. 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 17.2.8 and 17.2.9).

17.2.2 Division Vb

In Division Vb, CPUE of *S. marinus* were available from the Faeroes spring groundfish survey from 1994-2010 and the summer survey 1996-2009. Both surveys show similar trends in the indices from 1998 onwards with a sharp declines between 1998-1999 (Figure 17.2.7). After an increase in the mid 1990s, CPUE decreased drastically. CPUE in the spring survey has since 2000 been stable at low level whereas CPUE in the summer survey has gradually decreased. Both indices are at the lowest level recorded.

17.2.3 Subarea XIV

Relative abundance and biomass indices from the German groundfish survey from 1982 to 2009 for *S. marinus* (fish >17 cm) are illustrated in Figures 17.2.8. 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 a maximum in 2007. The survey index decreased considerable in 2008 but increased again in 2009 and is the second highest value observed in the time series. 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 of pre-fishery recruits (17-30 cm) have increased considerable (Figures 17.2.8*c* and 17.2.18).

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 2009 were 40,000 t, which was 5,000 t less than in 2008. The majority of the golden redfish catch is taken in ICES Division Va and in recent years contributes to about 98% of the total landings.

Landings of golden redfish of the main fishing ground in Division Va declined from about 98,000 t in 1982 to 39,000 t in 1994 (Table 17.3.1). Since then, landings have varied between 32,000 and 49,000 t. The landings in 2008 were about 39,300 t, about 5,000 t less than in 2008. 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 2009, as in previous years, most of the catches were taken along the shelf W, SW, and SE of Iceland, mostly between 12°W and 27°W (Figure 17.3.2).

In Division Vb, landings dropped gradually from 1985 to 1999 from 9,000 t to 1,500 t and varied between 1,500 and 2,500 t from 1999-2005 (Table 17.3.1). In 2006-2009 annual landings were less than 1,000 t which has not been observed before in the time series. The landings in 2009 was 462 which is the lowest catch since 1978. 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 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 direct 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.

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 but were 225 t in 2009.

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 off Iceland. Discard of redfish in bottom trawl fisheries directed towards other species are considered negligible (Palsson et al 2008).

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 2009. 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	39,259	283	76,973	1,838
Vb	Faeroe	Bottom trawl and gillnets	462	33	1,437	

17.3.4 Landings by length and age

The length distributions from the Icelandic commercial trawler fleet in 1989-2009 show that the majority of the fish caught is between 30 and 45 cm (Figure 17.3.3). The modes of the length distributions range between 35 and 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 still contributed to about 25% of the total catch in weight. The strong 1990-year class dominated the catch in 2003-2007 contributing between 25-30% of the total catch in weight. This year class contributed about 18% of the total catch in 2008 and the 1985-year class about 9%. The 1996-1998 year classes contributed in total about 30% of the total catch in 2009.

The average total mortality (Z), estimated from the 15-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 2001-2009 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

CPUE in VA was calculated as non-standardized CPUE and standardised using GLM multiplicative model. Description is given in the stock annex. The outcome of the GLM 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 and 2008. The un-standardized CPUE index was in 2008 the highest in the time series. Effort towards golden redfish gradually decreased from 1986 until 2004, increased in 2005 and 2006, but has decreased again (Figure 17.3.7).

Un-standardized CPUE of the Faroese otterboard (OB) trawlers 1991-2009 gradually declined to a record low in 1997 and increased till 2004 being about 80% of the 1991 value. CPUE has decreased again over the most recent years (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

Gadget model was used for analytical assessment of the golden redfish. Methods are found in stock annex.

Two 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 alternatives differ from the base case as follows:

Alternative 1. Only survey indices from the October survey were used.

Alternative 2. Tows from the March survey that had catches larger than 2000 kg were set to 2000 kg.

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 45 years. The total yield from the year class was then calculated as function of fishing mortality. The results gave $\mathbf{F_{max}}$=0.14, $\mathbf{F_{0.1}}$=0.085 and maximum yield was estimated to be 227 g/recruit (1 year) (Figure 17.4.1). Here, F is not fishing mortality, but close to it when small time steps are used, or when 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 estimates from catch at age models and F_{max} could be a candidate for $\mathbf{F_{target}}$.

Figure 17.4.2 shows estimated recruitment, selection pattern, fishing mortality of 8-25 years old redfish, and harvestable and total biomass from the model. The figure indicates that the 1985 and 1990 year classes are the most abundant in the series. Fishing mortality in recent years is estimated to be between 0.25 and 0.30, which is higher than estimated from the catch curves.

Figure 17.4.3 shows development of the harvestable biomass (biomass multiplied by the selection pattern) for different catch options after 2010. The results indicate that landings in excess of 30,000 tonnes will lead to substantial reduction of the harvestable stock in coming years.

Figure 17.4.4 shows the 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. 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. Part of the explanation for the positive blocks could also be the lack of 40 cm and larger redfish in recent years but high abundance of 30-38 cm fish 5-6 years ago should have contributed to that part 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.

Figure 17.4.6 shows the observed and modelled survey biomass indices. From this figure the model does not seems to follow the observed pattern, especially in recent years.

17.5 Reference points

The biological reference points are given in Table 17.5.1 and described in stock annex. 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.

Golden redfish is mainly caught in Division Va, and the relative state of the stock has been used as reference point ($U_{lim} = U_{max}$ /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 in the vicinity of U_{pa} during recent 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 but is slowly diminishing. The 1990-year class has also contributed significantly to the fishable biomass and landings in the last decade. 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 relatively good classes that are observed as 9-11 year-old fish (about 30 cm) in the October survey. The GADGET model estimated an exploitation rate of F=0.26 in 2009.

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 but there is an indication that relatively good year classes are coming into the fishery. 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 110 millions at age 1 (the average from 1979-2008 is about 145 millions) and maximum yield-per-recruit is estimated to about 225 g. There are though indications that recruitment is being underestimated.

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 model indicates that the year classes after the 1990 have been much smaller than the 1985- and 1990 year classes. Those estimates are based on the groundfish survey in March (Figure 17.2.7). In current assessment the combined 1996-1998 year classes are estimated to be larger than either the 1985 or the 1990 year classes. On the contrary, the indices shown in Figure 17.2.7 indicate that combined they are less than 1/3 of each of the two big year classes.

This could be an indication of recruitment from other areas, for example East-Greenland. The spatial distribution of the 1985- and 1990 year classes is also different from the 1996-1998 year classes. The earlier year classes were mostly found in the north while the latter year classes were mostly found west of Iceland. Much higher contrast in recruitment indices than stock abundance estimates is common and the traditional way of dealing with that problem is to use power curves. There are more than on possible explanation of the powercurves but they do not help if a major shift in the proportion of recruits within the survey area occurs.

Another factor that could explain part of this discrepancy in estimation of year classes strengths is discarding of juvenile redfish in the deep water shrimp fishery north of Iceland in the late 1980s and early 1990s. Small redfish was abundant in the deep water shrimp survey in 1986-1988 and in 1991-1995 and scaling the survey estimate with the effort by the shrimp fleet indicates that about 20% of the 1985- and 1990 year classes might have been discarded in the shrimp fishery. Since 1995 sorting grids have been used in the shrimp fishery but at the same time spatial distribution of redfish recruitment has changed.

The final factor that might partly explain this discrepancy is area closure of large area west and southwest of Iceland in order to protect juvenile redfish.

In conclusion, there are signs that the model, based on the March survey, has been underestimating recruitment in recent years.

As shown in Figure 17.4.4 the model has not followed the most important age groups in terms of biomass (30-38 cm) for the last 8 years. One reason is older recruitment estimates. Another explanation could be that no recovery has been seen in the indices of 40 cm and larger fish (Figure 17.2.1c). The index of this size class decreased rapidly from 1985-1990 and has since then been stable at low level. With the growth curve shown in Figure 17.4.1 the 1985- and 1990 year classes should have contributed to this size group but has not. The only way to obtain such results from the model, i.e. no increase in 40 cm and larger fish, is to reduce the number of smaller fish and increase estimated fishing effort.

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.

Another indication of the stock size of golden redfish is obtained by looking at age disaggregated catch in numbers and age disaggregated indices from the autumn survey (Figure 17.4.10). The data indicate that total mortality of the 1985 and 1990 year classes has been close to 0.2 in recent years, both according to survey and catch in numbers. This is considerably lower than the GADGET estimate that is around 0.30. Time series analysis (TSA) was run on those data indicating much larger stock and lower mortality than the Gadget runs (Figure 17.4.11, see also WD). The precision of the estimates is though low due to short time series (1996-2009) but the model results follow the biomass trends in the autumn survey better than the Gadget model does. As discussed earlier the Gadget results are to a large extent driven by comparison with abundance of large and small redfish in the years 1985–1992 before the autumn survey commenced.

There are only available data on nursery grounds of golden redfish in Icelandic and Greenland waters but no nursery grounds are known in the Faroese 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. (put into stock annex). This might explain the inconsistency between different indicators on the status of the stock.

17.10 Comparison with previous assessment and forecast

In Figure 17.4.7, the development of the available biomass according to the three Gadget runs described here is compared to the Gadget run from last year (real time retro). In Figure 17.4.8, the estimated recruitment is compared for the same runs. As can be seen from the model is that estimates from the 2009 runs are somewhat lower than the 2008 run.

Figure 17.4.9 shows analytical retro of the GADGET model. The comparison between 2009 and 2010 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 early 2007, this applies especially to the age data that are usually behind. The analytical retro shows that recruitment has been underestimated.

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 17.4.8).

17.11 Management plans and evaluation

17.12 Management consideration

The assessment was performed in the same way as last year. There are indicators for positive development in the golden redfish abundance but it is difficult to interpret. The Review Group concluded in 2009 that golden redfish in XIVb and V is an urgent candidate for benchmark. It will be proposed that all redfish stocks in the North-West Atlantic and in the Norwegian and Barents Seas (ICES Subareas I and II, V, XII, and XIVb) for benchmark in 2012 (redfish stocks dealt with at AFWG and NWWG). At this benchmark the GADGET model for golden redfish in Va would be reviewed, the use of alternative analytical assessment models, how to deal with high variation in the surveys (i.e. whether the Winsorization method to decrease the effect of few large hauls that count for the most of the total catches each year, is appropriate) etc.

Based on the GADGET model results, a TAC below 30,000 t in Va in the next 5 years would provide a fishable stock size around 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. The approximate **F** from the model would decrease from the current level and be close to $\mathbf{F_{max}}$.

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 1985-2008 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.

ACOM recommended in 2009 that the total allowable catch in Division V should be less than 30,000 t. However, the total annual catches in 2000-2000 were around 40,000 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. In late 2008, the Ministry of Fisheries in Iceland established a committee with the objective to review and recommend on how to separate quotas for the two species. Consensus was within the committee that quota for those two species should be given separately. The separation of quotas will be implemented in the next fishing year that starts 1 September 2010.

The biomass of the fishable stock of *S. marinus* in Subarea XIV has increased in recent years and was in 2009 high.

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 advise that no fishery should take place on offshore cod in Greenland waters. ICES therefore recommends measures that will keep effort on cod low in the redfish fishery that started in 2008.

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 potential redfish fisheries 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

No information available. .

Table 17.3.1 Official landings (in tonnes) of golden redfish, by area, 1978-2009 as officially reported to ICES. Landings statistics for 2009 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	38,364	689	0	83	39,134
2008	44,093	569	64	80	44,806
2009[1)]	39,259	462	225	50	39,995

1) Provisional

Table 17.2.1 Index on fishable stock of golden redfish in the Icelandic groundfish survey 1985-2010 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
2009	4.3	41.8	100.7	272.4	146.8	419.2
2010	4.5	54.4	108.7	62.1	167.6	233.6

Table 17.3.2 Golden redfish in Va. Observed catch in weight (tonnes) by age and years in 1995-2010. Highlighted are the 1985- and 1990-year classes. It should be noted that the catch-at-age results for 1996 are only based on three samples, which explains that there are no specimens older than 23 years.

Year/ Age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
7	62	0	**33**	24	7	40	122	130	201	227	236	187	137	449	107
8	374	360	230	**285**	350	65	138	910	211	849	782	1,063	454	1,238	963
9	1,596	825	482	596	**1,623**	852	395	767	1,366	499	1,925	2,221	1,765	2,172	1,726
10	**9,436**	3,701	1,039	1,211	1,259	**4,308**	1,623	841	1,120	2,109	1,526	3,724	2,488	5,007	3,100
11	2,719	**9,127**	2,702	1,132	1,855	1,894	**7,763**	3,188	1,197	795	3,139	2,145	3,372	3,926	4,985
12	1,319	2,102	**11,583**	3,252	2,528	2,277	1,807	**11,065**	3,952	982	1,919	2,841	1,932	4,574	4,432
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	3,097	2,218	3,377
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	1,061	2,730	1,805
15	5,971	4,347	3,142	2,039	1,244	**14,878**	839	1,856	1,978	2,158	**11,920**	2,849	970	1,450	1,957
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**	2,223	1,028	1,230
17	852	934	3,035	3,416	1,823	1,184	523	**12,046**	2,267	826	1,472	2,112	**9,527**	1,760	654
18	368	379	900	2,051	2,665	1,624	787	2,097	**6,427**	1,401	1,333	1,186	1,368	**7,944**	1,461
19	1,134	259	642	1,018	2,228	2,427	1,068	1,174	761	**5,342**	1,315	684	756	1,455	**5,974**
20	1,144	340	925	729	1,271	2,191	1,801	663	410	1,120	**6,797**	958	779	918	927
21	503	1,157	449	523	479	544	970	1,411	604	336	412	**5,658**	911	505	650
22	677	988	520	391	217	447	420	1,028	791	491	466	644	**4,997**	839	556
23	1,427	791	681	427	341	270	437	743	755	620	868	235	756	**4,056**	328
24	664	0	587	665	218	64	169	363	379	600	636	384	115	361	**2,523**
25	762	0	749	516	930	393	130	294	303	284	446	485	643	248	95
26	365	0	271	401	279	340	126	185	75	106	97	73	332	408	95
27	350	0	136	427	649	193	293	83	83	180	324	269	347	335	190
28	725	0	192	360	228	528	204	297	27	153	215	202	221	162	91
29	0	0	149	54	105	371	153	500	106	138	31	174	36	210	382
30	133	0	30	226	231	441	375	174	197	161	227	274	74	81	39
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	38,361	44,074	37,647

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 = lcatch ~ ltowtime + factor(year) + as.factor(month) +
factor(vessel) +
        factor(area), family = gaussian())
Deviance Residuals:
       Min         1Q     Median         3Q      Max
 -6.365412 -0.4799574 0.03339072 0.5158951 5.607539

Coefficients:
                            Value  Std. Error      t value
       (Intercept)    2.985144988 0.899530992    3.3185571
          ltowtime    1.132540398 0.004396911  257.5763586
    factor(year)1987  0.051922883 0.037351871    1.3901013
    factor(year)1988 -0.004289055 0.038108502   -0.1125485
    factor(year)1989  0.022572769 0.038487875    0.5864904
    factor(year)1990  0.045303994 0.038437524    1.1786398
    factor(year)1991  0.031474164 0.031925567    0.9858608
    factor(year)1992 -0.161046659 0.032233535   -4.9962457
    factor(year)1993 -0.289467452 0.031902015   -9.0736418
    factor(year)1994 -0.306982908 0.032927478   -9.3230008
    factor(year)1995 -0.287663207 0.033266809   -8.6471537
    factor(year)1996 -0.275392250 0.033812489   -8.1446901
    factor(year)1997 -0.283577368 0.033957153   -8.3510349
    factor(year)1998 -0.211318890 0.034345088   -6.1528125
    factor(year)1999 -0.268119443 0.033726585   -7.9497953
    factor(year)2000 -0.119785099 0.033833157   -3.5404648
    factor(year)2001  0.026009970 0.035077436    0.7415015
    factor(year)2002  0.064661214 0.034615467    1.8679862
    factor(year)2003  0.080451445 0.035962131    2.2371156
    factor(year)2004  0.134294691 0.037102523    3.6195568
    factor(year)2005  0.084541176 0.035402447    2.3880038
    factor(year)2006 -0.060899144 0.034526337   -1.7638461
    factor(year)2007 -0.020816783 0.035663938   -0.5836928
    factor(year)2008 -0.029041755 0.035922475   -0.8084564
    factor(year)2009 -0.030284514 0.035669739   -0.8490254
 as.factor(month)2    0.175222888 0.021147177    8.2858761
 as.factor(month)3    0.368688234 0.020215714   18.2377056
 as.factor(month)4    0.327499185 0.021131890   15.4978654
 as.factor(month)5    0.145475516 0.024770563    5.8729192
 as.factor(month)6    0.372180734 0.021946869   16.9582614
 as.factor(month)7    0.332012551 0.020794284   15.9665296
 as.factor(month)8    0.196749714 0.021045876    9.3486112
 as.factor(month)9    0.150849464 0.020654443    7.3034875
as.factor(month)10    0.104238070 0.020788443    5.0142317
as.factor(month)11    0.044061206 0.021941637    2.0081094
as.factor(month)12   -0.073872937 0.024414393   -3.0257945
....
(Dispersion Parameter for Gaussian family taken to be 0.7689384 )

    Null Deviance: 117201.2 on 45997 degrees of freedom

Residual Deviance: 35072.82 on 45612 degrees of freedom

Number of Fisher Scoring Iterations: 1

Analysis of Deviance Table
Gaussian model
Response: lafli

Terms added sequentially (first to last)
                  Df Deviance Resid. Df Resid. Dev  F Value Pr(F)
            NULL                  45997   117201.2
        ltowtime     1 68504.28     45996    48696.9 89089.43     0
      factor(year)  23  1410.33     45973    47286.5    79.74     0
as.factor(month)    11  1113.72     45962    46172.8   131.67     0
  factor(vessel)   200  8486.96     45762    37685.9    55.19     0
  factor(area)     150  2613.05     45612    35072.8    22.66     0
```

Table 17.5.1 Biological reference points for golden redfish in Division Va based on Gadget.

PARAMETERS	ESTIMATION
F_{max}	0.14
$F_{0.1}$	0.085
B_{pa}	125 000 t
Yield per recruit	227 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 2010 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
2009	154	0.27	265	40
2010	156	0.21	253	30
2011	162	0.20	248	30
2012	164	0.20	240	30
2013	162	0.20	230	30
2014	158	0.21	217	30
2015	151	0.22	202	30

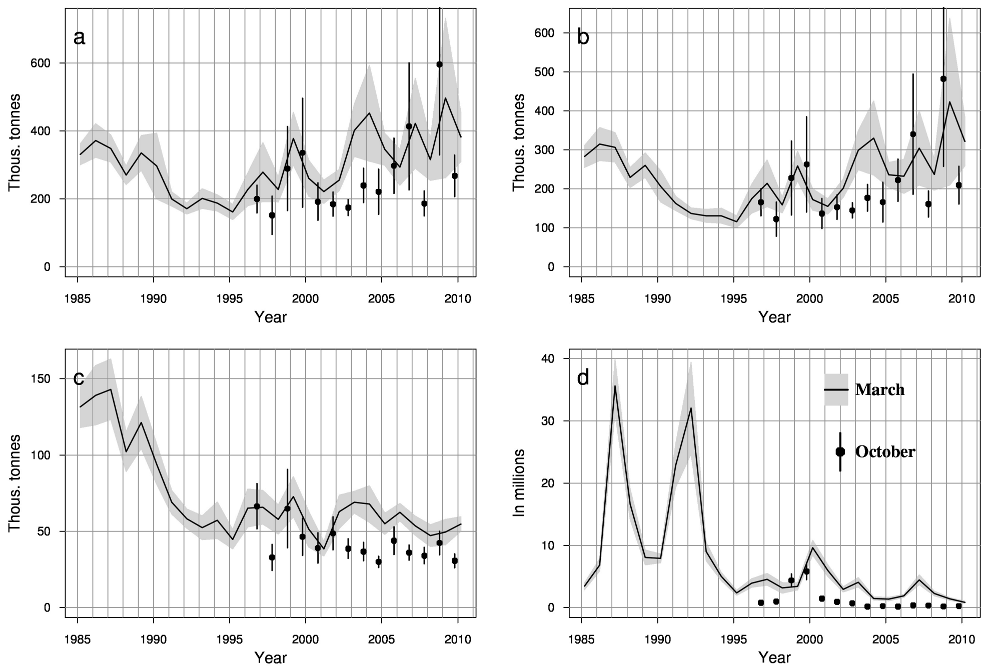

Figure 17.2.1 Indices of golden redfish from the groundfish surveys in March 1985-2010 (line, shaded area) and October 1996-2009 (points, vertical lines). a) Total biomass; b) biomass of fish larger than 32 cm; c) biomass of fish larger than 40 cm; d) indices of juvenile golden redfish (4-11) cm in millions. The shaded area and the vertical bar show ±1 standard error of the estimate.

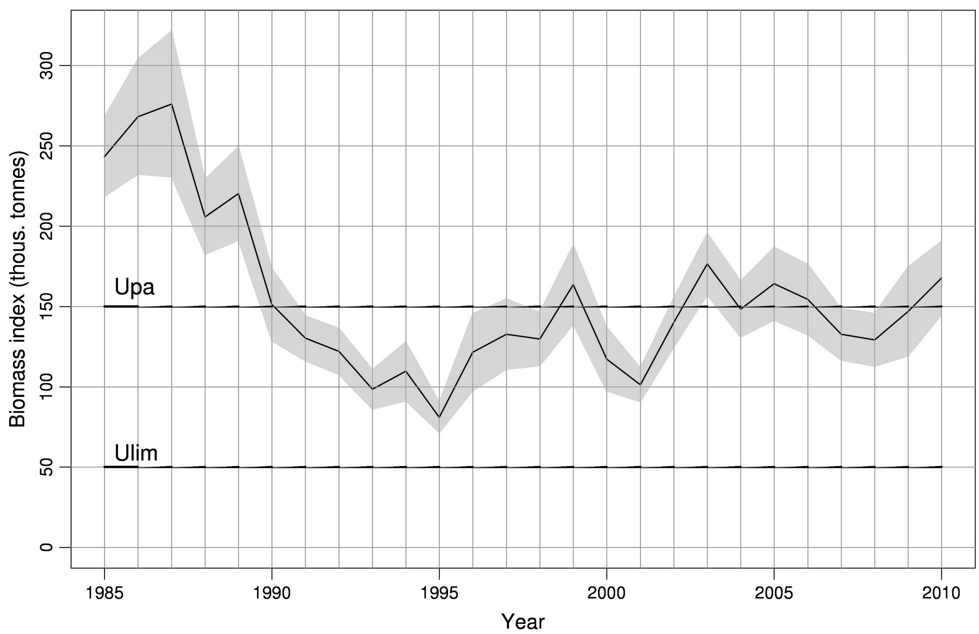

Figure 17.2.3 Index on fishable stock of golden redfish from Icelandic groundfish survey in March 1985-2010. The shaded area and the vertical bar show ±1 standard error of the estimate.

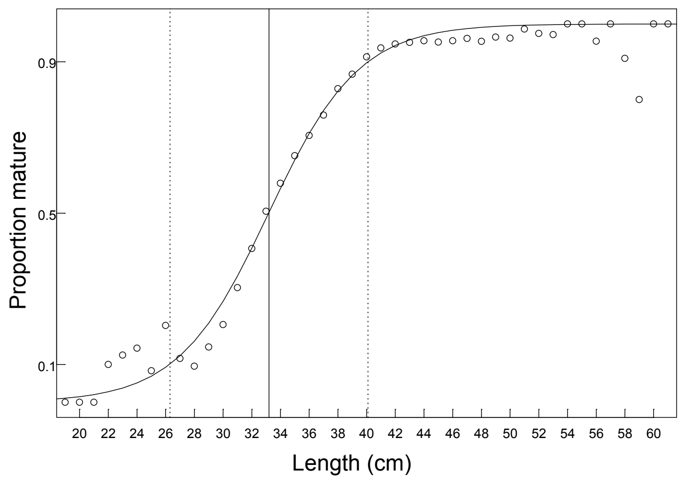

Figure 17.2.3 The proportion of mature golden redfish as a function of length from the commercial catch in Va 1995-2004 (all data pooled). The data points show the observed proportion mature and the lines the fitted maturity. The solid vertical line indicates the point where 50% of the fish mature and the two dotted lines indicate the 10% and 90% probability of being mature.

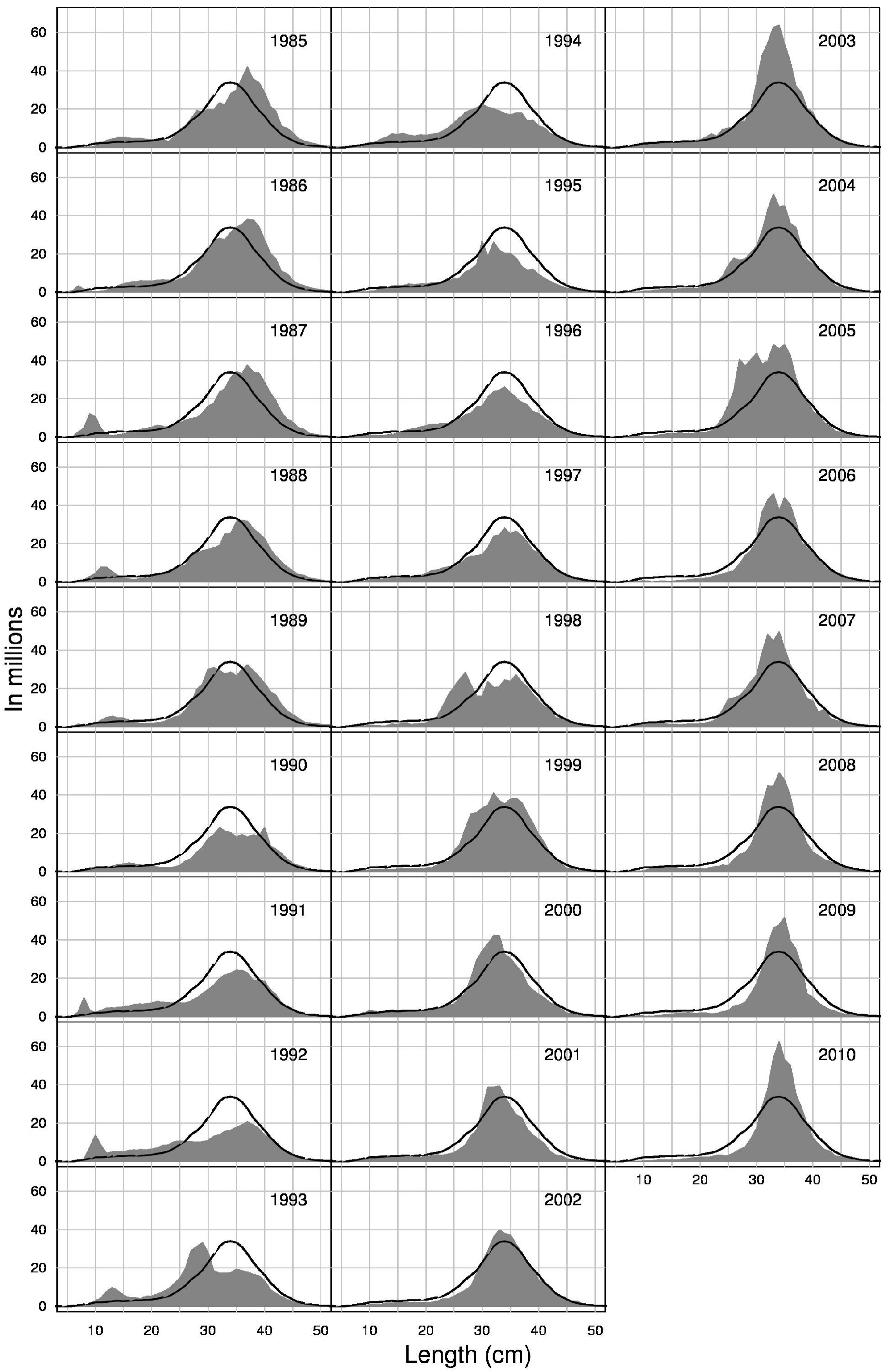

Figure 17.2.4. Length disaggregated abundance indices of golden redfish from the bottom trawl survey in March 1985-2010 conducted in Icelandic waters. The black line is the mean of total indices 1985-2010.

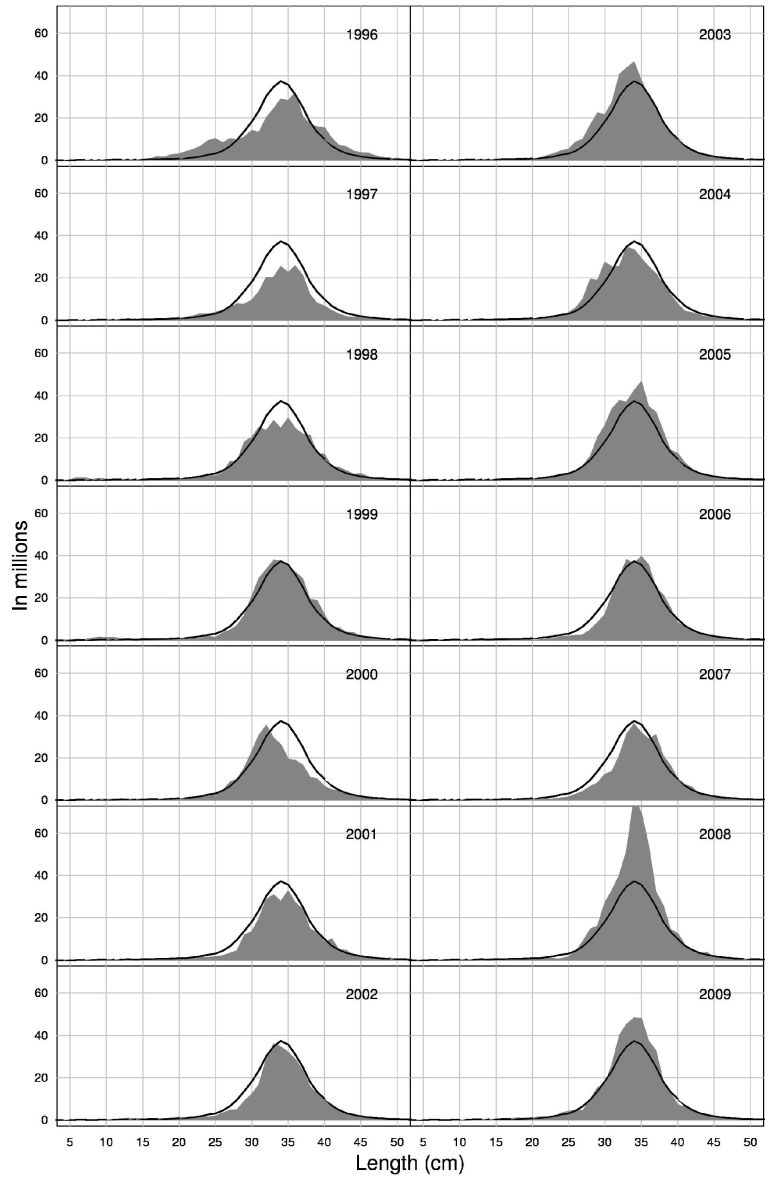

Figure 17.2.5. Length disaggregated abundance indices of golden redfish from the bottom trawl survey in October 1996-2009 conducted in Icelandic waters. The black line is the mean of total indices 1996-2009.

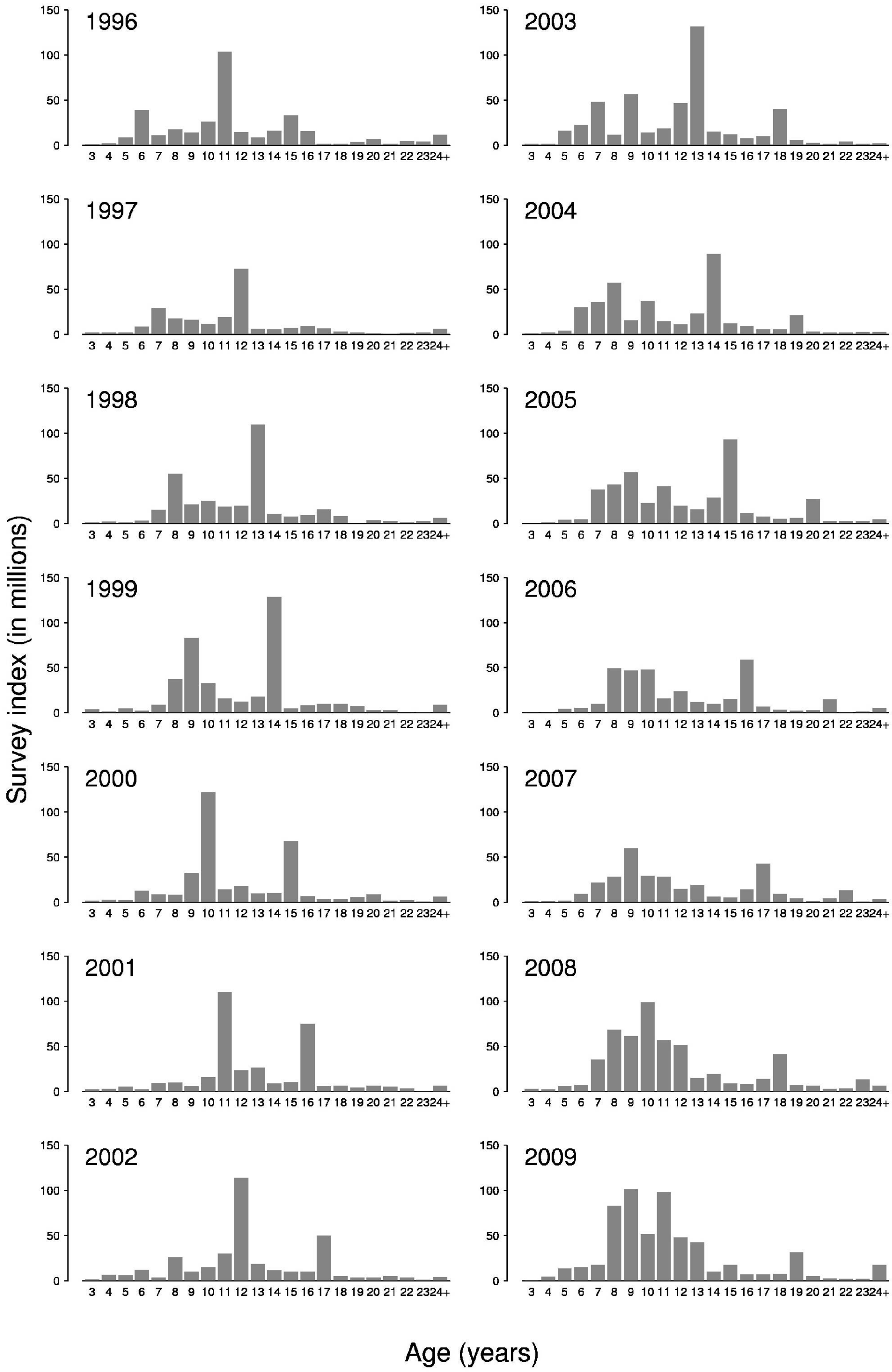

Figure 17.2.6 Age distribution of golden redfish in the bottom trawl survey in October conducted in Icelandic waters 1996-2009.

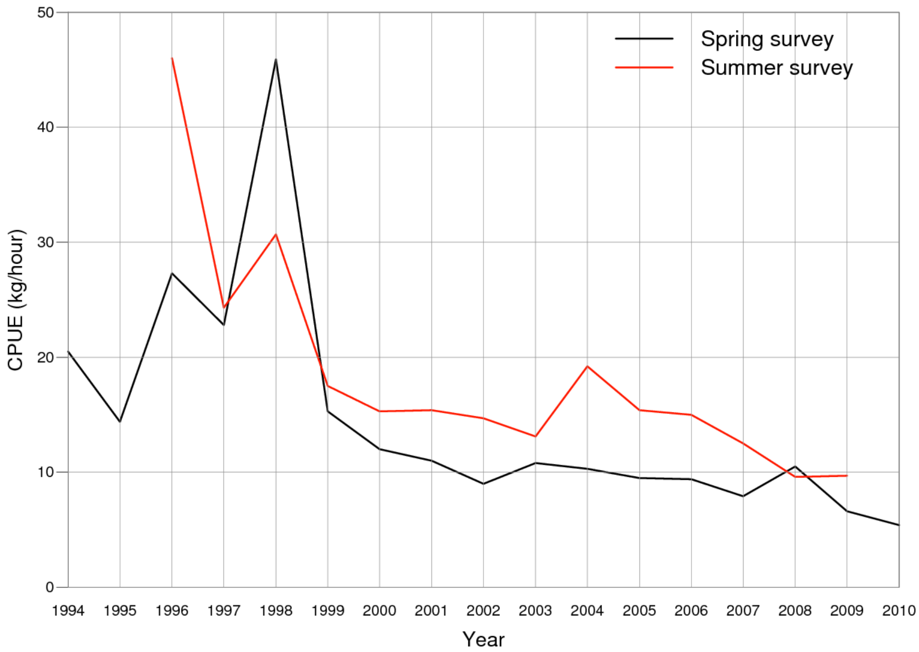

Figure 17.2.7 CPUE of golden redfish in the Faeroes spring groundfish survey 1994-2010 and the summer groundfish survey 1996-2009 in ICES Division Vb.

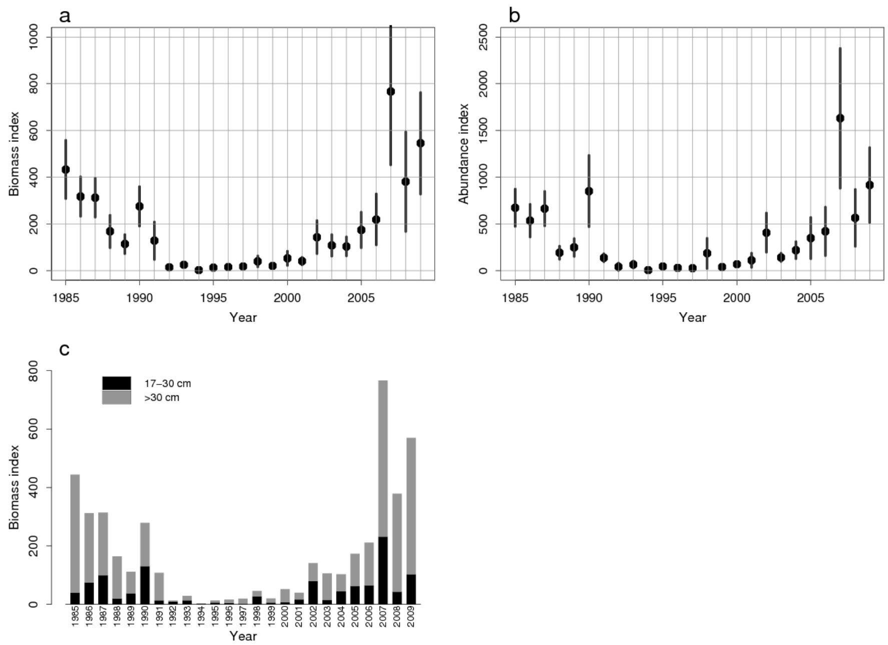

Figure 17.2.8 Golden redfish (≥17 cm). Survey abundance indices for East and West Greenland from the German groundfish survey 1985-2009. a) Total biomass index, b) total abundance index, c) biomass index divided by size classes (17-30 cm and > 30 cm).

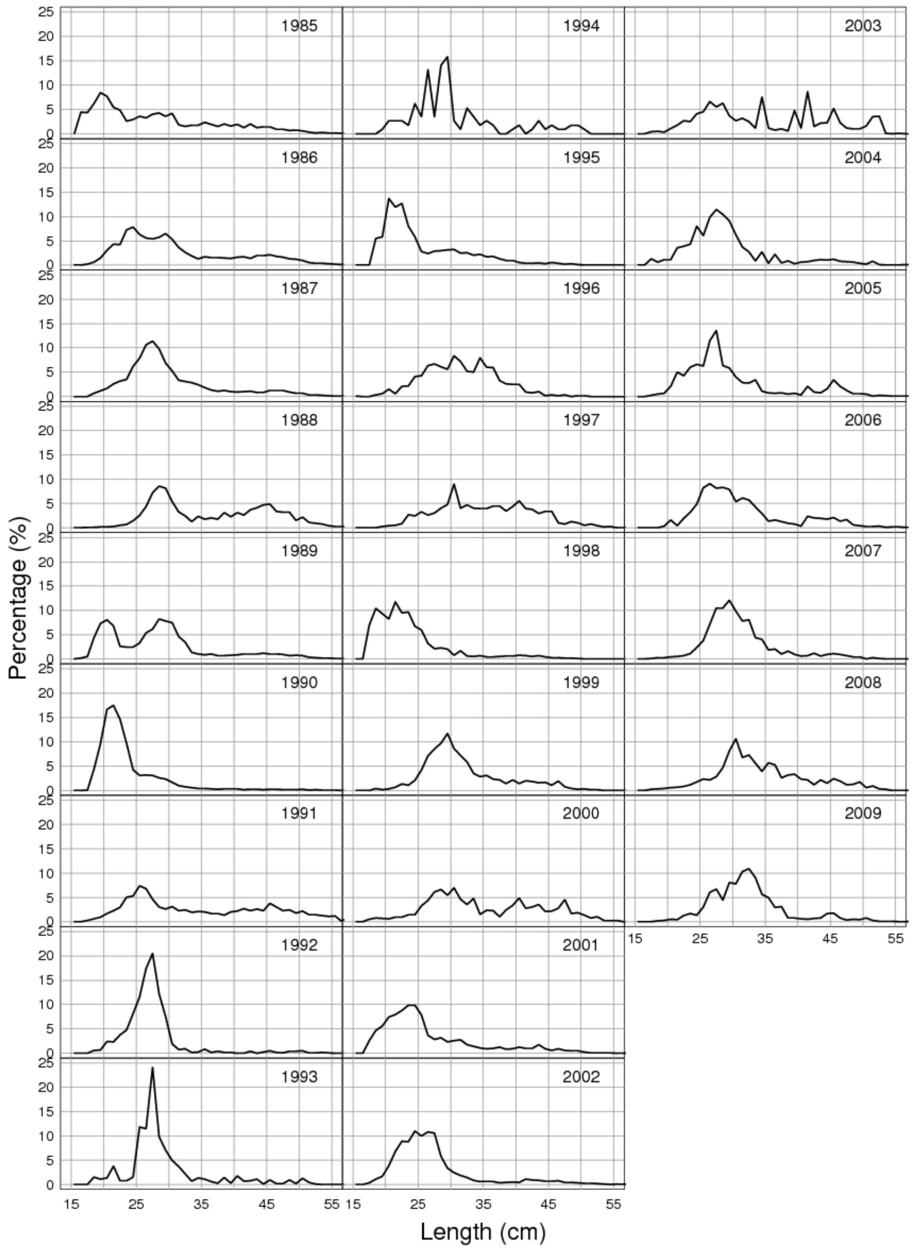

Figure 17.2.9 Golden redfish (>17 cm). Length frequencies for East and West Greenland 1985-2009.

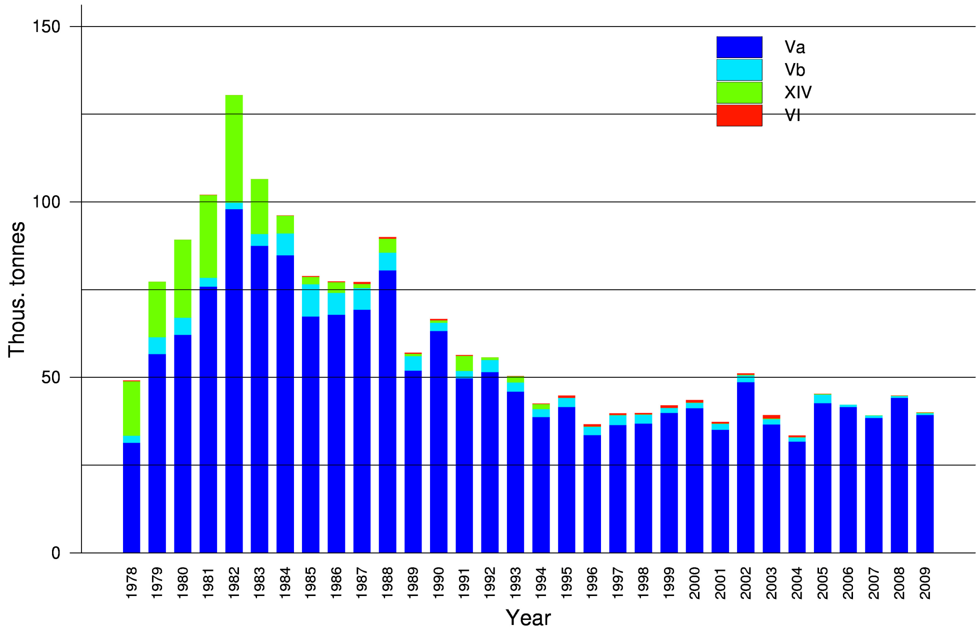

Figure 17.3.1 Nominal landings of golden redfish in tonnes by ICES Divisions 1978-2009. Landings statistics for 2009 are provisional.

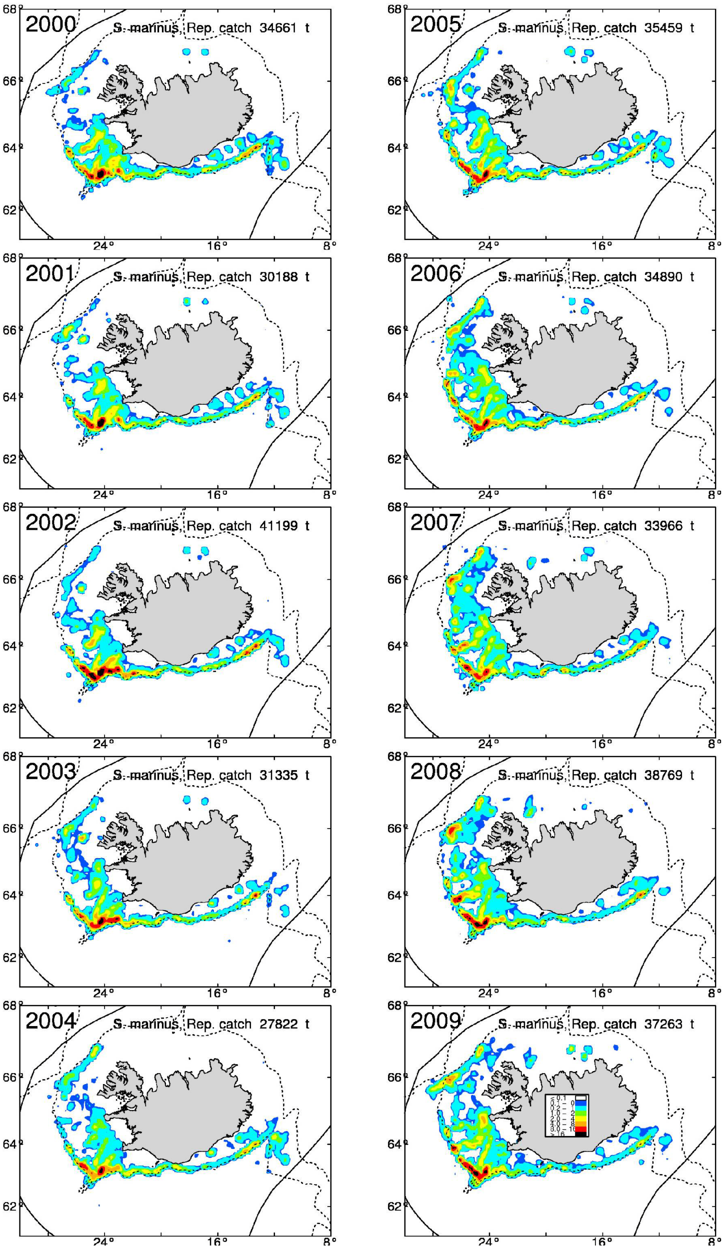

Figure 17.3.2 Geographical distribution of golden redfish bottom trawl catches in Division Va 2000-2009.

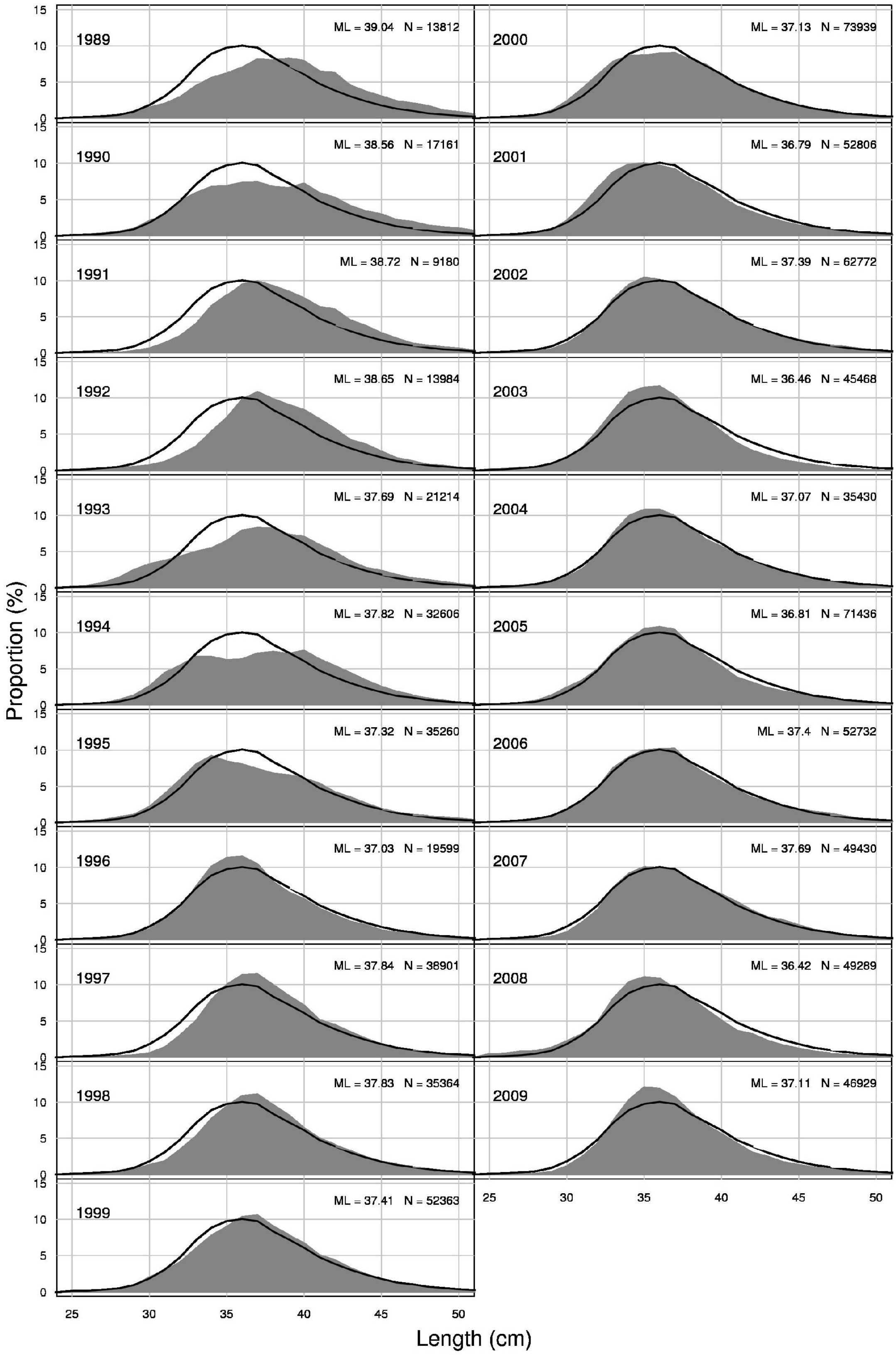

Figure 17.3.3 Length distribution of golden redfish in the commercial landings of the Icelandic bottom trawl fleet 1989-2009. The solid line is the mean 1989-2009.

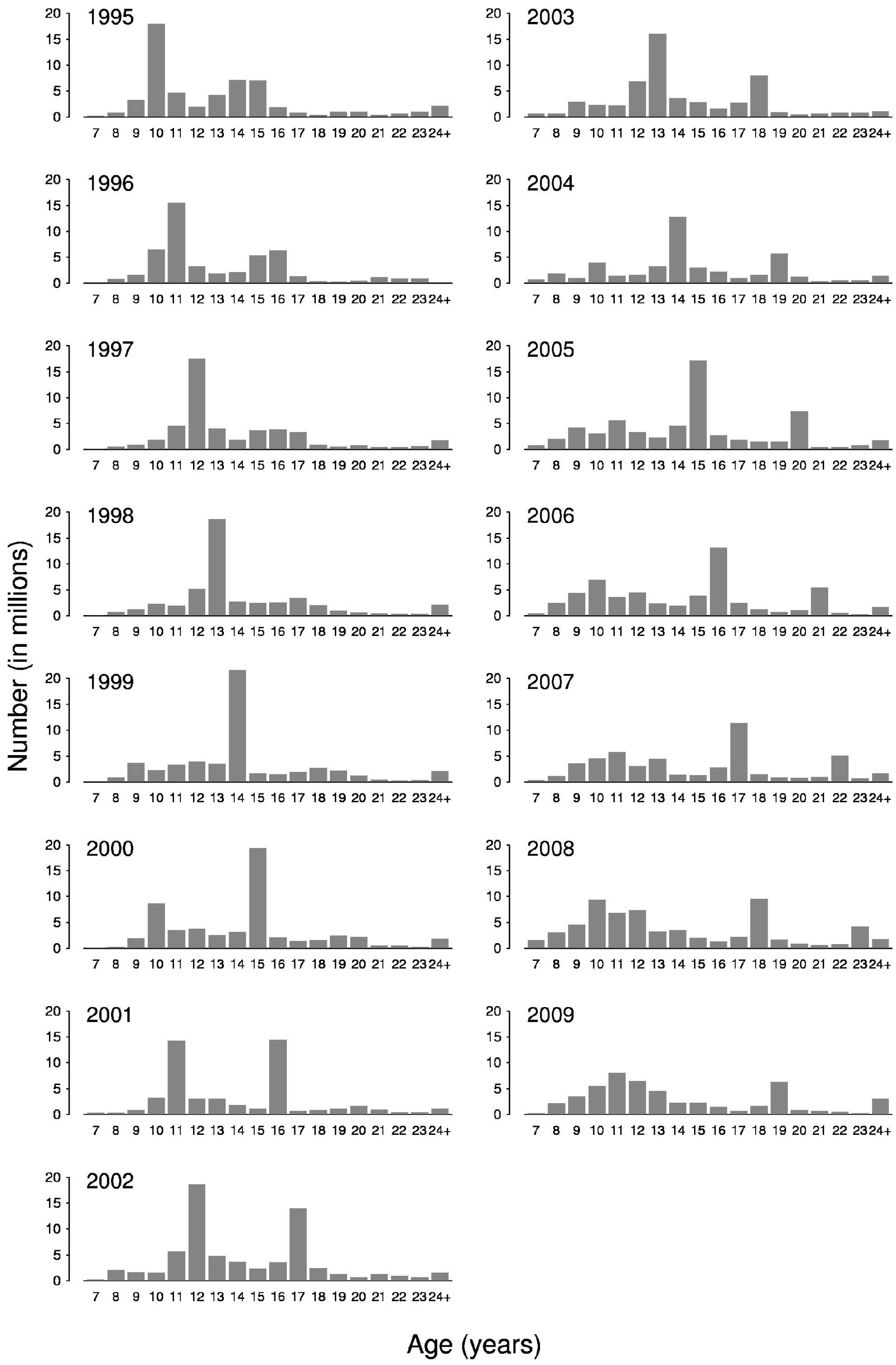

Figure 17.3.4 Catch-at-age of golden redfish in numbers in ICES Subdivision Va 1995-2009.

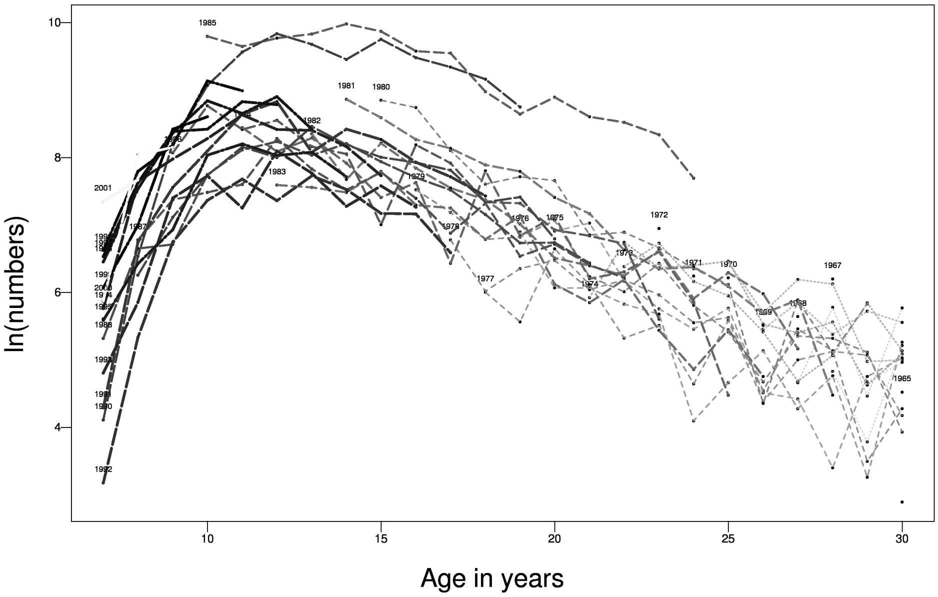

Figure 17.3.5 Catch curve of golden redfish based on the catch-at-age data in ICES Division Va 1995-2009.

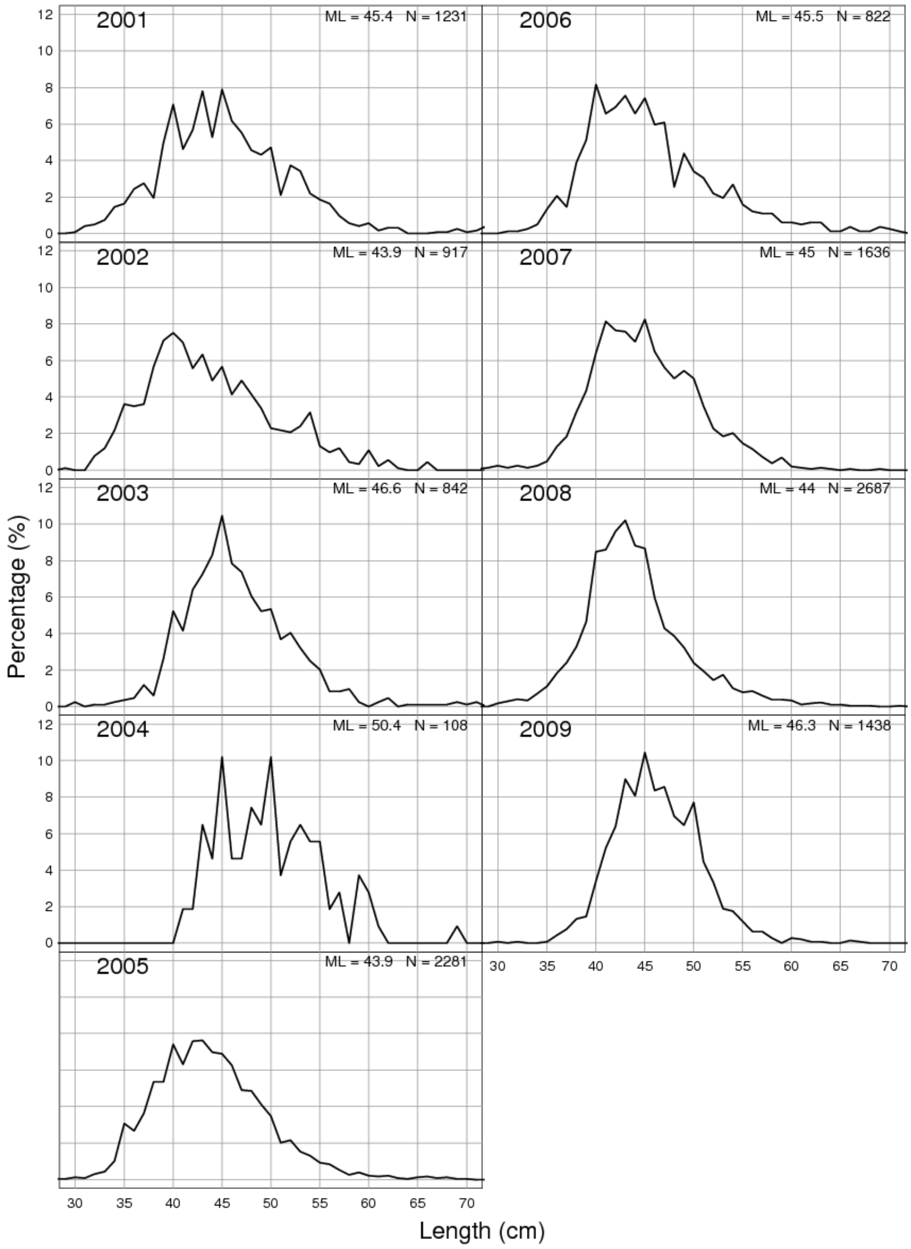

Figure 17.3.6 Length distribution of golden redfish from Faroese catches in 2001-2009.

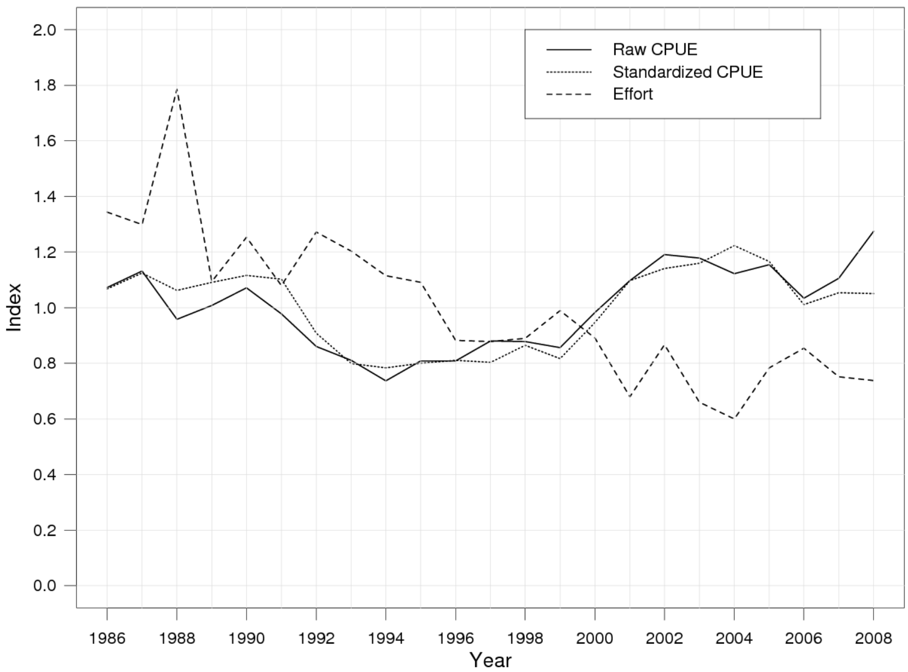

Figure 17.3.7 CPUE of golden redfish from Icelandic trawlers based on results from the GLM model 1985-2008 where golden redfish catch composed at least 50% of the total catch in each haul. The figure shows the raw CPUE index (sum(yield)/sum(effort)), standardized CPUE index estimated using a generalized linear model, and effort.

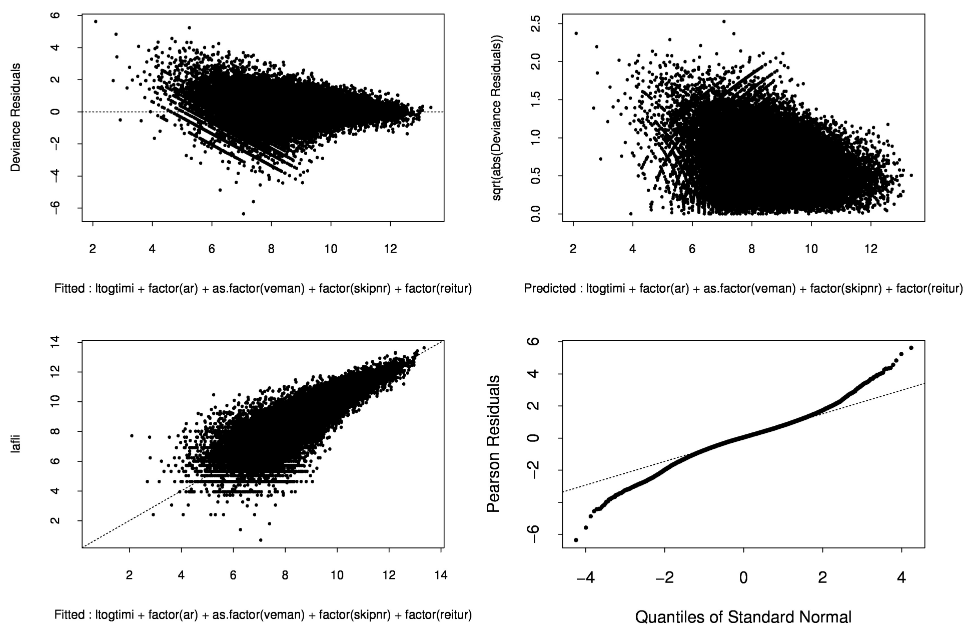

Figure 17.3.8 Results from the GLM modle (section 8.2.1) for the CPUE series of golden redfish in Va. From left to right, top to bottom: Residuals against fitted values; square root of the absolute value of residuals against predicted values; response against fitted values; normal QQplot of standardized residuals.

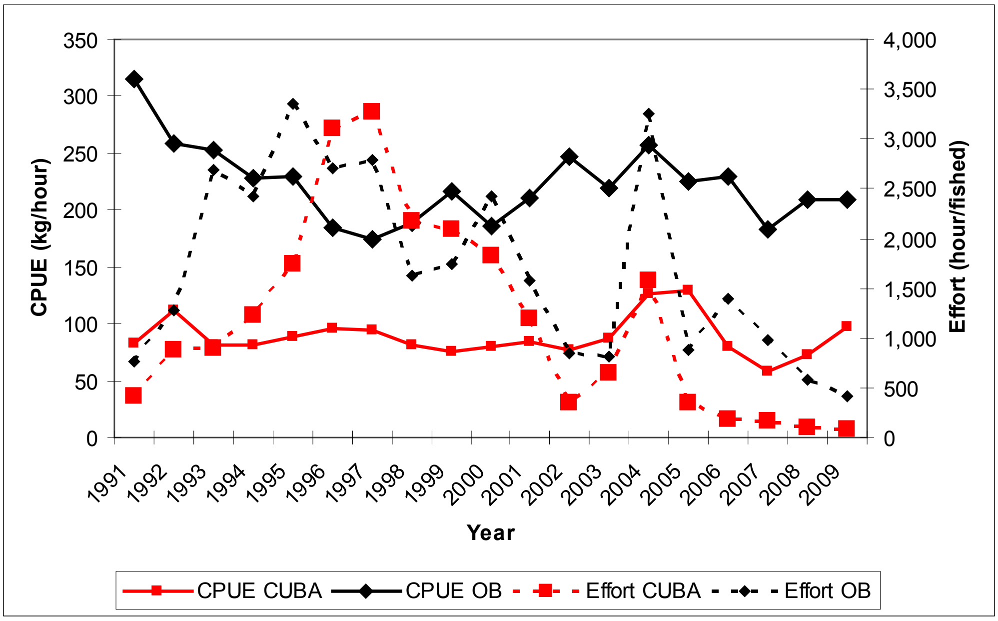

Figure 17.3.9 CPUE (solid lines) and effort (dotted lines) for golden redfish from the Faroese CUBA pair-trawlers (red) and otterboard trawlers (black) in ICES Division Vb 1991-2009.

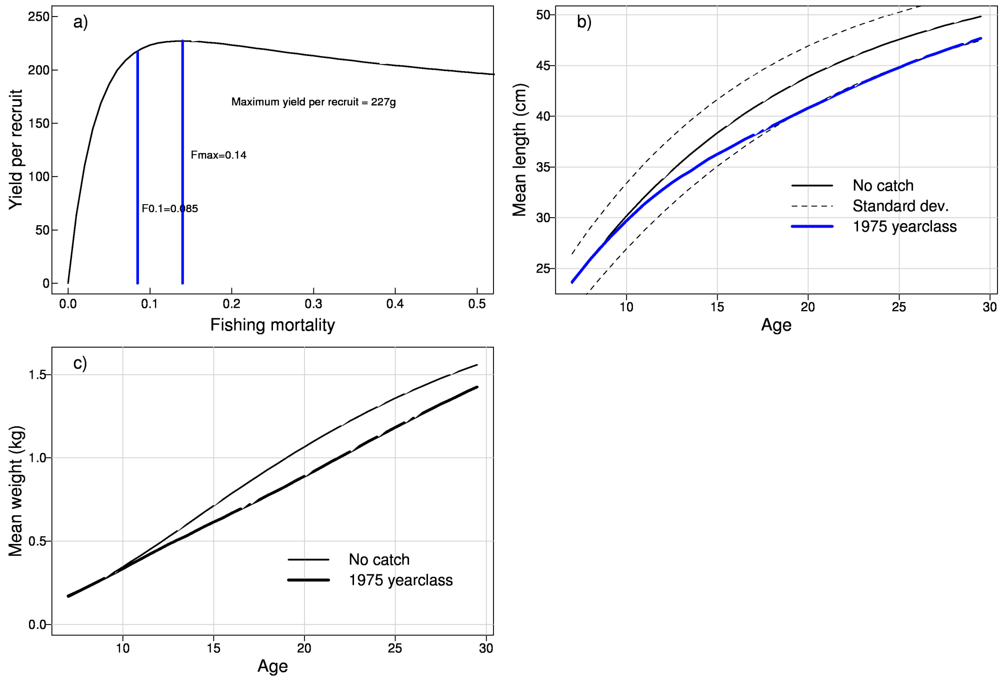

Figure 17.4.1 Results from the Gadget model for golden redfish using catch data from ICES Division Va. a) Yield-per-recruit, b) Mean length at age and effect of catch on length at age, c) Mean weight at age and effect of catch on weight at age.

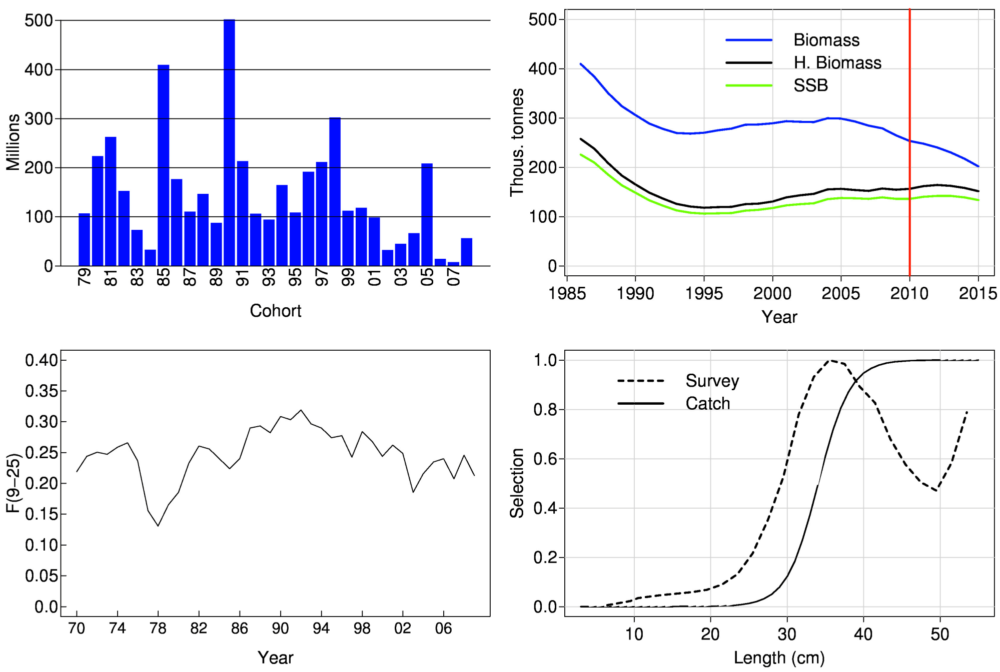

Figure 17.4.2 Results from the Gadget model for golden redfish using catch data from ICES Division Va. a) Estimated recruitment at age 1. b) Total and harvestable biomass using 30 000 tonnes after 2010. c) F. d) Estimated selection pattern of the commercial fleeit and the survey.

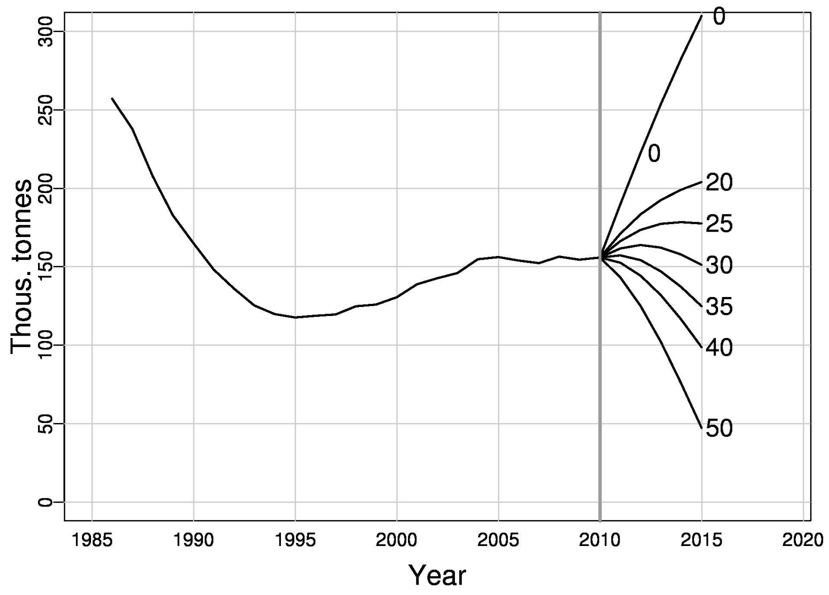

Figure 17.4.3 Development of catchable biomass of golden redfish using different catch options (0-50 000 t) after 2010 to 2015.

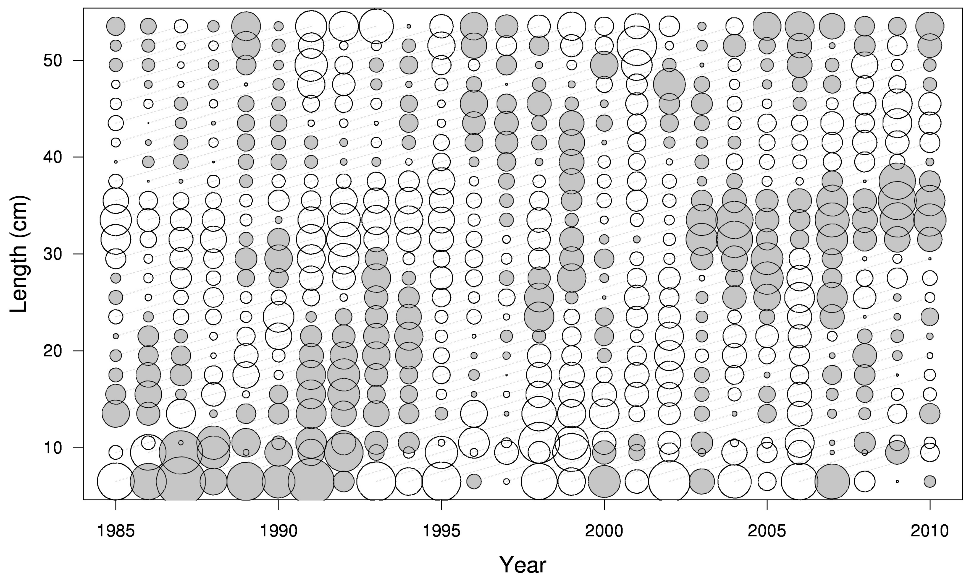

Figure 17.4.4 Residuals from the fit between model and survey indices. The shaded circles indicate positive residuals (survey results exceed model prediction). Largest residuals correspond to log(obs/mod) = 1.

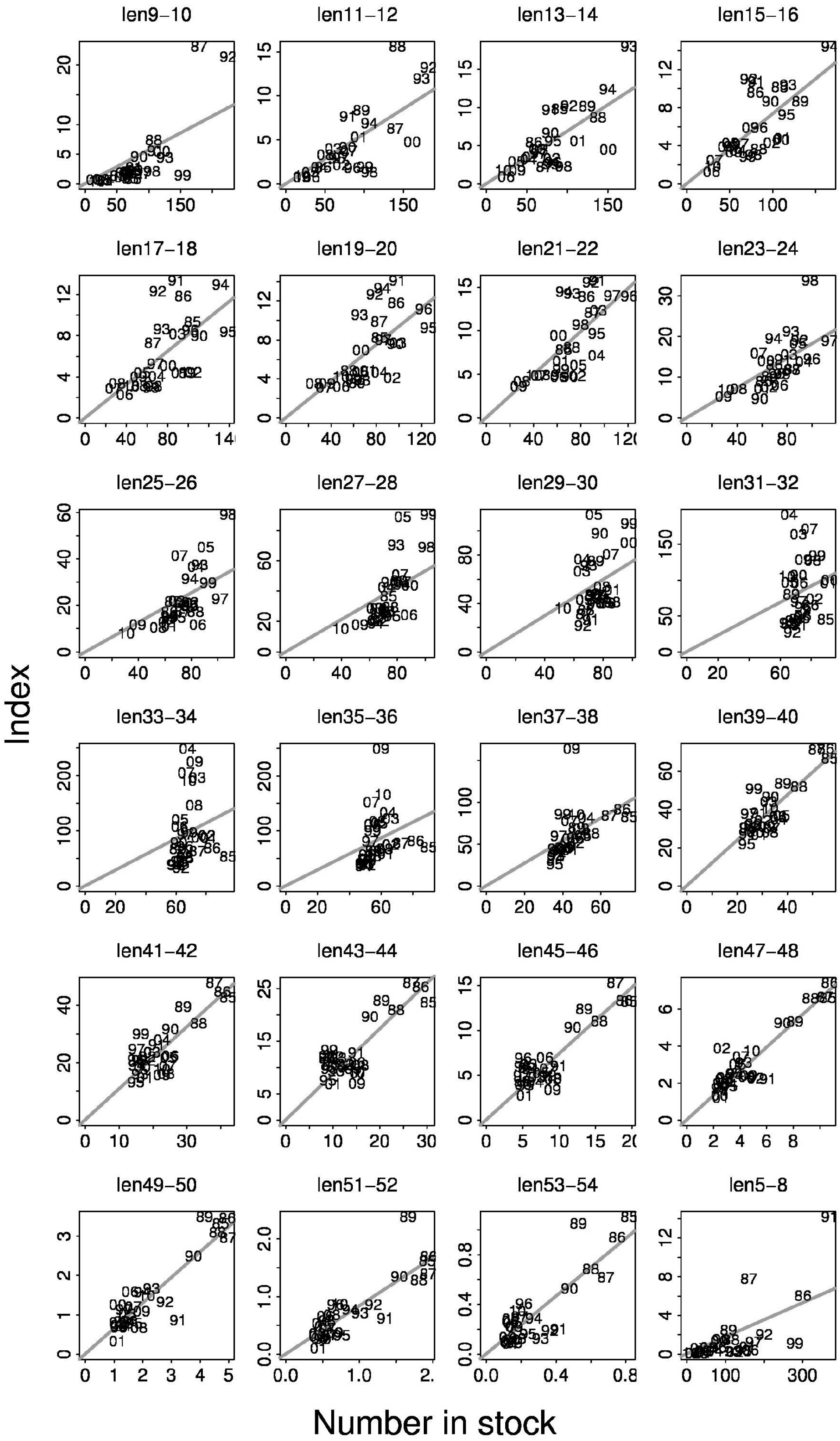

Figure 17.4.5 Survey indices for each length group plotted against the estimated number in stock from the model. The line shown is fitted on original scale but the model fit is on log scale. °

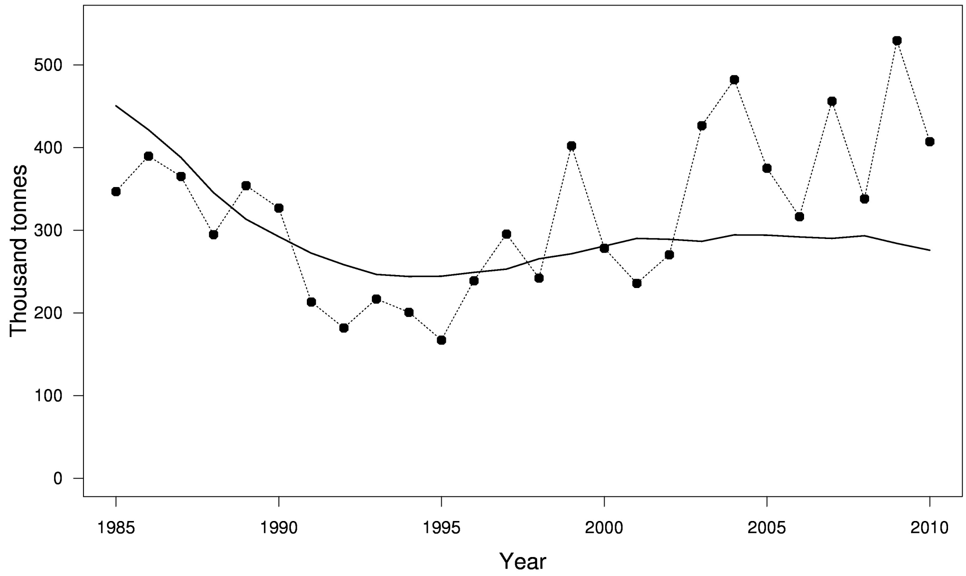

Figure 17.4.6 Results from the Gadget run, using only catch data from ICES Division Va. The Figure shows comparison of observed and modelled survey biomass (total biomass) 1985-2009.

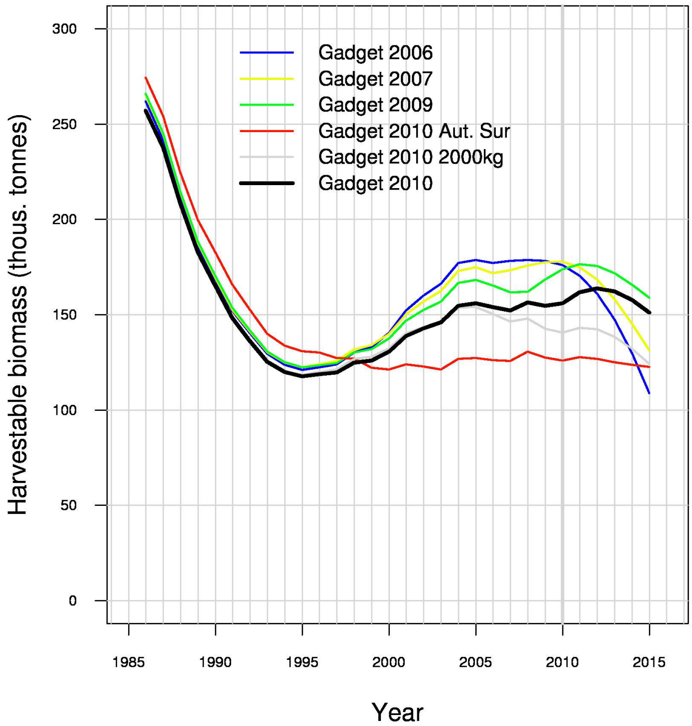

Figure 17.4.7 Comparison of the development of the available biomass in Va according to the GADGET runs this year and GADGET run last year. Prognosis is don with TAC constraints of 30 kt.

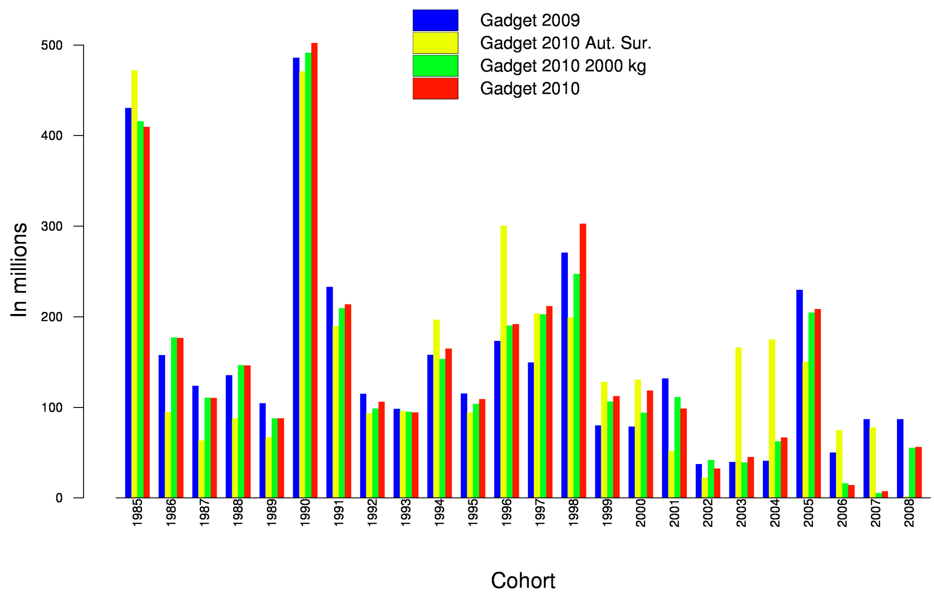

Figure 17.4.8 Comparison of the estimated recruitment according to the GADGET runs this year and GADGET run last year.

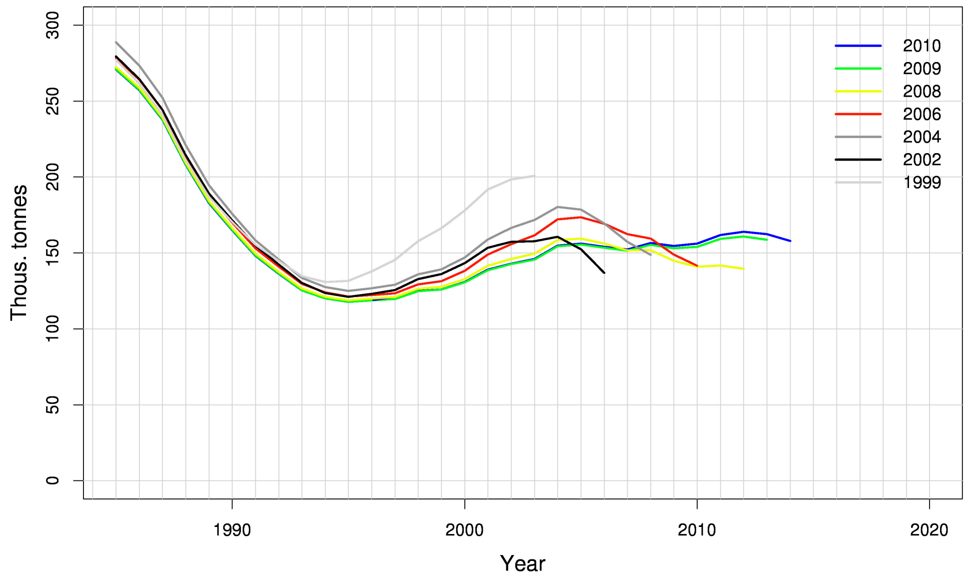

Figure 17.4.9 Retrospective pattern of the harvestable biomass of golden redfish in ICES Division Va. The retrospective patterns (1999-20010) show prognosis 5 years after the assessment year so the last retro ends in 2015.

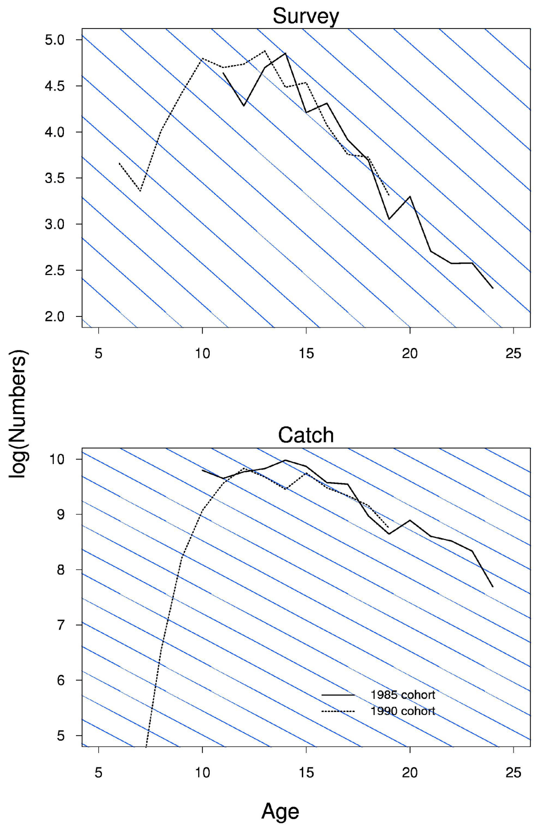

Figure 17.4.10 Autumn survey indices and number caught for year classes 1985 and 1990 of golden redfish. Lines correspond to Z=0.2.

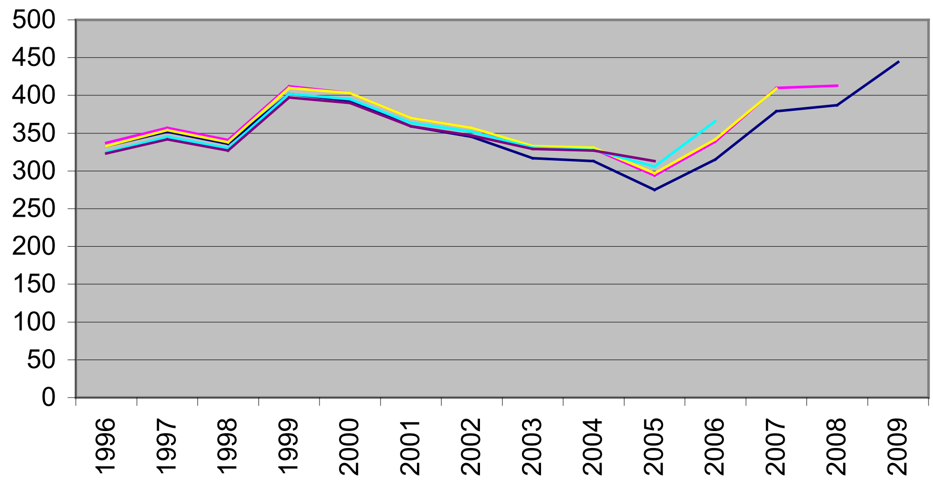

Figure 17.4.11 Retrospective analyses from the TSA. Biomass of ages 9-19. Terminal years 2005-2008.

18 Icelandic slope *Sebastes mentella* in Va and XIV

Executive summary

- ICES concluded in February 2009 that demersal *S. mentella* is to be divided to three biological stocks and that the *S. mentella* on the continental shelf and slope of Iceland should be treated as separate biological stock and management unit. This chapter therefore deals only with the Icelandic Slope stock.
- Total landings of demersal *S. mentella* in Icelandic waters in 2009 were about 18 700 t, about 7 000 t less than in 2008.
- 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 7 years.
- In recent years, good recruitment has been observed on the East-Greenland shelf which is assumed to contribute to the three stocks at unknown shares.

18.1 Stock description and management units

The stock structure of *S. mentella* in the Irminger Sea and adjacent water is described in Chapter 16. The *S. mentella* on the continental shelf and slope of Iceland is treated as separate biological stock and management unit. Only the fishable stock of Icelandic slope *S. mentella* is found in Icelandic waters, i.e. mainly fish larger than 30 cm. The East-Greenland shelf is most likely a common nursery area for the three biological stocks described in Chapter 16, including the Icelandic slope one.

18.2 Scientific data

Only the fishable stock of Icelandic slope *S. mentella* is found in Icelandic waters. The Icelandic autumn survey on the continental shelf and slope in Division Va, covering depths down to 1,500m, does, therefore, not cover the whole distribution of the stock. The total biomass index and the fishable biomass index (fish > 30 cm) from the autumn survey was highest in 2001, decreased in 2002 and has since then remained relatively stable (Figure 18.2.1*a* and *b*). The biomass index of fish larger than 45 cm was at lowest level in 2007 but increased again in 2008 and 2009 and was similar to the 2001 value (Figure 18.2.1*c*). The abundance index of fish smaller than 30 cm (Figure 18.2.1*d*) was in 2008 and 2009 at lowest level. The length of the Icelandic slope *S. mentella* in the autumn survey is between 25 and more than 50 cm. Since 2000, the mode has shifted to the right, that is, from 36-39 cm in 2000 to about 42 cm in 2009 (Figure 18.2.2).

18.3 Information from the fishing industry

18.3.1 Landings

Total annual landings of Icelandic slope *S. mentella* from ICES Division Va 1978-2009 are presented in Table 18.3.1 and in Figure 18.3.1. Annual landings gradually decreased from a record high of 57000 t in 1994 to 17 000 t in 2001 t. Landings in 2003 increased to 28 500 t but fluctuated between 16 000 t and 21 000 in 2004-2007. The landings in 2008 were about 24 500 t, an increase of about 8 500 t from the previous year, but decreased again in 2009 and to 18 700 t.

18.3.2 Fisheries and fleets

Most of the fishery for Icelandic slope *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 Icelandic slope *S. mentella* catches taken by pelagic trawls 1991-2000 varied between 10 and 44% of the total landings (Table 18.3.2). In 2001-2009, no pelagic fishery occurred or it was negligible except in 2003 and 2007 (see below). In general, the pelagic fishery 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 increased landings in 2008 are mainly due to increased bottom trawl fishery in September-November, which is unusual compared to other years (Figure 18.3.4). These catches were mainly taken in a fishing area northwest of Iceland (Figure (18.3.2). In 2009, the landings decreased again.

The catch pattern was different in 2003 and in 2007 than in other years. The catches peaked in July in 2003 and in June 2007, which was unusual (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 some years moved more northwards, and in 2003 and 2007 it merged with the Icelandic slope *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 Icelandic slope *S. mentella* and caught either with pelagic or bottom trawls (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 recent years very little Icelandic slope *S. mentella* was taken on these fishing grounds (Figure 18.3.2). This area has historically been an important fishing area for Icelandic slope *S. mentella*.

18.3.3 Sampling from the commercial fishery

The table below shows the 2009 biological sampling from the catch and landings of Icelandic slope *S. mentella* in ICES Division Va. This is considered to be adequate sampling from the fishery.

Yearea	Nation	Geyear	Landings (t)	No. samples	No. length measured
Va	Iceland	Bottom trawl	28 721	165	26 912

18.3.4 Length distribution from the commercial catch

Length distributions of Icelandic slope *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 2004-2009 peaked around 37-39 cm. The length distribution of Icelandic slope *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 (Figure 18.3.5).

18.3.5 Catch per unit effort

Data used to estimate CPUE for Icelandic slope *S. mentella* in Division Va 1986-2009 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% Icelandic slope *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. From 2000 to 2009 the CPUE was stable. From 1991 to 1994, when CPUE decreased, the fishing effort increased drastically. Since then, effort decreased and is now at similyear level as in the beginning of the series.

18.3.6 Discard

Although no direct measurements are available on discards, it is believed that there are no significant discards of Icelandic slope *S. mentella* in the Icelandic redfish fishery. This is because only the fishable stock is found in Icelandic waters.

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 Icelandic slope *S. mentella* in Division Va.

The fishable biomass index of Icelandic slope *S. mentella* in Division Va from the Icelandic autumn survey shows that the biomass index for 2002-2009 has been relatively stable on a lower level than in earlier years. Standardised CPUE indices 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 stable since 2000.

Recently, good recruitment has been observed on the East Greenland shelf (growth of about 2cm/yr) which is assumed to contribute to both the Icelandic slope 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 Icelandic slope *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 and 2009 was that a management plan to be developed and implemented which takes into account the uncertainties in science and the properties of the fisheries. ICES suggested that catches of *S. mentella* are set no higher than 10 000 t as a starting point for the adaptive part of the management plan.

The Icelandic slope *S. mentella* fishery southeast of Iceland has gradually ceased since 2000 and very little fishing is conducted in this area. This fishing area was prior to 2000 very important fishing area for Icelandic slope *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 Icelandic slope fishery at the redfish line. Those two fisheries merged again in 2007.

There are no explicit management for Icelandic slope *S. mentella*. Icelandic authorities give a joint quota for golden redfish and Icelandic slope *S. mentella* in Icelandic waters. In late 2008, the Ministry of Fisheries in Iceland established a committee with the objective to review and recommend on how to separate quotas for the two species. Consensus was within the committee that quota for those two species should be given separately. The separation of quotas will be implemented in the next fishing year that starts September 2010..

18.8 Regulation and their effects

There are no explicit management for Icelandic slope *S. mentella*. Icelandic authorities give a joint quota for golden redfish and Icelandic slope *S. mentella* in Icelandic waters. Both species are therefore treated as redfish by the Icelandic authorities. Redfish is managed under ITQ system (see chapter 7.5.1).

The minimum legal catch size of redfish in Icelandic waters is 33 cm for all fleets, with allowance to have up to 20% undersized (i.e. less than 33 cm) specimens of redfish (in numbers) in each haul. If the number of redfish smaller than 33 cm in a haul is more than 20% fishing is prohibited for at least two weeks in those areas (see Chapter 7.5.3 for further details about the quick closure system). Very few quick closures have been on small redfish since 2001.

Table 18.3.1 Nominal landings (in tonnes) of Icelandic slope *S. mentella* 1978-2009 ICES Division Va.

Year	Iceland	Others	Total
1978	3 693	209	3 902
1979	7 448	246	7 694
1980	9 849	348	10 197
1981	19 242	447	19 689
1982	18 279	213	18 492
1983	36 585	530	37 115
1984	24 271	222	24 493
1985	24 580	188	24 768
1986	18 750	148	18 898
1987	19 132	161	19 293
1988	14 177	113	14 290
1989	40 013	256	40 269
1990	28 214	215	28 429
1991	47 378	273	47 651
1992	43 414	0	43 414
1993	51 221	0	51 221
1994	56 674	46	56 720
1995	48 479	229	48 708
1996	34 508	233	34 741
1997	37 876	0	37 876
1998	32 841	284	33 125
1999	27 475	1 115	28 590
2000	30 185	1 208	31 393
2001	15 415	1 815	17 230
2002	17 870	1 175	19 045
2003	26 295	2 183	28 478
2004	16 226	1 338	17 564
2005	19 109	1 454	20 563
2006	16 339	869	17 208
2007	17 090	369	17 459
2008	25 585	0	25 585
2009[1)]	18 721	0	18 721

1) Provisional

Table 18.3.2 Proportion of the landings of Icelandic slope *S. mentella* taken in ICES Division Va by pelagic and bottom trawls 1991-2009.

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%
2008	0%	100%
2009	0%	100%

Table 18.3.3 Results of the GLM model to calculate standyeardized CPUE for Icelandic slope redfish fishery in Va. Note that the residuals are shown in Figure 18.3.8.

```
Call: glm(formula = log(catch) ~ log(towtime) + factor(year) + as.factor(month) +
factor(vessel) + factor(area), family = gaussian())
Deviance Residuals:
       Min         1Q     Median        3Q      Max
 -5.003212 -0.3255586 0.01466922 0.3434515 4.709436

Coefficients:
                            Value  Std. Error       t value
         (Intercept)  3.6267394415 0.643033234  5.640050e+00
             ltowtime  1.1343100869 0.004003986  2.832952e+02
    factor(year)1987  0.0619623929 0.043191464  1.434598e+00
    factor(year)1988 -0.0022302194 0.042437915 -5.255252e-02
    factor(year)1989 -0.0442849486 0.041761168 -1.060434e+00
    factor(year)1990 -0.1022107033 0.039430626 -2.592165e+00
    factor(year)1991 -0.0587570018 0.035186467 -1.669875e+00
    factor(year)1992 -0.3093421908 0.034838837 -8.879234e+00
    factor(year)1993 -0.4095229148 0.034909351 -1.173104e+01
    factor(year)1994 -0.5177586217 0.034968978 -1.480623e+01
    factor(year)1995 -0.4830985920 0.035348640 -1.366668e+01
    factor(year)1996 -0.4685096477 0.036125628 -1.296890e+01
    factor(year)1997 -0.4158649288 0.035908253 -1.158132e+01
    factor(year)1998 -0.4237834617 0.037780741 -1.121692e+01
    factor(year)1999 -0.3703983579 0.036955240 -1.002289e+01
    factor(year)2000 -0.3136803919 0.037550176 -8.353633e+00
    factor(year)2001 -0.3254044863 0.039424217 -8.253924e+00
    factor(year)2002 -0.3567616331 0.037880261 -9.418141e+00
    factor(year)2003 -0.2839996630 0.038064218 -7.461066e+00
    factor(year)2004 -0.3582828867 0.038722417 -9.252596e+00
    factor(year)2005 -0.3470904288 0.037512720 -9.252606e+00
    factor(year)2006 -0.3582157175 0.038434784 -9.320092e+00
    factor(year)2007 -0.3535343946 0.041249257 -8.570685e+00
    factor(year)2008 -0.2625523774 0.038576097 -6.806090e+00
    factor(year)2009 -0.3345365886 0.043468585 -7.696054e+00
 as.factor(month)2    0.1332417340 0.016077777  8.287323e+00
 as.factor(month)3    0.1452734947 0.016973579  8.558802e+00
 as.factor(month)4    0.1177954265 0.017092826  6.891513e+00
 as.factor(month)5    0.0401237669 0.018928105  2.119798e+00
 as.factor(month)6    0.0161104780 0.021087579  7.639795e-01
 as.factor(month)7   -0.0798948576 0.021187919 -3.770774e+00
 as.factor(month)8   -0.0919080130 0.020498376 -4.483673e+00
 as.factor(month)9   -0.0456182328 0.018066086 -2.525076e+00
as.factor(month)10   -0.0372151056 0.016897088 -2.202457e+00
as.factor(month)11   -0.0684336253 0.017188701 -3.981315e+00
as.factor(month)12   -0.1264298635 0.018007018 -7.021144e+00
.....

(Dispersion Pyearameter for Gaussian family taken to be 0.3948549 )

    Null Deviance: 51784.99 on 27560 degrees of freedom
Residual Deviance: 10749.53 on 27224 degrees of freedom
Number of Fisher Scoring Iterations: 1
```

```
Analysis of Deviance Table
Gaussian model
Response: lafli
Terms added sequentially (first to last)
                  Df Deviance Resid. Df Resid. Dev  F Value Pr(F)
           NULL                   27560   51784.99
        ltowtimi     1 37161.64     27559   14623.35 94114.67     0
      factor(year)  23   849.99     27536   13773.37    93.59     0
as.factor(month)    11   226.34     27525   13547.03    52.11     0
  factor(vessel)   153  1895.69     27372   11651.34    31.38     0
  factor(area)     148   901.81     27224   10749.53    15.43     0
```

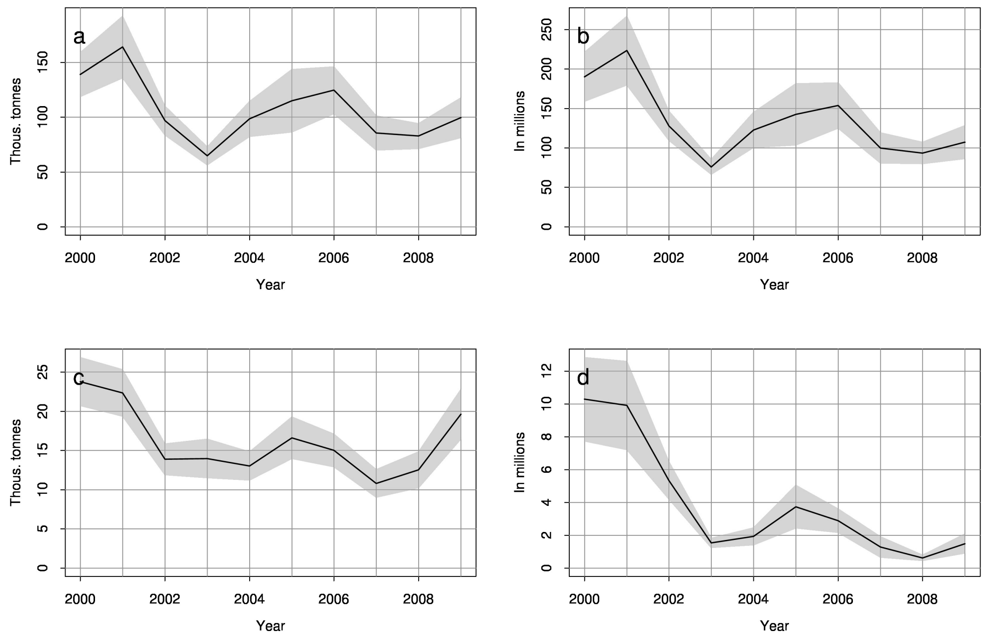

Figure 18.2.1 **Survey indices of the Icelandic slope *S. mentella* in the autumn survey in ICES Division Va 2000-2009. a) Total biomass index. b) Fishable biomass index (> 30 cm). c) Biomass index of fish larger than 45 cm. d) Abundance index of fish smaller than 30 cm.**

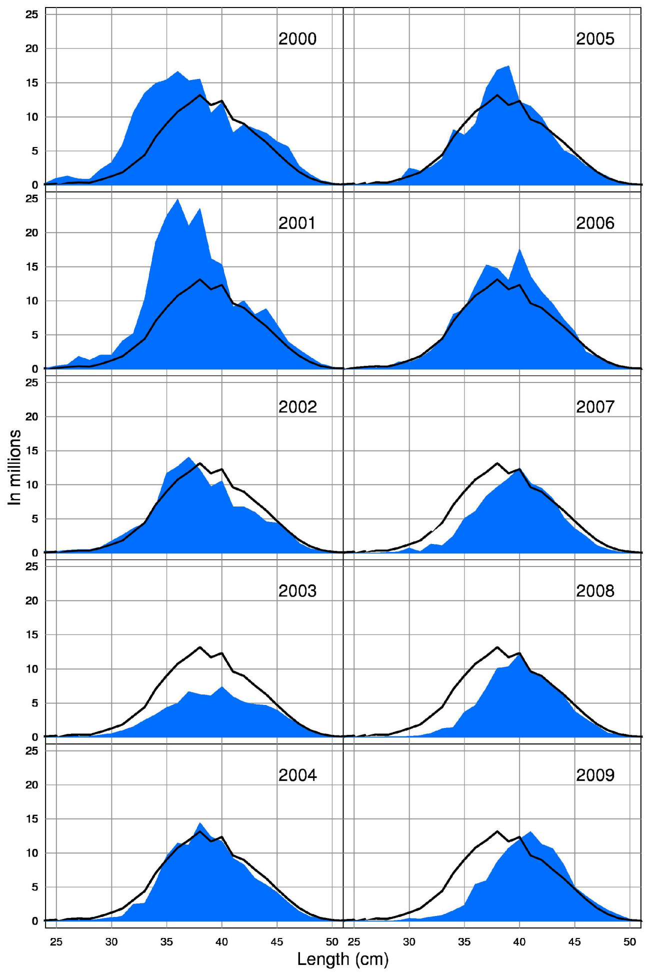

Figure 18.2.2 Length distribution of Icelandic slope *S. mentella* in the Autumn Groundfish Survey in October 2000-2009 in ICES Division Va. The black line is the mean of 2000-2009.

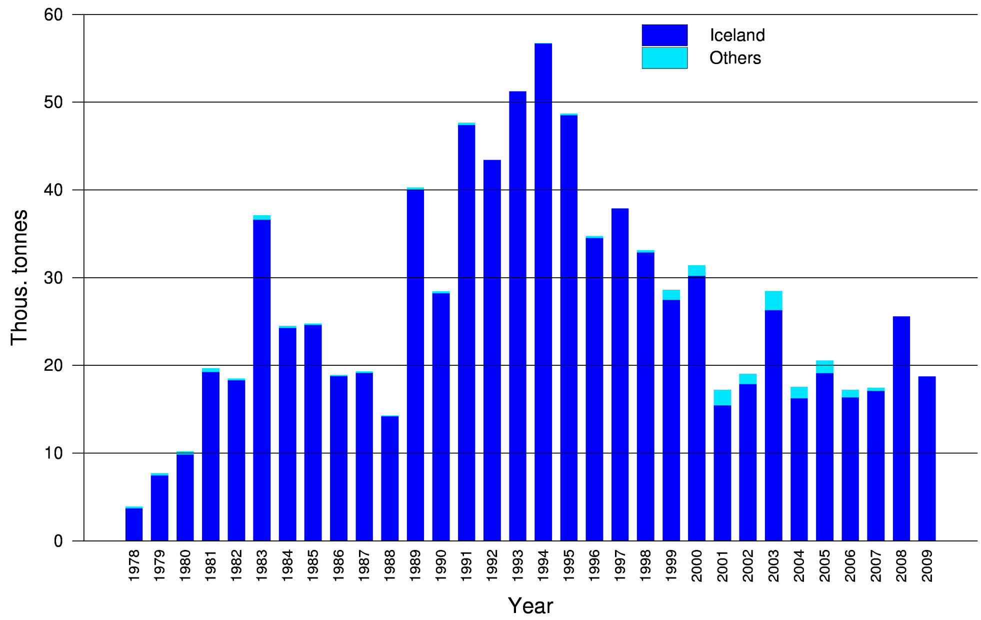

Figure 18.3.1 Nominal landings (in tonnes) of Icelandic slope *S. mentella* from ICES Divisions Va 1978-2009.

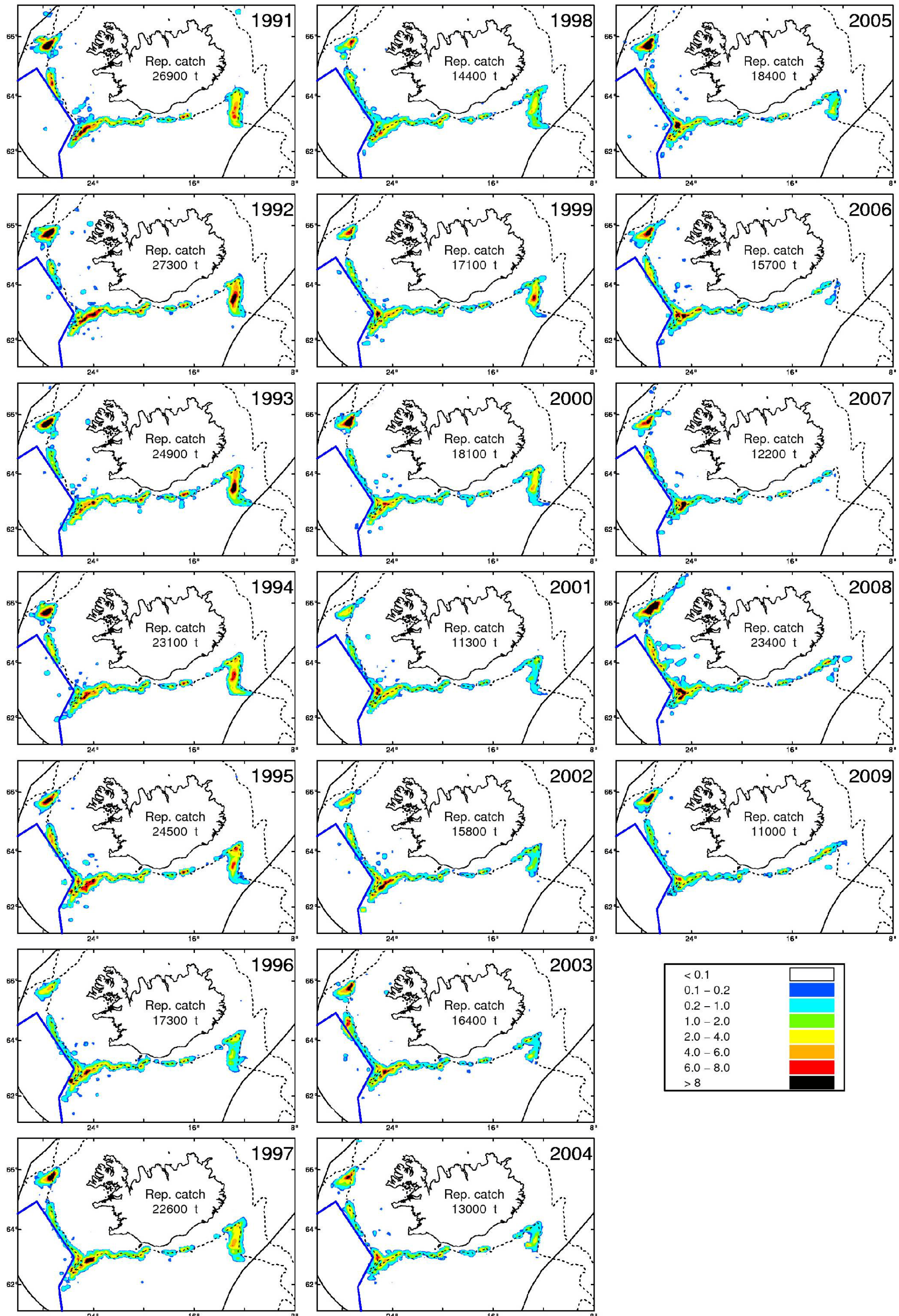

Figure 18.3.2 Geographical location of the Icelandic slope *S. mentella* catches in Icelandic waters (ICES Division Va and XIV) 1991-2009 as reported in log-books of the Icelandic fleet using bottom trawl. The blue line indicates part of the proposed management unit for the deep-pelagic redfish stock. The dotted line represents the 500 m isobaths.

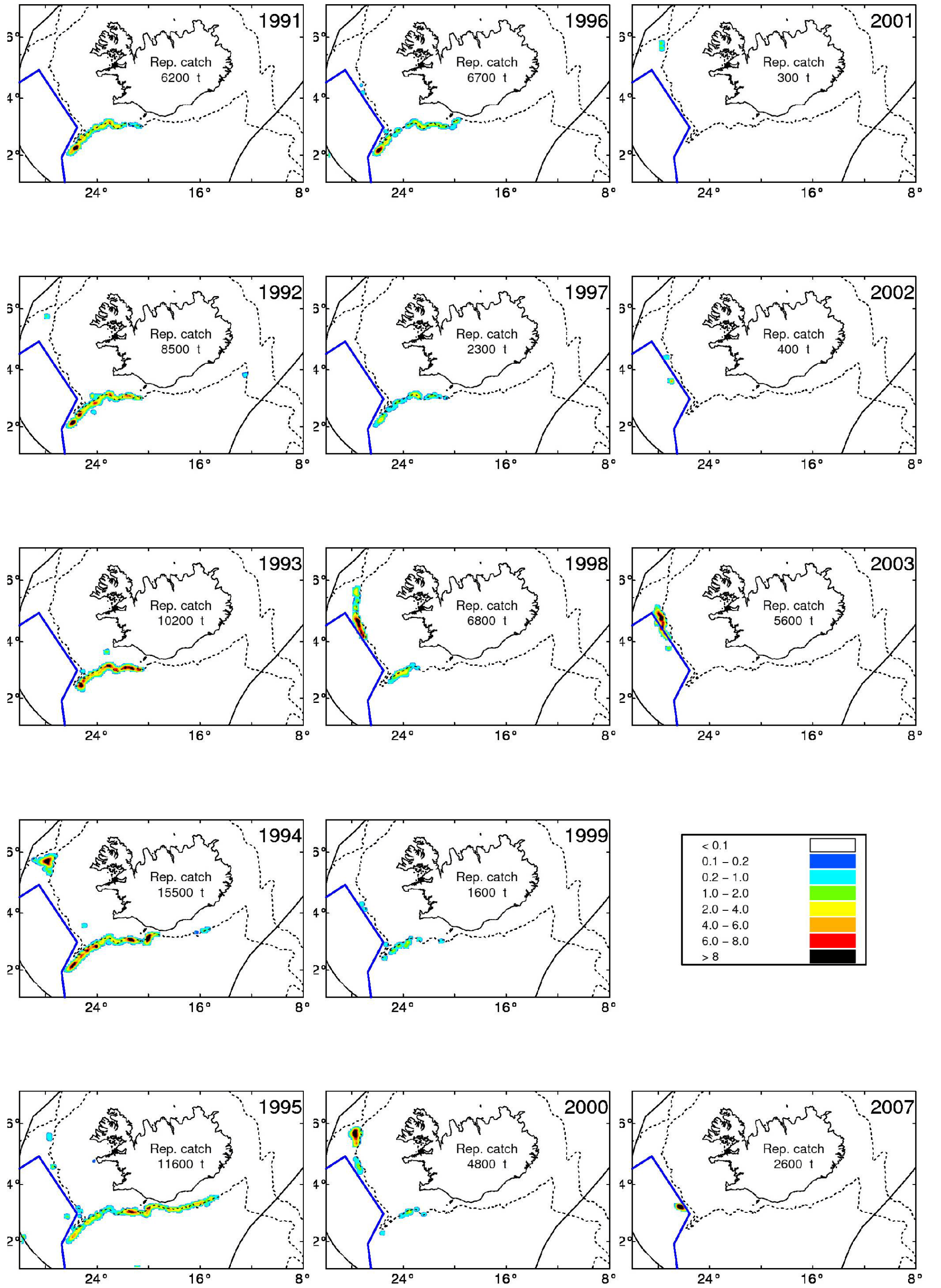

Figure 18.3.3 Geographical location of the Icelandic slope *S. mentella* catches in Icelandic waters (ICES Division Va and XIV) 1991-2003 and 2007 as reported in log-books of the Icelandic fleet using pelagic trawl. The blue line indicates part of the proposed management unit for the deep-pelagic redfish stock. The dotted line represents the 500 m isobaths.

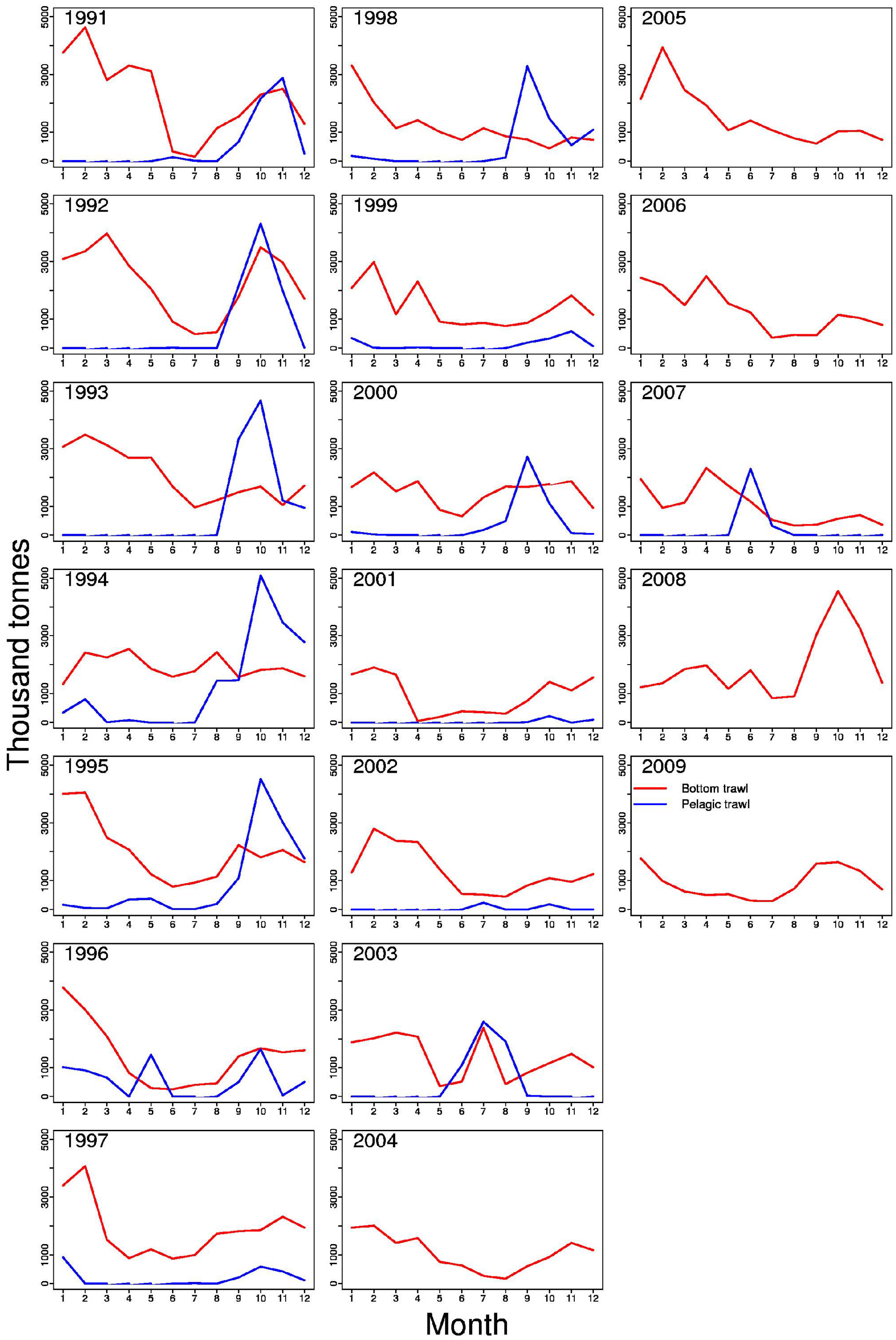

Figure 18.3.4 Nominal landings (in tonnes) of Icelandic slope *S. mentella* in Icelandic waters (ICES Division Va and XIV) of the Icelandic fleet using either bottom trawl (red line) or pelagic trawl (blue line) 1991-2009 divided by month.

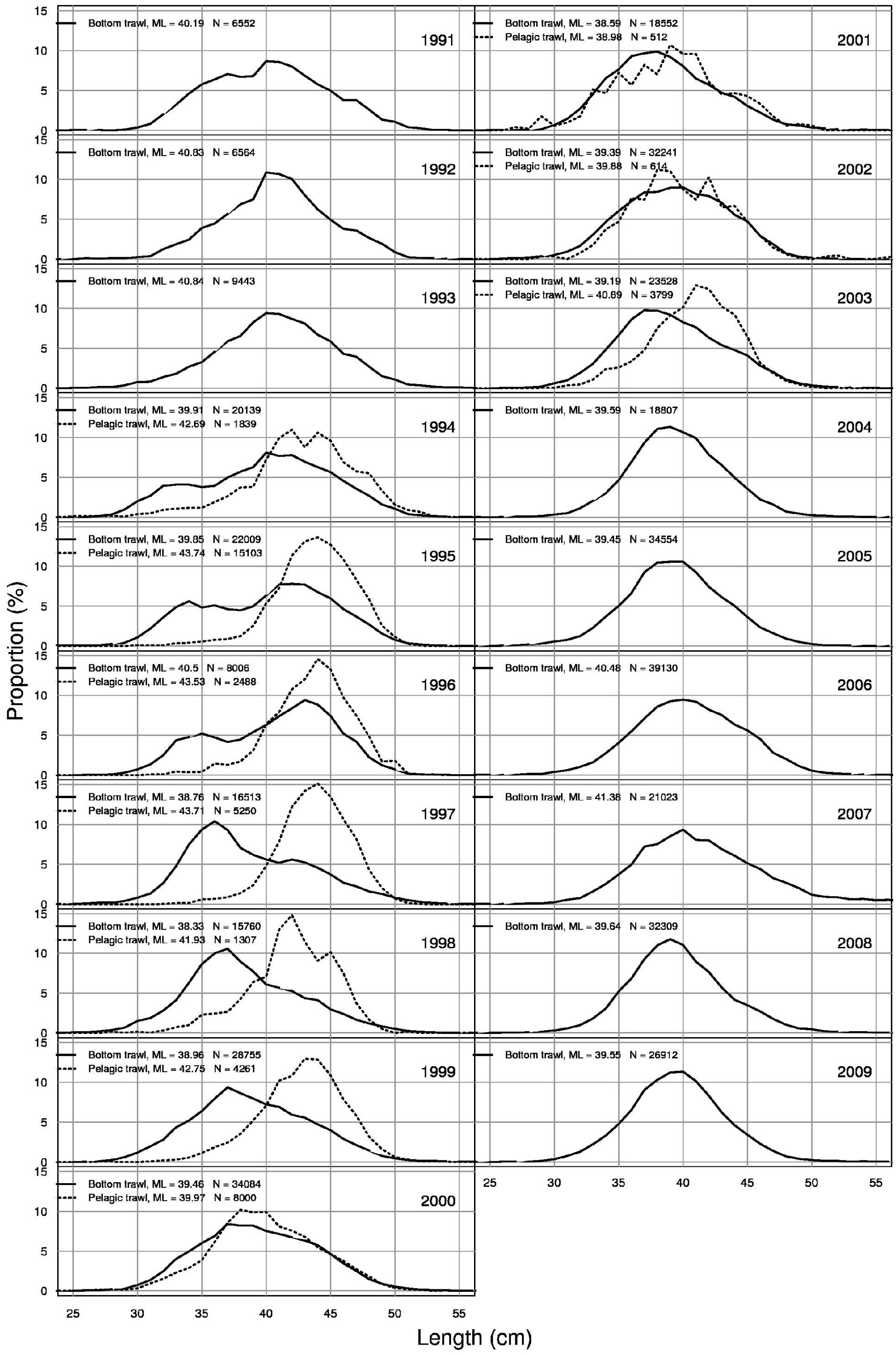

Figure 18.3.5 Length distributions of Icelandic slope *S. mentella* from the Icelandic landings taken with bottom trawl (solid line) and pelagic trawl (dotted line) in ICES Division Va 1991-2009.

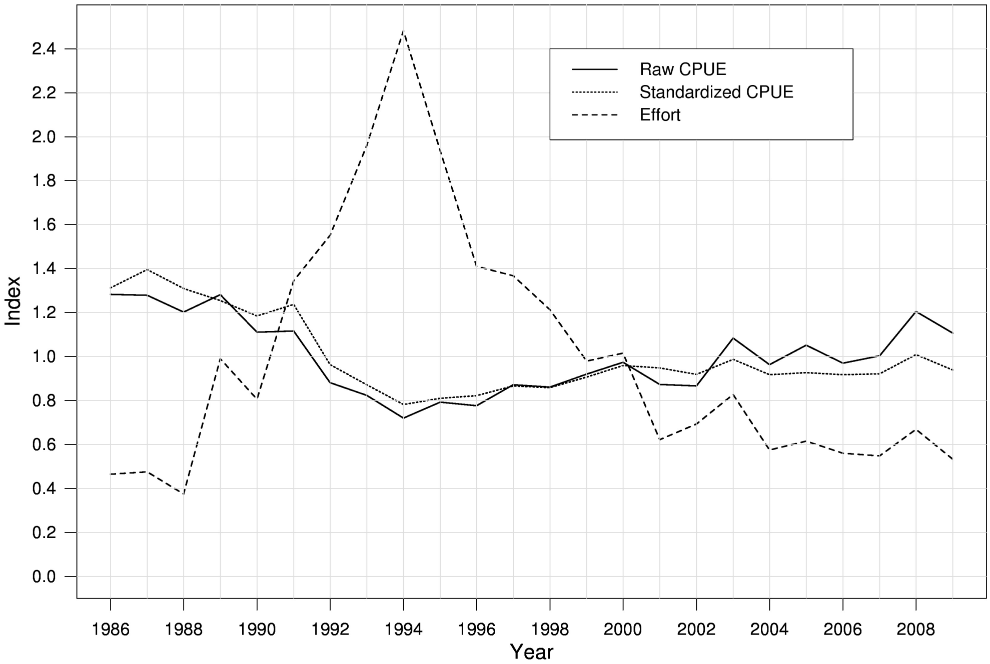

Figure 18.3.7 CPUE relative to 1986 of Icelandic slope *S. mentella* from the Icelandic bottom trawl fishery in Division Va. CPUE based on a GLM model based on data from log-books and where at least 50% of the total catch in each tow was Icelandic slope *S. mentella*. Also shown is fishing effort (hours fished in thousands).

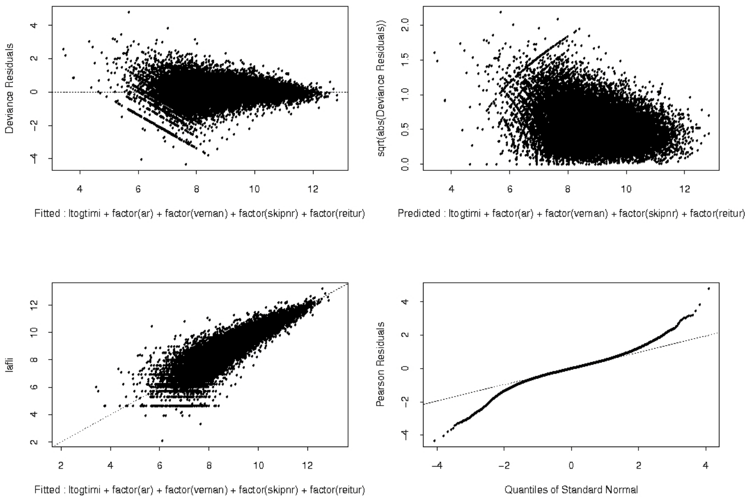

Figure 18.3.8 Residual of the GLM model (section 18.3.5) for the CPUE series of Icelandic slope *S. mentella*.

19 Shallow Pelagic *Sebastes mentella*

19.1 Stock description and management unit

This section addresses the fishery for shallow 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) at depths shallower than 500 m.

The following text table summarises the available information from fishing fleets in the Irminger Sea and adjacent waters in 2009:

Faroes	3 factory trawlers
Iceland	12 factory trawlers
Green-land	1 factory trawler
Poland	1 factory trawler
Portugal	6 factory trawlers
Russia	18 factory trawlers
Spain	6 factory trawlers

19.2 Summary of the development of the fishery

The historic development of the fisheries by nation can be found in the 2007 NWWG Report, of which an abstract is provided here. Russian trawlers started the pelagic *S. mentella* fishery in 1982, covering wide areas of the Irminger Sea (Figure 19.2.1). Vessels from Bulgaria, the former GDR and Poland joined in 1984. Annual landings for most of the period 1982-1995 ranged between 60,000 t and 100,000, declining to around 30,000 t. between 1989 and 1991. Fishing took place mainly from April to August in those years, but it delayed to July-October from 1992 onwards. During this first period of the fishery, 1982-1991, all landings were registered as oceanic *S. mentella* because the main fishing area was in the central Irminger Sea from 58° to 61°N and between 28° and 36°W, corresponding to the ICES Divisions XII and XIV beyond Greenland and Icelandic national jurisdictions at depths between 75 and 400 m.

Splitting of catches: In the period 1992-1996, the fishery gradually shifted towards greater depths and developed a clear seasonal spatial pattern (Figure 19.2.2). The fleets moved systematically to different areas and depths as the season progressed, fishing the shallow component, in the south-western Irminger Sea (south of 60°N and west of about 32°W) later in the season, or from mid June to October. Fishing is scarce between November and late March or early April. Landings from these years have been assigned to the different biological stocks according to several criteria, such as landings by ICES statistical areas, ICES Divisions, by nation, and logbook data. When a nation lacked data, the average from the other nations was used instead. Landing data disaggregated by biological stock from this period are considered to be the most unreliable and must be regarded as the WG's best estimates (guesstimates). This task was carried out according to the NWWG meeting celebrated in 2004, Bergen. A summary of the catches by ICES Divisions/NAFO regulatory area as estimated by the Working Group is given in Table 19.2.1 and shown in Figure 19.2.2.

In 1996, annual landings decreased to 41,000 t, a 60% decline in comparison with previous years, and they oscillated between 24,000 and 57,000 t (averaging 35,000 t) during the years 1997-2005. From 1997 onwards, logbook data from Russia, Iceland, Faroe Islands, Norway and Germany have been used to calculate landings by stock within each ICES Division. It is assumed that catches by other nations have the same spatial distribution. However, the figures for total catch are probably underestimated due to incomplete reporting of catches (see section 19.5). In 2006 there was another sharp decline in annual landings, which continued at very low levels, with 2,000 t caught in 2008 and 4,000 t caught in 2009. A large percentage of annual landings (50% on average) were taken in NAFO Area 1F in 200-2008, but 81% of the 2009 landings were caught in ICES division XIV (Table 19.2.1 and Figure 19.2.3). Table 19.2.2 shows catches by nation as estimated by the Working Group.

The fleets participating in this fishery keep updating their fishing technology, and most trawlers now use large pelagic trawls ("Gloria"-type) with vertical openings of 80-150 m.

Standardised CPUE series for Faroe Islands, Iceland, Greenland, and Norway are estimated with a GLM model including the factors year, ship, month and towing time. The results show a decreasing CPUE trend since 1995 (Figure 19.2.4). The model output is shown in Table 19.2.3 and the residuals are in Figure 19.2.5.

19.3 Biological information

The length distributions for the period 1989-2009 of biological stocks based on Icelandic data are shown in Figure 19.3.1. The length of the largest proportion of caught fish oscillates around 35 cm for the whole period.

19.4 Discards

Discards are not considered to be significant for the time being, according to available data from various institutes.

19.5 Illegal Unregulated and Unreported Fishing (IUU)

The Group had again difficulties in obtaining catch estimates from several fleets. Furthermore, there are problems with misreported catches from some nations. The Group requests NEAFC and NAFO to provide ICES in time with all the necessary information.

19.6 Surveys

The last international trawl-acoustic survey was carried out in 2009 and it is described in detail in ICES PGRS REPORT 2009/RMC:05). The next survey will be carried out in June/July 2011.

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 (see Table 19.7.1). In addition, several national surveys have been carried out. During the last decade, the horizontal and vertical coverage of the international 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.

19.6.1 Survey acoustic data

Since 1994, the results of the acoustic survey 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 19.6.1, Figures 19.6.1 and 19.6.2). The 2003 estimate, however, was considered to be 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 Germany from mid-June to mid-July 2009. Approximately 360 000 NM^2 were covered. A total biomass of 108 000 t was estimated acoustically in the layer shallower than the DSL. The results showed an abundance decline in all areas, especially in subarea E, south of Cape Farewell. Biological samples from the acoustic estimate <DSL showed a mean length of 35.4 cm.

19.6.2 Survey trawl estimates

In addition to the acoustic measurements, redfish biomass was estimated by correlating catches and acoustic values at depths shallower than 500 m (Figures 19.6.1 and 19.6.3).

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 depth < 500 m, evenly distributed over the survey area (Figure 19.6.3). For the time being, the correlation between the catch and acoustic values is based on few data points only and it is highly variable. It is also assumed that the catchability of the trawl is the same, regardless of the trawling depth, thus the abundance estimate obtained is questionable and must only be considered as a rough attempt to measure the abundance above and below 500 m depth. Evaluation on the consistency of the method has to wait until more data points are available.

Biological samples from the trawls taken at depth <500 m showed a mean length of 36 cm. Figure 19.6.4 shows the spatial distribution of samples used in the survey and Figure 19.6.5 shows the corresponding length distribution.

19.7 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, 19.4 and 19.6 for details.

19.8 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.

19.9 State of the stock

19.9.1 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.

19.9.2 Uncertainties in assessment and forecast

19.9.2.1 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 faces problems to obtain reliable catch data due to unreported catches of pelagic redfish and lack of catch data disaggregated by depth from some countries. There are indications that reported effort (and consequently landings) could represent only around 80% of the real effort in certain years (see Chapter 19.3.3 in the 2008 NWWG report). No new data in IUU were available in 2008 and 2009.

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.

The need and importance of having catch and biological data disaggregated by depth from all nations taking part in the fishery cannot be stressed strongly enough, and the Group urges all nations involved on supplying better data.

19.9.2.2 Assessment quality

The results of the international trawl-acoustic survey are given in section 19.6. 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 accross 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 about 500,000 t in the entire depth range in 1995-2009) alone. A decreasing trend in the relative biomass indices in the acoustic layer, however, is visible since 1991.

It is not known to what extent CPUE reflects changes in the stock status of pelagic *S. mentella*, since the fishery focuses on aggregations. Therefore, stable or increasing CPUE series might not indicate or reflect actual trends in stock size, although decreasing CPUE indexes are likely to reflect a decreasing stock.

19.9.3 Comparison with previous assessment and forecast

The data available for evaluating the stock status are similar to last year.

19.9.4 Management considerations

The Group needs more and better data and requests that NEAFC and NAFO provide ICES with all information leading 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.

19.9.5 Ecosystem considerations

The fisheries on pelagic redfish in the Irminger Sea and adjacent waters are generally regarded as having negligible impact on the habitat and other fish or invertebrate species due to very low bycatch and discard rates, characteristic of fisheries using pelagic gear.

19.9.6 Changes in the environment

Analysis of the oceanographic situation during the 2009 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, temperature and salinity in the Irminger Current have increased since 1997 to the highest values seen for decades (ICES, 2001).

The results of the 2003 survey 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 waters, 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 and 2007, water temperature 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. 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, as confirmed by the survey results obtained in 2009.

Table 19.2.1 Shallow Pelagic *S. mentella* (stock unit < 500 m). 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		9,689	17,048	458			27,195
1992	106	22,976	38,709				62,564
1993	0	66,458	32,500				100,771
1994	665	77,174	18,679				96,869
1995	77	78,895	17,895				100,136
1996	16	22,474	18,566				41,770
1997	321	18,212	8,245				27,746
1998	284	21,976	1,598				24,150
1999	165	23,659	827	534			25,512
2000	3,375	17,491	687	11,052			33,216
2001	228	32,164	1,151	5,290	8	1,751	41,825
2002	10	24,004	222	15,702		3,143	43,216
2003	49	24,211	134	26,594	325	5,377	56,688
2004	10	7,669	1,051	20,336		4,778	33,951
2005	0	6,784	281	16,260	5	4,899	28,229
2006	0	2,088	94	12,693	260	593	15,734
2007	71	378	99	2,843	175	2,561	6,126
2008	33	25	354	1,580			2,059
2009	400	290	2,858				3,548

1982-1991	All pelagic catches assumed to be of the shallow pelagic stock
1992-1996	Guesstimates based on different sources (see text)
1997-2009	Catches from calculations based on jointed catch database and total landings

Table 19.2.2 Shallow 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		201		8,724					6,197			9,747				27,179
1992	628		1,810	3,765	2	6,447	9	12,080		780	6,656		14,654			15,733				62,564
1993	3,216		6,365	6,812		16,677	710	10,167		6,803	7,899		14,112			25,229			2,782	100,771
1994	3,600		17,875	2,896	606	15,133		5,897		13,205	7,404		6,834		1,510	16,349			5,561	96,869
1995	2,660	421	11,798	3,667	158	10,714	277	8,733	841	3,502	16,025	9	4,288		2,170	28,314	1,934		2,230	100,136
1996	1,846	343	3,741	2,523		5,696	1,866	5,760	219	572	5,618		1,681		476	9,348	1,671	137	273	41,770
1997		102	3,405	3,510		9,276		4,446	28				330	776	367	3,693	1,812			27,746
1998			3,892	2,990		9,679	1,161	1,983	30		1,734		701	12	60	89	1,819			24,150
1999			2,055	1,190		8,271	998	3,662					2,098	6	62	6,538	447	183		25,512
2000			4,218	486		5,672	956	3,766			430		2,124		37	14,373	1,154			33,216
2001			9	4,364		4,755	1,083	14,745			8,269		947		256	5,964	1,433			41,825
2002			0	719		5,354	657	5,229		1,841	12,052		1,094	428	878	13,958	1,005			43,216
2003				1,955		3,579	1,047	4,274		1,269	21,629		3,214	917	1,926	15,418	1,461			56,668
2004				777		1,126	750	5,728		1,114	3,698		2,721	1,018	2,133	13,208	1,679			33,951
2005				210		1,152	0	3,086		919	1,169		624	1,170	2,780	15,562	1,557			28,229
2006				334		994	0	1,293		1,803	466		280	663	1,372	4,953	3,576			15,734
2007			209	98		0	0	71		186	467			189	529	4,037	339			6,126
2008				319			0	62			8			0	0	1,597	36			2,059
2009				93			0	404			138			178	0	1,298	1,438			3,548

Table 19.2.3 Output from the GLM model used to standardize CPUE

```
Call: glm(formula = lcatch ~ ltowtime + factor(year) + factor(month) +
factor(vessel), family = gaussian(), data = south)
Deviance Residuals:
       Min         1Q       Median        3Q     Max
 -2.584129 -0.2788619 1.332268e-14 0.2846941 1.71572

Coefficients:
                          Value Std. Error      t value
     (Intercept)     3.14206521 0.66228497   4.74427980
        ltowtime     1.02151202 0.02922822  34.94950953
  factor(year)1995  -0.02351941 0.17766778  -0.13237861
  factor(year)1996  -0.54108233 0.20907057  -2.58803682
  factor(year)1997  -0.79954032 0.19713162  -4.05587054
  factor(year)1998  -0.62008478 0.20589155  -3.01170583
  factor(year)1999  -1.04489718 0.20407190  -5.12024034
  factor(year)2000  -0.47137310 0.18590491  -2.53556030
  factor(year)2001  -0.30771637 0.19242271  -1.59916864
  factor(year)2002  -0.57167851 0.21312081  -2.68241526
  factor(year)2003  -0.46618216 0.21263786  -2.19237610
  factor(year)2004  -0.98118346 0.20446845  -4.79870359
  factor(year)2005  -0.88442420 0.22083613  -4.00488901
  factor(year)2006  -0.81789762 0.24081748  -3.39633830
  factor(year)2007  -0.16234111 0.31960059  -0.50794998
  factor(year)2008  -0.45895460 0.29191405  -1.57222511
  factor(year)2009  -1.12065713 0.27661681  -4.05129802
     factor(month)3  0.40744162 0.64556987   0.63113482
     factor(month)4  0.02813848 0.61721853   0.04558918
     factor(month)5  0.71010123 0.61498852   1.15465771
     factor(month)6  0.15511084 0.61355979   0.25280476
     factor(month)7  0.18354963 0.61700552   0.29748458
     factor(month)8  0.32223479 0.62003136   0.51970724
     factor(month)9  0.18757549 0.62162166   0.30175186
    factor(month)10 -0.04101553 0.63136452  -0.06496332
    factor(month)11 -0.09489895 0.64777129  -0.14650071
    factor(month)12 -0.66988276 0.86789688  -0.77184603
..................
(Dispersion Parameter for Gaussian family taken to be 0.3406234 )

    Null Deviance: 975.1301 on 449 degrees of freedom

Residual Deviance: 127.0525 on 373 degrees of freedom

Number of Fisher Scoring Iterations: 1


Analysis of Deviance Table
Gaussian model
Response: lcatch

Terms added sequentially (first to last)
             Df Deviance Resid. Df Resid. Dev  F Value        Pr(F)
        NULL                   449   975.1301
    ltowtime     1 707.1646       448   267.9655 2076.090 0.000000e+00
  factor(year)  15  47.2760       433   220.6895    9.253 0.000000e+00
  factor(month) 10  21.2182       423   199.4713    6.229 7.878247e-09
factor(vessel)  50  72.4188       373   127.0525    4.252 0.000000e+00
```

Table 19.6.1 Shallow Pelagic *S. mentella*. Results for the acoustic survey indices from shallower than the scattering layer, trawl estimates within the deep scattering layer and shallower than 500 m, and area coverage of the survey in the Irminger Sea and adjacent waters.

Year	Area covered (1000 NM^2)	Acoustic estimates 1000 t	Trawl estimates 1000 t
1991	105	2235	
1992	190	2165	
1993	121	2556	
1994	190	2190	
1995	168	2481	
1996	253	1576	
1997	158	1225	
1999	296	614	
2001	420	716	565
2003*	405	89*	92*
2005	386	550	
2007	349	372	
2009	360	108	276

*** The 2003 biomass estimate is considered as inconsistent as the survey was carried out about one month earlier than usual, and a marked seasonal effect was observed.**

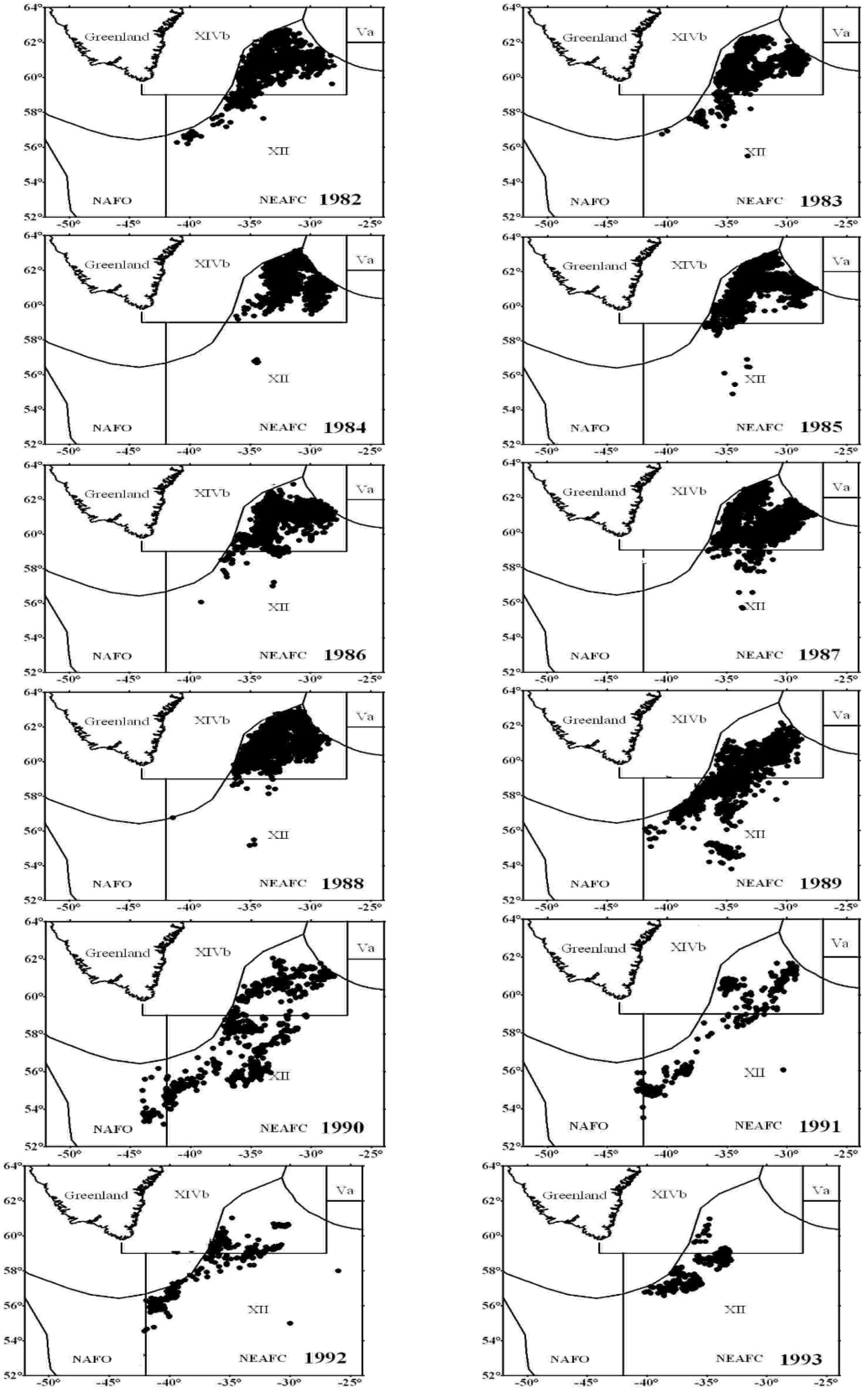

Figure 19.2.1 Location of the Russian fleet in the fishery for shallow *S. mentella* in the Irminger Sea during the period 1982-1993.

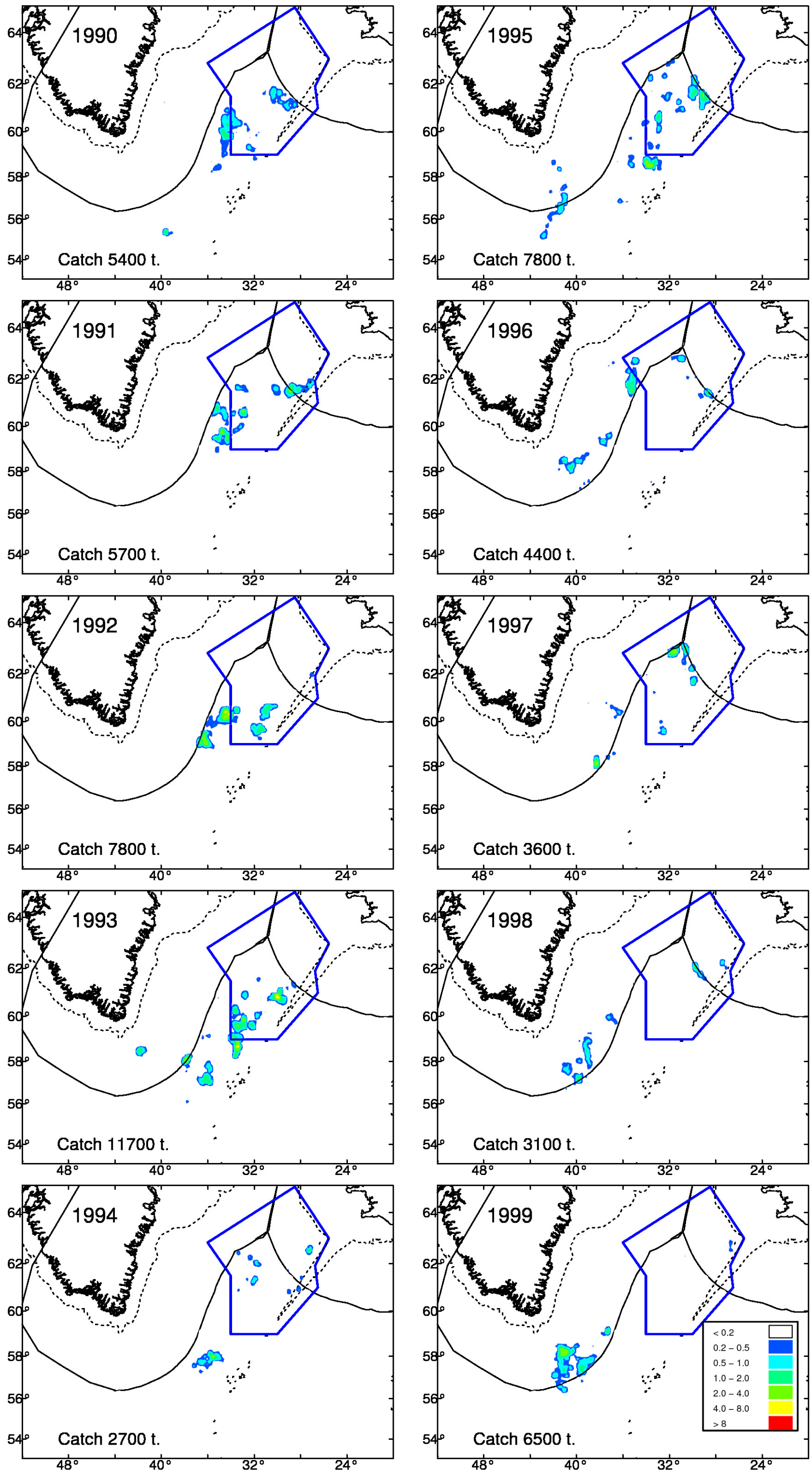

Figure 19.2.2 Fishing areas and total catch of pelagic redfish (*S. mentella*) in the Irminger Sea and adjacent waters 1990-2009. Data are from the Faroe Islands (1995-2009), Greenland (1999-2003), Iceland (1995-2009) and Norway (1995-2003 and 2008). The catches in the legend are given as tones per square nautical mile. The blue box represents the proposed management unit

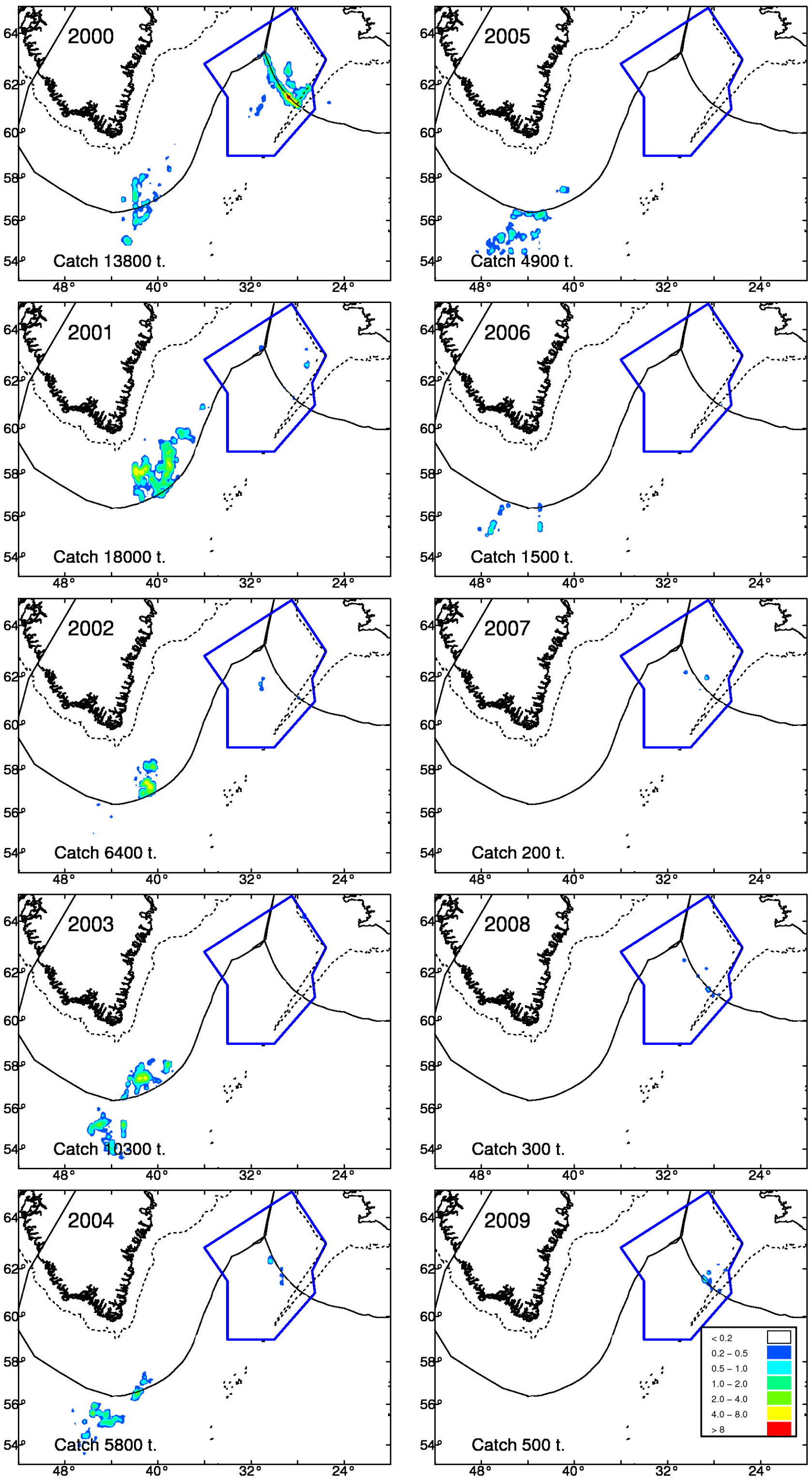

Figure 19.2.2 (Cont.) Fishing areas and total catch of pelagic redfish (*S. mentella*) in the Irminger Sea and adjacent waters 1990-2009. Data are from the Faroe Islands (1995-2009), Greenland (1999-2003), Iceland (1995-2009) and Norway (1995-2003 and 2008). The catches in the legend are given as tones per square nautical mile. The blue box represents the proposed management unit

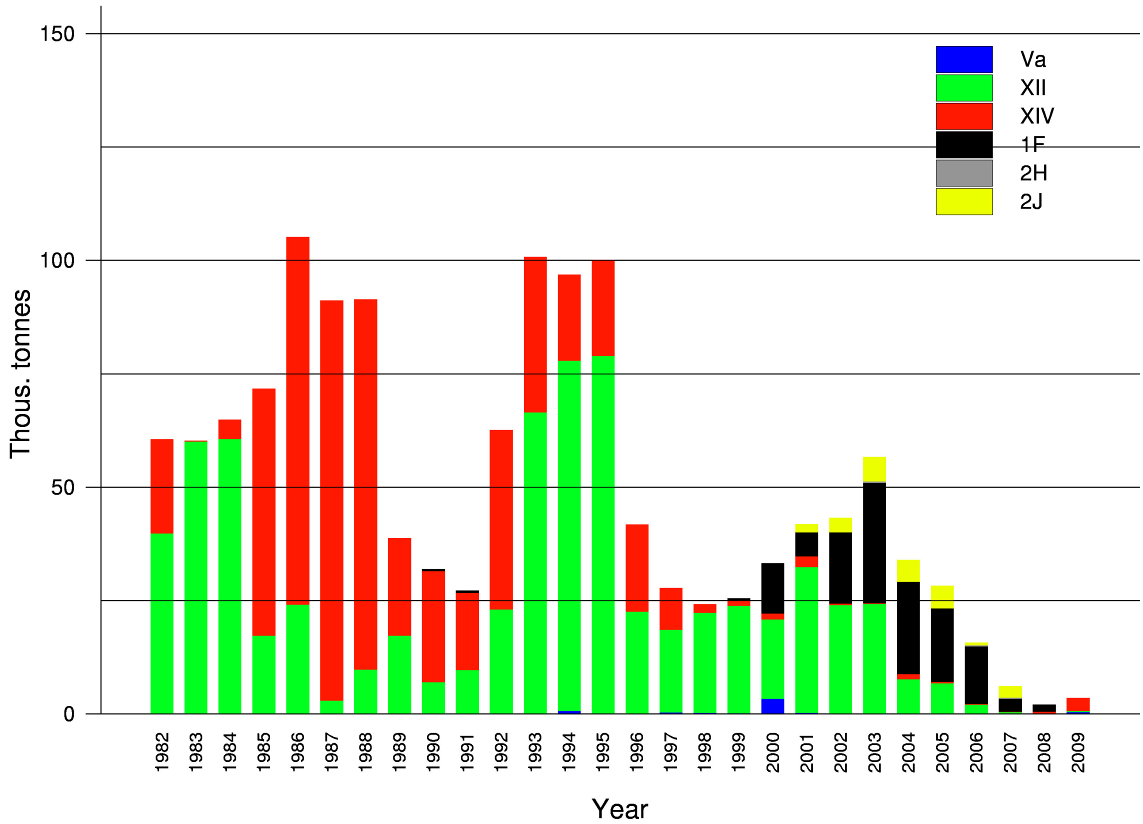

Figure 19.2.3 Landings of shallow pelagic *S. mentella* (Working Group estimates, see Table 19.2.1).

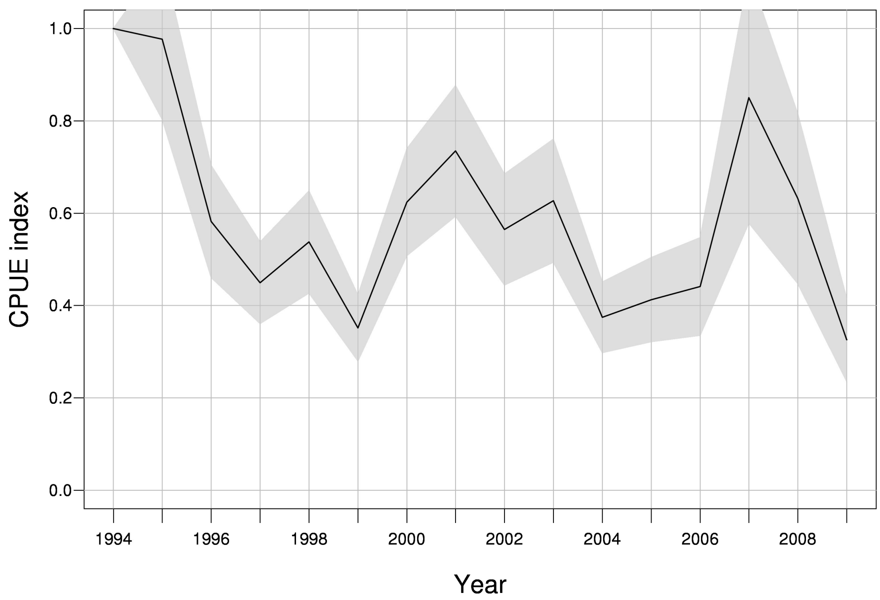

Figure 19.2.4 Trends in standardised CPUE of the shallow pelagic *S. mentella* fishery in the Irminger Sea and adjacent waters, based on log-book data from Faroes, Iceland, Norway, and Greenland.

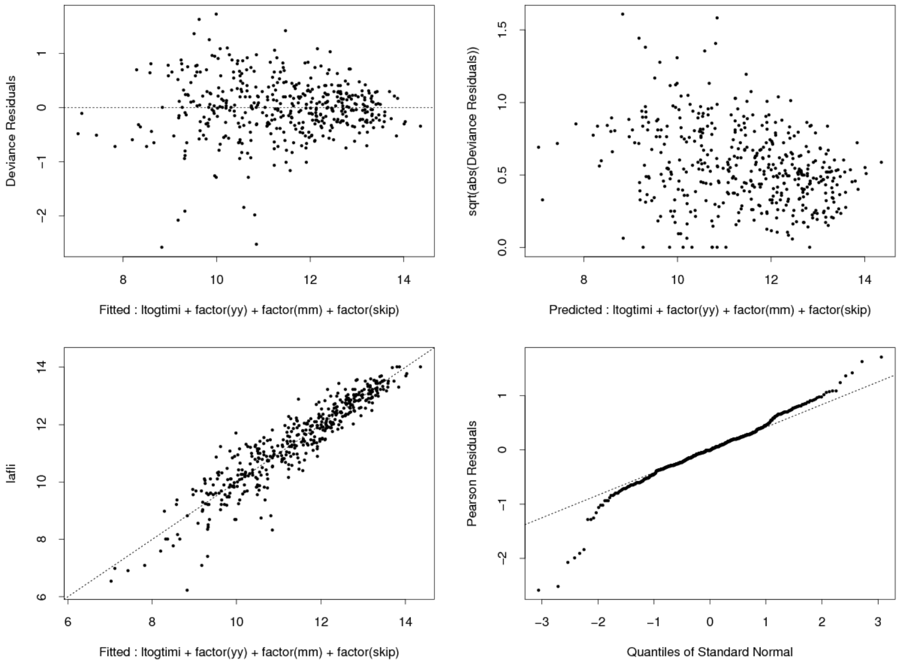

Figure 19.2.5 Residuals from the GLM model used to standardize CPUE, based on log-book data from Faroe Islands, Iceland, Greenland and Norway.

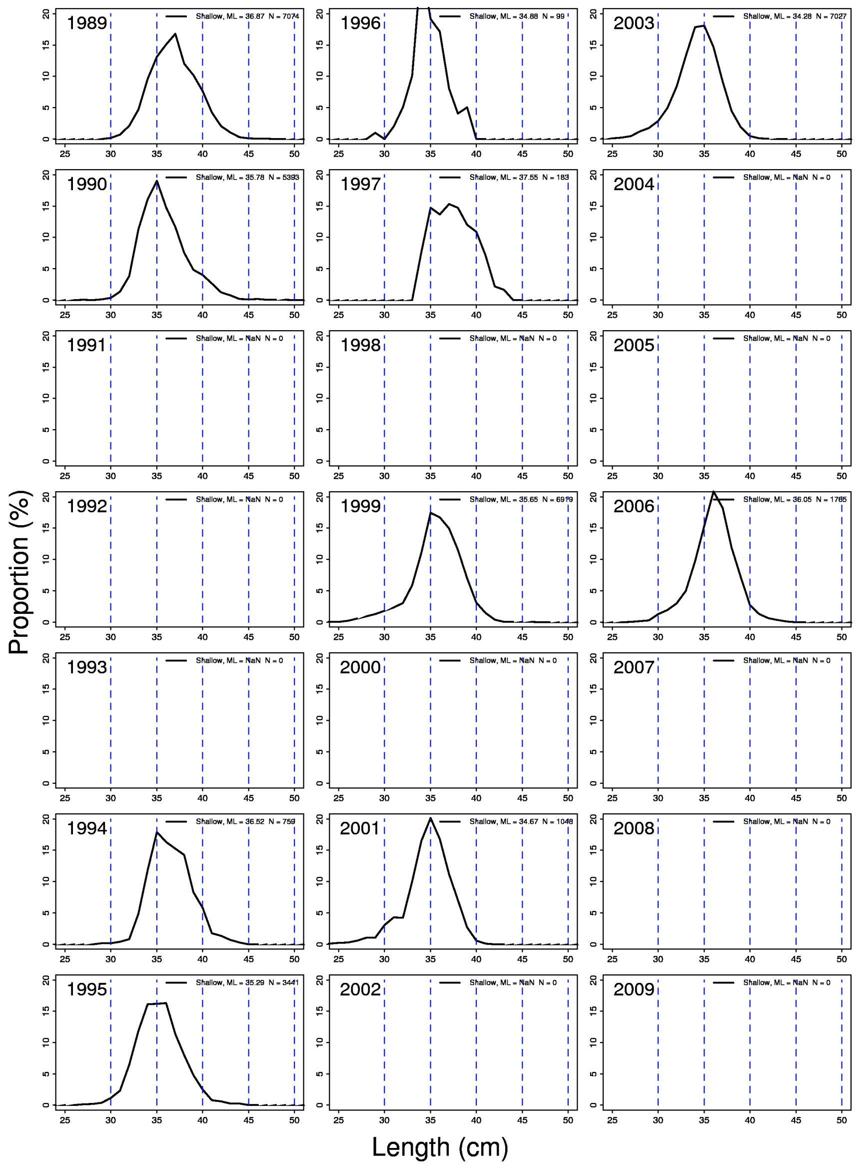

Figure 19.3.1 Length distribution from Icelandic landings of shallow pelagic *S. mentella*.

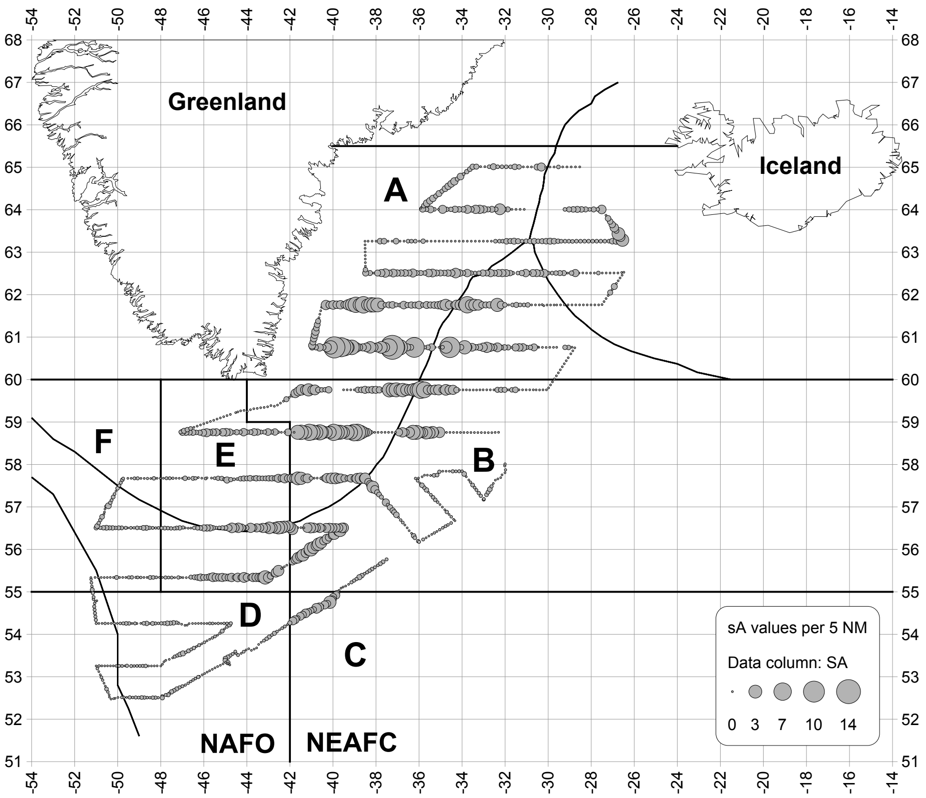

Figure 19.6.1 Pelagic *S. mentella*. Acoustic estimates (average s_A values by 5 NM sailed) shallower than the deep-scattering layer (DSL) from the joint trawl-acoustic survey in June/July 2009.

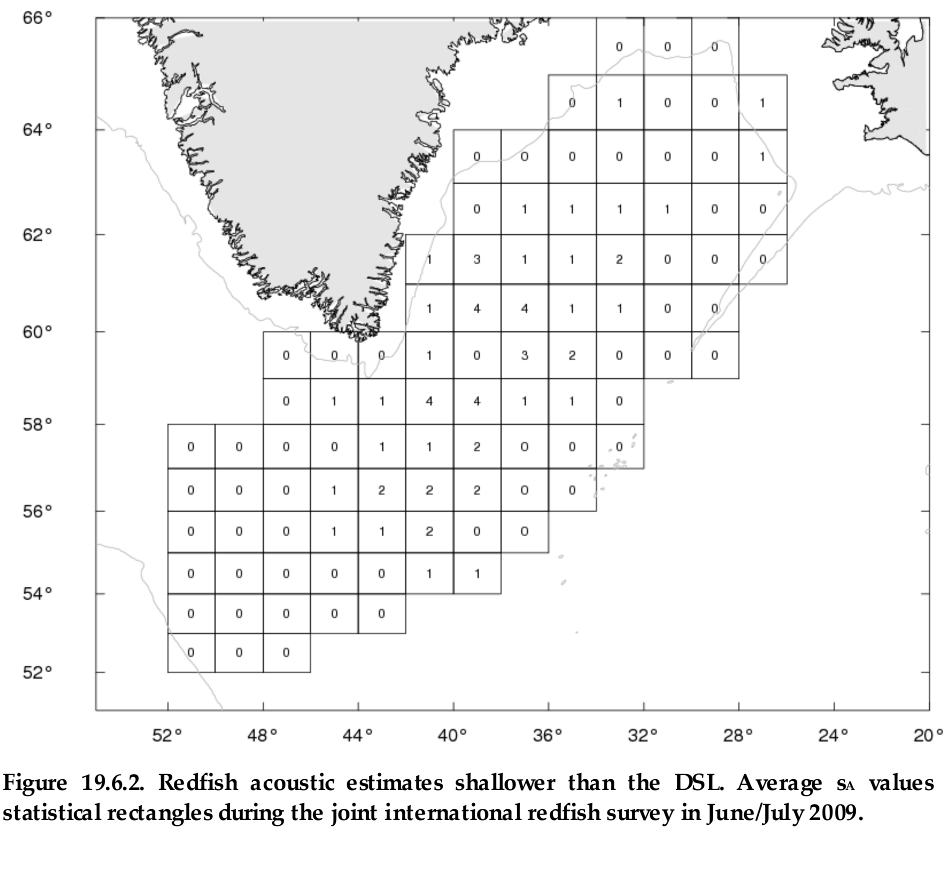

Figure 19.6.2. Redfish acoustic estimates shallower than the DSL. Average s_A values within statistical rectangles during the joint international redfish survey in June/July 2009.

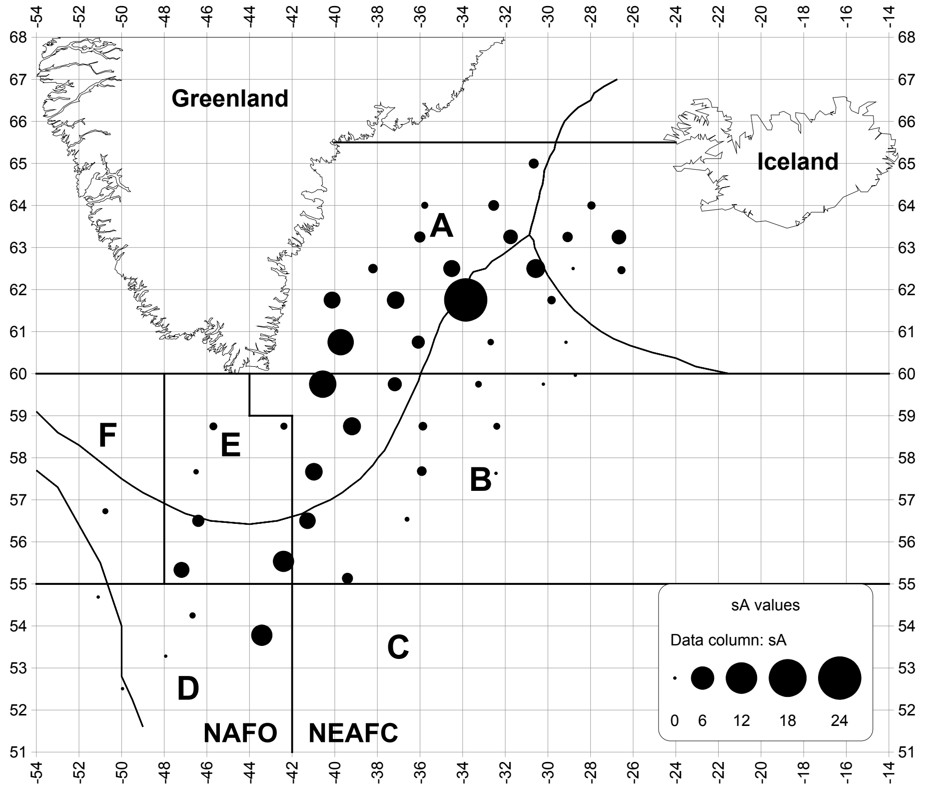

Figure 19.6.3 Redfish trawl estimates within the DSL shallower than 500 m (type 2 trawls). s_A values calculated by the trawl method (chapter 2.2.3) during the joint international redfish survey in June/July 2009.

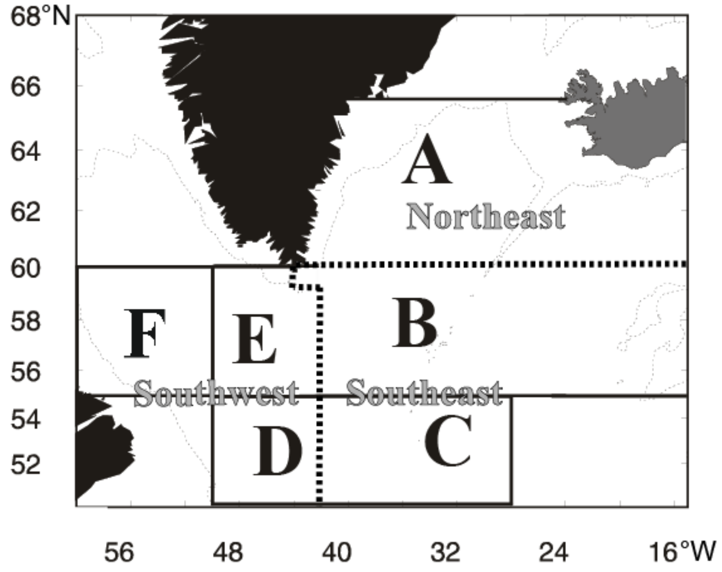

Figure 19.6.4 Sub-areas A-F used on international surveys for redfish in the Irminger Sea and adjacent waters, and divisions for biological data (Northeast, Southwest and Southeast; boundaries marked by broken lines).

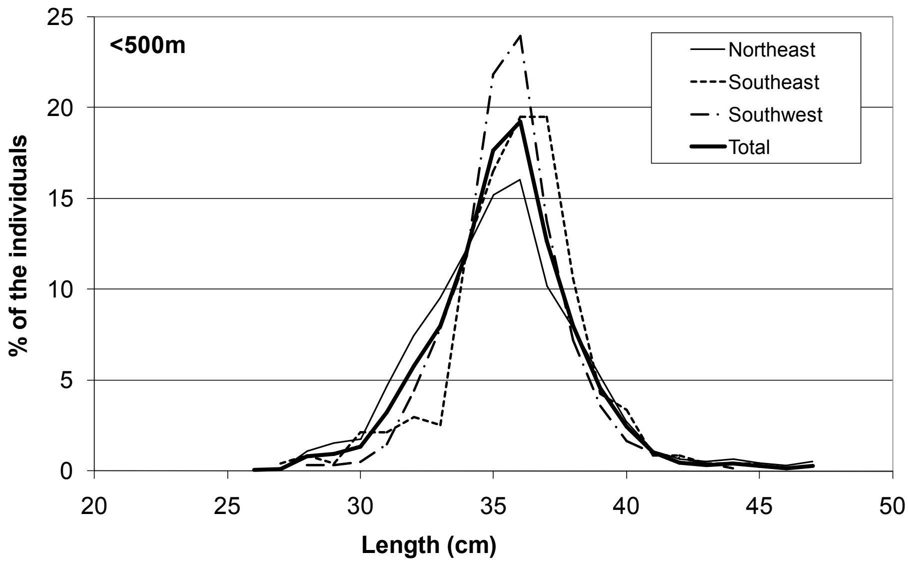

Figure 19.6.5 Length distribution of redfish in the trawls, by geographical areas and total, from fish caught shallower than 500 m.

20 Deep Pelagic *Sebastes mentella*

20.1 Stock description and management unit

This section addresses the fishery for the biological stock deep pelagic *S. mentella* in the Irminger Sea and adjacent areas: NAFO 1-2, ICES V, XII, and XIV at depths > 500m, including demersal habitats west of the Faeroe Islands. This stock corresponds to the management unit in the northeast Irminger Sea (ICES areas Va, XII and XIV).

The following text table summarises the available information from fishing fleets in the Irminger Sea and adjacent waters in 2009:

Faroes	3 factory trawlers
Iceland	12 factory trawlers
Greenland	1 factory trawlers
Poland	1 factory trawlers
Portugal	6 factory trawlers
Russia	18 factory trawlers
Spain	6 factory trawlers

20.2 Summary of the development of the fishery

The historic development of the fisheries by nation can be found in the 2007 NWWG Report, of which an abstract is provided here. The fishery for deep pelagic redfish started in the early 1990s and grew quickly, with vessels from Iceland, Faroes, Germany, Norway, Portugal and Russia. Other nations followed from 1995 onwards (Tables 20.2.1 and 20.2.2).

In the period 1992-1996, the fishery gradually shifted from the traditional fishing grounds towards greater depths, developing a clear seasonal spatial pattern (Figure 20.2.1). The fleets moved systematically to different areas and depths as the season progressed, fishing the deep component, in the northeastern Irminger Sea (north of 61°N and east of 32°W) during the first months of the fishing season, or from April to mid June, and moving to the shallow fishing grounds later in the season. Fishing is scarce between November and late March or early April.

Splitting of catches: Landings from the years 1992-1996 have been assigned to the different biological stocks according to several criteria, such as landings by ICES statistical areas, ICES Divisions, by nation, and logbook data (Figure 20.2.2). When a nation lacked data, the average from the other nations was used instead. Landing data disaggregated by biological stock from this period are considered to be the most unreliable and must be regarded as the WG's best estimates (guesstimates). This task was carried out according to the NWWG meeting celebrated in 2004, Bergen.

Annual landings increased quickly from 59 tonnes in 1991 to nearly 140,000 t in 1996, estabilishing at 85,000- 105,000 t during the period 1997-2004. A summary of the catches by ICES Divisions/NAFO regulatory area as estimated by the Working Group is given in Table 20.2.1 and shown in Figure 20.2.2.

From 2005 onwards, annual landings have declined and have been in the range 30,000 – 68,000 t. From 1997 onwards, logbook data from Russia, Iceland, Faroe Islands, Norway and Germany have been used to calculate landings by stock within each ICES Division. It is assumed that catches by other nations have the same spatial distribution. However, the figures for total catch are probably underestimated due to incomplete reporting of catches (see section 20.5). A large percentage of annual landings (63% on average) were taken in ICES division XIV in 1991-2009 (Table 20.2.1 and Figure 20.2.1). There are few and fragmentary information available from Russian catches about fishery horizons. These observation belong to range 400-850 m (Popov and Rolskiy, 2010 NWWG/WD:XX)

The assumption has been made that most of catches were taken from >500 m depth.

The fleets participating in this fishery keep updating their fishing technology, and most trawlers now use large pelagic trawls ("Gloria"-type) with vertical openings of 80-150 m.

Standardised CPUE series for Faroe Islands, Iceland, Greenland, and Norway are estimated with a GLM model including the factors year, ship, month and towing time. The results from the model show a decreasing CPUE trend since 1995 (Figure 20.2.3). The model output is shown in Table 20.2.3 and the residuals are in Figure 20.2.4.

20.3 Biological information

The length distribution from Icelandic landings for the period 2000-2009 is shown in Figure 20.3.1. Peak length between 1994 and 1997 was about 37 cm, but increased to roughly 42 from 1998 to 2005, although in 2002 the distribution showed two peaks, at 37 and 42 cm, and in 2003 the peak declined to 40 cm. Since 2006 the peak is at 40 cm.

20.4 Discards

Discards are not considered to be significant for the time being, according to available data from various institutes.

20.5 Illegal, Unregulated and Unreported Fishing (IUU)

The Group had again difficulties in obtaining catch estimates from several fleets. Furthermore, there are problems caused by misreported catches. The Group requests NEAFC and NAFO to provide ICES in time with all the necessary information.

20.6 Surveys

The last international trawl-acoustic survey took place in 2009 and it is described in detail in ICES CM 2009/RMC:05). The next survey will be carried out in June/July 2011.

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 (see Table 20.6.1). In addition, several national surveys have been carried out. During the last decade, the horizontal and vertical coverage of the international 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 (Figure 20.6.1).

20.6.1 Survey trawl estimates

Considering the conclusion of WKREDS (ICES, 2009a) and the recommendation of ICES on stock structure of redfish in the Irminger Sea and adjacent waters, the Group decided in the planning meeting (ICES, 2009b) to sample redfish separately above and below 500 m, i.e. to sample redfish as was done in the 1999, 2001 and 2003 surveys. (Fig. 20.6.2). The deep identification hauls covered the depth layers (headline) 550 m, 700 m, and 850 m.

Biological samples from the trawls taken at depth >500 m showed a mean length of 39.1 cm. Figure 20.6.3 shows the spatial distribution of samples used in the survey and Figure 20.6.4 shows the corresponding length distribution.

20.7 Methods

The assessment of pelagic redfish in the Irminger Sea and adjacent waters is based on survey indices, catches, CPUE and biological data.

20.8 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.

20.9 State of the stock

20.9.1 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.

20.9.1.1 Uncertainties in assessment and forecast

20.9.1.2 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 faces problems to obtain reliable catch data due to unreported catches of pelagic redfish and lack of catch data disaggregated by depth from some countries. There are indication that reported effort (and consequently landings) could represent only around 80% of the real effort in certain years (see Chapter 19.3.3 in the 2008 NWWG report). No new data in IUU were available in 2008 and 2009.

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.

The need and importance of having catch and biological data disaggregated by depth from all nations taking part in the fishery cannot be stressed strongly enough, and the Group urges all nations involved on supplying better data.

20.9.1.3 Assessment quality

The results of the international trawl-acoustic survey are given in section 20.6. 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 accross 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 about 500,000 t in the entire depth range in 1995-2009) alone. A decreasing trend in the relative biomass indices in the acoustic layer, however, is visible since 1991.

It is not known to what extent CPUE reflect changes in the stock status of pelagic *S. mentella*, since the fishery focuses on aggregations. Therefore, stable or increasing CPUE series might not indicate or reflect actual trends in stock size, although decreasing CPUE indexes are likely to reflect a decreasing stock.

20.9.2 Comparison with previous assessment and forecast

The data available for evaluating the stock status are similar to last year.

20.9.3 Management considerations

The Group needs more and better data and requests that NEAFC and NAFO provide ICES with all information leading 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 TAC set for 2008 and 2009 was not caught entirely.

20.9.4 Ecosystem considerations

The fisheries on pelagic redfish in the Irminger Sea and adjacent waters are generally regarded as having negligible impact on the habitat and other fish or invertebrate species due to very low bycatch and discard rates, characteristic of fisheries using pelagic gear.

20.9.5 Changes in the environment

Analysis of the oceanographic situation during the 2009 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, temperature and salinity in the Irminger Current have increased since 1997 to the highest values seen for decades (ICES, 2001).

The results of the 2003 survey 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 waters, 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 and 2007, water temperature 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. 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, as confirmed by the survey results obtained in 2009.

Table 20.2.1 Deep Pelagic *S. mentella* (stock unit > 500 m). Catches (in tonnes) by area as used by the Working Group.

Year	Va	XII	XIV	NAFO 1F	NAFO 2H	NAFO 2J	Total
1982		0	0				0
1983		0	0				0
1984		0	0				0
1985		0	0				0
1986		0	0				0
1987		0	0				0
1988		0	0				0
1989		0	0				0
1990		0	0	0			0
1991		7	52	0			59
1992	1,862	280	1,257				3,398
1993	2,603	6,068	6,393				15,064
1994	14,807	16,977	20,036				51,820
1995	1,466	53,141	21,100				75,707
1996	4,728	20,060	113,765				138,552
1997	14,980	1,615	78,485				95,079
1998	40,328	444	52,046				92,818
1999	36,359	373	47,421	0			84,153
2000	41,302	0	51,811	0			93,113
2001	27,920	0	59,073	0	0	0	86,993
2002	37,269	2	65,858	0		0	103,128
2003	46,627	21	57,648	0	0	0	104,296
2004	14,446	0	77,508	0		0	91,954
2005	11,726	0	33,759	0	0	0	45,485
2006	16,452	51	50,531	254	0	0	67,288
2007	17,769	0	40,748	0	0	0	58,516
2008	4,637	0	25,408	0			30,045
2009	14,977	4,337	32,514				51,828

Table 20.2.2 Deep 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.

Year	Bulgaria	Canada	Estonia	Faroes	France	Germany	Greenland	Iceland	Japan	Latvia	Lithuania	Nederland	Norway	Poland	Portugal	Russia	Spain	UK	Ukraine	Total
1982														0		0				0
1983						0										0				0
1984	0					0								0		0				0
1985	0					0								0		0				0
1986	0			0		0								0		0				0
1987	0			0		0								0		0				0
1988	0			0		0										0				0
1989	0			0		0	0	0						0		0				0
1990	0					0		0					0			0				0
1991			0	0		0		59					0			0				59
1992	0		0	0	0	0	0	3,398		0	0		0			0				3,398
1993	0		0	310		1,135	0	12,741		0	0		878			0			0	15,064
1994	0		0	0	0	2,019		47,435		0	0		523		377	1,465			0	51,820
1995	1,140	181	5,056	1,572	68	8,271	1,579	25,898	396	1,501	6,868	4	3,169		2,955	15,868	227		956	75,707
1996	1,654	307	3,351	3,748		15,549	1,671	57,143	196	512	5,031		5,161		1,903	36,400	5,558	123	245	138,552
1997		9	315	435		11,200		36,830	3				2,849	0	3,307	33,237	6,895			95,079
1998			76	4,484		8,368	302	46,537	1		34		438	0	4,073	25,748	2,758			92,818
1999			53	3,466		8,218	3,271	40,261					3,337	0	4,240	11,419	9,885	5		84,153
2000			7,733	2,367		6,827	3,327	41,466			0		3,108		3,694	14,851	9,740			93,113
2001			878	3,377		5,914	2,360	27,727			7,515		4,275		2,488	23,810	8,649			86,993
2002			15	3,664		7,858	3,442	39,263		0	9,771		4,197	0	2,208	25,309	7,402			103,128
2003				3,938		7,028	3,403	44,620		0	0		5,185	0	2,109	28,638	9,374			104,296
2004				4,670		2,251	2,419	31,098		0	0		6,277	1,889	2,286	31,067	9,996			91,954
2005				1,800		1,836	1,431	12,919		0	1,027		3,950	1,240	1,088	16,323	3,871			45,485
2006				3,498		1,830	744	20,942		0	1,294		5,968	1,356	1,313	23,670	6,673			67,288
2007			0	2,902		1,110	1,961	18,097		575	1,394		4,628	636	2,067	21,337	3,810			58,516
2008				2,632			1,170	6,723			749		571	219	1,733	15,106	1,142			30,045
2009				3,403			1,523	15,125			2,613			0	1,596	24,660	2,907			51,828

Table 20.2.3 Output from the GLM model used to standardize CPUE

```
Call: glm(formula = lcatch ~ ltowtime + factor(year) + factor(month) + fac-
tor(vessel), family = gaussian(), data = north)
Deviance Residuals:
       Min         1Q     Median        3Q      Max
 -3.470689 -0.2424714 0.01381726 0.2866456 1.502595

Coefficients:
                          Value Std. Error     t value
     (Intercept)     3.42406586 0.41000228   8.3513336
        ltowtime     1.07124223 0.01819918  58.8621273
  factor(year)1995  -0.53436869 0.09193448  -5.8124945
  factor(year)1996  -0.59006888 0.08625156  -6.8412548
  factor(year)1997  -1.07825159 0.08619052 -12.5100955
  factor(year)1998  -0.69021299 0.08583472  -8.0411863
  factor(year)1999  -0.79310232 0.08572733  -9.2514525
  factor(year)2000  -0.42879986 0.08691274  -4.9336826
  factor(year)2001  -0.95179501 0.08593787 -11.0753852
  factor(year)2002  -0.57455166 0.08699711  -6.6042615
  factor(year)2003  -0.31463832 0.08790396  -3.5793418
  factor(year)2004  -1.01944448 0.08981426 -11.3505858
  factor(year)2005  -1.32529907 0.09453330 -14.0193893
  factor(year)2006  -0.92662304 0.09801868  -9.4535354
  factor(year)2007  -0.67560931 0.10193648  -6.6277482
  factor(year)2008  -1.02206466 0.11696535  -8.7381831
  factor(year)2009  -0.56498147 0.10647317  -5.3063272
     factor(month)3 -0.83253079 0.39438385  -2.1109657
     factor(month)4 -0.41767391 0.37939440  -1.1008964
     factor(month)5 -0.24028307 0.38116299  -0.6303945
     factor(month)6 -0.37784871 0.38084490  -0.9921328
     factor(month)7 -0.54323973 0.38080624  -1.4265515
     factor(month)8 -0.66263541 0.38478943  -1.7220728
     factor(month)9 -0.48949015 0.39630547  -1.2351335
    factor(month)10 -0.78951957 0.43745598  -1.8047978
    factor(month)11 -0.76155744 0.50886954  -1.4965672
…………

(Dispersion Parameter for Gaussian family taken to be 0.222833 )

    Null Deviance: 1779.646 on 1229 degrees of freedom

Residual Deviance: 254.0296 on 1140 degrees of freedom

Number of Fisher Scoring Iterations: 1

Analysis of Deviance Table
Gaussian model
Response: lcatch

Terms added sequentially (first to last)
             Df Deviance Resid. Df Resid. Dev  F Value       Pr(F)
        NULL                  1229   1779.646
    ltowtime     1 1273.167      1228    506.479 5713.546 0.00000e+00
  factor(year)  15  104.531      1213    401.947   31.273 0.00000e+00
  factor(month)  9   20.866      1204    381.081   10.404 1.44329e-15
factor(vessel)  64  127.052      1140    254.030    8.909 0.00000e+00
```

Table 20.6.1 Deep pelagic *S. mentella*. Survey estimates for depth >500 m from trawl samples taken in 2009.

	A	B	C	D	E	F	Total
Area (NM²)	122,519	91,863	8,362	55,468	69,931	11,921	360,064
Mean length (cm)	39.7	39.1		37.1	35.7	36.1	39.1
Mean weight (g)	756	733		608	583	527	728
No. fishes ('000)	385,172	164,497	0	13,639	64,160	1,549	629,017
Biomass (t)	291,092	120,627	0	8,290	37,394	816	458,218
Lower CL	235,035	96,840	0	6,499	29,717	639	368,730
Upper CL	347,148	144,414	0	10,081	45,071	992	547,706

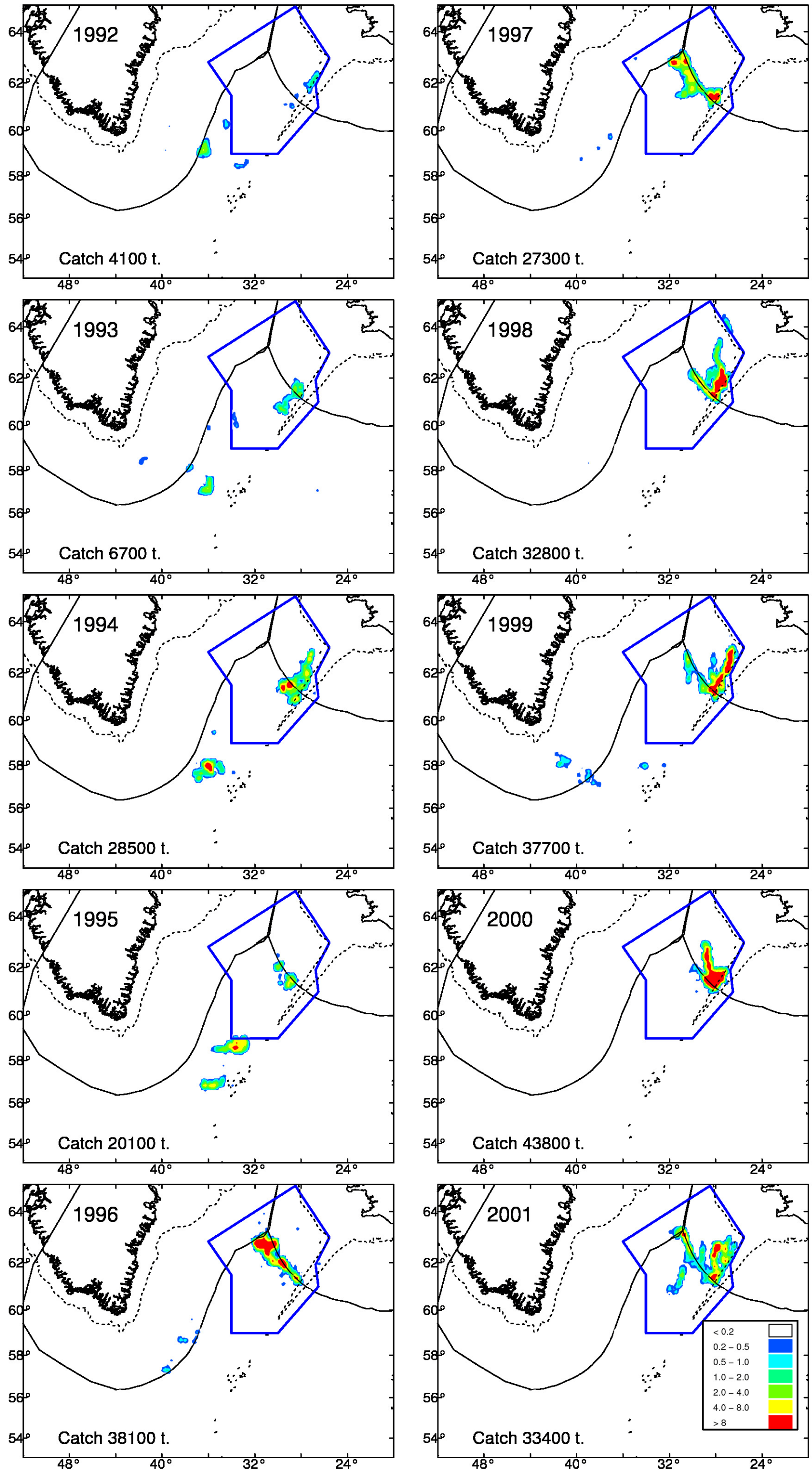

Figure 20.2.1 Fishing areas and total catch of deep pelagic redfish (*S. mentella*) in the Irminger Sea and adjacent waters 1992-2009. Data are from the Faroe Islands (1995-2009), Greenland (1999-2003), Iceland (1995-2009) and Norway (1995-2003 and 2008). The catches in the legend are given as tones per square nautical mile. The blue box represents the proposed management unit.

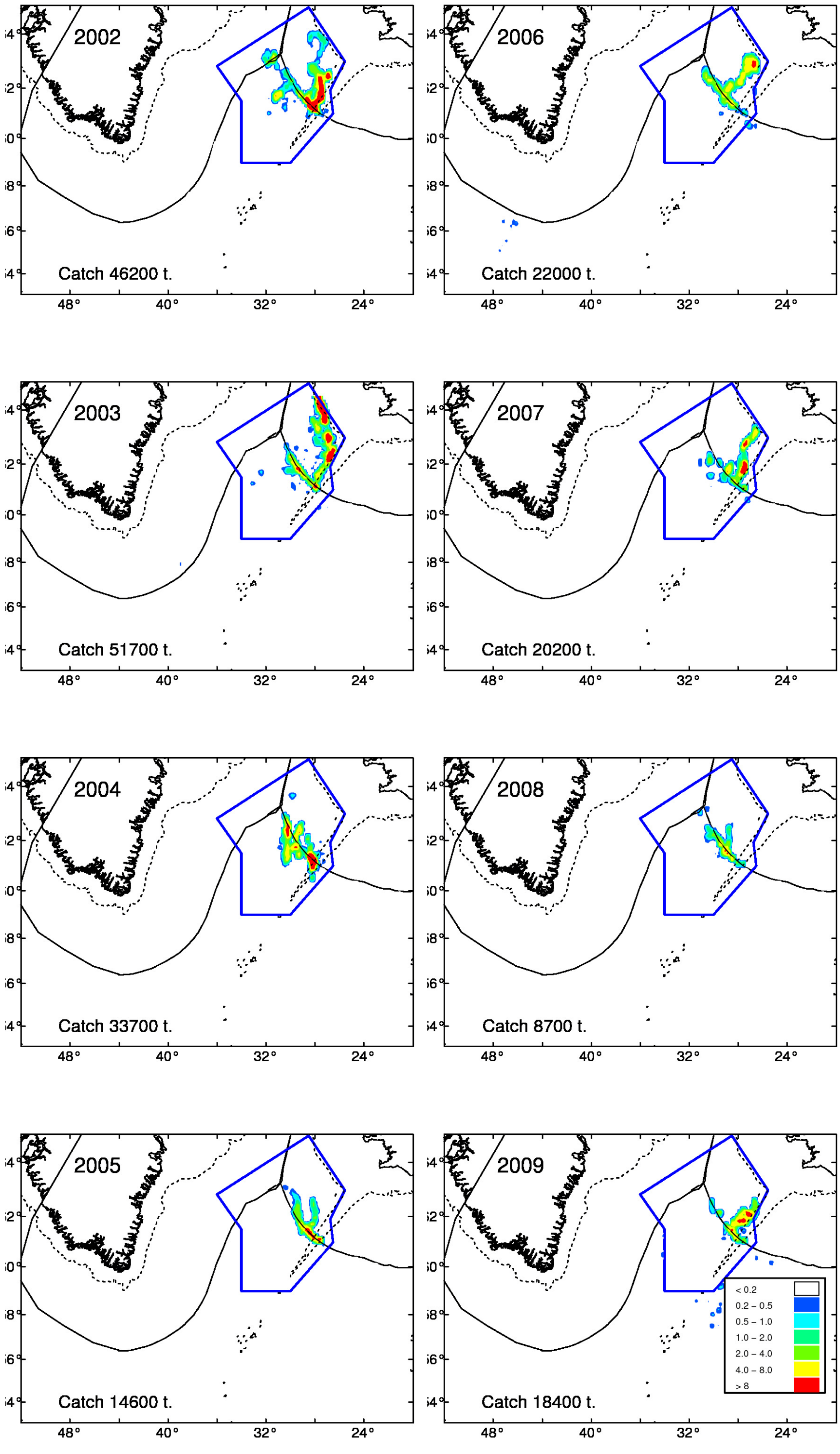

Figure 20.2.1 (Cont.) Fishing areas and total catch of deep pelagic redfish (*S. mentella*) in the Irminger Sea and adjacent waters 1992-2009. Data are from the Faroe Islands (1995-2009), Greenland (1999-2003), Iceland (1995-2009) and Norway (1995-2003 and 2008). The catches in the legend are given as tones per square nautical mile. The blue box represents the proposed management unit.

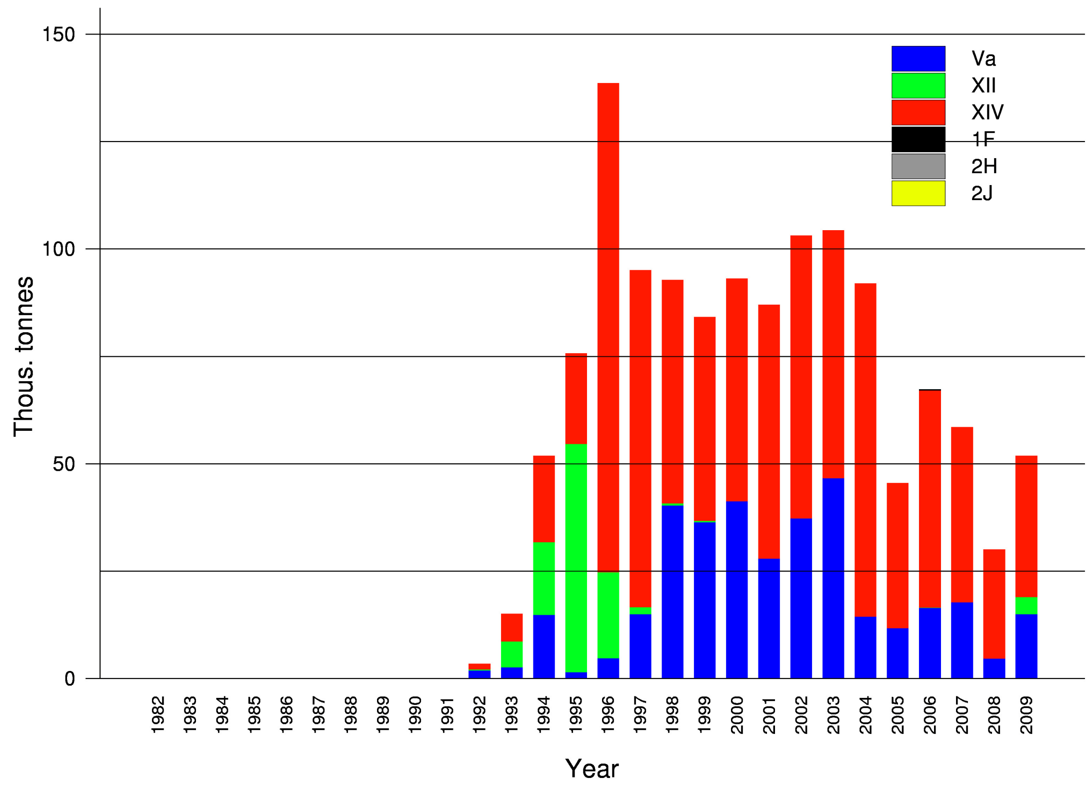

Figure 20.2.2 Landings of deep pelagic *S. mentella* (Working Group estimates, see Table 20.2.1).

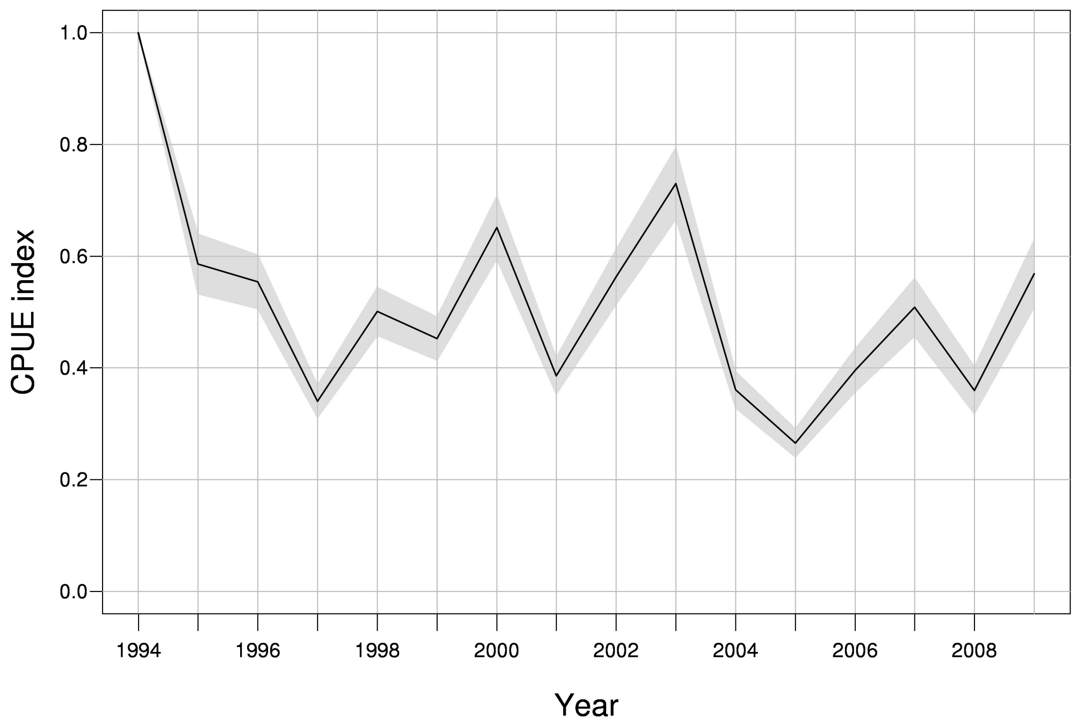

Figure 20.2.3 Trends in standardised CPUE of the deep pelagic *S. mentella* fishery in the Irminger Sea and adjacent waters, based on log-book data from Faroe Islands, Iceland, Greenland and Norway.

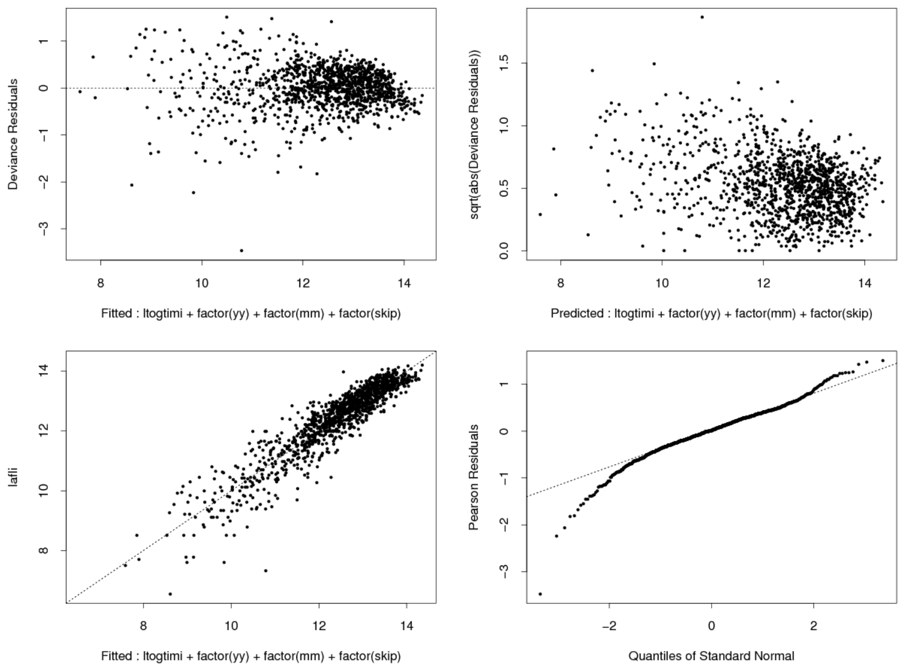

Figure 20.2.4 Residuals from the GLM model used to standardize CPUE, based on log-book data from Faroe Islands, Iceland, Greenland and Norway.

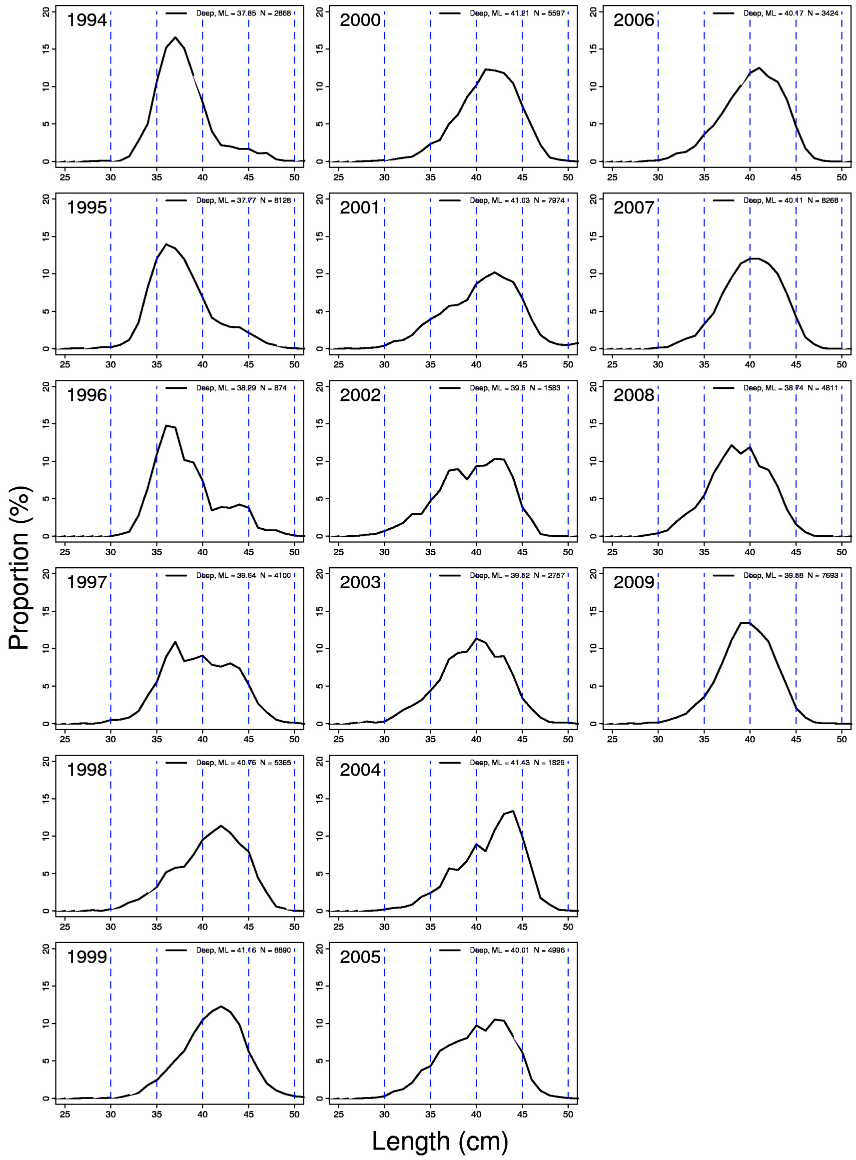

Figure 20.3.1 Length distribution from Icelandic landings of deep pelagic *S. mentella*.

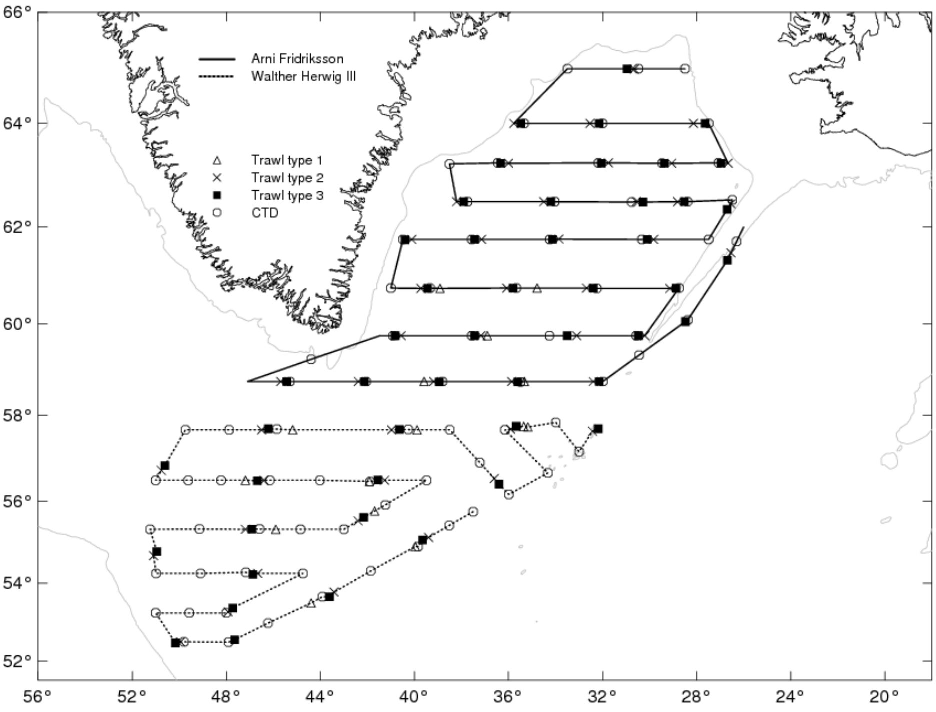

Figure 20.6.1 Cruise tracks and stations taken in the joint international redfish survey in June/July 2009.

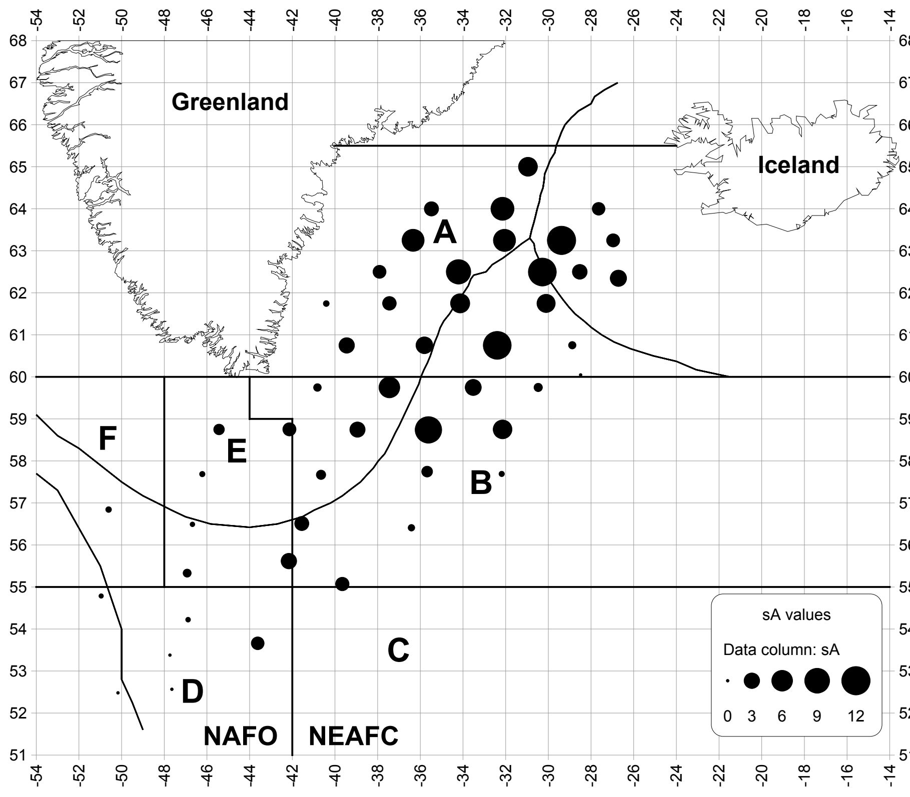

Figure 20.6.2. Redfish trawl estimates deeper than 500 m (type 3 trawls). s_A values calculated by the trawl method (chapter 2.2.3) during the joint international redfish survey in June/July 2009.

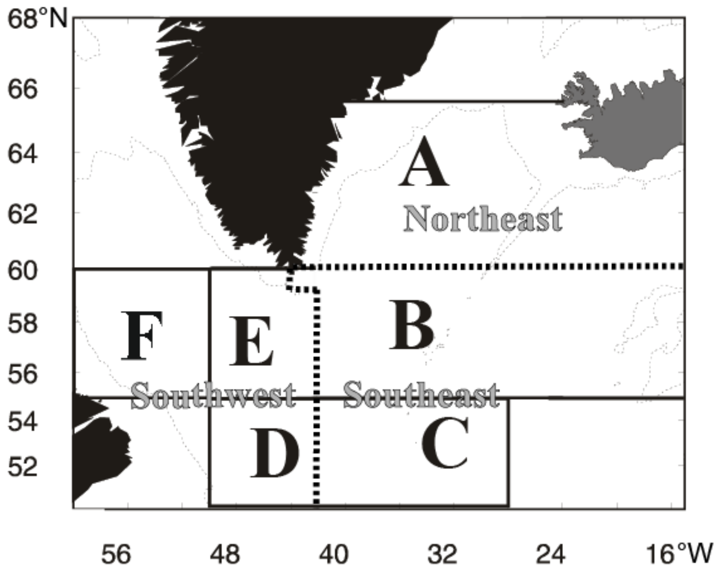

Figure 20.6.3 Sub-areas A-F used on international surveys for redfish in the Irminger Sea and adjacent waters, and divisions for biological data (Northeast, Southwest and Southeast; boundaries marked by broken lines).

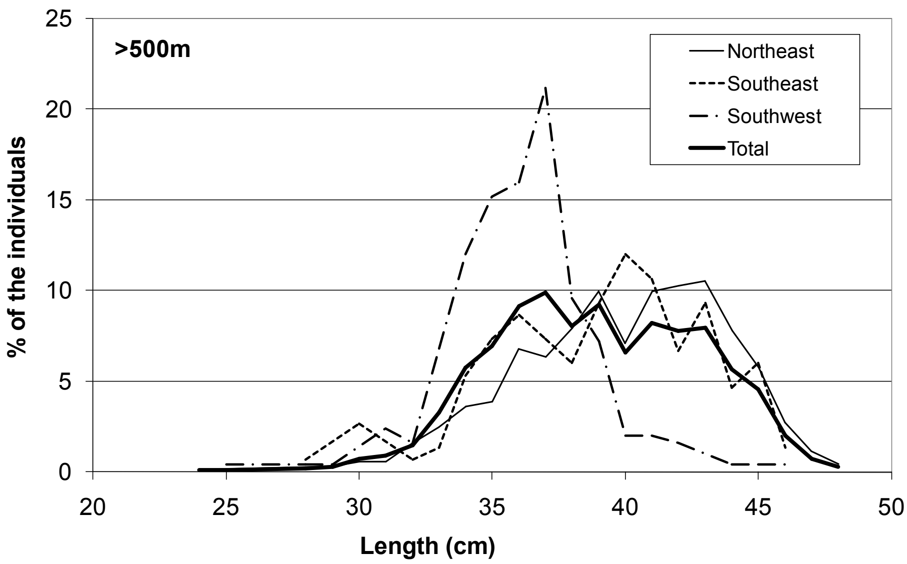

Figure 20.6.4 Length distribution of redfish in the trawls, by geographical areas (see Fig. 20.6.3) and total, from fish caught deeper than 500 m.

21 Greenlandic slope *Sebastes mentella* in XIVb

Executive summary

- ICES concluded in February 2009 that demersal *S. mentella* is to be divided to three biological stocks and that the *S. mentella* on the continental shelf and slope should be treated as separate biological stock and management unit. This separation of the stocks did not include the adult *S. mentella* on the Greenlandic slopes. ICES therefore decided that NWWG will conduct a separate assessment of *S. mentella* in subarea XIVb until further information is available to assign origin. This chapter therefore deals only with the *S. mentella* on the Greenlandic Slope.
- Total landings of demersal *S. mentella* in East Greenland waters in 2009 were about 900 t, which is large increase compared to 2008.
- In the latest decade *S. mentella* has mainly been a valuable by-catch in the fishery for Greenland halibut. However in 2009 a fishery directed towards demersal redfish took place.
- No formal assessment was conducted and there are no biological reference points for the species. Information from logbooks and survey indices are used as basis for advice.
- Available survey biomass indices show that in Division XIVb the biomass has been high and stable in the last 7 years. Especially the fishable proportion of *S. mentella* has increased in that period and is presently at the highest level in the latest 30 years.

21.1 Stock description and management units

See chapter 16 for description of the stock structure of *S. mentella* in the Irminger Sea and adjacent waters. Until further information is available to assign stock origin of adult *S. mentella* in XIVb ICES has decided that NWWG will conduct a separate assessment of the adult *S. mentella* found demersal in XIVb.

21.2 Scientific data

Indices were available from two surveys in XIVb. A German survey directed towards cod in Greenlandic waters(0-400 meters) (Fock and Bernreuther, ICES NWWG 2010, WD#14) and a Greenlandic deep water survey (400-1500) targetting Greenland halibut (Sünksen and Boje, ICES NWWG 2010, WD#18).

The German survey on the slope in XIVb has since 1982 been covering the slopes in the East Greenlandic waters. Since the target species in this survey is cod the survey operates from depths of 400 meters and shallower. From 1993-1998 a large number of Sebastes sp. smaller than 17 cm. was found in the survey (Figure 16.2.1). This coincided with a large increase in the amount of 17-30 cm large *S. mentella* from 1995-1998. In 2003 the biomass increased and has remained at that high level ever since (Figure 21.2.1a). In the same period the amount of fish larger than 30 cm has increased steadily. (Figure21.2.1c) and meanwhile the mean abundance decreases slightly (Figure 21.2.1b).The *S. mentella* found in the survey had in 2009 the largest average size with a mode at 37 cm (Figure 21.2.2).

The Greenlandic deep water survey has since 1998, except in 2001, surveyed the slopes of east Greenland from 400 to 1500 meters with the majority of stations deeper than 600 meters (Figure 21.2.3). The biomass of *S. mentella* is the four highest in the time series. Higher are only 1999, 2007 and 2008 (Figure 21.2.4). The overall length distribution from the entire area shows a mode at 20-30 cm but also a smaller mode at 12 cm (Figure 21.2.5). This small mode of juvenile *S. mentella* is found in the area north of 64° N (Figure 21.2.6 and 21.2.3).

21.3 Information from the fishing industry

21.3.1 Landings

The Greenland authorities operate the quota uptake with three types of redfish. 1) Fish caught by bottom trawl and longlines on the bottom are named *Sebastes marinus*. 2) Fish caught pelagic in the Irminger Sea are named *Sebastes mentella* and 3) fish caught as by-catch in the shrimp fishery are named Sebastes sp.

From the Greenland and German survey we know that the demersal redfish found in the area is a mixture of *S. marinus* and *S. mentella*. Both survey reports that *S. mentella* is dominating the catches. Of all redfish caught in the Greenlandic survey the proportion of *S. mentella* is close to 90% while the equal number in the German survey in 2008 was 75%. This is a reflection of the different depth distribution of the two surveys since *S. mentella* is known to prefer deeper waters than *S. marinus.* The German survey is targeting cod and is therefore fishing on more shallow ground than the Greenlandic survey that is targeting Greenland halibut and therefore has its majority of stations in deeper waters. On this background the amount of *S. mentella* caught in XIVb in 2009 is calculated as 80 % of the number derived from logbooks.

Total annual landings of demersal *S. mentella* from Divisions XIVb since 1978 are presented in Table 21.3.1 and in Figure 21.3.1. Annual landings were from 1978 to 1994 at a relatively high level with landings ranging from 2000 to nearly 20 000 tons. This fishery was however abrupt ended in 1995 due to the large amounts of very small redfish in the catches. From 1998 to 2002 the landing ranged from 1 000 to 2 000 tons and since 2002 landings has remained at a very low level. In 2009 however an exploratory fishery started giving rise to landings of 895 tons of *S. mentella*. This is a large increase compared to 2008 and where the first time in ten years where the fishing were limited by the TAC. The area where *S. mentella* is caught is closely related to the area where fishery for Greenland halibut takes place (Figure 8).

21.3.2 Fisheries and fleets

The fishery for *S. mentella* on the slopes in XIVb is mainly conducted with bottom trawl. From 1998-2009 only 1% were caught with longlines.

After the directed fishery were stopped in 1995 Germany in 1998, restarted a directed fishery for redfish with annual landings about 1,000 t in 1998-2001, and landings increased to 2 100 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 redfish fishery in XIVb 2003-2004 (less than 500 t). In 2005-2008 very little fishing took place and most *S. mentella* were caught as a valuable by-catch in the fishery for Greenland halibut.

In 2000-2002 and 2009 where some of the catches were due to fishing directed towards *S. mentella* areas with the largest catches are found in relatively concentrated areas at 64°N 36°W and just northeast from here at 64° 30′ N-65°N and 35°W on depths between 400 and 500 meters (Figure 21.3.2.1 and 21.3.2.2).

In 2009 three Greenlandic vessels started a fishery targeting demersal redfish. Each was given an explorative quota on 250 t. In 2010 a quota on 6000 tons has been given and of these are 400 t allocated to the Norwegian fleet. The industry claims to be able to fish this amount before fall (2 811 t were caught at 21 April 2010). On the steep slopes very little horizontal distances are separating the distribution of cod, redfish and Greenland halibut. The Greenlandic fleet with both quota for redfish and Greenland halibut takes advance of this by shifting between very short hauls targeting redfish and long hauls directed to Greenland halibut. Thereby avoiding time where the vessel not is fishing due to processing of the catch.

After the German fleet stopped fishing in 2002 the majority of the catches have been taken by the British, Faroese, Norwegian and Greenlandic fleet. The British fishery took place from 2001 to 2005 and since 2006 only Greenland, Faroese Islands and Norway has had any significant catches (Table 21.3.2.1).

21.3.3 By-catch/discard in the shrimp fishery

To minimize by-catch of fish species in the fishery for shrimp the trawls have since 2002 been equipped with grid separators (G.H. 2001), the 22 mm spacing between the bars in the separator however allows small fish to enter the codend. In a study of the amount of by-catch in the shrimp fishery the mean length of the redfish that entered the cod end was 13-14 cm. The same study also documented that redfish by weight accounted for less than 1% of the amount of shrimp that were caught (Sünksen 2007). Coincidently with the introduction of these separator grids the amount of juvenile redfish caught by the shrimp fishery dropped from annual 100-200 t to a lover level near 100 tons. Since 2006 not much shrimp fishery has taken place in ICES XIVb and the current level of by-catch must be considered insignificant (Table 21.3.3.1). Since 1999 the fishery has started in April-May due to poor winter conditions that prevents fishing such as ice and wind. Only in 2000 and 2002 the fishery started already in February (Table 21.3.3.2).

21.3.4 Sampling from the commercial fishery

No sampling took place in 2009. Data from the production log were however available indicating catches of fish with mean lengths close to 40cm and with only few fish below 30 cm. A sampling program has been initiated in 2010.

21.4 Methods

No analytical assessment were conducted.

21.5 Reference points

There are no biological reference points defined.

21.6 State of the stock

Survey indices suggest that the biomass of the *S. mentella* presently is high compared to the last 30 years. The previous perception of the depleted state of the *S. mentella* on the slope in XIVb is changed by the introduction of a fishery harvesting 1000-3000 t in 2009/2010. The proportion of fish larger than 30 cm in the surveys is also reflected by the very high catch rates experienced by the three vessels that had a directed fishery for *S. mentella* in 2009. The large biomass found in the recent years is most likely due to one or few large year classes as indicated by the surveys.

21.7 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 fishery should be regarded as exploratory and in the coming years be kept at low level with only few boats involved.

At the moment quota and quota uptake on demersal redfish in XIVb is handled as *S. marinus* in order to separate this fishery from the pelagic fishery in the Irminger Sea. The way that the authorities manage the different species found on the bottom in XIVb could be evaluated, so that quotas on demersal redfish could be given and managed on species level.

The area where *S. mentella* primarily is caught lies very close to a spawning area for cod. This area is at the moment closed to fishery for cod. There are therefore a potential and an incentive for high valuable by-catches of cod. Managers could ensure that this by-catch is minimized by observers onboard vessels that are allowed to fish for *S. mentella* on the slopes north of 62°N. Other measures could be closed areas (boxes) for protecting cod spawning grounds. However, further analyses of actual by-catch levels and a comparison of the spatial overlap between cod and *S. mentella* are needed before an introduction.

Since none of the surveys in the area are targeting the *S. mentella* it should be ensured that information from the exploratory fishery is available to ICES. Important information should be:

- Official logbooks with additional notes on the target species.
- Length measurements of e.g. 150 random fish from a random haul on daily basis.
- Length measurements of any by-catch appearing in the catch
- Information on which species is actually fished. This can be ensured only by sending three or four samples of 200 frozen fish from each trip to relevant scientific institutions in either Iceland or Greenland.

21.8 References

Fock, H and M. Bernreuther.2010. Abundance and length composition for *Sebastes marinus* L., deep sea *S. mentella* and juvenile redfish *(Sebastes spp.)*off Greenland based on groundfish surveys 1985-2009. ICES NWWG WD#14.

G.H. 2001. Hjemmestyrets bekendtgørelse nr. 39 af 6. december 2001 om regulering af fiskeri ved tekniskebevaringsforanstaltninger. http://www.nanoq.gl/gh.gl-love/dk/2001/bkg/bkg_nr_39-2001_dk.htm

Sünksen, K. 2007. Discarded by-catch in shrimp fisheries in Greenlandic offshore waters 2006-2007. NAFO SCR doc. 07/88Sünksen, K. and J. Boje. 2010 Survey for Greenland halibut in ICES division 14B, August-September 2009. ICES NWWG WD#18

Table 21.3.1 Nominal landings (tonnes) of demersal *S. mentella* 1978-2008 ICES division XIVb. *The 2008 value is the estimated proportion of the amount of demersal redfish given in the log-book that are estimated to be *S. mentella* (80%).

Year	Tons	
1978	5403	
1979	5131	
1980	10406	
1981	19391	
1982	12140	
1983	15207	
1984	9126	
1985	9376	
1986	12138	
1987	6407	
1988	6065	
1989	2284	
1990	6097	
1991	7057	
1992	7022	
1993	14828	
1994	19305	
1995	819	
1996	730	
1997	199	
1998	1376	
1999	853	
2000	982	
2001	901	
2002	2109	
2003	446	
2004	482	
2005	267	
2006	202	
2007	226	
2008	92	
2009	895	*

Table 21.3.2.1Landings (tons) of demersal redfish caught in ICES XIVb by nation. By far the largest proportion were probably *S. mentella* but none of these amounts were converted by the *mentella/marinus* ratio (80% *S. mentella*) found by the two surveys covering the area

Year	DEU	ESP	EU	FRO	GBR	GRL	ISL	NOR	POL	RUS	UNK	Sum
1999											853	853
2000	884		11			19		65			3	982
2001	782				11	9		99				901
2002	1703			48	16	246	29	32		36		2109
2003	3	2	2	20	155	232		32				446
2004	5	1	79	12	221	93		68	3			482
2005	2		4	38	96	72		56				267
2006	1					152		48				202
2007	7		15	138		35		30				226
2008	1		8	50	5	5		23				92
2009				203		822		93				1118
Sum	3389	2	120	508	505	1685	29	545	3	36	856	7677

Table 21.3.3.1 Discarded by-catch (tons) of Sebastes sp. from the shrimp fishery in ICES XIVb

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Sum
1999	6	16	17	5	1	13	2	48	22	30	40	33	234
2000	10	3	31	17	15	4	21	78	28	18	9	6	239
2001	7	9	10	16	9	11	4	5	3	3	28	6	111
2002	3	11	9	6	1	0	0	5	4	8	3	5	55
2003	5	6	8	5	5	8	8	15	2	10	12	4	88
2004	7	10	17	13	4	2	27	20	7	2	9	0	118
2005	7	14	16	8	7	5	6	21	14	4	5	20	126
2006	6	2	4	1	3	5	2	4	4	0	0	4	35
2007	7	3	2	1	0	0	0	0	0	0	0	0	14
2008	0	2	2	0	0	1	0	0	0	0	0	1	7
2009	1	2	11	1	0	0	0	0	0	0	0	0	16
Sum	61	78	127	74	44	49	71	195	83	75	106	79	1043

Table 21.3.3.2 Landings (tons) of demersal redfish caught in ICES XIVb by month. By far the largest proportion were probably *S. mentella* but none of these amounts were converted by the *mentella/marinus* ratio (80% *S. mentella*) found by the two surveys covering the area

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Sum
1999		10		108		4	42	10	15	34	481	149	853
2000	18	238	286	260	10	4	79	72	13	0	3		982
2001			1				108	2		184	369	236	901
2002		183	445	354	390	50	472	35	44	59	77		2109
2003			9	4	26	27	135	195	20	16	12		446
2004				35	41	63	75	48	64	96	25	35	482
2005			1	15	66	24	80	29	13	18	19		267
2006		3	7	50	14	39	20	61	2	1	1	2	202
2007	6	13	8	8	14	42	4	106	16	7	1	1	226
2008	4	3	1	6	12	11	31	12	10	2			92
2009				1	84	346	148	105	128		288	17	1118
Sum	29	451	757	842	657	609	1195	675	327	418	1276	442	7677

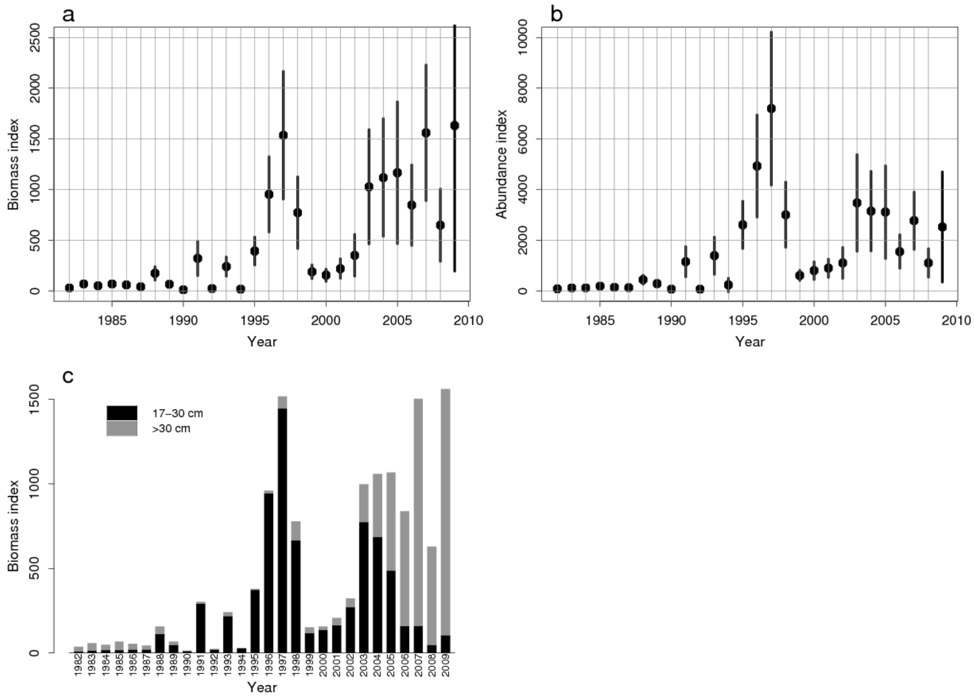

Figure 21.2.1. Indicies from the German East Greenland survey of *S. mentella* larger than 17 cm. Biomass (a), abundance (b), and biomass splitted on length(c). On figure (c) the grey bars represents the *S. mentella* that are larger than 30 cmwhile the black bars are the proportion of he bimass that ranges from 17-30 cm.

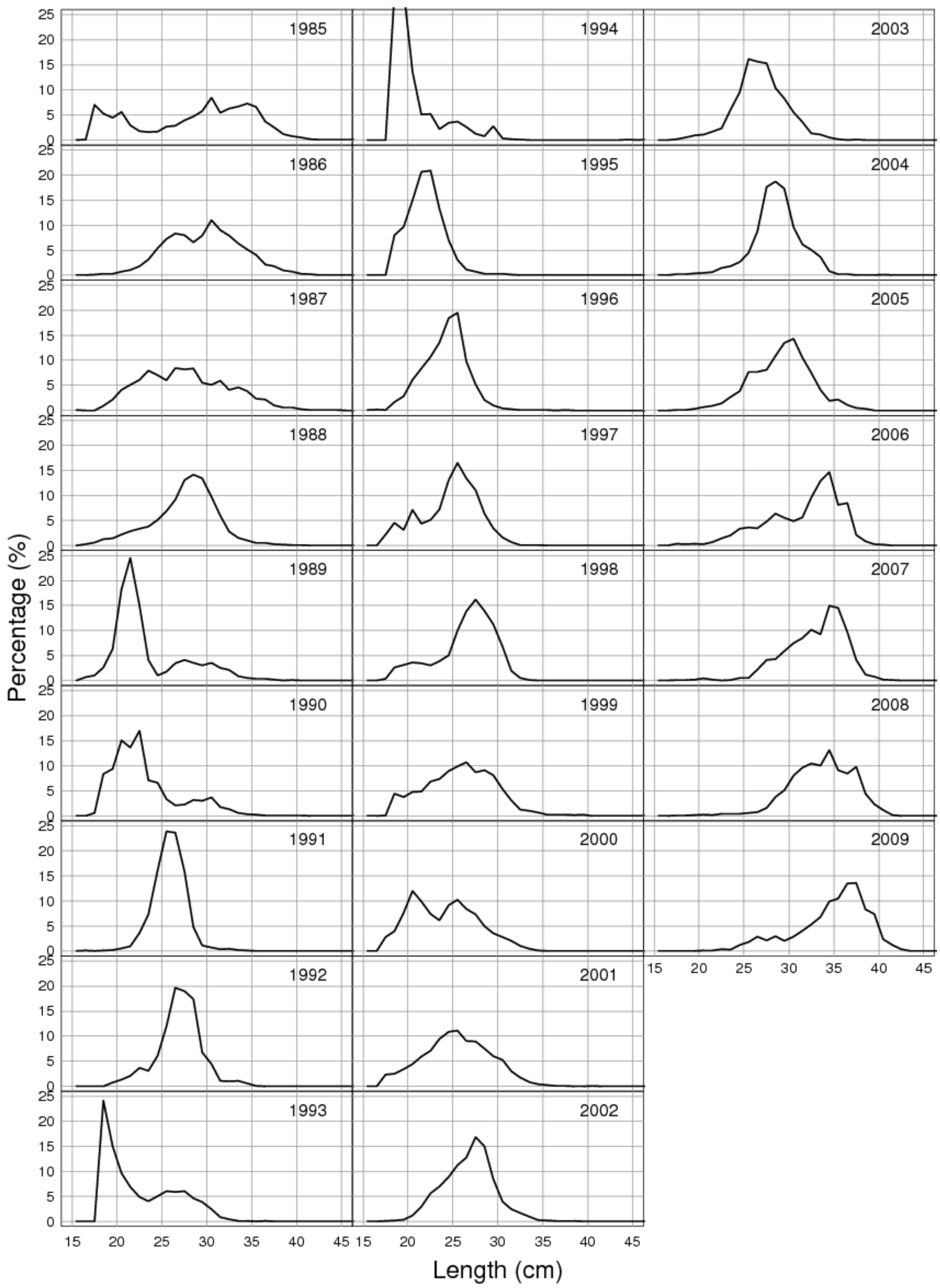

Figure 21.2.2. Length distributions from the German East Greenland survey 1985-2009

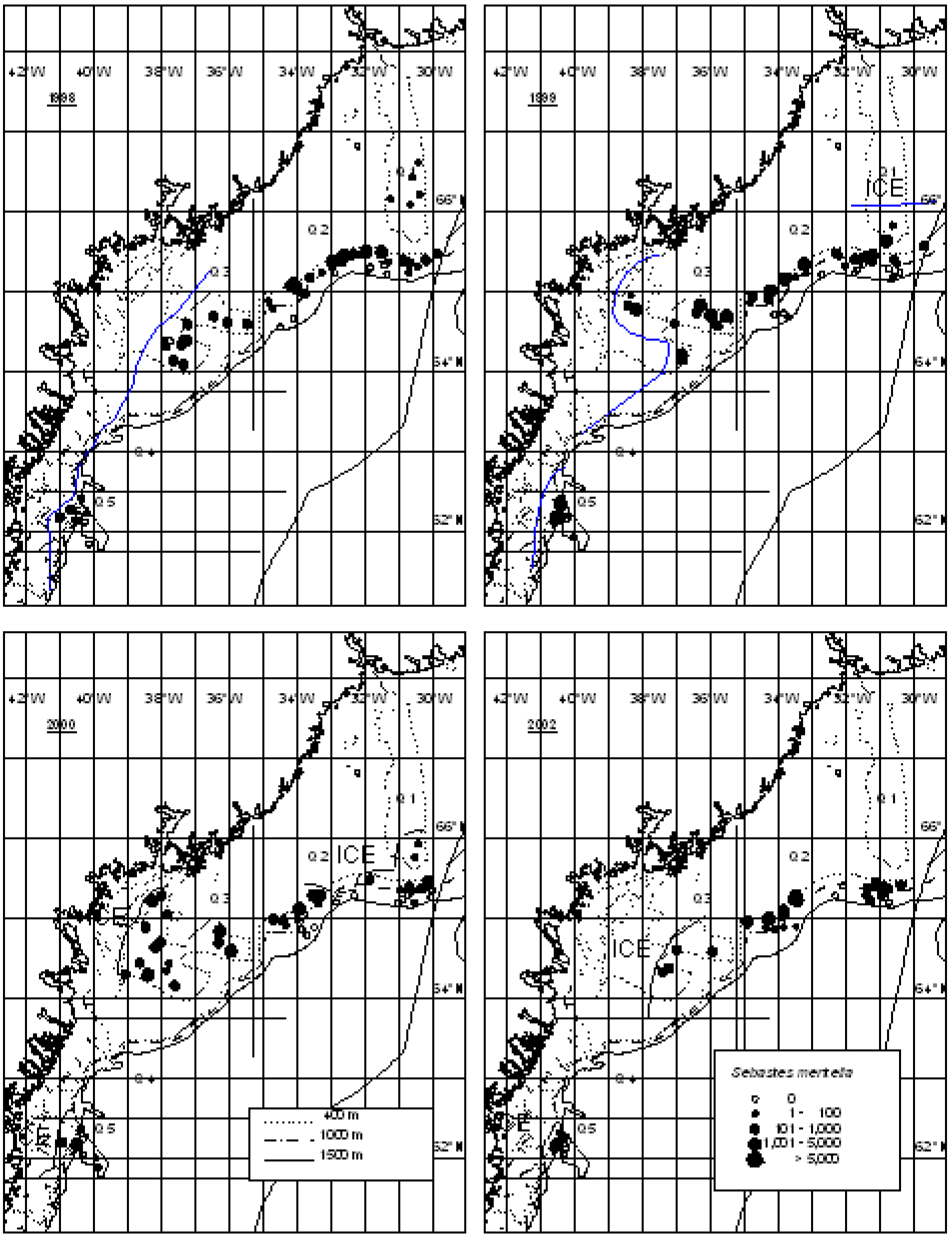

Figure 21.2.3. Distribution of catches of *Sebastes mentella* including *Sebastes Sp* at East Greenland.

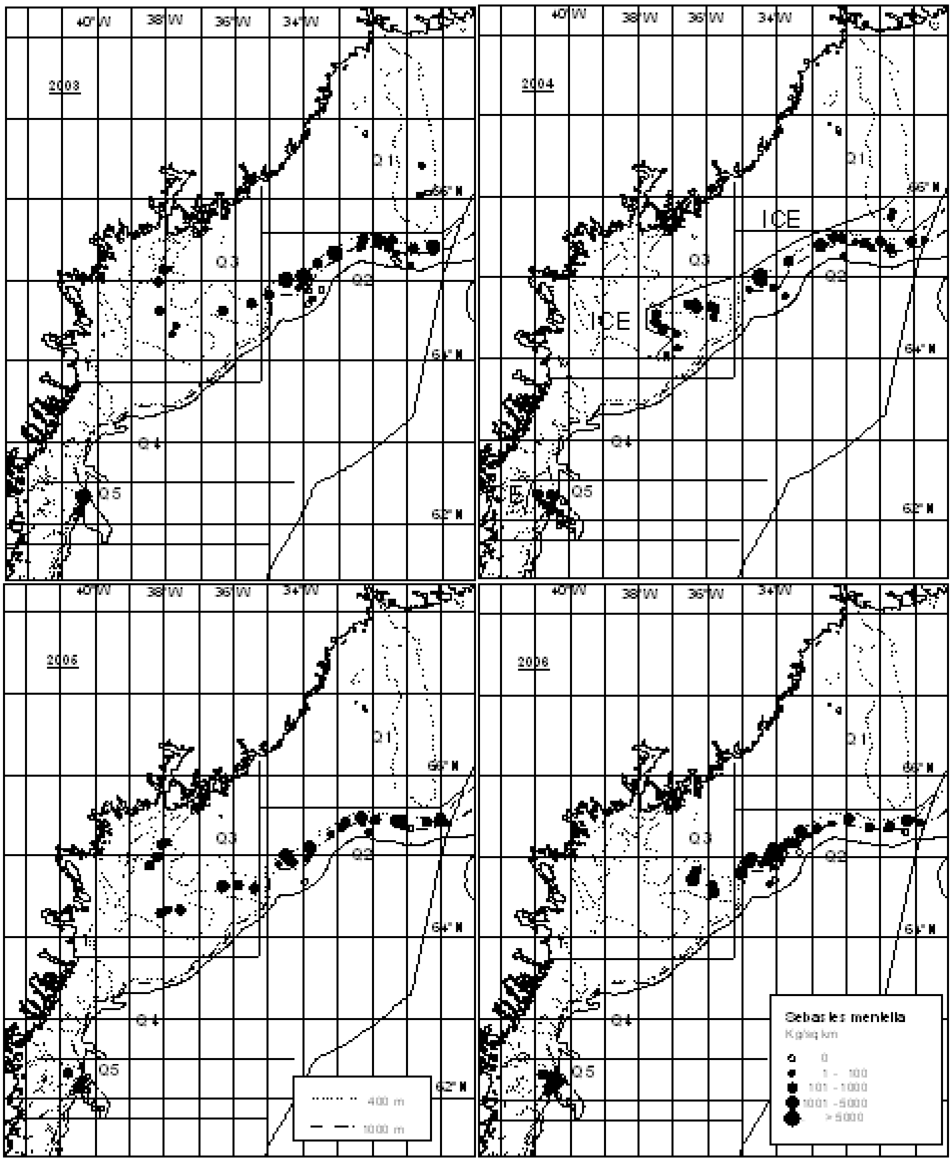

Figure 21.2.3 continued. Distribution of catches of *Sebastes mentella* including *Sebastes Sp* at East Greenland.

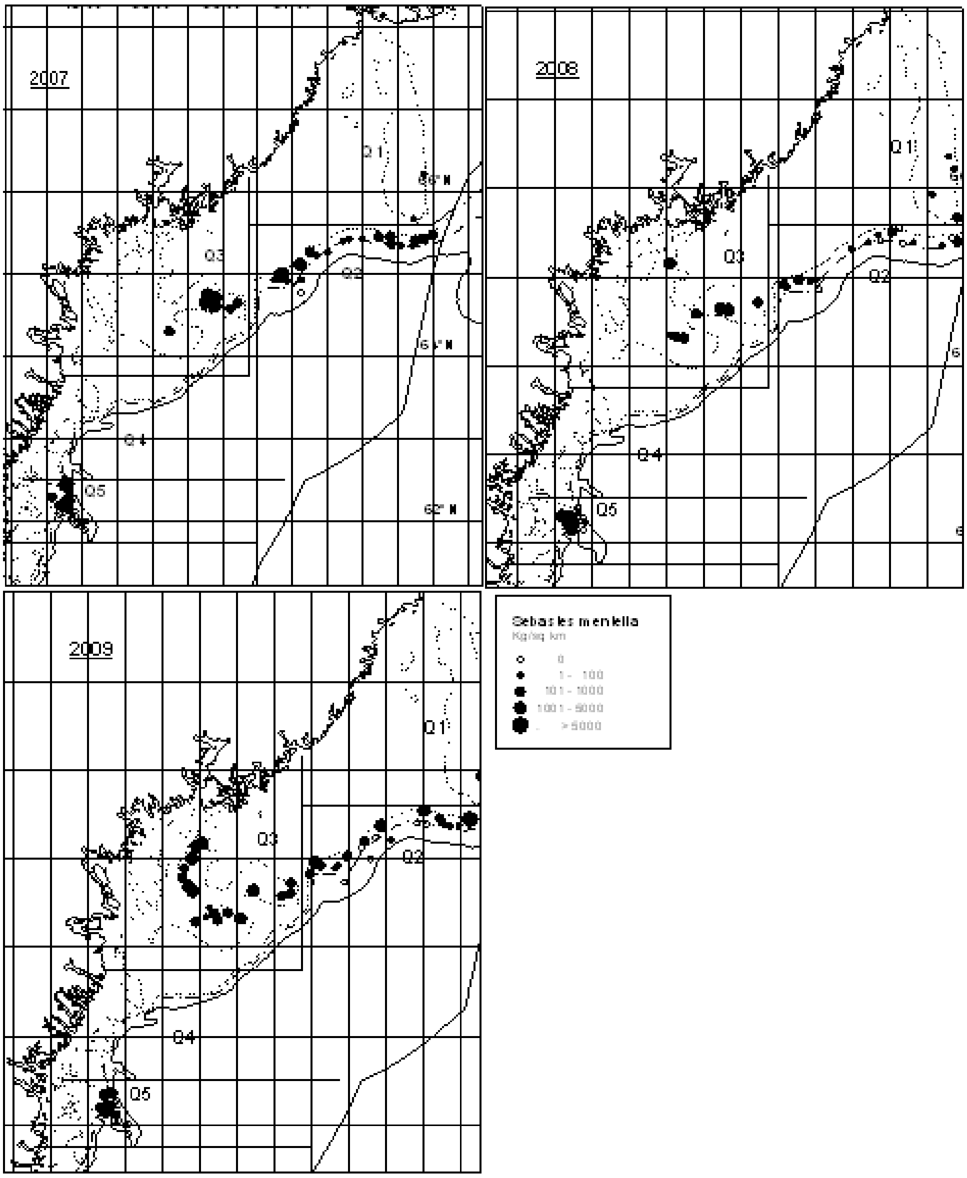

Figure 21.2.3. Distribution of catches of *Sebastes mentella* including *Sebastes Sp* at East Greenland.

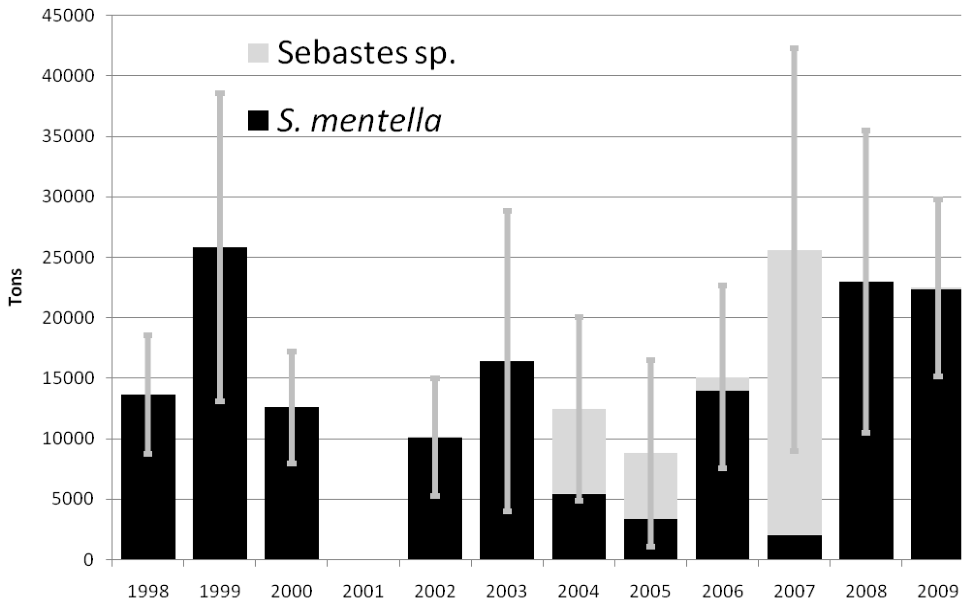

Figure 21.2.4. Biomass of *S .mentella* and Sebastes sp. Bars are indicating 2SE of the biomas of *S. mentella* including Sebastes sp.. No survey in 2001. In 2004, 2005 and 2007 a large proportion of the redfish were not determined to species and only reported as "Sebastes sp". It is most likely that the majority of these fish were *S.mentella*.

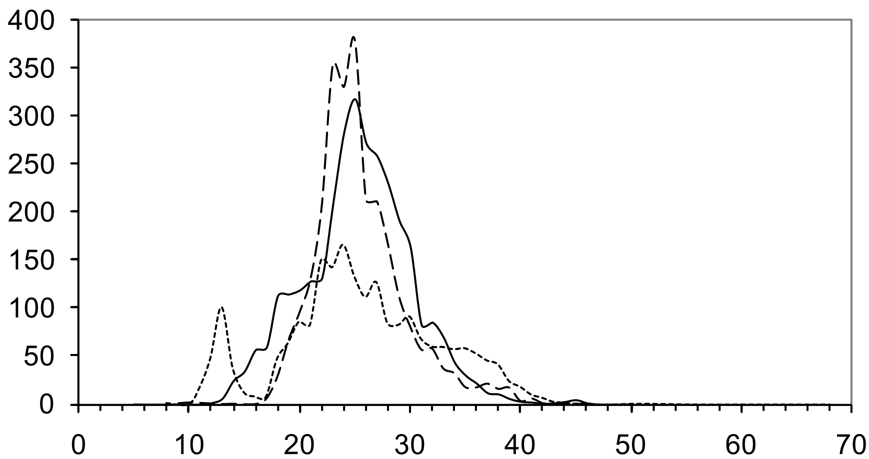

Figure 21.2.5. Overall length distribution of *Sebastes mentella* and *Sebastes sp.* (number per km²) from the deepwater survey. Solid line 2007. Dashed line 2008. Dotted line 2009.

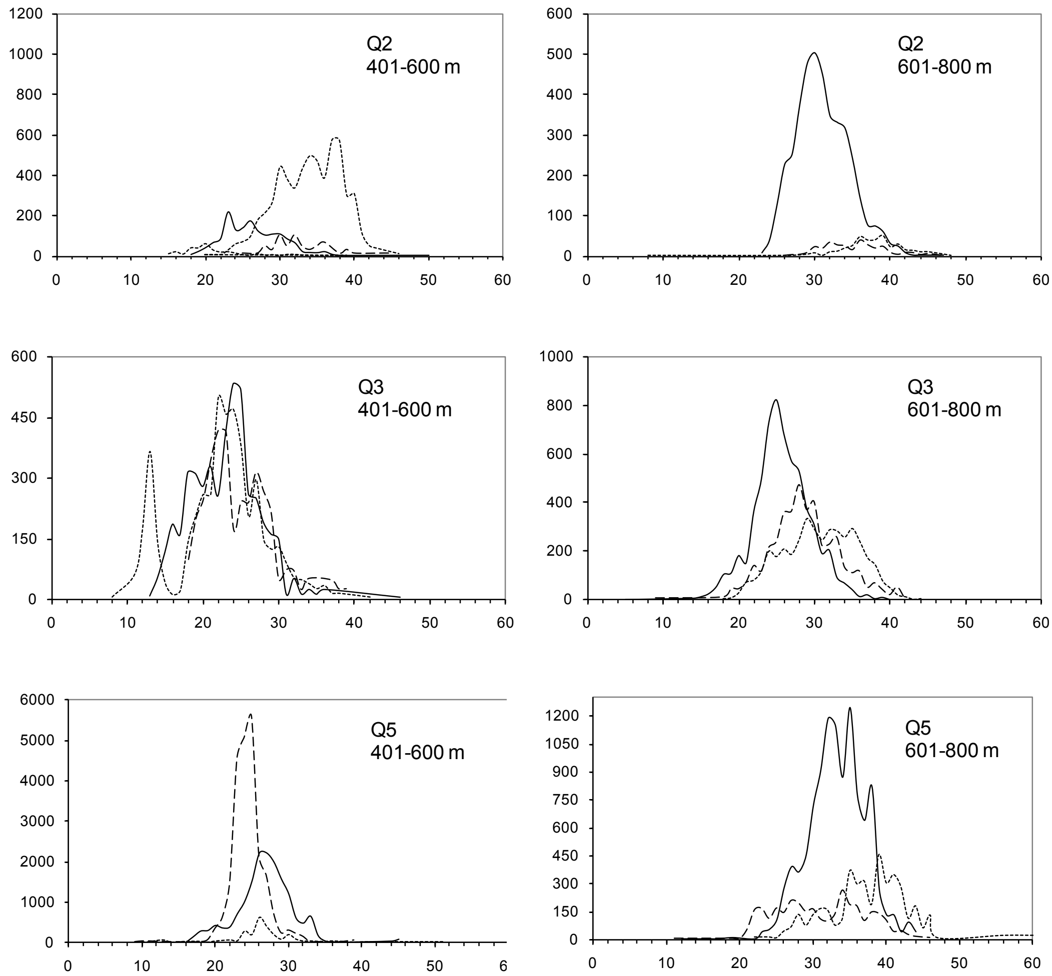

Figure 21.2.6. Length distributions (number per km²) of *Sebastes mentella* and *Sebastes sp.* by year, area and depth strata from the Greenland deepwater survey. Only strata with more than 20 observations are included... Solid line 2007. Dashed line 2008. Dotted line 2009.

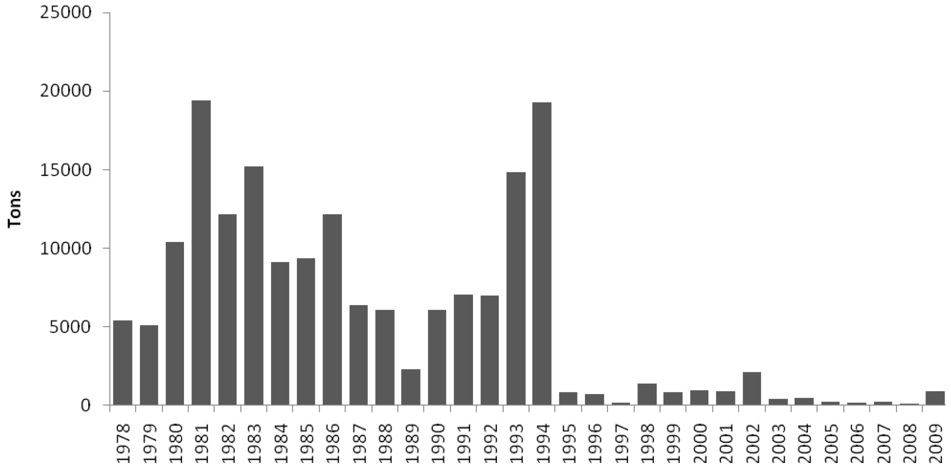

Figure 21.3.1. Landings of *S. mentella* in subarea IXVb.

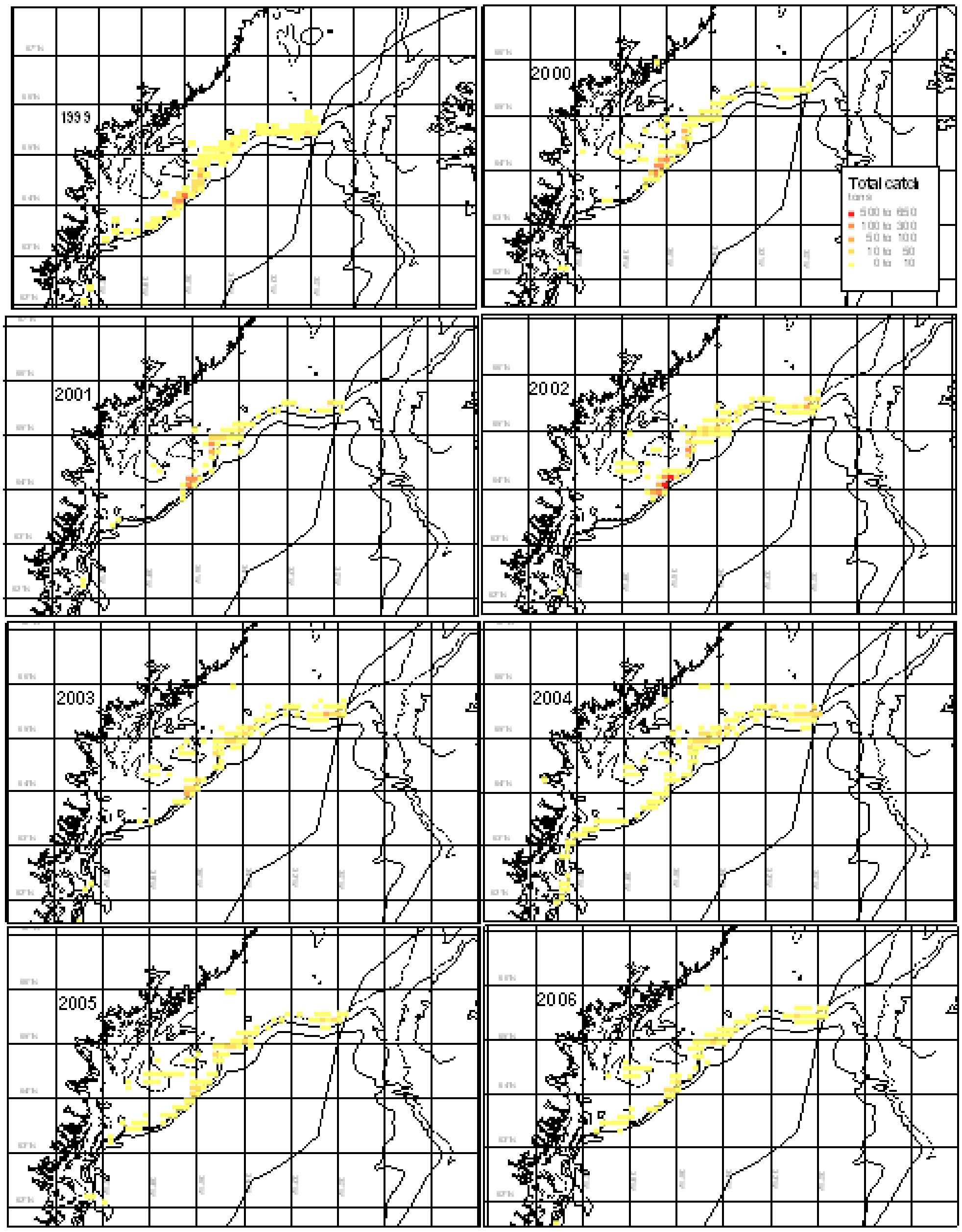

Figure 21.3.2.1 Annual distributions of catches of demersal redfish (1999-2006)

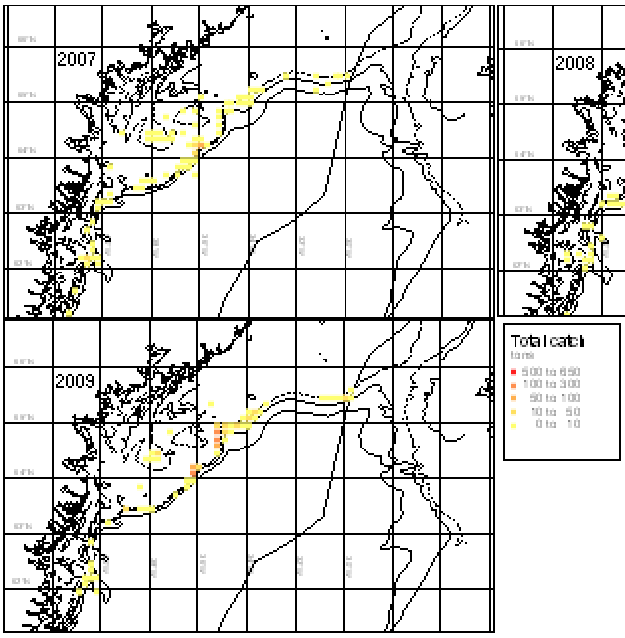

Figure 21.3.2.1 continued annual distribution of catches of demersal redfish (2007-2009)

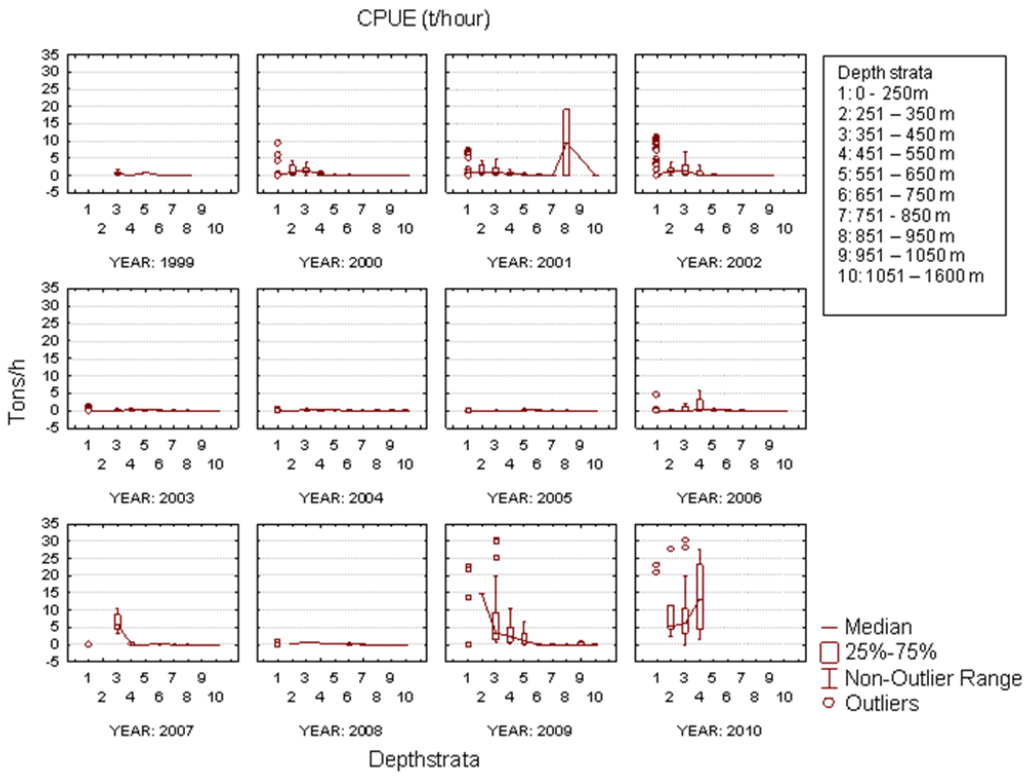

Figure 21.3.2.2. Catch rates from all hauls 1999-2009 and 1st quarter of 2010 where *S. mentella* were caught.

Annex 1 – List of Participants

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27 April – 4 May 2010

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Annex 2 – Stock Annexes

Stock Annex: Faroe Bank Cod

Stock specific documentation of standard assessment procedures used by ICES.

Stock:	Faroe Bank Cod
Working Group:	North-Western Working Group
Date:	May 2009
Revised by	Luis Ridao (Faroe Marine Research Insti tute)

A. General

A.1. Stock definition

The Faroe Bank is located approximately 75 km Southwest of the Faroe Islands (60º15′ S, 61º30′ N,9º 40′W,7º40′ E)(Eyðfinn, 2002). The Faroe Bank cod is 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 Faroe Bank cod is distributed mainly in the shallow waters of the Bank within the 200 m depth contour. 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).

A.2. Fishery

Due to the decreasing trend in cod landings the Bank was closed to all fishing in 1990. This advice was followed for depths shallower than 200 meters. In 1992 and 1993 longliners and jiggers were allowed to participate in an experimental fishery inside the 200-meter depth contour. The new management regime with fishing days was introduced on 1 June 1996 allowing longliners and jiggers to fish in depths below 200 m while trawlers are allowed to fish in waters deeper than 200 m.

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

A.3. Ecosystem aspects

The Faroe Bank is a geographically well-defined and self-contained ecosystem surrounded by an oceanic environment (Eyðfinn, 2002) in which cod 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 contained in the anti-cyclonic circulation on the Bank. The juveniles descend to the bottom of the Bank proper in July. No distinct nursery areas have been found on the Bank. It is anticipated that the juveniles are widely distributed on the Bank, finding shelter in areas difficult to access by fishing gear (Jákupsstovu, 1999).

Growth

Cod in the Faroe Bank is the fastest growing cod stock in the North Atlantic. For comparison the average size of 1-year old cod in the Bank is approximately 60 cm while the Faroe Plateau cod is slightly below 20 cm (Figure 1.)

Maturity

The majority of cod in the Faroe Bank mature at age three with usually all mature by age four.

Diet

The diet of cod in the Bank varies with the size of the fish and season. Adult cod feeds mainly of fish preys like sandeel and crustaceans specially crabs, shrimps, munida and galathea while whelks and worms may contribute to a lesser extent to its diet.

B. Data

B.1. Commercial catch

Faroese commercial catch in tonnes by month, area and gear are provided by the Faroese Statistical Office (Hagstova). Data on catch in tonnes from other countries are taken from ICES official statistics and/or from Coastal Guard reports.

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.

No discards are reported or accounted for in the assessment..

The following table gives the source of landings data for Faroe Bank cod:

Kind of data

Country	Caton (catch in weight)
Faroe Islands	x
Norway[1]	x
UK (E/W/NI) [1]	x
UK (Scotland) [1]	x

[1] As reported to Faroese authorities

B.2. Biological

Biological samples have been taken from commercial landings since 1974 and from the groundfish survey since 1983.

B.3. Surveys

Two research vessel survey series for cod in Vb2 were available to the Working Group in 2008.

- Faroese spring groundfish survey (FGFS1): years 1983–2003, 2006–2008 (discontinued in 2004 and 2005)
- Faroese fall groundfish survey (FGFS2): years 1996–2008.

The design for both bottom-trawl surveys is depth stratified with randomised stations. The number of stations is 29 and effort is recorded in terms of minutes towed (~60 min)

Plots of the spatial distribution of the fall (2000-2004) and spring (2006-2008) faroese groundfish surveys mean catch rates are given in Figure 2 and 3.

B.4. Commercial CPUE

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

B.5. 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.

C. Historical Stock Development

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.

D. 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.

E. Short-Term Projection

None

F. Medium-Term Projections

None

G. Long-Term Projections

None

H. Biological Reference Points

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

J. Other Issues

None

K. References

Eyðfinn, 2002. Demersal fish assemblages of Faroe Bank: species composition, distribution, biomass spectrum and diversity

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

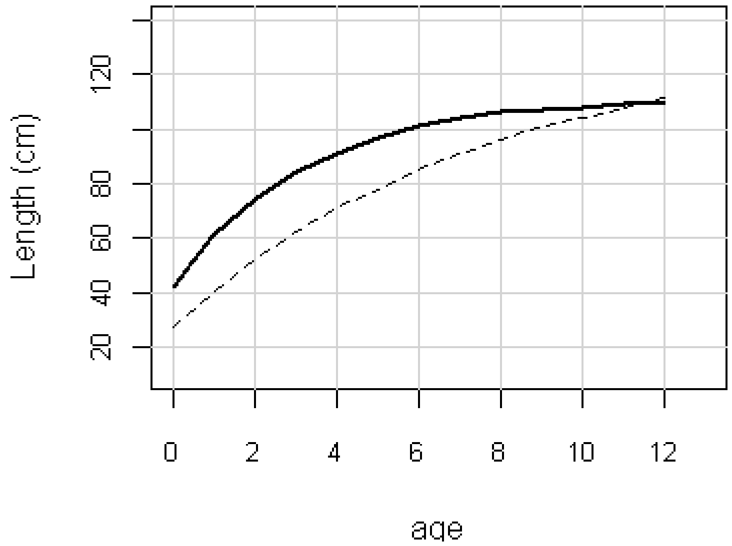

Figure 1. Von Bertalanfy growth equation for the Faroe Bank (thick line) and Faroe Plateau (dash line) cod stocks.

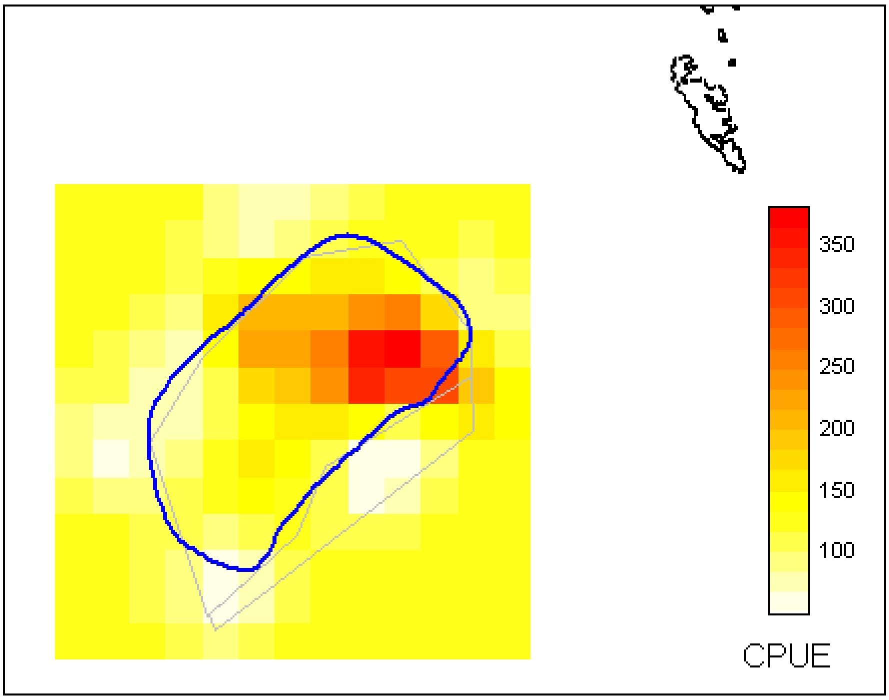

Figure 2. Cod in Division Vb2. Catch per unit of effort (CPUE) from the faroese summer groundfish survey 2000-2004.

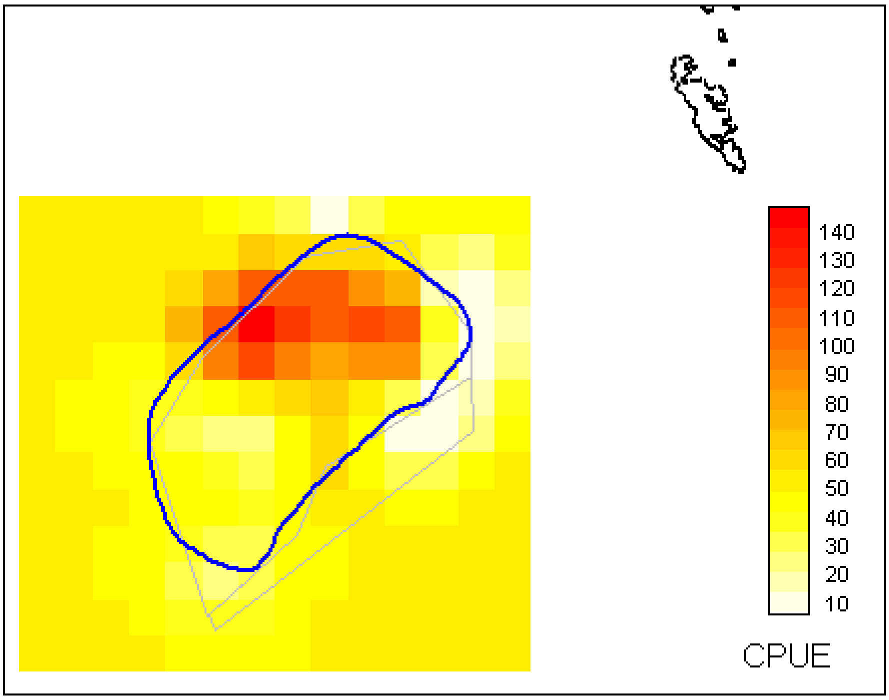

Figure 3. Cod in Division Vb2. Catch per unit of effort (CPUE) from the faroese spring groundfish survey 2006-2008.

Quality Handbook Stock Annex: Faroe Plateau Cod (Division Vb1

Stock specific documentation of standard assessment procedures used by ICES.

Stock:	Faroe Plateau cod (Division Vb1)
Working Group:	North-Western Working Group
Last updated:	May 2009
Revised by	………..

A. General

A.1. Stock definition.

Extensive tagging experiments on the Faroe Plateau (Strubberg, 1916; 1933; Tåning, 1940; Joensen *et al*., 2005; unpublished data) during a century strongly suggest that the cod stock on the Faroe Plateau is isolated from other cod stocks, e.g., from cod on the Faroe Bank and cod at Iceland. Only around 0.1% of recaptured tagged cod are recaptured in other areas than the Faroe Plateau (Joensen *et al*., 2005). The immigration rate from Iceland is even lower. During 1948-86, around 90,000 cod were tagged at Iceland and 11,000 recaptured. Of these, five cod were recaptured in Faroese waters and only three of them on the Faroe Plateau (Jónsson, 1996). Of cod tagged in the North Sea, one specimen has been recaptured at the Faroes (Bedford, 1966).

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 29 000 cod in Faroese waters during 1997-2009 and about 8 500 have been recaptured to March 2009. Of these, one individual was caught on the Icelandic shelf and one on the Faroe-Icelandic ridge. In 2002, 168 individuals were tagged on the Faroe-Icelandic Ridge (Midbank). Twelve have been recaptured so far, 6 at Iceland, 3 on the Faroe-Icelandic Ridge and 0 on the Faroe Plateau (3 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.

Genetic investigations indicate that Icelandic cod might be composed by two components (Pampoulie *et al*., 2006): a western component and an eastern component, which, genetically, is indistinguishable from the Faroe Plateau cod stock (Pampoulie *et al*., 2008). While Faroe Plateau cod is dominated by the Pan I^A allele (above 0.8), the frequency is much lower (between 0.2 and 0.8) for Icelandic populations (Case *et al*., 2005), especially on the Faroe-Icelandic Ridge (0.2). The cod populations in the North Sea are dominated by the Pan I^A allele (as the populations on the Faroe Plateau and the Faroe Bank) but they have a higher frequency of the HbI(1) hemoglobin allele (Sick, 1965). Hence, Faroe Plateau cod have a rather special combination of genetic traits, as they mainly possess the 'coldwater' hemoglobine allele (Hb-I(2)) and the 'warmwater' PanI^A allele.

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.

A.2. Fishery

The cod fishery on the Faroe Plateau was dominated by British trawlers during the 1950s and 1960s. Faroese vessels took an increasing part of the share during the 1960s. In 1977, the EEZ was extended to 200 nautical miles, excluding most foreign fishing vessels from Faroese fishing grounds. In the 1980s, closed areas (mostly during the spawning time) were introduced and these were extended in the 1990s. Longliners and jiggers fished in shallow (< 150 m) waters, targeting cod and haddock, whereas trawlers exploited the deeper waters, targeting saithe. Small trawlers were allowed to exploit the shallow fishing grounds for flatfish during the summertime. After the collapse in the fishery in the beginning of the 1990s, which contributed to a serious national economic crisis in the Faroes, a quota system was introduced in 1994. It was in charge during 1994-1995, but was replaced by the effort management system in June 1996. The cod stock had by then recovered rapidly, which was in contrast with the scientific expectations.

A.3. Ecosystem aspects

The rapid recovery of the cod stock in the mid 1990s strongly indicated that 'strange things' had happened in the environment. It became clear that the productivity of the ecosystem affected both cod and haddock recruitment and growth (Gaard *et al*., 2002), a feature outlined in Steingrund and Gaard (2005). The primary production on the Faroe Shelf (< 130 m depth), which took place during May-June, varied interannually by a factor of five, giving rise to low- or high-productive periods of 2-5 years duration (Steingrund and Gaard, 2005). The productivity over the outer areas seems to be negatively correlated with the strength of the Subpolar Gyre (Hátún *et al*., 2005; Hátún *et al*., 2009; Steingrund *et al*.,2010), which may reglulate the abundance of saithe in Faroese waters (Steingrund and Hátún, 2008).

B. Data

B.1. Commercial catch

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 2007-2008 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. The catches on the Faroe-Iceland ridge were not included in the catch-at-age calculations, a practice introduced in the 2005 WG. 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 catch-at-age by fleet was summed across all fleets and scaled to the correct catch.

Mean weight-at-age data were calculated using the length/weight relationship based on individual length/weight measurements of samples from the landings.

B.2. Biological

B.3. Surveys

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

In 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 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 proportion mature was obtained from the spring survey, where all aged individuals were pooled, i.e., from all stations, being in the spawning areas or not. 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.

B.4. Commercial CPUE

Two commercial cpue series (longliners and Cuba trawlers) are updated every year, but the WG decided in the benchmark assessment 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 the report although they were not used as tuning series.

B.5. Other relevant data

C. Historical Stock Development

An XSA has been performed during a number of years. The use of tuning indices has, however, varied quite a lot since the mid 1990s. The Faroese spring groundfish survey was excluded as a tuning series in the mid 1990s because the catch-curves in the survey showed an abnormal pattern. Two commercial tuning series (single trawlers 400-1000 HP and longliners > 100 GRT) were used during 1996-1998 where the effort was in number of days. In 1999, the tuning series constituted the pairtrawlers > 1000 HP (effort in the number of trawl hours) and the longliners > 100 GRT (effort in the number of hooks set). In 2002, the Faroese Summer Groundfish survey was used as the only tuning series, as was the case in 2003. A benchmark assessment was performed in the 2004 NWWG, where the Faroese Spring Groundfish Survey was reintroduced, albeit with a modified stratification, i.e., the two surveys were used as the only tuning series. All assessments since then have been update assessments where only minor changes in settings have been made.

Model used: Extended Survivors Analysis.

Software used: Virtual Population Analysis, version 3.2, beta: Windows 95. Copyright: MAFF Directorate of Fisheries Research. License number: DFRVPA31M.DFR.

Model Options chosen:

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.

Input data types and characteristics:

Type	Name	Year range	Age range	Variable from year to year Yes/No
Caton	Catch in tonnes	1961-2009		Yes
Canum	Catch at age in numbers	1961-2009	2-10+	Yes
Weca	Weight at age in the commercial catch	1961-2009	2-10+	Yes
West	Weight at age of the spawning stock at spawning time.	1961-2009	2-10+	Yes, the same data as for the commercial catch
Mprop	Proportion of natural mortality before spawning	1961-2009	2-10+	No, set to 0 for all ages in all years
Fprop	Proportion of fishing mortality before spawning	1961-2009	2-10+	No, so to 0 for all ages in all years
Matprop	Proportion mature at age	1983-2010	2-10+	Yes, but constant values used prior to 1983, i.e., average maturities during 1983-1996
Natmor	Natural mortality	1961-2009	2-10+	No, set to 0.2 for all ages in all years

Tuning data:

Type	Name	Year range	Age range
Tuning fleet 1	Summer Survey	1996-2009	2-8
Tuning fleet 2	Spring Survey	1994-2010	2-9

D. Short-Term Projection

Model used: Age structured.

Software used: MFDP prediction with management option table and yield per recruit routines.

Initial stock size. Taken from XSA for all ages (2-10+).

Natural mortality: Set to 0.2 for all ages in all years.

Maturity: The values observed in the spring survey 2010 are used for 2010 while average maturities 2008-2010 are used in 2011 and 2012.

F and M before spawning: Set to 0 for all ages in all years.

Weight at age in the stock: The same values as weight-at-age in the catch.

Weight at age in the catch: For each age, a regression was performed between the weight-at-age during the whole year and 1) the weight-at-age during January-February or 2) the weight-at-age in the spring survey 1994-2009. The relationship with the higher coefficient of correlation was used as a basis to predict the weight-at-age in 2010. The values for 2011-2012 was set to the 2010 value.

Exploitation pattern: Average for the three last years.

Intermediate year assumptions: average for the three last years, i.e., not rescaled to the terminal year.

Stock recruitment model used: none.

Procedures used for splitting projected catches: none.

E. Medium-Term Projections

Not performed.

F. Long-Term Projections

Model used: Yield and biomass per recruit over a range of F-values.

Software used: MFYPR version 1.

Maturity: Average for 1983-20010.

F and M before spawning: Set to 0 for all ages and years.

Weight at age in the stock: Same as the weights in the catch.

Weight at age in the catch: Average for 1978-2009 in order exclude the high values in former times.

Exploitation pattern: Average for 2000-2009 (not rescaled to the terminal year) in order to reflect a recent fishing pattern.

Procedures used for splitting projected catches: none.

A long-term simulation model is used, see text in the report.

G. Biological 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: B_{pa} = 40kt, B_{lim} = 21kt, F_{pa} = 0.35 and F_{lim} = 0.68.

H. Other Issues

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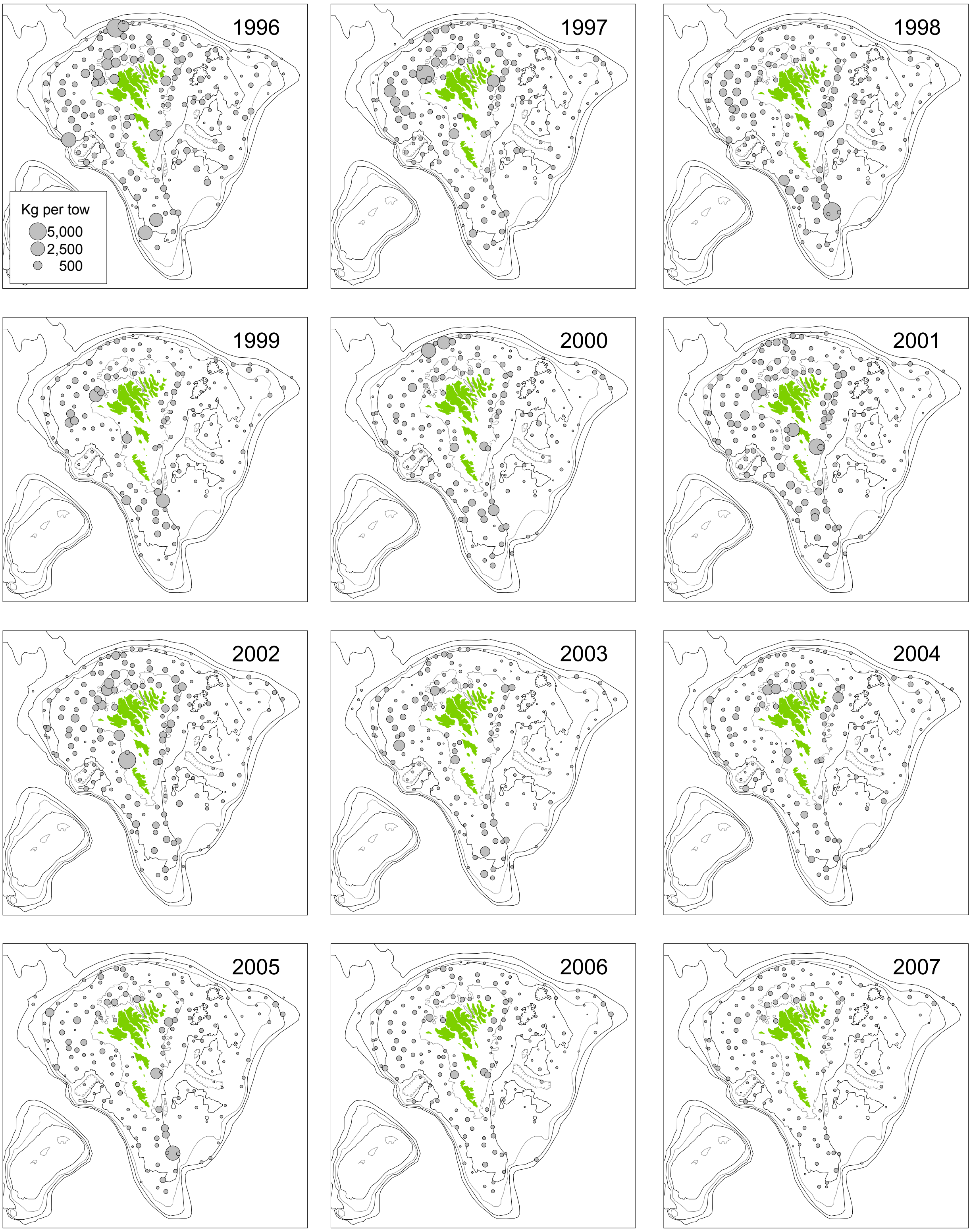
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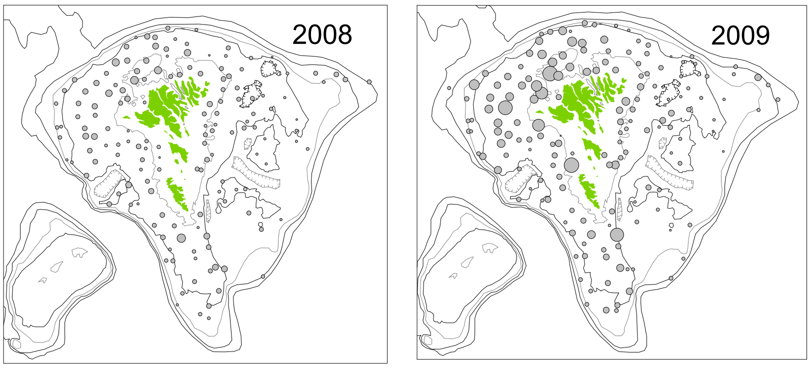
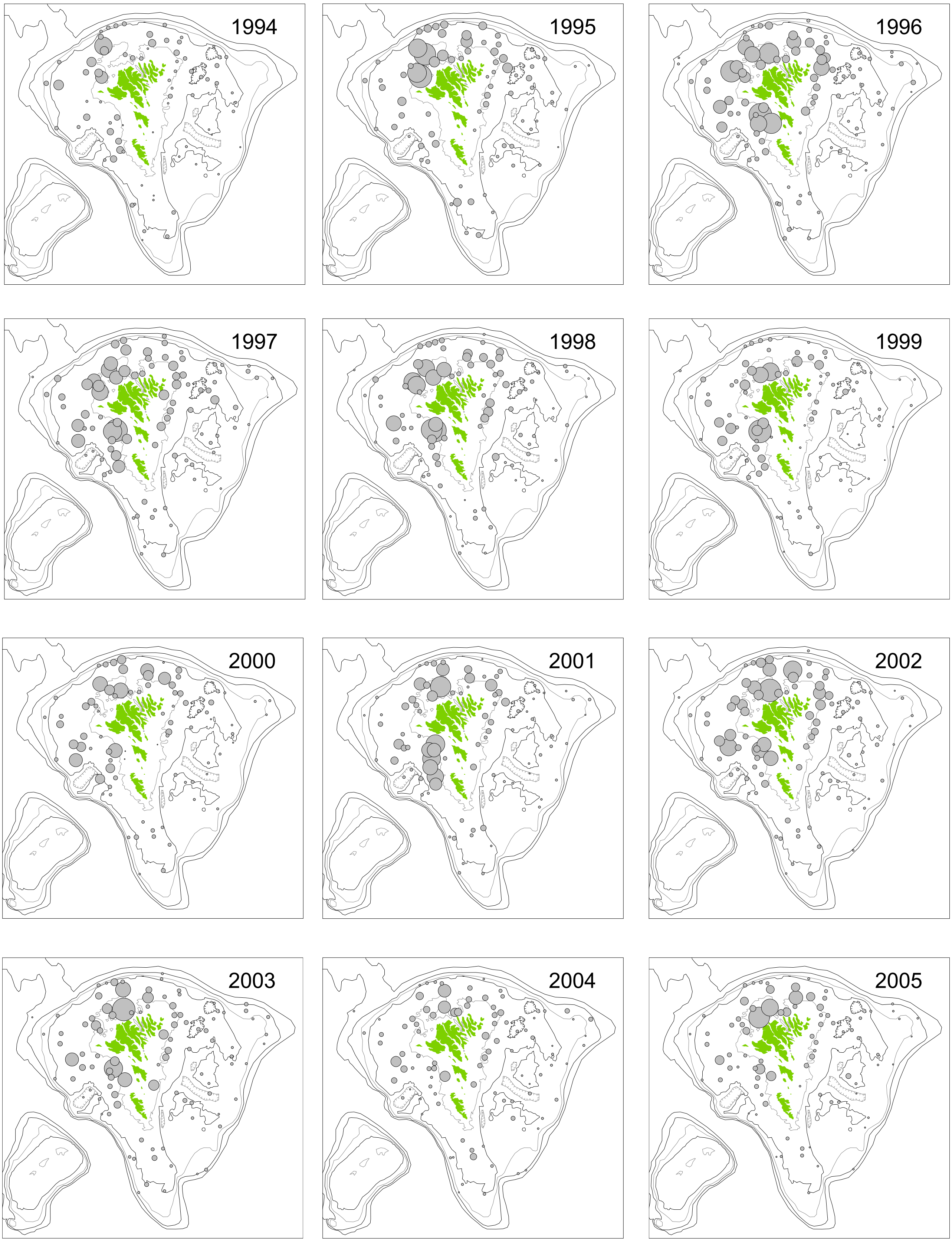


Figure 1. Cod in Division Vb1. The spatial distribution of cod according to the Summer survey on the Faroe Plateau (kg per tow, the size of the bubbles is on a logaritmic scale). 100 to 500 m depth contours are shown. The figure is continued on the following page.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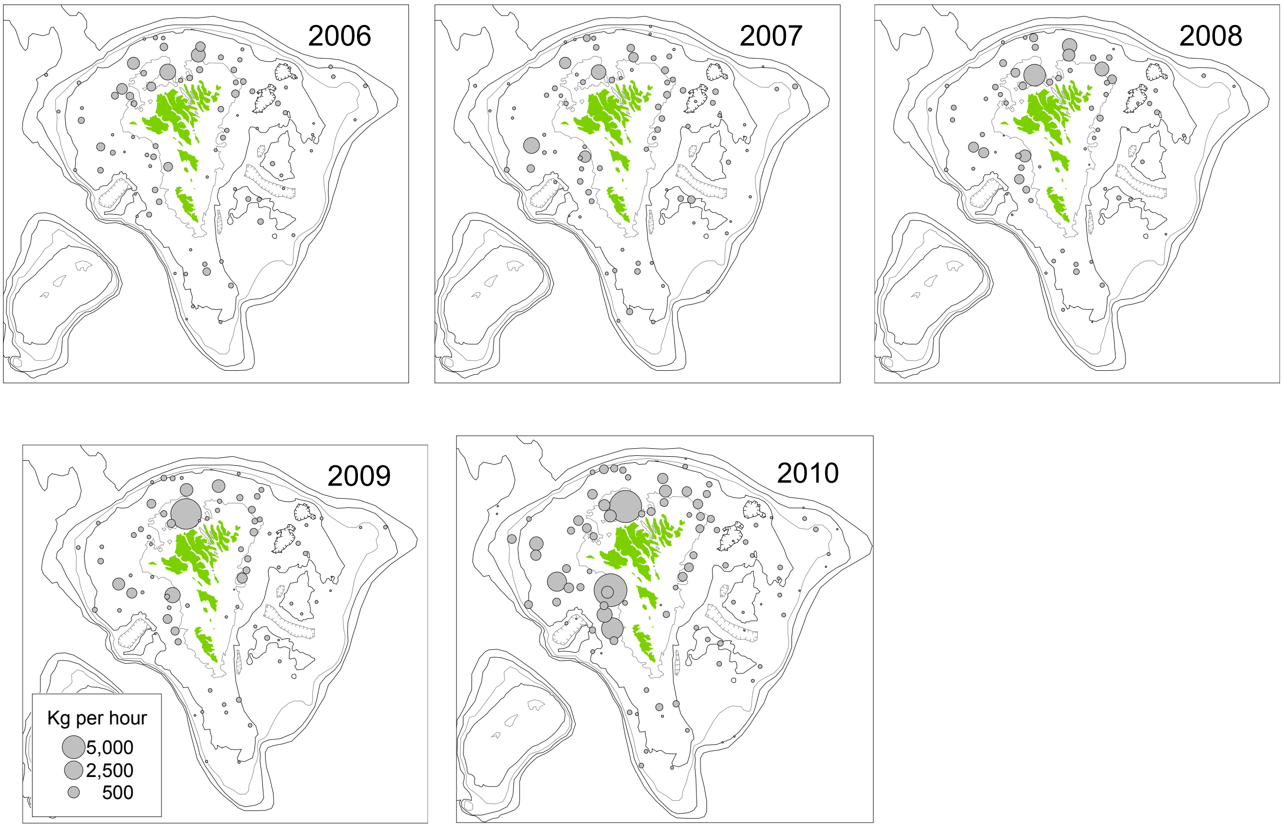

Figure 2. Cod in Division Vb1. The spatial distribution of cod according to the spring survey on the Faroe Plateau (kg per tow, the size of the bubbles is on a logaritmic scale). 100 to 500 m depth contours are shown. The figure is continued on the following pages.

Stock Annex: Faroe Saithe (Division Vb)

Stock specific documentation of standard assessment procedures used by ICES.

Stock	Faroe saithe (Division Vb)
Working Group:	North-Western Working Group
Date:	February 2010
Revised by	Luis Ridao & Petur Steingrund
	Faroe Marine Research Institute

A. General

A.1. Stock definition

Saithe is widely distributed around the Faroes, from 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).

Saithe in Division Vb is regarded as a management unit although tagging experiments have demonstrated migrations between the Faroes, Iceland, Norway, west of Scotland and the North Sea (Jákupsstovu 1999). Jakobsen and Olsen (1987) investigated taggings of saithe at the Finmark coast (off Northern Norway) during the 1960s-1970s. They found that emigration rates to the Faroe area by some 2-3 % of the North-east arctic saithe stock was sufficient to explain the tagging results, and that the emigration likely occurred before sexual maturity. Bearing in mind that the North-east arctic saithe stock is larger than the saithe stock at the Faroes (by a factor of 1 to 6), up to some 20 % of the saithe stock at the Faroes may be of norwegian origin, according to this study. However, it might be expected that the emigration rate of saithe from more southerly locations along the Norwegian coast could be higher than in Jakobsen and Olsen’s (1987) study (see Jakobsen (1981) for emigration to the North Sea). On the other hand, the emigration rate in the opposite direction also has to be accounted for. English tagging experiments (Jones and Jónsson, 1971) with Faroe Plateau saithe in the 1960s indicated an emigration rate to the Faroe Bank of 5 % (2 out of 41), North Sea of 15 %, and a rate of 20 % to Iceland (2 % had unknown recapture site). Regarding the migration between Icelandic and Faroese waters, there have been tagged some 18463 juvenile saithe in Icelandic waters in 2000-2005 (Armansson *et al*., 2007), and 1649 have been recaptured up to now, 7 of them in Faroese waters (Marine Research Institute, Iceland, pers. comm.). This indicates that emigration rate of saithe to Faroese waters might be limited. In conclusion, Faroe saithe seem to receive recruits from own waters as well as recruits from the North-east arctic saithe stock and probably also the North Sea stock. In addition there might be a net emigration to Icelandic waters (Jones and Jónsson, 1971; Jakobsen and Olsen, 1987).

A.2. Fishery

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 since 1992. 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 since 1997. The share of landings by the jigger fleet accounts for less than 4% of the total landings since 2000.

Since early-1980s the bulk of catches consists of age groups 4 to 7 while the contribution of older age groups was more substantial from 1961 to 1980 (WD 08)

Nominal landings of saithe in Division Vb have varied cyclically between 10 000 t and 68 000 t with three distinctive cycles of around 15 years period since 1960.

Catches used in the assessment include foreign catches that have been reported to the Faroese Authorities but not officially reported to ICES. Catches in Subdivision IIa, which lies immediately north of the Faroes, have also been included. Little discarding is thought to occur in this fishery.

A.3. Ecosystem aspects

The rapid recovery of the cod stock in the mid 1990s strongly indicated that 'strange things' had happened in the environment. It became clear that the productivity of the ecosystem affected both cod and haddock recruitment and growth (Gaard *et al.*, 2002), a feature outlined in Steingrund and Gaard (2005). The primary production on the Faroe Shelf (< 130 m depth), which took place during May-June, varied interannually by a factor of five, giving rise to low- or high-productive periods of 2-5 years duration (Steingrund and Gaard, 2005). Saithe, however, seem to be more affected by the productivity over the outer areas. The productivity over the outer areas seems to be negatively correlated with the strength of the Subpolar Gyre (Hátún *et al.*, 2005; Hátún *et al.*, 2009; Steingrund *et al.*, 2010), which may regulate the abundance of saithe in Faroese waters (Steingrund and Hátún, 2008). When comparing a gyre index (GI) 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.

There is a negative relationship between mean weight-at-age and the stock size of saithe in Faroese waters. This could be due to simple density-dependence, where there is a competition for limited food resources. Stomach content data show that blue whiting, Norway pout, and krill dominate the food of saithe, and the annual variations in the stomach fullness are mainly attributable to variations in the feeding on blue whiting. There seemed to be no relationship between the way stomach fullness is related to weights-at-age (í Homrum *et al.* 2009). One explanation for this might be the influx of fish (3 to 5 years old) to Faroese waters from other saithe stocks given that weights-at-age are very similar, e.g. for NEA and Faroe saithe in years when the Faroe saithe stock is large (4 years after a high GI) whereas Faroe saithe has up to two times larger individual weights when the stock size is low.

B. Data

B.1. Commercial catch

In order to compile catch-at-age data, the sampling strategy is to have length, length-age, and length-weight samples from all major gears (jiggers, single trawlers > 1000 HP, pair trawlers < 1000 HP, pair trawlers > 1000 HP and others) during three periods: January-April, May-August and September-December. When sampling was insufficient, length-age and length-weight samples were used from similar fleets in the same time period while avoiding if possible the use of length measurements. Landings were obtained from the Fisheries Ministry and Statistics Faroe Islands. Catch-at-age for fleets covered by the sampling scheme were calculated from the age composition in each fleet category and raised by their respective landings. Fleet based catch-at-age data was summed across all fleets and scaled to the correct catch.

Mean weight-at-age data were calculated using the length/weight relationship based on individual length/weight measurements of landing samples.

B.2. Biological

B.3. Surveys

The spring groundfish surveys in Faroese waters were initiated in 1983 with the research vessel Magnus Heinason. 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 first cruise was not conducted and one third of the stations used up to 1991 were fixed. Since 1993 all stations are fixed.

The summer (August-September) groundfish (bottom trawl) survey was initiated in 1996 and covers the Faroe Plateau with 200 fixed stations distributed within the 65 to 520 m contour. Effort for both surveys is recorded in terms of minutes towed (~60 min). Survey data for Faroe saithe are available to the WG from both the spring- (since 1994) and summer- (since 1996) surveys. The usual way was to calculate the index as the stratified mean number of saithe 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 saithe less than 20 cm were considered being 0 years and between 20-40 cm 1 year. Since the age length key was the same for all strata, a mean length distribution was calculated by stratum and the overall length distribution was calculated as the mean length distribution for all strata weighted by stratum area. Having this length distribution and the age length key, the number of fish at age per station was calculated, and scaled up to 200 stations in the summer survey.

Both survey indices are available to the Working Group. However the survey series have not been used due to high CVs. In order to address this issue, a data-driven post-stratification analysis was applied in 2008. The analysis suggested that the optimal number of strata to estimate relative stock abundances should be between 5 and 7 for both surveys. The new stratification results in less variable survey estimates while improving year class consistency from one year to the next (Ridao Cruz, L. 2008, WD 5). A similar approach was used at the Benchmark Assessment Workshop (WKROUND) in 2010 (WD 03). In this case one large haul was windsorized to the second largest in the spring series prior to the analysis proper. With these revised survey indices several age-based models were run, e.g., XSA, NTF-Adapt and Separable models. A strong bias was observed in the retrospective pattern for all models and therefore the revised survey series were yet regarded as not suitable for model tuning. However, WKROUND in 2010 noted that the surveys were able to capture annual changes in the range of the spatial distribution of saithe on the Faroe Plateau. This variability (proportion of all 300 hauls containing at least one saithe) was used as a scaling factor of the commercial cpue (based on the pairtrawlers, see later).

Maturity at age data from the spring survey is available since 1983. Some of the 1983-1996 values were revised in 2003 but not the maturities for the 1961-1982 period (Steingrund, 2003). The proportion mature was obtained from the spring survey, where all aged individuals were pooled, i.e., from all stations, being in the spawning areas or not. Due to poor sampling in 1988 the proportion mature for that year was calculated as the average of the two adjacent years. A model presented at the WKROUND workshop (WD 06) was utilized to smooth the maturity ogives (Eq 1.) The model kept the major trends in the observed data while smoothing out the maturity at age matrix.

$$M = \frac{M_{inf}}{1 + \exp(-k * (age - age50))} \qquad \textbf{Eq. 1}$$

where M is the proportion mature and Minf, k and age50 are parameters estimated by the model.

B.4. Commercial CPUE

The CPUE series from pair trawlers 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 vessels are greater than 1000 HP and have specialized in fishing on saithe and account for 5 000-20 000 t of saithe each year. The tuning series data are based on available logbooks of 4-10 trawlers since 1995. Data are stored in the database at the Faroe Marine Research Institute in Torshavn where they are quality controlled and corrected if necessary. Effort is estimated as the number of fishing (trawling) hours, i.e. from the time the trawl meets the bottom until hauling starts. It is not possible to determine effort in fishing days because day and time of fishing trips are not recorded in the logbooks. The effort distribution of the pair trawlers fleet covers most of the fishing areas in the deeper parts (bottom depth > 150 m) at the Faroes. Distribution of combined trawl catches (single- and pair-trawlers) from logbooks is shown in figure 1.

During 2002-2005 four pairs of these trawlers were decommissioned. 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 2009 two new pairs of trawlers were used to extend the tuning series. These trawlers were build in 2003 and 2004 and they show the same trends in CPUE as the others, but higher in absolute numbers. At the 2010 benchmark assessment the CPUE series were compiled based on hauls where saithe contributed more than 50% of the total catch, discarding a pair (pair-6) and constraining the spatial distribution to those statistical squares where most of the fishing activity takes place. A GLM model using year, month, pair and depth as explanatory variables (WD 09) was applied to the resulting input data. If 'fishing square' was added as an explanatory variable, the year-effect in the GLM model remained the same. However, 'fishing square' was excluded from the model in order to keep the number of the degrees of freedom as low as possible. In addition to the pairtrawler cpue, which is a measure of saithe density in the core area of saithe, the range of the spatial distribution of saithe was considered when constructing an abundance index for saithe. The pairtrawler cpue was scaled by the proportion of survey survey hauls in March and August (approximately 300 each year, except 100 in 1995) containing at least one saithe. The revised annual indices resulted in a substantial reduction in the bias observed in the retrospective pattern. The WKROUND working group regarded this novel approach to the commercial series as satisfactory.

B.5. Other relevant data

C. Historical Stock Development

The last benchmark assessment for Faroe Island saithe was conducted in 2005. The model explored during that benchmark workshop, an XSA model, was not used for interim assessments or to provide management advice after that workshop because of a retrospective pattern observed in model outputs at that time. It was hypothesized that the retrospective pattern was likely due to changes in selectivity due to changes in fish growth as it was observed that the average weight at age in the catch was dropping. The 2010 benchmark workshop further explored the XSA model as well as an ADAPT, TSA and separable statistical models. The CPUE series that has been used in the assessment since 2000 was introduced in 1998 (ICES C.M. 1998/ACFM:19), and consists of saithe catch at age and effort in hours, referred to as the pair trawler series. The commercial CPUE series was standardized and the density indices were multiplied by an area expansion factor to better represent a measure of total stock abundance (Sec. 6.2.5.2.) These data updates were found to significantly reduce the retrospective pattern previously observed in the assessment. The SSB, F and recruitment estimates generated by both models were comparable and the XSA assessment was adopted as the benchmark assessment because it had been the model historically used for this stock. The model settings are described below.

Model used: FLXSA, Extended Survivors Analysis for FLR

Software used: FLR, version 2.0

Model Options chosen:

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.

Input data types and characteristics:

Type	Name	Year range	Age range	Variable from year to year Yes/No
Caton	Catch in tonnes	1961-last data year	3 – 14+	Yes
Canum	Catch at age in numbers	1961-last data year	3 – 14+	Yes
Weca	Weight at age in the commercial catch	1961-last data year	3 – 14+	Yes
West	Weight at age of the spawning stock at spawning time.	1961-last data year	3 – 14+	Yes, assumed to be the same data as weight at age in the catch
Mprop	Proportion of natural mortality before spawning	1961-last data year	3 – 14+	No, set to 0 for all ages and years
Fprop	Proportion of fishing mortality before spawning	1961-last data year	3 – 14+	No, set to 0 for all ages and years
Matprop	Proportion mature at age	1983- last data year + 1 (2009)	3 – 14+	Predicted ogives. Data prior to 1983 is average of 1983-1996 values.
Natmor	Natural mortality	1961-last data year	3 – 14+	No, set to 0.2 for all ages and years

Tuning data:

Type	Name	Year range	Age range
Tuning fleet 1	Pair trawlers	1995- last data year	3-11

D. Short-Term Projection

Model used: Age structured.

Software used: Multi Fleet Deterministic projection (MFDP1a), prediction with management option table

Initial stock size: Taken from the final VPA run (table 10). Recruitment at age 3 is geometric mean of 1995-2009.

Natural mortality: Set to 0.2 for all ages in all years.

Maturity: First year (2009) is average of the last data year (2008) and last data year +1 (2009). The two next years (2010-2011) is average of three latest years (2007-2009)

F and M before spawning: Set to 0 for all ages in all years.

Weight at age in the stock: Assumed to be the same value as weight at age in the catch.

Weight at age in the catch: The same value as in the last data year.

Exploitation pattern: Average exploitation pattern in the final VPA for the last three years, not rescaled.

Intermediate year assumptions: None

Stock recruitment model used: None

Procedures used for splitting projected catches: None

E. Medium-Term Projections

Not performed.

F. Long-Term Projections

Model used: Yield and biomass per recruit over a range of F-values.

Software used: Multi Fleet Yield Per Recruit (MFYPR2a).

Maturity: Average for 1983 to last data year +1 (2009).

F and M before spawning: Set to 0 for all ages and years.

Weight at age in the stock: Assumed to be the same as weight at age in the catch.

Weight at age in the catch: Average weights from 1961 to last data year.

Exploitation pattern: Average exploitation pattern of the last five years

Procedures used for splitting projected catches: None.

Several scenarios were considered at the Benchmark assessment in 2010 (WKROUND 2010) simulating changes in growth. One scenario in which the stock was at low levels and the corresponding growth was high and another scenario in which the stock was estimated at high levels but growth was slow. In addition the entire time series were tested in order to provide yield per recruit estimates for F_{MSY} proxies such as F_{max} (Sec. G)

G. Biological Reference Points

At the 2010 Benchmark assessment the new MSY framework was assessed. In order to consider how FMSY should be evaluated, a brief summary of existing reference points is given, as well as proposals for changes that are found in previous NWWG reports. The stock size of Faroe saithe has fluctuated regularly between 100 and 330 thousand tonnes during the last 49 years. There are indications of a negative correlation between total stock size and growth. In addition total stock size is highly correlated with hydrographical conditions south-west of the Faroes some 4 years before, whereas the recruitment shows a weaker correlation (Figure 2.) There appears to be a negative relationship between the size of the spawning stock and subsequent recruitment, and the relationship is different for small-stock and large-stock situations.

In order to evaluate reference points, high-growth small-stock situations (1991-1998) and slow-growth large-stock situations (2002-2009) are compared. As a reference yield-per-recruit analysis is performed on the entire historical period (1961-2009.)

The yield-per-recruit is much higher for small-stock periods (i.e. high-growth) than for large-stock periods (i.e. slow-growth)(Figure 2), as well as spawning stock per recruit. Estimated $\mathbf{F}_{max}$ used as a proxy for $\mathbf{F}_{MSY}$ in periods of high growth is 0.44 which is very close to that obtained when the entire time series is selected ($\mathbf{F}_{max}$=0.43)

When the saithe stock experiences a period of slow growth the expected maximum yield obtained is lower $\mathbf{F}_{max}$=0.34.

Table 1 summarizes current and alternative reference points. The current $\mathbf{F}_{pa}$ is lower than any of the three proposed $\mathbf{F}_{max}$ values. One candidate for the FMSY is the average of 0.44 and 0.34, i.e. 0.39 (taking rounding of the former values into account). $\mathbf{B}_{trigger}$ could be set at the current $\mathbf{B}_{lim}$ of 60 thousand tonnes. The current $\mathbf{F}_{pa}$=0.28 also seems too low if the goal is to maximize yield.

Given the time constrained by the WG it might be suggested that a Management Strategy Evaluation (MSE) be considered for examination of harvest control strategies for faroe saithe. A range of F reference points including for this stock are established. The most appropriate F level is probably somewhere in the middle. A MSE approach would not only be useful from a management strategy view point under stationary assumptions, but also allow exploration of the influence of environmental drivers have on long-term management actions.

Table 1. Faroe saithe (Division Vb). Current and alternative reference points

Reference point	Small stock	Large stock	All sizes	Remarks
	1991-98	2002-08	1961-2009	
Reference Points using Previous Benchmark Results				
Blim	**60**	**60**	**60**	NWWG07: Recommends using Bpa
Flim	**0.40**	**0.40**	**0.40**	
Flim	0.48	0.81	0.65	New SSB per R applied to old Blim
Bpa	**85**	**85**	**85**	
Fpa	**0.28**	**0.28**	**0.28**	
Fpa	0.33	0.53	0.46	New SSB per R applied to old Bpa
Reference Points using 2010 Benchmark Approach				
Blim	50	50	50	Based on NWWG07 algorithm
Flim	0.54	1.00	0.77	New SSB per R applied to new Blim
Fmax	0.44	0.34	0.43	
Average Recruits	24	64	33	

H. Other Issues

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 winter 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 year's meeting.

2008

Technical minutes pointed out the problem of variability in pelagic/demersal occurrence of saithe, hence the problems in reliability of survey indices (high CV). Commercial CPUE indices were used for tuning. However, declining weight-at-age leading to declining catchability not accounted for in XSA.

At this point, there is no improvement in the 2009 year assessment compared to previous year. In the benchmark assessment the surveys should be closer investigated. The summer survey shows that the spatial distribution of saithe on the Faroe Plateau has become wider. An attempt should be made to incorporate this information into the index of stock size.

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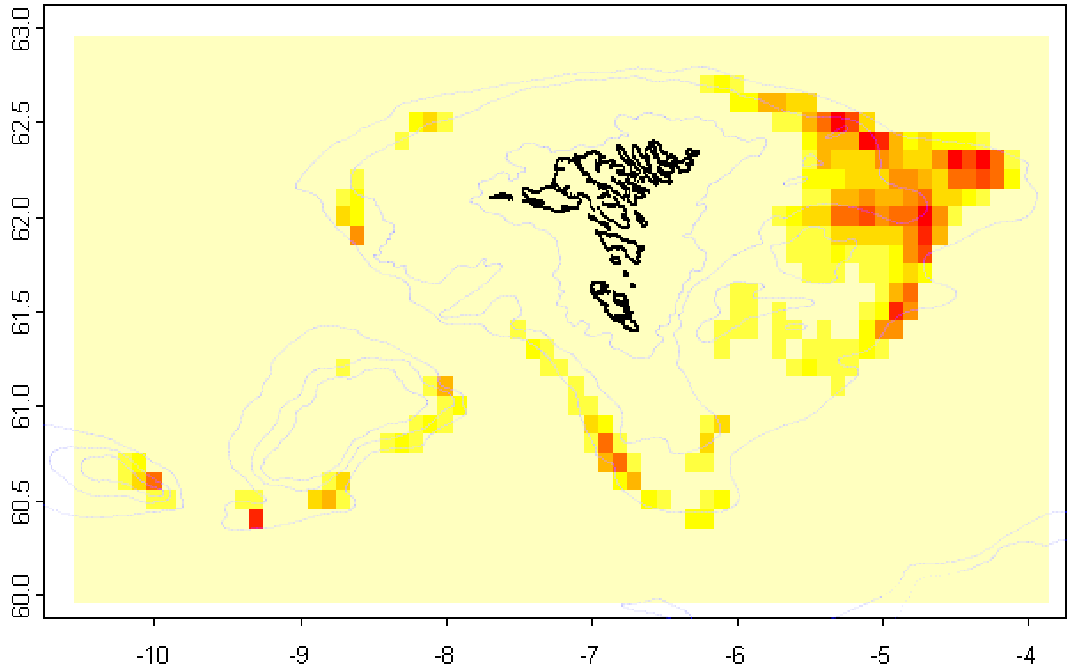


Figure 4. Faroe Saithe Vb. Distribution of combined trawl catches (single- and pair-trawlers) from 1995-2008 (logbooks.) Depth contour lines of 100, 200 and 400m are shown.

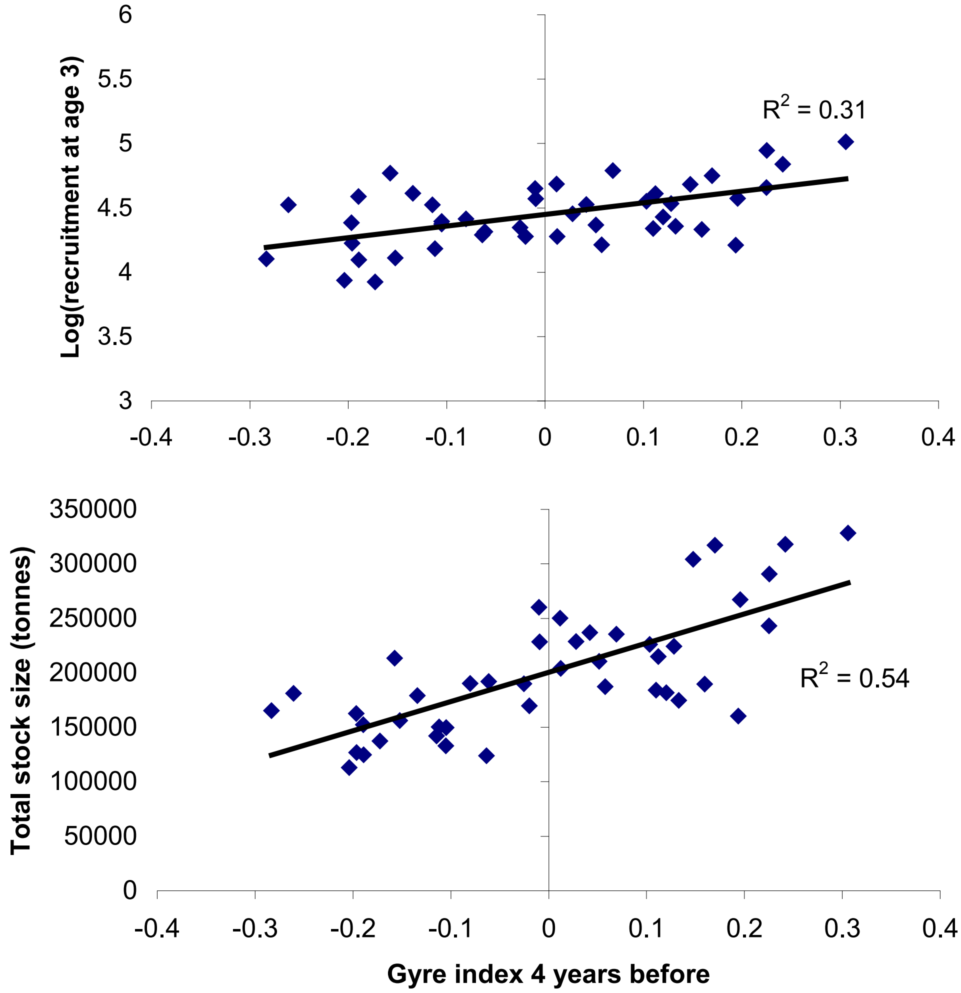


Figure 5. Relationship between the gyre index and both recruitment (top figure) and total stock biomass estimates (bottom figure.) Note that a large gyre index indicates a small subpolar gyre, and, consequently, a large influx of plankton-rich warmer-than-average water to the outer areas (bottom depth > 150 m) around the Faroes, where saithe typically are found.

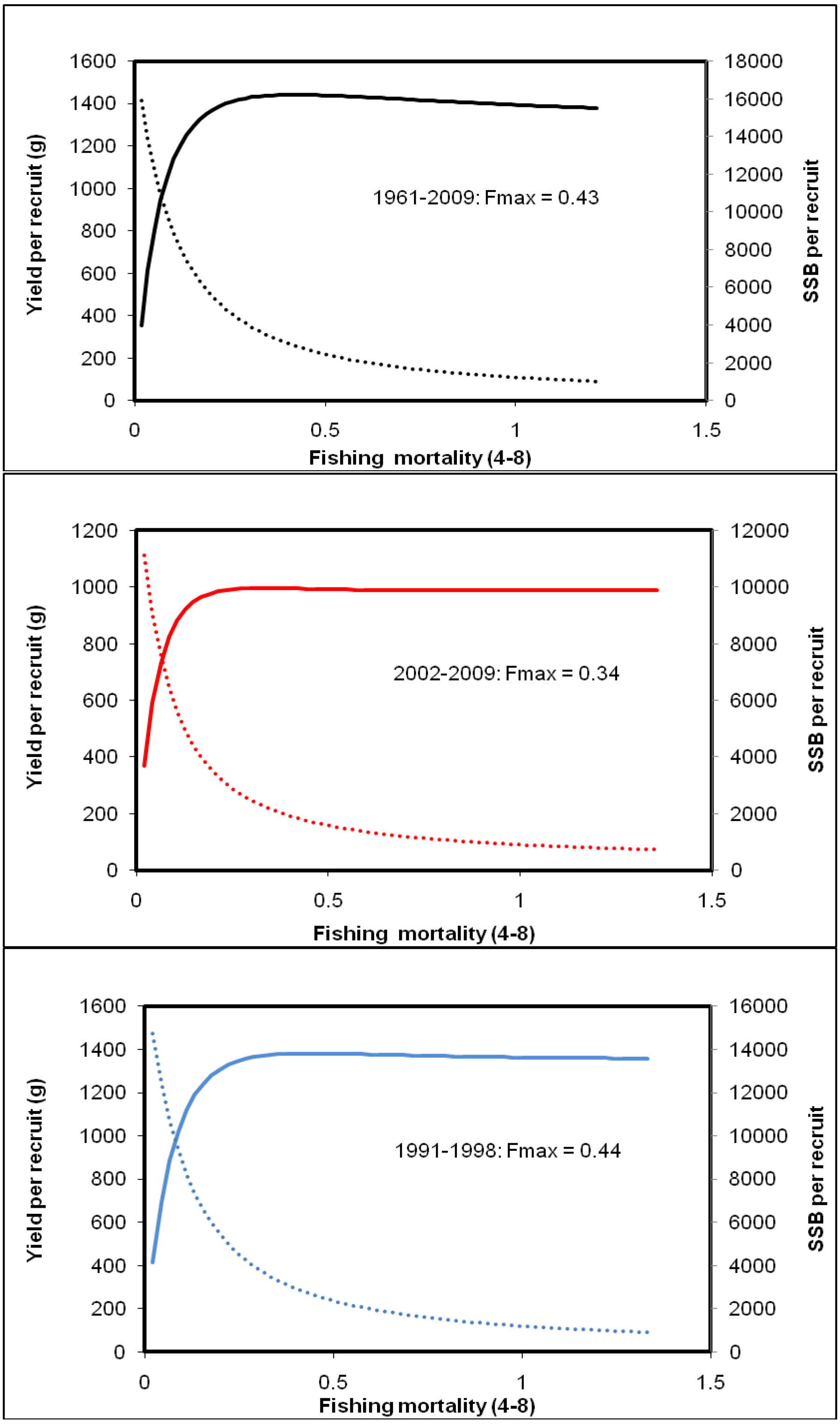


Figure 6. Yield per recruit calculations on the entire historical period (1961-2009) (top figure), for scenario with high-growth (small-stock) situations (1991-1998)(middle figure) and slow-growth (large-stock) situations (2002-2009)(bottom figure.)

Quality Handbook Stock Annex: Cod Stocks in the Greenland Area (NAFO Area 1 and ICES Subdivision XIVB)

Stock specific documentation of standard assessment procedures used by ICES.

Stock:	Cod Stock in the Greenland Area
Working Group:	North-Western Working Group
Date:	May 2010
Revised by:	

A. General

A.1. Stock definition

The cod found in Greenland is derived from three separate "stocks" that each is labeled 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.

Offshore, the offspring is carried pelagically over vast distances: the Icelandic offspring generally settles off East and South Greenland, the offspring from the Greenland offshore spawning is believed mainly to settled off the West Greenland coast (Wieland and Hovgård, 2002). Significant larval drifts from Iceland occur irregularly; e.g. in 1973 and 1984 (Buch et al, 1994, Schopka, 1994). Spawning cod is documented in many fjords between 64 and 67°N in West Greenland (Hansen 1949, Smidt 1979, Buch *et al*., 1994). Recent summaries of the stock structure and developments, that provide references to the more detailed studies includes: Hovgård and Wieland, 2008, 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).

A.2. Fishery

A short historical review

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.

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. 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.

The present fishery

Cod is fished by a coastal and an offshore fleet.

Coastal vessels are defined as vessels below 75BT/120BT. The coastal fisheries do not require a licence and has historically not been constrained by catch ceilings (for 2009 a TAC of 10,000 t has been introduced). The coastal fleet has historically mainly fished the inshore areas. The most important gear is pound-net (taking ca. 70-80% of the annual catches) anchored at shore and fishing the upper 20 m. Due to the ice conditions pound nets are not used during ca. November-April. In winter the inshore fishery uses hooks and gill nets. Trawling is not allowed within 3 nm off the base line. Inshore catches have since 00s increased with highest catches of 12,000 tons in 2008.

Offshore vessels are vessels above 75BT/120BT. The offshore vessels are restricted to the area more than 3nm off the base line. The offshore vessels require a license that stipulates the vessel quota. Trawl is the dominating gear but long lining also occurs.

Areas in the offshore fisheries started to be closed for directed cod fishery in 2008 in order to protect the spawning stock. In 2008 the area north of 63°N latitude off East Greenland was closed and in 2009 this area was extended to north of 62°N latitude and north of 61°N latitude off West Greenland. In 2010 the non-fishable area in West Greenland was further extended to west of 44°N Longitude. During the 00s the offshore catches increased with highest catches of 13,000 tons in 2008.

A.3. Ecosystem aspects

B. Data

B.1. Commercial catch

The information on landings in weight are compiled and processed by the Greenland Fisheries License Control (GFLK). Inshore catches are documented by sales slips only whereas the offshore information is available on the haul-by-haul scale provided by logbooks. Sampling of length frequencies and information on age, weights and maturities are collected and compiled by the Greenland Institute of Natural Resources.

A well-balanced sampling of the Greenland coastal fleets catches has always been impeded by the geographical conditions, i.e. the existence of many small landing sites separated along the 1000 km coast. Except for the Nuuk area that is easily covered samplings relies on dedicated sampling trips supplemented with ad hoc samplings when ports are called through other institute activities. The sampling coverage was especially poor in the late 1990s when catches were very low (< 1000t annually). The sampling coverage has improved since ca 2004 through a formal cooperation with GFLK observers.

Offshore sampling is difficult at present as most vessels produce frozen fillets that are commonly landed outside Greenland. When available, GFLK observer data is used, and in some cases skippers have been asked to organize for the length measuring of random samples and/or to freeze individual cod for later analysis at the laboratory.

Catches can generally not be separated into stock component. E.g. catches from the coastal fleet can not be taken as representing stocks spawning in the fiords as 1) tagging results indicate that the coastal zone is a mixing area of offshore and inshore cod and 2) coastal vessels may fish in offshore areas.

B.2. Biological

Spawning areas. Since 2007 the GINR has worked on mapping the spawning area of cod in Greenland. A number of inshore area has been visited, particularly the fjord system around Nuuk. The inshore program continues for over the next years to cover the entire West Coast. Offshore spawning was monitored in 2007 by observers on commercial trawlers. An Iceland Survey was carried out off East Greenland in April-May 2009.

Tagging has been reassumed in recent years taking place on the various surveys.

B.3. Surveys

At present, the surveys (two offshore trawl surveys and an inshore gill-net surveys) provide the core information relevant for stock assessment purposes.

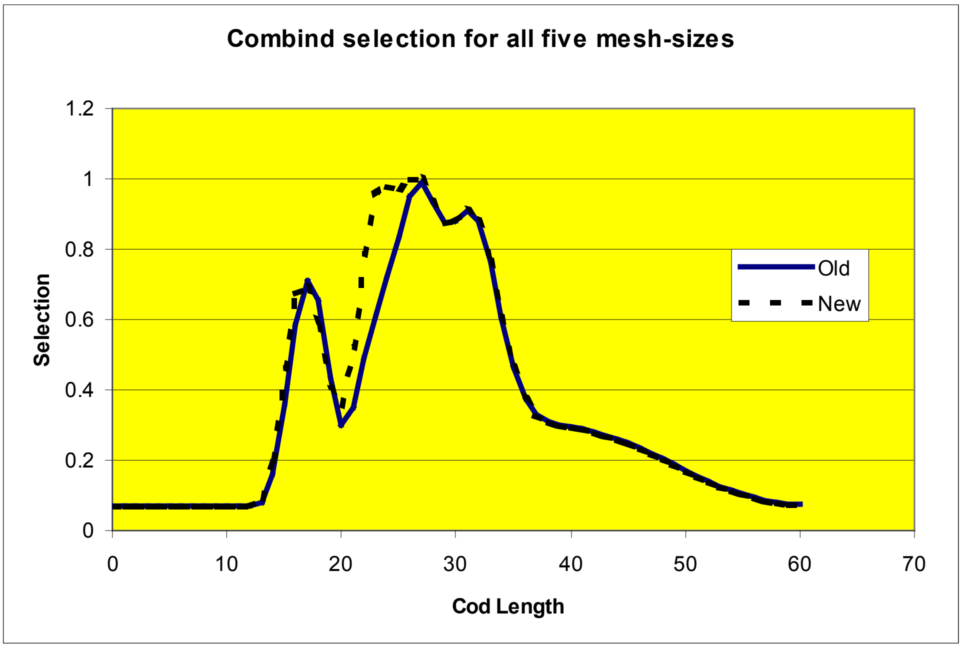
1 Inshore gill net survey

The objective of the gill-net survey is to assess the abundance and distribution of pre recruit cod in fiord areas in Greenland. The survey has been conducted annually since 1985 covering three inshore areas along the cost of West Greenland: Sisimiut (NAFO Division 1B), Nuuk (NAFO Division 1D) and more occasionally Qaqortoq (NAFO Division 1F). The survey uses gangs of gill nets with different mesh-sizes (16.5, 18, 24, 28 and 33mm, ½ mesh). 100-150 nets are set annually. The nets are set perpendicular to the cost in order to keep depth constant. The survey effort is evenly allocated between the depth zones of 0-5 m, 5-10 m, 10-15 m and 15-20 m. The abundance index used in the survey is defined as 100*(# caught/net*hour).

The original net materials are no longer commercial available for the three smallest mesh sizes. From 2004 this has implied a change in twine thickness (particularly for the 24mm mesh) that is expected to changes the fishing power of the nets.

Mesh-size (mm)	16.5	18.5	24	28	33
Old twine Ø (mm)	0.24	0.20	0.38	0.28	0.33
New twine Ø (mm)	0.20	0.22	0.25	0.28	0.33

The selection curve for the individual meshes are bi-modal with cod being either gilled or snagged (Hovgård, 1996a). For cod, as well as the by-catch of other species, the fishing power is found to depend on the twine thickness (Hovgård, 1996b). The effect of the potential change in fishing power, associated with the change in net material, can be evaluated from parameters in Hovgård and Lassen (2000, p. 48-51) that updates the selectivity estimates based on an improved version of the selection model (Hovgård et al, 1999). The change in the fishing power appears limited and confined to cod length between 20-27 cm (age group 2).



2 Trawl survey by Greenland (West Greenland Shrimp and Fish survey)

Since 1988, the Greenland Institute of Natural Resources has conducted an annual stratified random trawl survey at West Greenland. The survey was initially designed as a shrimp survey with the focus to evaluate the biomass and abundance of the Northern shrimp (*Pandalus borealis).* The survey has been continuously developed during the years particularly reflecting the needs of the shrimp assessments, as shrimp was the only important resource in the survey area after the cod stock collapse. Fish catches have been recorded since 1992. Due to the reoccurrence of stronger cod year-classes an increasing number of hauls have been allocated to the southern areas since 2005. The numbers of trawl hauls varied between 187-262 per year and total numbers of valid hauls was 258 in 2008.The survey design, the area coverage and the trawl and its rigging has been unchanged since 2005, i.e. coinciding with the period where significant cod year classes has been seen. The years prior to 2005 experienced a number of survey development that are detailed below.

<u>Survey area and stratification</u>: The trawl survey covered initially the traditional offshore shrimp area, between 60º - 72º North, depth 150-600m. In 1991 the area was extended to include the Disco Bay. The area is delimited by a line 3nm off the base line and the 600 m depth curve The areas shallower than 150 m was initially rather unsystematically covered but from 2004 two extra depth zones have been formally included (50-100m, and 100-150m). 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. The depth zones 0-100 m and 100-150m is delimited

by the NAFO Subdivision boundaries. Trawl stations are allocated to strata with the objective to minimise the variances of the shrimp biomass. The allocation algorithm utilises the historically observed shrimp variances where highest weight is placed on the most recent information. Stations positions were initially selected at random but since 1999 station positions were chosen to secure a minimum distance between stations. Since 1998 about half of the haul positions were randomly selected from the previous year hauls; the rest of the hauls being selected at random positions

Cod, as well as other ground fish species that historically has been assessed by NAFO, was up to 2007 analysed using a restratification that followed the NAFO divisions. Restratification implies a bias and the survey information from 2005 and onwards has therefore been reanalysed in accordance with the shrimp strata actually used in the survey. A recalculation of the entire time series back to 1992 is possible but complicated by a change in the data base system. Given that the 1992-2004 period is characterized by an almost lack of cod in the West Greenland offshore area such a reanalysis is given a low priority.

The Survey trawl and its operation: The initially used survey trawl was (a 3000/20-mesh "Skjervøy" trouser trawl) has from 2005 an onwards been replaced by a "Cosmos" trouser 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 low. A comparison of the catch efficiency towards cod indicates that the Cosmos trawl is ca. 1.5 times as efficient as the Skjervøy. (see NWWG 2008, WD19, Anex.). Tow duration has over the years been gradually reduced from 60 min to 30 and is now fixed at 15 min. Survey abundance and biomass is expressed per swept area: Wingspread*towed distance, where wingspread is inferred from Scanmar recordings and the towed distance is measured by GPS.

3 German Trawl survey

The survey commenced in 1982 and was designed for the assessment of cod. The surveyed area is the 0-400 m depth that is divided into 7 geographical strata and two depth zones (0-200m; 200-400m). The numbers of hauls were initially ca. 200 per year but were reduced from the early 1990s to 80-100 per year.

The surveys were carried out by the research vessel (R/V) WALTHER HERWIG (II) 1982-1993 (except 1984 throughout R/V ANTON DOHRN was used) and by R/V WALTHER HERWIG III,1994-2008. The fishing gear used was a standardized 140-feet bottom trawl, its net frame rigged with heavy ground gear because of the rough nature of the fishing grounds. A small mesh liner (10mm) was used inside the cod end. The horizontal distance between wing-ends was 25 m at 300 m depth, the vertical net opening being 4 m. In 1994, smaller Polyvalent doors (4.5 m^2, 1,500 kg) were used for the first time to reduce net damages due to overspread caused by bigger doors (6 m^2, 1,700 kg), which have been used earlier.

For historical reasons strata with less than 5 hauls were not included in the annual stock calculations op to 2008. From 2009 all valid hauls have been included and the entire time series have been corrected. I some years (notable 1992 and 1994) several strata were not covered due to weather conditions/vessel problems, implying that the survey estimate implicitly refers to varying geographical areas.

B.4. Commercial CPUE

Commercial CPUE data are available. However, due to the limited fisheries in recent years they are of little use for stock assessment.

B.5. Other relevant data

C. Historical Stock Development

XSAs were used until 1992. Some futile attempts were made during the 1990s to reassume XSA runs for the "inshore components". The attempted fix was to assume that inshore cod being equal to the catch by the coastal fleet.

Model used:

Software used:

Model Options chosen:

Input data types and characteristics:

Type	Name	Year range	Age range	Variable from year to year Yes/No
Caton	Catch in tonnes			
Canum	Catch at age in numbers			
Weca	Weight at age in the commercial catch			
West	Weight at age of the spawning stock at spawning time.			
Mprop	Proportion of natural mortality before spawning			
Fprop	Proportion of fishing mortality before spawning			
Matprop	Proportion mature at age			
Natmor	Natural mortality			

Tuning data:

Type	Name	Year range	Age range
Tuning fleet 1			
Tuning fleet 2			
Tuning fleet 3			
….			

D. Short-Term Projection

Model used:

Software used:

Initial stock size:

Maturity:

F and M before spawning:

Weight at age in the stock:

Weight at age in the catch:

Exploitation pattern:

Intermediate year assumptions:

Stock recruitment model used:

Procedures used for splitting projected catches:

E. Medium-Term Projections

Model used:

Software used:

Initial stock size:

Natural mortality:

Maturity:

F and M before spawning:

Weight at age in the stock:

Weight at age in the catch:

Exploitation pattern:

Intermediate year assumptions:

Stock recruitment model used:

Uncertainty models used:

1. Initial stock size:
2. Natural mortality:
3. Maturity:
4. F and M before spawning:
5. Weight at age in the stock:
6. Weight at age in the catch:
7. Exploitation pattern:
8. Intermediate year assumptions:
9. Stock recruitment model used:

F. Long-Term Projections

Model used:

Software used:

Maturity:

F and M before spawning:

Weight at age in the stock:

Weight at age in the catch:

Exploitation pattern:

Procedures used for splitting projected catches:

G. Biological Reference Points

H. Other Issues

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Quality Handbook **STOCK ANNEX: Icelandic summer-spawning herring**

Stock specific documentation of standard assessment procedures used by ICES.

Stock	Icelandic summer-spawning herring (Her-Va)
Working Group:	NWWG
Date:	02.05.2010
Revised by	Guðmundur J. Óskarsson

A. General

A.1. Stock definition

The Icelandic summer-spawning herring is constrained to Icelandic waters throughout its lifespan. Results from various researches including, tagging experiments around middle of last century, studies on larval transport, and studies on migration pattern and distribution, all suggest that the stock is local to Icelandic waters. No genetic studies have taken place to distinct the stock from the two other herring stocks around Iceland (Icelandic spring-spawning herring and Norwegian spring-spawning herring). The stocks are distinguished on the basis of their spawning time and spawning area, which are both represented by their naming.

A.2. Fishery

Since at least the year 2000, the herring fishery has been conducted by big vessels that in most cases have onboard both purse seines and mid-water-trawls that are used as needed in the fishery. Usually, most of the catch is taken by purse seine (ICES 2008). Bycatch in the herring fishery is normally insignificant as the fishing season is during the over-wintering period when the herring is in large dense schools.

A2.1. 1980 onwards

Until the autumn 1990, the herring fishery took place during the last three months of the calendar year. During 1990-2008 the autumn fishery continued until January or early February of the following year, and has started in September/October 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.

The number of vessels participating in the fishery has shown decreasing trend in the 2000s from around 30 down to 20 in 2007.

A2.2. Fishery regulations

The fishery of the summer-spawning herring is currently regulated by regulations set by the Icelandic Ministry of Fisheries in 2006 (no. 770, 8. September 2006). According to it, fishery of juveniles herring (27 cm and smaller) is prohibited and to prevent such a fishery, area closures are enforced.

The fishery can take place from 1st September to 31st May each fishing season (1st September-31st August) in nets, purse seines and mid-water trawls. The mid-water trawling is only allowed outside of the 12 nautical miles zones with some additional areal restrictions. Use of sorting grids in the mid-water trawls can be required in some areas, if necessary to avoid bycatch.

If nets are used in the herring fishery, the minimum mesh size (stretched) is 63 mm.

The annual total allowable catch is decided by the Ministry of Fisheries. Since 1985, the decision has more or less been based on the advices given by the Marine Research Institute, with very small discrepancy (ICES 2008).

A.3. Ecosystem aspects

A3.1. Geographic location and timing of spawning

The spawning of the stock takes place in 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. 2009a). Prior to 1998 it was mainly off the SE and E Iceland but from 1998 to 2006, the overwintering took place both off the east and west coast, with increasing proportion being in the western part. Since then (winters 2006/07 to 2009/10), most of the stock has been located in high density in coastal waters in northern part of Breidafjördur in western Iceland.

A3.2. Fecundity

A fixed maturity ogive has been used in the assessment since 2006, because of problems in estimating it annually from available data (Óskarsson and Guðmundsdóttir 2006). It was estimated that around 20% of the stock becomes mature at age 3, 85% is mature at age 4, and all older fish is mature. The fecundity is length dependent (Fecundity [$\times 10^3$] = 15.9 × Length [cm] - 382.2) where herring at average length in the catch (32 cm) spawns around 127 thousands eggs in as season and release all the eggs at once (Óskarsson and Taggart 2006).

A3.3. Diet

The variation in the diet composition of the Icelandic summer-spawning herring is poorly known due to limited examinations. The main prey is probably Calanoids (e.g. *Calanus finmarchicus*) but other zooplankton groups and species, and fish eggs and larvae could also be significant part of the diet according to preliminary research made by MRI in a small area in 2008.

A3.4. Predators

Adult herring is food resource for various animals in Icelandic waters according to various researches. The animals include mink whale (*Balaenoptera acutorostrata*), humpback whale (*Megaptera novaeangliae*), several sea bird species, cod (*Gadus morhua*) and pollack (*Pollachius virens*), but the annual consumption of herring by the different predators is relatively unknown. An increased predation of herring by cod has been observed since the *Ichthyophonus* outbreak started in the herring stock in November 2008, even if it has not been quantified.

B. Data

B.1. Commercial catch

B1.1. Landings

Information about landings of the fishery fleet are collected by the Icelandic Directorate of Fisheries. They have an access to both landings in the harbours (the official landing) and the registered catch in the digital logbook kept by all the vessels. The logbooks keep information about timing (day and time), location (latitude and longitude), fishing gear, catch size, and species composition in the catch of each fishing operation for each vessel.

Biological samples from the catch are taken at sea by the fishermen or in the harbours by people from MRI and/or inspectors from the Directorate of Fisheries and then analysed by MRI (record at least the fish length, weight, age (from scales), sex, maturation, and weight of sexual organs). The information from the samples are then used along with the total landing data and the logbook data to estimate the composition of the total landings. It includes estimating Caton (catch-in-weight), Canum (catch-at-age-in numbers), Weca (weight-at-age-in-the-catch), and length composition in the catch.

The annual estimations of the composition of the total landings (e.g. 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 fishery, the fishing gear used and intensity of biological sampling. 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 inspectors of the Directorate of Fisheries 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.

A planed re-aging of herring from the catch samples in the fishing seasons 1994/95 through 1997/98 was not finished in February 2010 and because of limited manpower at the Marine Research Institute it will be postponed further. 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.

B1.2. Discards

Discards is illegal in Icelandic waters. Normally, discards is considered to be insignificant in the fishery of Icelandic summer-spawning herring. There are few exceptions in the past 35 years where discards was estimated to be significant (1990-95; ICES 2008). These exceptions are related to large year classes being entering the fishery and juveniles have been numerous in the catch. Surveillance by inspectors from the Directorate of Fisheries during each fishing season is considered adequate in verifying if a discard is ongoing.

B.2. Biological

Natural mortality is assumed to be constant, M=0.1, for the whole range of ages and years. There are no direct estimates of M but the estimate of M=0.1 has been verified numerically by Jakobsson *et al.* (1993). They concluded, through comparison of acoustical- and VPA based stock size estimations that the assessed level of M ranged from 0.1 to 0.15.

Like mentioned above, the maturity-at-age has been assumed to be constant from 2006 and onwards (Óskarsson and Guðmundsdóttir 2006) as follows:

	Age	<3	3	4	5+
Proportion mature		0.00	0.20	0.85	1.00

Prior to 2006, the maturity-at-age was estimated from catch samples (ICES 2008).

B.3. Surveys

One survey is available and applied for assessment of the Icelandic summer-spawning herring stock. It is an acoustic research survey, which have been ongoing annually since 1974 except for the winters 1976/77, 1982/83, 1986/87, and 1994/95. These surveys have been conducted in October-December and/or January. The survey area varies spatially as the survey is focused on the adult and incoming year classes. The surveyed area is decided on the basis of all available information on the distribution of the stock in previous and the current year, which include information from the fishery. Thus, the survey area varies spatially as the survey is focused on the adult and incoming year classes. As normally practiced in acoustic surveys, trawl samples were used to get information about the schools species- and length composition.

In addition to this acoustic survey aimed at the fishable part of the stock, there have been occasionally acoustic surveys off the NW, N, and NE coast of Iceland aimed to estimate the year class strength of the juveniles. This survey has not taken place since 2003, but was partly resurrected in January 2009. The results of these measurements were normally not used in the assessment directly even if the year class indices at age-1 herring derived from the survey have shown a significant relationship to recruitment of the stock (Gudmundsdóttir *et al.* 2007).

B.4. Commercial CPUE

Not considered relevant to the assessment because of the nature of the fishery and the continuous development the vessels and the equipment used in the fishery.

B.5. Other relevant data

None

C. Historical Stock Development

The summer-spawning herring stock collapsed in late 1960s due to overfishing and environmental changes (Jakobsson *et al.* 1993). The spawning stock has increased from about 10 thous. tonnes in 1972 to about 700 thous. tonnes around the middle of the 2000s.

During the recovery period, the assessments were based on acoustic surveys. These surveys, during the early and mid-1970s, were considered very uncertain. During late 1980s and early 1990s the assessment tool used was a homemade Adapt type of VPA. The stock was consistently overestimated during the late 1980s and the early 1990s. The difference between the acoustic values and those obtained from VPA was about 30%. The most likely cause of this error was considered to be the use of too low target strength (TS) values in the acoustic surveys (Jakobsson *et al.*, 1993). The TS value was raised about 30% or to similar value as used for other herring stocks in the NE Atlantic and the old acoustic values in the tuning file corrected. Until 2002 the homemade Adapt-type of VPA was used for the final assessment of the Icelandic summer-spawning herring stock. Assessment tools like XSA and AMCI were run along as well for some years. In 2003-2004, AMCI runs were accepted as the final assessment. NFT-Adapt, which was first applied in the 2004 assessment, has been the main assessment tool since 2005, even if it was first in 2008 accepted as the final assessment. Both TSA (Gudmundsson, 1994) and XSA have been run along with NFT-Adapt for comparisona as alternative tools. In all these assessments, one sided retrospective pattern is seen, especially in the years 2002-2005, but it has diminished in the last years. The reasoning for this pattern is not known.

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 from 1997 to 2006 around 20-60% of the catch was taken by pelagic trawl; (4) the reduction of the part of the stock that was acoustically measured east of Iceland.

A benchmark assessment has not taken place but detailed examination has taken place during some working group meetings.

Model used: Age structured

Software used: 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 1994).

Model Options chosen: The model options differ slightly between years, but are given in tables or text in the WG assessment reports (e.g. ICES 2008).

Input data types and characteristics:

Type	Name	Year range	Age range	Variable from year to year Yes/No
Caton	Catch in tonnes	1947-last data year	2-15+	Yes
Canum	Catch at age in numbers	1947-last data year	2-15+	Yes
Weca	Weight at age in the commercial catch	1947-last data year	2-15+	Yes
West	Weight at age of the stock .	1947-last data year	2-15+	Yes
Mprop	Proportion of natural mortality before spawning	1947-last data year	2-15+	No –set to 0.5 for all ages in all years
Fprop	Proportion of fishing mortality before spawning	1947-last data year	2-15+	No –set to 0 for all ages in all years
Matprop	Proportion mature at age	1947-last data year	2-15+	No- since 2005 set 0.2 for age-3 and 0.85 for age-4
Natmor	Natural mortality	1947-last data year	2-15+	No – set to 0.1 for all ages in all years*

*Because of the *Ichthyophons* outbreak in the stock, M that accounted for the mortality caused by the infection (0.39) was added to 0.1 for the year 2009, giving M=0.49.

Tuning data:

Type	Name	Year range	Age range
Tuning fleet 1	Acoustic survey	1974-last data year	2-15+
Tuning fleet 2			
Tuning fleet 3			
….			

D. Short-Term Projection

Model used: Age structured

Software used: An Excel spreadsheet prepared in MRI, which has been compared to results from a Fortran script used at MRI for years for herring and other species, and they have giving identical results.

Initial stock size: Taken from NFT-Adapt in most recent years. The number of the youngest age-classes in the projection (age-3) is set as the geometrical mean for age-3 over the last 20 years, because no estimate exits.

Maturity: The same ogive as in the assessment for the year 2006 to present.

Natural mortality: Set to 0.1 for all ages in all years

F and M before spawning: Set to 0 for F and to 0.5 for M.

Weight at age in the stock: Normally based on simple three years means but sometimes on last year weights (e.g. ICES 2008), following an examination.

Weight at age in the catch: Same as used for the stock

Exploitation pattern: Average of five last years for age-3 and 4, but set 1.0 for age-5+.

Intermediate year assumptions: Not relevant

Stock recruitment model used: Geometrical mean for age-3 is used to determine the recruitment

Procedures used for splitting projected catches: Not relevant

E. Medium-Term Projections

Medium-term projection has not been completed in recent assessments for this stock. The reliance of the fishery on intermittent large year-classes, and the fluid nature of the fishery and related assessment, make the usefulness of medium-term projections questionable.

F. Long-Term Projections

It has not been completed in recent assessments.

G. Biological Reference Points

The Working Group have pointed 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 (ICES 2008). 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 now in February 2009.

The fishing mortality during 1990 to 2007 has been on the average 0.308 (ICES 2008) 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}.

H. Other Issues

In November 2008, an *Ichthyophonus hoferi* infection was observed in the Icelandic summer-spawning herring. A massive research program was launched immediately to quantify the infection rate and the results indicated that this was a massive outbreak (Óskarsson *et al.* 2009b). Around 32% of the adult stock was estimated to be infected, which is all believed to die because of it within few months. Infection was also observed in juveniles (year classes 2006 and 2007) at the main nursery grounds west and north of Iceland, except for the visited location furthest east (Skjálfandi) where most of the 2007 year class was found.

In the winter 2009/2010, a high prevalence of the infection was observed again, or on average 43% (Óskarsson et al. 2010). There is a large uncertainty regarding the development of the infection and if it will continue to infect the stock in the spring and summer 2010. The literature implies that *Ichthyophonus* outbreaks in herring last often for two years, so a decrease in the infection can be expected in the stock in the coming year. It will be examined as needed.

Another source of uncertainty regarding the infection relates to the period prior to the autumn 2008. Information given by fishermen in the autumn 2008, indicates that they had started to observe infected herring already in the winter 2007/08. MRI did not have any information about it at that time and were not running a program to determine *Ichthyophonus* infection. Thus, the magnitude of infection prior to the autumn 2008 is unknown and thereby the additional natural mortality rate related to the infection.

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. In earlier times, the fleet consisted of multi-purpose vessels, mostly under 300 GRT, operating purse-seines and driftnets. In recent 20 years, larger vessels (up to 1500 GRT) have been entering the fishery, and today they represent the whole herring fishing fleet. 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 contributed to around 20–60% of the catches for several years, but to less than 5% in most recent years.

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Quality Handbook **Stock Annex – Cod in Icelandic waters (Division Va)**

Stock specific documentation of standard assessment procedures used by ICES.

Stock	Cod in Icelandic waters (Division Va)
Working Group:	NWWG
Date:	May 2010
Revised by:	Einar Hjörleifsson

A. General

A.1. Stock definition

Not completed, see annual report.

A.2. Fishery

Annual landings and overview of the major fleets

Annual estimates of landings of cod from Icelandic waters are available since 1905 (Figure A.2.1). The historical information are largely derived from Statistical Bulletin, with unknown degree of accuracy. The more recent landings (from 1980 onwared) statistics are from the Directorate of Fisheries as annually reported to ICES.

After WWII the fishery was initially dominated by foreign fleets, mainly English and German trawlers. The former were primarily targeting cod and catching saithe as a bycatch, while the latter were more directly targeting saithe as well as redfish. The domestic fleet has more or less been the sole exploiter of the cod resource since 1978, following the expansion of the Icelandic EEZ from 50 to 200 miles in 1975.

Information on landings of the Icelandic fishing fleet by fishing gear is available since 1974, with the exception of the years 1979-1981. Largest portion of the catch is taken by trawl, with gillnet fisheries playing a secondary role. The importance of the gillnet fisheries has declined, being between 13-43 % in the period 1974-1995, but only around 10% of the total landings since then.

Attempts have been made at estimating discarding in the Icelandic fisheries since 2001 (Pálsson et al. 2008) based on a method using length measurements taken by observers on-board and measurements taken of landed fish. Discarding of cod is hardly detectable, while that observed e.g. for haddock has been around 8% of landings in numbers.

Management

The fisheries in Icelandic waters have since 1984 been managed under a TAC system, where each boat owns a certain percentage of the TAC. The management year is from start of September to end of. August in the following year. The system is an ITQ system, allowing free transferability of quota between boats. This transferability can either be on a temporary (one year leasing) or a permanent (permanent selling) basis. This system has resulted in boats having quite diverse species portfolios, with companies often concentrating/specializing on particular group of species. The system allows for some but limited flexibility with regards converting a quota share of one species into another within a boat, allowance of landings of fish under a certain size without it counting fully in weight to the quota and allowance of transfer of un-fished quota between management years. The objective of these measures is to minimize discarding, which is effectively banned. Landings in Iceland are restricted to particular licensed landing sites, with information being collected on a daily basis time by the Directorate of Fisheries (the native enforcement body). All fish landed has to be weighted, either at harbour or inside the fish processing factory. The information on landing is stored in a centralized database maintained by the Directorate and is available in real time on the internet (www.fiskistofa.is). Insignificant amount of the saithe caught in Icelandic waters is landed in foreign ports. The accuracy of the landings statistics are considered reasonable although some bias is likely.

All boats operating in Icelandic waters have to maintain a log-book record of catches in each haul. The records are available to the staff of the Directorate for inspection purposes as well as to the stock assessors at the Marine Research Institute.

A system of instant area closure is in place for many species, including cod. The aim of the system is to minimize fishing on smaller fish. For cod, an area is closed temporarily (for 3 weeks) for fishing if on-board inspections (not 100% coverage) reveal that more than 25% of the catch is composed of fish less than 55 cm in length. No minimum landing size of any fish species exist in Icelandic waters. The minimum allowable mesh size is 135 mm in the trawl fisheries, with the exception of targeted shrimp fisheries in waters north of the island.

The Marine Research Institute has issued a recommended annual TAC since 1984, with advice also given by ICES. The set TAC has often been set higher than the advice and but with the implementation of a HCR landings have been xx

A.3. Ecosystem aspects

B. Data

B.1. Commercial catch

Sampling from the Icelandic fleet

The sampling protocol by the staff of the Marine Research Institute has in the last years been linked to the progression of landings within the year. The system is fully computerized (referred to as "Sýnó" by the natives) and directly linked to the daily landings statistics available from the Directorate of Fisheries. For each species, each fleet/gear and each landing strata a certain target of landings value behind each sample is pre-specified. Once the cumulative daily landings value pass the target value an automatic request is made to the sampling team for a specific sample to be taken. The system as such should thus take into account seasonal variability in the landings of any species. The sampling design is not per se linked to the geographical distribution of the fisheries. However the fishing location of the fish measured at harbour is known with reasonably accuracy, because fishing date is registered for each fish boxes and can hence be linked to geographic location of the fishing at that date, based on the captain's log-book record.

Calculation of catch in numbers

The calculation of the annual catch in number of the Icelandic cod has since 1980 been based on only 8 metiers, two areas, 4 gears and 2 seasons. For the cod the length distribution are compiled into bins of 5 cm and used as such in the length age key. The parameters used to convert length to weights are:

Cond = 0.024498

Power = 2.7567

Otherwise the calculations of calculation of annual catch in number and weight at age for cod have since 1980 been calculated in the same way as was done for other species assessed by age based methods at the Marine Research Institute. What follows is a general description of the algorithm used in the calculations in the unix software package (referred to as PAX: "Poplulation Assessment in uniX"):

PAX is a menubased system where one has among other things the options of fetching data from a centralized database; calculate catches in numbers; make cpue indices and run a vpa program. It was first written late eighties and has been updated several times since then. Most of the modules in the system are prelude shellscrips which are run in unix/linux. Now the most used unit is the catches in numbers calculations. That module will be described here.

Catch in numbers are calculated for each area, a sason and a gear combination and then combined to total catches in numbers over all areas, seasons and gears.

Length distributions

Data used are length frequency samples taken in area **r**, season **t** and gear **g**.

L_l is the number of fishes at length l.

One has the option to run the length distributions on 1 cm or 5 cm basis. If the latter one is chosen, a temporary variable *lemultfj* is assigned the value $l * L_l$ to be able to calculate the correct mean length in the length distribution. Then the grouping in 5 cm intervals is done in the way that the numbers get the middle value from the interval. As an example the values in the range 10-14 and 15-19 are assigned 12 and 17 respectively. Lengths are then in fact either

$$l \in \{1,2,3,...\} \, or \; l \in \{2,7,12,17,...\}$$

Age-length and maturity keys

Data used are age-determined data from otolith samples in area **r**, season **t** and gear **g**. If no otolith samples exist from this area, season and gear combination, they have to be borrowed from other season or gear for the same area or from other areas.

K_{la} is the number at length l and at age a, a>0.

M_{la} is the number mature at length l and at age a, a>0.

IM_{la} is the number immature at length l and at age a, a>0.

A fish is assigned to IM_{la} if is has a maturity value 1 in the database otherwise it is assigned to M_{la} .

Multiply the age-length and maturity keys with the length distribution

Sum of the numbers at length l over all ages:

$$K_{l.} = \sum_a K_{la}$$

Make a new key with the number of fishes:

$$C_{la} = \frac{K_{la}}{K_{l.}} \cdot L_l$$

And new maturity keys:

$$CM_{la} = \frac{M_{la}}{M_{la} + IM_{la}} \cdot C_{la} \text{ and } CIM_{la} = \frac{IM_{la}}{M_{la} + IM_{la}} \cdot C_{la}$$

Average length and weight

In this step average length and weight at age are calculated. For each area, season and gear the condition factor (*cond*) and the power (*power*) in a length-weight relationship are input data.

$$\tilde{w}_{la} = C_{la} \cdot cond \cdot \exp(power \cdot \log(l)) \text{ (the weight in each cell)}$$

$$\tilde{l}_{la} = C_{la} \cdot l$$

Note that in the above 2 equations l is a midpoint if 5 cm grouping has been chosen.

The total frequency in the key is:

$$C_{..} = \sum_l \sum_a C_{la}$$

and total weight

$$\tilde{w}_{..} = \sum_l \sum_a \tilde{w}_{la}$$

So the mean weight in this area, season and gear combination is

$$\overline{w} = \frac{\tilde{w}_{..}}{C_{..}}$$

The ratio of weight and number by age from the total:

$$ratio\_w_a = \sum_l \tilde{w}_{la} / \tilde{w}..$$

$$ratio\_C_a = \sum_l C_{la} / C..$$

The mean weight and mean length at age and ratio mature at age are:

$$\overline{w}_a = \frac{\sum_l \tilde{w}_{la}}{\sum_l C_{la}}$$

$$\bar{l}_a = \frac{\sum_l \tilde{l}_{la}}{\sum_l C_{la}}$$

$$ratio\_M_a = \frac{\sum_l CM_{la}}{\sum_l (CM_{la} + CIM_{la})}$$

if the denominator > 0 otherwise the *ratio_M_a is set to -1.*

Catches in numbers

Input data for this module is the landings in tons (*catch*) for each area, season and gear.

The total number of fishes caught are:

$$C_{tot} = \frac{catch}{\overline{w}}$$

The catches in numbers and weight by age is then

$$C_a = C_{tot} \cdot ratio\_C_a$$
$$W_a = C_a \cdot \overline{w}_a$$

To derive the total catches in numbers and weight summation is done over all areas, seasons and gears.

B.2. Biological

A fixed natural mortality of 0.2 is used both in the assessment and the forecast.

The proportion of natural mortality before spawning (Mprop) and the proportion of fishing mortality before spawning (Fprop) are set to 0.

Weight at age in the stock is assumed to be the same as in the landings. For predicting next year's weights the catch weights from last year are used. If a large year class occurs having a low mean weight account should be taken in the short term predictions.

Maturity at age is based on measurements obtained in the Icelandic groundfish spring survey (Figure B.2.1) using a smother (see below). Spawning of saithe starts late January with a peak in February, just before the survey time. The survey time is thus close to the spawning time making visual detection of maturity stages optimal. Maturity at age data from surveys are considered to give better estimates of maturity at age in the stock than those from landings data, in particular because of limited ungutted samples in the landings (figure B.1.2).

Since the annual survey estimates of maturity at age are very noisy (figure x) a model to smooth the maturity data is used. All fishes at age 10 and older are set as mature. The model fitted (using Splus) is:

logit(Pa,t) = $\alpha + \beta$ s(age,df=4) + ns(year,df=6)

where P is the proportion mature at age a in year t. S and ns are smoothing splines used to increase the flexibility of the model. Results for two age groups, 5 and 7, are shown in Figure B2.2 along with the mean proportion mature for the same age groups from the survey data.

B.3. Surveys

An account of the Icelandic March (Spring, 1985-onwards) and October (Fall, 1996-onwards) groundfish surveys were provided as a WD for the Benchmark 2010 (WD-03). The WD is a translation of a citable report (http://www.hafro.is/Bokasafn/Timarit/rall_2007.pdf) written in the native language. It will be formally published in non-native speaking language in fall 2010. In summary, the surveys design is a classical random stratified design with fixed stations with time. With the caveat that experienced captains given the freedom to choose particular stations within a certain predefined geographical contraint determined by the scientist. The number of stations in the spring survey are 530, the number of stations in the fall are 380. The spring survey covers depth to 500 meters, but the fall survey covers depths down to 1200 m.

B.4. Commercial CPUE

Catch per unit of effort are routinely calculated during the annual assessment process. However, the cpue for Icelandic cod has not been considered a reliable unbiased index to be used quantitatively as a tuning series in an analytical model.

C: Modelling framework

The model used is a forward running statistical catch at age model. The fishing mortality is allowed to deviate from separability using a random walk penalty in the objective function. The software used is ADMODEL builder, adapted to the cod by Höskuldur Björnsson, MRI. The source code and an LINUX executable version are stored by ICES. The model is set up so that both stock assessment and predictions are run at the same time. The code is to a large extent the same as is used for Icelandic saithe and Haddock and that used by ICES for the HCR evaluation of Icelandic cod in December 2009. However in these cases the separability was assumed.

Operating model

The operating model is the virtual world, which is supposed to reflect the true system in the evaluation framework. The virtual world here is very simple with constant M, no length based parameters etc.

The biological model is a simple single-species age structured population following the classical exponential stock-equation:

$$N_{a+1,y+1} = N_{ay} e^{-(F_{ay}+M_{ay})}$$

The age groups in the model are 1 to 14 years with age 3 the youngest age in the landings.

Migration events are estimated at specific year and ages and are then added to the number in stock in the beginning of the year. The size of migration events is estimated as an additional parameter, equivalently as annual recruitment estimates.

Catches are taken according to the catch-equation:

$$\hat{C}_{ay} = \frac{F_{ay}}{F_{ay} + M_{ay}} \left(1 - e^{-(F_{ay}+M_{ay})}\right) N_{ay}$$

$$\hat{C}_y = \sum_a \hat{C}_{a,y} W^c_{a,y}$$

In the separable module the fishing mortality by year and age is modelled as:

$$F_{ay} = s_a F_y$$

The selection pattern of ages 11-14 is assumed to be identical and defined as 1. For Icelandic cod a random walk constraint in the fishing mortality between Fay and Fay-1 is implemented as a part of the objective function (see below).

Spawning stock is calculated by first calculating the total mortality before spawning $pZ_{y,a} = pM_aM_{y,a} + pF_aF_{y,a}$

The values pM_a and pF_a are input from file and describe proportion of M and F before spawning. The spawning stock is then calculated by

$$SSB_y = \sum_a N_{y,a} W_{y,a}^{ssb} \; p_{y,a} \; e^{-pZ_{y,a}}$$

where $p_{y,a}$ is the proportion mature by year and age.

Reference biomass is calculated from

$$B_y^{ref} = \sum_{a=4}^{a=14} N_{ay} W_{ay}^c$$

where W_{ay}^c are the mean weight at age in the landings.

Observation model and objective functions

The model parameters are estimated by minimizing a negative log-likelihood that is the sum of 4 components..

1) Landings in numbers.

$$\Psi_1 = \sum_{a,y} \frac{\log \dfrac{C_{ay} + \delta_a}{\hat{C}_{ay} + \delta_a}}{2(\Omega_1 \sigma_a)^2} + \log(\Omega_1 \sigma_a)$$

where Ω_1 is an estimated parameter but the pattern of the measurement error with age σ_a is read from the input files. The values δ_a are input from file. They are supposed to reflect the value where the error goes from being lognormal to multinomial. Typical value could be corresponding to 5 otoliths sampled.

2) Landings in tonnes.

$$\Psi_2 = \sum_{a,y} \frac{\log \dfrac{C_y}{\hat{C}_y}}{2\Omega_2^{\,2}} + \log \Omega_2$$

where C_y are the "real" landings in tonnes in year y, $\hat{C}_y$ the modelled landings and Ω_2 the assumed standard error of the landings. The value of 0.05 was used for Ω_2 in these runs. The likelihood component Ψ_2 is somewhat redundant as it is already incorporated in Ψ_1. Leaving Ψ_2 out will on the other hand lead to unacceptable deviation between observed and predicted landings in numbers.

3) Survey abundance in numbers.

Initially the survey likelihood was calculated by.

$$\Psi_3 = \sum_{a,y} \frac{\log \frac{I_{ay} + \delta_a^s}{\hat{I}_{ay} + \delta_a^s}}{2(\Omega_3 \sigma_a^s)^2} + \log(\Omega_3 \sigma_a^s)$$

were Ω_3 is an estimated parameter but the pattern of the measurement error with age σ_a^s is read from the input files. The values δ_a^s are input from file and are similar to δ_a in Ψ_1. The predicted survey numbers $\hat{I}_{ay}$ are calculated from the equation $\hat{I}_{ay} = q_a N_{ay}^{b_a}$. The parameters q_a are estimated. The parameters b_a are set to one for age 6 and older but estimated for the younger age groups. The estimated values b_a increase with decreased age.

For Icelandic cod some year effects are apparent in the survey (although not as pronounced as for the Icelandic saithe and haddock) and were taken into account by modelling the survey residuals by a multivariate normal distribution.

$$\Gamma = \log \frac{I_{ay} + \delta_a^s}{\hat{I}_{ay} + \delta_a^s}$$

a=1:10 is the vector of survey residuals in a given year. Hence the likelihood equation above is replaced with:

$$\Psi_3 = 0.5 \sum_y \log\det\Theta_6 + \Gamma_y{}^T \Theta_6^{-1} \Gamma_y$$

The matrix Θ_6 is calculated from the equation. $\Theta_{6ij} = \Omega_3^2 \sigma_i^s \ \sigma_j^s \ \kappa^{abs(i-j)}$ where κ is an estimated parameter and the parameters Ω_3 and σ_a^s are explained above. When the value κ is high the equation approaches modelling the survey indices as a year factor.

When both surveys are included in the tuning the second survey is treated similar as above.

4) Random walk constraint on fishing mortality.

$$\Psi_4 = \sum_{y,a} \frac{\log F_{y+1,a} - \log F_{y,a}}{2\sigma_{1,a}^2} + \log \sigma_{1,a}$$

This likelyhood component is actually modelled using multivariate normal distribution taking into account positive correlation of changes in fishing mortality of adjacent age gorups (similar as is done in the survey estimates).

5) Stock – recruitment parameters.

$$\Psi_5 = \sum_{a,y} \frac{\log \frac{N_{1y}}{\hat{N}_{1y}}}{2\Omega_4{}^2} + \log \Omega_4$$

where $\hat{N}_{1y}$ is the estimated recruitment from a stock –recruitment function and Ω_4 is an estimated parameter. Ω_4 can be set as a function of SSB, often increasing with smaller SSB.

The stock recruitment models used in the HCR evaluation were either constant recruitment or Hockeystick recruitment using the yearclasses 1985 onward, with the breakpoint estimated.

5) Overall objective function

The total objective function to be minimized is ρ is in used to in a first order AR model in future predictions. The estimated value is 0.45 and inclusion of it does not have much effect on the outcome of prognosis.

$$\Psi = \sum_{i=1}^{i=5} \Psi_i$$

Parameter estimated

The estimated parameters in most of the runs are

Number of age 1 cod 1956-onwards.

Initial number in each age group (usually in 1955).

Migration events (from Greenland) 12 events since 1955, the last three at age 7 in 1981 and at age 6 in 1990 and 2009.

Parameters of the stock recruitment function (2-4 depending on the function used). In addition CV in the stock recruitment function is estimated.

Catchability and power for the survey q_a for ages 1-10 and b_a for ages 1-6 and 3 CV parameters Ω_1 Ω_3 and Ω_4 for those components of the objective function. The catchability for age group 1 is estimated for the period 1985-2000 and 2001 onwards.

After the estimation is done the estimated variance-covariance matrix was used as proposal distribution in MCMC simulations (see Admodel builder manuals). The number of runs was between 300 000 and 1 000 000 and the parameters values were saved every 250th or 500th time. The saved chain was then used in prediction.

Prediction model

Natural mortality was fixed at 0.2.

Maturity at age is fixed to the recent values.

Future weight at age in the stock (W^s_{ay}) ,the catch (W^c_{ay}) and spawning stock (W^{ssb}_{ay}) are modelled as:

$$W^s_{ay} = \hat{W}^s_{ay} e^{E^w_y}$$

$$W^c_{ay} = \hat{W}^c_{ay} e^{E^w_y}$$

$$W^{ssb}_{ay} = \hat{W}^{ssb}_{ay} e^{E^w_y}$$

where,

$$E_y^w = \left(\rho_w E_{y-1}^w + \sqrt{1-\rho_w^{\,2}}\,\varepsilon_y\right)$$

$$\varepsilon_y = N(0,1)$$

The error in the weight at age in landings and reference stock in the assessment year is assumed to be 1/3 of the modelled value as the existing survey weights in the assessment year are used to predict the catch weights.

The mean values of $\hat{W}_{ay}^{s}$, $\hat{W}_{ay}^{c}$ and $\hat{W}_{ay}^{ssb}$ are read from file.

In the prediction recruitment is generated by the estimated stock-recruitment function. Added to the estimated recruitment is random lognormal noise with CV estimated in by the assessment part of the model. Uncertainty in the stock – recruitment parameters can be an important part of the total uncertainty in the prediction.

Assessment error is modelled as autocorrelated lognormal noise as done for the stochasticity in weight.

$$\tilde{B}_y^{ref} = B_y^{ref} e^{E_y^b}$$

where

$$E_y^b = \left(\rho E_{y-1}^b + \sqrt{1-\rho^2}\,\varepsilon_y\right)$$

The TAC for the next fishing year (y/y+1) is then calculated by

$$Tac_{y/y+1} = \left(\frac{Tac_{y-1/y+}R\tilde{B}_y^{ref}}{2}\right)$$ where R is the harvest ration (0.2).

No implementation error is included in the simulations so

$$C_{y/y+1} = Tac_{y/y+1}$$

Transferred to calendar years 1/3 of the TAC for the fishing year y/y+1 is put on calendar year y and 2/3 on calendar year y+1. Therefore $C_y = \frac{2}{3}C_{y-1/y} + \frac{1}{3}C_{y/y+1}$

The above implementation means that error in estimation of SSB is taken into account, when fishing mortality is underestimated and vice versa. The ultimate goal in using this assessment framework is to implement HCR based on biomass that leads to a definition of target fishing mortality in relation to the ICES Fmsy concept. Given that uncertainity in the assessment and the short term prediction is already taken into account, the estimates of the Fmsy proxy derived here are not comparable with that derived from a deterministic approach.

Input data types and characteristics:

Type	Name	Year range	Age range	Variable from year to year Yes/No
Caton	Catch in tonnes	1955-onward		Yes
Canum	Landings at age in numbers	1955-onward	3-14	Yes
Weca	Weight at age in the commercial catch	1955-onward	3-14	Yes
West	Weight at age of the reference stock.	1955-onward	4-14	Yes.
WeSSB	Weight at age from the survey	1955-onward	3-14	Yes
Mprop	Proportion of natural mortality before spawning	1955-onward	3-14	No
Fprop	Proportion of fishing mortality before spawning	1955-onward	3-14	No
Matprop	Proportion mature at age in the survey	1955-onward	3-14	Yes
Natmor	Natural mortality	1955-onward	3-14	No, kept fixed at 0.2.

Tuning data:

Type	Name	Year range	Age range
Tuning fleet 1	Icelandic spring groundfish survey	1985-onward	1-10
Tuning fleet 2	Icelandic fall groundfish survey	1996-onward	1-10

Note Tuning fleet 2 was part of the final run in the 2010 assessment.

D. Short-Term Projection

Model used/software used: The same software is used for forward projections as the assessment. Additionally an Excel spreadsheet is used to calculate an F-option table.

E. Medium-Term Projections

Model used/software used: The same software is used for forward projections as the assessment.

F. Long-Term Projections

Model used/software used: The same software is used for forward projections as the assessment.

G. Biological Reference Points

	Type	Value	Technical basis
Precautionary approach	B_{lim}	125 Kt.	B_{loss} estimated in 2010
	B_{pa}	Not defined	
	F_{lim}	Not defined.	
	F_{pa}	Not defined	
Targets	F_y		$TAC_{y/y+1} = \frac{TAC_{y-1/y} + 0.2B_y}{2}$

I. References

Quality Handbook Stock Annex – Saithe in Icelandic waters (Division Va)

Stock specific documentation of standard assessment procedures used by ICES.

Stock Saithe in Icelandic waters (Division Va)

Working Group: NWWG

Date: 16.2 2010

Revised by: Asta Gudmundsdottir, Einar Hjörleifsson, and Höskuldur Björnsson.

A. General

A.1. Stock definition

Saithe in Icelandic waters (Division Va) is managed as a one unit, though taggings have shown that in some years saithe migrates from distinct waters into Icelandic waters and vice versa. Saithe is both demersal and pelagic. They can be found all around Iceland, but are most common in the warm waters south and southwest off Iceland. Spawning starts late January with a peak in February in shallow water (100-200 m) off the southeast, south and west coast of Iceland. The main spawning area is considered to be south/southwest off Iceland (Selvogsbanki, Eldeyjarbanki). The larvae drift clockwise all around Iceland and mid June juveniles can be found in many coves, bays and harbours then about 3-5 cm long. At age 2 they move to deeper waters in winter. Saithe becomes mature at age 4-7.

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-SENE gradient, migration of e.g. northeast arctic saithe to Icelandic waters will, theoretically, be detectable as a reduction in size at age in the Icelandic saithe catches. 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 recent 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 or around 2.5% of the recaptures outside the management area of the stock. Most were tagged at eastern localities. and recaptured in Faroes waters, with a pulse of tags recovered in early 2006. Other foreign returns have come from areas west of Scotland and east of Greenland. Figure A.1.1 shows the total returns from this tagging program (2007 ICES NWWG).

A.2. Fishery

Annual landings and overview of the major fleets

Annual estimates of landings of saithe from Icelandic waters are available since 1905 (Figure A.2.1). The historical information are largely derived from Statistical Bulletin, with unknown degree of accuracy. The more recent landings (from 1980 onward) statistics are from the Directorate of Fisheries as annually reported to ICES.

After WWII the fishery was initially dominated by foreign fleets, mainly English and German trawlers. The former were primarily targeting cod and catching saithe as a bycatch, while the latter were more directly targeting saithe as well as redfish. The domestic fleet has more or less been the sole exploiter of the saithe resource since 1978, following the expansion of the Icelandic EEZ from 50 to 200 miles in 1975.

Information on landings of the Icelandic fishing fleet by fishing gear is available since 1974, with the exception of the years 1979-1981 (figure A2.2). Largest portion of the catch is taken by trawl, with gillnet fisheries playing a secondary role. The importance of the gillnet fisheries has declined, being between 13-43 % in the period 1974-1995, but only around 10% of the total landings since then.

Information from captains logbook records, available since 1991 show that gillnet and trawl fisheries are of mixed nature (see WD 04). Between 40-80% of the annual bottom trawl landings based on hauls where saithe is reported as catch constitutes 75% or more of the catches. During the 1990's an increasing portion of the total annual saithe trawl landings was taken as bycatch, with the trend somewhat reversing in the since then. The less important gillnet fishery in terms of landings are somewhat more of a mixed mixed species fisheries compared with the trawl fishery. Here between 20-80% of annual gillnet catches are from settings where saithe constitutes 75% or more of the catches. Relatively speaking the gillnet fishery became more of a bycatch fisheries in 1996-2006 compared with that observed in the 1991-1995 (in a period when catches were higher). Since 2003 until 2008 the gillnet fishery, according to the logbook records have become increasingly a targeted fishery.

In the pelagic fishery a small amount of by-catch of saithe (~1%) has been reported in the blue whiting fishery in the Icelandic EEZ (NWWG report in 2009).

Attempts have been made at estimating discarding in the Icelandic fisheries since 2001 (Pálsson et al. 2008) based on a method using length measurements taken by observers on-board and measurements taken of landed fish. Discarding of saithe is hardly detectable, while that observed e.g. for haddock has been around 8% of landings in numbers.

Spatial and temporal distribution catches

The saithe fishery in Icelandic waters is largely limited to the southern and western shores of Iceland (figure A2.3), with an increase in share of the catches taken in the southeast and in the northwest relative to that obtained in the southwest (WD 04). The gillnet fishery occurs over a relatively narrower geographic range and in shallower water relative to the bottom trawl fishery. The saithe fishery takes place more or less continuously throughout the whole year, although catches in November through January tend to be lower than in other months, and somewhat higher in March.

Fleet composition

The fishing fleet operating in Icelandic waters consists of a diverse boat types and sizes, operating various types of gear. The largest share of the saithe catches (76% in 2008) are taken with trawler larger than 40 BRT. The bulk of the gill net catches are taken by 13 boats in the size classes 30-41 BRT. The top 50 trawler and boats took around 85% of the total saithe catch in 2008. The remainder of the saithe catch come from myriads of smaller boats, using handlines, jigging and Danish seine. These boats are largely targeting cod, haddock and flatfishes with saithe being only a bycatch.

Management

The fisheries in Icelandic waters have since 1984 been managed under a TAC system, where each boat owns a certain percentage of the TAC. The management year is from start of September to end of. August in the following year. The system is an ITQ system, allowing free transferability of quota between boats. This transferability can either be on a temporary (one year leasing) or a permanent (permanent selling) basis. This system has resulted in boats having quite diverse species portfolios, with companies often concentrating/specializing on particular group of species. The system allows for some but limited flexibility with regards converting a quota share of one species into another within a boat, allowance of landings of fish under a certain size without it counting fully in weight to the quota and allowance of transfer of un-fished quota between management years. The objective of these measures is to minimize discarding, which is effectively banned. Landings in Iceland are restricted to particular licensed landing sites, with information being collected on a daily basis time by the Directorate of Fisheries (the native enforcement body). All fish landed has to be weighted, either at harbour or inside the fish processing factory. The information on landing is stored in a centralized database maintained by the Directorate and is available in real time on the internet (www.fiskistofa.is). Insignificant amount of the saithe caught in Icelandic waters is landed in foreign ports. The accuracy of the landings statistics are considered reasonable although some bias is likely.

All boats operating in Icelandic waters have to maintain a log-book record of catches in each haul. The records are available to the staff of the Directorate for inspection purposes as well as to the stock assessors at the Marine Research Institute.

A system of instant area closure is in place for many species, including saithe. The aim of the system is to minimize fishing on smaller fish. For saithe, an area is closed temporarily (for 3 weeks) for fishing if on-board inspections (not 100% coverage) reveal that more than 25% of the catch is composed of fish less than 55 cm in length. No minimum landing size of any fish species exist in Icelandic waters. The minimum allowable mesh size is 135 mm in the trawl fisheries, with the exception of targeted shrimp fisheries in waters north of the island.

The Marine Research Institute has issued a recommended annual TAC since 1984, with advice also given by ICES since 1987. The set TAC has often been set higher than the advice and no formal harvest control rule exists for this stock. The landings (by quota year) have in 6 out of 25 years exceeded the national TAC by more than 10%. With the exception of 1995/96 the landings in other years have been closed to or lower than the national TAC.

A.3. Ecosystem aspects

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.

Significant changes in the length and weight at age have been observed in the Icelandic saithe. It is unknown if these factors are fisheries or environmentally driven.

B. Data

B.1. Commercial catch

Sampling from the Icelandic fleet

Sampling of size and age composition of saithe in the Icelandic fisheries only started in 1974 (Figures B.1.1 and B.1.2). In the years 1974 to 1977, the sampling was rather limited, with less than 50 independent samples taken each year. Thereof otoliths were taken in 15 samples or less, annually. In the years 1978 and 1979 a significant sampling occurred from the fisheries, with the primary objective to establish the relationship between length and weight. Since 1980 regular sampling, with the objective to calculate annual catch in number has taken place. During 1980-1998 the number of independent samples were 50-100 per year but have increased significantly in recent years being above 200 in the last four years. This increase is in part due to random samples taken by the staff of the Directorates of Fisheries, partly aimed at studying potential discarding.

Over the period the 1980-1998 the number of length measurements in each sample was around 200. Thereof, 100 fish were sampled for otoliths/age. In 1999 there was a change in the protocol within each sample, where the number of fish measured was reduced to 150, with 50 fish being weighted and sampled for otoliths. This did not result in fewer individuals being sampled, due to the increase in the sampling intensity that occurred at the same time. Systematic gutted weight measurements of fish sampled for otoliths commenced in 1995.

The sampling protocol by the staff of the Marine Research Institute has in the last years been linked to the progression of landings within the year. The system is fully computerized (referred to as "Sýnó" by the natives) and directly linked to the daily landings statistics available from the Directorate of Fisheries. For each species, each fleet/gear and each landing strata a certain target of landings value behind each sample is pre-specified. Once the cumulative daily landings value pass the target value an automatic request is made to the sampling team for a specific sample to be taken. The system as such should thus take into account seasonal variability in the landings of any species. An overview of the cumulative landings of the saithe and the cumulative sampling of saithe seem to be in reasonable sync (Figure B.1.3), although there seem to be lesser sampling intensity in the summer months, possibly associated with summer holiday of the staff. The sampling design is not per se linked to the geographical distribution of the fisheries. However the fishing location of the fish measured at harbour is known with reasonably accuracy, because fishing date is registered for each fish boxes and can hence be linked to geographic location of the fishing at that date, based on the captain's log-book record. An overview of the sampling of Saithe based on theses information (Figures B.1.4 and B.1.5) show that overall, the geographical sampling intensity mirrors the geographical distribution of the fisheries (see Figures A.2.3).

Calculation of catch in numbers

The calculation of the annual catch in number of the Icelandic saithe has since 1989 been based on only 2 metiers, trawl and gillnet, with no splitting by season or geographic distribution of fishing. Catches in other gears (long line and Danish seine) are included with the trawl gear. For the saithe the length distribution are compiled into bins of 5 cm and used as such in the length age key. The parameters used to convert length to weights are:

Cond = 0.024498

Power = 2.7567

Otherwise the calculations of calculation of annual catch in number and weight at age for saithe have since 1980 been calculated in the same way as was done for other species assessed by age based methods at the Marine Research Institute. What follows is a general description of the algorithm used in the calculations in the unix software package (referred to as PAX: "Poplulation Assessment in uniX"):

PAX is a menubased system where one has among other things the options of fetching data from a centralized database; calculate catches in numbers; make cpue indices and run a vpa program. It was first written late eighties and has been updated several times since then. Most of the modules in the system are prelude shellscrips which are run in unix/linux. Now the most used unit is the catches in numbers calculations. That module will be described here.

Catch in numbers are calculated for each area, a season and a gear combination and then combined to total catches in numbers over all areas, seasons and gears.

Length distributions

Data used are length frequency samples taken in area **r**, season **t** and gear **g**.

L_l is the number of fishes at length l.

One has the option to run the length distributions on 1 cm or 5 cm basis. If the latter one is chosen, a temporary variable *lemultfj* is assigned the value $l * L_l$ to be able to calculate the correct mean length in the length distribution. Then the grouping in 5 cm intervals is done in the way that the numbers get the middle value from the interval. As an example the values in the range 10-14 and 15-19 are assigned 12 and 17 respectively. Lengths are then in fact either

$$l \in \{1,2,3,...\} or\ l \in \{2,7,12,17,...\}$$

Age-length and maturity keys

Data used are age-determined data from otolith samples in area **r**, season **t** and gear **g**. If no otolith samples exist from this area, season and gear combination, they have to be borrowed from other season or gear for the same area or from other areas.

K_{la} is the number at length l and at age a, a>0.

M_{la} is the number mature at length l and at age a, a>0.

IM_{la} is the number immature at length l and at age a, $a>0$.

A fish is assigned to IM_{la} if is has a maturity value 1 in the database otherwise it is assigned to M_{la} .

Multiply the age-length and maturity keys with the length distribution

Sum of the numbers at length l over all ages:

$$K_{l.} = \sum_a K_{la}$$

Make a new key with the number of fishes:

$$C_{la} = \frac{K_{la}}{K_{l.}} \cdot L_l$$

And new maturity keys:

$$CM_{la} = \frac{M_{la}}{M_{la} + IM_{la}} \cdot C_{la} \text{ and } CIM_{la} = \frac{IM_{la}}{M_{la} + IM_{la}} \cdot C_{la}$$

Average length and weight

In this step average length and weight at age are calculated. For each area, season and gear the condition factor (*cond*) and the power (*power*) in a length-weight relationship are input data.

$$\tilde{w}_{la} = C_{la} \cdot cond \cdot \exp(\, power \cdot \log(l)\,) \text{ (the weight in each cell)}$$

$$\tilde{l}_{la} = C_{la} \cdot l$$

Note that in the above 2 equations l is a midpoint if 5 cm grouping has been chosen.

The total frequency in the key is:

$$C_{..} = \sum_l \sum_a C_{la}$$

and total weight

$$\tilde{w}_{..} = \sum_l \sum_a \tilde{w}_{la}$$

So the mean weight in this area, season and gear combination is

$$\overline{w} = \frac{\tilde{w}_{..}}{C_{..}}$$

The ratio of weight and number by age from the total:

$$ratio\_w_a = \sum_l \tilde{w}_{la} / \tilde{w}_{..}$$

$$ratio\_C_a = \sum_l C_{la} / C_{..}$$

The mean weight and mean length at age and ratio mature at age are:

$$\overline{w}_a = \frac{\sum_l \widetilde{w}_{la}}{\sum_l C_{la}}$$

$$\bar{l}_a = \frac{\sum_l \widetilde{l}_{la}}{\sum_l C_{la}}$$

$$ratio\_M_a = \frac{\sum_l CM_{la}}{\sum_l (CM_{la} + CIM_{la})}$$

if the denominator > 0 otherwise the *ratio_M*$_a$ *is set to -1.*

Catches in numbers

Input data for this module is the landings in tons (*catch*) for each area, season and gear.

The total number of fishes caught are:

$$C_{tot} = \frac{catch}{\overline{w}}$$

The catches in numbers and weight by age is then

$$C_a = C_{tot} \cdot ratio\_C_a$$
$$W_a = C_a \cdot \overline{w}_a$$

To derive the total catches in numbers and weight summation is done over all areas, seasons and gears.

Historical catch in numbers and weight at age: 1960–1979

Tabulated annual catch in numbers at age of the Icelandic saithe catches can be found from 1960 onwards, with the earliest record found in the Report on the Saithe (Coalfish) Working Group 1976 (ICES C.M. 1976/F:2). However, it is obvious that the Coalfish working group members had compiled these historical numbers (from 1960 onward) already by 1973 (Report of the Saithe (Coalfish) Working Group, ICES C.M. 1973 / F: 10), this being deduced from the resulting VPA analysis done by the 1973 group, where a tabulation of stock in numbers and fishing mortality by age is given for the period 1960-1970. From the various recent ICES assessment reports dealing with Icelandic saithe, it can be deduced that the catch in numbers as originally reported in the Coalfish reports have remained unchanged, i.e no later revisions were done to the calculated numbers.

Description on how the annual age composition of the catch for the period 1960-1980 were compiled by the ICES working group at the time are very limited and the calculation cannot be repeated. Number of annual samples, fish measured and age composition by fleet (countries) is not stated in the ICES assessment report from this time. In the 1973 Coalfish report it is noted that catch in numbers for Icelandic saithe in this early period were based only on samples from the German and English fleet. In the report it is then stated: "As a result it had to be assumed that the catches of the countries for which no data were available had the same age composition as the countries for which data were available. For … each year the available age distributions of national catches were summed and the resultant age composition was then raised by the ratio of total landed weight of all countries to landed weight of countries for which age composition were known." However, in the same report it is further noted that "young saithe recruited first to the Icelandic purse-seine and trawl fisheries, then to the English trawl fishery and finally to the German trawl fishery". Given this, the approach of raising the catch composition from the German/UK age distribution to the total landings will most likely lead to a bias in the total catch at age distribution to some unknown degree. In particular since the Icelandic fleet took the largest share of the catches from 1967 onwards (Figure A.2.1). The earliest account where age composition from the Icelandic fleet is used as a part of the total annual catch at age matrix is in 1977 (Report of the Saithe (Coalfish) Working Group. ICES C.M. 1978/G:3). This is understandable since samples from the Icelandic fleet prior to that year are very limited (see above).

No information is provided in the early working group reports on how weight at age in the catches were derived. In all cases, annual weight at age used is a constant value over the time period. However, as early as 1973 (Report of the Saithe (Coalfish) Working Group. ICES C.M: 198-73/F:10) it was noted that ".. in the English data there was a clear trend of reducing length at age over the past 10-12 years for saithe …. The rate of reduction of average length has been about 1 cm per year, and over the period of 10 or 12 years this is equivalent to more than a year's growth. Similar but less marked trend is apparent in the German data." Given this observation, the use of a constant weight at age over this time period is obviously wrong. In addition it explains the significant discrepancy between sumproduct of catch numbers and weight at age vs that of the total landings exist, particularly in the early part of the time series. The catch weight at age has historically been used in the calculation of SSB. Using the constant weight at age results in significantly higher historical maximum SSB (Figure B.1.6, based on a simple VPA model) than if weights scaled so that the sumproducts of catch in number and weight at age are the same as the total landings (see WD02 for details of how rescaling was done).

Given that:

- The that samples of the catch composition from the Icelandic fleet is not available in the early time period
- Fixed weight at age used in the early time period
- Sumproduct discrepancy
- Consequences different derivations have on the perception on the dynamic range

data information prior to 1980 is not used, albeit at the cost of loosing information on the dynamic history of the stock and its response to fisheries. However, based on the VPA model (Figure B.1.6) the dynamic range of SSB in the period observed from 1980 is within the range observed in the long time series.

B.2. Biological

A fixed natural mortality of 0.2 is used both in the assessment and the forecast.

The proportion of natural mortality before spawning (Mprop) and the proportion of fishing mortality before spawning (Fprop) are set to 0.

Weight at age in the stock is assumed to be the same as in the landings. For predicting next year's weights the catch weights from last year are used. If a large year class occurs having a low mean weight account should be taken in the short term predictions.

Maturity at age is based on measurements obtained in the Icelandic groundfish spring survey (Figure B.2.1) using a smother (see below). Spawning of saithe starts late January with a peak in February, just before the survey time. The survey time is thus close to the spawning time making visual detection of maturity stages optimal. Maturity at age data from surveys are considered to give better estimates of maturity at age in the stock than those from landings data, in particular because of limited ungutted samples in the landings (figure B.1.2).

Since the annual survey estimates of maturity at age are very noisy (figure x) a model to smooth the maturity data is used. All fishes at age 10 and older are set as mature. The model fitted (using Splus) is:

$$\text{logit}(Pa,t) = \alpha + \beta\, s(age,df=4) + ns(year,df=6)$$

where P is the proportion mature at age a in year t. S and ns are smoothing splines used to increase the flexibility of the model. Results for two age groups, 5 and 7, are shown in Figure B.2.2 along with the mean proportion mature for the same age groups from the survey data.

B.3. Surveys

An account of the Icelandic March (Spring, 1985-onwards) and October (Fall, 1996-onwards) groundfish surveys were provided as a WD for the Benchmark 2010 (WD-03). The WD is a translation of a citable report (http://www.hafro.is/Bokasafn/Timarit/rall_2007.pdf) written in the native language. It will be formally published in non-native speaking language in spring 2010. In summary, the surveys design is a classical random stratified design with fixed stations with time. With the caveat that experienced captains given the freedom to choose particular stations within a certain predefined geographical constraint determined by the scientist. The number of stations in the spring survey are 530, the number of stations in the fall are 380. The spring survey covers depth to 500 meters, but the fall survey covers depths down to 1200 m.

The longer spring survey time series covers to a large degree the traditional fishing grounds of saithe (Figure A.2.3). The shorter fall survey covers almost the entire distributional range of the fisheries (Figure B.3.1), although with only half the station density. The covarge of both surveys is however very poor for juvenile saithe, which are thought largely to inhabit coastal areas very close to shore. Hence the surveys do not provide reliable measurements of incoming recruits.

The survey indices for saithe, that are used as tuning indices are derived using conventional methods. Year effects, particularly in the earlier period are very apparent in the survey biomass indices (Figure B.3.2) and result in age based indices, when plotted as “consistency plots” to look very non-informative (figures B.3.3 and B.3.4). The “year effect” seen in the surveys is largely thought to be a result of the schooling nature of the species, with an accompanying high cv estimates in the survey abundance indices. However, there are indication that the surveys are able to track cohorts to some degree, in particular when catch curves of survey indices are plotted on a the log-scale, the scale that the model “sees the data” (figure B.3.5). Hence, in order to use the information in the cohort signal from the surveys for species such as icelandic saithe in an assessment framework some measures must unfortunately be made to allow for the year effect in the survey to be “a parameter” in the model.

B.4. Commercial CPUE

Catch per unit of effort are routinely calculated during the annual assessment process (Figure B.4.1). The overall trend in catch rates show similar trend with time, irrespective of how the indices are derived (mean, median, <50% or >50% saithe per haul), but the absolute values differ. The indices increased sharply from 2000-2004 but have decreased since then, but are still above the level in 1988-2000. Although this trend corresponds roughly with the perceived stock dynamics, the cpue for Icelandic saithe has not been considered a reliable unbiased index to be used quantitatively as a tuning series in an analytical model.

C: Modelling framework (Historical stock development)

Historical account of models used for saith assessments:

In the 1980s and early 1990s a traditional VPA was used for assessing the Icelandic saithe. The input terminal F for the VPA was estimated by various data sources and different ad hoc methods.

From 1993-2001 both XSA (except in 1999 and 2000) and TSA were run and compared. In all years cpue data were used as tuning series in XSA. Only catch data were used running TSA, except in 1997 and 1999 where cpue data were used as well. The decision taken each year was to use the terminal Fs estimated by TSA as input values for a traditional VPA.

In 2002 survey indices for saithe from the Icelandic groundfish survey in spring were used for the first time in an assessment. XSA, TSA and an ADAPT model were used. The conclusion was the same as in last years, Fs taken from TSA and put into a traditional VPA.

In 2003 Icelandic saithe was not assessed by ICES. Domestic TSA, ADAPT and camera (a separable model implementation in ADMODEL builder) were used as assessments programs. The decision taken this time was to use camera as the final run.

In 2004-2006 camera was used as a final run by ICES, but other models like TSA, cadapt (ADAPT type model implemented in ADMODEL builder), AMCI (a “flexable” separable model) and ADCAM (a forward running statistical catch at age model implemented in ADMODEL builder, allowing for “random walk” in Fay) were un as well. In 2006 XSA was also run again.

In 2007 Icelandic saithe was not assessed by ICES. Domestic TSA, camera and ADCAM were run. The use of camera was rejected due to shifts in the age composition of the landings and it was not considered realistic to assume a fixed selection pattern for the whole assessment period like camera did. Then ADCAM was adopted and since then it has been the assessment program giving the final results each year. For comparison TSA has also been run every year.

Current model used – adopted at the Benchmark 2010:

A forward running separable statistical catch at age model, allowing changes in selectivity to occur in specified years is used. The software used is ADMODEL builder, adapted to the saithe by Höskuldur Björnsson, MRI. The source code and an LINUX executable version are stored by ICES. The model is set up so that both stock assessment and predictions are run at the same time. The code is to a large extent the same as was used by ICES for the HCR evaluation of Icelandic cod in December 2009.

Operating model

The operating model is the virtual world, which is supposed to reflect the true system in the evaluation framework. The virtual world here is very simple with constant M, no length based parameters etc.

The biological model is a simple single-species age structured population following the classical exponential stock-equation:

$$N_{a+1,y+1} = N_{ay} e^{-\left(F_{ay} + M_{ay}\right)}$$

The age groups in the model are 1 to 14 years with age 3 the youngest age in the landings. In the settings here the oldest group (14 years) is not a plus group!.

Migration events are estimated at specific year and ages and are then added to the number in stock in the beginning of the year. The size of migration events is estimated as an additional parameter, equivalently as annual recruitment estimates.

Catches are taken according to the catch-equation:

$$\hat{C}_{ay} = \frac{F_{ay}}{F_{ay} + M_{ay}} \left(1 - e^{-(F_{ay} + M_{ay})}\right) N_{ay}$$

$$\hat{C}_y = \sum_a \hat{C}_{a,y} W^c_{a,y}$$

Fishing mortality by year and age is modelled as:

$$F_{ay} = s_a F_y$$

The time period that where catch at age data are available can be divide in a number of subperiods with the selection pattern s_a estimated separately for each period. The selection pattern of ages 11-14 is assumed to be identical and defined as 1.

Spawning is assumed to occur in the beginning of the year so no mortality takes place before spawning. This is not strictly correct but a good approximation

The spawning stock is then calculated by

$$SSB_y = \sum_a N_{y,a} W^{ssb}_{y,a} \; p_{y,a}$$

where $p_{y,a}$ is the proportion mature by year and age.

The predicted recruitment is (in the Benchmark 2010) calculated as a simple hockey-stick given the data available at the time.

Reference biomass is calculated from

$$B^{ref}_y = \sum_{a=4}^{a=14} N_{ay} W^c_{ay}$$

where W^c_{ay} are the mean weight at age in the landings.

Observation model and objective functions

The model parameters are estimated by minimizing a negative log-likelihood that is the sum of 4 components.

1) Landings in numbers.

$$\Psi_1 = \sum_{a,y} \frac{\log \frac{C_{ay} + \delta_a}{\hat{C}_{ay} + \delta_a}}{2(\Omega_1 \sigma_a)^2} + \log(\Omega_1 \sigma_a)$$

where Ω_1 is an estimated parameter but the pattern of the measurement error with age σ_a is read from the input files. The values δ_a are input from file. They are supposed to reflect the value where the error goes from being lognormal to multinomial. Typical value could be corresponding to 5 otoliths sampled.

2) Landings in tonnes.

$$\Psi_2 = \sum_{a,y} \frac{\log \frac{C_y}{\hat{C}_y}}{2\Omega_2^{\ 2}} + \log \Omega_2$$

where C_y are the "real" landings in tonnes in year y, $\hat{C}_y$ the modelled landings and Ω_2 the assumed standard error of the landings. The value of 0.05 was used for Ω_2 in these runs. The likelihood component Ψ_2 is somewhat redundant as it is already incorporated in Ψ_1. Leaving Ψ_2 out will on the other hand lead to unacceptable deviation between observed and predicted landings in numbers.

3) Survey abundance in numbers.

Initially the survey likelihood was calculated by.

$$\Psi_3 = \sum_{a,y} \frac{\log \frac{I_{ay} + \delta_a^s}{\hat{I}_{ay} + \delta_a^s}}{2(\Omega_3 \sigma_a^s)^2} + \log(\Omega_3 \sigma_a^s)$$

were Ω_3 is an estimated parameter but the pattern of the measurement error with age σ_a^s is read from the input files. The values δ_a^s are input from file and are similar to δ_a in Ψ_1. The predicted survey numbers $\hat{I}_{ay}$ are calculated from the equation $\hat{I}_{ay} = q_a N_{ay}^{b_a}$. The parameters q_a are estimated, but the parameters b_a are set to all set one as the survey indices are considered too noisy to estimate those extra parameters.

For Icelandic saithe year effects are apparent in the survey and were taken into account by modelling the survey residuals by a multivariate normal distribution.

$$\Gamma = \log \frac{I_{ay} + \delta_a^s}{\hat{I}_{ay} + \delta_a^s}$$

a=2:10 is the vector of survey residuals in a given year.

$$\Psi_3 = 0.5 \sum_y \log\det \Theta_6 + \Gamma_y^{\ T} \Theta_6^{-1} \Gamma_y$$

The matrix Θ_6 is calculated from the equation. $\Theta_{6ij} = \Omega_3^2 \sigma_i^s \ \sigma_j^s \ \kappa^{abs(i-j)}$ where κ is an estimated parameter and the parameters Ω_3 and σ_a^s are explained above. When the value κ is high the equation approaches modelling the survey indices as a year factor.

4) Stock – recruitment parameters.

$$\Psi_4 = \sum_{a,y} \frac{\log \dfrac{N_{1y}}{\hat{N}_{1y}}^2}{2\Omega_4^2} + \log \Omega_4$$

where $\hat{N}_{1y}$ is the estimated recruitment from the stock –recruitment function and Ω_4 is an estimated parameter. Ω_4 can be set as a function of SSB (usually increasing with smaller SSB) but that option was not used in the simulations in the 2010 Benchmark. Autocorrelation of the residuals are quite high for saithe exemplified by periods of good and bad recruitment. The modelling of the autocorrelation is done in the same way as the modelling of the year factor in the survey.

$$\Gamma_y = \log \frac{N_{1y}}{\hat{N}_{1y}}$$

y=1980:2009 is the vector of recruitment residuals in a given year.

$$\Psi_4 = 0.5 \sum_y \operatorname{logdet} \Theta_7 + \Gamma_y^T \Theta_7^{-1} \Gamma_y$$

The matrix Θ_7 is calculated from the equation. $\Theta_{7ij} = \Omega_4^2 \ \rho^{abs(i-j)}$ where ρ is an estimated parameter and the parameters Ω_4 explained above.

The stock recruitment models used were either constant recruitment or Hockeystick recruitment with the breakpoint estimated.

5) Overall objective function

The total objective function to be minimized is ρ is in used to in a first order AR model in future predictions. The estimated value is 0.45 and inclusion of it does not have much effect on the outcome of prognosis.

$$\Psi = \sum_{i=1}^{i=4} \Psi_i$$

Parameter estimated

The estimated parameters in most of the runs are:

- Effort F_y for each year 1980 – 2009
- Selection pattern s_a for ages 3-10 (set to 1 for ages 11-14) in 2 periods, 1980-1995 and 1996-2009.
- Number of age 2 saithe 1980 to the present.

- Initial number in each age group (2-14) in 1980.
- Migration events. Age 7 1991 is always include but diagnostics by allowing migration event at age 7 in 1999 is sometimes checked.
- Parameters of the stock recruitment function (2-4 depending on the function used). In addition CV in the stock recruitment function is estimated.
- Catchability the survey q_a for ages 1-7 with 8-10 same as 7. 3 CV parameters Ω_1 Ω_3 and Ω_4, parameter κ for modelling yearblocks in the survey and parameter ρ to model recruitment residuals.

After the estimation is done the estimated variance-covariance matrix was used as proposal distribution in MCMC simulations (see Admodel builder manuals). The number of runs was between 300 000 and 1 000 000 and the parameters values were saved every 250th or 500th time. The saved chain was then used in prediction.

Prediction model

Natural mortality was fixed to 0.2

Stochasticity in future weight at age in the stock (W^s_{ay}), the catch (W^c_{ay}) and spawning stock (W^{ssb}_{ay}) are modelled as:

$$W^s_{ay} = \hat{W}^s_{ay} e^{E^w_y}$$

$$W^c_{ay} = \hat{W}^c_{ay} e^{E^w_y}$$

$$W^{ssb}_{ay} = \hat{W}^{ssb}_{ay} e^{E^w_y}$$

where,

$$E^w_y = \left(\rho_w E^w_{y-1} + \sqrt{1-\rho_w{}^2}\,\varepsilon_y \right)$$

$$\varepsilon_y = N(0,1)$$

The mean values of $\hat{W}^s_{ay}$, $\hat{W}^c_{ay}$ and $\hat{W}^{ssb}_{ay}$ in the 2010 Benchmark were the most recently observed values from 2009. The selection of those "average value" has considerable effect on the outcome and the selected values are around 12% below the average from the long term. Expert judgement by WG, based on future patterns may change the basis used.

In the prediction recruitment is generated by the estimated stock-recruitment function (Hockey-Stick in the 2010 Benchmark). Added to the estimated recruitment is random lognormal noise with CV estimated by the assessment part of the model. Autocorrelated residuals in recruitment are modelled in the same way as autocorrelated stochasticity in mean weight at age.

The selection pattern used in the 2010 Benchmark prediction is the selection pattern of the last "selection period" (1996-2009). This may change if different selection pattern is considered appropriate by the WG for years where data have not yet observed. No stochasticity is modelled in the selection pattern but the uncertainty in the estimated selection pattern is transferred to the prediction.

Assessment error is modelled as autocorrelated lognormal noise as done for the stochasticity in weight.

$$\widetilde{F}_y^{ref} = F_y^{ref} e^{E_y^b}$$

where

$$E_y^b = \left(\rho E_{y-1}^b + \sqrt{1-\rho^2}\,\varepsilon_y\right)$$

When the stock is below $B_{trigger}$ intended fishing mortality was not reduced in the 2010 Benchmark. Could be replaced in the future by e.g.: …was reduced by linear reduction in fishing mortality according to:

$$F_y^{ref} = F_y^{ref0-} \frac{SSB_y}{B_{trigger}}.$$

(as suggested in the ACOM "default" approach in the new MSY concept.

The above implementation means that error in estimation of SSB is taken into account, when fishing mortality is underestimated and vice versa. The ultimate goal in using this assessment framework is to implement HCR based on biomass that leads to a definition of target fishing mortality in relation to the ICES Fmsy concept. Given that uncertainity in the assessment and the short term prediction is already taken into account, the estimates of the Fmsy proxy derived here are not comparable with that derived from a deterministic approach.

Of note is that no implementation error is included in the simulations.

CV of residuals in the catch and the survey estimated, with and one multiplier estimated the survey and one for the catch. The *a priori* set age group patterns (σs) and stabilizers (εs) are given in the text table below: δ_a is set to 0.7% of the total catch in numbers each year.

Age Group	Catch σ_a	Survey δ_a^s	Suvey σ_a^s
1			
2		1	0.50
3	0.17	0.5	0.30
4	0.13	0.5	0.22
5	0.11	0.5	0.19
6	0.10	0.5	0.16
7	0.10	0.3	0.19
8	0.10	0.3	0.24
9	0.11	0.3	0.35
10	0.12	0.3	0.45
11	0.15		
12	0.19		
13	0.26		
14	0.37		

Linear catchability relationship for all age groups in survey.

Weights and maturity have been given with matrices based on different data to produce alternative versions/flavours of stock and SSB biomass.

Migration is estimated for 1 events, *i. e.* for age group 7 in 1991. 4 other events are hypothesised, i.e age 10 in 1986, 9 in 1993, 7 in 1999 and 8 in 2000, but were not used in the Benchmark 2010. The timing of these migration events and the age groups included are determined/based on loose indications from deviations from 'normal' weight at age, *i. e.* abnormally low. Potential future migrations will be evaluated using the same procedure.

Input data types and characteristics:

Type	Name	Year range	Age range	Variable from year to year Yes/No
Caton	Catch in tonnes	1980-onward		Yes
Canum	Catch at age in numbers	1980-onward	3-14	Yes
Weca	Weight at age in the commercial catch	1980-onward	3-14	Yes
West	Weight at age of the spawning stock at spawning time.	1980-onward	3-14	Weca is used as West.
Mprop	Proportion of natural mortality before spawning	1980-onward	3-14	No, kept fixed at 0.
Fprop	Proportion of fishing mortality before spawning	1980-onward	3-14	No, kept fixed at 0.
Matprop	Proportion mature at age in the survey	1980-onward	3-14	Yes, but modelled with a smoother.
Natmor	Natural mortality	1980-onward	3-14	No, kept fixed at 0.2.

The input data used in the 2010 Benchmark are archieved on the 2010 Benchmark sharepoint site

Tuning data:

Type	Name	Year range	Age range
Tuning fleet 1	Icelandic spring groundfish survey	1985-onward	1-10

D. Short-Term Projection

Model used/software used: The same software is used for forward projections as the assessment. For parameter settings and input data see chapter C.

E. Medium-Term Projections

Model used/software used: The same software is used for forward projections as the assessment. For parameter settings and input data see chapter C.

F. Long-Term Projections

Model used/software used: The same software is used for forward projections as the assessment. For parameter settings and input data see chapter C.

G. Biological Reference Points

	Type	Value	Technical basis
Precautionary approach	B_{lim}	90Kt.	B_{loss} estimate in 1998
	B_{pa}	150Kt.	Observed low SSB values in 1978–1993
	F_{lim}	Not defined.	
	F_{pa}	0.3	Fishing mortality sustained for 3 decades.
Targets	F_y	Not defined.	

(unchanged since 1998)

Note: taking into account the strong reductions in mean weight-at-age and change in fishing pattern, the F_{pa} as defined in 1998 now corresponds to a lower fishing mortality than 0.3. Under the current conditions F_{pa} corresponds to a value of 0.22. B_{pa} has been calculated based on of inappropriate historic weight-at-age. Therefore it cannot be used as basis for advice.

The time series used has been shortened to 1980 – onwards in 2010 Benchmark. In addition the maturity 0-gives now used are based on maturity derived from the survey, not from the catches as done in 1998. The result is that the SSB has been scaled downwards relative to calculated in 1998. Because of the new MSY framework being established by ICES the above reference points, established in 1998 were not addressed by 2010 Benchmark.

[text to have here]: Within the developing MSY-framework in ICES an Fmsy proxy for the stock of 0.2x was considered as a suitable candidate by the 2010 Benchmark??????? Btrigger????

I. References

Armannsson, H., Jonsson, S. Th., Neilson, J.D., and Marteinsdottir, G. 2007. Distribution and migration of saithe (Pollachius virens) around Iceland inferred from mark-recapture studies. ICES Journal of Marine Science, 64: 1006-1016.

Gunnar Jónsson and Jónbjörn Pálsson, xxxx. Íslenskir fiskar. Vaka-Helgafell. 336 p.

ICES 2007. Report of the North-Western Working Group (NWWG). ICES CM 2007/ ACFM:17

ICES 2009. Report of the North-Western Working Group (NWWG). ICES CM 2009/ACOM:04.

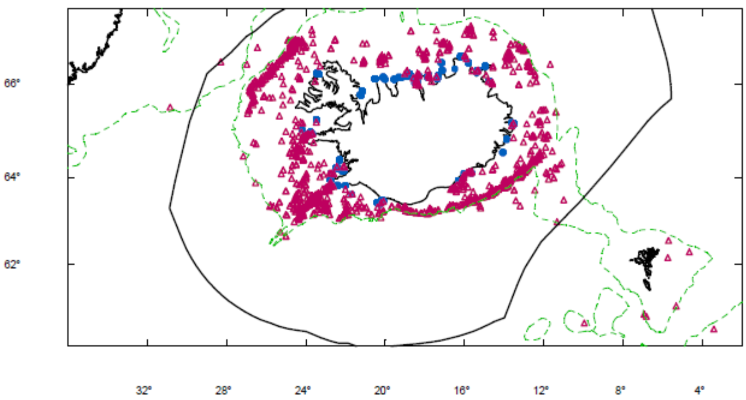
Ólafur K. Pálsson, Höskuldur Björnsson, Ari Arason, Eyþór Björnsson, Guðmundur Jóhannesson and Þórhallur Ottesen 2008. Discards in demersal Icelandic fisheries 2007. Marine Research Institute, report series no. 142.

S.T. Jonsson, 1996. Saithe on a shelf. Two studies of Pollachius virens in Icelandic waters. Masters thesis, University of Bergen. 151 pp.

WD03, 2010. Saithe in Va as observed in the Icelandic groundfish surveys. Gudmundur Thordarson, 2010.

WD04, 2010. Short overview of the Icelandic saithe fishery. Asta Gudmundsdottir and Einar Hjörleifsson, 2010.

WD07, 2010. Stock assessment of Saithe in Va using ADCAM on data from 1980-2008. Höskuldur Björnsson, 2010.



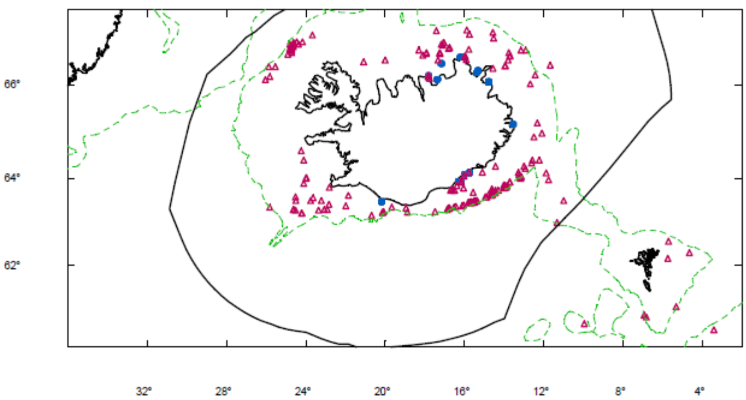


Figure A.1.1 Results from taggings in 2000-2004. Total returns, above; returns after more than 560 days at liberty (the shortest period at liberty in the recaptures from the Faroes) from the set of stations from which tags were recaptured at the Faroes or on the Faroe-Iceland Ridge, below. Blue dots denote tagging locality, violet triangles recapture location, the 500 m isobath and approximate Icelandic EEZ boundary are also shown.

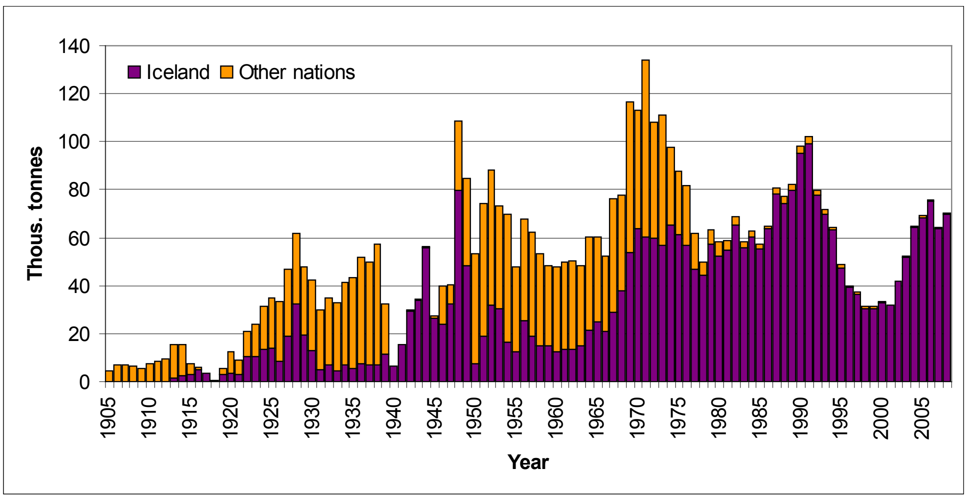


Figure A.2.1. Saithe in Va. Landings in thousand tonnes in the years 1905-2008

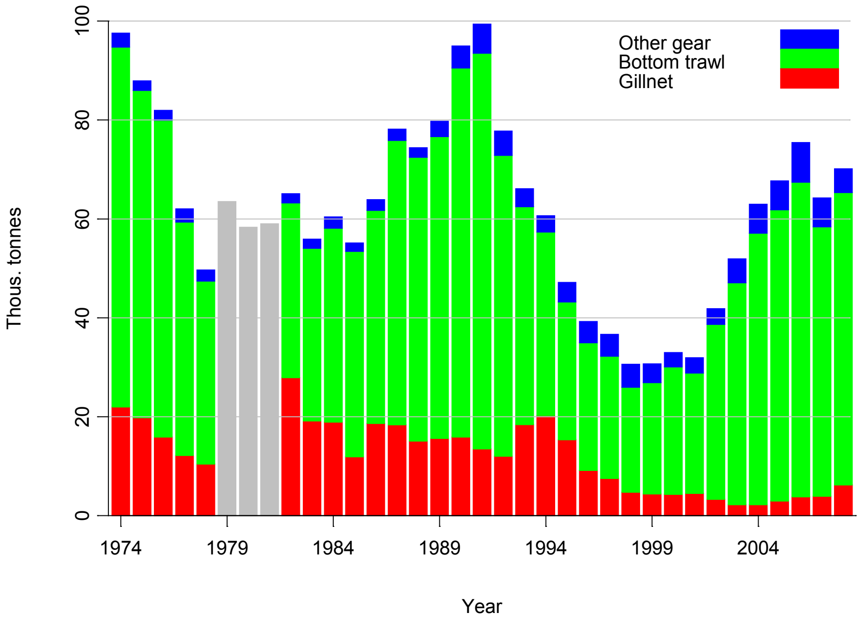


Figure A.2.2. Saithe in Va. Annual landings by gear type 1974-2008.

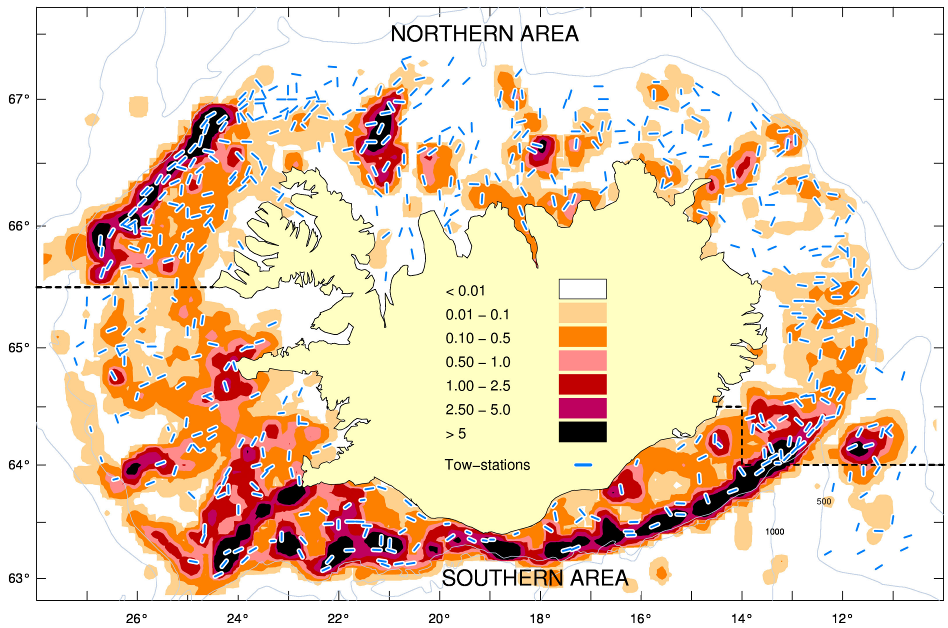


Figure A.2.3: Contour-plot of the distriburtion of commercial catches of saithe in Va (tonnes/square mile) in 2008, blue lines are tow-stations in the Spring Survey (March). The 500 and 1000 m depth contours are shown.

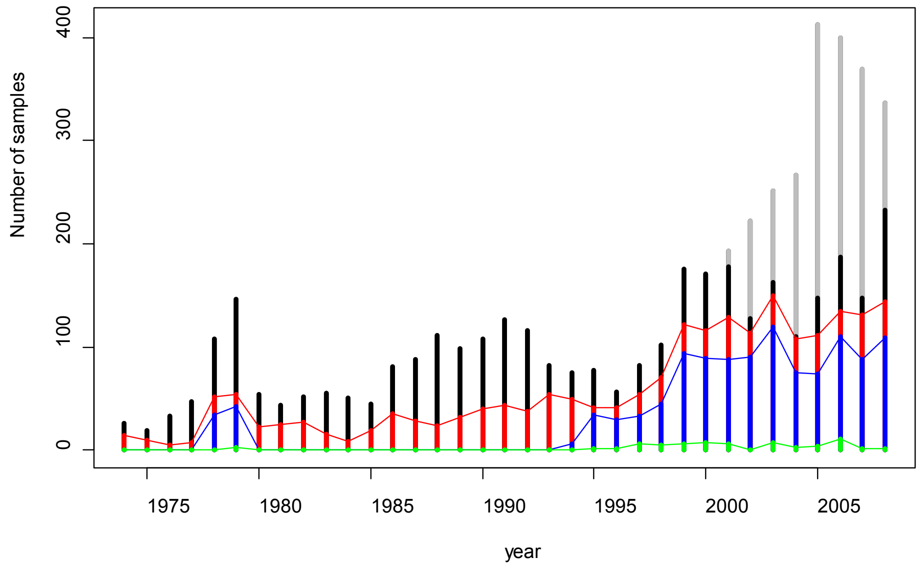


Figure B.1.1. Saithe in Va. Number of annual samples from the Icelandic fishing fleet 1974-2008. The grey bars refer to the total number of samples (including from the discarding program), black bars refer to number of samples (excluding those from the discarding program), the red bars to the number of samples where otoliths were taken, blue bars to the numbers sampled for gutted weight and green bars to numbers sampled for ungutted weight.

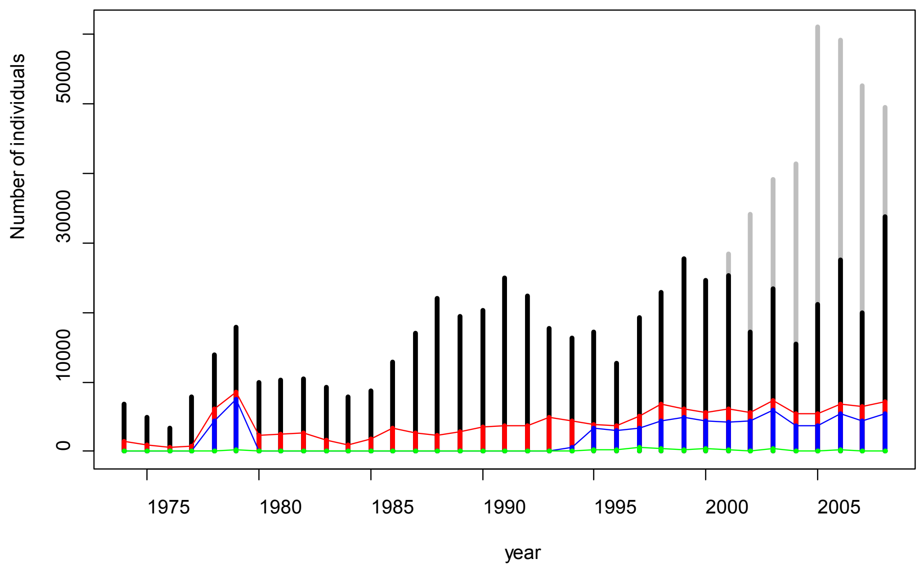


Figure B.1.2. Saithe in Va. Number of individual fish measurements from the Icelandic fishing fleet 1974-2008. The grey bars refer to the total number of measurements (including from the discarding program), black bars refer to number of samples (excluding those from the discarding program), the red bars to the number of samples where otoliths were taken, blue bars to the numbers sampled for gutted weight and green bars to numbers sampled for ungutted weight.

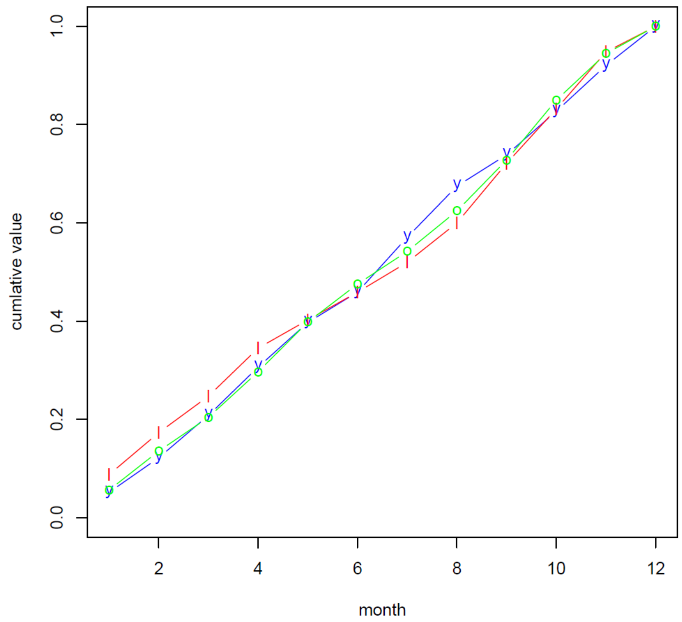


Figure B.1.3. Saithe in Va. Cumulative plot of landings (y: blue) and length (l: red) and otolith (o: green) sampling by month over the period 2005 to 2008.

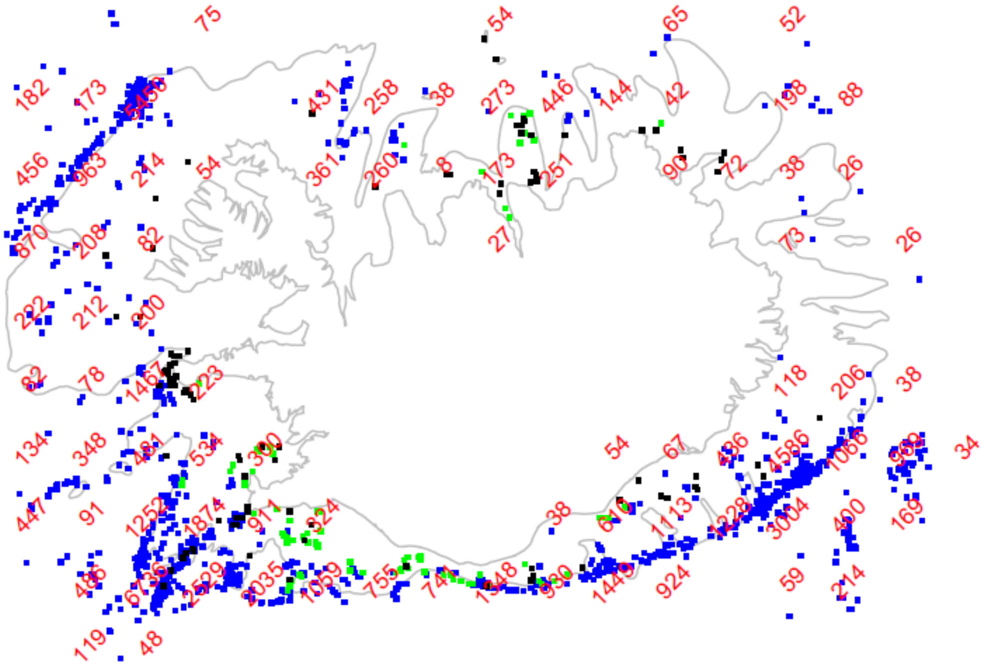


Figure B.1.4. Length samples: Location and average annual number sampled by statistical square for in 2005 to 2008. Blue dots indicate trawl sample, green gill net samples and black dots other gear.

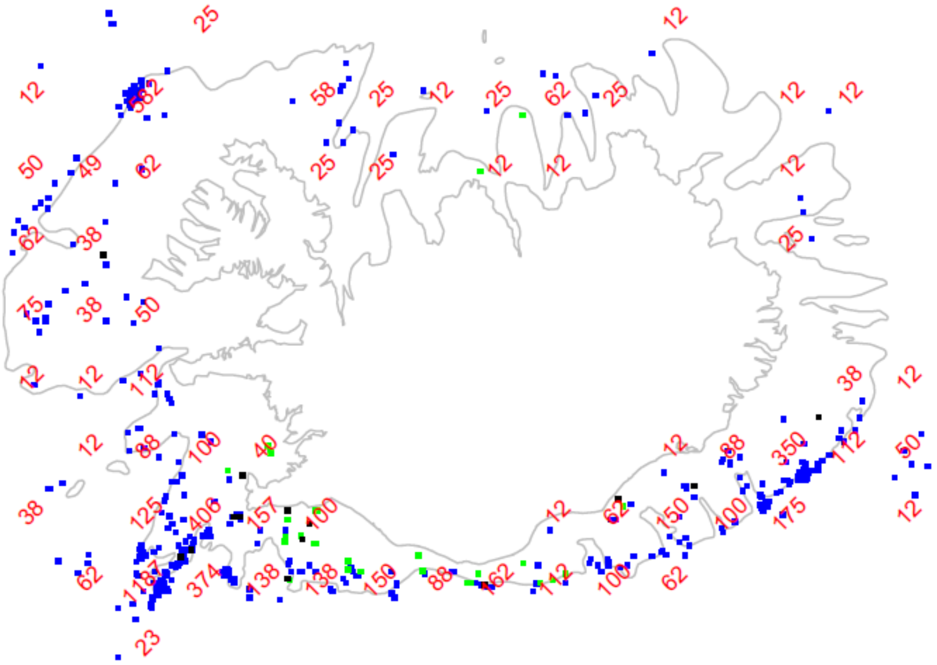
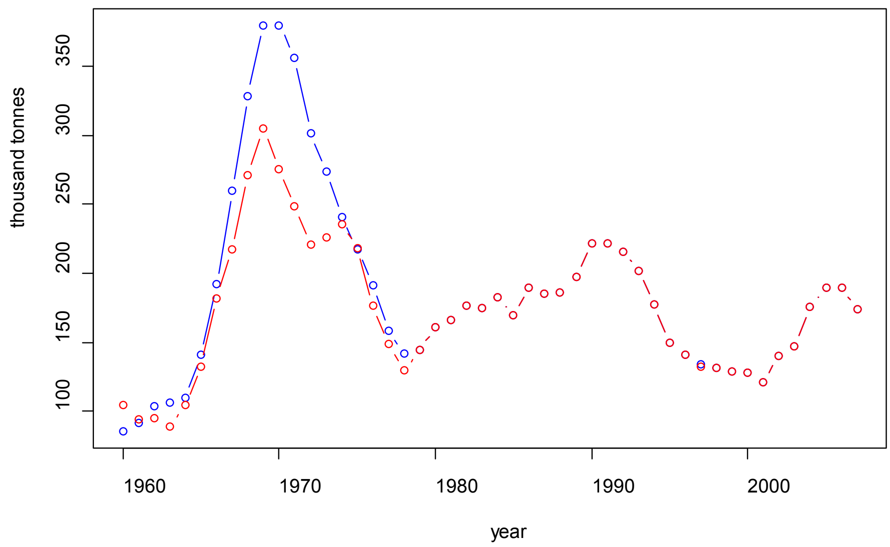


Figure B.1.5. Saithe in Va. Otolith samples: Location and average annual number sampled by statistical square for in 2005 to 2008. Blue dots indicate trawl sample, green gill net samples and black dots other gear.



Figures B.1.6. Saithe in Va. Comparison of SSB trajectory based on constant weight at age (blue) matrix in period prior to 1979 and one where weights in that period were rescaled (red)

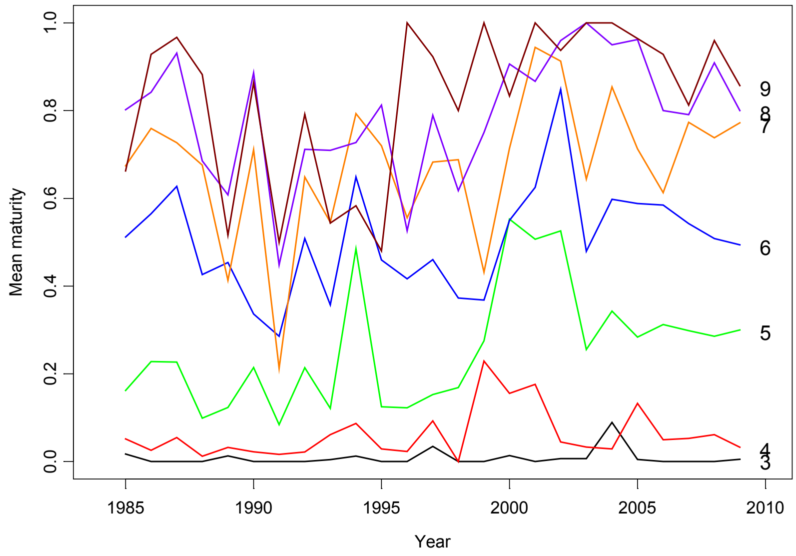


Figure B.2.1. Saithe in Va. Proportion mature at age by year in the spring survey (SMB).

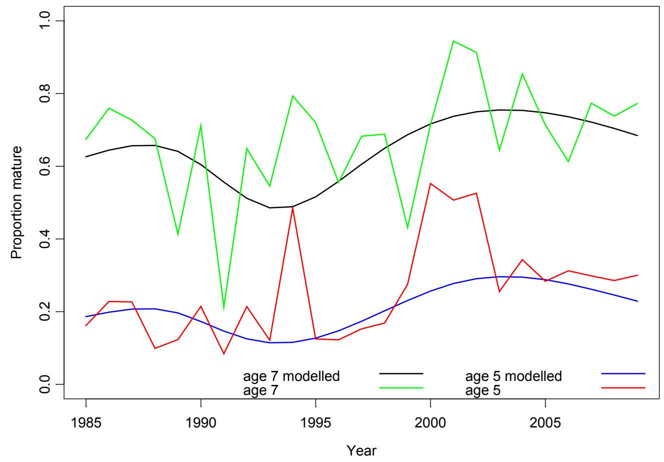


Figure B.2.2. Saithe in Va. Proportion mature at age 5 and 7 from the raw survey data and the modelled values from the smoothed glm model.

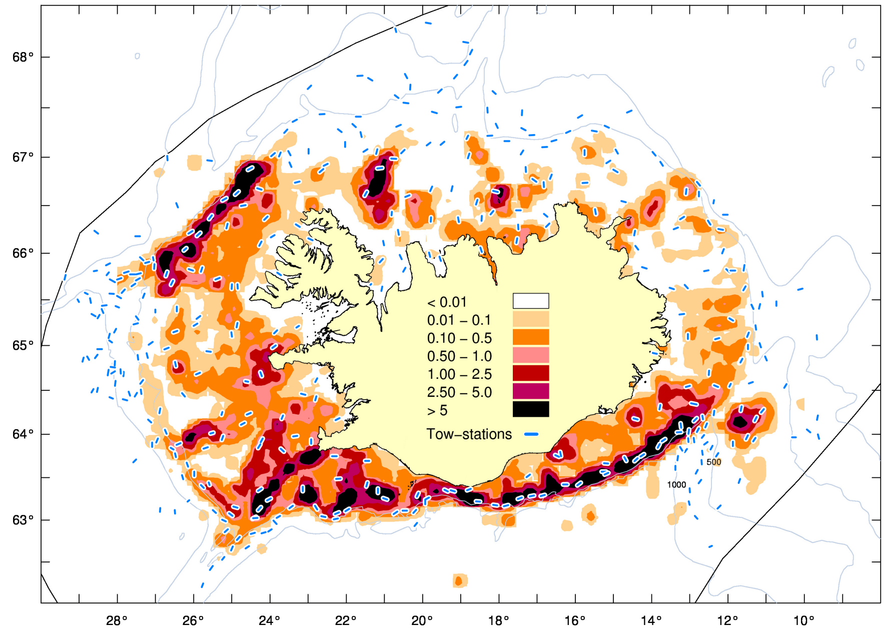


Figure B.3.1: Contour-plot of the distriburtion of commercial catches of saithe in Va (tonnes/square mile) in 2008, blue lines are tow-stations in the Autumn Survey (October). The 500 and 1000 m depth contours are shown.

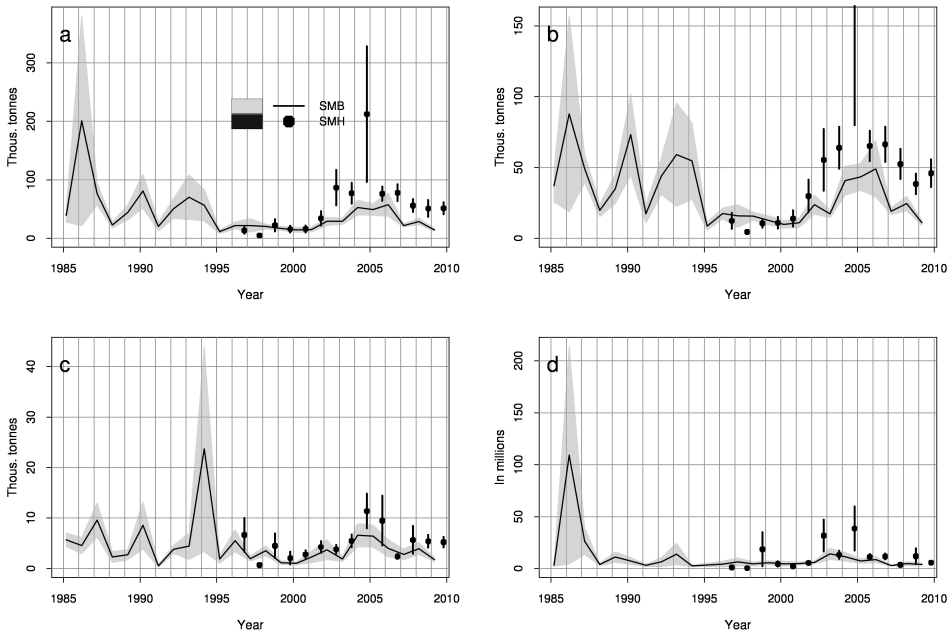


Figure B.3.2: Saithe in Va. Shown are a) total biomass indices, b) biomass indices larger than 55 cm, c) biomass indices larger than 90 cm and d) abundance indices smaller than 55 cm. The lines with shades show the Spring survey indices from 1985 (SMB) and the points with the vertical line show the Autumn survey (SMH) from 1997. The shades and vertical line indicate +/- 1 standard error.

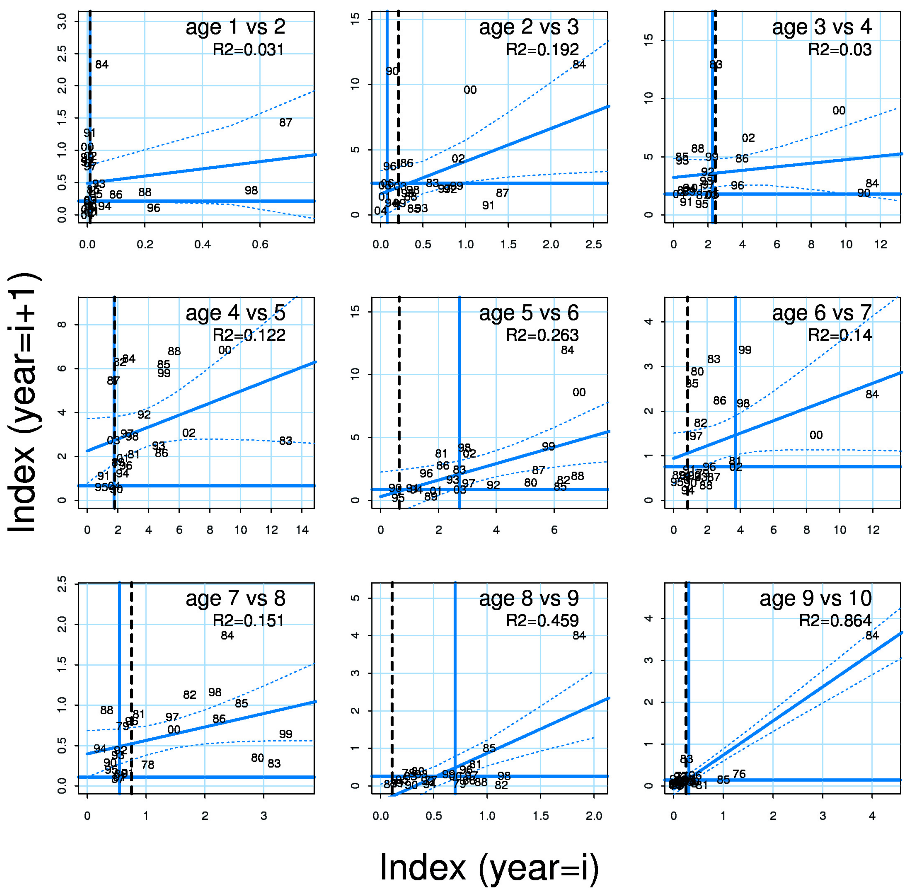


Figure B.3.3: Saithe in division Va. Indices from the Spring Survey vs. index of the same year class in survey a year later. The cross represents the last cohort age pair and the dotted vertical line is the value from the 2009 for the younger age in the pair plot.

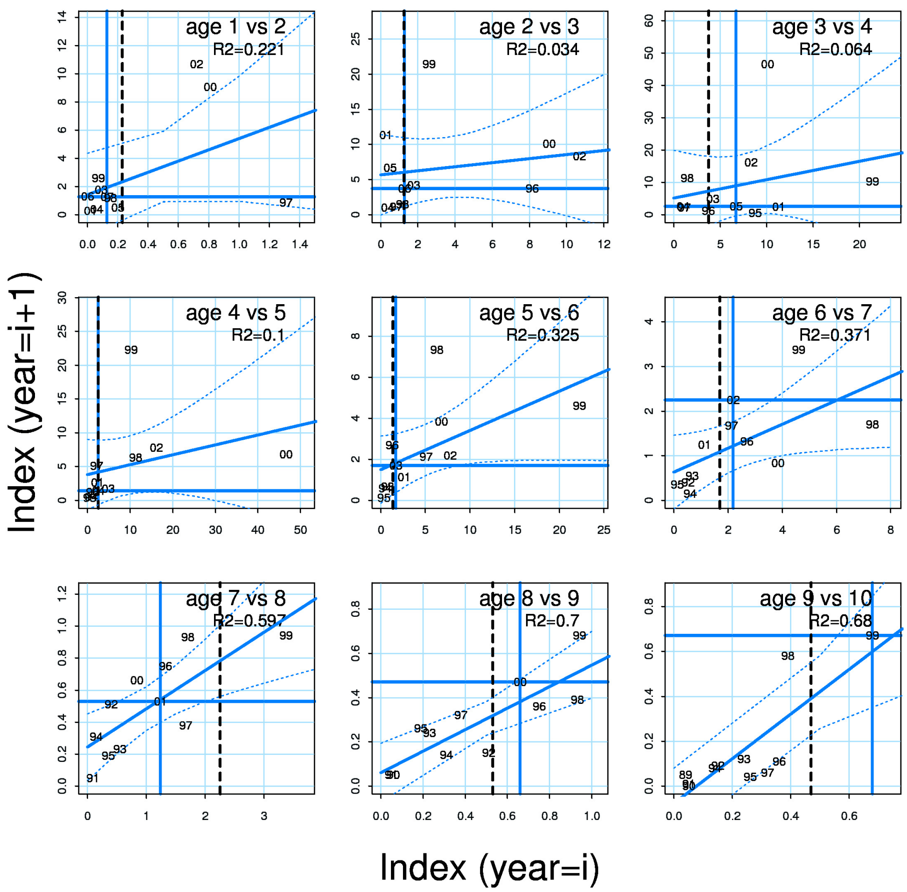


Figure B.3.4: Saithe in division Va. Indices from the Autumn survey vs. index of the same year class in survey a year later. The cross represents the last cohort age pair and the dotted vertical line is the value from the 2009 for the younger age in the pair plot.

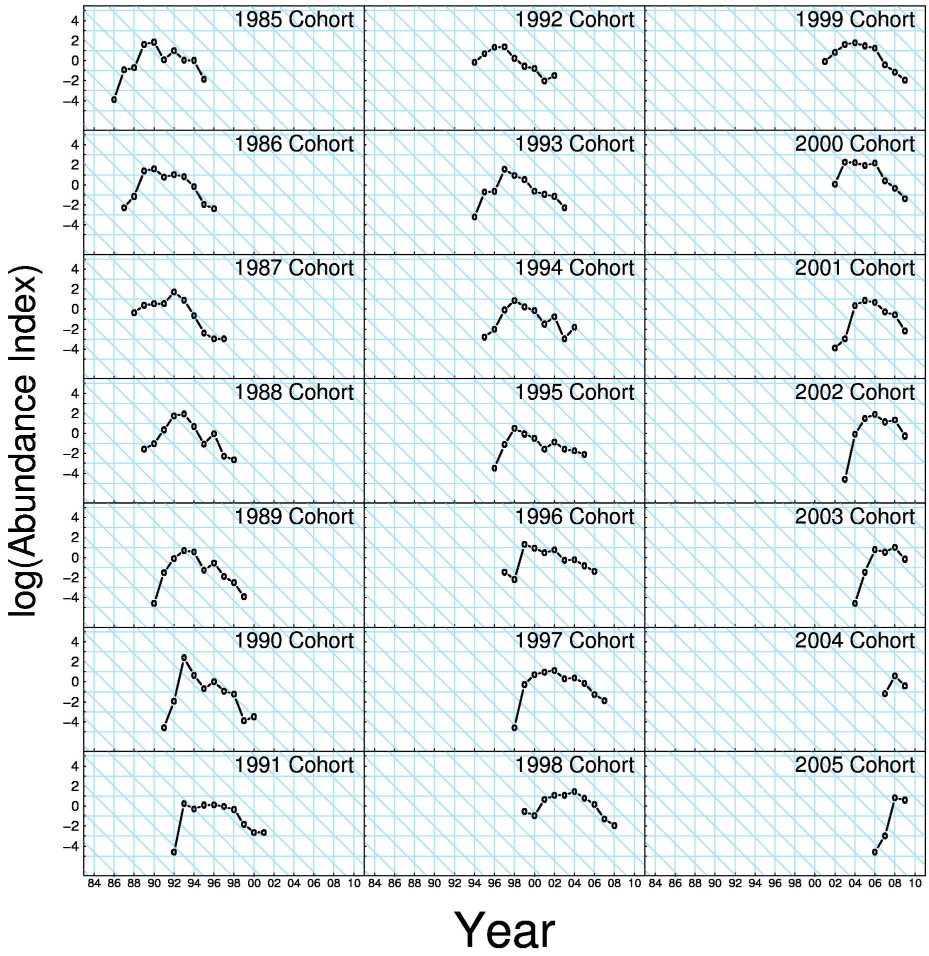


Figure B.3.5: Saithe in division Va. Catch curves from the Spring Survey. The grey lines show Z=1.

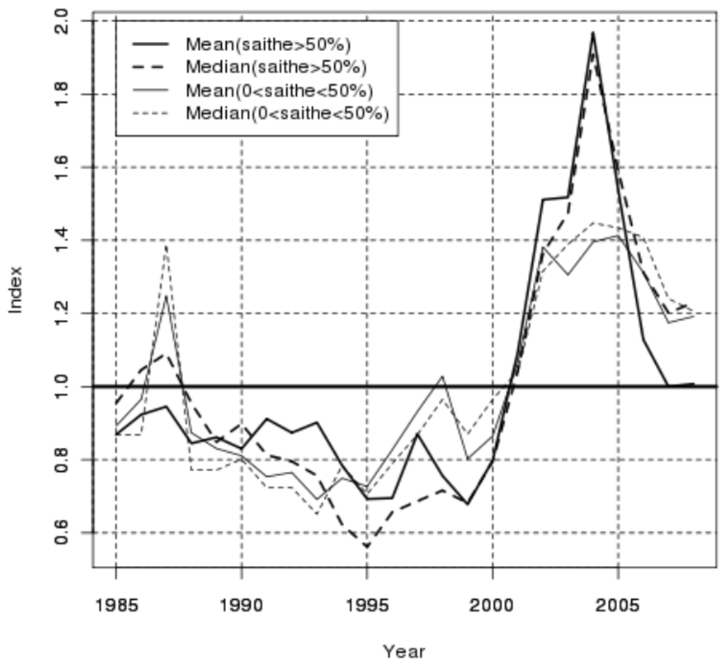


Figure B.4.1. Saithe in Va. CPUE where saithe is > 50% and < 50% of the catches in each tow. Shown are mean and median values and the long term mean. The numbers are scaled to the mean of the time series. The figure is taken from the NWWG report in 2009.

Annex 3 Technical Minutes of a review of the ICES North Western Working Group (NWWG)

Report 2010 (by correspondence)

6-20 May 2010

Reviewers:	Noel Cadigan (chair)
	Rasmus Nielsen
	Jean-Claude Mahe
	Fernando González
Chair WG:	Gudmundur Thordarson
Secretariat:	Mette Bertelsen

Audience to write for: advice drafting group, ACOM, benchmark groups and next years EG.

General

Use bullet points and subheadings (Recommendations, General remarks for WGs, etc.) if needed

The Review Group ToR's (from Guidelines for Review Groups):

1. Thoroughly check to ensure that the assessment is carried out according to the descriptions in the stock annex.
2. Check the content of figures and tables, and review whether the texts are supported by the scientific results.
3. Check consistency with the previous years reporting.

Reviewers also provided comments additional to the ToR's, and these are included as well.

The Review Group considered the following stocks:

- Cod in Subdivision Vb2 (Faroe Plateau)
- Cod in Subdivision Vb2 (Faroe Bank)
- Haddock in Division Vb
- Saithe in Division Vb
- Cod in Division Va (Icelandic cod)
- Haddock in Division Va (Icelandic haddock)
- Saithe in Division Va (Icelandic saithe)
- Herring in Division Va (Icelandic summer-spawners)
- Capelin in Subareas V, XIV and Division IIa
- Greenland halibut in Subareas V, VI, XII and XIV
- Redfish (Sebastes marinus) in Subareas V, VI, XII and XIV
- Redfish (Sebastes mentella) on the continental shelf
- Beaked Redfish (S. mentella) (Shallow Pelagic)

- Beaked Redfish (S. mentella) (Deep Pelagic)
- Beaked Redfish (S. mentella) Greenlandic Slope
- Cod in ICES Subarea XIV and NAFO Subarea 1

And the following special requests:

- none

The RG acknowledges the intense effort expended by the working group to produce the report. The report was well structured and information was usually easy to find.

The stocks listed above were all updates, except Cod in Subdivision Vb2 (SALY), and were reviewed by the group. In some cases a quality handbook (annex) was available with instructions on the procedure to carry out the assessment; however, no annexes were available during the review for Icelandic haddock and all redfish stocks. Other annexes were vague in some aspects, especially on model formulations.

The reviewers met by correspondence and had contact through e-mail and share-point. For the purpose of evaluation the chair of the review group split the stocks between the reviewers. The chair read all stock reports. It was checked by the reviewers whether the procedures followed were according the procedures established in a previous bench mark assessment. In most cases the present assessments were also compared with those of last year. There was insufficient time to review other chapters of the report. Also no draft stock summaries were considered by the review group.

Stock	Name	Assessment Type	Reviewers
cod-farp	Cod in Subdivision Vb2 (Faroe Plateau)	Update	Jean-Claude Mahe
cod-farb	Cod in Subdivision Vb2 (Faroe Bank)	SALY	Jean-Claude Mahe
had-faro	Haddock in Division Vb	Update	Noel Cadigan
sai-faro	Saithe in Division Vb	Update	Fernando González
cod-iceg	Cod in Division Va (Icelandic cod)	Update	Jean-Claude Mahe
had-iceg	Haddock in Division Va (Icelandic haddock)	Update	Noel Cadigan
sai-icel	Saithe in Division Va (Icelandic saithe)	Update	Fernando González
her-vasu	Herring in Division Va (Icelandic summer-spawners)	Update	Noel Cadigan
cap-icel	Capelin in Subareas V, XIV and Division IIa	Update	Fernando González
ghl-grn	Greenland halibut in Subareas V, VI, XII and XIV	Update	Noel Cadigan
smr-5614	Redfish (*Sebastes marinus*) in Subareas V, VI, XII and XIV	Update	Fernando González
smn-con	Redfish (*Sebastes mentella*) on the continental shelf and Icelandic slope	Update	Fernando González
smn-sp	Beaked Redfish (*S. mentella*) (Shallow Pelagic)	Update	Fernando González
smn-dp	Beaked Redfish (*S. mentella*) (Deep Pelagic)	Update	Fernando González
smn-gre	Beaked Redfish (S. mentella) Greenlandic Slope	Update	Jean-Claude Mahe
cod-ewgr	Cod in ICES Subarea XIV and NAFO Subarea 1	Update	Jean-Claude Mahe

A general point to the Faroese stocks. These stocks are managed by effort control. It is important that effort data are presented for those fleets which are subject to effort management. These data should allow to identify the applied effort, the permitted effort and the advised effort. From these data it would become clear what effort parameters are managed. Also from these data a table could be constructed in the stock summary with effort information, comparable to those stocks which are managed by TAC (ICES advised TAC, agreed TAC and catch).

Stock: Faroe Bank Cod (report section 3)

Short description of the assessment: extremely useful for reference of ACOM!

1) **Assessment type:** update/SALY
2) **Assessment** There is no analytical assessment for Cod in Subdivision Vb_2 (Faroe Bank)
3) **Forecast**: not presented
4) **Assessment model**: descriptive – survey based (summer + spring survey)
5) **Consistency**: Perception of stock status is unchanged, from both surveys. Consistent with the advice given in 2009 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 for the period 1996 - 2002.
6) **Stock status**: Survey indices indicate that the stock is at a low level. Catches have declined steeply in the last four years while exploitation ratios (proxy for fishing mortality) remains higher than average. Biological reference points have not been defined
7) **Man. Plan.**: No Management Plan agreed

General comments

Given the poor data and assessment situation this was a fairly short section; within these limitations it was well documented, well ordered and considered section in the report. The text in the report is an update from last year's report containing only a limited number of tables and figures that appeared to be also updated.

Technical comments

- The review was restricted to a check whether the assessment was carried in the same way as last year and as detailed in the annex. This was the case. No deviations were spotted.
- The report has just been updated to include the 2009 data.
- The assessment is primarily based on two survey indices where the catch rates (kg/hr) are used as an index for indicating stock trends.
- the data have been used as specified in the stock annex.
- the assessment has been applied as specified in the stock annex
- Figure 3.7.2. should be labeled to identify which line is which survey.
- there seems to be some evidence of a response in survey cpue (late 90's) following reductions in landings (early 90's).

Conclusions

The assessment was purely descriptive. Survey indices indicate that the stock is at a low level.

There are many assessment methods proposed for data-poor stocks, and a benchmark assessment should consider some of these approaches (e.g. Bayesian production model with errors in catch, etc.).

Stock: Cod in Subdivision Vb2 (Faroe Plateau) (report section 4)

Short description of the assessment: extremely useful for reference of ACOM!

1) **Assessment type:** update/SPALY
2) **Assessment**: analytical
3) **Forecast**: a short-term prediction until year 2012 carried out with MFDP by using a management option table and yield per recruit routines gives landings dependent on Fbar; the initial stock size was taken from XSA for all ages (2-10+). No medium term projection was performed. However, a long-term prediction was performed instead using MFYPR indicating the development of Y/R dependent on Fbar.
4) **Assessment model**: XSA based on commercial catch-at-age data for 1961-2009 and ages 2-10+, plus two tuning fleets (1 summer survey for period 1996-2009 and ages 2-8, 1 spring survey for period 1993-2009 and ages 1-8).
5) **Consistency**: The perception of the state of the stock is not really consistent with that of last year in terms of biomass. Last year SSB in 2009 was estimated to be 16kt < B_{lim} (see below), whereas this year SSB in 2009 is estimated to be 22kt > B_{lim}. These differences are not apparent in retrospective plots (i.e. Fig. 4.9.1) and must be related to a change in data. Catch at age data for 2008 were updated from the last assessment. This was related to revision of landings, and the 2008 landings are now considered official. This year the retrospective pattern on F3-7 seems stronger than the 2009 report.
6) **Stock status**: The reference points for this stock are: B_{pa} = 40kt, B_{lim} = 21kt, Fpa = 0.35 and F_{lim} = 0.68. The current fishing mortality (2009) is estimated as 0.46, and the average F for 1997-2008 = 0.58, is above rates that would support an optimal yield and low risk of stock depletion ($F_{0.1}$ and F_{max}). Under status quo F the stock is expected to increase above B_{lim} in the short term up to 55000 in 2012 which is optimistic.
7) **Man. Plan.**: An effort management system was implemented in the Faroese demersal fisheries in Division Vb in 1996 to achieve sustainable fisheries. The aim of the effort management system was to harvest on average 33% (in numbers) of the exploitable stock of cod. This management plan has not been evaluated by ICES.

General comments

This was a well documented, well ordered and considered section. The text in the report is an update from last years report with relative little changes.

The more optimistic view in the2010 assessment is largely due to the value of recent recruitment (2007 and 2008 YC) as seen in the surveys.

Based on the most recent estimates of SSB (in 2010) and fishing mortality (in 2009), the stock is classified as suffering reduced reproductive capacity and as being harvested unsustainably.

There are some overstatements e.g. in the scientific data section, the comment about the spring survey cpue being considerably higher in 2009-2010 or in the state of the stock, the trend in fishing mortality from 1996 is not that obvious and the change in perception is due to the revision of the 2008 value from 0.76 to 0.43.

The section on MSY in the Long term forecast is not very conclusive although the attempt is worthwhile. The relation is described in Steingrund 2010 and deserves a closer look before using it in an MSY context.

In the same section, the rational for the statement that 0.39 could be a candidate for Fmsy (paragraph 10 of the section) is not clear.

Technical comments

- The review was restricted to a check whether the assessment was carried in the same way as last year and as detailed in the annex. This was the case. No deviations were spotted.
- There is an error in the stock annex section D : the ages and year ranges should be 1-8 and 1993-2008 for the spring survey used for tuning.
- Some tables have been updated during the review (content and titles).
- The caption for Table 4.2.4 seems wrong. Values are not in percentages.
- the data have been used as specified in the stock annex
- the assessment and forecast model has been applied as specified in the stock annex except for the recruitment value used in the short term forecast.
- The weights at older ages in Table 4.2.7 seems very noisy and should probably be modeled in the future. This may have substantial effects on SSB's.
- The projection values for weights at age deviated somewhat from the annex. The annex says constant values are used for each of the three projection years. This is not the case in Table 4.7.3. The differences are not too large however.
- The range of years in Table 4.2.9 for the summer survey does not match the data, but the XSA seems OK.
- The calculation of recruitment in the short term forecast deviated from the annex. The annex says to simply use the most recent XSA estimate. In the assessment, "The strength of the 2008 year class was estimated as the average of 33 and 16 millions. The higher value was obtained from the XSA run. The lower value was obtained from a regression of recruitment versus the number of 1year old cod caught deeper than 200 m in the spring survey." The rationale for this change was "such a high value is not expected when the contemporary age 3+ biomass (see Steingrund et al., 2010) is as low as 40 thousand tonnes".
- the main conclusions are in accordance with the WG report

Conclusions

The assessment has been performed correctly. The information given by the assessments is sufficient to provide advice. SSB in 2010 is > B_{pa} and F_{lim} < F2009 < F_{pa}

Stock: Faroe Haddock in Division Vb (report section 5)

Short description of the assessment: extremely useful for reference of ACOM!

1) **Assessment type:** update/SPALY
2) **Assessment**: analytical
3) **Forecast**: a short-term prediction until year 2012 carried out with MFDP using the same procedures as last year. No medium term projection was performed. A long-term prediction was performed instead using MFYPR indicating the development of Y/R dependent on Fbar.
4) **Assessment model**: XSA based on commercial catch-at-age data for 1957-2009 and ages 0-10, plus two tuning fleets (1 summer survey for period 1996-2009 and ages 1-8, 1 spring survey for period 1993-2009 and ages 0-6).
5) **Consistency**: This assessment is an update of the 2009 assessment, with exactly the same settings of the XSA. There were minor revisions of recent landings according to revised data. Tuning indices were revised since errors were found in some formulas calculating the stratified mean numbers at age from the surveys. This affected indices at age from 2007 onwards. The effects of these revisions were negligible and the conclusions on the status of the stock made in 2009 are similar in these two assessments.
6) **Stock status**: The reference points for this stock are: B_{pa} = 35kt, B_{lim} = 22kt SSB, F_{pa} = 0.25 and F_{lim} = 0.40. $F_{0.1}$ estimated at 0.19. The current fishing mortality (2009) is estimated as 0.25. B2010 is projected to be 17kt which is less than Bl_{im}. The stock is at a low level, where recruitment over-fishing is a concern. Under status quo F the stock is expected to remain below B_{lim} in the short term (i.e. 20kt SSB in 2012).
7) **Man. Plan.**: An effort management system was implemented in the Faroese demersal fisheries in Division Vb in 1996 to achieve sustainable fisheries. The aim of the effort management system was to harvest on average 33% (in numbers) of the exploitable stock of cod. This management plan has not been evaluated by ICES.

General comments

This was a well documented, well ordered and considered section. The text in the report is an update from last years report with relative little changes.

Based on the most recent estimates of SSB (in 2010) and fishing mortality (in 2009), the stock is classified as suffering reduced reproductive capacity and may be harvested unsustainably. However, a tentative exercise running the short term prediction a few more years more than usual indicates that with the same settings and a status quo fishing mortality, the spawning stock biomass will increase above B_{lim} in 2014. Of course this depends on average recruitment being realized.

Technical comments

- The review was restricted to a check whether the assessment was carried in the same way as last year and as detailed in the annex. This was the case. No deviations were spotted.
- the data have been used as specified in the stock annex
- the assessment and forecast model has been applied as specified in the stock annex.

- The title to Table 5.1 refers to landings in Vb1, when in fact the totals given at the bottom are for Vb (I think). This title should be clarified to reflect what the table is about.
- the main conclusions are in accordance with the WG report

Conclusions

The assessment has been performed correctly. The information given by the assessments is sufficient to provide advice. Management of fisheries on haddock needs to take into account measures for cod and saithe. SSB in 2010 is projected to be less than B_{lim} and F2009 is approximately equal to F_{pa}.

Stock: Saithe in Division Vb (Faroe saithe) (report section 6)

Short description of the assessment: extremely useful for reference of ACOM!

1) **Assessment type**: update/SPALY
2) **Assessment**: analytical
3) **Forecast**: Deterministic short term analytical forecast presented (Fsq=F(2007-2009), unscaled to F2009).
4) **Assessment model**: XSA tuning with commercial CPUE.
5) **Consistency**: 2006-2009 assessments were rejected due to retrospective pattern. In the current adopted assessment, the standardisation of commercial CPUE data carried out at the 2010 benchmark assessment has resulted in a substantial reduction in the bias observed in the retrospective pattern in the last years assessment.
6) **Stock status**: SSB in 2010 is 115kt which is above the ICES B_{lim}=60kt and B_{pa} = 85kt. F in 2009 was 0.47 which was higher than F_{lim}=0.4 and F_{pa}=0.28. With status quo fishing mortality SSB in 2012 will decrease to 100kt.
7) **Man. Plan.**: There is no management plan. Fishery is managed with annual TAC and technical measures. *Status quo* fishing mortality will produce 57.000 tons of catches in 2011.

General comments

In general, this was an ordered and well considered section. However tables and figures numbers could be number with the section numbers. Figures and tables of section 6.2.3 text should start with this number to make it easier to find tables or figures.

Technical comments

- The review was restricted to a check whether the assessment was carried in the same way as last year and as detailed in the annex. This was the case. No deviations were spotted.
- Table 6.2.1.1. have some superscripts that are not explained as table footnotes.
- Section 6.2.1 The description of the catches in the text is based on the Working Group catches estimates. In my opinion it would be necessary to explain the differences between the Total and the Working Group catches estimates.
- Section 6.3. Results of the fishing mortality and Patterns in log-catchability residuals from the XSA and Adapt in the last year 2009 could show a change in the exploitation pattern in 2009. Years before seems to be more or less flat for the exploitation ages and in 2009 seems to be domed shape. The assessment model suggests that fishing mortality has remained reasonably stable in recent years (Fbar) but for ages 6-9 have increase in the last year and for oldest ages have decreased.
- Section 6.3.1 and Figure 6.5.1.2. In my opinion, it is difficult compare Fmax when the Yield per Recruit curve maximum is not well define as it seems this case.
- Section 6.4 "The relation between stock and recruitment (Figure 6.6.3) shows that the highest recruitment has been observed at lower levels of

SSBs". Other intrepretation is that the highest recruitment has been observed close to the B_{pa} level.

- Section 6.5.1. I think it would be good to explain why the annex specifies in the projections the weights are taken as the 2009 weights-at-age and not the mean of the 3 last years as usual. Other point in this chapter is why the exploitation pattern for short term prognosis is set to the unscaled three year average from 2007 to 2009. If the change in the 2009 exploitation pattern is true then the projections results could be slightly different. It would be good see the different between the two options.
- 2010 estimates are not included in Figure 6.6.1 and 6.6.2, whereas the 2010 estimates were included in some other stocks.

Remarks by the reviewers

- The 2010 benchmark workshop explored the XSA model in association with updated catch-at-age data. The commercial CPUE series was also updated and standardized to better represent a measure of total stock abundance. These data and model updates have reduced very much the retrospective patter in the present assessment. The retrospective patter was the main cause to not approve last year the assessment.
- The XSA approved diagnostics seem to have a good quality and the XSA results are similar to other models (ADAPT, TSA, Separable).
- WG suggests that a Management Strategy Evaluation (MSE) framework be used for evaluation of reference points and harvest control rules with the new assessment approved. In my opinion MSE would by a good way to calculate the new reference points taking in account the uncertainty in the results.
- Inputs for the deterministic short term projection (mean weight-at-age and exploitation patter) should be tested to see the robustness of the results.
- It is surprising that a benchmark concluded that 2 surveys were unreliable for tuning XSA, but that a CPUE index was reliable.

Conclusions

The assessment has been performed correctly. SSB in 2010 is above B_{lim} and F in 2009 was higher than F_{lim}.

There is a need for revision of reference points. Otherwise the assessment provides a solid basis for the formulation of the advice.

Stock: Saithe in Icelandic waters – Saithe in Division Va (report section 8)

1) **Assessment type**: update
2) **Assessment**: analytical
3) **Forecast**: Short term deterministic analytical forecast presented;
4) **Assessment model**: Separable Statistical Catch-At-Age model tuning with survey information. Selectivity is constant over the time period 1980-1995 and 1996-2009, but could be different between these two periods.
5) **Consistency**: Results of this years assessment are somewhat consistent with last years assessment.
6) **Stock status**: The 2009 estimate of fishing mortality (0.47) is higher than the approved Fpa (0.3) and the Fmsy (0.28) and $F_{0.1}$ and is unsustainable. The 2010 estimate of SSB (86.000 tonnes) is less than Blim (90 000 tonnes) but much less than Bpa (150 000). B2010 is very close to the Btrigger candidate (80.000).
7) **Man. Plan**.: Advice for Icelandic saithe has been based on fishing at F_{4-9}=0.3 except when the spawning stock has been below 150 thous tonnes.

General comments

In general, this was an ordered and well considered section. However tables and figures numbers could be number with the section numbers and in order as appear in the text. Figures and tables of the 6.2.3 text section should start with this number to make it easier to find tables or figures.

There are substantial differences in the tables of population estimates in the current document (Table 8.11) and the report from last year (Table 8.10). These differences require clarification. One year retrospective results (Figure 8.9; see technical comment below) are substantially different which is worrying. Additional text to that presented in Section 8.9 is required to explain what is happening.

Technical comments

- Figure 8.5 caption "Saithe in Division Va. Shown are a) total biomass indices, b) biomass indices larger than 55 cm, biomass indices smaller than 90 cm and d) abundance indices smaller than 55 cm. The lines with the shades show the spring survey indices from 1985 (SMB) and the points with the vertical line she fall survey indices from 1997. The shades and the vertical lines indicate +/- 1 standard error". It should be "Saithe in Division Va. Shown are a) total biomass indices, b) biomass indices larger than 55 cm, c) biomass indices smaller than 90 cm and d) abundance indices smaller than 55 cm. The lines with the shades show the spring survey indices from 1985 (SMB) and the points with the vertical line she fall survey indices from 1997. The shades and the vertical lines indicate +/- 1 standard error".
- "8.2 Assessment method" Section, it should be 8.4 and all later sections should change the numeration.
- In the assessment method chapter, there is not explanation about the SSB/R relationship used by the assessment model. I think the SCAA model need to assume one SSB/R relationship.

- Figure 8.8 plot the f_{5-10} and the F_{bar} is between 4-9. I think that in Figure 8.8 should be the F_{bar} plot.
- Section 8.4.. "The model was then run forward for number of different fishing mortalities". In my opinion, it would be necessary to know how long are the projections of simulations (years).
- Section 8.4. "No SSB/recruitment relationship. Gives an indication of yield per recruit". How is the recruitment estimate in this case for the projections. Bootstrap from the assessment results?? It is not clear for me how is estimate the recruitment in the projections or simulations.
- Section 8.7 "Short term forecast". "The assumed recruitment of around 30 million fish for year classes 2008 onward are the estimate of the assessment modal". It not very clear for me where the recruitment estimates come from. The recruitment projection inputs are different for each year. Is calculate based on SSB/r relationship for each year or only is calculated the 2008 year class and you assume the same recruitment level for all year and the different come from some error assumption? This should be described better in Section D of the annex.
- Figure 8.9. (retrospective) is difficult to see the different runs due to the colours.
- Some of the retrospective results are different than in the last assessment. For example, Fbar in 2008 was 0.38 in the last assessment (see Table 8.1 in the 2009 WG report) whereas it is much higher (almost 0.6) in Figure 8.9 of this report based on the second last run which I presume is based on the same data as last year.
- N3 numbers in Table 8.11 are different than N3 in Table 8.10.

Remarks by the reviewers

- Uncertain survey indices are a major concern for this assessment due to the low quality of the survey indices for this species. However, the model is mainly driven by catch data. Since discard seems to be no problem for this fishery and landings data are of good quality, the assessment is certain enough to give advice.
- The group suggests new candidates for Reference Points (RP). I don't know very well the new ICES protocol to approved the new Reference Points but the results shows that the new RP seem to be robust and sustainable.
- The group suggests a candidates for the Harvest Control Rules (HCR). I don't know very well the new ICES protocol to approved the new HCR but the results shows that the new HCR seem to be robust and sustainable.
- The stock annex provides comprehensive and valuable information for stock assessment.

Conclusions

The assessment has been performed correctly, although it is uncertain due to the quality of the survey indices used. The information given by the assessments is sufficient to provide advice.

The assessment indicates that the stock is at a low level where productivity is impaired (i.e. SSB in 2010 < B_{lim}), and the current fishing mortality rates are not sustainable (i.e. F in 2009 > F_{pa}).

Stock: Icelandic cod (section 9)

1) **Assessment type**: update/SPALY, but formulation has changed
2) **Assessment**: analytical
3) **Forecast**: short term forecasts are presented
4) **Assessment model**: ADCAM tuned with the spring and the fall survey indices. In 2010 the model settings were modified from last years, the tuning data changed by addition of the Fall survey, estimation of immigration of age 6 in 2009, and spring survey q at age one is estimated separately for the time period 1985-2001 and 2002-2010. Analysis and conclusions using different ADCAM Time Series Analysis formulations are presented, ADAPT and Separable analysis have been explored but not presented.
5) **Consistency:** The assessment is roughly in line with that from 2009. Reference fishing mortality in 2008 is now 0.38 compared with 0.42 estimated last year. The SSB in 2009 estimated to have been 254 kt compared with 223 kt.
6) **Stock status:** The spawning stock is relatively small compared to the period around 1960 and is estimated to be about 300 kt. The year classes from 2001 to 2007 are below average. The preliminary estimates of the 2008 and 2009 year classes indicate they may be above average or strong. The productivity of the stock at present is very low. Fishing mortality has declined in 2008 and is estimated around 0.4. Biological reference points have not been defined.
7) **Man. Plan.**: A formal Harvest Control Rule was implemented for this stock in 1995. The TAC for a fishing year was set as 25% of the "available biomass", computed as the biomass of age 4+ over intermediate and projection years. Following a request in 2009 and the ICES evaluation report in 2010 a new HCR is implemented TAC was set at 150 000. According to the harvest control rule the TAC in the next fishing year is 160 kt. Fishing mortality is expected to decline further from a point estimate of just under 0.4 in 2009 to 0.3 in 2010 and beyond..

General comments

The report is well in general and the text is an update from last years with substantial changes.

Technical comments

- The stock annex was made available this year. The reference section was not completed (any reference for ADCAM?)
- The review was restricted to a check whether the procedures described in the technical annex (handbook) were applied, and a comparison with last years assessment was performed
- The assessment procedure is consistent with the stock annex. However, there is a general lack of diagnostics to judge on the fit of the ADCAM to the data (especially on the estimated parameters). Also, the software is not readily available on the WG website.
- Tables and figures should be made available other than as images in the report for easier review.

- Chapter 9.2.1. Landings of cod in 2009 mentioned as 183 kt, however in table 9.2.1. is not updated to 2009 figures and in table 9.7.1 is 181.
- Table 9.2.1. Missing landings data for Iceland and for 2009 all figures. Figures need renumbering, there is no figure 9.2.3. Figure 9.11.1 is numbered 9.1.1.
- Section 9.2.2. .the comment on there seems to be an increase of older age groups in the recent catch is not well supported by table 9.2.2
- Section 9.4. is hard to follow, there are mention of ADAPT, SEPARABLE and TSA exploration, the later being described in a WD but not included in the report . In the overview section there is no clear support for the final choice for the method and formulation. Why estimate survey q separately?
- In exploration of the TSA framework, there is a reference to an equation (4) from WD but not in the report (about random walk).
- Similar to Section 9, it is not clear where the recruitment estimates come from in the short term projections. This should be described better in Section D of the annex.
- 2009 values are not in Table 9.2.1.

Remarks by the reviewers

- Many models and formulation were looked at during the WG meeting but there is not much in the report on these other formulations.
- The assessment ADCAM model and formulation using 2 surveys was chosen because it "gives estimates that are somewhere between the extreme ranges", and that "the working group concluded that that may the most pragmatic compromise as an advice basis this year"
- The WG suggested to set a B_{lim} at 125 kt based on a hockey stick S/R, but looking at the figure, there is no evidence of a break point and the value proposed is more of a B_{loss}.
- This year both the spring and the fall survey were used in the tuning, compared with last year when only the spring survey was used in the final run. Without further information on what may be going on in these surveys, I agree that both should be used.

Conclusions

The assessment has been performed correctly, although it is uncertain as the results from alternative model show. The information given by the assessments is however sufficient to provide advice. There is an urgent need for a benchmark to set a definitive framework for the assessment, chose a model formulation ("Update assessment framework" as mentioned in section 9.2.1) and define reference points.

Stock: Icelandic haddock (section 10)

1) **Assessment type:** update/SPALY
2) **Assessment**: analytical
3) **Forecast**: Short-term forecasts using the same procedures as last year gives expected future landings dependent on Fbar; these forecasts indicate that stock size and landings will decrease rapidly in coming years when the large year classes disappear. Also similar to last year, medium-term stochastic simulations were conducted to see how much risk there was of going below Bloss in 2015.
4) **Assessment model**: ADAPT type model; the assessment is based on age-disaggregated landings from 1979 to 2009; the model is tuned with survey data from the March survey 1985–2010 and the October survey 1995–2009. The model included ages 1-12 this year, whereas last year the model included ages 1-9. The assessment does not include discards, which are thought to be small in recent years. The assessment is compared with three other models: TSA, XSA, and ADCAM.
5) **Consistency**: The estimates for biomass and fishing mortality are consistent with that of 2009; the basis for the advice is the same as in 2009; however, in 2009 the WG recommended to lower the target F from 0.47 to 0.35 to keep the effort comparable to what 0.47 led to earlier; given this the predicted catch for 2010 is 55 000 t and for 2011 is 51 000 t.
6) **Stock status**: No reference points are defined; given this the state of the stock cannot be evaluated; however, the recent spawning stock size has decreased and is predicted to decrease rapidly next years when strong year classes disappear from the stock and average year classes replace them; recent recruitment has been around the long-term average since year class 2004; growth has reduced considerably and at the beginning of 2010 the mean weight of most age groups was near a historic low; the large 2003 year class grows especially slowly.
7) **Man. Plan.**: There are no explicit management objectives and no management plan defined for this stock; however, the WG recommends the application of a lower fishing mortality than before (i.e. F_{4-7}=0.30) as under the current conditions a fishing mortality of F_{4-7} = 0.35 is seen to lead to similar results as in case of F_{4-7}= 0.47 in previous years (1985–2000).

General comments

This was a well documented, well ordered and considered section. The text in the report is an update from last years report with a few changes. The result of the assessment gives the same perception of the stock and fishery as last year's assessment. There was no annex to check the assessment against.

Technical comments

- The review was restricted to a check whether the assessment was carried in the same way as last year. Only minor deviations were spotted.
- the main conclusions are in accordance with the WG report

Conclusions

The assessment has been performed correctly. The update assessment gives a valid basis for advice.

Stock: Icelandic summer spawning herring (section 11)

Short description of the assessment: extremely useful for reference of ACOM!

1) **Assessment type:** update/SPALY
2) **Assessment**: analytical
3) **Forecast**: There is uncertainty in the assessment due to the development of the *Ichthyophonus* infection in the stock and the WG did not consider a short-term forecast to be useful.
4) **Assessment model**: NFT-ADAPT and TSA using catch at ages 3-12+ and survey indices from 1 survey
5) **Consistency**: The estimates for biomass and fishing mortality are consistent with that of 2009. Retrospective differences for the last few years are seem small. However, the advice is different due to levels of *Ichthyophonus* infection found in 2009.
6) **Stock status**: unknown. The assessment indicates the stock in SBL (SSB 2010 = 246kt > Blim = 200kt) but a second outburst of *Ichthyophonus* infection was observed that will further reduce the stock in 2010.
7) **Man. Plan.**: There is no formal management plan but there is a 'tradition' to set TAC based on F=0.22

General comments

This was a well documented, well ordered and considered section. The text in the report is an update from last years report with relative little changes.

The annex was vague on the formulation of the assessment model, and simply says that model options may differ slightly between years – to be described in WG reports.

Technical comments

- The review was restricted to a check whether the assessment was carried in the same way as last year and as detailed in the annex. This was the case. No deviations were spotted
- This is an update assessment. Comparison of the tables shows that there were no revisions in last year's data. Only the year 2009 has been added.
- The surveys are been carried out in an unusual way (non standard area), but apparently this has been done so for a long time and is an Icelandic tradition. Do the surveys provide an index time-series that is comparable from year to year? Is it possible to roughly estimate the fraction of the stock that is surveyed, based on commercial fishery distribution information?
- Table 11.3.2.1.says that there are 7 indices, but only one survey is used with 7 ages. It should be clarified why each age seems to be treated as a separate index. Is it for self-weighting?
- The increase in catchability at ages 9 and 10 shown in Fig 11.3.2.1 is curious. Why would these ages be more represented in the survey? To help understand this, it would be useful to plot the fishery partial recruitment, averaged over some range of years.

- SSB in the beginning 2010 is estimated at 430 kt. Accounting for mortality because of the *Ichthyophonus* infection, a fixed mortality percentage of 43% has been applied to the stock in SSB. SSB in 2010 becomes than 246kt.
- The fact that proportion of M before spawning is set at 0.5 (summer spawners) is used in the prediction. Does this means that the SSB after the predicted TAC's have been taken is at spawning time? The standard summary table suggests that the SSB result of the assessment is at 1st January. If that is the case the SSB in the prediction cannot be compared with the assessment.
- Due to the uncertainty regarding the development of the *Ichthyophonus* infection in the summer 2010, the WG consider it necessary to postpone a recommendation of final TAC until the results of a planned survey early next autumn and more information about the infection rates become available.

Remarks by the reviewer

- Surveys can have year effects which show up as correlated residuals. However, I find cohorts effects in residuals more puzzling. Several cohorts in Figure 11.2.3.2 have residuals mostly with the same sign. This could be cohort-specific deviations from the assumed M, but I wonder if it could also be explained by violations in some other ADAPT assumptions.
- The main difference between ADAPT and TSA is TSA estimates the 1999 and 2000 year classes weaker than NFT Adapt did. Since ADAPT seems to under-estimate these year classes I think TSA must under-estimate even more. So on the surface there does not seem to be a reason to prefer TSA

Conclusions

The assessment has been performed almost the same way as last year and only data were updated. There should soon be a benchmark to set a definitive framework for the assessment.

The advice will depend on the severity of the *Ichthyophonus* infection. The magnitude of that will become clear later in the year. In consultation with the client, the advice should be postponed to later in the year, when the magnitude of the infection is clearer.

Stock: Capelin in the Iceland–East Greenland–Jan Mayen area (section 12)

1) **Assessment type**: update/SPALY
2) **Assessment**: analytical (acoustic measurements)
3) **Forecast:** not presented
4) **Assessment model:** The calculations are simple back-projections of stock numbers. The stock numbers at age are calculated on the January 1st with take into account the results from the acoustic surveys and catch taken by the fishery. The TAC for the next season is calculated from the prognosis on fishable stock take into account monthly natural mortality and a linear relationship between the abundance of one years old capelin (1 January) and the number of 2 years old mature capelin in the autumn, and the same method for the 3 years old mature ones. An account is taken mean weight that gain from autumn to winter and that the number have to be left to spawn.
5) **Consistency:** The Benchmark Workshop on Short-lived Species (WKSHORT) in 2009 was unable to approve the assessment of Icelandic capelin. This was primarily because there are reasons to believe that that the value of natural mortality used in the assessment (0.035 per month) is too low. The current assessment was using the same methodology and the same natural mortality value as last year and that it was not approved by WKSHORT. I think NWWG should clarify a bit more in the report the reasons of why if the assessment methodology it was not approved by WKSHORT, this year they used the same and with the same natural mortality value.
6) **Stock status:** The state of the stock is very uncertain. The SSB is highly variable because it is dependent on only two age groups. The stock have been at low levels the last 5 years. Reference points have not been defined. The proposal is to use B_{lim}=400 000 t, which is the targeted remaining spawning stock (in march). Last estimations gives 410 000 t were left for spawning in spring 2010. The advice is therefore not to open the fishery in the season 2010/11 until new assessment will be available.
7) **Man. Plan.:** The fishery is managed according to a minimum spawning-stock biomass of 400 000 t by the end of the fishing season (march). The initial quota is set at 2/3 of the preliminary TAC. Later based on the results of another survey conducted during the fishing season the initial quota is revised 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.

General comments

This was a well documented text. In my opinion it would be good divided the chapter 12.2 and 12.4 in subchapters to be more easy reading. The text in the report is an update from the last year report with a few changes. It was easy to follow and to interpret.

Technical comments

- Chapter 12.1. It should be good present a map with the stock distribution.
- Chapter 12.2 . Table 12.2.1 only presents the survey results for 2009. With this table it is impossible to compare the results with the previous years and to know if the level of biomass or abundance are high or low for people not related with this stock. I would propose to include a new table with the historical series of abundance and biomass by age.
- Figure 12.2.1. "Capelin. Cruise tracks and trawl stations (upper figure), distribution of 1-3 year old capelin (lower figure) and the ice edge during an acoustic survey by r/v Arni Fridriksson in November/December 2009". It is not clear for me the figure caption, I only see one figure and the caption says there are upper and lower??.
- Chapter 2.2. Surveys on the adult fishable stock. For me it is not clear the following sentence: "A few days later on the 3rd of January a part of this migration entered the coastal waters at SE Iceland (Myrarbugur)." The time reference is the end January and few days later it should be February.
- Figure 12.2.4 caption "Capelin. The distribution of SA-values, cruiselines and trawl stations from an assessment survey carried out with M/V Börkur February 8, 2010." In this figure I only see the cruise lines. It is difficult see where were the trawl stations and the SA values.
- Figure 12.2.6 caption "Capelin. The distribution of SA-values from an assessment survey carried out with r/s Arni Fridriksson, February 14-17, 2010. Black lines show the cruise lines." In the text (Chapter 2.2) appear February 14-18.
- Table 12.3.2 caption " 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". It should be summer-autumn season to be consistent with all Chapter 2.3 text.
- Table12.3.5 caption "Preliminary TACs for the summer/autumn fishery, recommended TACs for the entire season and landings (000 tonnes) in the 1994/95–2008/09 seasons". It should be 1994/95–2009/10 seasons.

Remarks by the reviewer

The assessment has been performed with the last years model and the Benchmark Workshop on Short-lived Species (WKSHORT) in 2009 was unable to approve the assessment of Icelandic capelin. This was primarily because there are reasons to believe that that the value of natural mortality used in the assessment (0.035 per month) is too low. The current assessment was using the same methodology and the same natural mortality value as last year and that it was not approved by WKSHORT.

In my opinion if the WKSHORT considered the natural mortally value very low last year, this year it should have tried a natural mortality value higher than the 2009 value.

The stock annex is brief and should include a better description of the projection model.

Conclusions

The state of the stock is very uncertain. The information given by the report and the uncertainty in the results are sufficient to advice not to open the capelin fishery until new acoustic surveys measurement will be done in late 2010 and early 2011.

Stock: Cod in ICES Sub-area XIV and NAFO Sub-area 1 (Greenland cod) (report section 14)

Short description of the assessment: extremely useful for reference of ACOM!

1) **Assessment type:** update
2) **Assessment**: survey trends
3) **Forecast**: not presented
4) **Assessment model**: descriptive, trawl and gill-net survey abundance indices used to estimate SSB index; CANUM and WECA not used in the assessment
5) **Consistency**: Update assessment.
6) **Stock status**: Two survey abundance indices indicate that the cod stock is presently considerably above the very depressed state observed in the 1990's. However, the stock is well below historical levels. The surveys indicate an improvement in recruitment with almost all year-classes since 2002.
7) **Man. Plan.**: Greenland and EC established an agreement on offshore fisheries valid from 2007 to 2012. A variable TAC regulation has been agreed, with annual TACs adjusted to take account of ICES information on stock trends but aiming at fishing mortalities at 0.1. The agreement also provides for a transfer of unutilized quota into future years, should a rapid increase in the stock occur. The management agreement between EC and Greenland has not been evaluated by ICES.

General comments

This was a well documented, well ordered and considered section. The text was relevant to tables and figures presented, and the text was also easy to follow. The assessment (trends) is consistent with last year's assessment.

Technical comments

- Technical annex was made available to Review Group this year. The annex provided very thorough information on surveys both in terms of their weakness and advantages. It would be very useful for clarity to provide for each survey a map of the area covered and stratification used (for the trawl surveys). Also for clarity the use of an acronym or at least a standardized name for each survey would be welcome ("Inshore gillnet survey" in the annex, "West Greenland young cod survey" in the report).
- Errors in the titles of sections 14.3.2 and 14.3.3 change 2008 to 2009.
- Tables and figures are correctly ordered and numbered in line with the text of the report. Tables and figures are correctly labeled and the units of measure always presented.
- There are references to WDs in the text but these are not readily available or included in the report (sections 14.2.3 WD 16, 2010 and 14.2.4 WD 19 2008 .

Remarks by the reviewer

- Since 2008 both trawl surveys are covering East and West Greenland which is an improvement as the total area of distribution is covered.

- There is an issue is poor area coverage due to stormy weather conditions observed in number of years. This again reflects that survey biomass and abundance estimates correspond to only a part of the whole area in some years.
- The absence of the 2003 YC in the East Greenland German survey in 2009 is not surprising as it does seem to follow a general pattern as shown in table 14.8. Cod seem to disappear after age 4, this pattern is not seen in East Greenland, table 14.9. This is related to migration to spawning grounds.
- There is also a question on how to proceed with large hauls that may represent large part of the abundance and biomass.

Conclusions

The assessment has been performed correctly. Surveys provide the core information relevant for stock assessment purposes. The information given by the assessments is sufficient to provide advice.

This stock could benefit from a benchmark assessment.

Stock: Greenland halibut in Sub-areas V, VI, XII and XIV (Greenland halibut) (report section 15)

Short description of the assessment: extremely useful for reference of ACOM!

1) **Assessment type:** update/SPALY
2) **Assessment**: logistic production model in a Bayesian framework
3) **Forecast**: logistic production model in a Bayesian framework
4) **Assessment model**: the assessment was performed using difference version of the Schaffer model in Bayesian framework. Three tuning series were used, one commercial CPUE and two surveys.
5) **Consistency**: in 2007 the stock production model was presented in a Bayesian framework and accepted by the NWWG. This approach was accepted in the 2008-2009 assessments. Model parameters are fairly consistent, although a notable difference is MSY was estimated as 29 kt in the 2009 estimate, but 23 kt in this assessment.
6) **Stock status**: Stock size: stock biomass $0.4B_{msy}$ (median), 100% probability of being below B_{msy}, 6-33% risk of being below B_{lim}. Exploitation: $3.5F_{msy}$ (median), approx. 90% risk of exceeding F_{lim}.
7) **Man. Plan.**: 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.

General comments

This was a well documented, well ordered and considered section. The text in the report is an update from last years report with relative little changes.

Technical comments

- The review was restricted to a check whether the assessment was carried in the same way as last year and as detailed in the annex. This was the case. No deviations were spotted.
- The annex hardly describes the details of the Bayesian assessment model.
- Tables and figures are correctly ordered and numbered in line with the text of the report. Tables and figures are correctly labeled and the units of measure always presented.
- There should be a table a annual estimates of biomass and fishing mortalities.
- It is mentioned that, prior to the introduction of sorting grids in 2002, discards of Greenland Halibut in shrimp fisheries were much higher. It would be useful to assess the potential magnitude of discards relative to landings for this earlier period, and if possible include discards in the catch statistics.
- There were insufficient details in the WG report or annex on the exploratory fisheries/survey (Fig. 15.5.5). I did not understand differences between estimated and observed in this figure.
- Should state clearly that P = B/K in the report.

- Should show the posteriors for P2009, and implied priors for P1985 and P2009. With this we can better assess prior sensitivity.
- Is inference about current stock status relative to Bmsy sensitive to prior for K?
- The posterior for CPUE observation error was identical to the prior, so the statement that "the model was robust to changes in the priors for the process and observation errors" is questionable.

Remarks by the reviewer

- Included tuning series are consistent, showing similar trends.
- Residuals from the fitted values do not show specific patterns.
- Retrospective analysis was performed and produced consistent estimates of stock biomass.
- I did not understand "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. 15.6.8).". The model does not make recruitment predictions, at least explicitly.
- Stationarity assumptions with production models are always a concern.

Conclusions

The assessment has been performed correctly and makes good use of the available information. The assessment provides a basis for the formulation of the advice.

The stock is at a low level, and fishing mortalities are high.

Stock: Golden Redfish (Sebastes marinus) in Subareas V, VI and XIV (report section 17)

Short description of the assessment: extremely useful for reference of ACOM!

1) **Assessment type**: update/SPALY
2) **Assessment**: analytical.
3) **Forecast**: presented
4) **Assessment model:** Gadget using survey and cpue data
5) **Consistency**: consistent with last year
6) **Stock status:** survey cpue is above Upa, but very close to it. There is abundant conflicting information which suggest otherwise.
7) **Man. Plan.**: There is no management plan.

General comments

This is a well documented update assessment, described in an organised and informative(?) section. The report clearly states the problems related to the quality of the data used in the assessment.

Technical comments

- For this review the stock annex was not available in the NWWG share point. The annex in last years report for *Sebastes marinus* in ICES Subareas V and XIV seemed out of date, and contained almost no information on the formulation of the gadget assessment model.
- The review was restricted to a check whether the assessment was carried in the same way as last year. This was the case. No deviations were spotted
- Division Va. "In comparison the total biomass index in both surveys has shown great variability, especially in recent years, without any clear trend (Figure 17.2.1)". In my opinion this Figure (Mars survey total biomass) shows a clear increasing trend in the last years, since 2001, despite the great variability in the index.
- "Figure 17.2.3 Index on fishable stock of golden redfish from Icelandic groundfish survey in March 1985-2010. The shaded area and the vertical bar show ◎1 standard error of the estimate". It should be Figure 17.2.2
- Subarea XIV. "During the recent period of increase, both the fishable biomass (> 30 cm) and the biomass of pre-fishery recruits (17-30 cm) have increased considerable (Figures 17.2.8c and 17.2.18). It should be considerable (Figures 17.2.8c and 17.2.9).
- In Table 17.3.3 I assume that Pr(F) is the p-value, if this is the case it would be good to show 3 decimals to see the significance of the different factors.
- Figure 17.3.8. The bending of the tails of the QQplot points may be a cause for concern in the results of the GLM model.
- In the chapter 17.2.1 it is said that, according to survey information, the 1985- and 1990-year classes were very good. And chapter 17.4.1, based on the assessment results, draws the same conclusion. But it seems to me that the good year classes were 1984 and 1989. These year classes were 1 year old in 1985 and 1990. This

confusion between year classes and recruitment age 1 is found throughout the text.

- I have not a good knowledge of the model but in Figure 17.4.4 is possible to see a change in the residuals pattern in the years 1996-1997 and I think it should be explained in the text.
- 17.5 Reference points. "Based on these definitions, the stock has been in the vicinity of Upa during recent years (Figure 17.2.3)". It should be Figure 17.2.2
- 17.12 "A large proportion of the catch will be from the 1985- and 1990-year classes. The approximate F from the model would decrease from the current level and be close to Fmax". If we take the F_{20} as reference F (Table 17.7.1), we can see that 30.000 ton catches each year decrease F but not very much, and it will not be close to the estimated value of F_{max}=0.14.
- The reviewer had no experience with Gadget. It has been checked and confirmed that the model and its configuration are the same as last year.
- Some problems with the residuals pattern of the model and with unexpected survey indices for younger ages are explained in the report as being caused by immigration from other areas but there is no additional information to support this theory.
- "Alternative 2. Tows from the March survey that had catches larger than 2000 kg were set to 2000 kg." This needs more description. Was it only for sets <=400m depth range?

Remarks by the reviewers

- The stock occurs in several areas but the catches are almost entirely from area Va.
- 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 years but a decrease in the total biomass to the lowest level in the time series.
- One concern in the assessment is the quality of the survey data as stock indices for this species. There is great variability in the indices, caused by relatively few tows accounting for a large part of the total amount of fish caught.
- Icelandic authorities give a joint quota for golden redfish and Icelandic slope S. mentella in Icelandic waters. Quota for those two species should be given separately to facilitate the data recollection and management of both stocks.
- The removal of sets in the 400-500m depth range did not seem to reduce confidence interval lengths substantially (compare Fig. 17.2.1a and Fig. 17.2.3). I suggest this step is an unnecessary distraction

Conclusions

The assessment has been performed almost the same way as last year and only data were updated.

Catch advice of 30 kt in 2011 could be sustainable in the short term but in the medium term it will lead to a substantial reduction in total biomass.

This assessment is an urgent candidate for a benchmark with expertise from outside included.

Stock: Icelandic slope Sebastes mentella in Va and XIV (section 18)

1) **Assessment type**: update
2) **Assessment**: Based on survey indices. No analytical assessment.
3) **Forecast**: not presented (not possible).
4) **Assessment model**: Based on indices (poor data).
5) **Consistency**: The Icelandic autumn survey in Va gives the biomass index and biological data. CPUE and sampling from the commercial fishery also available. Results show the same picture as in last year assessment.

   At ADGANW a difference was noted between the total biomass index in this years report compared to last years report (Fig 18.2.1). It was clarified that the survey was re-stratified and this had some effect on the biomass index.
6) **Stock status**: The state of the stock is stable at a low level. The fishable biomass index from the Icelandic autumn survey shows that the biomass index for 2002-2009 has been at a lower level than in earlier years. Good recruitment has been observed on the East Greenland shelf but their contribution to the demersal stock is unknown. There are no biological reference points.
7) **Man. Plan.**: There is no explicit management plan for Icelandic slope S. mentella. The advice for 2008 and 2009 was limiting S. mentella catches to a maximum of 10 000 t as a starting point for the adaptive part of the management plan. However, the total landings in last years were well above this amount. Icelandic authorities give a joint quota for golden redfish and Icelandic slope S. mentella in Icelandic waters. Quota for those two species should be given separately to facilitate the data recollection and management of both stocks.

General comments

The poor data and the lack of long time series of survey indices of abundance prevent analytical assessment and the situation cannot be fully evaluated. However, the corresponding section in the report was well documented and organised.

Technical comments

- The review was restricted to a check whether the assessment was carried in the same way as last year. No annex was available for this review.
- Figure 18.2.1b. The text says "b) fishable biomass index (> 30 cm)", but on the picture we can see "in millions". It should change biomass by abundance.
- In Table 18.3.3 I assume that Pr(F) is the p-value, if this is the case it would be good to show 3 decimals to see the significance of the different factors.
- Chapter 18.3.4. "The length distribution of Icelandic slope *S. mente*lla from the pelagic fishery, where available, showed that in most years the fish was on average bigger than taken in the bottom trawl fishery". Any ideas to explain this? Different stocks, fishing time or mesh size? Lengths from the pelagic fishery seem more similar to the Deep pelagic *S. mentella* stock.

- Figure 18.3.8. The bending of the tails of the QQplot points may be a cause for concern in the results of the GLM model.
- Figure 18.3.7 finish in 2008, would it be possible to update the figure with 2009 data?
- 18.3.6 Discard. "This is because only the fishable stock is found in Icelandic waters". This sentence is not clear for me, what does mean?
- 18.4 Methods. "No formal assessment was conducted on this stock". In my opinion the assessment is formal but it is not analytical.

Remarks by the reviewer

From the biological view the "redfish line" is something strange and difficult to accept. This artificial line cannot split two migrating living stocks. This split favours misreporting (or mistakes) of data for different fisheries and stocks. Most of the Icelandic slope *Sebastes mentella* catches were caught very close to the redfish line and catches from the pelagic fishery are more similar to the Deep pelagic *S. mentella* stock.

Conclusions

There are a number of uncertainties in the assessment of the demersal *Sebastes mentella* on the Icelandic slope. The development of a management plan and definition of agreed reference point are necessary. For the last two years ICES advised that catches were set at a level no higher than 10 000 t as a starting point for the adaptive part of the management plan. There are no indications that there are changes in the stock status or advice.

This assessment requires a benchmark meeting.

Stock: Beaked Redfish (Sebastes mentella) in Division V, XII, XIV and NAFO Sub-areas 1+2 (Shallow Pelagic stock<500 m) (report section 19)

Short description of the assessment: extremely useful for reference of ACOM!

1) **Assessment type**: update
2) **Assessment**: Base on survey indices. No analytical assessment.
3) **Forecast:** not presented
4) **Assessment model:** descriptive, trawl-acoustic survey indices and commercial CPUE. Data poor.
5) **Consistency:** the data available for evaluating the stock status are similar to last year.
6) **Stock status:** Trawl pelagic estimate of the stock size in 2009 is one of the lowest of the time series, starting in 1991.
7) **Man. Plan.**: There is no management plan established. Last year ICES advised that no directed fishery should be conducted and by-catch of this stock in non-directed fisheries should be kept as low as possible. A recovery plan should be developed. Given the very low state of the stock, the directed fishery should be closed in 2010 irrespective of whether the recovery plan has been developed by that time or not.

General comments

Some chapters of the report for this stock (19.2, 19.9.4) seem to me that deal with two different redfish stocks (Shallow and Deep Pelagic). In my opinion all the paragraphs about pelagic redfish in general (Shallow and Deep Pelagic) should be moved to section 16 "Redfish in Subareas V, VI, XII and XI" and leave in section 19 all the subjects related only with the Shallow Pelagic stock.

Technical comments

- The review was restricted to a check whether the assessment was carried in the same way as last year. No annex was available for this review.
- 19.1 Stock description and management unit. "The following text table summarises the available information from fishing fleets in the Irminger Sea and adjacent waters in 2009:" In my opinion it should be clarify in the text that these fleets also fishing for other redfish stocks in the area (the deep pelagic stock) or move the paragraph to section 16 "Redfish in Subareas V, VI, XII and XI".
- 19.2 Summary of the development of the fishery. "A summary of the catches by ICES Divisions/NAFO regulatory area as estimated by the Working Group is given in Table 19.2.1 and shown in Figure 19.2.2". It should be Figure 19.2.3
- 19.2 Summary of the development of the fishery (pag. 2). "A large percentage of annual landings (50% on average) were taken in NAFO Area 1F in 200-2008, but 81% of the 2009 landings were caught in ICES division XIV (Table 19.2.1 and Figure 19.2.3)". The period should be 2000-2008.
- 19.3 Biological information. "The length distributions for the period 1989-2009 of biological stocks based on Icelandic data are shown in Figure 19.4.1". It should be Figure 19.3.1.

- 19.6 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 (see Table 19.7.1)". It should be Table 19.6.1
- There is a very good environmental background provided in the report.

Remarks by the reviewer

- The need and importance of having catch and biological data disaggregated by depth from all nations taking part in the fishery are essential to carry out the assessment of this stock.
- In general, the credibility of landing statistics is questionable. There are indications suggesting that unreported catches might be substantial.
- High variability in the correlation between trawl and acoustic indices and also the assumptions made about constant catchability with depths and areas makes the uncertainty of trawl estimates very high.
- It is not very clear in the text what it is the NWWG advice for this stock.

Conclusions

There are a number of uncertainties regarding the data quality and the methodology described in the report which gives in general the impression that the perception of the stock size is very imprecise. However all the indices (survey and commercial CPUEs) show very low level and last years ICES advice is still valid: no directed fishery should be conducted and by-catch of this stock in non-directed fisheries should be kept as low as possible. A recovery plan should be developed. Given the very low state of the stock, the directed fishery should be closed in 2010 irrespective of whether the recovery plan has been developed by that time or not.

This assessment requires a benchmark meeting.

Stock: Beaked Redfish (Sebastes mentella) in Division V, XII, XIV and NAFO Sub-areas 1+2 (Deep Pelagic stock>500 m) (report section 20)

Short description of the assessment: extremely useful for reference of ACOM!

1) **Assessment type**: update
2) **Assessment**: based on survey indices, and commercial CPUE.
3) **Forecast**: not presented
4) **Assessment model**: descriptive, trawl-acoustic survey indices and commercial CPUE. Data poor.
5) **Consistency**: the data available for evaluating the stock status are similar to those from last years.
6) **Stock status:** due to data uncertainties and the lack of reliable data no analytical assessment was carried out and consequently no ref. points can be derived. Based on the trawl survey estimates, there is indication of a decreasing trend in the time series. CPUE has been variable over the years. The exploitation rate for this stock is unknown.
7) **Man. Plan.**: There is no established management plan. ICES advised last year, on the basis of precautionary considerations, to reduce the fishery below the 2008 level to 20 000 t and to develop and implement a management plan. ICES suggests that catches of Deep Pelagic *S. mentella* are set at 20 000 t as a starting point for the adaptive part of the management plan.

General comments

Some paragraphs of this stock seem to me that deal with two different redfish stocks (Shallow and Deep Pelagic). In my opinion all the paragraphs about pelagic redfish in general (Shallow and Deep Pelagic) should be moved to section 16 "Redfish in Subareas V, VI, XII and XI" and leave in section 20 all the subjects related only with the Deep Pelagic stock.

Technical comments

- The review was restricted to a check whether the assessment was carried in the same way as last year. No annex was available for this review.
- 20.1 Stock description and management unit. "The following text table summarises the available information from fishing fleets in the Irminger Sea and adjacent waters in 2009:" In my opinion it should be clarify in the text that these fleets also fishing for other redfish stocks in the area (the shallow pelagic stock) or move the paragraph to section 16 "Redfish in Subareas V, VI, XII and XI".
- 20.2 Summary of the development of the fishery. "From 1997 onwards, logbook data from Russia, Iceland, Faroe Islands, Norway and Germany have been used to calculate landings by stock within each ICES Division". In my opinion the phrase is clearer changing calculate by split.
- 20.2 Summary of the development of the fishery. "The results from the model show a decreasing CPUE trend since 1995 (Figure 20.2.4)". It should be Figure 20.2.3. It is not so clear the decreasing trend in the figure, in my opinion the CPUE trend is not clear.

- 20.3 Biological information. "The length distribution from Icelandic landings for the period 2000-2009 is shown in Figure 20.4.1". It should be Figure 20.3.1.
- 20.6 Surveys. In my opinion it is necessary to include in the section a table or figure with the survey time series to see the trend, or at least give a clear statement if trends can be inferred from this survey data. In the report only appear a table with the last year result.
- 20.9.1.3 Assessment quality. "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 about 500,000 t in the entire depth range in 1995-2009) alone. A decreasing trend in the relative biomass indices in the acoustic layer, however, is visible since 1991". In my opinion this paragraph is related with the Shallow pelagic stock (<500 m.). My advice would be to take out of this section the paragraph.
- 20.9.3 Management considerations. "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". ". In my opinion this paragraph is related with both pelagic stocks (Shallow and deep). My advice would be to move this paragraph to Section 16 of this report.
- 20.9.3 Management considerations. "The TAC set for 2008 and 2009 was not caught entirely". My suggestion for this sentence would be "The TAC set by NEAFC for 2008 and 2009 was not caught entirely".
- There is a very good environmental background provided in the report.

Remarks by the reviewer

- The need and importance of having catch and biological data disaggregated by depth from all nations taking part in the fishery are essential to carry out the assessment of this stock.
- In general credibility of landing statistics is questionable. There are indications suggesting that unreported catches might be substantial.
- High variability in the correlation between trawl and acoustic indices and also the assumptions made about constant catchability with depths and areas make the uncertainty of trawl estimates very high.
- It is not very clear in the text what it is the NWWG advice for this stock.

Conclusions

There are a number of uncertainties regarding the data quality and the methodology described in the report which gives in general the impression that the perception of the stock size is very imprecise. Due to this high uncertainty and on the basis of precautionary considerations my opinion is that last year ICES advice is still valid. ICES advised last year to reduce the fishery below the 2008 level to 20 000 t and to develope and implement a management plan. ICES suggested limiting catches of Deep

Pelagic *S. mentella* to a maximum of 20 000 t as a starting point for the adaptive part of the management plan.

This assessment requires a benchmark meeting.

Stock 21 Greenlandic slope Sebastes mentella in XIVb (report section 21))

Short description of the assessment: extremely useful for reference of ACOM!

1) **Assessment type**: Advice
2) **Assessment**: Surveys trends, logbooks data
3) **Forecast**: not presented
4) **Assessment model:** not relevant
5) **Consistency**: not relevant
6) **Stock status:** Surveys indicate a very high biomass of S. mentella in the Greenlandic slope of XIVb compared to the average of the last 30 years.
7) **Man. Plan.**: no management plan

General comments

This is a short section, fairly well documented and well ordered. It was fairly easy to follow and interpret although there is sometimes a lack of precision in interpretation of data and figures.

There is no biological evidence to identify the origin of the adult S. mentella found on the Greenlandic slope in area XIVb. Therefore, until further information is available to assign stock origin of S. mentella in XIVb ICES has decided that NWWG will conduct a separate assessment of the adult S. mentella found demersal in XIVb.

Management of redfish in the Irminger sea and adjacent areas is a complex issue not resolved yet. There is no consensus among scientists, neither on the biological stock structure of *S. Mentella* in the Irminger Sea, nor the approach used in reaching the conclusion with regards to biological stocks and management units. (see section 16).

Technical comments

Even if it is a repetition, it would be more convenient to include all figures mentioned in the text in the section (e.g. Figure 16.2.1).

Figures labels are not always mentioning the origin of data shown (e.g. figure 21.2.4 should mention the Greenlandic deepwater survey).

In paragraph 2 of 21.2 add reference to figure 21.2.2 after "This coincided with a large increase…"

The drop in biomass in years 1999 to 2002 is not mentioned and commented in the text. Could it be due to movements in and out from adjacent areas and/or in the water column?

Last sentence in section 21.2 should mention that the mode at 12cm was observed in 2009 only.

Section 21.3.1. second paragraph mentions how was the estimation of the amount of S. mentella caught in 2009 was done. What about other years (table21.3.1 and figure 21.3.1)?

Section 21.6 It is mostly the increase in survey indices observed since 2003 that changes the perception of the state of the species in on the slope in XIVb, not the introduction of a fishery in 2009/2010. The very high catch rates mentioned for the 3 vessels are not presented anywhere in the section and the sentence is not relevant.

Conclusions

The available information supports the conclusion on the WG on the state of the demersal *S. mentella* found in the Greenlandic slope of XIVb. There are issues to be resolved about stock structure and management units and this assessment is only an "interim measure" (see section 16).