ICES NWWG REPORT 2015

ICES ADVISORY COMMITTEE

ICES CM 2015/ACOM:07

REF. ACOM

Report of the North-Western Working Group (NWWG)

28 April–5 May

ICES HQ, Copenhagen Denmark

ICES International Council for the Exploration of the Sea

CIEM Conseil International pour l'Exploration de la Mer

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

H. C. Andersens Boulevard 44–46
DK-1553 Copenhagen V
Denmark
Telephone (+45) 33 38 67 00
Telefax (+45) 33 93 42 15
www.ices.dk
info@ices.dk

Recommended format for purposes of citation:

ICES. 2015. Report of the North-Western Working Group (NWWG), 28 April-5 May, ICES HQ, Copenhagen Denmark. ICES CM 2015/ACOM:07. 717 pp.

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Executive summary

Faroe Bank Cod

The total reported landings in 2014 were the lowest recorded since 1965 (30 tonnes).

The spring index suggests that the stock increased from 2012 to 2014 and declined substantially again in 2015. Nevertheless both the summer and spring index suggest that the stock is well below average and there is no indication of strong incoming year classes.

The results of an exploratory production model based on both surveys indicate a good agreement in the stock biomass index in recent years whereas the observed survey-based exploitation rates correlates reasonably well with estimated fishing mortalities. However the model failed to pick up the large increases in stock biomass observed in the 1996—2003 period. Correlation between modelled F's and summer survey based exploitation rates is R=0.90. The exploitation ratio increased in 2011 as a consequence of the increase in landings and it decreased afterwards reflecting the fall of catches observed since 2012.

Faroe Plateau cod

The input data consisted of the catch-at-age matrix (ages 2—10+ years) for the period 1959-2014 and two age-disaggregated abundance indices obtained from the two Faroese groundfish surveys: the spring survey 1994—2015 (shifted back to the previous year) and the summer survey 1996—2014. The maturities were obtained from the spring survey 1983—2015.

The assessment settings were the same as in the 2014 assessment. An XSA was tuned with the two survey indices. The fishing mortality in 2014 (average of ages 3—7 years) was estimated at 0.41, which was higher than the Fmsy of 0.32. The total stock size (age 2+) in the beginning of 2014 was estimated at 27 700 tonnes and the spawning stock biomass at 21 100 tonnes, which was slightly above the limit biomass of 21 000 tonnes.

The short term prediction until year 2017 showed a slightly decreasing total stock biomass to 24 200 tonnes and a spawning stock biomass to 19 500 tonnes. It is advised to reduce the fishing mortality substantially to rebuild the stock

Faroe haddock

Being an update assessment, the changes compared to last year are additions of new data from 2014 and 2015 and some minor revisions of recent landings data with corresponding revisions of the catch at age data. The main assessment tool is an XSA tuned with two research vessel bottom trawl surveys. The results are in line with those from 2014, showing a very low SSB mainly due to poor recruitment but also due to higher than recommended fishing mortalities in recent years. SSB is now estimated well below B_{lim} and is predicted to stay below B_{lim} in 2016-2017 with status quo fishing mortality. Fishing mortality in 2014 is estimated at 0.29 and the average fishing mortality from 2012—2014 at 0.28 (F_{MSY} and F_{pa} = 0.25). Landings in 2014 were 3200 t, which is slightly higher than in 2012 and 2013. This years assessment indicates that the 2014 assessment underestimated the 2013 recruitment by 23% (2 million versus 2.6 million, which still is the lowest on record), overestimated the fishing mortality in 2013 by 6% (0.28 versus 0.26) and underestimated the 2013 total- and spawning stock biomasses by 3% and 6%, respectively (20 and 19 thous. t versus 19.6 and 18 thous. t).

Faroe Saith

The most recent benchmark assessment was completed in 2010.

Nominal landings decreased by more than 25% from 35 kt. in 2012 to 24 kt. in 2014. The corresponding estimate of fishing mortality in 2014 (average of ages 4-8 years) decreased to F=0.31 which is lower than the historical average (F=0.36) and very close to F_{msy}=0.30 and F_{pa}=0.28. Due to high fishing mortality SSB decreased substantially from 127 000 t. in 2005 to 48 000 t. in 2013, i.e., below $B_{trigger}$=55kt. but it increased again to 70 000 t. in 2014 as a consequence of improved weights and maturity ogives.

Numbers of the most recent year-class (2011, age 3 in 2014) has increased substantially from 36 mill. in 2013 to 62 million in 2014. However a statistical separable model suggests that the 2011 year-class is not as strong as the spaly assessment estimate and it predicts recruitment for 2014 at 20 mill.

At status-quo F_{bar}(2015)=0.31 and recruitment Rec(2015)=27 mill. the SSB is predicted to increase to 97 kt. in 2016.

Predicted landings for 2014 in the last year assessment were around 38kt while the actual measurement was 24 kt. The estimate of F_{bar} in 2014 was F_{bar}=0.53 in last year's assessment and F_{bar}=0.32 in the 2015 assessment. Recruitment strength for 2014 was predicted at 28 million while the estimate for that year in the present assessment reached 62 million. SSB was predicted exactly in 2014 SSB(2014)= 70 000 t.

Icelandic saithe

The 2015 reference biomass (B4+) is estimated as 255 kt, around the average in the assessment period (1980 to the present). Spawning biomass is estimated as 139 kt, above the average in the assessment period and well above $B_{trigger}$ = 65 kt and B_{lim} = 61 kt.

Harvest rate has been around the HCR target of 20% since 2011, with fishing mortality rate between 0.19 and 0.25. Year classes 2008 and 2009 are above average, but recruitment has declined below average since then.

Weights of ages 3—6 have been low in recent years, but older ages are close to average weight. Maturity at ages 4—9 has decreased in recent years and is currently around average.

The assessment model is a separable statistical catch-at-age model implemented in AD Model Builder. Selectivity is age-specific and varies between three periods: 1980—1996, 1997—2003, and 2004 onwards.

The default separable model (ADSEP) estimates a slightly larger stock size than alternative diagnostic models (ADAPT, TSA, SAM). The estimates of this year's B4+ range from 209 (TSA) to 255 kt (ADSEP).

In 2013, the Icelandic government adopted a harvest control rule for managing the Icelandic saithe fishery, evaluated by ICES (2013). It is similar to the 20% rule used for the Icelandic cod fishery. When the population is above $B_{trigger}$, the TAC set in year t equals the average of 0.2 B4+ in year t and last year's TAC.

According to the adopted harvest control rule, the TAC will be 55 kt in the next fishing year.

Icelandic cod

The spawning stock (SSB2015) is estimated to be 547 kt and is higher than has been observed over the last five decades. The reference biomass (B4+;2015) is estimated to be 1302 kt, the highest observed since the late 1970's. Fishing mortality, being 0.3 in 2014, has declined significantly in recent years and is presently the lowest observed in last 6 decades. Year classes since the mid-1980s are estimated to be relatively stable but with the mean around the lower values observed in the period 1955 to 1985. According to the adopted management harvest rule the TAC will be 239 kt in the next fishing season. ICES has evaluated the plan and concludes that it is in accordance with the precautionary approach and the ICES MSY framework.

Mean weight at age in the stock and the catches that were record low in 2006-8 have been increasing in recent years and are now around the long term mean. The input in the analytical assessments are catch at age 1955-2014 and spring groundfish survey (SMB) indices at age from 1985-2015 and fall survey groundfish survey (SMH) indices at age from 1996—2014. The results from the AD-Model builder statistical Catch at Age Model (ADCAM) as was used as the final run. This framework has been the basis for the advice since 2002.

The reference stock (B4+) in 2014 is now estimated to be 1181 kt compared to 1106 kt last year. The SSB in 2014 is now estimated to be 425 kt compared to 427 kt estimated last year. Fishing mortality in 2013 is now estimated 0.29 compared to 0.3 estimated last year. Year classes 2011-2013 were estimated to be 181, 160 and 109 million in last years assessment and are now estimated to be 181, 161 and 115 millions.

Icelandic haddock

The 2014 yearclass is estimated to be large, after 6 consecutive small yearclass from 2008—2013. The Current assessment shows some upward revision of the stock compared to last years assessment, mostly caused by more growth than predicted. The main features are though the same that recruitment is poor and the stock is predicted to decrease somewhat in next two years before the 2014 yearclass recruits to the stock.

Growth in 2014 was above average since 1985 and more than predicted and the mean weight of young fish is above average while old fish are close to average. The assessment procedure was the same as last year (SPALY), an Adapt type model tuned with both the surveys.

There are differences in the perception of the state of stock in assessment based on either the spring or autumn survey with autumn survey indicating a larger stock. It has been like that since 2009. Different models using the same tuning data show similar results.

Advice is given according to the adopted Harvest Control Rule, and the advice for the fishing year 2014/2015 (September 1st 2015 – August 31st 2016) is 36 400 tonnes. The advice for the following fishing year is predicted to be approximately 31 000 tonnes but increasing after that when the 2014 yearclass comes in.

No environmental drivers or ecosystem effects are known that can help in prediction of the development of the haddock stock. Some effect of the environment on the stock can though not be excluded.

Icelandic summer spawning herring

The total reported landings in 2014/15 fishing season were 95.5 kt but the TAC was set at 83 kt –the difference being caused by a transfer of quota between years. The fishable stock (age 4+) in the winter surveys 2014/15 was estimated at 433 kt, compared to 410 kt in the winter 2013/14. The 2013 year class (age 1 in 2014) appears small.

This is an update assessment where the 2014 data have been added to the input data and no revisions of last year's data. The analytical assessment model, NFT-Adapt, indicates that the biomass of age 3+ is 438 kt and SSB is 342 kt in the beginning of 2015. Record small year class from 2011 entering the spawning stock in 2015, causes a decline in SSB but it is still above BPA. Fishing at F0.1= 0.22 in the fishing season 2015/16 will give a catch of 71 thousand tons. SSB in 2016 is expected to be 327 kt.

Changes in the predictions approach, where the geometric mean for number at age-3 in the assessment year (2015) was replaced by a projection of number at age 3 from a survey estimate at age-1 of the year class, has decreased the uncertainty and has minor impacts on the advice (3% lower). This year's results support that additional natural mortality in the stock due to Ichthyophonus infection should only be applied for the first two years of the outburst.¨

Capelin in the Iceland-East Greenland-Jan Mayen area

In May 2014 ICES advised on the basis of precautionary considerations that the initial quota be set at the 50% of the predicted quota, implying an initial quota of 225 000 t. The quota was revised to 260 000 t after an acoustic survey in October. The final TAC of 580 000 t for the fishing season 2014/2015 was set after an acoustic survey in January 2015.

The total landings in the fishing season 2014/2015 amounted 517 thous. t (preliminary data). Around 40 000 t were taken in July 2014, 5 000 t in November 2014 and the rest during the winter months January-March 2015.

The stock was benchmarked in January 2015. New methods for setting a final TAC and an initial quota were established. They will both apply for the next fishing season. B_{lim} was defined during the meeting.

The acoustic index of 1 year old capelin from the acoustic survey is of an average size. On the basis of the new prediction model the initial quota in 2015/16 is 54 thous. t.

As the capelin increases its weight rapidly over the summer it is recommended that the fishery doesn't start until late autumn.

Offshore West Greenland Cod

From 2015 the advice for cod in Greenland offshore waters has been split in two stock components (advice year 2016). The West Greenland offshore stock component is now comprised of the NAFO subdivisions 1A-E in West Greenland. The East Greenland stock component is comprised of the area NAFO subdivision 1F in South Greenland and ICES subarea XIV in East Greenland.

Some mixing occurs between the two stocks in West Greenland which at present is considered to act as a nursing area for juveniles of the East Greenland stock component. The offshore fishery in West Greenland was closed in accordance with an implemented management plan in 2014. However, a dispensation was given to a small trawler that fished 116 tons and the 2009 YC dominated the catches.

Survey indices show that the biomass and abundance has increased due to the 2009 YC which is present in considerable numbers. This YC is distributed further south in 2012—2014 than in 2011.

The spatial distribution of the 2009 YC is different than previous year classes that usually migrate out of the area at age 4, but a large part of the 2009 YC still remains in the southern area (NAFO 1E) at age 5 in 2014.

No formal assessment is conducted and there are no biological reference points for the stock. Information from survey indices (German Groundfish survey and Greenland Shrimp and Fish survey) are used as basis for advice.

No significant spawning has been observed in the area, and fish older than 6 yrs are lacking in the area.

Inshore Greenland cod

Total catches from the inshore fishery were 18 331 t in 2014 which is the highest since early 1990'ies. Several year-classes were caught in the fishery but catches were dominated by the 2009 YC.

The mean length in the fisheries has increases from 44 cm in 2006 to 58 cm in 2014. Survey recruitment indices from the inshore area show that incoming year classes (2011 and 2012) are below average.

The stock was benchmarked in 2015 and a new procedure for making catch advice was adopted. The procedure is based on a linear regression on pairs of survey values (ages 3—8) and catches in the following year. The advice is based on the average of the 2013 and 2014 survey values for ages 3-8 multiplied by a scaling factor.

Cod in East Greenland, South Greenland

From 2014 the management for cod in Greenland offshore waters has been split in two stock components according to areas: NAFO subdivisions 1A-E in West Greenland and NAFO subdivision 1F in South Greenland combined with ICES subarea XIV in East Greenland. The ICES advice for 2016 has for the first time been given according to these two areas.

The offshore fishery in East and South Greenland in 2014 was conducted as an experimental fishery with a TAC of 10 000 tons. Total catches were 7 893 tons. The year-class dominating the catches was the 2007 YC, which it has done since 2012. The largest cod (mean length of 83 cm) were caught by trawlers on Dohrn Bank close to the Iceland EEZ.

Available survey biomass indices from the Greenland and German surveys show that the biomass has increased due to the growth of the 2009 YC and in part the 2007 YC. Abundance has however decreased as fewer young fish are observed.

The 2009 YC followed by the 2007 YC has dominated the survey since 2012. The 2009 YC is primarily distributed in South Greenland, whereas the 2007 YC is distributed more to the north in East Greenland. Spawning offshore cod are only found in East Greenland in local high densities.

The procedure suggested as basis for advice at the Benchmark in 2015 was not implemented by NWWG due to shortcomings. Instead, advice was based on an Fproxy multiplier generated from the relationship between the catches and survey index in a period with a considered sustainable fishery, multiplied by the latest year's smoothed survey index (Greenland Shrimp and Fish survey).

Greenland Halibut in Subareas V, VI, XII, and XIV

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 which impede age based assessment.

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 assumed virgin status of the stock at the beginning of the fishery in 1961. Estimated stock biomass showed an overall decline along with the high catches in the late 1980s and early 1990s. Since 2004/2005 the stock has increased slowly and is now at 70%BMSY and fishing mortality has decreased to FMSY. Although the indices that are used for input to the assessment model (combined survey index at Greenland and Iceland) and logbook information from Iceland trawler fishery all show a slight decrease in 2014, the remaining available indices from East Greenland (logbook from trawl fishery) and from Faroese waters (logbooks from trawl fishery and a survey) all suggest high and stable biomass in recent years.

Golden redfish (*Sebastes norvegicus*) in Subareas V, VI and XIV

Total landings in 2014 were about 50 800 t, which is about 2 500 t less than in 2013. About 94% of the catches were taken in Division Va. A substantial increase in landings from XIVb since 2010, the highest since early 1990s, and is in relation to re-established redfish fishery in 2010. Very little redfish is now taken in Vb.

Catch-at-age data from Va show that the catch was dominated by two strong year classes from 1985 and 1990. From 2008-2011 year-classes 1996—1999 were the most important in the fisheries. Their share has reduced relatively fast and the 2000—2005 year classes are now most important contributing about 60% of the total catch.

Recruitment seems to be low in all areas, both according to the Icelandic groundfish surveys, and the German survey and the Greenland shrimp and fish survey in East-Greenland. Recruitment is likely to be underestimated as the surveys do not adequately cover nursery areas of the stock.

The stock was benchmarked in 2014 and a management plan evaluated and adopted. The Gadget model was used as basis for advice but the main difference in settings from earlier years was inclusion data from the German survey in East-Greenland and changes in growth rate.

The management plan was based on F9-19=0.097 reducing linearly if the spawning stock is estimated below 220 000 t ($B_{trigger}$). B_{lim} was proposed as 160 000 t, lowest SSB in the 2012 run.

According to the management plan the TAC for 2016 will be 51 000 t.

Icelandic slope Sebastes mentella in Va and XIV

ICES concluded in February 2009 that *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 a separate biological stock and management unit.

Total landings of demersal *S. mentella* in Icelandic waters in 2014 were about 9 500 t, 750 t more than in 2013.

No analytical assessment was conducted and there are no biological reference points for the species. Survey indices from the annual autumn survey since 2000 are used as basis for advice.

Available survey biomass indices show that in Division Va the biomass has gradually decreased from 2006 to 2013, but increased in 2014.

The East-Greenland shelf is most likely a nursery area for the stock. No new recruits (>18 cm) are seen in the survey catches of the German survey and the Greenland shrimp and fish shallow water survey conducted in the area and no juveniles are present (<18 cm) recent years.

Icelandic slope *S. mentella* is considered a data limited stock (DLS) and follows the ICES framework for such (Category 3.2). When the precautionary approach is applied, catches in 2016 should be no more than 9 954 t. All catch are assumed to be landed.

Shallow Pelagic *Sebastes mentella*

ICES concluded in February 2009 that *S. mentella* is to be divided into three biological stocks and that the shallow pelagic *S. mentella* in the Irminger Sea and adjacent areas should be treated as separate biological stock and management unit.

Total landings of shallow pelagic *S. mentella* in 2014 were 6 423 t, a significant increase compared to 1 527 t in 2013. The catches were almost entirely taken in ICES XII.

No analytical assessment was conducted and there are no biological reference points for the species. Survey indices from the biennial international acoustic redfish survey conducted in the Irminger Sea and adjacent waters since 1991 are used as basis for advice.

The last survey was conducted in June/July 2013. Since 1994, the results of the acoustic survey show a drastic decreasing trend within the deep scattering layer (DSL) from 2.2 million t to 91 000 t in 2013. With the trawl method within the DSL (350—500 m) the biomass was estimated 200 000 t, significantly below the 361 000 t of 2011. The next international acoustic redfish survey was scheduled to be conducted in June/July 2015.

No signs of recruitment have been observed in the latest German survey on the East-Greenland shelf.

Deep Pelagic *Sebastes mentella*

ICES concluded in February 2009 that *S. mentella* is to be divided to three biological stocks and that the deep pelagic *S. mentella* in the Irminger Sea and adjacent areas should be treated as separate biological stock and management unit.

Total landings of deep pelagic *S. mentella* s in 2014 were 23 755 t, half of the 2013 total catch.

No analytical assessment was conducted and there are no biological reference points for the species. Survey indices from the biennial international trawl-acoustic redfish survey conducted in the Irminger Sea and adjacent waters since 1999 are used as basis for advice.

The survey was conducted in June/July 2013. A total biomass of 280 900 t was estimated, a 41% less than in 2011 (474 000 t).Trawl survey estimates in 2011 and 2013 are lower than the average for 1999—2009 and the estimate for 2013 is the lowest observed. The next international trawl-acoustic redfish survey in the Irminger Sea will be conducted in June/July 2015.

No recruitment has been observed on the East-Greenland shelf during 2013 and 2014, which is a concern because it is assumed to contribute to the three *S. mentella* stocks at unknown shares.

Greenlandic slope *Sebastes mentella* in XIVb

ICES concluded in February 2009 that demersal *S. mentella* is to be divided into three biological stocks and that the *S. mentella* on the continental shelf and slope should be treated as a 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 stock 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 2014 were about 4600 tons, which is less than 2010—2012 landings. The lower catches are partly due to a lower presence of *S. mentella* in the mixed stock fishery and partly due to a lower total landing of demersal redfish.

In the decade before 2009 *S. mentella* was mainly a valuable by-catch in the fishery for Greenland halibut. However, since 2009 a fishery directed towards demersal redfish has taken place.

Available survey biomass indices show that in Division XIVb the biomass decreased further in 2014. No new recruits (>18 cm) are seen in the surveys since 2012, and no juveniles are present (<18 cm) in both 2013 and 2014 surveys

The advice is based on the DLS approach (3.2) using the Greenland shallow water survey as basis for advice. The ratio is applied to the 2014 advice as catches are well above the current advice. The advice for 2016 is 2 240 t.

1 Introduction

1.1 Terms of Reference (ToR)

1.1.1 Specific ToR

2014/2/ACOM08 The **North-Western Working Group** (NWWG), chaired by Rasmus Hedeholm, Greenland, will meet at ICES Headquarters, 28 April – 5 May, 2015 to:

a) Address generic ToRs for Regional and Species Working Groups.

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.

For capelin in Iceland-East Greenland-Jan Mayen area, Iceland will provide a WG type report and a draft advice sheet on 5 May. NWWG will agree any changes to the WG type report and the Advice sheet no later than 7 May. An ADG will work by correspondence 11 May. The WEBEX will be 15 May, and the Advice Release date 19 May.

Other 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 19 May 2015 for the attention of ACOM. For capelin in Iceland-East Greenland-Jan Mayen area NWWG will report by 1 February 2015 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)	Faroe Islands	Faroe Islands	Faroe Islands	Update
cod-farb	Cod in Subdivision Vb2 (Faroe Bank)	Faroe Islands	Faroe Islands	Faroe Islands	Multiyear
had-faro	Haddock in Division Vb	Faroe Islands	Faroe Islands	Faroe Islands	Update
sai-faro	Saithe in Division Vb	Faroe Islands	Faroe Islands	Faroe Islands	Update
cod-iceg	Cod in Division Va (Icelandic cod)	Iceland	Iceland	Iceland	Update
had-iceg	Haddock in Division Va (Icelandic haddock)	Iceland	Iceland	Iceland	Update
sai-icel	Saithe in Division Va (Icelandic saithe)	Iceland	Iceland	Iceland	Update
her-vasu	Herring in Division Va (Icelandic summer-spawners)	Iceland	Iceland	Iceland	Update
cap-icel	Capelin in Subareas V, XIV and Division IIa west of 5°W (Iceland-East Greenland-Jan Mayen area	Iceland	Iceland	Iceland	Update
cod-ingr	Cod (Gadus morhua) in NAFO Subarea 1, inshore (Inshore West Greenland)	Greenland	Greenland	Greenland	Update
cod-segr	Cod (Gadus morhua) in ICES Subarea XIV and NAFO Subdivision 1F (East Greenland, South Greenland)	Greenland	Greenland	Germany	Update
cod-wgr	Cod (Gadus morhua) in NAFO Subdivision 1A-E (Offshore West Greenland)	Greenland	Greenland	Germany	Update
ghl-grn	Greenland halibut in Subareas V, VI, XII and XIV	Greenland	Greenland	Iceland	Update
smr-5614	Redfish (Sebastes marinus) in Subareas V, VI, XII and XIV	Iceland	Iceland	Faroe Islands	Update
smn-con	Beaked redfish (Sebastes mentella) in Division Va and Subarea XIV (Icelandic slope stock).	Iceland	Iceland	Germany	Multiyear
smn-sp	Beaked Redfish (Sebastes mentella) in Subareas V, XII, XIV and NAFO Subareas 1+2 (Shallow Pelagic stock < 500 m deep)	Iceland	Germany	Spain	Update
smn-dp	Beaked Redfish (Sebastes mentella) in Subareas V, XII, XIV and NAFO Subareas 1+2 (Deep Pelagic stock > 500 m deep)	Iceland	Germany	Spain	Update
smn-grl	Beaked Redfish (Sebastes mentella) in Subarea XIV (East Greenland Slope)	Greenland	Greenland	Germany	Update

1.1.2 Generic ToRs for Regional and Species Working Groups

The working group should focus on:

a) Consider and comment on ecosystem overviews where available

b) For the fisheries considered by the working group consider and comment on:

    i. descriptions of ecosystem impacts of fisheries where available

    ii. descriptions of developments and recent changes to the fisheries

    iii. Mixed fisheries overview, and

    iv. emerging issues of relevance for the management of the fisheries.

c) Conduct an assessment to update advice on the stock(s) using the method (analytical, forecast or trends indicators) as described in the stock annex and produce a brief report of the work carried out regarding the stock, summarising 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. For relevant stocks estimate the percentage of the total catch that has been taken in the NEAFC regulatory area by year in the recent three years.

    iv. The developments in spawning stock biomass, total stock biomass, fishing mortality, catches (wanted and unwanted landings and discards) using the method described in the stock annex;

    v. The state of the stocks against relevant reference points;

    vi. Catch options for next year;

    vii. Historical performance of the assessment and catch options and brief description of quality issues with these;

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

The working group is furthermore requested to:

e) Propose specific actions to be taken to improve the quality and transmission of the data (including improvements in data collection);

f) Prepare the data calls for the next year update assessment and for the planned data compilation workshops

g) Update, quality check and report relevant data for the stock:

    i. Load fisheries data on effort and catches into the INTERCATCH database by fisheries/fleets;

    ii. Abundance survey results;

iii. Environmental drivers.

h) Produce an overview of the sampling activities on a national basis based on the INTERCATCH database or, where relevant, the regional database.

i. Identify research needs of relevance for the working group.

1.2 NWWG 2015 work in relation to the ToR

The ToRs were not addressed systematically for all stocks. 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. This year, individual report stock sections were not reviewed in plenary due to time constraints, but relevant issues were discussed in plenary and each section was reviewed by other WG members. The summary sheets were all reviewed in plenary.

ad a) Ecosystem overviews were available for the Faroe Islands, Iceland and Greenland ecoregions. In the Icelandic ecosystem the increased temperature/salinity since mid 1990s is regarded as a major factor, which has shifted the distribution of many fish species northwards. The biomass of capelin (an important forage fish) is the only ecosystem driver, which has been used directly in the assessment (predicting individual weights of cod). This relationship became less clear in recent years and the weights of cod were therefore estimated in other ways. No new ecosystem driver was proposed this year. It was, however, remarked that the effects of important ecosystem drivers was expected to be expressed in the input data of the stock assessments and therefore taken into account in an indirect way. In the Greenland ecoregion the effect of temperature and wind is outlined since these measures are good indicators of the recruitment of cod. These measures are, however, not used directly in the assessments or the advice. In the Faroe ecoregion there has been shown a positive relationship between primary production and the production of demersal fish (cod, haddock and saithe). Primary production is, however, not used directly in the assessments or advice.

ad b) In the overview sections there is a description of the fisheries, including mixed fisheries. In the Icelandic ecoregion the ecosystem effect of fisheries is briefly mentioned with corals being destroyed by fishing gears.

ad e-h) INTERCATCH is not used extensively for any stocks considered in this WG as they are mostly national non-EU stocks, and no data was loaded into INTERCATCH that was not already uploaded. The members of the group were however encouraged to use it and to provide the status on the use of INTERCATCH. The 2015 data call was evaluated for all stocks and updated to facilitate the 2016 data call.

1.3 MSY/HCR approaches for individual stocks

See Introduction in the 2013 NWWG report.

1.4 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	Trend based assessment	Survey
Faroe Plateau cod	XSA	Survey
Faroe haddock	XSA	Survey
Faroe saithe	XSA	CPUE**
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	Linear regression	Survey
Inshore West Greenland cod	Linear regression	Survey
East Greenland, South Greenland cod	Fproxy multiplier	Survey
Offshore West Greenland cod	Descriptive	Survey
Greenland halibut	Stock production model (Bayesian)	Survey + CPUE
S. norvegicus	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**

**** The CPUE is adjusted by survey information about distribution width.**

1.5 Benchmarks and workshops

At WKICE cod from Iceland, Greenland and the IGJM capelin stock were benchmarked. For the Iceland cod no significant changes were suggested. For Greenland cod the benchmark concluded that advice should be given for three separate stocks: Inshore West Greenland cod, East Greenland/South Greenland cod and Offshore West Greenland cod. For capelin a new advice procedure was proposed and accepted.

No stocks are scheduled to be benchmarked in 2016 and no new stocks were proposed for a 2017 benchmark. Faroe plateau and bank cod are scheduled to be benchmarked in 2017 and issue lists have previously been prepared for both stocks.

1.5.1 Inshore West Greenland cod and the 2015 NWWG assessment

There are age disaggregated data on both survey and landings for this stock. However, the data are highly variable and the internal consistency is low. As a consequence, none of the proposed analytical assessment approaches presented at the benchmark produced convincing results and were not considered appropriate to generate advice. However, the previously used approach (DLS on the survey) was also rejected. Instead an alternative regression approach was approved. It is based on a simple linear regression between survey indices (year y) and subsequent catches (year y+1). The NWWG concluded that the average of the last two years survey should be used (and not only the latest as concluded by the benchmark) to smooth the otherwise noisy survey biomass estimate. Both the benchmark and NWWG concluded that this approach should be an interim solution and that a full stock assessment is developed.

1.5.2 East Greenland/South Greenland cod and the 2015 NWWG assessment

The benchmark suggested that the advice should be based on the DLS approach since no satisfactory analytical assessment models could be developed in time for the benchmark to properly assess them. The NWWG concluded that this method was inappropriate for this stock but insufficient exploratory analysis at the benchmark failed to realize this. NWWG instead suggested that the advice is based on an estimate of fishing mortality (F_{proxy}) and the Greenland survey index for the area. To incorporate uncertainty and adopt a precautionary approach, the F_{proxy} was based on a period of stock increase and the survey was smoothed using a random effects smoother to minimize year-to-year variation.

1.5.3 Offshore West Greenland cod and the 2015 NWWG assessment

The benchmark and the NWWG both concluded that this stock is at a low level although recent survey results show an increase in biomass caused mainly by the 2009 year class. Consequently, the advice continues to be that no fishery should take place on this stock.

1.5.4 Iceland-Greenland- Jan Mayen capelin (IGJM) and the 2015 NWWG assessment

The NWWG produced advice in accordance with the benchmark conclusions. Hence, for IGJM capelin the advice will be based on a stochastic projection of the stock that will be conducted starting from acoustic measurements, aiming at a TAC that is associated with less than 5% probability of the stock being below Blim (150.000 t). An initial TAC advice given for the 2015/2016 fishing season will be subject to revision following a 2015 autumn survey and again following a 2016 winter survey. A special request was received from the coastal states involved in the fishery on IGJM capelin, and they wished to be informed about the advice had it been based on the management in place for this stock. This was provided by the NWWG.

1.6 Chairman

This is the first year for the new chairman, Rasmus Hedeholm, Greenland, who is scheduled to chair the group from 2015-2017.

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

2.1 Overview Fisheries

The main fisheries in Faroese waters are mixed-species, demersal fisheries and single species pelagic fisheries (Figure 2.1). The demersal fisheries are mainly conducted by Faroese vessels, whereas the pelagic fisheries are conducted both by Faroese vessels and by foreign vessels licensed through bilateral and multilateral fisheries agreements. The usual picture changed in 2011, however, since no mutual agreement could be reached between the Faroe Islands and the EU and Norway, respectively, due to the dispute regarding the share of mackerel. From 2013, the agreement has been re-established.

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 conducted by purse seiners, larger purse seiners also equipped for pelagic trawling and trawlers otherwise performing demersal fisheries. 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 number of licenses can be found in Table 2.3. The grouping of the vessels under the management scheme can be seen in section 2.1.3.

2.1.1 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 19^{th} 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) of the catches; after 1—2 weeks, sometimes longer, 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 especially cod and haddock but also 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 were in 2011 included into the fishing days system and were allocated a number of fishing days (Tables 1 and 2). 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 was before 2011 limited by maximum by-catch allocation. This fleet has now started to pair-trawl, and since the fiscal year 2011/12, merged with the pair-trawlers group. 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 shows the allocated number of fishing days by fleet group since the fiscal year 1996/1997 and in Table 2.2 is a comparison between number of allocated days and number of actually used fishing days. From Table 1 it can been seen that since 1996/1997, the number of days allocated has been reduced considerable and is now 50% of the originally allocated days. Despite this, there still are many unused days in the system (Table 2.2).

Holders of individual transferable effort quotas who fish outside the thick line on Figure 2.2 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 110 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 except for a minor jigging fishery during summer time.

The fleet segmentation used to regulate the demersal fisheries in the Faroe Islands and the regulations applied are summarized in Table 2.3.

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. The realized fishing mortalities have been substantially higher than the target for cod, appear to have exceeded the target for saithe in recent years, while for haddock, fishing mortality remains below the target.

In addition to the number of days allocated in the law, it is also stated in the law what percentage of total catches of cod, haddock, saithe and redfish, each fleet category on average is expected to fish. These percentages are as follows:

Fleet category	Cod	Haddock	Saithe	Redfish
Longliners < 110GRT,				
jiggers, single trawl. < 400HP	51 %	58 %	17.5 %	1 %
Longliners > 110GRT	23 %	28 %		
Pairtrawlers	21 %	10.25 %	69 %	8.5 %
Single trawlers > 400 HP	4 %	1.75 %	13 %	90.5 %
Others	1 %	2 %	0.5 %	0.5 %

The technical measures as mentioned above are still in effect. An additional measure to reduce the fishing mortality on cod and haddock and to especially reduce the mortality on the youngest age groups has been introduced (See the 2013 NWWG report) in July 2011, but was terminated in August 2013.

2.1.2 The marine environment and potential indicators

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 there 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. Since then, there have been several periods with high or low productivity, which has been reflected in the fish landings a couple of years afterwards.

There has been observed a 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.* 2002). There is a positive relationship between primary production and the cod and haddock individual fish growth and recruitment ½-2 years later. The primary production index has been below average since 2002 except for 2004 and 2008-2010 when it was above average (Figure 2.3). The estimate of primary production in 2014 will not be available until July. The primary production index could therefore be a candidate ecosystem and stock indicator. Another potential indicator candidate is the so-called Sub-polar Gyre Index, which is an index for the primary production in the outer areas (Figure 2.3).

Recent work (Steingrund *et al.*, 2012) shows that there is a moderate positive correlation between primary production on the Faroe Shelf and the subsequent production of cod (Steingrund and Gaard, 2005). There is also a moderate positive correlation for haddock and saithe. However, if all three species are combined, the positive correlation becomes very strong (Figure 2.4). This indicates that a nearly fixed portion of the energy produced by the primary production goes to predatory demersal fish on the Faroe Plateau, but that the portion to each of the fish stocks (to cod, haddock or saithe) may vary much between years. As an example, the last period of high productivity (2008—2010) did not lead to any marked increase in the stock size of cod/haddock, but only in saithe.

2.1.3 Summary of the 2015 assessment of Faroe Plateau cod, haddock and saithe

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 have 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 have been fluctuating 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 close to the highest values observed in 2009. It has since declined again.

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 fluctuations and time-trends.

2.1.4 Reference points for Faroese stocks

As explained elsewhere in this report, MSY reference points have recently been estimated for cod, haddock and saithe in addition to the already existing PA reference points. These reference points are all estimated based on single-species models. Multi-species models may give very different perception of F_{MSY} reference points than single-species models, and for the Faroe area this could be extra true, since there is a close relationship between the environment and the fish stocks and between fish stocks (see section 2.1.3). Adding the recruitment of cod and haddock and relating them to zooplankton concentration shows a strong negative correlation (Figure 2.5), but a potential causal relationship is unknown.

2.1.5 Management plan

In 2011 the Faroese minister of fisheries established a group of experts to formulate a management plan for cod, haddock and saithe including a harvest control rule and a recovery plan. The group consisted of scientists from the Faroe Marine Research Institute of one representative from the industry and 1 from the Ministry of Fisheries. The results of this work was delivered to the Minister of Fisheries in the autumn 2011 but the outcome has not been approved by the authorities so far and not been implemented. Basically, the plan builds on the MSY framework developed by ICES.

2.1.6 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.

Steingrund, P., Gaard, E., Reinert, J., Olsen, B., Homrum, E., and Eliassen, K. 2012. Trophic relationships on the Faroe Shelf ecosystem and potential ecosystem states. In: Homrum, E., 2012. The effects of climate and ocean currents on Faroe Saithe. PhD-thesis, 2012.

Table 2.1. Number of allocated days since the fiscal year 1996/97.

Fleeet	Smb. Ll.:	Serlig viðm.	1 ytri	1 innaru	2 ytri	2 innari	3	4 A	4 B	4 D	4 T	5	(at ráða yvir)	Dagar tils.
1996/97	(50 20/5-96)	(12/15 mdr!)				8225	3040	4700	3080	1540		22000	1000	43585
1996/97	(84 6/6-97)	(12/15mdr!)				8225	3040	5600	3410	1650		27000	660	49585
1997/98	(133 9/8-97)	12 mdr!				7199	2660	4696	4632			23625	577	43389
1998/99	(69 18/8-98)					6839	2527	4461	4400			22444	548	41219
1999/2000	(80 17/8-99)					6839	2527	4461	4400			22444	548	41219
2000/2001	(104 17/8-00)					6839	2527	4461	4400			22,444	548	41219
2001/2002	(115 15/8-01)					6839	2527	4461	4400			22444	0	40671
2002/2003	(76 13/8-02)					6771	2502	4416	4356			22220	0	40265
2003/2004	(100 8/8-03)					6636	2452	4328	4269			21776	0	39461
2004/2005	(49 18/8-04)					6536	2415	4263	4205			21449	0	38868
2005/2006	(98 19/8-05)					5752	3578	1770	2067		1766	21235	0	36168
2006/2007	(81 17/8-06)					5752	3471	1717	2005		1713	20598	0	35256
2007/2008	(80 20/8-07)					5637	3402	1683	1965		1679	20186	0	34552
2008/2009	(76 15/8-08)					5073	3062	1515	1769		1511	18167	0	31097
2008/2009	(62 25/5-09)					4638	3095	1393	1848		1621	18167	0	30762
2009/2010	(106 17/8-09					4406	2940	1323	1756		1540	17259	0	29224
2010/2011	(87 18/8-10)		1700	900		4274	2852	1323	1756		1540	13259	0	25004
2010/2011	sama -		1700	900		4274	2852	1323	1756		1540	13259	0	27604
2011/12	(105 18/8-11) (112 2/9-11)				1530	4657	2567	1058	1405		1386	10607		23210
2012/13	(89 17/8-12)				1530	4626	2567	1011	1533		1386	10607		23260
2013/14	(109 16/8-13)				1530	4441	2387	1011	1533		1386	9865		22153
2014/15	(L89-18/8-14)				1530	4455	2387	1029	1530		1386	9865		22182

Table 2.2. Number of days allocated and the number actually used since the fiscal year 2010/2011

Fleet segment	Allocated days 2010/11	Used days 2010/11	% used days 2010/11	Allocated days 2011/12	Used days 2011/12	% used days 2011/12	Allocated days 2012/13	Used days 2012/13	% used days 012/13	Allocated days 2013/14	Used days pr. Dato	% used days	Allocated days 2014/15	Used days pr. Dato	% used days
Reference:	Ll87 18/8-10(JV)			Ll105 18/8-11 og Ll112 2/9-11(JD)			(89 17/8-12)			Ll105 18/8-11 og Ll112 2/9-11(JD)			(L89-18/8-14)		
Group 1 - innaru leiðir	900	552.39	61%												
Group 1 - ytri leiðir	1700	785.3	46%												
Group 2 - (innaru leiði	4274	3883.23	91%	4657	4758.02	102%	4626	3952.52	85%	4441	3915.82	88%	4455	1915.88	43%
Group 2 - ytri leiðir				1530	894.94	58%	1530	878.57	57%	1530	796.53	52%	1530	367.74	24%
Group 3	2852	2071.16	73%	2567	1985.90	77%	2567	1205.23	47%	2387	1119.66	47%	2387	749.11	31%
Group 4A	1323	405.36	31%	1058	259.5	25%	1011	270.72	27%	1011	272.34	27%	1029	118.5	12%
Group 4B	1756	1015.65	58%	1405	656.61	47%	1533	687.73	45%	1533	518.77	34%	1530	230.77	15%
Group 4T	1540	1411.98	92%	1386	1313.14	95%	1386	1165.71	84%	1386	895.41	65%	1386	243.92	18%
Group 5A	5304	2856	54%	5060	1834	36%	4730	1410	30%	4311	998	23%	2640	1000	38%
Group 5B	7955	4525	57%	5547	3160	57%	5877	2845	48%	5554	2842	51%	7225	1000	14%
Total	27604	17506.07	63%	23210	14862.11	64%	23260	12415.48	53%	22153	11358.53	51%	22182	5625.92	25%

Table 2.3. 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		Sub groups		Main regulation tools
1	Single trawlers > 400 HP	none		Fishing days, have from 2011/12 been merged with the pair trawlers, 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

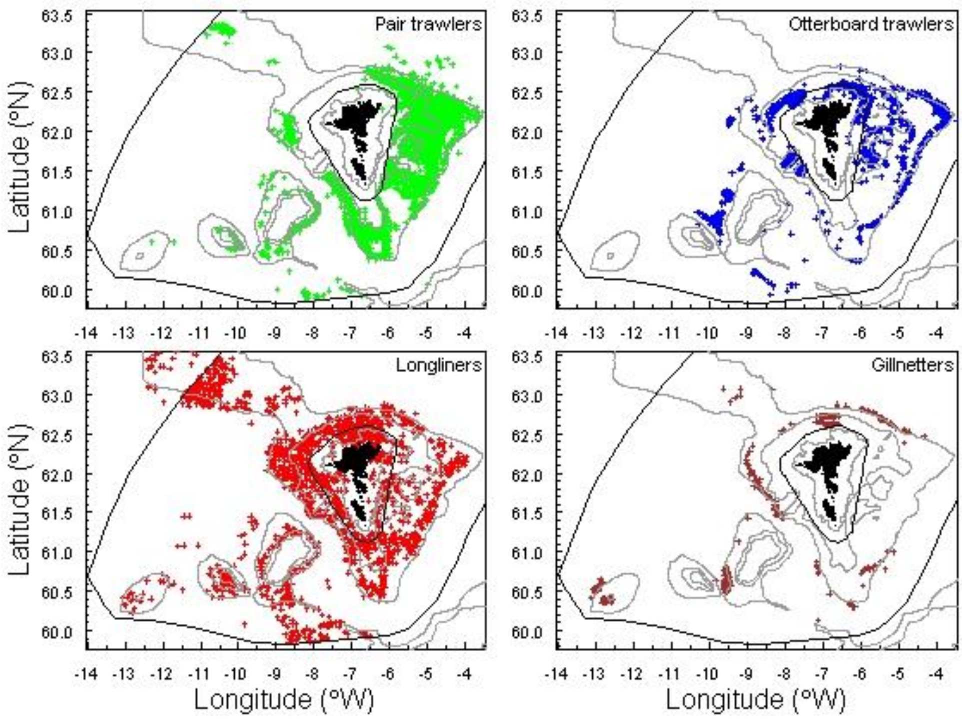
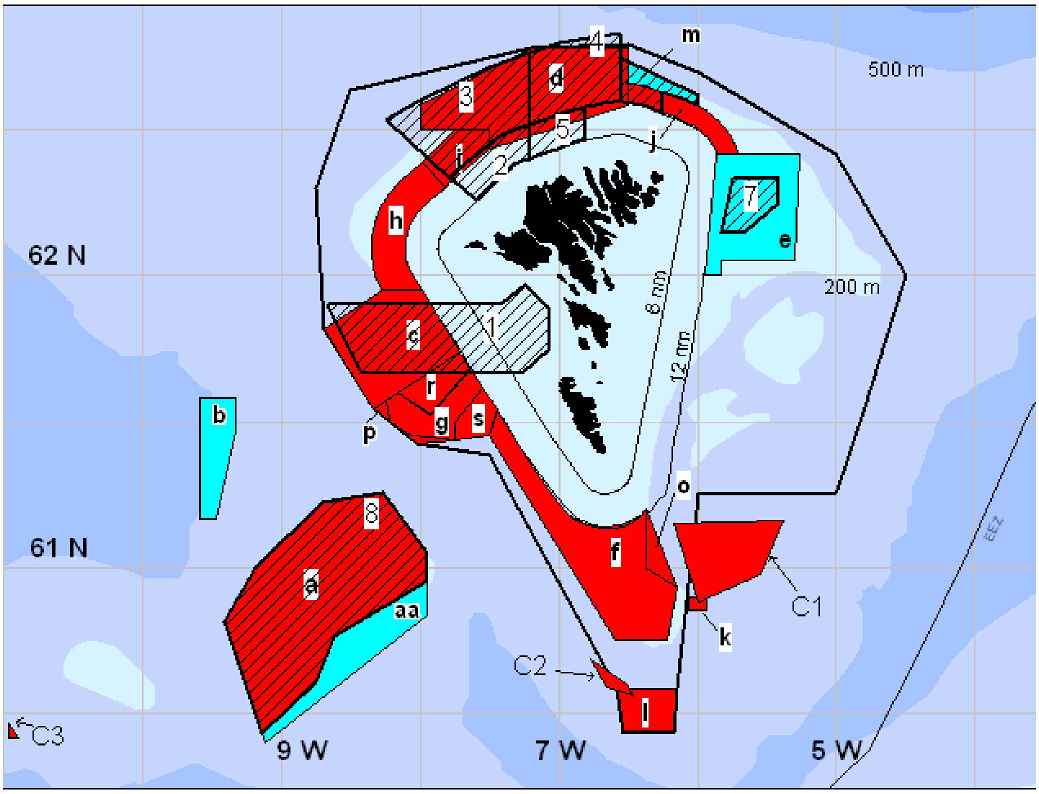


Figure 2.1. The 2012 distribution of fishing activities by some major fleets. The longline fleet below 15 GRT is not shown here since they are not obliged to keep logbooks.



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 2.2. 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.

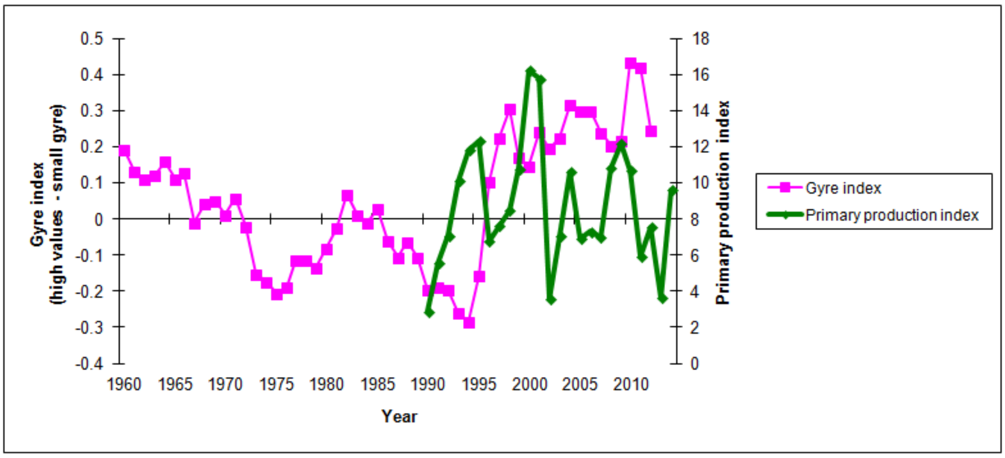


Figure 2.3. Temporal development of the phytoplankton index over the Faroe Shelf area (< 130 m) and the subpolar gyre index which indicates productivity in deeper waters.

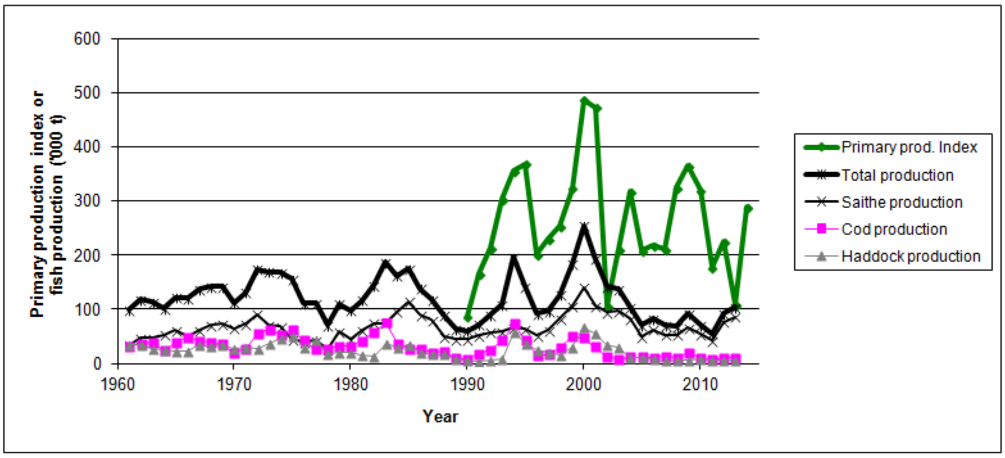


Figure 2.4. Relationship between primary production and production of cod, haddock and saithe.

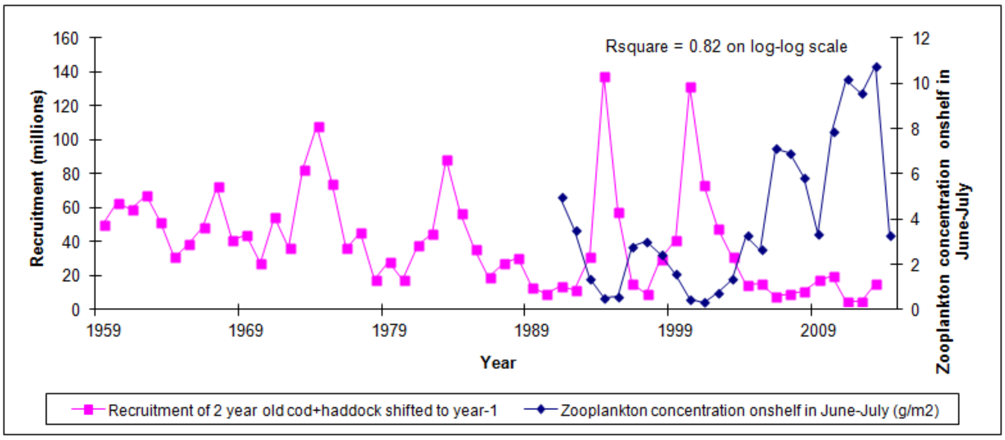


Figure 2.5. Relationship between zooplankton concentration and recruitment of cod+haddock on the Faroe Plateau.

3 Faroe Bank Cod

Summary

The total reported landings in 2014 were the lowest recorded since 1965 (30 tonnes).

The spring index suggests that the stock increased from 2012 to 2014 and declined substantially again in 2015. Nevertheless both the summer and spring index suggest that the stock is well below average and there is no indication of strong incoming year classes.

The results of an exploratory production model based on both surveys indicate a good agreement in the stock biomass index in recent years whereas the observed survey-based exploitation rates correlates reasonably well with estimated fishing mortalities. However the model failed to pick up the large increases in stock biomass observed in the 1996—2003 period. Correlation between modelled F's and summer survey based exploitation rates is R=0.90. The exploitation ratio increased in 2011 as a consequence of the increase in landings and it decreased afterwards reflecting the fall of catches observed since 2012.

3.1 State of the stock

Total nominal catches of the Faroe Bank cod from 1987 to 2014 as officially reported to ICES are given in Table 3.1 and since 1965 in Figure 3.1. 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 3500t in 1987 to only 330 t in 1992 before increasing to 3 600t in 1997. In 2013 landings were estimated at 36t which is the lowest ever recorded since 1965 (Figure 3.1). 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 3.1). From 2005 to 2007 the effort has been reduced substantially. In the 2010/2011 and 2011/2012 fishing years a total of 61 and 100 fishing-days were allocated to the Bank. No days have been allocated since 2012.

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 3.2.

The spring survey was initiated in 1983 and discontinued in 1996, 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 2013 and the 2014 spring point estimates suggest that the stock increased and decreased sharply again in 2015. it is however well below the average of that of the period 1996—2002. The 2014 summer index is estimated at 25 kg per tow, which is the second lowest value in the series. There are conflicting signals between both indices from 2012 to 2014.. The agreement between the summer and spring index is good during 1996 to 2001 and since 2006, but they diverged in the 2002—2003 and 2012—2014 periods.. Both indexes have remained well below average since 2004.

The figure of length distributions (figures 3.3 and 3.5) 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 2015 reflecting the weak year classes observed in the summer survey since 2004. Age-disaggregated indices confirm the pattern observed in the length composition (figure 3.4 and figure 3.6)

A way to estimate recruitment strength is 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 was good from 2000 to 2003, while the recruitment has been relatively poor since 2004 (Figure 3.7) The spring recruitment index in 2014 shows no sign of incoming year classes. Correlation between the spring and summer survey recruitment indices is fairly good (r=0.85). Correlation between numbers of 1-year and 2-years old cod in the age-disaggregated summer and spring surveys respectively is estimated at r=0.79.

The group tried the ASPIC (Prager 1992) stock production model for the stock. The model requires catch data and corresponding effort or CPUE data that are reasonable indices of the stock biomass.

ASPIC requires starting guesses for *r*, the intrinsic rate of increase, MSY, B1/Bmsy ratio and *q*, catchability coefficients. No sensitivity analysis was performed to explore the stability of parameter estimation.

The program was run with the time-series from 1983-2014 including spring survey and 1996—2014 summer CPUE's separately. The result of the runs are presented in tables 3.2 and 3.3 For both runs the model seemed to follow reasonably well survey trends in periods of low stock abundances but it failed to pick up the large increases observed in the 1996-2003 period (figures 3.8 and 3.9).

However estimates of *r*=0.07 and Fmsy=0.035 (using the fall survey series) seem spurious given that the Faroe Bank cod is the fastest growing cod stock in the Atlantic.

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 3.1). The exploitation ratio has decreased since 2006 but increased in 2011 due to the increase in catches and decreased again afterwards reflecting the fall of catches observed since 2011.

3.2 Comparison with previous assessment and forecast

The status of the stock remains almost unchanged with respect to last year's assessment. Both the spring and the summer indexes suggest the stock is well below average while there are no indications of incoming recruitment. The spring index suggests an increasing stock biomass from 2012 to 2014 which it is however not picked up by the summer survey. The exploratory production model performed since 2013 confirms the poor status of the stock.

3.3 Management plans and evaluations

None

3.4 Management considerations

The landing estimates are uncertain because since 1996 vessels are allowed to fish both on the Plateau and on Faroe Bank during the same trip, rendering landings from both areas uncertain. Given the relative size of the two fisheries, this is a bigger problem for Faroe Bank cod than for Faroe Plateau cod, but the magnitude remains unquantified for both. The ability to provide advice depends on the reliability of input data. If the cod landings from Faroe Bank are not known, it is difficult to provide advice. If the fishery management agency intends to manage the two fisheries to protect the productive capacity of each individual unit, then it is necessary to 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 2014 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

In 1990, the decreasing trends 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. However, in the 2010/2011 and 2011/2012 fishing years a total of 61 and 100 fishing-days were allocated to the Bank to jiggers in the shallow waters of the Bank. No days have been allocated since 2012.

Table 3.1. Faroe Bank (sub-division Vb2) cod. Nominal catches (tonnes) by countries 1986-2014 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	1998	1999
Faroe Islands	1836	3409	2966	1270	289	297	122	264	717	561	2051	3459	3092	1001
Norway	6	23	94	128	72	38	32	2	8	40	55	135	147	88
UK (E/W/NI)	-	-	-	-	2 [2]	1 [2]	74 [2]	186 [2]	56 [2]	43 [2]	126 [3]	61 [3]	27 [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]	265 [3]	51 [3]
Total	1905	3479	3097	1412	568	426	404	570	1008	1195	2614	3932	3531	210 [3]
Used in assessment					289	297	154	266	725	601	2106	3594	3239 0	1350
														1089

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Faroe Islands		1094	1840	5957	3607	1270	1005	471	231	81	111	393	115	40	32 *
Norway	49	51	25	72	18	37	10	7	1	4	1		0		
Greenland	-	-	-	-	-	-	-	-	-	-	5		1		
UK (E/W/NI) [3]	18 [3]	50 [3]	42 [3]	15 [3]	15 [3]	24 [3]	1 [3]								
UK (Scotland) [3]	245 [3]	288 [3]	218 [3]	254 [3]	244 [3]	1129 [3]	278 [3]	53	32	38	54				270
Total	312	1483	2125	6298	3884	2460	1294	531	264	123	171	393	116	40	302
Correction of Faroese catches in Vb2		-65	-109	-353	-214	-75	-60	-28	-14	-5	-7	-23	-7	-2	-2
Used in assessment	1194	1080	1756	5676	3411	1232	955	450	218	80	105	370	108	38	30

Table 3.2. Faroe Bank (sub-division Vb2) cod. Surplus production model output using the summer index.

Faroe Bank Cod RV Page 1

14 Apr 2015 at 12:00.44

ASPIC -- A Surplus-Production Model Including Covariates (Ver. 3.82) FIT Mode

Author: Michael H. Prager; NOAA/NMFS/S.E. Fisheries Science Center ASPIC User's Manual

101 Pivers Island Road; Beaufort, North Carolina 28516 USA is available gratis

from the author.

Ref: Prager, M. H. 1994. A suite of extensions to a nonequilibrium

surplus-production model. Fishery Bulletin 92: 374-389.

CONTROL PARAMETERS USED (FROM INPUT FILE)

Number of years analyzed:	50	Number of bootstrap trials:	0
Number of data series:	1	Lower bound on MSY:	5.000E+02
Objective function computed:	in effort	Upper bound on MSY:	1.000E+09
Relative conv. criterion (simplex):	1.000E-08	Lower bound on r:	7.000E-02
Relative conv. criterion (restart):	3.000E-08	Upper bound on r:	2.500E+00
Relative conv. criterion (effort):	1.000E-04	Random number seed:	2010417
Maximum F allowed in fitting:	8.000	Monte Carlo search mode, trials:	1 10000

PROGRAM STATUS INFORMATION (NON-BOOTSTRAPPED ANALYSIS) code 20

ERROR: Estimate of r is at or near minimum constraint, 7.000E-02

Solution may be trivial--examine carefully.

GOODNESS-OF-FIT AND WEIGHTING FOR NON-BOOTSTRAPPED ANALYSIS

Loss component number and title	Weighted SSE	N	Weighted MSE	Current weight	Suggested weight	R-squared in CPUE
Loss(-1) SSE in yield	0.000E+00					
Loss(0) Penalty for B1R > 2	0.000E+00	1	N/A	1.000E-01	N/A	
Loss(1) Survey CPUE Summer	2.466E+00	19	1.451E-01	1.000E+00	1.000E+00	0.775
TOTAL OBJECTIVE FUNCTION:	2.46625417E+00					

Number of restarts required for convergence: 6

Est. B-ratio coverage index (0 worst, 2 best): 0.7511 < These two measures are defined in Prager

Est. B-ratio nearness index (0 worst, 1 best): 0.7853 < et al. (1996), Trans. A.F.S. 125:729

MODEL PARAMETER ESTIMATES (NON-BOOTSTRAPPED)

Parameter		Estimate	Starting guess	Estimated	User guess
B1R	Starting biomass ratio, year 1965	7.853E-01	1.000E+00	1	1
MSY	Maximum sustainable yield	1.775E+03	3.000E+03	1	1
r	Intrinsic rate of increase	7.000E-02	8.000E-01	1	1
....	Catchability coefficients by fishery:				
q(1)	Survey CPUE Summer	1.712E-02	1.000E-02	1	1

MANAGEMENT PARAMETER ESTIMATES (NON-BOOTSTRAPPED)

Parameter		Estimate	Formula	Related quantity
MSY	Maximum sustainable yield	1.775E+03	Kr/4	
K	Maximum stock biomass	1.014E+05		
Bmsy	Stock biomass at MSY	5.072E+04	K/2	
Fmsy	Fishing mortality at MSY	3.500E-02	r/2	
F(0.1)	Management benchmark	3.150E-02	0.9*Fmsy	
Y(0.1)	Equilibrium yield at F(0.1)	1.757E+03	0.99*MSY	
B-ratio	Ratio of B(2015) to Bmsy	3.807E-02		
F-ratio	Ratio of F(2014) to Fmsy	4.558E-01		
F01-mult	Ratio of F(0.1) to F(2014)	1.975E+00		
Y-ratio	Proportion of MSY avail in 2015	7.469E-02	2*Br-Br^2	Ye(2015) = 1.326E+02
....	Fishing effort at MSY in units of each fishery:			
fmsy(1)	Survey CPUE Summer	2.045E+00	r/2q(1)	f(0.1) = 1.840E+00

Faroe Bank Cod RV Page 2

ESTIMATED POPULATION TRAJECTORY (NON-BOOTSTRAPPED)

Obs	Year or ID	Estimated total F mort	Estimated starting biomass	Estimated average biomass	Observed total yield	Model total yield	Estimated surplus production	Ratio of F mort to Fmsy	Ratio of biomass to Bmsy
1	1965	0.059	3.983E+04	3.950E+04	2.341E+03	2.341E+03	1.688E+03	1.693E+00	7.853E-01
2	1966	0.049	3.918E+04	3.906E+04	1.909E+03	1.909E+03	1.681E+03	1.396E+00	7.725E-01
3	1967	0.040	3.895E+04	3.901E+04	1.569E+03	1.569E+03	1.680E+03	1.149E+00	7.680E-01
4	1968	0.102	3.906E+04	3.794E+04	3.871E+03	3.871E+03	1.662E+03	2.915E+00	7.702E-01
5	1969	0.067	3.685E+04	3.644E+04	2.457E+03	2.457E+03	1.634E+03	1.927E+00	7.266E-01
6	1970	0.085	3.603E+04	3.533E+04	3.002E+03	3.002E+03	1.612E+03	2.428E+00	7.104E-01
7	1971	0.060	3.464E+04	3.439E+04	2.079E+03	2.079E+03	1.591E+03	1.727E+00	6.830E-01
8	1972	0.064	3.415E+04	3.386E+04	2.168E+03	2.168E+03	1.579E+03	1.830E+00	6.734E-01
9	1973	0.161	3.356E+04	3.174E+04	5.101E+03	5.101E+03	1.526E+03	4.592E+00	6.618E-01
10	1974	0.070	2.999E+04	2.969E+04	2.068E+03	2.068E+03	1.470E+03	1.990E+00	5.913E-01
11	1975	0.070	2.939E+04	2.910E+04	2.036E+03	2.036E+03	1.453E+03	1.999E+00	5.795E-01
12	1976	0.080	2.881E+04	2.839E+04	2.258E+03	2.258E+03	1.431E+03	2.272E+00	5.680E-01
13	1977	0.034	2.798E+04	2.821E+04	9.590E+02	9.590E+02	1.426E+03	9.712E-01	5.517E-01
14	1978	0.163	2.845E+04	2.692E+04	4.379E+03	4.379E+03	1.384E+03	4.648E+00	5.609E-01
15	1979	0.051	2.545E+04	2.547E+04	1.306E+03	1.306E+03	1.335E+03	1.465E+00	5.018E-01
16	1980	0.047	2.548E+04	2.555E+04	1.203E+03	1.203E+03	1.338E+03	1.345E+00	5.024E-01
17	1981	0.048	2.562E+04	2.567E+04	1.229E+03	1.229E+03	1.342E+03	1.368E+00	5.050E-01
18	1982	0.086	2.573E+04	2.530E+04	2.184E+03	2.184E+03	1.329E+03	2.467E+00	5.073E-01
19	1983	0.094	2.487E+04	2.437E+04	2.284E+03	2.284E+03	1.296E+03	2.677E+00	4.904E-01
20	1984	0.093	2.389E+04	2.342E+04	2.189E+03	2.189E+03	1.261E+03	2.671E+00	4.709E-01
21	1985	0.132	2.296E+04	2.209E+04	2.913E+03	2.913E+03	1.209E+03	3.767E+00	4.526E-01
22	1986	0.088	2.125E+04	2.091E+04	1.836E+03	1.836E+03	1.162E+03	2.508E+00	4.191E-01
23	1987	0.176	2.058E+04	1.940E+04	3.409E+03	3.409E+03	1.098E+03	5.021E+00	4.058E-01
24	1988	0.172	1.827E+04	1.727E+04	2.966E+03	2.966E+03	1.003E+03	4.908E+00	3.602E-01
25	1989	0.079	1.631E+04	1.614E+04	1.270E+03	1.270E+03	9.503E+02	2.248E+00	3.215E-01
26	1990	0.018	1.599E+04	1.632E+04	2.890E+02	2.890E+02	9.585E+02	5.060E-01	3.152E-01
27	1991	0.017	1.666E+04	1.700E+04	2.970E+02	2.970E+02	9.906E+02	4.991E-01	3.284E-01
28	1992	0.009	1.735E+04	1.778E+04	1.540E+02	1.540E+02	1.027E+03	2.474E-01	3.421E-01
29	1993	0.014	1.822E+04	1.862E+04	2.660E+02	2.660E+02	1.064E+03	4.082E-01	3.593E-01
30	1994	0.038	1.902E+04	1.920E+04	7.250E+02	7.250E+02	1.090E+03	1.079E+00	3.750E-01
31	1995	0.031	1.938E+04	1.964E+04	6.010E+02	6.010E+02	1.108E+03	8.744E-01	3.822E-01
32	1996	0.109	1.989E+04	1.938E+04	2.106E+03	2.106E+03	1.097E+03	3.105E+00	3.922E-01
33	1997	0.205	1.888E+04	1.756E+04	3.594E+03	3.594E+03	1.016E+03	5.848E+00	3.723E-01
34	1998	0.214	1.631E+04	1.510E+04	3.239E+03	3.239E+03	8.995E+02	6.127E+00	3.215E-01
35	1999	0.072	1.397E+04	1.388E+04	1.001E+03	1.001E+03	8.389E+02	2.060E+00	2.754E-01
36	2000	0.088	1.380E+04	1.362E+04	1.194E+03	1.194E+03	8.253E+02	2.505E+00	2.722E-01
37	2001	0.081	1.343E+04	1.330E+04	1.080E+03	1.080E+03	8.088E+02	2.320E+00	2.649E-01

38	2002	0.139	1.316E+04	1.267E+04	1.756E+03	1.756E+03	7.759E+02	3.961E+00	2.595E-01
39	2003	0.603	1.218E+04	9.414E+03	5.676E+03	5.676E+03	5.964E+02	1.723E+01	2.402E-01
40	2004	0.628	7.104E+03	5.435E+03	3.411E+03	3.411E+03	3.595E+02	1.793E+01	1.401E-01
41	2005	0.349	4.052E+03	3.532E+03	1.232E+03	1.232E+03	2.386E+02	9.965E+00	7.990E-02
42	2006	0.360	3.059E+03	2.653E+03	9.550E+02	9.550E+02	1.808E+02	1.029E+01	6.031E-02
43	2007	0.211	2.285E+03	2.129E+03	4.500E+02	4.500E+02	1.459E+02	6.039E+00	4.505E-02
44	2008	0.112	1.981E+03	1.938E+03	2.180E+02	2.180E+02	1.331E+02	3.214E+00	3.905E-02
45	2009	0.042	1.896E+03	1.922E+03	8.000E+01	8.000E+01	1.320E+02	1.189E+00	3.738E-02
46	2010	0.054	1.948E+03	1.963E+03	1.050E+02	1.050E+02	1.347E+02	1.529E+00	3.840E-02
47	2011	0.200	1.977E+03	1.853E+03	3.700E+02	3.700E+02	1.274E+02	5.704E+00	3.899E-02
48	2012	0.062	1.735E+03	1.741E+03	1.080E+02	1.080E+02	1.198E+02	1.773E+00	3.420E-02
49	2013	0.021	1.747E+03	1.789E+03	3.800E+01	3.800E+01	1.230E+02	6.070E-01	3.444E-02
50	2014	0.016	1.832E+03	1.881E+03	3.000E+01	3.000E+01	1.292E+02	4.558E-01	3.611E-02
51	2015		1.931E+03				3.807E-02		

Faroe Bank Cod RV Page 3

RESULTS FOR DATA SERIES # 1 (NON-BOOTSTRAPPED) Survey CPUE Summer

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Data type CC: CPUE-catch series Series weight: 1.000

Obs	Year	Observed CPUE	Estimated CPUE	Estim F	Observed yield	Model yield	Resid in log scale	Resid in yield
1	1965	*	6.761E+02	0.0593	2.341E+03	2.341E+03	0.00000	0.000E+00
2	1966	*	6.686E+02	0.0489	1.909E+03	1.909E+03	0.00000	0.000E+00
3	1967	*	6.676E+02	0.0402	1.569E+03	1.569E+03	0.00000	0.000E+00
4	1968	*	6.494E+02	0.1020	3.871E+03	3.871E+03	0.00000	0.000E+00
5	1969	*	6.237E+02	0.0674	2.457E+03	2.457E+03	0.00000	0.000E+00
6	1970	*	6.047E+02	0.0850	3.002E+03	3.002E+03	0.00000	0.000E+00
7	1971	*	5.887E+02	0.0604	2.079E+03	2.079E+03	0.00000	0.000E+00
8	1972	*	5.795E+02	0.0640	2.168E+03	2.168E+03	0.00000	0.000E+00
9	1973	*	5.432E+02	0.1607	5.101E+03	5.101E+03	0.00000	0.000E+00
10	1974	*	5.081E+02	0.0697	2.068E+03	2.068E+03	0.00000	0.000E+00
11	1975	*	4.980E+02	0.0700	2.036E+03	2.036E+03	0.00000	0.000E+00
12	1976	*	4.859E+02	0.0795	2.258E+03	2.258E+03	0.00000	0.000E+00
13	1977	*	4.829E+02	0.0340	9.590E+02	9.590E+02	0.00000	0.000E+00
14	1978	*	4.607E+02	0.1627	4.379E+03	4.379E+03	0.00000	0.000E+00
15	1979	*	4.359E+02	0.0513	1.306E+03	1.306E+03	0.00000	0.000E+00
16	1980	*	4.373E+02	0.0471	1.203E+03	1.203E+03	0.00000	0.000E+00
17	1981	*	4.394E+02	0.0479	1.229E+03	1.229E+03	0.00000	0.000E+00
18	1982	*	4.330E+02	0.0863	2.184E+03	2.184E+03	0.00000	0.000E+00
19	1983	*	4.172E+02	0.0937	2.284E+03	2.284E+03	0.00000	0.000E+00
20	1984	*	4.008E+02	0.0935	2.189E+03	2.189E+03	0.00000	0.000E+00
21	1985	*	3.781E+02	0.1319	2.913E+03	2.913E+03	0.00000	0.000E+00
22	1986	*	3.580E+02	0.0878	1.836E+03	1.836E+03	0.00000	0.000E+00
23	1987	*	3.320E+02	0.1757	3.409E+03	3.409E+03	0.00000	0.000E+00
24	1988	*	2.955E+02	0.1718	2.966E+03	2.966E+03	0.00000	0.000E+00
25	1989	*	2.763E+02	0.0787	1.270E+03	1.270E+03	0.00000	0.000E+00
26	1990	*	2.793E+02	0.0177	2.890E+02	2.890E+02	0.00000	0.000E+00
27	1991	*	2.910E+02	0.0175	2.970E+02	2.970E+02	0.00000	0.000E+00
28	1992	*	3.044E+02	0.0087	1.540E+02	1.540E+02	0.00000	0.000E+00
29	1993	*	3.187E+02	0.0143	2.660E+02	2.660E+02	0.00000	0.000E+00
30	1994	*	3.287E+02	0.0378	7.250E+02	7.250E+02	0.00000	0.000E+00
31	1995	*	3.361E+02	0.0306	6.010E+02	6.010E+02	0.00000	0.000E+00
32	1996	3.105E+02	3.317E+02	0.1087	2.106E+03	2.106E+03	0.06617	0.000E+00
33	1997	4.492E+02	3.006E+02	0.2047	3.594E+03	3.594E+03	-0.40172	0.000E+00
34	1998	3.871E+02	2.585E+02	0.2145	3.239E+03	3.239E+03	-0.40367	0.000E+00
35	1999	1.495E+02	2.376E+02	0.0721	1.001E+03	1.001E+03	0.46319	0.000E+00
36	2000	1.199E+02	2.331E+02	0.0877	1.194E+03	1.194E+03	0.66472	0.000E+00
37	2001	2.626E+02	2.276E+02	0.0812	1.080E+03	1.080E+03	-0.14292	0.000E+00

38	2002	3.472E+02	2.168E+02	0.1386	1.756E+03	1.756E+03	-0.47080	0.000E+00
39	2003	1.618E+02	1.611E+02	0.6029	5.676E+03	5.676E+03	-0.00396	0.000E+00
40	2004	7.304E+01	9.303E+01	0.6276	3.411E+03	3.411E+03	0.24190	0.000E+00
41	2005	6.188E+01	6.046E+01	0.3488	1.232E+03	1.232E+03	-0.02321	0.000E+00
42	2006	2.927E+01	4.541E+01	0.3600	9.550E+02	9.550E+02	0.43905	0.000E+00
43	2007	3.331E+01	3.644E+01	0.2114	4.500E+02	4.500E+02	0.08977	0.000E+00
44	2008	3.117E+01	3.317E+01	0.1125	2.180E+02	2.180E+02	0.06204	0.000E+00
45	2009	4.927E+01	3.289E+01	0.0416	8.000E+01	8.000E+01	-0.40409	0.000E+00
46	2010	4.164E+01	3.359E+01	0.0535	1.050E+02	1.050E+02	-0.21484	0.000E+00
47	2011	5.854E+01	3.172E+01	0.1996	3.700E+02	3.700E+02	-0.61266	0.000E+00
48	2012	3.425E+01	2.979E+01	0.0620	1.080E+02	1.080E+02	-0.13949	0.000E+00
49	2013	1.737E+01	3.062E+01	0.0212	3.800E+01	3.800E+01	0.56678	0.000E+00
50	2014	2.575E+01	3.219E+01	0.0160	3.000E+01	3.000E+01	0.22324	0.000E+00

* Asterisk indicates missing value(s).

```
Faroe Bank Cod RV                                              Page 4

UNWEIGHTED LOG RESIDUAL PLOT FOR DATA SERIES # 1
             -1     -0.75    -0.5    -0.25     0      0.25     0.5     0.75     1
              |   .   |   .   |   .   |   .   |   .   |   .   |   .   |   .   |
Year  Residual   -------------------------------------------------------------------------------
1965    0.0000                                |
1966    0.0000                                |
1967    0.0000                                |
1968    0.0000                                |
1969    0.0000                                |
1970    0.0000                                |
1971    0.0000                                |
1972    0.0000                                |
1973    0.0000                                |
1974    0.0000                                |
1975    0.0000                                |
1976    0.0000                                |
1977    0.0000                                |
1978    0.0000                                |
1979    0.0000                                |
1980    0.0000                                |
1981    0.0000                                |
1982    0.0000                                |
1983    0.0000                                |
1984    0.0000                                |
1985    0.0000                                |
1986    0.0000                                |
1987    0.0000                                |
1988    0.0000                                |
1989    0.0000                                |
1990    0.0000                                |
1991    0.0000                                |
1992    0.0000                                |
1993    0.0000                                |
1994    0.0000                                |
1995    0.0000                                |
1996    0.0662                                |===
1997   -0.4017                ================|
1998   -0.4037                ================|
1999    0.4632                                |===================
2000    0.6647                                |===========================
2001   -0.1429                          ======|
2002   -0.4708             ===================|
2003   -0.0040                                |
2004    0.2419                                |==========
```

```
2005   -0.0232                           =|
2006    0.4390                            |==================
2007    0.0898                            |====
2008    0.0620                            |==
2009   -0.4041          ================|
2010   -0.2148                 =========|
2011   -0.6127  =========================|
2012   -0.1395                    ======|
2013    0.5668                            |=======================
2014    0.2232                            |=========
            --------------------------------------------------------------------------------
```

Faroe Bank Cod RV Page 5

Observed (O) and Estimated (*) CPUE for Data Series # 1 -- Survey CPUE Summer

```
       :
  900. -:
       :
       :
       :
       :
  750. -:
       :
       :      *
       :       ** *
       :          *
  600. -:            * *
       :              *
       :               *
       :                * *
       :                  * *
  450. -:                      ** * *           O
       :                       * *
       :                          **           O
       :                           *              O
       :                             *     ** * *
  300. -:                              *   * *    O*
       :                             * *       *  O
       :                                       ** *
       :                                          *
       :
  150. -:                                         O   2
       :                                         O
       :                                            *
       :                                            O 2*   O  O
       :                                              O 2 2* 2 *2 2 2
    0. -:
       :..............................................................
       :     :     :     :     :     :     :     :     :     :     :
    1959.  1965.  1971.  1977.  1983.  1989.  1995.  2001.  2007.  2013.  2019.
```

Time Plot of Estimated F-Ratio and B-Ratio

```
       :
   18. -:                                            F
       :                                           F
       :
       :
       :
```

```
15. -:
    :
    :
    :
    :
12. -:
    :
    :
    :                                              FF
    :
 9. -:
    :
    :
    :
    :
 6. -:                                      F F          F    F
    :
    :              F      F          FF
    :                                              F
    :                            F
 3. -:        F                               F              F
    :         F       F       F F F  F   F            F F
    :    F    F  F F  F F                           F            F  F
    : -- - -- - 22 - -- - -- - -- 2 -2 2 2- - -- - -- - -- - -2 - -- - -- - -- - -- - -2 - -- - -- - -- - -
    :    B BB B BB B BB B BB B BB B BB B BB B BB B 22 B 2B 2 BB B               F F
 0. -:                                   F        BB B BB B BB B BB B BB B BB
    :.........................................................................................
    :      :      :      :      :      :      :      :      :      :      :
  1959.  1965.  1971.  1977.  1983.  1989.  1995.  2001.  2007.  2013.  2019.
```

Table 3.3. Faroe Bank (sub-division Vb2) cod. Surplus production model output using the spring index.

Faroe Bank Cod RV Page 1

14 Apr 2015 at 12:02.17

ASPIC -- A Surplus-Production Model Including Covariates (Ver. 3.82) FIT Mode

Author: Michael H. Prager; NOAA/NMFS/S.E. Fisheries Science Center ASPIC User's Manual

101 Pivers Island Road; Beaufort, North Carolina 28516 USA is available gratis

from the author.

Ref: Prager, M. H. 1994. A suite of extensions to a nonequilibrium

surplus-production model. Fishery Bulletin 92: 374-389.

CONTROL PARAMETERS USED (FROM INPUT FILE)

Number of years analyzed:	50	Number of bootstrap trials:	0
Number of data series:	1	Lower bound on MSY:	5.000E+02
Objective function computed:	in effort	Upper bound on MSY:	1.000E+09
Relative conv. criterion (simplex):	1.000E-08	Lower bound on r:	7.000E-02
Relative conv. criterion (restart):	3.000E-08	Upper bound on r:	2.500E+00
Relative conv. criterion (effort):	1.000E-04	Random number seed:	2010417
Maximum F allowed in fitting:	8.000	Monte Carlo search mode, trials:	1 10000

PROGRAM STATUS INFORMATION (NON-BOOTSTRAPPED ANALYSIS) code 0

Normal convergence.

GOODNESS-OF-FIT AND WEIGHTING FOR NON-BOOTSTRAPPED ANALYSIS

Loss component number and title	Weighted SSE	N	Weighted MSE	Current weight	Suggested weight	R-squared in CPUE
Loss(-1) SSE in yield	0.000E+00					
Loss(0) Penalty for B1R > 2	0.000E+00	1	N/A	1.000E-01	N/A	
Loss(1) Survey CPUE Spring	1.895E+01	29	7.020E-01	1.000E+00	1.000E+00	0.131
TOTAL OBJECTIVE FUNCTION:	1.89548543E+01					

Number of restarts required for convergence: 18

Est. B-ratio coverage index (0 worst, 2 best): 0.6336 < These two measures are defined in Prager

Est. B-ratio nearness index (0 worst, 1 best): 0.7091 < et al. (1996), Trans. A.F.S. 125:729

MODEL PARAMETER ESTIMATES (NON-BOOTSTRAPPED)

Parameter		Estimate	Starting guess	Estimated	User guess
B1R	Starting biomass ratio, year 1965	5.900E-01	1.000E+00	1	1

MSY	Maximum sustainable yield	2.931E+03	3.000E+03	1	1
r	Intrinsic rate of increase	3.993E-01	8.000E-01	1	1
....	Catchability coefficients by fishery:				
q(1)	Survey CPUE Spring	3.065E-02	1.000E-02	1	1

MANAGEMENT PARAMETER ESTIMATES (NON-BOOTSTRAPPED)

Parameter		Estimate	Formula	Related quantity
MSY	Maximum sustainable yield	2.931E+03	Kr/4	
K	Maximum stock biomass	2.936E+04		
Bmsy	Stock biomass at MSY	1.468E+04	K/2	
Fmsy	Fishing mortality at MSY	1.997E-01	r/2	
F(0.1)	Management benchmark	1.797E-01	0.9*Fmsy	
Y(0.1)	Equilibrium yield at F(0.1)	2.902E+03	0.99*MSY	
B-ratio	Ratio of B(2015) to Bmsy	5.709E-01		
F-ratio	Ratio of F(2014) to Fmsy	2.066E-02		
F01-mult	Ratio of F(0.1) to F(2014)	4.356E+01		
Y-ratio	Proportion of MSY avail in 2015	8.159E-01	2*Br-Br^2	Ye(2015) = 2.392E+03

.... Fishing effort at MSY in units of each fishery:

fmsy(1)	Survey CPUE Spring	6.514E+00	r/2q(1)	f(0.1) = 5.863E+00

Faroe Bank Cod RV Page 2

ESTIMATED POPULATION TRAJECTORY (NON-BOOTSTRAPPED)

Obs	Year or ID	Estimated total F mort	Estimated starting biomass	Estimated average biomass	Observed total yield	Model total yield	Estimated surplus production	Ratio of F mort to Fmsy	Ratio of biomass to Bmsy
1	1965	0.269	8.662E+03	8.716E+03	2.341E+03	2.341E+03	2.447E+03	1.345E+00	5.900E-01
2	1966	0.211	8.768E+03	9.068E+03	1.909E+03	1.909E+03	2.502E+03	1.054E+00	5.972E-01
3	1967	0.159	9.362E+03	9.888E+03	1.569E+03	1.569E+03	2.618E+03	7.947E-01	6.376E-01
4	1968	0.397	1.041E+04	9.746E+03	3.871E+03	3.871E+03	2.598E+03	1.989E+00	7.091E-01
5	1969	0.268	9.138E+03	9.169E+03	2.457E+03	2.457E+03	2.518E+03	1.342E+00	6.224E-01
6	1970	0.336	9.199E+03	8.931E+03	3.002E+03	3.002E+03	2.481E+03	1.684E+00	6.266E-01
7	1971	0.234	8.678E+03	8.877E+03	2.079E+03	2.079E+03	2.473E+03	1.173E+00	5.911E-01
8	1972	0.234	9.072E+03	9.256E+03	2.168E+03	2.168E+03	2.531E+03	1.173E+00	6.179E-01
9	1973	0.643	9.435E+03	7.929E+03	5.101E+03	5.101E+03	2.303E+03	3.222E+00	6.427E-01
10	1974	0.312	6.636E+03	6.627E+03	2.068E+03	2.068E+03	2.049E+03	1.563E+00	4.520E-01
11	1975	0.307	6.618E+03	6.624E+03	2.036E+03	2.036E+03	2.048E+03	1.539E+00	4.508E-01
12	1976	0.347	6.630E+03	6.510E+03	2.258E+03	2.258E+03	2.023E+03	1.737E+00	4.516E-01
13	1977	0.138	6.395E+03	6.969E+03	9.590E+02	9.590E+02	2.121E+03	6.892E-01	4.356E-01
14	1978	0.700	7.557E+03	6.252E+03	4.379E+03	4.379E+03	1.959E+03	3.508E+00	5.148E-01
15	1979	0.244	5.137E+03	5.358E+03	1.306E+03	1.306E+03	1.749E+03	1.221E+00	3.499E-01
16	1980	0.203	5.580E+03	5.920E+03	1.203E+03	1.203E+03	1.887E+03	1.018E+00	3.801E-01
17	1981	0.184	6.264E+03	6.676E+03	1.229E+03	1.229E+03	2.059E+03	9.219E-01	4.266E-01
18	1982	0.309	7.094E+03	7.074E+03	2.184E+03	2.184E+03	2.144E+03	1.546E+00	4.832E-01
19	1983	0.328	7.054E+03	6.972E+03	2.284E+03	2.284E+03	2.123E+03	1.641E+00	4.805E-01
20	1984	0.320	6.893E+03	6.846E+03	2.189E+03	2.189E+03	2.096E+03	1.601E+00	4.695E-01
21	1985	0.461	6.801E+03	6.315E+03	2.913E+03	2.913E+03	1.978E+03	2.310E+00	4.632E-01
22	1986	0.312	5.866E+03	5.888E+03	1.836E+03	1.836E+03	1.880E+03	1.562E+00	3.996E-01
23	1987	0.687	5.910E+03	4.965E+03	3.409E+03	3.409E+03	1.644E+03	3.438E+00	4.025E-01
24	1988	0.951	4.145E+03	3.118E+03	2.966E+03	2.966E+03	1.109E+03	4.764E+00	2.823E-01
25	1989	0.630	2.288E+03	2.015E+03	1.270E+03	1.270E+03	7.492E+02	3.156E+00	1.558E-01
26	1990	0.146	1.767E+03	1.984E+03	2.890E+02	2.890E+02	7.387E+02	7.294E-01	1.204E-01
27	1991	0.118	2.217E+03	2.516E+03	2.970E+02	2.970E+02	9.183E+02	5.911E-01	1.510E-01
28	1992	0.046	2.838E+03	3.327E+03	1.540E+02	1.540E+02	1.177E+03	2.318E-01	1.933E-01
29	1993	0.060	3.861E+03	4.460E+03	2.660E+02	2.660E+02	1.509E+03	2.987E-01	2.630E-01
30	1994	0.129	5.104E+03	5.640E+03	7.250E+02	7.250E+02	1.818E+03	6.438E-01	3.476E-01
31	1995	0.087	6.197E+03	6.937E+03	6.010E+02	6.010E+02	2.113E+03	4.339E-01	4.221E-01
32	1996	0.270	7.709E+03	7.801E+03	2.106E+03	2.106E+03	2.288E+03	1.352E+00	5.251E-01
33	1997	0.504	7.891E+03	7.135E+03	3.594E+03	3.594E+03	2.155E+03	2.523E+00	5.375E-01
34	1998	0.567	6.451E+03	5.712E+03	3.239E+03	3.239E+03	1.835E+03	2.840E+00	4.394E-01
35	1999	0.185	5.047E+03	5.425E+03	1.001E+03	1.001E+03	1.766E+03	9.240E-01	3.438E-01
36	2000	0.193	5.812E+03	6.187E+03	1.194E+03	1.194E+03	1.950E+03	9.665E-01	3.959E-01
37	2001	0.152	6.568E+03	7.097E+03	1.080E+03	1.080E+03	2.148E+03	7.622E-01	4.473E-01
38	2002	0.222	7.635E+03	7.913E+03	1.756E+03	1.756E+03	2.308E+03	1.111E+00	5.201E-01

39	2003	0.932	8.187E+03	6.087E+03	5.676E+03	5.676E+03	1.911E+03	4.670E+00	5.577E-01
40	2004	1.092	4.422E+03	3.123E+03	3.411E+03	3.411E+03	1.109E+03	5.469E+00	3.012E-01
41	2005	0.672	2.120E+03	1.832E+03	1.232E+03	1.232E+03	6.857E+02	3.367E+00	1.444E-01
42	2006	0.714	1.574E+03	1.338E+03	9.550E+02	9.550E+02	5.099E+02	3.574E+00	1.072E-01
43	2007	0.402	1.129E+03	1.118E+03	4.500E+02	4.500E+02	4.296E+02	2.015E+00	7.688E-02
44	2008	0.177	1.108E+03	1.231E+03	2.180E+02	2.180E+02	4.708E+02	8.871E-01	7.549E-02
45	2009	0.050	1.361E+03	1.612E+03	8.000E+01	8.000E+01	6.079E+02	2.486E-01	9.271E-02
46	2010	0.047	1.889E+03	2.230E+03	1.050E+02	1.050E+02	8.224E+02	2.358E-01	1.287E-01
47	2011	0.126	2.606E+03	2.938E+03	3.700E+02	3.700E+02	1.055E+03	6.307E-01	1.775E-01
48	2012	0.028	3.292E+03	3.882E+03	1.080E+02	1.080E+02	1.344E+03	1.393E-01	2.242E-01
49	2013	0.007	4.527E+03	5.345E+03	3.800E+01	3.800E+01	1.743E+03	3.561E-02	3.084E-01
50	2014	0.004	6.232E+03	7.271E+03	3.000E+01	3.000E+01	2.179E+03	2.066E-02	4.245E-01
51	2015		8.381E+03				5.709E-01		

Faroe Bank Cod RV Page 3

RESULTS FOR DATA SERIES # 1 (NON-BOOTSTRAPPED) Survey CPUE Spring

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Data type CC: CPUE-catch series Series weight: 1.000

Obs	Year	Observed CPUE	Estimated CPUE	Estim F	Observed yield	Model yield	Resid in log scale	Resid in yield
1	1965	*	2.671E+02	0.2686	2.341E+03	2.341E+03	0.00000	0.000E+00
2	1966	*	2.779E+02	0.2105	1.909E+03	1.909E+03	0.00000	0.000E+00
3	1967	*	3.031E+02	0.1587	1.569E+03	1.569E+03	0.00000	0.000E+00
4	1968	*	2.987E+02	0.3972	3.871E+03	3.871E+03	0.00000	0.000E+00
5	1969	*	2.810E+02	0.2680	2.457E+03	2.457E+03	0.00000	0.000E+00
6	1970	*	2.737E+02	0.3361	3.002E+03	3.002E+03	0.00000	0.000E+00
7	1971	*	2.721E+02	0.2342	2.079E+03	2.079E+03	0.00000	0.000E+00
8	1972	*	2.837E+02	0.2342	2.168E+03	2.168E+03	0.00000	0.000E+00
9	1973	*	2.430E+02	0.6433	5.101E+03	5.101E+03	0.00000	0.000E+00
10	1974	*	2.031E+02	0.3121	2.068E+03	2.068E+03	0.00000	0.000E+00
11	1975	*	2.030E+02	0.3074	2.036E+03	2.036E+03	0.00000	0.000E+00
12	1976	*	1.995E+02	0.3468	2.258E+03	2.258E+03	0.00000	0.000E+00
13	1977	*	2.136E+02	0.1376	9.590E+02	9.590E+02	0.00000	0.000E+00
14	1978	*	1.916E+02	0.7004	4.379E+03	4.379E+03	0.00000	0.000E+00
15	1979	*	1.642E+02	0.2437	1.306E+03	1.306E+03	0.00000	0.000E+00
16	1980	*	1.814E+02	0.2032	1.203E+03	1.203E+03	0.00000	0.000E+00
17	1981	*	2.046E+02	0.1841	1.229E+03	1.229E+03	0.00000	0.000E+00
18	1982	*	2.168E+02	0.3088	2.184E+03	2.184E+03	0.00000	0.000E+00
19	1983	7.899E+01	2.137E+02	0.3276	2.284E+03	2.284E+03	0.99524	0.000E+00
20	1984	1.752E+02	2.098E+02	0.3198	2.189E+03	2.189E+03	0.18032	0.000E+00
21	1985	1.735E+02	1.936E+02	0.4613	2.913E+03	2.913E+03	0.10958	0.000E+00
22	1986	2.661E+02	1.805E+02	0.3118	1.836E+03	1.836E+03	-0.38823	0.000E+00
23	1987	1.640E+02	1.522E+02	0.6865	3.409E+03	3.409E+03	-0.07495	0.000E+00
24	1988	7.311E+01	9.558E+01	0.9511	2.966E+03	2.966E+03	0.26800	0.000E+00
25	1989	3.655E+01	6.176E+01	0.6302	1.270E+03	1.270E+03	0.52465	0.000E+00
26	1990	2.324E+01	6.082E+01	0.1456	2.890E+02	2.890E+02	0.96212	0.000E+00
27	1991	5.097E+01	7.713E+01	0.1180	2.970E+02	2.970E+02	0.41426	0.000E+00
28	1992	2.843E+01	1.020E+02	0.0463	1.540E+02	1.540E+02	1.27735	0.000E+00
29	1993	2.576E+01	1.367E+02	0.0596	2.660E+02	2.660E+02	1.66894	0.000E+00
30	1994	8.674E+01	1.729E+02	0.1286	7.250E+02	7.250E+02	0.68956	0.000E+00
31	1995	9.017E+01	2.126E+02	0.0866	6.010E+02	6.010E+02	0.85789	0.000E+00
32	1996	*	2.391E+02	0.2700	2.106E+03	2.106E+03	0.00000	0.000E+00
33	1997	5.934E+02	2.187E+02	0.5037	3.594E+03	3.594E+03	-0.99817	0.000E+00
34	1998	6.074E+02	1.751E+02	0.5671	3.239E+03	3.239E+03	-1.24403	0.000E+00
35	1999	4.210E+02	1.663E+02	0.1845	1.001E+03	1.001E+03	-0.92888	0.000E+00
36	2000	3.645E+02	1.896E+02	0.1930	1.194E+03	1.194E+03	-0.65339	0.000E+00
37	2001	1.022E+03	2.175E+02	0.1522	1.080E+03	1.080E+03	-1.54755	0.000E+00

38	2002	4.439E+02	2.425E+02	0.2219	1.756E+03	1.756E+03	-0.60439	0.000E+00
39	2003	8.671E+02	1.866E+02	0.9325	5.676E+03	5.676E+03	-1.53632	0.000E+00
40	2004	*	9.574E+01	1.0921	3.411E+03	3.411E+03	0.00000	0.000E+00
41	2005	*	5.616E+01	0.6724	1.232E+03	1.232E+03	0.00000	0.000E+00
42	2006	6.051E+01	4.102E+01	0.7136	9.550E+02	9.550E+02	-0.38875	0.000E+00
43	2007	5.206E+01	3.428E+01	0.4023	4.500E+02	4.500E+02	-0.41779	0.000E+00
44	2008	6.402E+01	3.772E+01	0.1771	2.180E+02	2.180E+02	-0.52893	0.000E+00
45	2009	5.550E+01	4.940E+01	0.0496	8.000E+01	8.000E+01	-0.11647	0.000E+00
46	2010	5.808E+01	6.836E+01	0.0471	1.050E+02	1.050E+02	0.16300	0.000E+00
47	2011	1.224E+02	9.006E+01	0.1259	3.700E+02	3.700E+02	-0.30687	0.000E+00
48	2012	4.454E+01	1.190E+02	0.0278	1.080E+02	1.080E+02	0.98270	0.000E+00
49	2013	1.390E+02	1.638E+02	0.0071	3.800E+01	3.800E+01	0.16444	0.000E+00
50	2014	2.092E+02	2.229E+02	0.0041	3.000E+01	3.000E+01	0.06331	0.000E+00

* Asterisk indicates missing value(s).

Faroe Bank Cod RV Page 4

UNWEIGHTED LOG RESIDUAL PLOT FOR DATA SERIES # 1

```
                -2        -1.5      -1        -0.5      0         0.5       1         1.5       2
                |    .    |    .    |    .    |    .    |    .    |    .    |    .    |    .    |
Year Residual   ------------------------------------------------------------------------------------
1965    0.0000                                          |
1966    0.0000                                          |
1967    0.0000                                          |
1968    0.0000                                          |
1969    0.0000                                          |
1970    0.0000                                          |
1971    0.0000                                          |
1972    0.0000                                          |
1973    0.0000                                          |
1974    0.0000                                          |
1975    0.0000                                          |
1976    0.0000                                          |
1977    0.0000                                          |
1978    0.0000                                          |
1979    0.0000                                          |
1980    0.0000                                          |
1981    0.0000                                          |
1982    0.0000                                          |
1983    0.9952                                          |====================
1984    0.1803                                          |====
1985    0.1096                                          |==
1986   -0.3882                                  ========|
1987   -0.0750                                         =|
1988    0.2680                                          |=====
1989    0.5246                                          |==========
1990    0.9621                                          |===================
1991    0.4143                                          |========
1992    1.2774                                          |==========================
1993    1.6689                                          |=================================
1994    0.6896                                          |==============
1995    0.8579                                          |=================
1996    0.0000                                          |
1997   -0.9982                      ====================|
1998   -1.2440                 =========================|
1999   -0.9289                       ===================|
2000   -0.6534                             =============|
2001   -1.5476           ===============================|
2002   -0.6044                              ============|
2003   -1.5363           ===============================|
2004    0.0000                                          |
```

```
2005   0.0000              |
2006  -0.3887      ========|
2007  -0.4178      ========|
2008  -0.5289   ===========|
2009  -0.1165            ==|
2010   0.1630              |===
2011  -0.3069        ======|
2012   0.9827              |===================
2013   0.1644              |===
2014   0.0633              |=
        ----------------------------------------------------------------------------------
```

Faroe Bank Cod RV Page 5

Observed (O) and Estimated (*) CPUE for Data Series # 1 -- Survey CPUE Spring

```
        :
 1200. -:
        :
        :
        :
        :                                      O
 1000. -:
        :
        :
        :                                       O
        :
  800. -:
        :
        :
        :
        :
  600. -:                                    O O
        :
        :
        :
        :                                     O   O
  400. -:
        :                                     O
        :    *
        :   * *  * ** * *            O
        :          *                     *    *        *
  200. -:             * ** * *  * ** * ** *      * *   * * *         O
        :              *    OO  2     *   * *         *
        :                         * *           O* O
        :                 O   2 * **  O O      *  O  O  * *
        :                     O OO O O          ** 2 *2 O  O
    0. -:
        :......................................................................
         :     :     :     :     :     :     :     :     :     :     :
      1959.  1965.  1971.  1977.  1983.  1989.  1995.  2001.  2007.  2013.  2019.
```

Time Plot of Estimated F-Ratio and B-Ratio

```
        :
    6. -:
        :
        :
```

```
   :                                          F
   :
5. -:
   :                              F
   :                                          F
   :
   :
4. -:
   :
   :                     F                             F
   :                           F                    F
   :                  F                F
3. -:
   :                                       F
   :                                      F
   :                           F
   :
2. -:           F                                        F
   :                    F
   :            F     F F        F F F  F
   :        F     F                              F
   :                 F F        F                          F
1. -:  -- - -- - 2- - -- - -- - -- - -- 2 2- - -- - -- - -- - -- - -- - 22 - -- - -- - -- - -- - -- - -- - -
   :           F B                           F              F         F
   :        B BB   BB B BB      F B                  F    F   BB        BB          F     B
   :                  B BB B  B B BB B BB B B         B 2    B BB B    B             B B
   :                                    B B BB 2 2                 BB    F 2 B2
0. -:                                                        B BB       F F
   :.........................................................................................
    :       :       :       :       :       :       :       :       :       :       :
  1959.    1965.    1971.    1977.    1983.    1989.    1995.    2001.    2007.    2013.    2019.
```

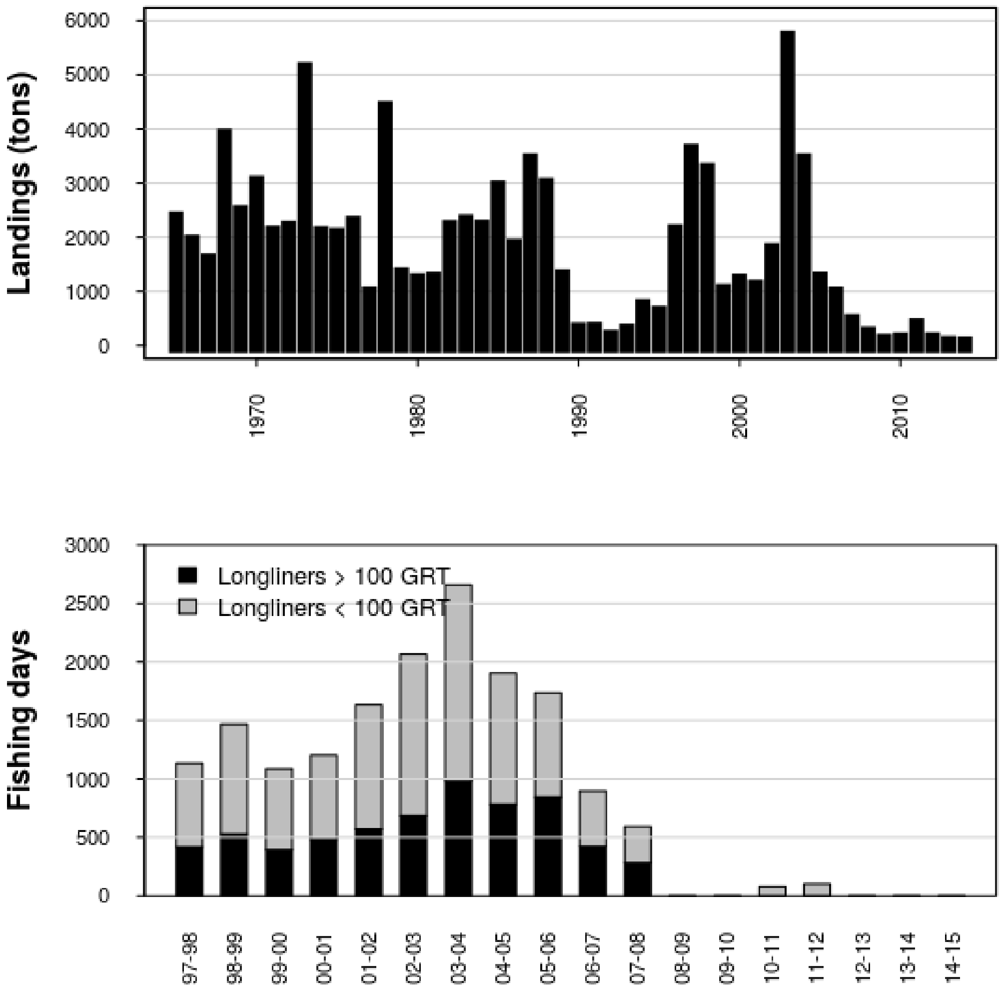

Figure 3.1. Faroe Bank (sub-division Vb2) cod. Reported landings 1965-2014. Since 1992 only catches from Faroese and Norwegian vessels are considered to be taken on Faroe Bank. Lower plot: fishing days (fishing year) 1997-2015 for long line gear type in the Faroe Bank.

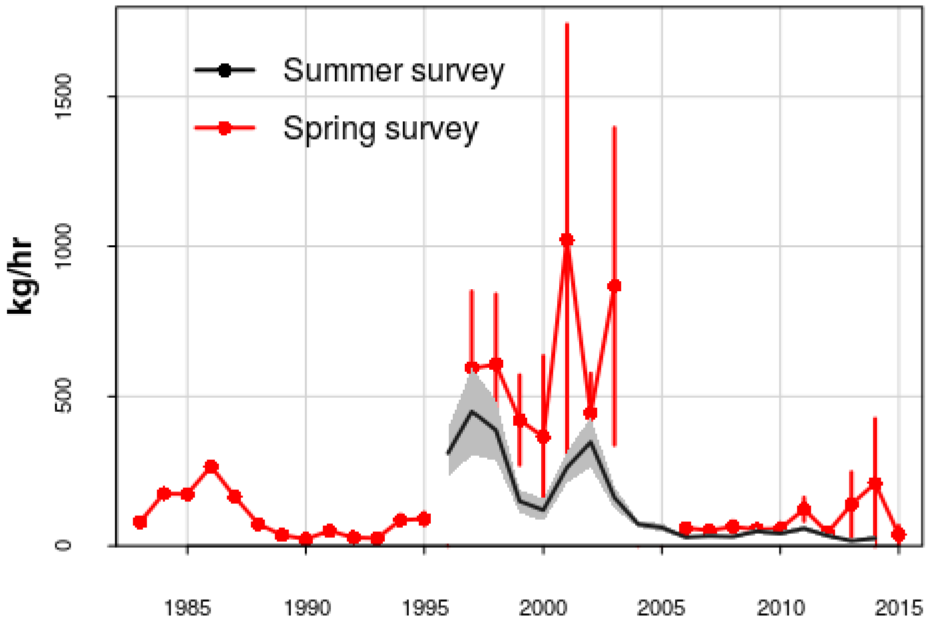

Figure 3.2. Faroe Bank (subdivision Vb2) cod. Catch per unit of effort in the spring groundfish survey (1983-2015)(red line) and summer survey (1996-2014)(black line). Vertical bars and shaded areas show the standard error in the estimation of indexes.

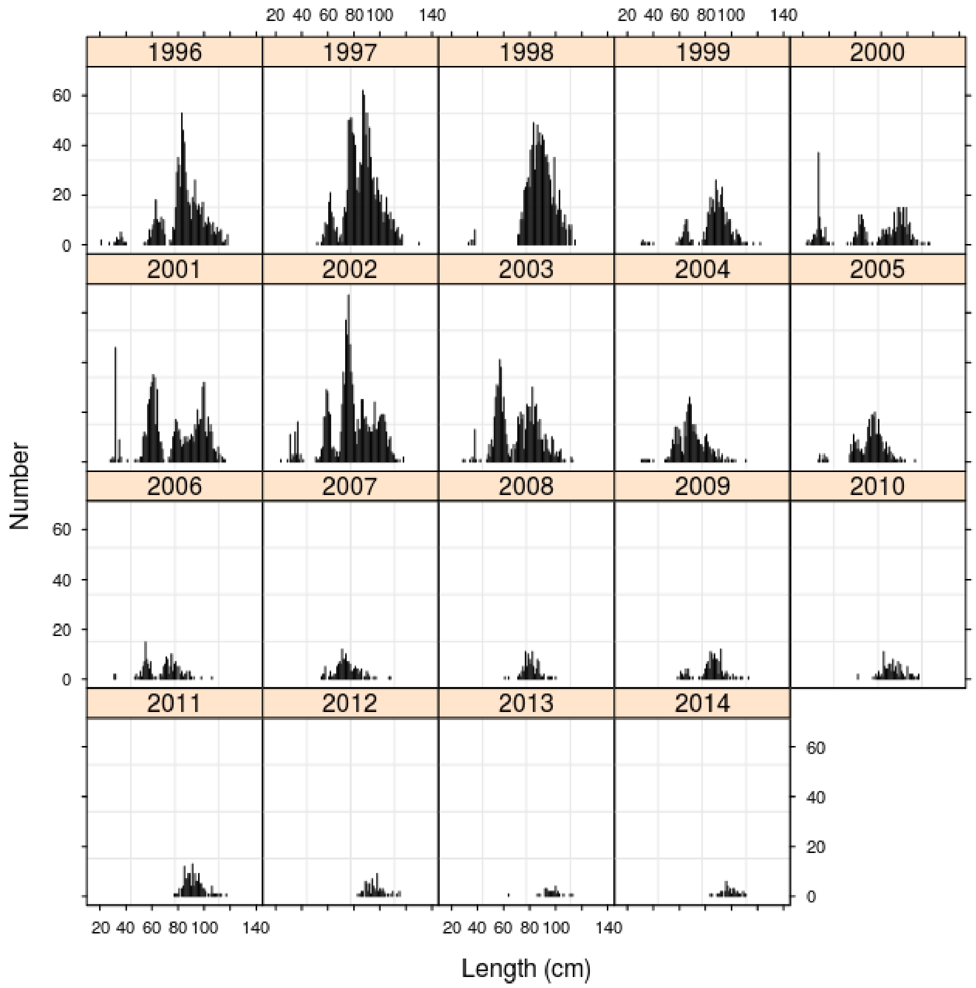

Figure 3.3. Faroe Bank (sub-division Vb2) cod. Length distributions in summer survey (1996-2014)

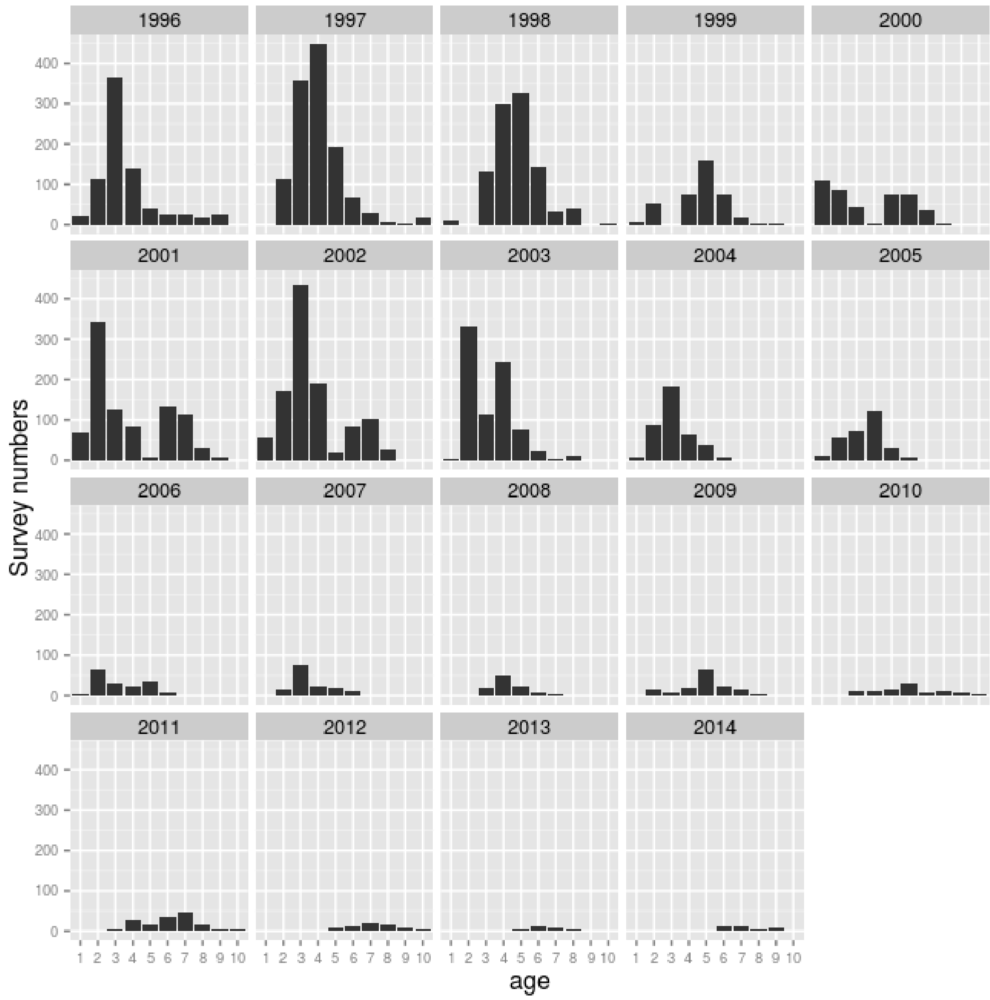

Figure 3.4. Faroe Bank (sub-division Vb2) cod. Age-disaggregated indices in the summer survey (ages 1-11)(1996-2014)

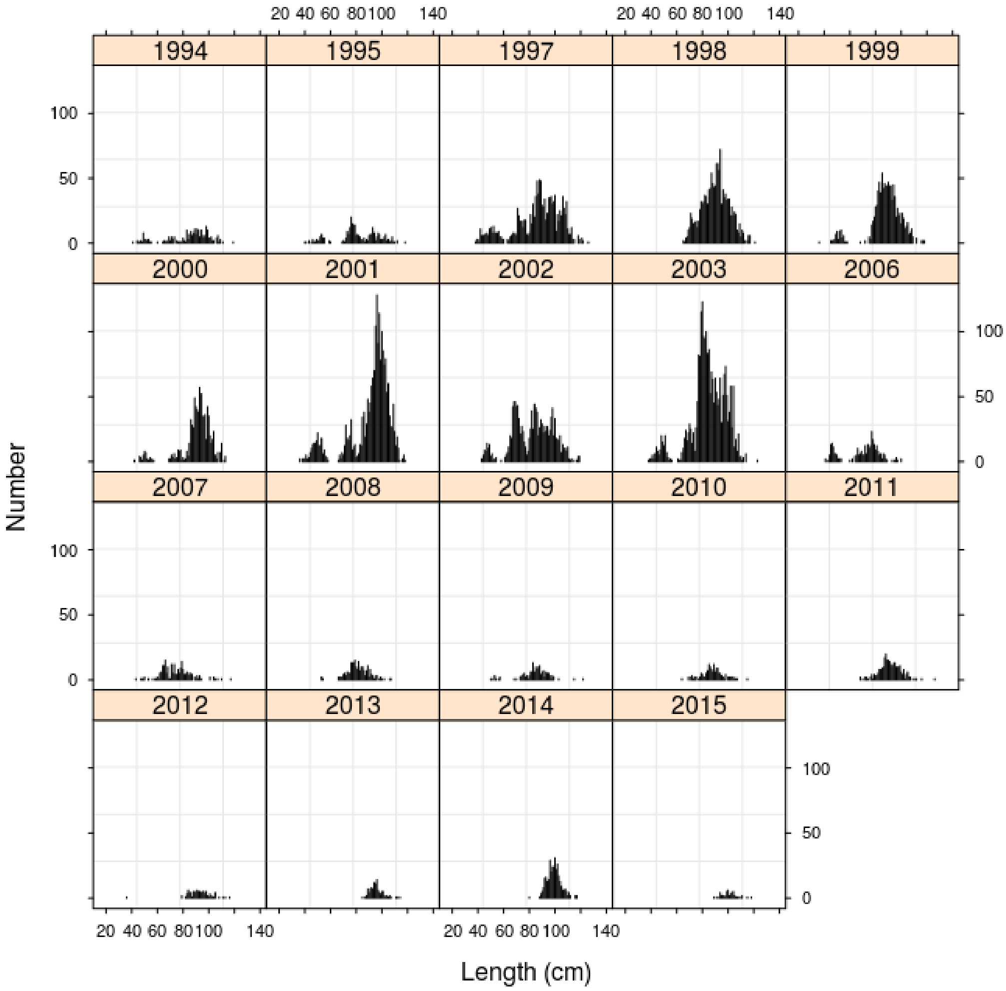

Figure 3.5. Faroe Bank (sub-division Vb2) cod. Length distributions in spring survey (1994-2015). No surveys were conducted in 1996, 2004 and 2005.

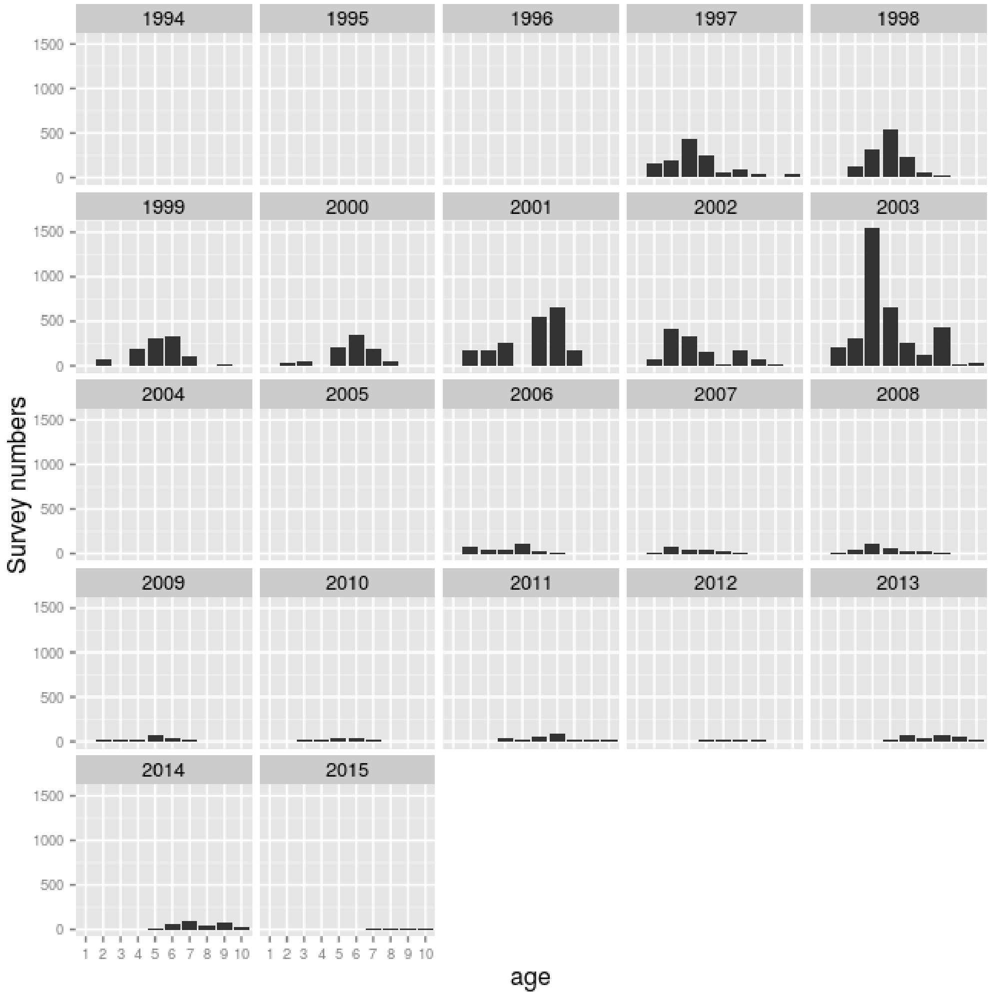

Figure 3.6. Faroe Bank (sub-division Vb2) cod. Age-disaggregated indices in the spring survey (ages 1-11) (1994-2015). No surveys were conducted in 1996, 2004 and 2005.

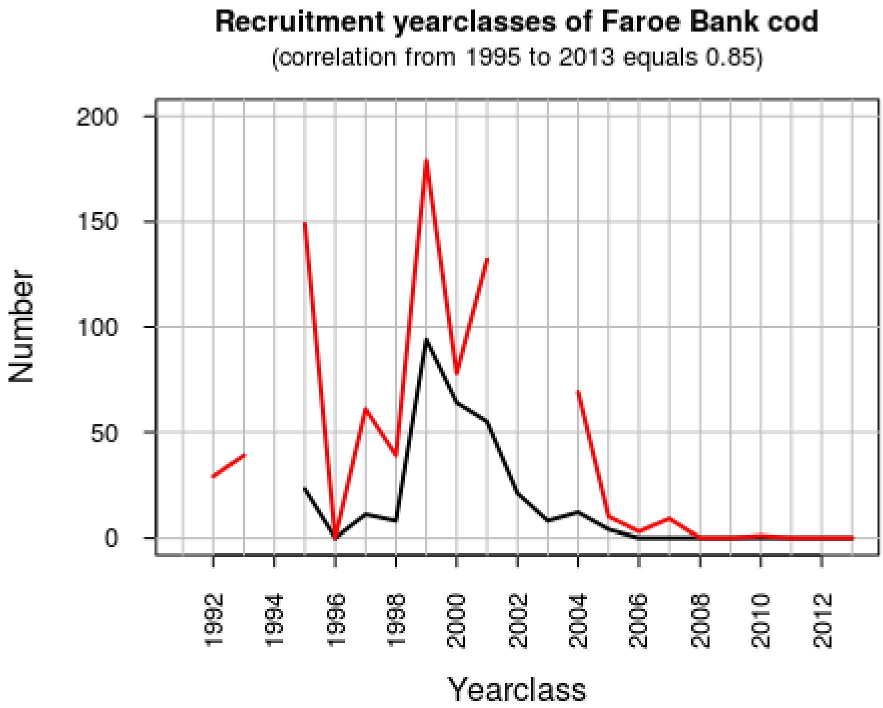

Figure 3.7. Faroe Bank (sub-division Vb2) cod. Correlation between recruitment year classes in both survey indices.

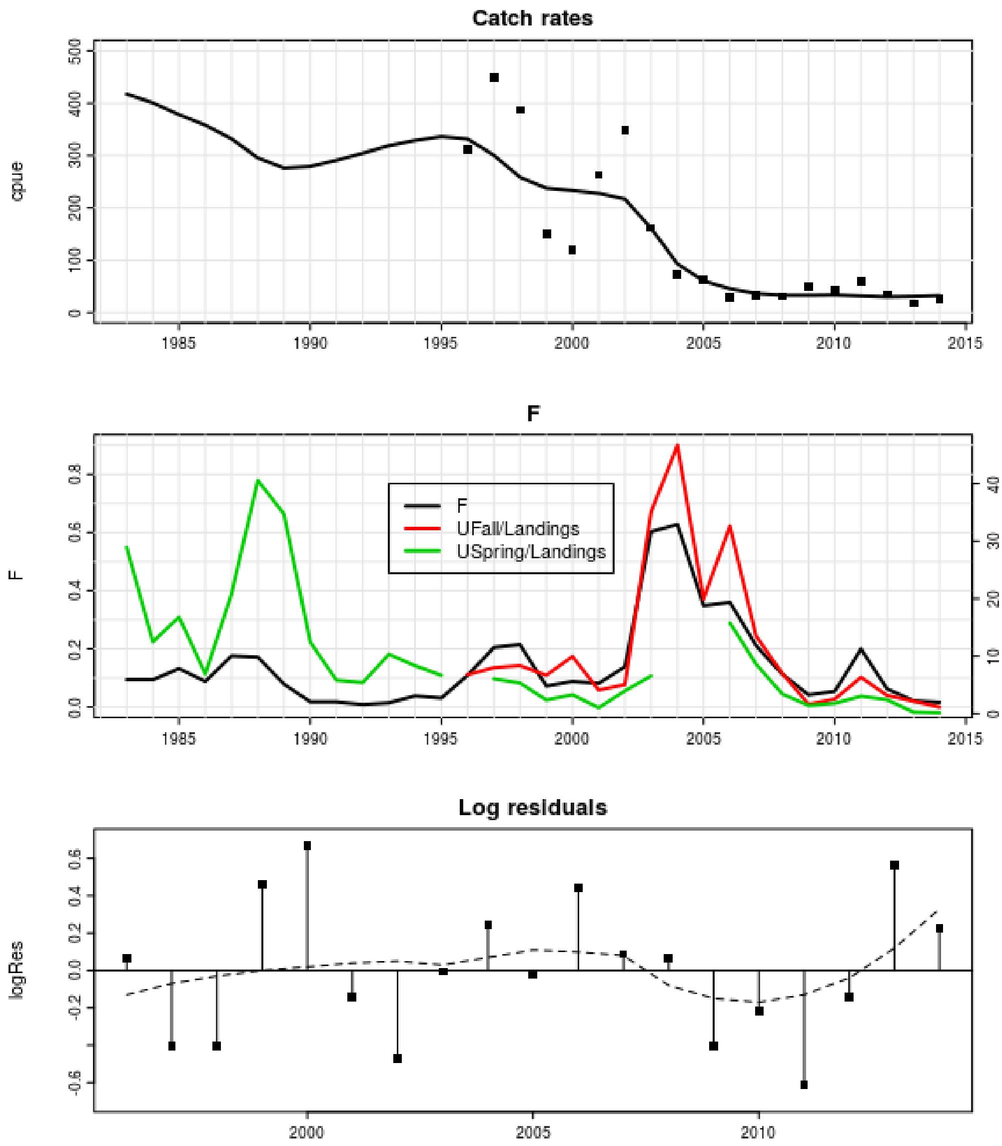

Figure 3.8. Results from the surplus production model using the summer index. Observed (points) and expected catch rates (kg/hour) (top panel). Estimated fishing mortality (black line) and exploitation ratios (ratio of spring index to landings)(green line) (ratio of summer index to landings)(red line)(middle panel). Model residuals in log scale (bottom panel)

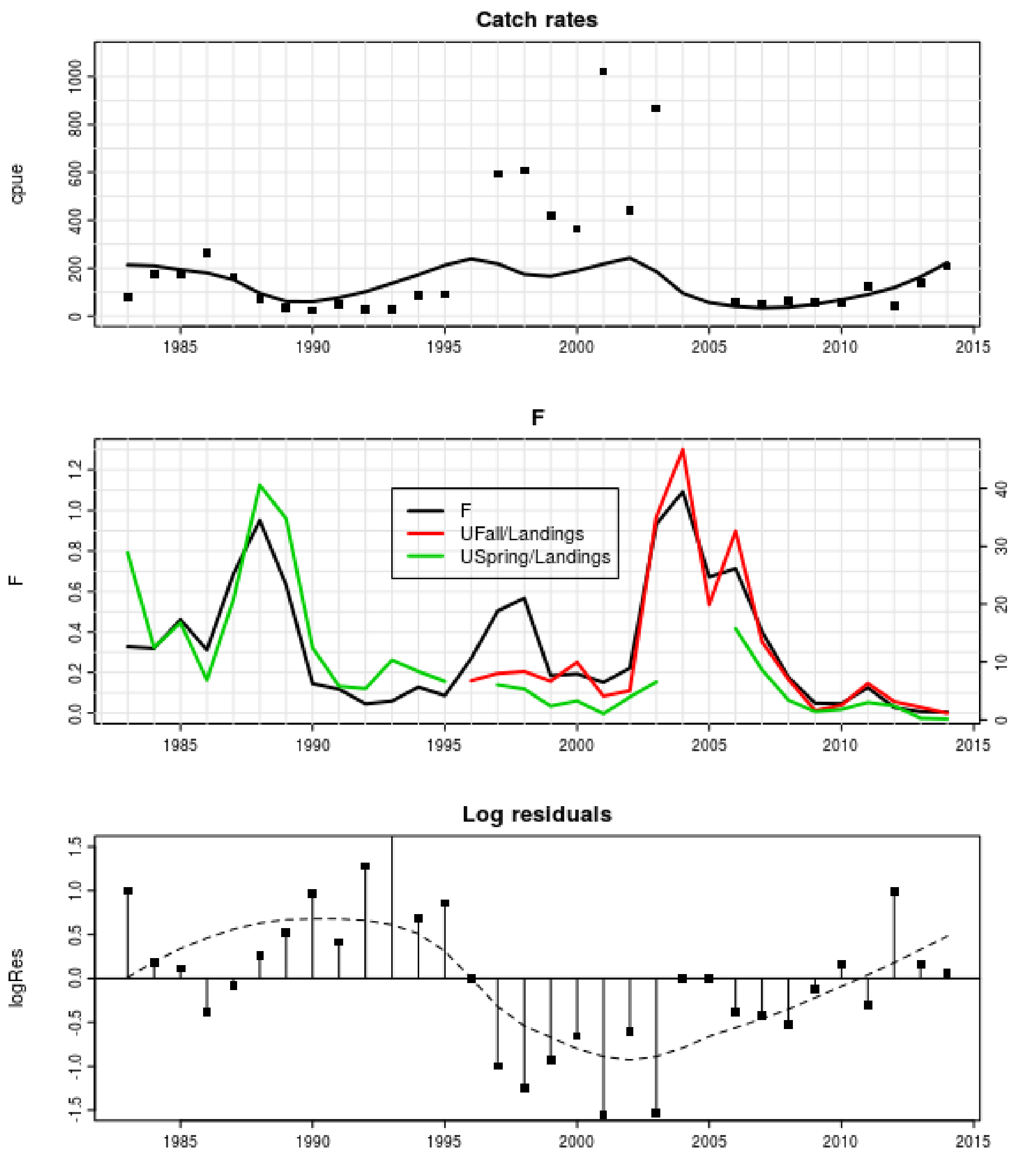

Figure 3.9. Results from the surplus production model using the spring index. Observed (points) and expected catch rates (kg/hour) (top panel). Estimated fishing mortality (black line) and exploitation ratios (ratio of spring index to landings)(green line) (ratio of summer index to landings)(red line)(middle panel). Model residuals in log scale (bottom panel)

4 Faroe Plateau cod

Summary

The input data consisted of the catch-at-age matrix (ages 2-10+ years) for the period 1959-2014 and two age-disaggregated abundance indices obtained from the two Faroese groundfish surveys: the spring survey 1994-2015 (shifted back to the previous year) and the summer survey 1996-2014. The maturities were obtained from the spring survey 1983-2015.

The assessment settings were the same as in the 2014 assessment. An XSA was tuned with the two survey indices. The fishing mortality in 2014 (average of ages 3-7 years) was estimated at 0.41, which was higher than the Fmsy of 0.32. The total stock size (age 2+) in the beginning of 2014 was estimated at 27 700 tonnes and the spawning stock biomass at 21 100 tonnes, which was slightly above the limit biomass of 21 000 tonnes.

The short term prediction until year 2017 showed a slightly decreasing total stock biomass to 24 200 tonnes and a spawning stock biomass to 19 500 tonnes.

It is adviced to reduce the fishing mortality substantially to rebuild the stock

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 (Division Vb2), on the Faroe Plateau (Division Vb1) 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

4.2.1 Trends in landings and fisheries

The landings were obtained from the Fisheries Ministry and Statistics Faroe Islands. The landings are presented in 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 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 4.2.3).

4.2.2 Catch-at-age

Landings-at-age for 2014 are provided for the Faroese fishery in Table 4.2.4. Faroese landings from most of the fleet categories were sampled (Table 4.2.5). The catch-at-age is 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.

4.2.3 Weight-at-age

Mean weight-at-age data 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 2014 showed a discrepancy of 0 %. The weights have increased in recent years (Figure 4.2.2).

4.2.4 Maturity-at-age

The proportion of mature cod by age during the Faroese groundfish surveys carried out during the spawning period (March) is given in Table 4.2.8 and in Figure 4.2.3. 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.

4.2.5 Catch, effort and research vessel data

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), i.e., a decreasing trend after age 5. The stratified mean catch of cod per unit effort (Figure 4.2.5) has been low in the recent years.

The other tuning series used is the Summer Groundfish Survey. The stratified mean catch of cod per unit effort has been low in recent years (Figure 4.2.5). The catch curves (Figure 4.2.6) 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 and they show that there are few small cod in the stock.

Three commercial cpue series (longliners and pairtrawlers) are also presented (Tables 4.2.10, 4.2.11, and 4.2.12 as well as Figure 4.2.7), although they are not used as tuning series. All these series show that the incoming year classes are small. Note that the small boats (0-25 GRT) operating with longlines and jigging reels close to land have had a relatively higher cpue in recent years compared with the other cpue series and the two tuning series (Figure 4.2.8 and Figure 4.2.9), although the larger longliners also have had a high catchability in recent years. When that happens, the recruitment of 2-year old cod tends to be low.

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 using XSA and the procedure is described in stock annex and the results of the assessment is mostly data-driven implying that there may be little difference in the assessment results by using another method.

4.5 Reference points

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

The reference points based on the yield-per-recruit curve are the following: F_{max} = 0.25, $F_{0.1}$ = 0.11, F35%SPR = 0.17, F_{med} = 0.41, F_{low} = 0.10, F_{high} = 0.97.

The group adopted in 2011 following preliminary MSY reference points: F_{msy} = 0.32, see section 4.8. The $B_{trigger}$ was set at B_{pa} = 40 kt.

4.6 State of the stock

Since the current assessment is an update assessment, the same procedure is followed as last year: to use the two surveys for tuning. The commercial series showed a similar overall tendency as the surveys (Figure 4.2.7) but were not used in the tuning. The XSA-run (Table 4.6.1) showed that the fit between the model and the tuning series (logQ residuals, Figure 4.6.1) was rather poor for the young ages and there seemed to be both year class effects and year effects.

The results from the XSA-run shows that fishing mortality (F3-7) has fluctuated in recent years without a trend (Table 4.6.2, Figure 4.6.2), and other measures of fishing mortality have done so as well (Table 4.6.4, Figure 4.6.3). The population numbers, total biomass and spawning stock biomass have been low compared with other years in the series (Table 4.6.3, Table 4.6.4, Figure 4.6.2). The poor state of the stock since 2005 has been due to poor recruitment (not poor individual growth). Prior to that time, extremely weak year classes (< 5 million individuals) were only observed two times, whereas it has happened four times since 2005 (in 2011-2014). In the past there has been a poor relationship between the size of the spawning stock and subsequent recruitment (Figure 4.6.4), but the increasing number of low data points in recent years have strengthened the stock-recruitment relationship. The spawning stock biomass in the terminal year was close to Blim and the fishing mortality above Fmsy (Figure 4.6.5).

During the years 1938-55 a large work was undertaken in ICES ("The North-Western Area Committee", which established the "Sub-Committee on the Faroe Question", sometimes referred to as "The Sub-Committee on a proposed Closure of Certain Extra-territorial Waters off the Faroes") to investigate whether certain areas around the Faroe Islands should be closed to fishing. Although no areas were closed as a result of this work a large amount of data became available. These data, together with other data, are now used to estimate the stock size of Faroe Plateau cod back to 1906, which puts the present stock size into a wider perspective (Working Document no. 32). A cpue series (tonnes per million tonn-hours) for British steam 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 1959-1972. Another cpue series (cwts per day of absence from port, 1 cwt = 50.8 kg) was available for English steam trawlers 1906-1954 (with gaps). In addition there was a record of Faroese boat catches that extended into the war periods. In WD 32 the biomass back in time is estimated in four steps: 1) Extending the British cpue back to 1906 by the use of English steam trawlers. 2-3) Extending the British cpue to the World War 1 period and World War 2 period (with gaps) by the Faroe boat catches. 4) Extending the age 2+ biomass from the age-based assessment back to 1906 by using the raw or constructed British cpue series. The result depended upon whether a regression line (biomass versus cpue) was used or a scaling factor (sum of biomass divided by the sum of cpue), the latter giving a higher biomass estimate back in time. The resulting exploitation ratio of the higher biomass was in better correspondence with tagging returns and a Faroese longliner series (see WD 32) and is probably more reliable. The results are presented in Table 4.6.5 and Figure 4.6.6. The biomass in 2005-2014 was very low compared with the entire period, but it is worth noting that the fishing mortality (exploitation ratio) was high already in the 1930s. The extension of biomass back in time can likely be improved in the future by including the Faroe longliner CPUE series mentioned above and also to include age data prior to 1959.

4.7 Short term forecast

4.7.1 Input data

The input data for the short term prediction are given in Table 4.7.1. Note the extremely weak YC2010, YC2011,YC2012 and YC2013, which were set to the face value from the XSA-run, i.e., according to the Annex. 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 2012-2014. The weights at age in the catches in 2015 were estimated from the spring survey (ages 2 and 6-8 years) whereas the other ages were estimated from the catch weights in January-February 2015. The weights in the catches in 2016 were set to the values in 2015 and the average of 2013-2015 was expected for 2017. The proportion mature in 2014 was set to the 2014 values from the spring groundfish survey, and for 2015-2016 to the average values for 2012-2014.

4.7.2 Results

The landings in 2015 are expected to be 6600 tonnes (Table 4.7.2) (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 18 900 tonnes in 2015, 19 700 tonnes in 2016 and eventually 19 500 tonnes in 2017. The "old" year classes (YC 2008 and YC2009) are still important for the SSB in 2016 and 2017 (Figure 4.7.1).

4.8 Long term forecast

The input to the traditional long term forecast (yield per recruit) is presented in Table 4.8.1 and the result is presented in Table 4.8.2 and Figure 4.8.1.

Single species long term forecasts for Faroe Plateau cod indicated Fmsy values lower than Fpa. An FLR procedure (MSE, Management strategy evaluations using FLR standard packages; a simulation of management and stock response over a 20 yr period) for Faroe Plateau cod indicates that Fmsy is 0.32. This value (0.32) was adopted by the NWWG 2011 as a preliminary Fmsy.

4.9 Uncertainties in assessment and forecast

Since there is no incentive to discard fish or misreport catches under the effort management system, the catch figures are considered adequate, as well as the catch-at-age, although the number of otoliths should have been higher.

There was a clear retrospective pattern (Figure 4.9.1), indicating uncertainties in the assessment.

Steingrund et al. (2010) found that the recruitment of Faroe Plateau cod (age 2) could be rather precisely estimated as there is a relationship between cod biomass (age 3+) and the amount of cannibalistic cod in nearshore waters in June-October the previous year. This approach showed that the recent year classes were extremely weak (Figure 4.9.2).

4.10 Comparison with previous assessment and forecast

The assessment settings were according to the Stock Annex. The 2015 assessment was much in line with the 2014 assessment and forecast (Figure 4.10.1).

4.11 Management plans and evaluations

There is no explicit management plan for this stock. A management system based on number of fishing days, closed areas and other technical measures was introduced in 1996 with the purpose to ensuring sustainable demersal fisheries in Vb. This was before ICES introduced PA and MSY reference values and at the time it was believed that the purpose was achieved, if the total allowable number of fishing days was set such, that on average 33% of the cod exploitable stock in numbers would be harvested annually. This translates into an average F of 0.45, above the Fpa of 0.35. ICES considers this to be inconsistent with the PA and MSY approaches. Some work has been done in the Faroes to move away from the Ftarget of 0.45 to be more consistent with the ICES advice.

4.12 Management considerations

The cod stock is assessed to be in a very poor state and is predicted to remain so for the next two years due to poor recruitment. Although the environmental conditions have been rather special since 2007 (lots of mackerel) and may partly be responsible for the poor state of the cod stock, it is certainly necessary to protect the cod stock as much as possible. The reason is not only that it may prevent a total collapse of the stock but also that the stock may recover faster in the future.

Hence, the number of fishing days should be considered and further area closures might be necessary.

The managers should consider changing the management system, or changing the implementation of it, in order to rebuild the cod stock.

4.13 Ecosystem considerations

Regarding the ecosystem effects on fishing, this issue is partly addressed in the ecological modelling work presented in the overview section for Faroese stocks.

4.14 Regulations and their effects

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 help to reduce fishing mortality, but they cause practical problems for the fishing fleets (e.g. high concentrations of vessels in certain areas). Area restrictions may be best suited to protect certain fish species/sizes in certain areas, whereas the number of fishing days remains the only tool to reduce the overall fishing mortality, given the effort management system.

The area closure (for commercial longliners close to land) introduced in July 2011 and ending in August 2013 to protect young fish has not yet resulted in strong recruitment, since the 2008 year class is below average size, and the 2009-2011 year classes either poor or exceptionally poor.

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 recent years 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 and jiggers still exploit the shallow areas.

4.16 Changes in the environment

The primary production has been low for a number of years, albeit high in 2008 to 2010, but it is not believed that this has any relationship with a change in the environment. The temperature has been high in recent years, which may have a negative effect on cod recruitment (Planque and Fredou, 1999).

4.17 References

ICES, 2009. Report of the North Western Working Group. ICES CM 2009/ACOM: 4. 655 pp.

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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.

Planque, B., and Fredou, T. 1999. Temperature and the recruitment of Atlantic cod (Gadus morhua). Canandian Journal of Fisheries and Aquatic Sciences. 56: 2069–2077.

Steingrund, P., Gaard, E., Reinert, J., Olsen, B., Homrum, E., and Eliasen, K. 2012. Trophic relationships on the Faroe Shelf ecosystem and potential ecosystem states. Manuscript in PhD-thesis by Eydna í Homrum, submitted in April 2012.

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 cod (sub-division Vb1). Nominal catch (t) by countries, as officially reported to ICES.

	Denmark	Faroe Islands	France	Germany	Iceland	Norway	Greenland	Portugal	UK (E/W/NI)	UK (Scotland)	United Kingdom	Total
1986	8	34,492	4	8		83	-		-	-	-	34,595
1987	30	21,303	17	12		21	-		8	-	-	21,391
1988	10	22,272	17	5		163	-		-	-	-	22,467
1989	-	20,535	-	7		285	-		-	-	-	20,827
1990	-	12,232	-	24		124	-		-	-	-	12,380
1991	-	8,203	-[1]	16		89	-		1	-	-	8,309
1992	-	5,938	3[2]	12		39	-		74	-	-	6,066
1993	-	5,744	1[2]	+		57	-		186	-	-	5,988
1994	-	8,724	-	2		36	-		56	-	-	8,818
1995	-	19,079	2[2]	2		38	-		43	-	-	19,164
1996	-	39,406	1[2]	+		507	-		126	-	-	40,040
1997	-	33,556	-	+		410	-		61[2]	-	-	34,027
1998	-	23,308	-[*]	-		405	-		27[2]	-	-	23,740
1999	-	19,156	-[*]	39	-	450	-		51	-		19,696
2000		0	1	2	-	374	-		18	-		395
2001		29,762	9[2]	9	-	531[*]	-		50	-		30,361
2002		40,602	20	6	5	573			42	-		41,248
2003		30,259	14	7	-	447	-		15	-		30,742
2004		17,540	2	3[2]		414		1	15	-		17,975
2005		13,556	-			201			24	-		13,781
2006		11,629	7	1[2]		49	5		1	-		11,691
2007		9,905	1[2]			71	7		3	358		10,344
2008		9,394	1			40				383		9,818
2009		10,736	1			14	7			300		11,058
2010		13,878	1			10				312		14,201
2011		11,348	-									11,348
2012		8,437	0		28							8,465
2013[*]		5,331	0		20		2					5,333
2014		7,037 *				6				270		7,314

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

Table 4.2.2. Faroe Plateau cod (sub-division Vb1). Nominal catch (t) used in the assessment.

		Faroese catches:				Catches reported as Vb2:			Foreign catches:				Used in the
	Officially reported	in Vb1	Corrections in Vb1	on Faroe-Iceland ridge	in IIA within Faroe area jurisdiction	UK (E/W/NI)	UK (Scotland)	UK	French[2]	Greenland[2]	Russia[2]	UK[2]	assessment
1986	34595												34595
1987	21391												21391
1988	22467				715								23182
1989	20827				1229				12				22068
1990	12380				1090	-	205		17				13692
1991	8309				351	-	90						8750
1992	6066				154	+	176						6396
1993	5988					1	118						6107
1994	8818					1	227						9046
1995	19164	3330[3]				-	551						23045
1996	40040					-	382						40422
1997	34027					-	277						34304
1998	23740					-	265						24005
1999	19696			-1600		-	210						18306
2000	395	21793 *		-1400		-	245						21033
2001	30361		-1766	-700		-	288						28183
2002	41248		-2409	-600		-	218	-					38457
2003	30742		-1795	-4700		-	254	-					24501
2004	17975		-1041	-4000		-	244	-					13178
2005	13781		-804	-4200			1129	-					9906
2006	11691		-690	-800			278						10479
2007	10344		-588	-1800			53			6			8015
2008	9818		-557	-1828			32						7465
2009	11058		-637	-487			38			26	4		10002
2010	14201		-823	-680			54			5			12757
2011	11348		-673	-918						3			9760
2012	8465		-500	-760						5			7210
2013	5333		-316	-387							0.2		4630
2014	7314 *		-417	-547									6349

[*)] Preliminary, [1)] In order to be consistent with procedures used previous years, [2)] Reported to Faroese Coastal Guard, [3)] expected misreporting/discard.

Table 4.2.3. Faroe Plateau cod (sub-division Vb1). The landings of Faroese fleets (in percents) of total catch (t). Note that the catches on the Faroe-Iceland ridge (mainly belonging to single trawlers > 1000 HP) are included in this table, but excluded in the XSA-run.

Year	Open boats	Longliners <100 GRT	Singletrawl <400 HP	Gill net	Jiggers	Singletrawl 400-1000 HP	Singletrawl >1000 HP	Pairtrawl <1000 HP	Pairtrawl >1000 HP	Longliners >100 GRT	Industrial trawlers	Others	Faroe catch Round.weight
1985	16.0	27.2	6.7	0.6	4.3	7.9	11.2	12.3	5.6	7.5	0.2	0.6	39,422
1986	9.5	15.1	5.1	1.3	2.9	6.2	8.5	29.6	14.9	5.1	0.4	1.3	34,492
1987	9.9	14.8	6.2	0.5	2.9	6.7	8.0	26.0	14.5	9.9	0.5	0.1	21,303
1988	2.6	13.8	4.9	2.6	7.5	7.4	6.8	25.3	15.6	12.7	0.6	0.2	22,272
1989	4.4	29.0	5.7	3.2	9.3	5.7	5.5	10.5	8.3	17.7	0.7	0.0	20,535
1990	3.9	35.5	4.8	1.4	8.2	3.7	4.3	7.1	10.5	19.6	0.6	0.2	12,232
1991	4.3	31.6	7.1	2.0	8.0	3.4	4.7	8.3	12.9	17.2	0.6	0.1	8,203
1992	2.6	26.0	6.9	0.0	7.0	2.2	3.6	12.0	20.8	13.4	5.0	0.4	5,938
1993	2.2	16.0	15.4	0.0	9.0	4.1	3.6	14.2	21.7	12.6	0.8	0.4	5,744
1994	3.1	13.4	9.6	0.5	19.2	2.7	5.3	8.3	23.7	13.7	0.5	0.1	8,724
1995	4.2	17.9	6.5	0.3	24.9	4.1	4.7	6.4	12.3	18.5	0.1	0.0	19,079
1996	4.0	19.0	4.0	0.0	20.0	3.0	2.0	8.0	19.0	21.0	0.0	0.0	39,406
1997	3.1	28.4	4.4	0.5	9.8	5.1	2.9	4.8	11.3	29.7	0.0	0.1	33,556
1998	2.4	31.2	6.0	1.3	6.5	6.3	5.5	3.1	8.6	29.1	0.1	0.0	23,308
1999	2.7	24.0	5.4	2.3	5.4	5.2	11.8	6.4	14.5	21.9	0.4	0.1	19,156
2000	2.3	19.3	9.1	0.9	10.5	9.6	12.7	5.7	13.9	15.7	0.1	0.1	21,793
2001	3.7	28.3	7.4	0.2	15.6	6.4	6.4	5.2	9.2	17.8	0.0	0.0	28,838
2002	3.8	32.9	5.8	0.3	9.9	6.7	6.6	2.5	7.2	24.4	0.0	0.0	38,347
2003	4.9	28.7	4.0	1.5	7.4	3.0	14.4	2.2	7.4	26.5	0.0	0.0	29,382
2004	4.4	31.1	2.1	0.5	6.6	1.6	12.9	2.2	11.7	26.8	0.0	0.0	16,772
2005	3.7	27.5	5.1	0.8	5.4	2.4	28.1	1.7	6.4	18.8	0.0	0.0	15,472
2006	6.2	35.0	3.2	0.2	7.1	1.6	12.9	2.5	6.6	24.7	0.0	0.0	8,636
2007	5.1	28.2	2.6	0.3	6.1	1.7	17.5	1.7	4.8	32.0	0.0	0.0	8,866
2008	5.1	32.7	4.7	0.7	6.4	3.2	14.6	1.0	3.1	28.6	0.0	0.0	7,666
2009	6.9	41.6	4.3	0.3	10.1	2.5	1.9	2.8	6.5	23.0	0.0	0.0	7,146
2010	6.2	31.9	2.7	0.0	12.6	1.3	1.4	3.4	9.6	30.8	0.0	0.0	10,258
2011	3.6	26.5	3.4	0.1	6.7	1.3	1.4	3.1	21.9	31.9	0.0	0.0	9,502
2012	2.7	23.5	4.9	0.0	5.3	1.1	2.6	5.3	21.5	32.9	0.0	0.0	6,378
2013	4.6	26.3	6.3	0.2	8.0	2.3	2.0	4.0	15.9	30.2	0.0	0.0	4,749
2014	8.7	28.0	6.4	0.4	6.4	1.2	5.2	2.5	12.3	28.7	0.0	0.0	5,699
Average	4.9	26.2	5.7	0.8	9.0	4.0	7.6	7.6	12.4	21.4	0.4	0.1	

Table 4.2.4. Faroe Plateau cod (sub-division Vb1). Catch in numbers at age per fleet in terminal year. Numbers are in thousands and the catch is in tonnes, gutted 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	0	346	29	0	8	3	1	11	48	0	-16	430
3	0	342	44	0	16	14	2	50	129	0	-22	575
4	0	160	24	0	16	10	2	37	81	0	-12	318
5	0	234	40	0	38	20	4	87	153	0	-22	554
6	0	111	22	0	30	19	4	88	130	0	-15	389
7	0	23	6	0	8	4	1	21	36	0	-4	95
8	0	5	1	0	1	1	0	4	4	0	-1	15
9	0	3	1	0	0	1	0	2	4	0	-1	10
10+	0	0	0	0	0	0	0	0	0	0	1	1
Sum	0	1224	167	0	117	72	14	300	585	0	-92	2387
G.weight	0	2242	368	0	354	258	49	1105	1565	0	-221	5720

Others include gillnetters, 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 4.2.5. Faroe Plateau cod (sub-division Vb1). Number of samples, lengths, otoliths, and individual weights in terminal year.

Fleet	Size	Samples	Lengths	Otoliths	Weights
Open boats		4	677	20	677
Longliners	<100 GRT	15	2,985	460	2,580
Longliners	>100 GRT	14	2,926	317	2,926
Jiggers		0	0	0	0
Gillnetters		0	0	0	0
Sing. trawlers	<400 HP	0	0	0	0
Sing. trawlers	400-1000 HP	17	3,560	319	3,560
Sing. trawlers	>1000 HP	0	0	0	0
Pair trawlers	<1000 HP	0	0	0	0
Pair trawlers	>1000 HP	30	5,718	479	4,514
Total		80	15,866	1,595	14,257

Table 4.2.6. Faroe Plateau cod (sub-division Vb1). Catch in numbers at age used in the XSA model.

	Age								
Year	1	2	3	4	5	6	7	8	9	10+
1959	0	2002	4239	858	1731	200	207	50	10	0
1960	0	4728	4027	2574	513	876	171	131	61	0
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

	Age								
Year	1	2	3	4	5	6	7	8	9	10+
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	1167	499	706	852	355	81	11	3
2007	0	540	1308	771	336	308	273	91	21	3
2008	0	293	776	799	439	191	160	159	58	20
2009	0	875	2267	863	619	297	85	55	43	17
2010	0	2113	2034	861	468	481	178	58	33	38
2011	0	330	2360	1242	367	189	127	50	19	2
2012	0	49	518	1348	556	201	99	69	25	22
2013	0	57	179	344	608	182	40	26	15	6
2014	0	430	575	318	554	389	95	15	10	1

Table 4.2.7. Faroe Plateau cod (sub-division Vb1). Mean weight at age (kg) in the catches.

	Age								
Year	1	2	3	4	5	6	7	8	9	10+
1959	0	0.850	1.730	3.230	4.400	5.800	6.370	7.340	7.880	10.270
1960	0	1.000	2.030	3.370	4.420	6.020	6.650	8.120	11.000	10.270
1961	0	1.080	2.220	3.450	4.690	5.520	7.090	9.910	8.030	10.270
1962	0	1.000	2.270	3.350	4.580	4.930	9.080	6.590	6.660	10.270
1963	0	1.040	1.940	3.510	4.600	5.500	6.780	8.710	11.720	10.820
1964	0	0.970	1.830	3.150	4.330	6.080	7.000	6.250	6.190	14.390
1965	0	0.920	1.450	2.570	3.780	5.690	7.310	7.930	8.090	11.110
1966	0	0.980	1.770	2.750	3.510	4.800	6.320	7.510	10.340	11.650
1967	0	0.960	1.930	3.130	4.040	4.780	6.250	7.000	11.010	10.690
1968	0	0.880	1.720	3.070	4.120	4.650	5.500	7.670	10.950	9.280
1969	0	1.090	1.800	2.850	3.670	4.890	5.050	7.410	8.660	14.390
1970	0	0.960	2.230	2.690	3.940	5.140	6.460	10.310	7.390	9.340
1971	0	0.810	1.800	2.980	3.580	3.940	4.870	6.480	6.370	10.220
1972	0	0.660	1.610	2.580	3.260	4.290	4.950	6.480	6.900	11.550
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

	Age									
Year	1	2	3	4	5	6	7	8	9	10+
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
2010	0	1.049	1.642	2.400	3.212	3.678	4.774	5.973	7.094	9.800
2011	0	0.815	1.367	2.413	3.493	4.525	5.076	6.631	6.863	10.089
2012	0	1.007	1.315	1.893	3.102	4.279	5.573	5.871	7.482	9.206
2013	0	1.011	1.527	2.528	3.180	4.672	6.776	6.966	9.028	10.324
2014	0	1.099	1.653	2.466	3.000	4.148	6.489	9.394	9.236	12.120

Table 4.2.8. Faroe Plateau cod (sub-division Vb1). Proportion mature at age. From 1961-1982 the average from 1983-1996 is used (as it was used in the 1990s). In 2002, the high maturities for age 2 in 1983 (0.63), 1984 (0.4) and in 1993 (0.25) were revised, but not the maturities back in time.

	Age								
Year	1	2	3	4	5	6	7	8	9	10+
1959	0.00	0.17	0.64	0.87	0.95	1.00	1.00	1.00	1.00	1.00
1960	0.00	0.17	0.64	0.87	0.95	1.00	1.00	1.00	1.00	1.00
1961	0.00	0.17	0.64	0.87	0.95	1.00	1.00	1.00	1.00	1.00
1962	0.00	0.17	0.64	0.87	0.95	1.00	1.00	1.00	1.00	1.00
1963	0.00	0.17	0.64	0.87	0.95	1.00	1.00	1.00	1.00	1.00
1964	0.00	0.17	0.64	0.87	0.95	1.00	1.00	1.00	1.00	1.00
1965	0.00	0.17	0.64	0.87	0.95	1.00	1.00	1.00	1.00	1.00
1966	0.00	0.17	0.64	0.87	0.95	1.00	1.00	1.00	1.00	1.00
1967	0.00	0.17	0.64	0.87	0.95	1.00	1.00	1.00	1.00	1.00
1968	0.00	0.17	0.64	0.87	0.95	1.00	1.00	1.00	1.00	1.00
1969	0.00	0.17	0.64	0.87	0.95	1.00	1.00	1.00	1.00	1.00
1970	0.00	0.17	0.64	0.87	0.95	1.00	1.00	1.00	1.00	1.00
1971	0.00	0.17	0.64	0.87	0.95	1.00	1.00	1.00	1.00	1.00
1972	0.00	0.17	0.64	0.87	0.95	1.00	1.00	1.00	1.00	1.00
1973	0.00	0.17	0.64	0.87	0.95	1.00	1.00	1.00	1.00	1.00
1974	0.00	0.17	0.64	0.87	0.95	1.00	1.00	1.00	1.00	1.00
1975	0.00	0.17	0.64	0.87	0.95	1.00	1.00	1.00	1.00	1.00
1976	0.00	0.17	0.64	0.87	0.95	1.00	1.00	1.00	1.00	1.00
1977	0.00	0.17	0.64	0.87	0.95	1.00	1.00	1.00	1.00	1.00
1978	0.00	0.17	0.64	0.87	0.95	1.00	1.00	1.00	1.00	1.00
1979	0.00	0.17	0.64	0.87	0.95	1.00	1.00	1.00	1.00	1.00
1980	0.00	0.17	0.64	0.87	0.95	1.00	1.00	1.00	1.00	1.00
1981	0.00	0.17	0.64	0.87	0.95	1.00	1.00	1.00	1.00	1.00
1982	0.00	0.17	0.64	0.87	0.95	1.00	1.00	1.00	1.00	1.00
1983	0.00	0.03	0.71	0.93	0.94	1.00	1.00	1.00	1.00	1.00
1984	0.00	0.07	0.96	0.98	0.97	1.00	1.00	1.00	1.00	1.00
1985	0.00	0.00	0.50	0.96	0.96	1.00	1.00	1.00	1.00	1.00
1986	0.00	0.00	0.38	0.93	1.00	1.00	0.96	0.94	1.00	1.00
1987	0.00	0.00	0.67	0.91	1.00	1.00	1.00	1.00	1.00	1.00
1988	0.00	0.06	0.72	0.90	0.97	1.00	1.00	1.00	1.00	1.00
1989	0.00	0.05	0.54	0.98	1.00	1.00	1.00	1.00	1.00	1.00
1990	0.00	0.00	0.68	0.90	0.99	0.96	0.98	1.00	1.00	1.00
1991	0.00	0.00	0.72	0.86	1.00	1.00	1.00	1.00	1.00	1.00
1992	0.00	0.06	0.50	0.82	0.98	1.00	1.00	1.00	1.00	1.00
1993	0.00	0.03	0.73	0.78	0.91	0.99	1.00	1.00	1.00	1.00
1994	0.00	0.05	0.33	0.88	0.96	1.00	0.96	1.00	1.00	1.00
1995	0.00	0.09	0.35	0.33	0.66	0.97	1.00	1.00	1.00	1.00
1996	0.00	0.04	0.43	0.74	0.85	0.94	1.00	1.00	1.00	1.00
1997	0.00	0.00	0.64	0.91	0.97	1.00	1.00	1.00	1.00	1.00
1998	0.00	0.00	0.62	0.90	0.99	0.99	1.00	1.00	1.00	1.00
1999	0.00	0.02	0.43	0.88	0.98	1.00	1.00	1.00	1.00	1.00

2000	0.00	0.02	0.39	0.69	0.92	0.99	1.00	1.00	1.00	1.00
2001	0.00	0.07	0.47	0.86	0.94	1.00	1.00	1.00	1.00	1.00
2002	0.00	0.04	0.37	0.76	0.97	0.93	0.97	1.00	1.00	1.00
2003	0.00	0.00	0.29	0.79	0.88	0.98	1.00	1.00	1.00	1.00
2004	0.00	0.00	0.51	0.78	0.92	0.89	0.87	1.00	1.00	1.00
2005	0.00	0.05	0.66	0.90	0.93	0.98	0.92	1.00	1.00	1.00
2006	0.00	0.04	0.59	0.80	0.99	0.99	1.00	1.00	1.00	1.00
2007	0.00	0.00	0.47	0.78	0.91	0.99	0.97	1.00	1.00	1.00
2008	0.00	0.10	0.78	0.91	0.90	0.95	1.00	1.00	1.00	1.00
2009	0.00	0.09	0.61	0.81	0.96	0.94	0.96	1.00	1.00	1.00
2010	0.00	0.08	0.61	0.77	0.94	0.97	1.00	1.00	1.00	1.00
2011	0.00	0.06	0.51	0.69	0.84	0.93	0.98	1.00	1.00	1.00
2012	0.00	0.00	0.63	0.85	0.94	0.97	1.00	1.00	1.00	0.83
2013	0.00	0.24	0.82	0.95	0.98	1.00	1.00	1.00	1.00	1.00
2014	0.00	0.24	0.73	0.98	1.00	1.00	1.00	1.00	1.00	1.00

Table 4.2.9. Faroe Plateau cod (sub-division Vb1). Summer survey tuning series (number of individuals per 200 stations) and spring survey tuning series (number of individuals per 100 stations) used as tuning series in the XSA model.

```
FAROE PLATEAU COD (ICES SUBDIVISION VB1)        Surveys_revised.TXT

102

SUMMER SURVEY

1996 2014

1 1 0.6 0.7

2 8

 200  707     6576.5   3705.1   1298.1   701.5  233.1   48.5

 200  512.7   1500.7   6754.6   1466.6   178.4  137.8   30.1

 200  524.9    505.1    979.4   3675.2   902.6   50     37

 200  373.3   1256.8    753.1    675.3  1422.5  238     40.4

 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

 200 1239.3   1543.9   1012      363.4   243.6  148.9   41.5

 200  301.7   1373.6   1084.2    380.1   160.6  104.6   37.4

 200   22.1    230.8   1081.8    511.7    88.4   35.8   19.5

 200  101.7    205.9    209.3    888.4   542.5  104.2   43.9

 200  642.3    861.2    357.6    358.2   401.5  124.3   36.6

SPRING SURVEY (shifted back to december)

1993 2014

1 1 0.9 1.0

1 8

 100  612.5     336.9      912.8      508.5      129.7      187.2      28.6       0.1

 100  623.2     845.7     1528.4     1525.2     1191.4      285.6     350.8      48.9

 100  215.5    4043.9     3984.4     1892.1     1372        420.8      82.8     169.7

 100   72.5     834.4     5398.3     2359.5      333.9      227        58.8       5.3
```

100	69.7	425.2	1572.1	4919.3	1136	82.3	40.7	35.2
100	704.7	674.9	991.3	1225.2	2079.2	252.1	25.2	13.4
100	316	1432.4	746.1	441	506.7	836.7	63.8	3.1
100	938.4	2387.8	1993.8	456.2	324.4	578.6	128.6	3.9
100	383	4564.1	2892.1	1579.7	331.9	231.8	178.9	131.9
100	90.2	719	3915	1260.4	528.7	67.4	51.7	39.7
100	609.5	575.8	844.6	1175.1	292.9	66	22.2	11.9
100	383.1	438.2	1151.7	1440.2	844.5	140.6	14	3.8
100	167.5	156.7	177.3	360.1	292	95	15.5	4
100	41.1	270.9	286.6	155.2	170.4	105.1	37.8	14.4
100	176.6	474.5	851.9	479.2	151.5	83.9	39.4	13.3
100	307.8	475.5	977.7	1159.1	427.3	73.7	31.6	24.9
100	697.6	1318.8	745.6	538.1	381	98.9	41	17.2
100	148.4	1319	1240.3	562.4	300.2	237.8	85.2	21.9
100	41.1	273.8	1303.8	326.7	73.6	27	23.7	6.2
100	68	377.6	1699.8	2053.2	295.6	32.6	22.4	17.7
100	130.9	113.4	159.6	419.7	333	74.8	22	13.6
100	**22.4**	**533.3**	**225.6**	**193.9**	**305.2**	**138.9**	**32.6**	**8**

Table 4.2.10. Faroe Plateau cod (sub-division Vb1). Pair trawler abundance index (number of individuals per 1000 fishing hours). This series was not used in the tuning of the XSA. The season is June – December. The otoliths are selected from deep (> 150 m) locations.

	Age							
Year	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
2010	1578	2917	1787	543	603	190	0	81
2011	22	1487	4078	1967	622	441	95	25
2012	0	95	1531	1789	950	223	40	107
2013	35	102	761	1583	670	103	57	36
2014	292	1631	1006	1690	1812	477	94	101

Table 4.2.11. Faroe Plateau cod (sub-division Vb1). Longliner abundance index (number of individuals per 100 000 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							
Year	1	2	3	4	5	6	7	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	297	2169	1543	2313	2327	1360	170	13
2006	151	5813	5319	674	2205	2352	1148	56
2007	274	3578	6383	2778	1927	1159	1118	134
2008	1270	2243	4449	4773	2564	1133	816	716
2009	294	2670	15107	6308	3028	2491	683	132
2010	23	20287	16914	8733	2595	4780	1878	864
2011	160	2817	28218	14391	4295	2207	1252	195
2012	0	1833	9562	8309	2364	1296	403	197
2013	0	52	209	2887	5132	2654	1222	359
2014	93	5898	9602	4695	4398	3475	1289	116

Table 4.2.12. Longliner abundance index (number of individuals per day) for longliners < 25 GRT operating mainly near shore. This series was not used in the tuning of the XSA. The age composition was obtained from all longliners.

	Age							
Year	1	2	3	4	5	6	7	8
1983	0.9	7.5	4.7	3.8	1.6	0.9	0.5	0.2
1984	0.0	33.3	32.1	13.2	5.8	6.3	1.0	0.7
1985	0.0	3.7	50.1	35.0	25.3	14.1	19.6	5.8
1986	0.0	5.6	41.6	24.0	15.3	6.8	6.2	2.2
1987	0.0	6.8	11.3	16.6	27.5	12.4	5.3	0.9
1988	0.0	3.1	6.4	13.0	8.5	19.1	6.5	2.6
1989	0.1	43.7	21.3	20.5	13.9	7.5	16.1	2.2
1990	0.0	7.9	40.3	8.6	12.2	6.5	7.7	4.2
1991	0.0	0.0	5.2	27.0	8.7	3.9	2.4	0.7
1992	0.0	6.2	17.1	6.9	3.9	3.6	1.8	1.4
1993	0.4	4.6	19.2	7.3	1.4	1.3	0.3	1.3
1994	0.1	14.9	18.4	15.4	6.6	2.1	2.6	0.5
1995	0.0	53.6	47.8	12.2	8.4	5.1	2.0	3.1
1996	0.0	5.9	76.2	52.1	13.1	28.8	14.3	4.2
1997	0.0	4.6	16.6	71.8	54.5	7.9	7.6	0.9
1998	5.8	12.1	5.6	8.2	33.1	9.9	0.4	0.4
1999	0.3	29.2	10.0	4.7	7.0	15.9	2.5	0.1
2000	9.6	40.4	23.5	1.3	1.3	2.4	4.2	0.5
2001	0.6	96.6	48.7	17.1	3.0	5.7	12.6	12.9
2002	0.1	47.6	97.2	43.4	30.0	7.3	11.5	6.8
2003	0.0	17.5	37.4	106.4	59.1	12.9	4.1	1.5
2004	0.0	7.0	21.5	21.0	31.1	8.2	0.3	0.0
2005	0.6	14.7	20.5	18.5	32.9	15.6	1.5	0.0
2006	2.0	58.7	47.0	9.1	10.6	13.6	4.1	0.4
2007	0.2	11.2	23.2	8.9	4.2	4.9	3.5	0.6
2008	0.3	3.4	16.2	21.1	14.4	3.3	1.5	2.1
2009	3.1	33.3	154.6	57.5	33.9	23.5	9.6	5.9
2010	2.6	135.7	147.1	62.4	27.3	28.5	8.5	1.8
2011	0.0	19.7	156.5	65.0	25.2	15.6	8.5	1.9
2012	0.3	4.6	39.3	59.0	15.1	5.2	2.6	1.3
2013	1.2	16.6	23.8	63.6	58.0	7.8	2.9	0.0
2014	2.1	103.4	102.0	46.9	27.3	17.1	1.4	0.0

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

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Lowestoft VPA Version 3.1

  22/04/2015  10:42

 Extended Survivors Analysis

 COD FAROE PLATEAU (ICES SUBDIVISION Vb1)                 COD_ind_Surveys_revised

 CPUE data from file Surveys_revised_1replacedvalue.TXT

 Catch data for  56 years. 1959 to 2014. Ages  1 to  10.

      Fleet,           First, Last, First, Last, Alpha,  Beta
                   ,    year, year,  age ,  age
 SUMMER SURVEY       ,   1996, 2014,   2,     8,   .600,   .700
 SPRING SURVEY (shift,   1993, 2014,   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   29 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,  2005,  2006,  2007,  2008,  2009,  2010,  2011,  2012,  2013,  2014

      1,  .000,  .000,  .000,  .000,  .000,  .000,  .000,  .000,  .000,  .000
      2,  .094,  .188,  .124,  .051,  .122,  .211,  .092,  .031,  .026,  .073
      3,  .257,  .334,  .328,  .263,  .683,  .459,  .385,  .205,  .151,  .393
      4,  .382,  .360,  .385,  .342,  .527,  .606,  .570,  .397,  .203,  .438
      5,  .472,  .610,  .441,  .396,  .488,  .614,  .569,  .545,  .313,  .587
      6,  .774,  .820,  .594,  .485,  .514,  .907,  .542,  .720,  .342,  .339
      7,  .844,  .957,  .687,  .724,  .415,  .676,  .647,  .617,  .296,  .301
      8,  .574, 1.031,  .698, 1.212,  .591,  .559,  .403,  .927,  .320,  .172
      9, 1.157,  .293,  .846, 1.543, 1.514,  .893,  .357,  .361,  .520,  .195



 XSA population numbers (Thousands)

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

 2005 ,    9.31E+03, 6.10E+03, 2.88E+03, 3.06E+03, 3.30E+03, 1.69E+03, 3.95E+02, 1.04E+02, 3.06E+01,
 2006 ,    6.25E+03, 7.62E+03, 4.54E+03, 1.82E+03, 1.71E+03, 1.68E+03, 6.37E+02, 1.39E+02, 4.79E+01,
 2007 ,    7.95E+03, 5.12E+03, 5.17E+03, 2.66E+03, 1.04E+03, 7.60E+02, 6.07E+02, 2.00E+02, 4.07E+01,
 2008 ,    1.03E+04, 6.51E+03, 3.70E+03, 3.05E+03, 1.48E+03, 5.49E+02, 3.43E+02, 2.50E+02, 8.15E+01,
 2009 ,    1.50E+04, 8.43E+03, 5.06E+03, 2.33E+03, 1.77E+03, 8.17E+02, 2.77E+02, 1.36E+02, 6.09E+01,
 2010 ,    5.06E+03, 1.23E+04, 6.11E+03, 2.09E+03, 1.13E+03, 8.91E+02, 4.00E+02, 1.50E+02, 6.17E+01,
 2011 ,    2.17E+03, 4.14E+03, 8.16E+03, 3.16E+03, 9.34E+02, 4.99E+02, 2.95E+02, 1.67E+02, 7.00E+01,
 2012 ,    3.00E+03, 1.77E+03, 3.09E+03, 4.54E+03, 1.46E+03, 4.33E+02, 2.38E+02, 1.26E+02, 9.13E+01,
 2013 ,    8.27E+03, 2.45E+03, 1.41E+03, 2.07E+03, 2.50E+03, 6.94E+02, 1.72E+02, 1.05E+02, 4.09E+01,
 2014 ,    1.07E+03, 6.77E+03, 1.96E+03, 9.90E+02, 1.38E+03, 1.50E+03, 4.04E+02, 1.05E+02, 6.23E+01,

 Estimated population abundance at 1st Jan 2015

    ,     0.00E+00, 8.74E+02, 5.16E+03, 1.08E+03, 5.23E+02, 6.28E+02, 8.73E+02, 2.45E+02, 7.24E+01,

 Taper weighted geometric mean of the VPA populations:

    ,     1.39E+04, 1.19E+04, 8.96E+03, 5.56E+03, 3.10E+03, 1.52E+03, 6.74E+02, 2.75E+02, 1.11E+02,

 Standard error of the weighted Log(VPA populations) :

    ,        .7703,    .6870,    .6742,    .6490,    .6085,    .6210,    .6624,    .7089,    .8270,


 Log catchability residuals.
```

Fleet : SUMMER SURVEY

Age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
1	No data for this fleet at this age									
2	99.99	-.16	.21	.35	-.87	.13	.66	1.10	-.07	.62
3	99.99	.10	-.25	-.63	.49	-.45	.04	.57	-.39	.01
4	99.99	.19	.31	-.60	-.13	.07	.10	.09	.10	-.20
5	99.99	.65	-.08	.23	-.71	-.80	-.12	.11	-.35	.43
6	99.99	.14	-.21	.59	.11	-.65	-.59	-.35	-.73	.26
7	99.99	.27	-.05	-.39	.53	.04	-.32	-.42	-1.40	.09
8	99.99	-.15	-.29	.10	.40	-.24	-.05	-.47	-1.07	.19

Age	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
1	No data for this fleet at this age									
2	.49	.79	-.29	-1.80	-.18	.56	.16	-1.65	-.45	.41
3	.37	-.11	-.66	-.56	1.08	.49	.04	-.89	-.25	1.00
4	.21	-.20	-.67	-.79	.51	.89	.52	.04	-.94	.49
5	.25	-.32	-.49	-.07	.13	.25	.45	.28	.15	.01
6	.65	-.40	-.40	.03	.55	.24	.16	-.17	.92	-.15
7	.47	-.08	-.69	-.46	.48	.40	.33	-.55	.63	-.04
8	.48	.02	-.47	-.47	.28	.03	-.29	-.32	.28	.00

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	-7.8857	-6.7379	-6.3878	-6.1480	-6.1144	-6.1144	-6.1144
S.E(Log q)	.7684	.5560	.4813	.3902	.4676	.5196	.3921

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	.70	1.742	8.19	.66	19	.51	-7.89
3	.99	.059	6.76	.67	19	.57	-6.74
4	.99	.067	6.41	.73	19	.49	-6.39
5	.98	.111	6.17	.76	19	.40	-6.15
6	1.04	-.209	6.08	.64	19	.50	-6.11
7	1.04	-.209	6.17	.60	19	.55	-6.17
8	1.31	-1.697	6.53	.64	19	.47	-6.22

Fleet : SPRING SURVEY (shift

Age	1993	1994
1	-.05	-.56
2	-.91	-.89
3	-.65	-.01
4	-.58	-.02
5	-.57	.76
6	-.63	.92
7	-.32	.35
8	-4.57	.74

Age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
1	-.42	-.82	-.78	.65	-.47	.21	.12	-.57	1.88	.90
2	.19	-.23	-.21	.39	.27	.49	.76	-.26	.22	.39
3	.10	-.05	-.17	.09	.05	.19	.29	.36	-.51	.38
4	.58	-.06	.19	-.23	-.51	-.14	.33	-.03	-.27	.24
5	.39	-.12	.26	.21	-.55	-.33	.09	.28	-.41	.39
6	.55	-.06	-.01	.28	.44	.38	.15	-.23	-.43	.32
7	.21	-.11	-.20	-.18	.20	-.68	.09	.17	-.24	-.66
8	.03	-1.43	.94	.10	-1.28	-1.53	.19	-.01	-.14	-.74

Age	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
1	-.15	-1.16	.06	.35	.79	.33	-.10	.08	-.28	.00
2	-1.09	-.68	.22	-.09	.74	.45	-.15	.96	-.57	.01
3	-.98	-.89	.07	.48	.29	.40	.09	1.16	-.47	-.23
4	-.49	-.84	-.06	.64	.32	.55	-.44	.87	-.11	.07
5	-.65	-.40	-.18	.46	.25	.59	-.68	.24	-.39	.37
6	-.54	-.40	-.04	.05	-.02	1.14	-.80	-.30	-.30	-.46
7	-.84	-.32	-.48	-.10	.08	.69	-.31	-.18	-.18	-.63
8	-1.11	.31	-.45	.44	.09	.21	-1.31	.51	-.14	-.81

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,  -8.2792,   -6.8938,   -5.9763,   -5.7006,   -5.7402,   -6.0145,   -6.0145,   -6.0145,
S.E(Log q),    .6722,     .5682,     .4868,     .4368,     .4385,     .4933,     .4069,    1.2620,



Regression statistics :


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

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

 1,    1.08,    -.456,      8.21,     .62,     22,     .74,   -8.28,
 2,    1.02,    -.092,      6.86,     .65,     22,     .59,   -6.89,
 3,     .92,     .582,      6.19,     .75,     22,     .46,   -5.98,
 4,     .94,     .481,      5.86,     .76,     22,     .42,   -5.70,
 5,     .92,     .584,      5.90,     .74,     22,     .41,   -5.74,
 6,     .90,     .662,      6.13,     .67,     22,     .45,   -6.01,
 7,     .95,     .420,      6.18,     .78,     22,     .36,   -6.18,
 8,     .63,    1.649,      6.02,     .50,     22,     .71,   -6.47,


Terminal year survivor and F summaries :

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

Year class = 2013

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
SUMMER SURVEY       ,         1.,   .000,       .000,    .00,   0,  .000,     .000
SPRING SURVEY (shift,       874.,   .687,       .000,    .00,   1, 1.000,     .000

  F shrinkage mean  ,         0.,   2.00,,,,                        .000,     .000

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
      874.,       .69,      .00,    1,    .000,   .000



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

Year class = 2012

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
SUMMER SURVEY       ,      7761.,   .788,       .000,    .00,   1,  .231,     .049
SPRING SURVEY (shift,      4600.,   .444,       .142,    .32,   2,  .730,     .081

  F shrinkage mean  ,      3835.,   2.00,,,,                        .039,     .097

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
     5155.,       .38,      .15,    4,    .392,   .073


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

Year class = 2011

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
SUMMER SURVEY       ,      1807.,   .462,       .687,   1.49,   2,  .332,     .253
SPRING SURVEY (shift,       828.,   .331,       .170,    .51,   3,  .642,     .487

  F shrinkage mean  ,      1128.,   2.00,,,,                        .026,     .379

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
     1082.,       .27,      .26,    6,    .956,   .393



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

Year class = 2010

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
SUMMER SURVEY       ,       469.,   .339,       .538,   1.59,   3,  .382,     .479
SPRING SURVEY (shift,       562.,   .267,       .282,   1.06,   4,  .600,     .413

  F shrinkage mean  ,       487.,   2.00,,,,                        .018,     .464

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
```

```
at end of year,   s.e,       s.e,     ,   Ratio,
      523.,       .21,       .23,    8,   1.102,   .438


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

Year class = 2009

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
    ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
SUMMER SURVEY       ,        432.,   .262,       .273,   1.04,   4,  .452,     .771
SPRING SURVEY (shift,        860.,   .233,       .227,    .97,   5,  .532,     .459

  F shrinkage mean  ,        754.,   2.00,,,,                        .016,     .510

Weighted prediction :

Survivors,         Int,      Ext,    N,    Var,     F
at end of year,   s.e,       s.e,     ,   Ratio,
      628.,       .17,       .19,   10,   1.093,   .587



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

Year class = 2008

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
    ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
SUMMER SURVEY       ,        902.,   .244,       .081,    .33,   5,  .486,     .330
SPRING SURVEY (shift,        863.,   .230,       .243,   1.06,   6,  .500,     .342

  F shrinkage mean  ,        418.,   2.00,,,,                        .014,     .610

Weighted prediction :

Survivors,         Int,      Ext,    N,    Var,     F
at end of year,   s.e,       s.e,     ,   Ratio,
      873.,       .17,       .12,   12,    .739,   .339


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

Year class = 2007

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
    ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
SUMMER SURVEY       ,        359.,   .247,       .174,    .70,   6,  .446,     .215
SPRING SURVEY (shift,        182.,   .231,       .164,    .71,   7,  .540,     .388

  F shrinkage mean  ,        122.,   2.00,,,,                        .014,     .535

Weighted prediction :

Survivors,         Int,      Ext,    N,    Var,     F
at end of year,   s.e,       s.e,     ,   Ratio,
      245.,       .17,       .15,   14,    .862,   .301



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

Year class = 2006

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
    ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
SUMMER SURVEY       ,         88.,   .243,       .153,    .63,   7,  .587,     .143
SPRING SURVEY (shift,         57.,   .256,       .119,    .47,   8,  .399,     .214

  F shrinkage mean  ,         18.,   2.00,,,,                        .014,     .565

Weighted prediction :

Survivors,         Int,      Ext,    N,    Var,     F
at end of year,   s.e,       s.e,     ,   Ratio,
       72.,       .18,       .11,   16,    .642,   .172


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

Year class = 2005

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
    ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
SUMMER SURVEY       ,         47.,   .249,       .134,    .54,   7,  .604,     .176
SPRING SURVEY (shift,         37.,   .245,       .169,    .69,   8,  .373,     .220

  F shrinkage mean  ,         20.,   2.00,,,,                        .022,     .370

Weighted prediction :

Survivors,         Int,      Ext,    N,    Var,     F
at end of year,   s.e,       s.e,     ,   Ratio,
       42.,       .18,       .11,   16,    .579,   .195
```

Table 4.6.2. Faroe Plateau cod (sub-division Vb1). Fishing mortality at age from the XSA model.

	Age								
	2	3	4	5	6	7	8	9	10+	FBAR 3- 7
1959	0.1829	0.4853	0.4463	0.6303	0.3909	0.6060	0.3005	0.4784	0.4784	0.5117
1960	0.4570	0.6793	0.6222	0.5290	0.7826	0.6920	1.0328	0.7389	0.7389	0.6610
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	0.9680	0.8520	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	0.3900
1968	0.1010	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	0.4180	0.5709	0.5118	0.8457	0.5499	0.5499	0.4375
1970	0.0530	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	0.4800	0.4800	0.3526
1972	0.0464	0.1476	0.2070	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	0.5330	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	0.4850	0.5968	0.5674	0.5054	0.5054	0.4259
1979	0.0433	0.2623	0.4309	0.5049	0.4906	0.4480	0.6903	0.5170	0.5170	0.4273
1980	0.0544	0.2391	0.3695	0.4337	0.5182	0.4119	0.6437	0.4790	0.4790	0.3945
1981	0.0523	0.2877	0.3409	0.4369	0.5644	0.6940	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	0.0991	0.4672	0.5585	0.6411	0.7835	1.0779	0.9416	0.8087	0.8087	0.7056
1984	0.1073	0.3711	0.5790	0.6609	0.4533	0.4761	0.4791	0.5340	0.5340	0.5081
1985	0.0658	0.3543	0.5075	0.6134	0.9234	1.1081	1.3203	0.9042	0.9042	0.7013
1986	0.0247	0.3544	0.6225	0.7030	0.8256	0.8399	0.5407	0.7131	0.7131	0.6691
1987	0.0291	0.2208	0.4753	0.4849	0.5555	0.4895	0.6221	0.5297	0.5297	0.4452
1988	0.0666	0.3530	0.5637	0.5489	0.7732	0.7979	0.8639	0.7163	0.7163	0.6073
1989	0.1633	0.4395	0.7614	0.7614	0.9611	1.0566	1.0988	0.9381	0.9381	0.7960
1990	0.0778	0.3287	0.6376	0.8014	0.7129	0.8504	1.1337	0.8358	0.8358	0.6662
1991	0.0324	0.1990	0.4365	0.5987	0.7459	0.5797	0.7153	0.6207	0.6207	0.5120
1992	0.0201	0.1001	0.3256	0.3326	0.6381	0.8909	0.4433	0.5304	0.5304	0.4575
1993	0.0132	0.1020	0.1868	0.2535	0.1912	0.4421	0.5779	0.3325	0.3325	0.2351
1994	0.0255	0.1129	0.1907	0.2501	0.2212	0.1481	0.3228	1.0965	1.0965	0.1846
1995	0.0704	0.1619	0.4651	0.2805	0.3615	0.3361	0.2156	0.7443	0.7443	0.3210
1996	0.0306	0.1935	0.4530	0.8107	0.9071	1.1451	0.9361	0.8738	0.8738	0.7019
1997	0.0348	0.1489	0.4138	0.8362	1.0504	1.4087	1.3725	1.0695	1.0695	0.7716
1998	0.0887	0.1760	0.2732	0.6530	1.0628	0.7973	1.1943	0.8977	0.8977	0.5925
1999	0.0958	0.2841	0.2904	0.3183	0.6678	1.0916	0.8046	0.5191	0.5191	0.5304
2000	0.1247	0.3191	0.3799	0.2477	0.3268	0.5479	0.8501	0.1974	0.1974	0.3643
2001	0.1574	0.3448	0.4554	0.3078	0.3506	0.6988	0.6566	0.8359	0.8359	0.4315

2002	0.1903	0.4904	0.5998	0.8219	0.8296	1.3662	1.2399	1.3959	1.3959	0.8216
2003	0.1279	0.3039	0.6642	0.8523	0.9072	0.9026	0.9391	1.8019	1.8019	0.7260
2004	0.0309	0.1862	0.2977	0.7556	0.9873	1.1291	1.0716	2.1045	2.1045	0.6712
2005	0.0938	0.2575	0.3816	0.4720	0.7745	0.8443	0.5739	1.1569	1.1569	0.5459
2006	0.1881	0.3339	0.3600	0.6103	0.8196	0.9574	1.0306	0.2931	0.2931	0.6163
2007	0.1239	0.3281	0.3855	0.4407	0.5945	0.6869	0.6982	0.8459	0.8459	0.4871
2008	0.0511	0.2634	0.3420	0.3961	0.4853	0.7241	1.2123	1.5432	1.5432	0.4422
2009	0.1219	0.6832	0.5265	0.4876	0.5136	0.4148	0.5911	1.5140	1.5140	0.5252
2010	0.2106	0.4591	0.6065	0.6145	0.9074	0.6761	0.5594	0.8932	0.8932	0.6527
2011	0.0921	0.3853	0.5701	0.5695	0.5423	0.6474	0.4027	0.3566	0.3566	0.5429
2012	0.0310	0.2045	0.3975	0.5450	0.7201	0.6174	0.9268	0.3607	0.3607	0.4969
2013	0.0260	0.1515	0.2035	0.3132	0.3421	0.2962	0.3202	0.5197	0.5197	0.2613
2014	0.0728	0.3927	0.4384	0.5867	0.3388	0.3012	0.1718	0.1951	0.1951	0.4115

Table 4.6.3. Faroe Plateau cod (sub-division Vb1). Stock number at age from the XSA model.

	Age								
Year	2	3	4	5	6	7	8	9	10+	Total
1959	13238	12185	2634	4092	683	503	213	29	0	50976
1960	14245	9027	6141	1380	1784	378	225	129	0	47989
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	59931
1979	14998	8298	5282	4463	5433	1509	297	238	103	69424
1980	23583	11759	5226	2811	2206	2723	789	122	52	66371
1981	14001	18286	7580	2957	1491	1076	1477	339	150	74384
1982	22128	10878	11228	4413	1564	694	440	732	348	83159
1983	25162	17087	7128	6412	2450	854	284	207	200	118129
1984	47769	18656	8767	3339	2765	916	238	91	174	103874
1985	17323	35132	10538	4023	1412	1439	466	121	146	82219
1986	9513	13280	20182	5194	1784	459	389	102	81	63093
1987	9914	7598	7628	8867	2106	640	162	185	69	47827
1988	8726	7884	4989	3883	4470	989	321	71	53	51427
1989	16408	6684	4535	2324	1836	1689	365	111	16	38422
1990	3646	11410	3526	1734	889	575	481	99	50	30547
1991	6662	2762	6725	1526	637	357	201	127	57	32967
1992	11392	5280	1853	3558	687	247	164	81	90	35685
1993	10097	9142	3911	1096	2089	297	83	86	97	57624
1994	25156	8158	6759	2657	696	1413	156	38	26	96979
1995	42508	20078	5967	4573	1694	457	997	93	102	92173
1996	12858	32437	13981	3068	2828	966	267	658	88	75034
1997	6454	10210	21884	7277	1117	935	252	86	198	55645
1998	5922	5103	7203	11846	2582	320	187	52	46	50773
1999	14338	4437	3504	4487	5048	730	118	46	19	56802
2000	19710	10667	2734	2146	2672	2119	201	43	6	76558
2001	29687	14245	6347	1531	1371	1578	1003	70	12	72038

2002	13258	20766	8262	3295	921	791	642	426	10	55993
2003	6240	8974	10411	3713	1186	329	165	152	26	35631
2004	3631	4496	5422	4387	1296	392	109	53	45	27275
2005	6095	2882	3055	3296	1687	395	104	31	47	26900
2006	7619	4543	1824	1708	1683	637	139	48	13	24469
2007	5120	5169	2664	1042	760	607	200	41	6	23554
2008	6506	3703	3048	1483	549	343	250	82	27	26282
2009	8425	5061	2330	1773	817	277	136	61	23	33923
2010	12297	6106	2093	1127	891	400	150	62	70	28258
2011	4145	8156	3159	934	499	295	167	70	7	19597
2012	1773	3095	4542	1462	433	238	126	91	80	14836
2013	2453	1407	2065	2499	694	172	105	41	16	17724
2014	6772	1957	990	1380	1496	404	105	62	6	14239

Table 4.6.4. Faroe Plateau cod (sub-division Vb1). Summary table from the XSA model. The results from the short term prediction are shown in bold.

	RECRUITS	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 3- 7
	Age 2					
1959	13238	67803	48869	22415	0.4587	0.5117
1960	14245	75862	54447	32255	0.5924	0.661
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	153664	109566	36775	0.3356	0.3947
1976	18575	161260	123077	39799	0.3234	0.4749
1977	9995	136212	112057	34927	0.3117	0.6757
1978	10748	96227	78497	26585	0.3387	0.4259
1979	14998	85112	66723	23112	0.3464	0.4273
1980	23583	85038	58887	20513	0.3483	0.3945
1981	14001	88411	63562	22963	0.3613	0.4648
1982	22128	98964	67033	21489	0.3206	0.4138
1983	25162	123256	78543	38133	0.4855	0.7056
1984	47769	152162	96774	36979	0.3821	0.5081
1985	17323	131245	84789	39484	0.4657	0.7013
1986	9513	99280	73698	34595	0.4694	0.6691
1987	9914	78372	62249	21391	0.3436	0.4452
1988	8726	66185	52134	23182	0.4447	0.6073
1989	16408	59280	38427	22068	0.5743	0.796
1990	3646	38547	29450	13692	0.4649	0.6662
1991	6662	28951	21301	8750	0.4108	0.512
1992	11392	36023	21073	6396	0.3035	0.4575
1993	10097	51491	33502	6107	0.1823	0.2351
1994	25156	84335	42937	9046	0.2107	0.1846
1995	42508	144616	54735	23045	0.421	0.321
1996	12858	142597	85457	40422	0.473	0.7019
1997	6454	96379	81121	34304	0.4229	0.7716
1998	5922	65797	55445	24005	0.4329	0.5925
1999	14338	64613	44611	18306	0.4103	0.5304
2000	19710	90668	45736	21033	0.4599	0.3643

2001	29687	109541	58652	28183	0.4805	0.4315
2002	13258	98034	55679	38457	0.6907	0.8216
2003	6240	60425	40399	24501	0.6065	0.726
2004	3631	37025	27059	13178	0.487	0.6712
2005	6095	31865	23470	9906	0.4221	0.5459
2006	7619	30285	20897	10479	0.5015	0.6163
2007	5120	27367	17387	8015	0.461	0.4871
2008	6506	29800	20433	7465	0.3653	0.4422
2009	8425	29989	19563	10002	0.5113	0.5252
2010	12297	38774	21525	12757	0.5927	0.6527
2011	4145	30826	19114	9760	0.5106	0.5429
2012	1773	24323	19290	7210	0.3738	0.4969
2013	2453	23476	20785	4630	0.2228	0.2613
2014	6772	27720	21142	6349	0.3003	0.4115
2015	874	26110	18781	6648	0.3540	0.3899
2016	3666	24201	19687	6037	0.3066	0.3899
2017	3666	24179	19472			
Avg.59-14	14720	80017	55471	21817	0.41	0.51

Table 4.6.5. Faroe Plateau cod (sub-division Vb1). Results from the back-calculation of the age2+ biomass back to 1906 (in tonnes). The exploitation ratio (catch/biomass, C/B) is also provided. The higher biomass estimate is obtained by using a scaling factor between age 2+ biomass from the age-based assessment and the cpue of British trawlers. The lower estimate is obtained by using a regression line.

		Factor	Regression		
Year	Catch (t)	Biomass (t)	Biomass (t)	C/B	C/B
1906	18510	125162	108644	0.148	0.170
1907	19802	148793	122844	0.133	0.161
1908	11609	108532	98651	0.107	0.118
1909	19825	175051	138622	0.113	0.143
1910	21682	149669	123370	0.145	0.176
1911	31406	175051	138622	0.179	0.227
1912	38718	161922	130733	0.239	0.296
1913	33228	137415	116007	0.242	0.286
1914	30580	112908	101281	0.271	0.302
1915	19810	122391	106979	0.162	0.185
1916	17785	143731	119802	0.124	0.148
1917	18155	171332	136387	0.106	0.133
1918	23160	213691	161841	0.108	0.143
1919	43468	205685	157030	0.211	0.277
1920	17726	98904	92866	0.179	0.191
1921	12088	117284	103911	0.103	0.116
1922	19315	160172	129681	0.121	0.149
1923	25553	133039	113377	0.192	0.225
1924	45197	136895	115694	0.330	0.391
1925	38296	129353	111163	0.296	0.345
1926	44066	185574	144945	0.237	0.304
1927	45172	162034	130800	0.279	0.345
1928	30303	126611	109515	0.239	0.277
1929	26506	135524	114871	0.196	0.231
1930	33022	142608	119128	0.232	0.277
1931	45418	139409	117205	0.326	0.388
1932	44646	121354	106356	0.368	0.420
1933	37087	108327	98529	0.342	0.376
1934	35495	107870	98254	0.329	0.361
1935	32125	91187	88229	0.352	0.364
1936	34758	102385	94958	0.339	0.366
1937	26639	95758	90976	0.278	0.293
1938	23755	93244	89465	0.255	0.266
1939	6399	143439	119627	0.045	0.053
1940	8113	193635	149789	0.042	0.054
1941	6559	216611	163595	0.030	0.040
1942	6791	188465	146682	0.036	0.046
1943	9850	196270	151372	0.050	0.065
1944	7847	210683	160033	0.037	0.049

		Factor	Regression		
Year	Catch (t)	Biomass (t)	Biomass (t)	C/B	C/B
1945	8646	225096	168693	0.038	0.051
1946	30485	239509	177354	0.127	0.172
1947	30993	177346	140001	0.175	0.221
1948	20712	122497	107043	0.169	0.193
1949	28134	164777	132448	0.171	0.212
1950	35973	152207	124895	0.236	0.288
1951	35076	124325	108142	0.282	0.324
1952	30259	116783	103610	0.259	0.292
1953	27055	116783	103610	0.232	0.261
1954	36170	146493	121462	0.247	0.298
1955	38583	149464	123247	0.258	0.313
1956	27628	108327	98529	0.255	0.280
1957	31393	112898	101275	0.278	0.310
1958	27807	84102	83972	0.331	0.331

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

		Recr.	Source
2014	YC2012	6772	XSA-output
2015	YC2013	874	XSA-output
2016	YC2014	3666	Average R 2012-14
2017	YC2015	3666	Average R 2012-14

Age	Stock size 2015	Source
2	874	XSA-output
3	6772	XSA-output
4	1082	XSA-output
5	523	XSA-output
6	628	XSA-output
7	873	XSA-output
8	245	XSA-output
9	72	XSA-output
10+	46	XSA-output

	Maturity			Exploitation pattern (not rescaled)			Weights		
	Observed	Av. 13-15	Av. 13-15	Av. 12-14	Av. 12-14	Av. 12-14		As 2015	Av.13-15
Age	2015	2016	2017	2015	2016	2017	2015	2016	2017
2	0.28	0.25	0.25	0.0433	0.0433	0.0433	1.098	1.098	1.069
3	0.48	0.68	0.68	0.2496	0.2496	0.2496	1.648	1.648	1.609
4	0.70	0.88	0.88	0.3465	0.3465	0.3465	2.098	2.098	2.364
5	0.95	0.98	0.98	0.4816	0.4816	0.4816	2.82	2.82	3
6	0.97	0.99	0.99	0.4670	0.4670	0.4670	4.241	4.241	4.354
7	1.00	1.00	1.00	0.4049	0.4049	0.4049	5.269	5.269	6.178
8	1.00	1.00	1.00	0.4729	0.4729	0.4729	7.182	7.182	7.847
9	1.00	1.00	1.00	0.3585	0.3585	0.3585	9.236	9.236	9.167
10+	1.00	1.00	1.00	0.3585	0.3585	0.3585	12.12	12.12	11.521
			Fbar:	0.3899	0.3899	0.3899			

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

2015						
Biomass	SSB	FMult	FBar	Landings		
26110	18781	1.0000	0.3899	6648		
2016					2017	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
24201	19687	0.0000	0.0000	0	31564	26685
.	19687	0.1000	0.0390	710	30677	25817
.	19687	0.2000	0.0780	1394	29824	24983
.	19687	0.3000	0.1170	2053	29003	24181
.	19687	0.4000	0.1560	2688	28214	23409
.	19687	0.5000	0.1950	3299	27455	22667
.	19687	0.6000	0.2340	3888	26725	21954
.	19687	0.7000	0.2729	4455	26022	21267
.	19687	0.8000	0.3119	5002	25346	20607
.	19687	0.9000	0.3509	5529	24695	19973
.	19687	1.0000	0.3899	6037	24069	19362
.	19687	1.1000	0.4289	6526	23466	18774
.	19687	1.2000	0.4679	6998	22886	18209
.	19687	1.3000	0.5069	7453	22328	17665
.	19687	1.4000	0.5459	7891	21790	17142
.	19687	1.5000	0.5849	8314	21272	16638
.	19687	1.6000	0.6239	8722	20774	16154
.	19687	1.7000	0.6629	9115	20294	15687
.	19687	1.8000	0.7019	9495	19832	15238
.	19687	1.9000	0.7408	9861	19387	14806
.	19687	2.0000	0.7798	10214	18958	14390

Input units are thousands and kg - output in tonnes

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

	Expl. pattern	Weight at age	Prop mature
	Average	Average	Average
Age	2002-2014	1978-2014	1983-2015
	Not rescaled		
2	0.105	1.040	0.06
3	0.342	1.559	0.57
4	0.444	2.272	0.83
5	0.574	3.066	0.94
6	0.674	3.881	0.98
7	0.736	4.977	0.99
8	0.749	6.200	1.00
9	0.999	7.703	1.00
10+	0.999	9.638	0.99

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

Reference point	F multiplier	Absolute F
Fbar(3-7)	1.0000	0.554
FMax	0.4513	0.25
F0.1	0.2087	0.1156
F35%SPR	0.3147	0.1743
Flow	0.16	0.0886
Fmed	0.6973	0.3863
Fhigh	1.6044	0.8888
Weights in kilograms		

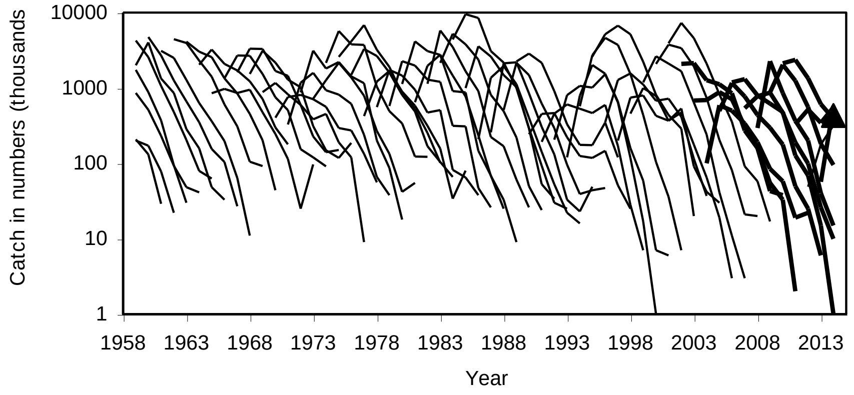


Figure 4.2.1. Faroe Plateau cod (sub-division Vb1). Catch in numbers at age shown as catch curves.

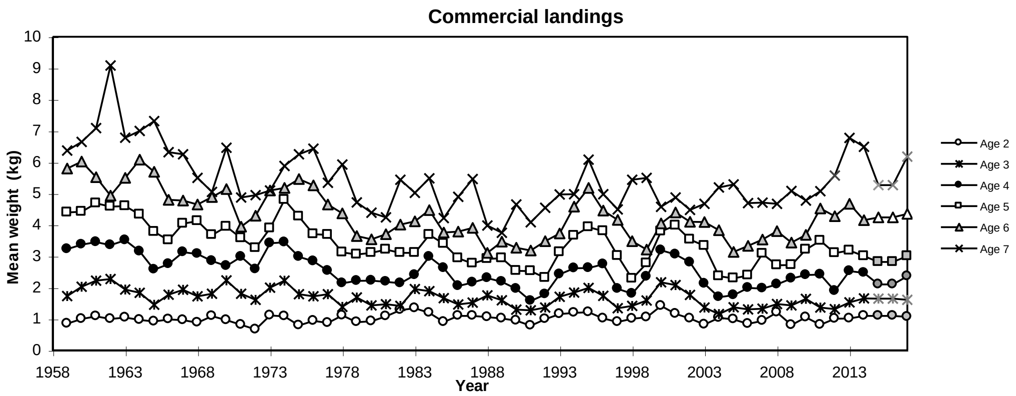


Figure 4.2.2. Faroe Plateau cod (sub-division Vb1). Mean weight at age. The predicted weights are also shown.

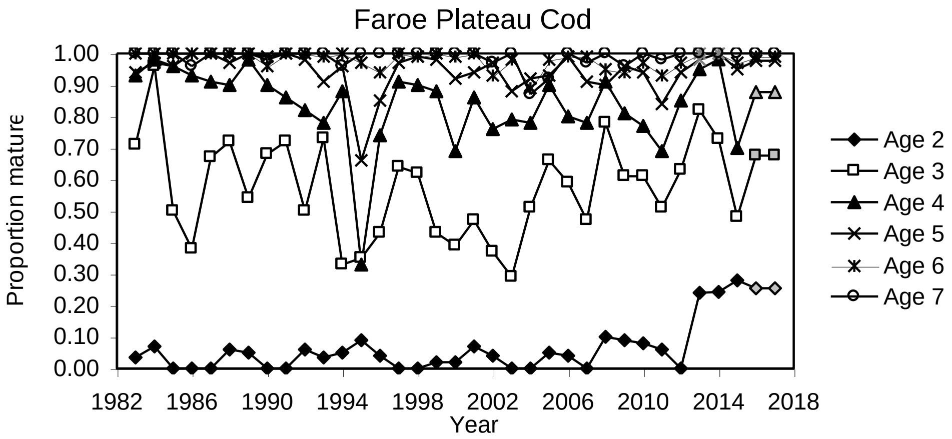


Figure 4.2.3. Faroe Plateau cod (sub-division Vb1). Proportion mature at age as observed in the spring groundfish survey. The predicted values are shown in grey.

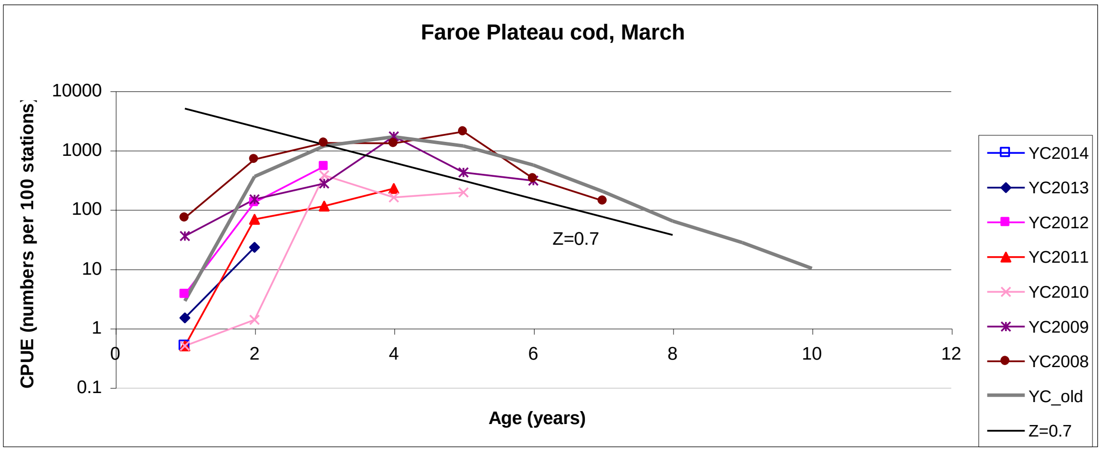


Figure 4.2.4. Faroe Plateau cod (sub-division Vb1). Catch curves from the spring groundfish survey.

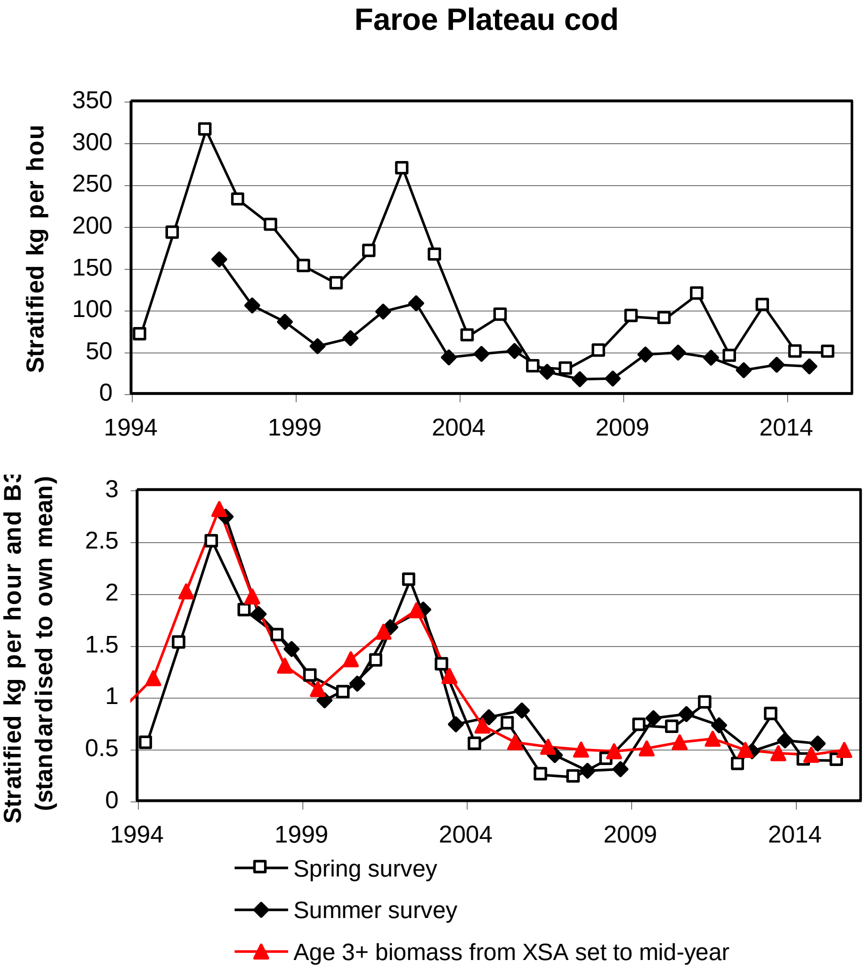


Figure 4.2.5. Faroe Plateau cod (sub-division Vb1). Stratified kg/hour in the spring and summer surveys (upper figure). The age 3+ biomass obtained from the assessment is also included as an index.

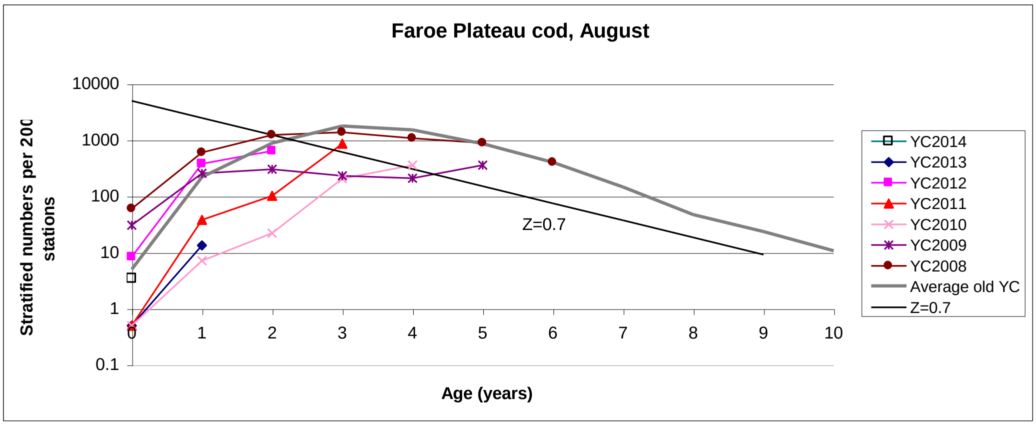


Figure 4.2.6. Faroe Plateau cod (sub-division Vb1). Catch curves from the summer groundfish survey.

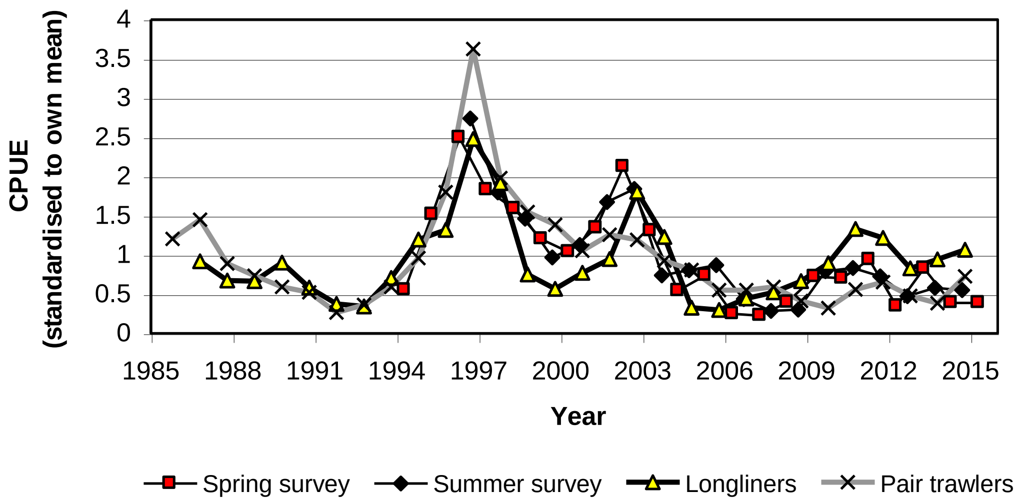


Figure 4.2.7. Faroe Plateau cod (sub-division Vb1). Standardised catch per unit effort for pair trawlers and longliners. The two surveys are shown as well.

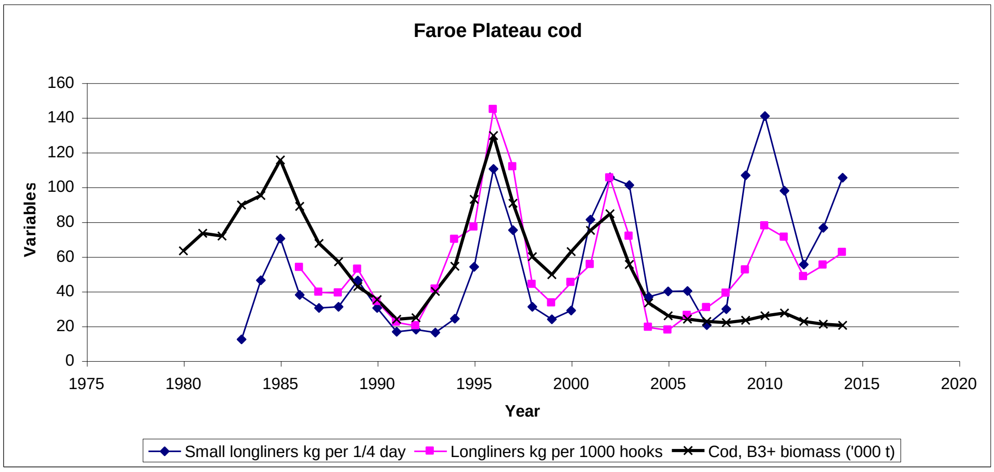


Figure 4.2.8. Faroe Plateau cod (sub-division Vb1). Catch per unit effort for small and large long-liners compared with the fishable (age 3+) biomass.

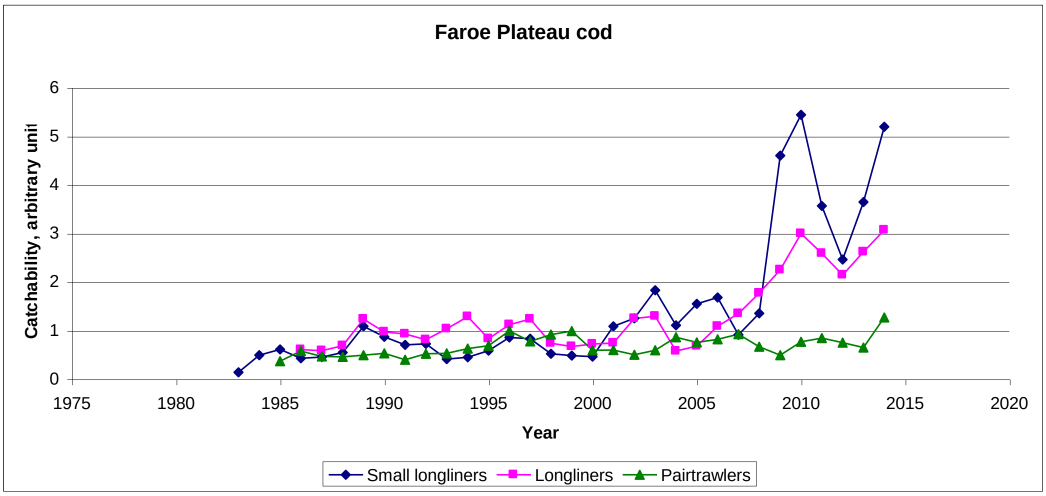


Figure 4.2.9. Faroe Plateau cod (sub-division Vb1). Catchability (cpue divided by age 3+ biomass) for small and large longliners and pair trawlers.

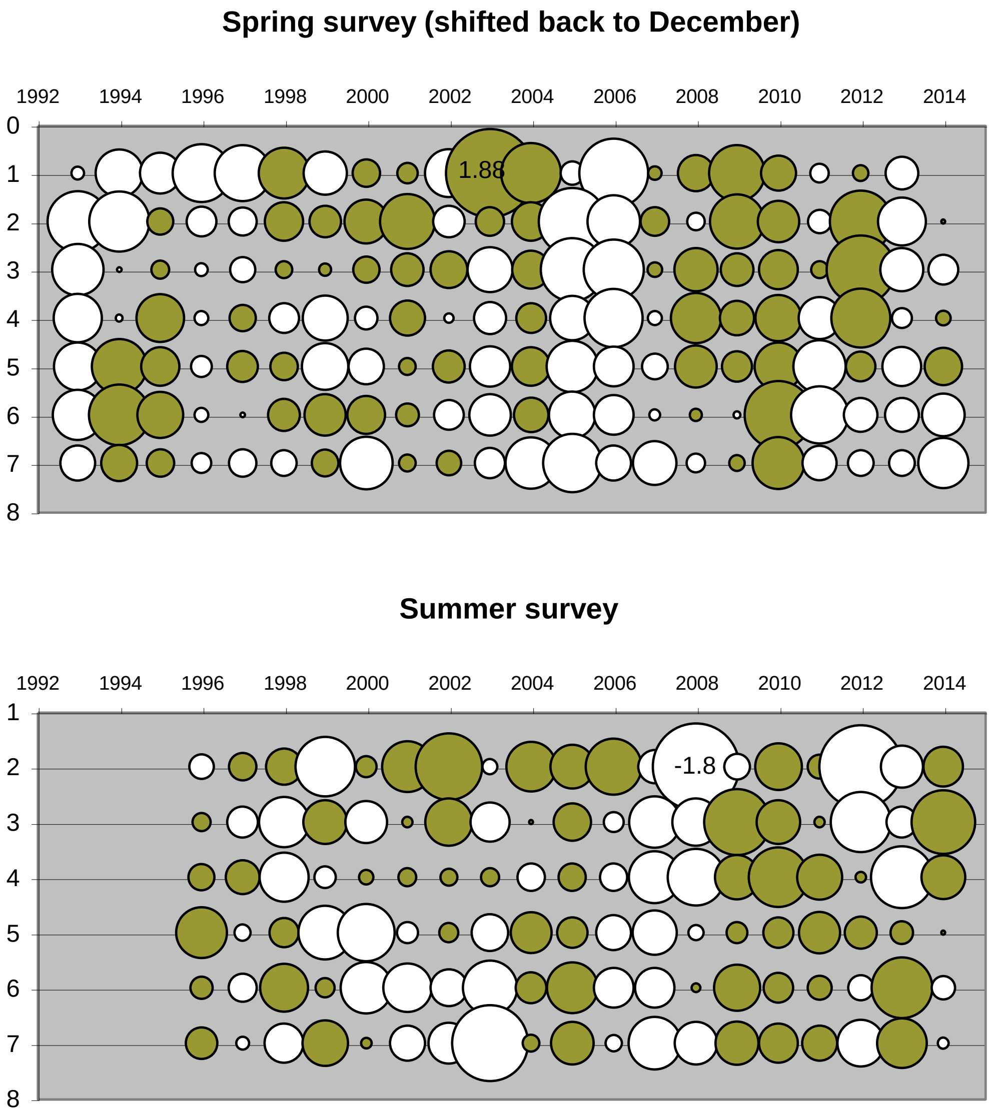
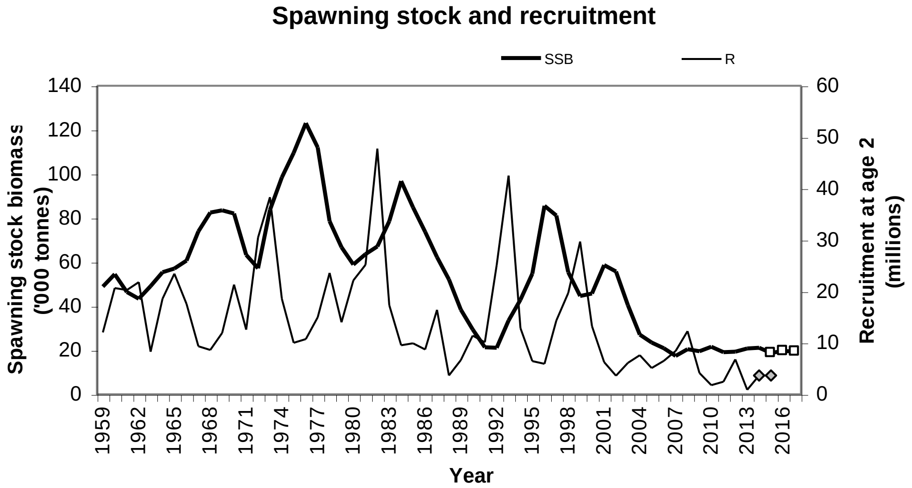


Figure 4.6.1. Faroe Plateau cod (sub-division Vb1). Log catchability residuals for age 2 to 7 for the spring (upper figure) and summer survey. The residuals for age 8 are not presented because some values were off scale. White bubbles indicate negative residuals.



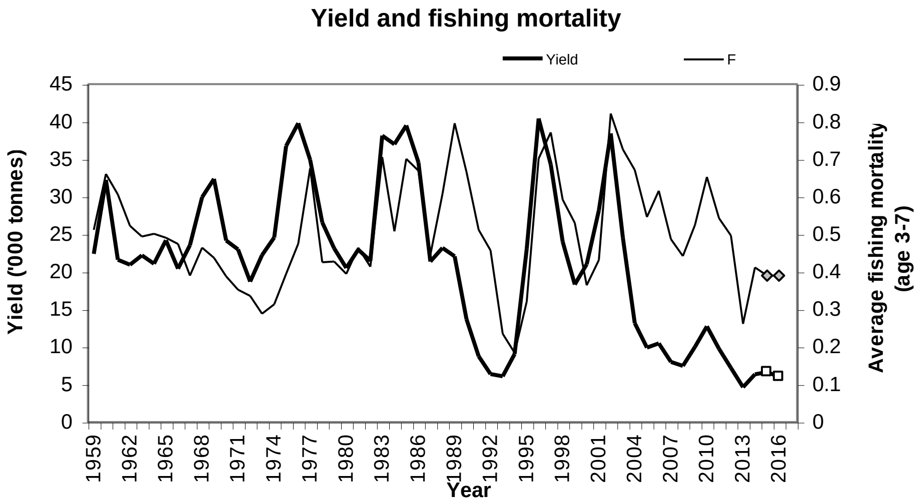


Figure 4.6.2. Faroe Plateau cod (sub-division Vb1). Spawning stock biomass (SSB) and recruitment (year class) versus year (upper figure) and yield and fishing mortality versus year. Points (white and grey) are taken from the short term projections.

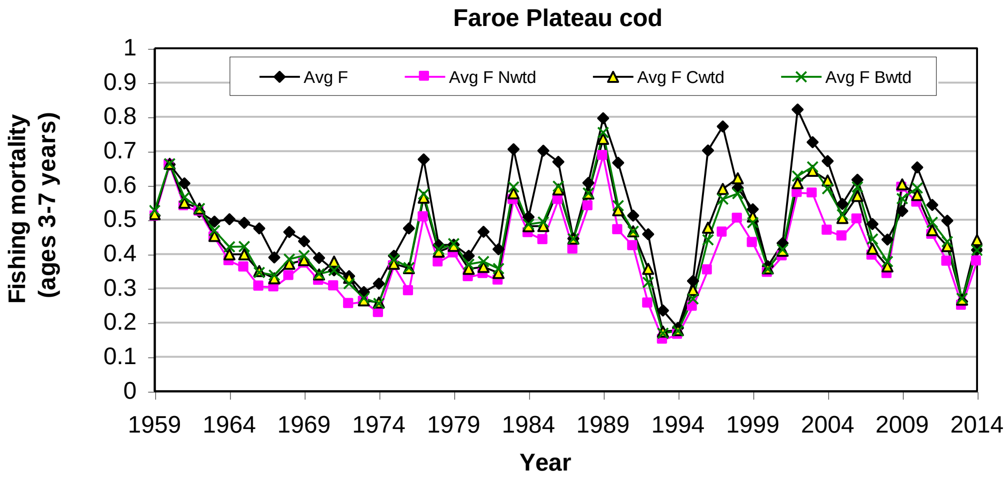


Figure 4.6.3. Faroe Plateau cod (sub-division Vb1). Different measures of fishing mortality: straight arithmetic average (Avg F), weighted by stock numbers (Nwtd), weighted by stock biomass (Bwtd) or weighted by catch (Cwtd).

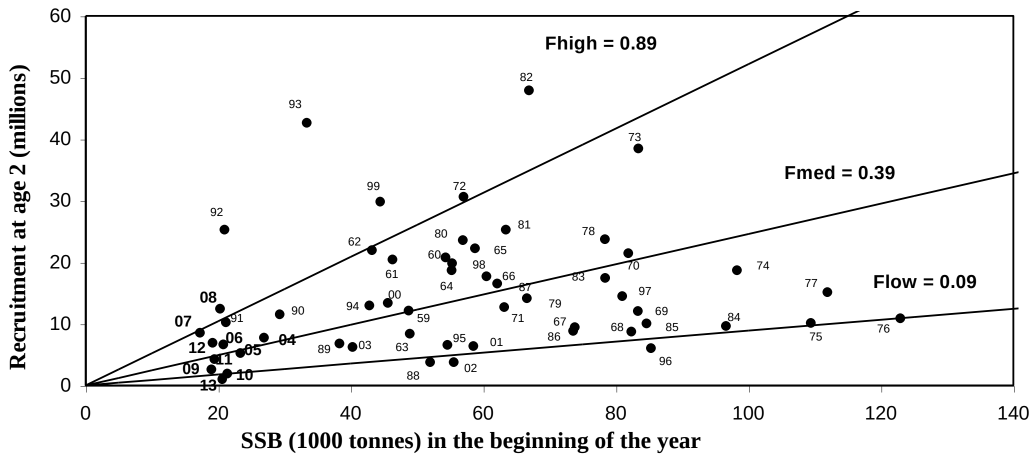


Figure 4.6.4. Faroe Plateau cod (sub-division Vb1). Spawning stock – recruitment relationship. Years are shown at each data point.

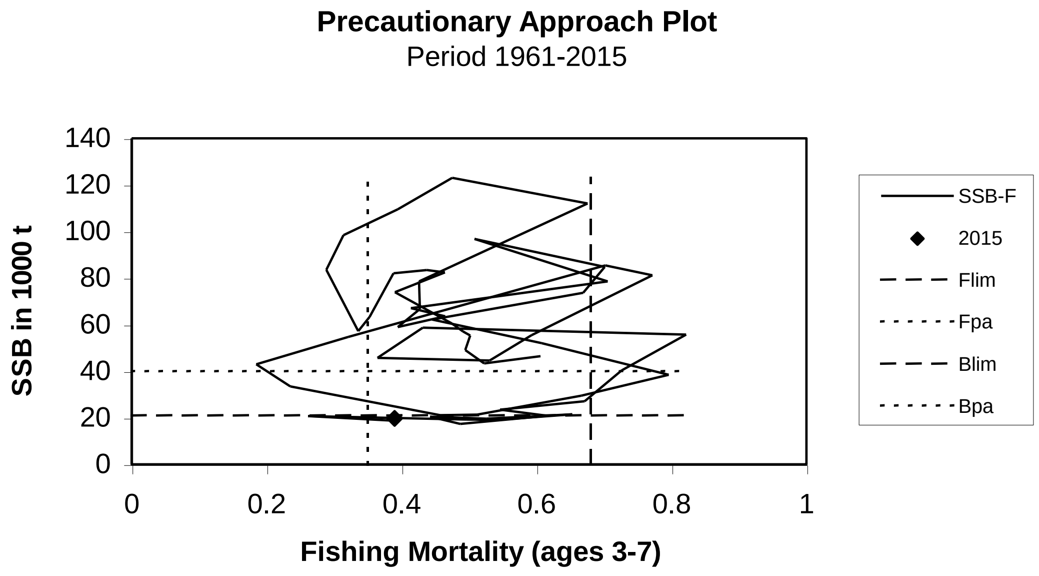


Figure 4.6.5. Faroe Plateau cod (sub-division Vb1). Spawning stock biomass versus fishing mortality.

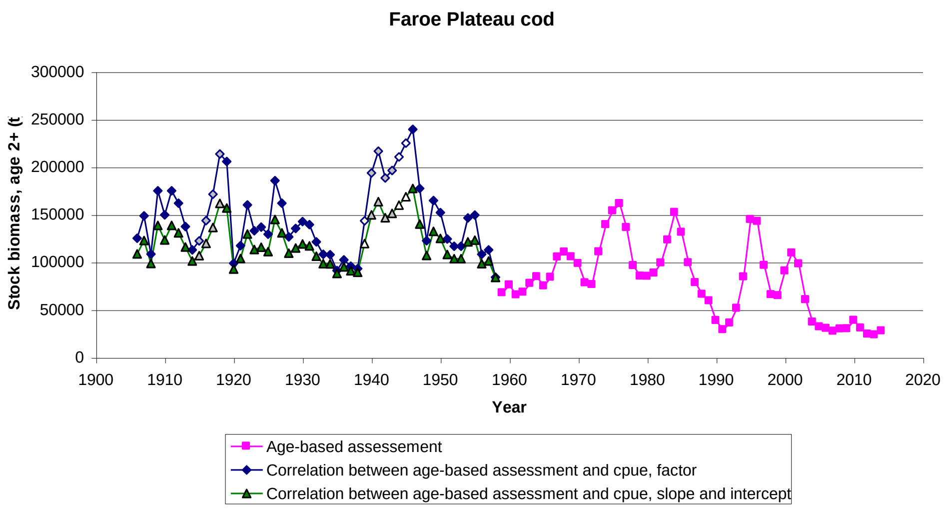


Figure 4.6.6. Faroe Plateau cod (sub-division Vb1). Biomass obtained from the age-based assessment as well as from cpue of British trawlers back in time. There was an overlap between cpue and the age-based assessment in the period 1959-72 and the two versions of the biomass prior to 1959 was whether a regression line was used or a scaling factor. During the wars (grey symbols) catch data from Faroe boats were used as indicative of stock biomass and regressed against cpue of British trawlers for a period prior to the wars. The missing years of data were estimated by linear interpolation (open symbols).

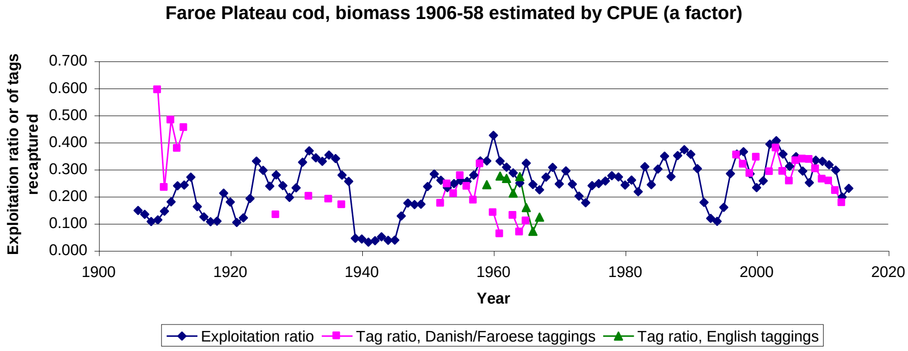


Figure 4.6.7. Faroe Plateau cod (sub-division Vb1). Exploitation ratio (based on the higher biomass) compared with tag returns. The taggings in 1909-13 were on small cod close to land, in 1930s on large spawning cod, in 1950s-60s and in 1997-2013 on cod on the feeding grounds.

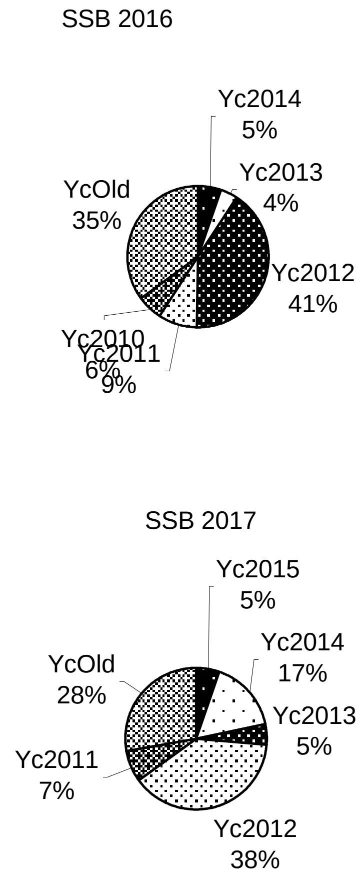


Figure 4.7.1. Faroe Plateau cod (sub-division Vb1). Predictions of the contribution of various year classes to the spawning stock biomass in terminal year +1 (upper figure) and terminal year +2 (lower figure).

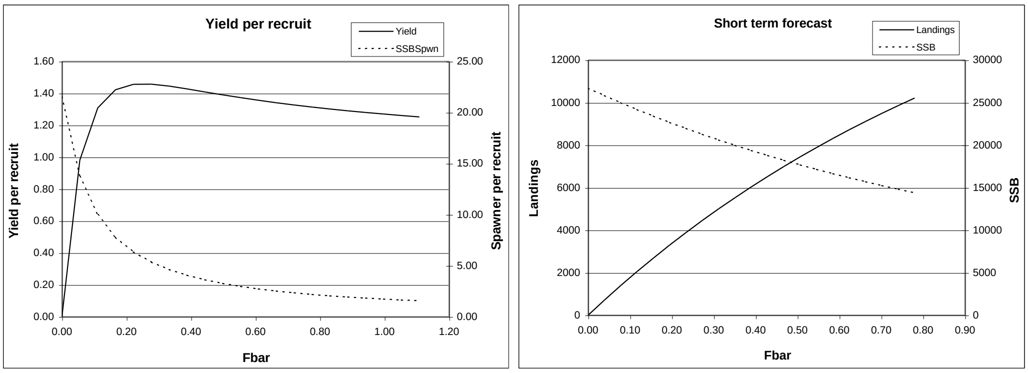


Figure 4.8.1. Faroe Plateau cod (sub-division Vb1). Yield per recruit and spawning stock biomass (SSB) per recruit versus fishing mortality (left figure). Landings and SSB versus Fbar (3-7) (right figure).

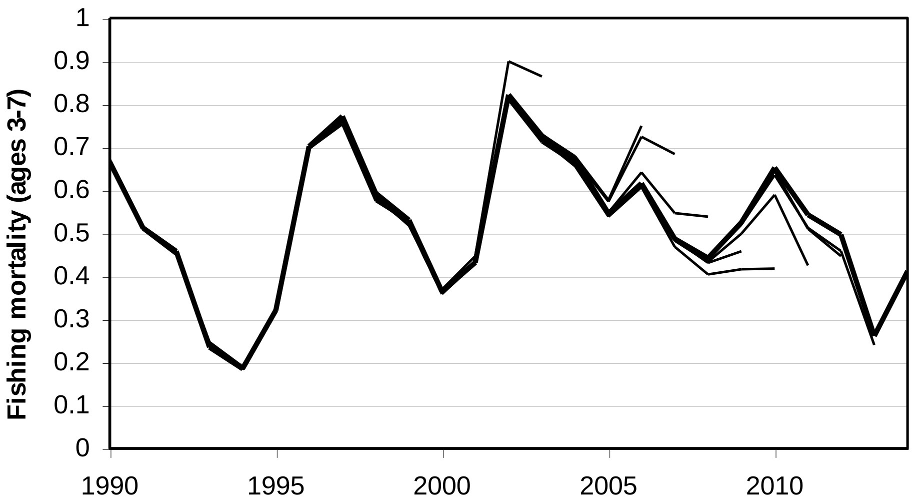


Figure 4.9.1. Faroe Plateau cod (sub-division Vb1). Results from the XSA retrospective analysis of fishing mortality (ages 3-7).

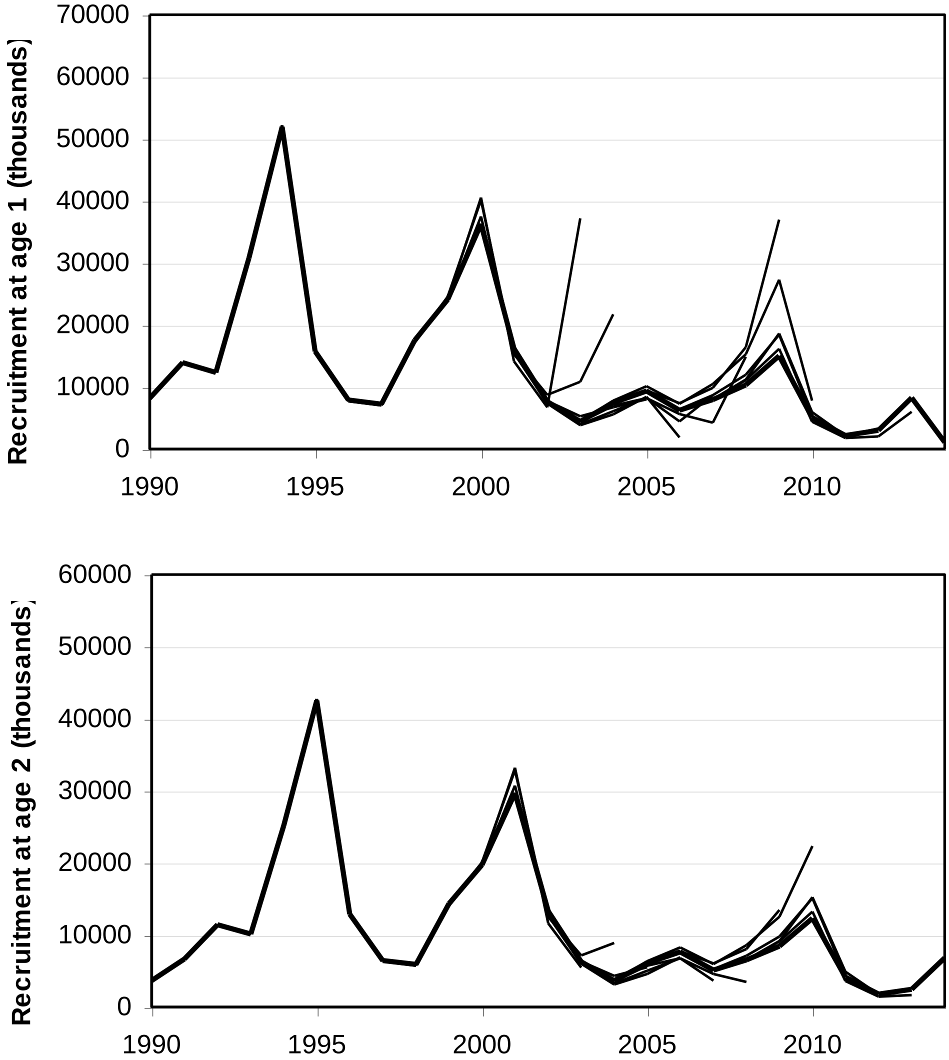


Figure 4.9.1. Faroe Plateau cod (sub-division Vb1). Results from the XSA retrospective analysis (continued). Recruitment at age 1 (upper figure) and at age 2.

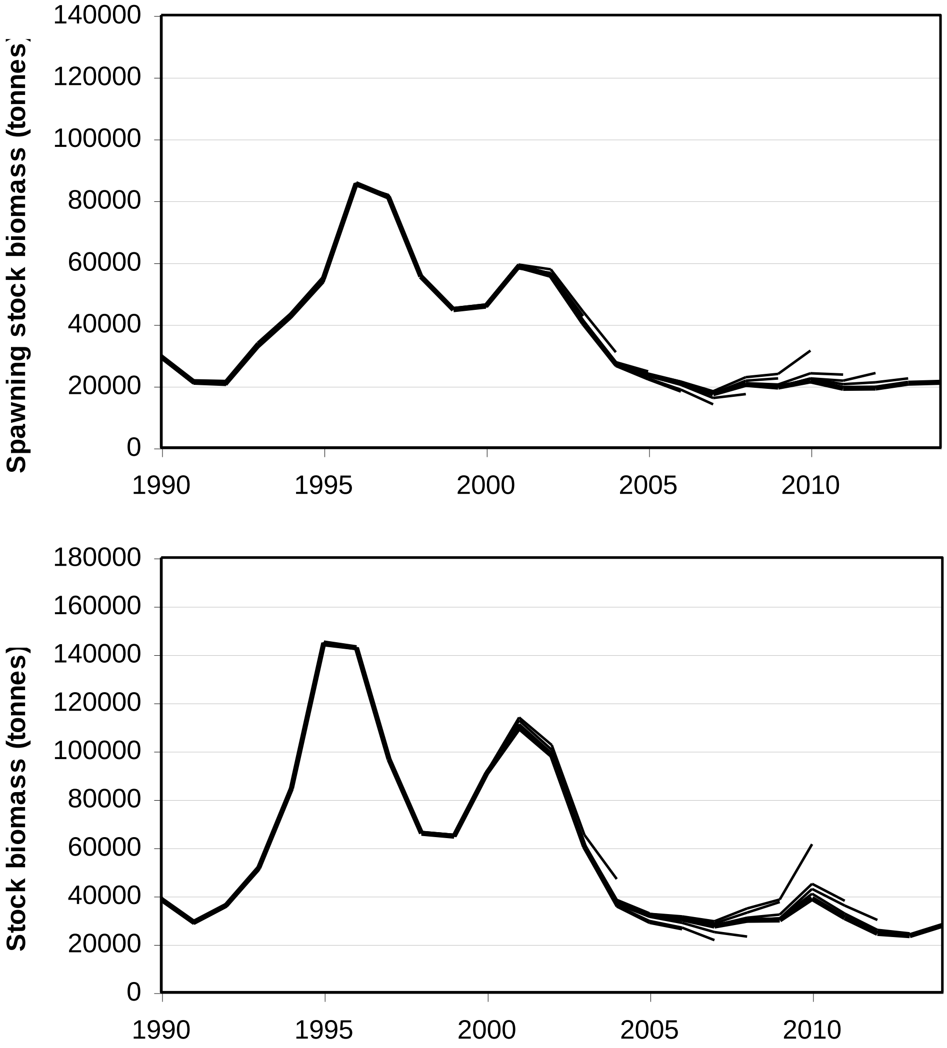


Figure 4.9.1. Faroe Plateau cod (sub-division Vb1). Results from the XSA retrospective analysis (continued). Spawning stock biomass (upper figure) and total stock biomass.

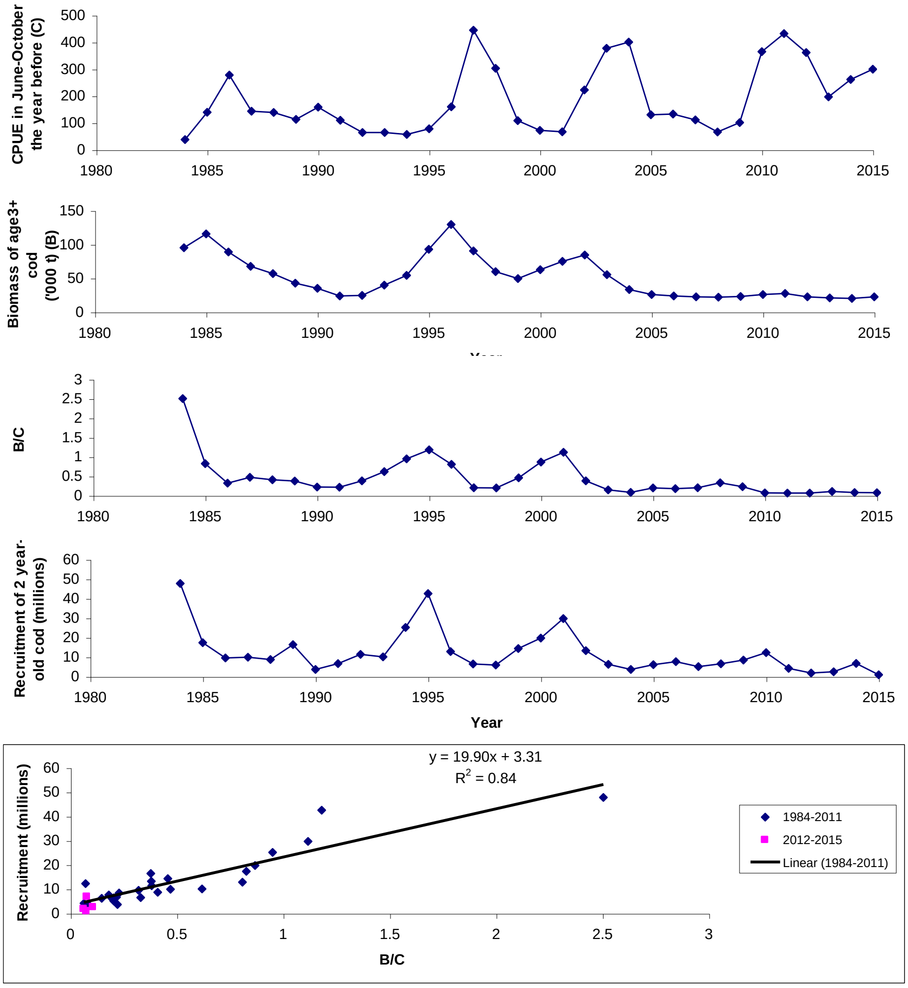


Figure 4.9.2. Faroe Plateau cod (sub-division Vb1). Modelling cod recruitment in three steps. First, the catch-per-unit –effort of cod (C) for small boats operating close to land, as being indicative of the amount of cannibalistic cod. Second, the amount of cod (older than the recruiting cod) (B), as being indicative of e.g. the amount of schools to which recruiting cod can join and hide in. Third, the ratio between B and C, as indicative of recruitment success. Fourth and fifth, a comparison with observed recruitment. Note that the model predicts that the recruitment in recent years is very poor.

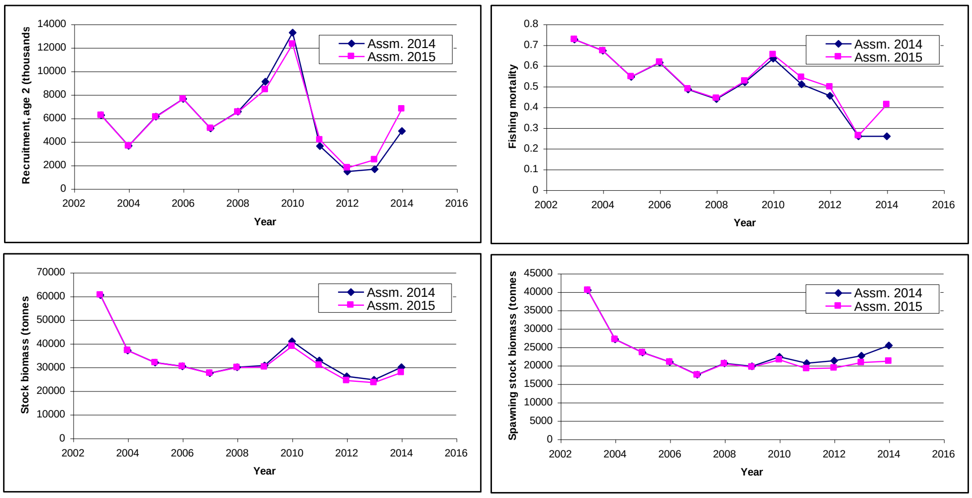


Figure 4.10.1. Faroe Plateau cod (sub-division Vb1). Comparison between the results from the current assessment (Assm. 2015) and the assessment last year (Assm. 2014) for recruitment (upper left), fishing mortality (upper right), stock biomass (lower left) and spawning stock biomass (lower right).

5 Faroe haddock

Executive summary

Being an update assessment, the changes compared to last year are additions of new data from 2014 and 2015 and some minor revisions of recent landings data with corresponding revisions of the catch at age data. The main assessment tool is an XSA tuned with two research vessel bottom trawl surveys. The results are in line with those from 2014, showing a very low SSB mainly due to poor recruitment but also due to higher than recommended fishing mortalities in recent years. SSB is now estimated well below B_{lim} and is predicted to stay below B_{lim} in 2016-2017 with status quo fishing mortality. Fishing mortality in 2014 is estimated at 0.29 and the average fishing mortality from 2012—2014 at 0.28 (F_{MSY} and F_{pa} = 0.25). Landings in 2014 were 3200 t, which is slightly higher than in 2012 and 2013. This years assessment indicates that the 2014 assessment underestimated the 2013 recruitment by 23% (2 million versus 2.6 million, which still is the lowest on record), overestimated the fishing mortality in 2013 by 6% (0.28 versus 0.26) and underestimated the 2013 total- and spawning stock biomasses by 3% and 6%, respectively (20 and 19 thous. t versus 19.6 and 18 thous. t).

5.1 Stock description and management units

Haddock in Faroese Waters, i.e. ICES Sub-Divisions Vb1 and Vb2 and in the southern part of ICES Division IIa, close to the border of Sub-Division Vb1, are generally believed to belong to the same stock and are treated as one management unit named Faroe haddock. Haddock is distributed all over the Faroe Plateau and the Faroe Bank from shallow water down to more than 450 m. A more detailed description of haddock in Farose waters is given in the stock annex. The spatial distribution of the haddock in the summer survey and in the spring survey is shown in figure 5.9. The figure do clearly illustrate the drastic decrease in the stock biomass in recent years.

5.2 Scientific data

5.2.1 Trends in landings and fisheries

Nominal landings of Faroe haddock increased very rapidly from only 4 000 t in 1993 to 27 000 t in 2003, but have declined drastically since and amounted in 2014 to only about 3 200 t. Most of the landings are taken from the Faroe Plateau; the 2014 landings from the Faroe Bank (Sub-Division Vb2), where the area shallower than 200 m depths has been closed to almost all fishing since the fiscal year 2008—2009, amounted to only about 64 t (Tables 5.1 and 5.2). The cumulative landings by month are shown in Figure 5.2.

Faroese vessels have taken almost the entire catch since the late 1970s (Figure 5.1). Due to the dispute on mackerel quota share, there has been no agreement on mutual fishery rights between the Faroe Islands and Norway and EU, respectively, since 2011 and therefore there was no fishery by those parties in Vb in 2012 and 2013; in 2014 the parties happened to make an agreement again. The proportion of the Faroese landings taken by each fleet category since 1985 are shown in the annex. The longliners have taken most of the catches in recent years followed by the trawlers. This was also the case in 2014, where the share by longliners was 82% and that by trawlers 18% (Figure 5.3).

5.2.2 Catch-at-age

Catch-at-age data were provided for fish taken by the Faroese fleets from Vb1 and Vb2. The sampling intensity in 2014 is shown in Table 5.4 showing some decrease in intensity as compared to 2013. There is a need to increase the sampling level. Reasons for the inadequate sampling level are shortage of resources (people, money) but also that the total catches (and stock) are so small that it is difficult to obtain enough samples. From late 2011, a landing site has been established in Tórshavn close to the Marine Research Institute and it is the intention that technicians from the Institute will regularly be sampling the landings there; this will increase the sampling level in coming years. This has also turned out to be difficult of the above mentioned reasons but the outlook is very positive regarding raising enough money to hire a new technician to among other things do the sampling.

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, all longliners were grouped into 2 fleets (larger and smaller than 100 GRT, respectively), and all trawlers were also grouped into 2 fleets (larger and smaller than 1000 Hp, respectively)The longliner samples had to be treated by using 2 seasons only (Jan-Jun, Jul-Dec. The results are given in Table 5.3. No catch-at-age data were available from other nations (Norwegian longliners and British trawlers) and they were assumed to have the same age composition as the Faroese corresponding fleets. The most recent data were revised according to the final catch figures. The resulting total catch-at-age in numbers are given in Tables 5.4 and 5.5, and in Figure 5.4 the LN(catch-at-age in numbers) is shown since 1957.

In general the catch-at-age matrix in recent years appears consistent although from time to time a few very small year classes are disturbing this consistency, both in numbers and mean weights at age. The recent very small year classes need to be very carefully inspected when the FBAR is calculated. 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 periods 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 (See the 2005 NWWG report). 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 5.5). Figure 5.5 shows the mean weights-at-age in the landings for age groups 2—7 since 1976. During this period, weights have shown cyclical changes. They were at a minimum in 2007—2009, but have increased again since then In the 3 latest years the weights have been fluctuated without a clear trend and a simple average of these years will be used in the short term predictions (Figure 5.5). The mean weights 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—2014. 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 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 5.6 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 directly in the 2015 assessment but catch per unit effort for some selected fleets (logbook data) is used as an additional information on the status of the stock (see section 5.4.1.1).

5.4 Methods

This assessment is an update of the 2014 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 catch-at-age input. All other input files (VPA) are the same except for the addition of the 2014 data.

5.4.1 Tuning and estimates of fishing mortality

Commercial cpue series

Several commercial catch per unit effort series are updated every year, but as discussed in previous reports of this WG they are not used directly for tuning of the VPA but as additional information on stock trends (for details see the stock annex). 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 changes in productivity of the ecosystem (see chapter 2). Both series, however, indicate that the stock is very low. The longliner cpue's do not decrease as much as the trawler cpue's which in addition to the explanation given above may be attributed to the fact that in the management of the demersal Faroese stocks, large areas have been closed to trawling with the effect that when the haddock stock is small, the distribution of it is mainly outside the "trawl areas".

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 spatial distribution of haddock catches in the surveys Biomass estimates (kg/hour) are available for both series since they were initiated (Figure 5.8). The main trends from the surveys are the same but the summer survey indicates a considerably more depleted stock in recent years than the summer survey. 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, some artefacts 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 (ages 0-2), since these ages have length distributions almost without overlap. LN(numbers at age) for the surveys are presented in Figures 5.10—5.11. Further analyses of the performances of the two series are shown in the stock annex. In general there is a good relationship between the indices for one year class in two successive years. The same applies when comparing the corresponding indices at age from both surveys .

A SPALY (same procedure as last year) run, with the same settings of the XSA as in 2014 (tuned with the two surveys combined, Table 5.8), with 2015 data included and some minor revisions of recent catch figures, gave in general similar results as last year (Table 5.9), although this years assessment indicates that the 2014 assessment underestimated the 2013 recruitment by 23% (2 million versus 2.6 million, which still is the lowest on record), overestimated the fishing mortality in 2032 by 6% (0.28 versus 0.26) and overestimated the 2013 total- and spawning stock biomasses by 3% and 6%, respectively (20 and 19 thous. t versus 20 and 18 thous. t). The log q residuals for the two surveys are shown in Figure 5.12.

The retrospective analysis of fishing mortality, recruitment and spawning stock biomass of this XSA is shown in Figure 5.13. 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 development of recent small year classes 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, the 2010 NWWG carried out an exploratory XSA without shrinkage (Shr. 2.0). Based on that it was concluded to continue with a shrinkage of 0.5 and this shrinkage was also applied this year.

Results

The fishing mortalities from the final XSA run are given in Table 5.9 and in Figure 5.14. The fishing mortality was high (around 0.6) in the 1950s and early 1960s but declined to around 0.2 from 1965—1975. Since then, fishing mortality has usually been low, the exceptions are peaks in 1977, 1982, 1997—1999 and 2003—2006. They occur near the end of relatively high catch periods and some of the highest values (0.32—0.45) are nearly certainly an artefact of the unweighted fishing mortality. Exploitation ratio (Yield/Biomass) is a bit more stable and may be used to indicate the level of fishing mortality.

5.5 Reference points

The yield- and spawning stock biomass per recruit (age 2) based on the long-term data are shown in Table 5.16 and Figure 5.16. $\mathbf{F}_{med}$, and $\mathbf{F}_{high}$ were calculated at 0.23 and 0.89, respectively. The F_{max} of 0.89 should not be used since it is very poorly determined due to the flat YPR curve. $F_{0.1}$ is estimated at 0.18. The F35%SPR was estimated at 0.24.

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 in 2012 investigated possible candidates for F_{MSY}. Based on Medium –term projections, Medium-term projections the NWWG suggested, that FMSY preliminary could be set at 0.25 and the MSY $B_{trigger}$ at 35 thous. t (same as B_{pa}) These values were accepted by ACOM. Some further analyses have indicated that these values are acceptable, but it is anticipated that further work will be untertaken in connection with the next benchmark assessment. See the stock annex for more details.

5.6 State of the stock

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 5.14. 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 does not seem to be the decisive factor in this development since it most of the period has fluctuated around the F_{MSY} and F_{pa}. It must though be remembered that the characteristics of the stock in recent decades with long periods of poor recruitment make it less resilient to high fishing mortality.

The most recent increase in the spawning stock is due to new strong year classes entering the stock of which the 1999 year class is the highest on record (103 million at age 2). Also the YC's from 2000 and 2001 are estimated well above average and the 2002 YC above average, but the more recent YC's are all estimated to be very small except the 2009 YC, which is estimated to be slightly above the half of the average for the whole series back to 1957 and the 2012 and 2013 YC's, which are estimated somewhat higher than the other small year-classes. Fishing mortality has been relatively high since 2003, highest whent the stock was large leading to large variability in catches. Currently fishing mortality is estimated close to F_{MSY} (0.25).

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 explained in Tables 5.12-13. The YC 2015 at age 2 in 2017 is estimated as the geometric mean of the 2-year-olds since 2005. This procedure was introduced in 2011. All available information suggests that using the recent short series with poor recruitment is more appropriate than the longer period used in the past. However, the choice of recruitment in 2017 has little effect on the short term prediction.

5.7.2 Results

Although the allocated number of fishing days for the fishing year 2014—2015was reduced for some fleets as compared to the year before (see section 2), it should not be unrealistic to assume fishing mortalities in 2015 as the average of some recent years, here the average of F(2012—2014), since not all allocated days were actually used; however, possible changes in the catchability of the fleets (which seems to be linked to productivity changes in the environment) could undermine this assumption; price differences between cod and haddock may also influence this assumption. The landings in 2015 are then predicted to be about 3800 t, and continuing with this fishing mortality will result in 2016 landings of about 4700 t. The SSB will decline to 19 000 t in 2015, will be 19 000 t in 2016 and decrease to 18 000 t in 2017 i.e. will be below B_{lim} (22 000t) in the next years. The results of the short-term prediction are shown in Table 5.16 and in Figure 5.14. The contribution (%) by year-classes to the age composition of the predicted 2016 and 2017 SSB's is shown in Figure 5.17. It should be noted that young YC's which not have really entered the fishery in 2014/15, will contribute by a heavy proportion of the SSB in 2016/17.

5.8 Medium term forecasts and yield per recruit

No medium term projections were made this year; however, the 2013 projections, which were the basis for suggested MSY reference points, are presented in the stock annex.

The input data for the long-term yield and spawning stock biomass (yield-per-recruit calculations) are listed in Table 5.15. Mean weights-at-age (stock and catch) are averages for the 1977—2014 period. The maturity o-gives are averages for the years 1982—2014. The exploitation pattern is the same as in the short term prediction.

The results are given in Table 5.16, in Figure 5.16 and under Reference points (section 5.5).

5.9 Uncertainties in assessment and forecast

Retrospective analyses indicate periods with tendencies to overestimate spawning stock biomass and underestimate fishing mortality and vice versa. Similar things can be seen with the recruitment. This years assessment indicates that the 2014 assessment underestimated the 2013 recruitment 23% (20 millions versus 26 million, which still is the lowest on record), overestimated the fishing mortality in 2013 by 6% (0.28 versus 0.26) and underestimated the 2013 total- and spawning stock biomasses by 3% and 6%, respectively (20 and 19 thous. t versus 19.6 and 18 thous. t), see text table below..

Recruitment estimates from surveys are not very consistent for small cohorts.

The sampling of the catches for length measurements, otolith readings and length-weight relationships has decreased somewhat compared to 2014. Although it is regarded to be adequate for the assessment, there is a need to improve it again (see 5.2).

5.10 Comparison with previous assessment and forecast

As explained previously in the report, this assessment is an update of the 2014 assessment. The only changes are minor revisions of recent landings according to revised data and corresponding revisions of the catch-at-age input. All other input files (VPA and tuning fleets) are the same except for the addition of the 2014 data.

Following differences in the 2013 estimates were observed as compared to last year (see text above):

Comparisons between 2014 and 2015 assessment of 2013 data
The year of comparison is 2013

	R at age 2 (thousands)	Total B (tonnes)	SSB (tonnes)	Landings (tonnes)	F (3-7)
2014 spaly	1992	20183	19017	3105	0.2753
2015 spaly	2596	19643	17931	2950	0.2595
%-change	23	-3	-6	-5	-6

5.11 Management plans and evaluations

There is no explicit management plan for this stock. A management system based on number of fishing days, closed areas and other technical measures was introduced in 1996 with the purpose of ensuring sustainable fisheries. There has been some work with establishing a management plan with a harvest control rule for cod, haddock and saithe including a recovery plan, but the proposal has not yet been officially accepted. 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, the 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 allocated fishing days, gear specifications, closed areas during spawning times, closed areas for longlining close to land and large areas closed to trawling. As a consequence, around 80% of the haddock 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, and in 2011-2013 no agreement could be made between the Faroe Islands and EU and Norway, respectively, due to the dispute on mackerel quota sharing. In 2014, however, the parties managed to get an agreement in place again. Discarding of haddock is considered minimal and there is a ban to discarding.

5.15 Changes in fishing technology and fishing patterns

See section 2.

5.16 Changes in the environment

See section 2.

Table 5.1 Faroe Plateau (Sub-division Vb1) HADDOCK. Nominal catches (tonnes) by countries 2000-2014 and Working Group estimates in Vb.

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014 [2]
Faroe Islands	13,620 [8]	13,457 [8]	20,776 [6]	21,615	18,995	18,172	15,600	11,689	6,728	4,895	4,932	3,350	2,490	2,877	2,704
France[1]	6	8 [7]	2	4	1 [5]	+	12 [5]	4 [5]	3 [5]	2 [5]	1 [7]	3			
Germany	1	2	6	1	6		1								
Greenland	22 [6]	0 [6]	4 [4]				1	9 [4]		6 [4]	12 [6]	+	1 [4]		
Iceland			4										2	26 [4]	
Norway	355	257 [2]	227	265	229	212	57	61	26	8	5				2
Russia					16				10						
Spain					49										
UK (Engl. and Wales)	19 [7]	4 [7]	11 [5]	14	8	1	1								
UK (Scotland)[5]				185	186	126	106	35	60	64					
United Kingdom											73 [4]				424
Total	14,023	13,728 #	21,030	22,084	19,490	18,511	15,778	11,798	6,827	4,975	5,023	3,353	2,493	2,903	3,130
Used in the assessmer	15,821 0	15,890	24,933	27,072	23,101	20,455	17,154	12,631	7,388	5,197	5,202	3,540	2,634	2,950	3,194

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) Reported as Division Vb, to the Faroese coastal guard service.
5) Reported as Division Vb.
6) Includes Faroese landings reported to the NWWG by the Faroe Marine Research Institute

Table 5.2 Faroe Bank (Sub-division Vb2) HADDOCK. Nominal catches (tonnes) by countries, 2000-2014.

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014 [2]
Faroe Islands	1,565 [5]	1,948	3,698	4,934	3,594	2,444	1,375	810	556	192	178	194	141	47	63
France1						+									
Norway	48	66	28	54	17	45	1	8		3	1				1
UK (Engl. and Wales)	[1]	[1]	[1]	[1]	[1]	[1]	[4]								
UK (Scotland)3	185	148	177	[4]	[1]	[1]	[4]	15	5	27	33				
Total	1,798	2,162	3,903	4,988	3,611	1,944	1,376	833	561	222	212	194	141	47	64

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

Catch at age 2014

Age	Vb LLiners < 100GRT	Vb LLiners > 100GRT	Vb Trawl < 1000HP	Vb Trawl > 1000HP	Vb Others	Vb All Faroese fleets	Vb Foreign Trawlers	Vb Total All fleets
1	0	0	0	0	0	0	0	0
2	157	35	12	10	0	214	18	232
3	101	30	145	39	0	316	69	385
4	235	122	160	39	0	556	70	626
5	321	251	343	71	1	986	126	1112
6	19	27	26	9	0	82	17	99
7	11	19	16	5	0	51	8	59
8	5	10	8	3	0	26	5	31
9	1	1	7	2	0	11	4	15
10	4	8	3	3	0	18	4	22
11	3	7	3	2	0	15	4	19
12	0	0	1	1	0	2	1	3
13	1	1	0	0	0	2	0	3
14	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0
Total no.	858	513	722	184	2	2279	327	2606
Catch, t.	885	656	738	215	2	2495	382	2877

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 trav Pair Trawl. = Pair trawlers

Comm. Sampling 2014	Vb LLiners < 100GRT	Vb LLiners > 100GRT	Vb Trawl <1000HP	Vb Trawl <1000HP	Vb Others	Vb All Faroese Fleets	Vb Foreign Trawlers	Vb Total
No. samples	10	14	8	37	0	73	0	73
No. lengths	1918	2923	1722	8182	0	16942	0	16942
No. weights	1718	2923	1722	7951	0	16942	0	16942
No. ages	180	360	20	679	0	1379	0	1379

As compared to 2013, the sampling in 2014 was:
no samples - 5%, no of lengths - 13%, no of weights 16%, no of otoliths - 10%.

Tabel 5.4 Faroe haddock. Catch number-at-age

Run title : FAROE HADDOCK (ICES DIVISION Vb) HAD_IND

At 3/05/2015 14:07

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

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

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

YEAR,	1965,	1966,	1967,	1968,	1969,	1970,	1971,	1972,	1973,	1974,
AGE										
0,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
1,	39,	90,	70,	49,	95,	57,	55,	43,	665,	253,
2,	1368,	1081,	1425,	5881,	2384,	1728,	717,	750,	3311,	5633,
3,	4286,	3304,	2405,	4097,	7539,	4855,	4393,	3744,	8416,	2899,
4,	5133,	4804,	2599,	2812,	4567,	6581,	4727,	4179,	1240,	3970,
5,	1443,	2710,	1785,	1524,	1565,	1624,	3267,	2706,	2795,	451,
6,	1209,	1112,	1426,	1526,	1485,	1383,	1292,	1171,	919,	976,
7,	673,	740,	631,	923,	1224,	1099,	864,	696,	1054,	466,
8,	1345,	180,	197,	230,	378,	326,	222,	180,	150,	535,
9,	43,	54,	52,	68,	114,	68,	147,	113,	68,	68,
+gp,	8,	9,	13,	12,	20,	10,	102,	95,	11,	147,
TOTALNUM,	15547,	14084,	10603,	17122,	19371,	17731,	15786,	13677,	18629,	15398,
TONSLAND,	18479,	18766,	13381,	17852,	23272,	21361,	19393,	16485,	18035,	14773,
SOPCOF %,	94,	109,	101,	102,	108,	102,	97,	96,	97,	97,

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

YEAR,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,	1983,	1984,
AGE										
0,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
1,	94,	40,	0,	0,	1,	0,	0,	0,	0,	25,
2,	7337,	4396,	255,	32,	1,	143,	74,	539,	441,	1195,
3,	7952,	7858,	4039,	1022,	1162,	58,	455,	934,	1969,	1561,
4,	2097,	6798,	5168,	4248,	1755,	3724,	202,	784,	383,	2462,
5,	1371,	1251,	4918,	4054,	3343,	2583,	2586,	298,	422,	147,
6,	247,	1189,	2128,	1841,	1851,	2496,	1354,	2182,	93,	234,
7,	352,	298,	946,	717,	772,	1568,	1559,	973,	1444,	42,
8,	237,	720,	443,	635,	212,	660,	608,	1166,	740,	861,
9,	419,	258,	731,	243,	155,	99,	177,	1283,	947,	388,
+gp,	187,	318,	855,	312,	74,	86,	36,	214,	795,	968,
TOTALNUM,	20293,	23126,	19483,	13104,	9326,	11417,	7051,	8373,	7234,	7883,
TONSLAND,	20715,	26211,	25555,	19200,	12424,	15016,	12233,	11937,	12894,	12378,
SOPCOF %,	117,	107,	98,	99,	104,	100,	109,	92,	106,	106,

Tabel 5.4 Faroe haddock. Catch number-at-age (cont.)

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

YEAR,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,
AGE										
0,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
1,	0,	0,	0,	0,	0,	0,	0,	0,	43,	1,
2,	985,	230,	283,	655,	63,	105,	77,	40,	113,	277,
3,	4553,	2549,	1718,	444,	1518,	1275,	1044,	154,	298,	191,
4,	2196,	4452,	3565,	2463,	658,	1921,	1774,	776,	274,	307,
5,	1242,	1522,	2972,	3036,	2787,	768,	1248,	1120,	554,	153,
6,	169,	738,	1114,	2140,	2554,	1737,	651,	959,	538,	423,
7,	91,	39,	529,	475,	1976,	1909,	1101,	335,	474,	427,
8,	61,	130,	83,	151,	541,	885,	698,	373,	131,	383,
9,	503,	71,	48,	18,	133,	270,	317,	401,	201,	125,
+gp,	973,	712,	334,	128,	81,	108,	32,	162,	185,	301,
TOTALNUM,	10773,	10443,	10646,	9510,	10311,	8978,	6942,	4320,	2811,	2588,
TONSLAND,	15143,	14477,	14882,	12178,	14325,	11726,	8429,	5476,	4026,	4252,
SOPCOF %,	106,	101,	102,	97,	100,	102,	106,	106,	103,	100,

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

YEAR,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,
AGE										
0,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
1,	0,	1,	0,	0,	9,	73,	19,	0,	0,	3,
2,	804,	326,	77,	106,	174,	1461,	4380,	1515,	133,	243,
3,	452,	5234,	2913,	1055,	1142,	3061,	3128,	14039,	3436,	2007,
4,	235,	1019,	10517,	5269,	942,	210,	2423,	2879,	13551,	4802,
5,	226,	179,	710,	9856,	4677,	682,	173,	1200,	2224,	10426,
6,	132,	163,	116,	446,	6619,	2685,	451,	133,	949,	1163,
7,	295,	161,	123,	99,	226,	2846,	1151,	239,	163,	409,
8,	290,	270,	93,	87,	26,	79,	1375,	843,	334,	89,
9,	262,	234,	220,	95,	20,	1,	17,	1095,	858,	166,
+gp,	295,	394,	516,	502,	192,	71,	18,	33,	924,	811,
TOTALNUM,	2991,	7981,	15285,	17515,	14027,	11169,	13135,	21976,	22572,	20119,
TONSLAND,	4948,	9642,	17924,	22210,	18482,	15821,	15890,	24933,	27072,	23101,
SOPCOF %,	103,	100,	103,	101,	100,	103,	100,	100,	100,	99,

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

YEAR,	2005,	2006,	2007,	2008,	2009,	2010,	2011,	2012,	2013,	2014,
AGE										
0,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
1,	0,	0,	0,	6,	0,	0,	0,	0,	0,	0,
2,	85,	247,	76,	66,	27,	389,	170,	8,	83,	232,
3,	1671,	446,	982,	204,	329,	445,	773,	960,	510,	385,
4,	3852,	2566,	547,	918,	402,	426,	324,	513,	1118,	626,
5,	6753,	3949,	2732,	424,	555,	279,	198,	156,	219,	1112,
6,	6127,	5423,	3309,	1471,	514,	484,	186,	114,	95,	99,
7,	542,	3278,	2758,	1706,	1133,	553,	280,	123,	78,	59,
8,	147,	136,	1117,	1254,	739,	718,	353,	94,	88,	31,
9,	28,	63,	89,	320,	285,	444,	367,	171,	71,	15,
+gp,	154,	70,	9,	39,	48,	159,	187,	114,	119,	47,
TOTALNUM,	19359,	16178,	11619,	6408,	4032,	3897,	2838,	2253,	2381,	2606,
TONSLAND,	20455,	17154,	12631,	7388,	5197,	5202,	3540,	2634,	2950,	3194,
SOPCOF %,	100,	100,	100,	101,	100,	101,	101,	102,	101,	101,

Table 5.5 Faroe haddock. Catch weight-at-age.

Run title : FAROE HADDOCK (ICES DIVISION Vb) HAD_IND

At 3/05/2015 14:07

Table 2 Catch weights at age (kg)

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

Table 2 Catch weights at age (kg)

YEAR,	1965,	1966,	1967,	1968,	1969,	1970,	1971,	1972,	1973,	1974,
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,	.9383,	1.0885,	1.0117,	1.0246,	1.0787,	1.0249,	.9688,	.9597,	.9690,	.9678,

Table 2 Catch weights at age (kg)

YEAR,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,	1983,	1984,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.2500,	.2500,	.0000,	.0000,	.3000,	.0000,	.0000,	.0000,	.0000,	.3590,
2,	.4700,	.4700,	.3110,	.3570,	.3570,	.6430,	.4520,	.7000,	.4700,	.6810,
3,	.7300,	.7300,	.6330,	.7900,	.6720,	.7130,	.7250,	.8960,	.7400,	1.0110,
4,	1.1300,	1.1300,	1.0440,	1.0350,	.8940,	.9410,	.9570,	1.1500,	1.0100,	1.2550,
5,	1.5500,	1.5500,	1.4260,	1.3980,	1.1560,	1.1570,	1.2370,	1.4440,	1.3200,	1.8120,
6,	1.9700,	1.9700,	1.8250,	1.8700,	1.5900,	1.4930,	1.6510,	1.4980,	1.6600,	2.0610,
7,	2.4100,	2.4100,	2.2410,	2.3500,	2.0700,	1.7390,	2.0530,	1.8290,	2.0500,	2.0590,
8,	2.7600,	2.7600,	2.2050,	2.5970,	2.5250,	2.0950,	2.4060,	1.8870,	2.2600,	2.1370,
9,	3.0700,	3.0700,	2.5700,	3.0140,	2.6960,	2.4650,	2.7250,	1.9610,	2.5400,	2.3680,
+gp,	3.5500,	3.5500,	2.5910,	2.9200,	3.5190,	3.3100,	3.2500,	2.8560,	3.0400,	2.6860,
SOPCOFAC,	1.1696,	1.0741,	.9784,	.9947,	1.0380,	1.0017,	1.0870,	.9238,	1.0554,	1.0593,

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

Table 2 Catch weights at age (kg)

YEAR,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.3600,	.0000,
2,	.5280,	.6080,	.6050,	.5010,	.5800,	.4380,	.5470,	.5250,	.7550,	.7540,
3,	.8590,	.8870,	.8310,	.7810,	.7790,	.6990,	.6930,	.7240,	.9820,	1.1030,
4,	1.3910,	1.1750,	1.1260,	.9740,	.9230,	.9390,	.8840,	.8170,	1.0270,	1.2540,
5,	1.7770,	1.6310,	1.4620,	1.3630,	1.2070,	1.2040,	1.0860,	1.0380,	1.1920,	1.4650,
6,	2.3260,	1.9840,	1.9410,	1.6800,	1.5640,	1.3840,	1.2760,	1.2490,	1.3780,	1.5930,
7,	2.4400,	2.5190,	2.1730,	1.9750,	1.7460,	1.5640,	1.4770,	1.4300,	1.6430,	1.8040,
8,	2.4010,	2.5830,	2.3470,	2.3440,	2.0860,	1.8180,	1.5740,	1.5640,	1.7960,	2.0490,
9,	2.5320,	2.5700,	3.1180,	2.2480,	2.4240,	2.1680,	1.9300,	1.6330,	1.9710,	2.2250,
+gp,	2.6860,	2.9220,	2.9330,	3.2950,	2.5140,	2.3350,	2.1530,	2.1260,	2.2400,	2.4230,
SOPCOFAC,	1.0559,	1.0141,	1.0197,	.9695,	1.0025,	1.0195,	1.0635,	1.0554,	1.0320,	.9969,

Table 2 Catch weights at age (kg)

YEAR,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0000,	.3600,	.0000,	.0000,	.2780,	.2800,	.2800,	.0000,	.0000,	.3670,
2,	.6660,	.5340,	.5190,	.6220,	.5040,	.6610,	.6080,	.5840,	.5710,	.5740,
3,	1.0540,	.8580,	.7710,	.8460,	.6240,	.9360,	.9400,	.8570,	.7150,	.7700,
4,	1.4890,	1.4590,	1.0660,	1.0160,	.9740,	1.1660,	1.3740,	1.4050,	1.0080,	.8870,
5,	1.7790,	1.9930,	1.7990,	1.2830,	1.2200,	1.4830,	1.7790,	1.7990,	1.5370,	1.1590,
6,	1.9400,	2.3300,	2.2700,	2.0800,	1.4900,	1.6160,	1.9710,	1.9740,	1.9110,	1.6380,
7,	2.1820,	2.3510,	2.3400,	2.5560,	2.4560,	1.8930,	2.1190,	2.3010,	2.0910,	1.8700,
8,	2.3570,	2.4690,	2.4750,	2.5720,	2.6580,	2.8210,	2.3730,	2.3700,	2.3010,	2.4380,
9,	2.4900,	2.7770,	2.5010,	2.4520,	2.5980,	3.7490,	2.7500,	2.6260,	2.4060,	2.3570,
+gp,	2.6780,	2.5820,	2.6760,	2.7530,	2.9530,	3.1960,	3.9660,	3.1300,	2.5350,	2.4170,
SOPCOFAC,	1.0331,	1.0043,	1.0250,	1.0106,	.9973,	1.0349,	.9960,	1.0010,	1.0049,	.9929,

Table 2 Catch weights at age (kg)

YEAR,	2005,	2006,	2007,	2008,	2009,	2010,	2011,	2012,	2013,	2014,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0000,	.0000,	.0000,	.4910,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.5380,	.4750,	.6280,	.6360,	.4820,	.6920,	.5530,	.6190,	.5760,	.5470,
3,	.6490,	.6010,	.6690,	.7540,	.7340,	.8700,	.8150,	.7860,	.8300,	.9020,
4,	.7970,	.7680,	.8590,	.8600,	.9850,	1.1490,	1.0860,	1.0690,	1.1490,	1.1650,
5,	1.0200,	.9110,	.9690,	.9910,	1.1300,	1.3080,	1.3030,	1.4050,	1.4650,	1.3540,
6,	1.2450,	1.1260,	1.0600,	1.0820,	1.2640,	1.3860,	1.3870,	1.6160,	1.7100,	1.6930,
7,	1.8430,	1.3740,	1.2450,	1.1510,	1.3570,	1.4290,	1.4690,	1.6560,	1.8270,	1.8410,
8,	2.0610,	2.1580,	1.4750,	1.3790,	1.5450,	1.5680,	1.5380,	1.6750,	1.8860,	1.8720,
9,	2.2630,	2.2110,	2.2660,	1.7270,	1.7920,	1.7400,	1.7020,	1.7270,	1.8560,	1.8560,
+gp,	2.5790,	2.5690,	2.2560,	2.4350,	2.1540,	1.8410,	1.8620,	1.9050,	2.0850,	1.8230,
SOPCOFAC,	.9988,	.9987,	.9999,	1.0065,	.9955,	1.0076,	1.0060,	1.0190,	1.0077,	1.0118,

Table 5.6 Faroe haddock. Proportion mature-at-age.

Run title : FAROE HADDOCK (ICES DIVISION Vb) HAD_IND

At 3/05/2015 14:07

Table 5 Proportion mature at age

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

Table 5 Proportion mature at age

YEAR,	1965,	1966,	1967,	1968,	1969,	1970,	1971,	1972,	1973,	1974,
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,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,	1983,	1984,
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,	.0800,	.0800,	.0800,
3,	.4800,	.4800,	.4800,	.4800,	.4800,	.4800,	.4800,	.6200,	.6200,	.7600,
4,	.9100,	.9100,	.9100,	.9100,	.9100,	.9100,	.9100,	.8900,	.8900,	.9800,
5,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
6,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
7,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
8,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
9,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
+gp,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,

Table 5.6 Faroe haddock. Proportion mature-at-age (cont.).

Table 5 Proportion mature at age

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

Table 5 Proportion mature at age

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

Table 5 Proportion mature at age

YEAR,	2005,	2006,	2007,	2008,	2009,	2010,	2011,	2012,	2013,	2014,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.0100,	.0100,	.0200,	.0100,	.0100,	.0300,	.0900,	.1300,	.1700,	.1600,
3,	.3400,	.4200,	.5200,	.6400,	.6100,	.6500,	.7400,	.7900,	.8300,	.8400,
4,	.9100,	.9100,	.9100,	.9500,	.9300,	.9600,	.9700,	.9900,	.9900,	.9900,
5,	.9900,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
6,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
7,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
8,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
9,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
+gp,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,

Table 5.7 Faroe haddock. 2015 tuning file.

```
FAROE Haddock (ICES SUBDIVISION VB)       COMB-SURVEY-SPALY-15-jr.txt
102
SUMMER SURVEY
1996 2014
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   10461.67  1394.00   410.40   1336.32  1270.33   933.93 2228.54 1224.04
200   24598.14  3779.02  1315.66   1091.24   571.38   809.59  763.94 1276.77
200     642.08 10501.38  1670.76    406.26   355.99   208.31  223.15  290.88
200    2359.69   405.59  5655.72   1081.33   205.64   135.56  147.14   95.56
200    8886.32   215.98  1379.90   5048.56  1039.73   202.49  101.84  157.04
200   13337.55  4051.10   889.30   1042.92  2866.25   393.81   81.02   76.70
SPRING SURVEY SHIFTED
1993 2014
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   4655.30    638.10    418.70    196.20   280.20    265.90
100    101.10   6320.00   1865.90    449.30    260.30   212.60    244.60
100    420.00    367.60   4957.20    908.00    227.80   142.50    293.30
100   3419.90   1232.21    302.60   4022.40    619.60   120.30    103.78
100   3542.60   4099.30    869.80    930.30   2238.40   270.20     90.30
```

100 1534.70 3282.20 3989.20 971.20 1762.60 1113.90 156.70

Table 5.8 Faroe haddock 2015 xsa.

```
Lowestoft VPA Version 3.1

    2/05/2015  23:12

 Extended Survivors Analysis

 FAROE HADDOCK (ICES DIVISION Vb)                HAD_IND

 CPUE data from file D:\Vpa\vpa2015\input-files\comb-survey-spaly-15-jr.txt

 Catch data for  58 years. 1957 to 2014. Ages  0 to  10.

      Fleet,           First, Last, First, Last, Alpha,  Beta
                     ,   year, year,  age ,  age
 SUMMER SURVEY       ,   1996, 2014,   1,     8,   .600,   .700
 SPRING SURVEY SHIFTE,   1993, 2014,   0,     6,   .950,  1.000


 Time series weights :

      Tapered time weighting not applied

 Catchability analysis :

      Catchability independent of stock size for all ages

      Catchability independent of age for ages >=    6

 Terminal population estimation :

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

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

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

      Prior weighting not applied


 Tuning converged after   35 iterations


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


 Fishing mortalities
    Age,  2005,  2006,  2007,  2008,  2009,  2010,  2011,  2012,  2013,  2014

      0,  .000,  .000,  .000,  .000,  .000,  .000,  .000,  .000,  .000,  .000
      1,  .000,  .000,  .000,  .002,  .000,  .000,  .000,  .000,  .000,  .000
      2,  .011,  .036,  .028,  .029,  .013,  .089,  .012,  .003,  .036,  .029
      3,  .085,  .074,  .198,  .096,  .194,  .301,  .258,  .087,  .249,  .233
      4,  .178,  .183,  .123,  .287,  .277,  .415,  .374,  .272,  .139,  .550
      5,  .352,  .280,  .302,  .132,  .282,  .316,  .345,  .310,  .178,  .200
      6,  .559,  .535,  .402,  .263,  .235,  .425,  .361,  .342,  .316,  .114
      7,  .671,  .672,  .579,  .373,  .333,  .428,  .469,  .432,  .416,  .330
      8,  .622,  .347,  .509,  .571,  .274,  .366,  .539,  .282,  .638,  .288
      9,  .766,  .600,  .403,  .264,  .241,  .263,  .322,  .550,  .357,  .206
```

Table 5.8 Faroe haddock 2015 xsa (cont.)

XSA population numbers (Thousands)

YEAR	AGE 0	1	2	3	4	5	6	7	8	9
2005	4.62E+03	9.36E+03	8.48E+03	2.26E+04	2.61E+04	2.51E+04	1.58E+04	1.23E+03	3.51E+02	5.78E+01
2006	3.86E+03	3.78E+03	7.67E+03	6.87E+03	1.70E+04	1.79E+04	1.45E+04	7.40E+03	5.13E+02	1.54E+02
2007	3.50E+03	3.16E+03	3.10E+03	6.05E+03	5.22E+03	1.16E+04	1.10E+04	6.94E+03	3.10E+03	2.97E+02
2008	7.49E+03	2.87E+03	2.59E+03	2.47E+03	4.07E+03	3.78E+03	7.02E+03	6.05E+03	3.18E+03	1.52E+03
2009	2.34E+04	6.14E+03	2.34E+03	2.06E+03	1.83E+03	2.50E+03	2.71E+03	4.42E+03	3.41E+03	1.47E+03
2010	4.68E+03	1.92E+04	5.02E+03	1.89E+03	1.39E+03	1.14E+03	1.54E+03	1.75E+03	2.59E+03	2.12E+03
2011	3.87E+03	3.83E+03	1.57E+04	3.76E+03	1.15E+03	7.50E+02	6.79E+02	8.26E+02	9.36E+02	1.47E+03
2012	1.32E+04	3.17E+03	3.14E+03	1.27E+04	2.38E+03	6.46E+02	4.35E+02	3.88E+02	4.23E+02	4.47E+02
2013	1.28E+04	1.08E+04	2.60E+03	2.56E+03	9.52E+03	1.48E+03	3.88E+02	2.53E+02	2.06E+02	2.61E+02
2014	7.58E+03	1.05E+04	8.87E+03	2.05E+03	1.64E+03	6.78E+03	1.02E+03	2.32E+02	1.37E+02	8.91E+01

Estimated population abundance at 1st Jan 2015

, 0.00E+00, 6.20E+03, 8.56E+03, 7.05E+03, 1.33E+03, 7.73E+02, 4.55E+03, 7.43E+02, 1.36E+02, 8.39E+01,

Taper weighted geometric mean of the VPA populations:

, 2.31E+04, 1.96E+04, 1.64E+04, 1.29E+04, 8.88E+03, 5.45E+03, 3.20E+03, 1.79E+03, 8.97E+02, 4.33E+02,

Standard error of the weighted Log(VPA populations) :

, 1.1032, 1.0995, 1.0995, 1.0746, 1.0521, 1.0264, 1.0194, 1.0309, 1.1351, 1.3687,

Log catchability residuals.

Fleet : SUMMER SURVEY

Age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
0	No data for this fleet at this age									
1	99.99	1.21	.26	-.15	-.22	.11	.15	.41	.18	-.28
2	99.99	.17	.67	.07	-.14	.27	.31	.21	.20	.53
3	99.99	.35	.19	-.39	1.53	.22	.40	.36	-.14	-.23
4	99.99	-.43	.43	.04	-.51	-.69	.27	.12	.34	-.17
5	99.99	-.11	.03	.11	.15	-.10	-.92	.18	.59	.31
6	99.99	.21	.43	-.28	.07	.09	-.33	-.51	-.14	-.09
7	99.99	-.02	-.35	.97	.29	.05	.00	-.35	-.28	-.44
8	99.99	-.07	.16	.63	.44	.29	-.08	-.27	.42	-.73

Age	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
0	No data for this fleet at this age									
1	.29	-.23	.06	.34	.39	.10	-1.93	-.44	-.35	.10
2	.25	.58	1.18	.08	-.17	.11	-.06	-1.71	-2.13	-.43
3	.04	-.64	-.61	-.15	-.94	.37	-.10	-.21	.09	-.14
4	.17	-.01	-.65	.22	.37	.53	-.29	-.11	-.04	.41
5	.09	.12	-.19	-.62	.14	.15	.11	-.31	.39	-.10
6	.73	.27	.14	.01	-.26	.28	-.30	-.29	.20	-.23
7	.22	.30	.00	.25	.18	.10	-.35	-.04	.01	-.19
8	-1.21	-.53	-.74	.18	-.20	.18	-.17	-.66	.79	.26

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	-5.0205	-5.5052	-5.7113	-5.6741	-5.7982	-5.8181	-5.8181	-5.8181
S.E(Log q)	.5965	.7636	.5269	.3751	.3441	.3130	.3288	.5290

Table 5.8 Faroe haddock 2015 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,     .88,    1.049,      5.52,     .83,     19,     .53,   -5.02,
  2,     .82,    1.507,      6.19,     .80,     19,     .60,   -5.51,
  3,     .95,     .527,      5.88,     .87,     19,     .51,   -5.71,
  4,     .94,     .940,      5.86,     .93,     19,     .35,   -5.67,
  5,     .93,    1.398,      5.99,     .95,     19,     .31,   -5.80,
  6,     .93,    1.519,      5.95,     .96,     19,     .28,   -5.82,
  7,     .99,     .220,      5.82,     .95,     19,     .33,   -5.80,
  8,    1.10,   -1.087,      5.83,     .87,     19,     .57,   -5.89,


 Fleet : SPRING SURVEY SHIFTE

  Age  ,  1993,  1994
     0 ,  -.59,   .96
     1 ,  -.45,  -.86
     2 ,  -.63,  -.73
     3 ,  -.21,  -.23
     4 ,  -.50,  -.38
     5 ,  -.38, -1.17
     6 ,   .15,  -.63
     7 , No data for this fleet at this age
     8 , No data for this fleet at this age


  Age  ,  1995,  1996,  1997,  1998,  1999,  2000,  2001,  2002,  2003,  2004
     0 ,   .89, -1.11,  -.29,  -.37,  -.18,   .33,   .51,   .11,  -.34,   .92
     1 ,   .43,   .64,  -.15,  -.09,  -.20,  -.30,  -.48,   .11,   .18,   .39
     2 ,  -.15,   .38,   .46, -2.04,   .29,  -.33,   .10,  -.05,   .04,   .16
     3 ,  -.44,   .44,   .28,   .08,  -.69,  -.69,  -.41,  -.15,  -.30,  -.17
     4 ,  -.32,   .25,   .35,   .08,  -.52, -2.11,  -.29,  -.57,   .44,  -.25
     5 ,  -.34,   .94,   .53,  -.28,  -.11, -1.24, -1.02,  -.53,  -.05,   .53
     6 ,  -.54,  -.34,  -.92,  -.47,  -.06,  -.81,  -.69, -1.18,  -.61,   .17
     7 , No data for this fleet at this age
     8 , No data for this fleet at this age


  Age  ,  2005,  2006,  2007,  2008,  2009,  2010,  2011,  2012,  2013,  2014
     0 ,  -.28,   .42,  -.06,  1.00,   .38, -2.24,  -.62,   .24,   .31,   .00
     1 ,   .54,   .23,   .57,   .62,   .66,  -.17, -1.41,  -.01,  -.04,  -.22
     2 ,  -.24,   .87,   .13,   .63,   .15,   .53,   .29,  -.90,   .38,   .66
     3 ,  -.07,  -.37,   .39,  -.24,   .07,   .33,   .30,   .41,   .70,   .95
     4 ,  -.24,   .27,  -.38,   .45,  -.30,   .40,   .41,   .58,   .35,  2.28
     5 ,   .21,   .61,   .26,  -.28,  -.01,   .54,   .58,   .53,   .38,   .30
     6 ,   .26,   .93,   .39,   .25,  -.07,   .59,  1.53,   .92,   .87,   .26
     7 , No data for this fleet at this age
     8 , No data for this fleet at this age


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


   Age ,        0,         1,         2,         3,         4,         5,         6
 Mean Log q,  -6.0068,  -5.3462,  -5.8437,  -5.8842,  -6.0745,  -6.3176,  -6.4305,
 S.E(Log q),    .7512,    .5191,    .6440,    .4340,    .7748,    .6068,    .7016,
```

Table 5.8 Faroe haddock 2015 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,     .88,    1.025,      6.46,     .78,     22,     .66,   -6.01,
  1,    1.13,   -1.209,      4.81,     .82,     22,     .58,   -5.35,
  2,     .93,     .707,      6.10,     .82,     22,     .60,   -5.84,
  3,    1.04,    -.493,      5.77,     .89,     22,     .46,   -5.88,
  4,     .96,     .286,      6.17,     .76,     22,     .76,   -6.07,
  5,     .99,     .144,      6.34,     .83,     22,     .61,   -6.32,
  6,     .97,     .296,      6.47,     .79,     22,     .69,   -6.43,

 Terminal year survivor and F summaries :

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

 Year class = 2014

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SUMMER SURVEY       ,         1.,   .000,      .000,    .00,   0,  .000,     .000
 SPRING SURVEY SHIFTE,      6202.,   .768,      .000,    .00,   1, 1.000,     .000

   F shrinkage mean  ,         0.,    .50,,,,                        .000,     .000

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      6202.,       .77,      .00,    1,    .000,   .000


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

 Year class = 2013

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SUMMER SURVEY       ,      9419.,   .612,      .000,    .00,   1,  .337,     .000
 SPRING SURVEY SHIFTE,      8150.,   .437,      .251,    .58,   2,  .663,     .000

   F shrinkage mean  ,         0.,    .50,,,,                        .000,     .000

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      8558.,       .36,      .15,    3,    .429,   .000
```

Table 5.8 Faroe haddock 2015 xsa (cont.)

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

 Year class = 2012

 Fleet,                Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SUMMER SURVEY       ,      4837.,   .482,      .040,    .08,   2,  .269,     .042
 SPRING SURVEY SHIFTE,      8968.,   .364,      .213,    .58,   3,  .473,     .023

   F shrinkage mean  ,      6736.,    .50,,,,                       .258,     .031

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      7054.,       .25,      .15,    6,    .589,   .029


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

 Year class = 2011

 Fleet,                Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SUMMER SURVEY       ,       690.,   .360,      .540,   1.50,   3,  .303,     .409
 SPRING SURVEY SHIFTE,      1934.,   .281,      .322,   1.14,   4,  .495,     .166

   F shrinkage mean  ,      1425.,    .50,,,,                       .202,     .219

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      1330.,       .20,      .28,    8,   1.353,   .233


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

 Year class = 2010

 Fleet,                Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SUMMER SURVEY       ,       603.,   .265,      .556,   2.10,   4,  .410,     .662
 SPRING SURVEY SHIFTE,       646.,   .266,      .715,   2.69,   5,  .367,     .630

   F shrinkage mean  ,      1637.,    .50,,,,                       .223,     .297

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
       773.,       .18,      .39,   10,   2.101,   .550
```

Table 5.8 Faroe haddock 2015 xsa (cont.)

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

 Year class = 2009

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SUMMER SURVEY       ,      4226.,   .212,       .040,    .19,   5,  .515,     .214
 SPRING SURVEY SHIFTE,      5831.,   .245,       .097,    .39,   6,  .360,     .159

   F shrinkage mean  ,      3018.,    .50,,,,                         .126,     .288

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      4548.,       .15,      .08,   12,    .518,   .200


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

 Year class = 2008

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SUMMER SURVEY       ,       754.,   .183,       .120,    .66,   6,  .611,     .112
 SPRING SURVEY SHIFTE,      1174.,   .243,       .083,    .34,   7,  .277,     .074

   F shrinkage mean  ,       223.,    .50,,,,                         .112,     .338

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
       743.,       .14,      .15,   14,   1.071,   .114


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

 Year class = 2007

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SUMMER SURVEY       ,       127.,   .170,       .095,    .56,   7,  .667,     .351
 SPRING SURVEY SHIFTE,       222.,   .251,       .108,    .43,   7,  .183,     .216

   F shrinkage mean  ,       103.,    .50,,,,                         .150,     .419

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
       136.,       .14,      .09,   15,    .618,   .330
```

Table 5.8 Faroe haddock 2015 xsa (cont.)

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

 Year class = 2006

 Fleet,                Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SUMMER SURVEY       ,        85.,   .171,       .110,    .64,   8,  .665,     .287
 SPRING SURVEY SHIFTE,       141.,   .250,       .115,    .46,   7,  .151,     .181

   F shrinkage mean  ,        53.,    .50,,,,                        .184,     .423

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
        84.,       .15,      .10,   16,    .679,   .288


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

 Year class = 2005

 Fleet,                Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SUMMER SURVEY       ,        67.,   .168,       .150,    .89,   8,  .578,     .185
 SPRING SURVEY SHIFTE,        81.,   .240,       .260,   1.08,   7,  .147,     .154

   F shrinkage mean  ,        39.,    .50,,,,                        .275,     .298

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
        59.,       .17,      .13,   16,    .746,   .206
```

Table 5.9 Faroe haddock. Fishing mortality (F) at age.

Run title : FAROE HADDOCK (ICES DIVISION Vb) HAD_IND

At 3/05/2015 14:07

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

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

Table 8 Fishing mortality (F) at age

YEAR,	1965,	1966,	1967,	1968,	1969,	1970,	1971,	1972,	1973,	1974,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0017,	.0032,	.0012,	.0014,	.0024,	.0033,	.0015,	.0016,	.0114,	.0033,
2,	.0691,	.0610,	.0641,	.1261,	.0860,	.0551,	.0526,	.0253,	.1677,	.1266,
3,	.2354,	.2370,	.1873,	.2647,	.2363,	.2528,	.1936,	.4226,	.4320,	.2172,
4,	.4767,	.4515,	.2971,	.3483,	.5320,	.3344,	.4186,	.2853,	.2392,	.3730,
5,	.3678,	.5006,	.2997,	.2847,	.3330,	.3639,	.2754,	.4517,	.3143,	.1279,
6,	.5882,	.5421,	.5406,	.4540,	.4975,	.5561,	.5560,	.1495,	.2703,	.1714,
7,	.9618,	.9128,	.6906,	.8367,	.8277,	.8740,	.8385,	.6721,	.1951,	.2134,
8,	2.3618,	.7509,	.6634,	.5851,	1.0631,	.5430,	.4224,	.4066,	.2907,	.1433,
9,	.9619,	.6373,	.5022,	.5057,	.6566,	.5386,	.5061,	.3957,	.2633,	.2068,
+gp,	.9619,	.6373,	.5022,	.5057,	.6566,	.5386,	.5061,	.3957,	.2633,	.2068,
FBAR 3- 7,	.5260,	.5288,	.4031,	.4377,	.4853,	.4762,	.4564,	.3962,	.2902,	.2206,

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,	1983,	1984,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0015,	.0014,	.0000,	.0000,	.0002,	.0000,	.0000,	.0000,	.0000,	.0006,
2,	.1230,	.0908,	.0108,	.0010,	.0004,	.0325,	.0237,	.0383,	.0252,	.0329,
3,	.2650,	.1878,	.1128,	.0547,	.0458,	.0285,	.1374,	.4618,	.1917,	.1167,
4,	.2412,	.3810,	.1815,	.1665,	.1255,	.2025,	.1314,	.3709,	.3481,	.3896,
5,	.2116,	.2216,	.5273,	.2115,	.1913,	.2750,	.2112,	.2918,	.3498,	.2171,
6,	.0957,	.2871,	.7246,	.3820,	.1409,	.2136,	.2264,	.2775,	.1383,	.3336,
7,	.0859,	.1601,	.3904,	.5760,	.2721,	.1702,	.2004,	.2524,	.2991,	.0853,
8,	.1599,	.2539,	.3788,	.4969,	.3303,	.3954,	.0920,	.2266,	.3102,	.2929,
9,	.1595,	.2621,	.4437,	.3690,	.2130,	.2526,	.1730,	.2854,	.2907,	.2651,
+gp,	.1595,	.2621,	.4437,	.3690,	.2130,	.2526,	.1730,	.2854,	.2907,	.2651,
FBAR 3- 7,	.1799,	.2476,	.3873,	.2782,	.1551,	.1780,	.1814,	.3309,	.2654,	.2285,

Table 5.9 Faroe haddock. Fishing mortality (F) at age (cont.).

Run title : FAROE HADDOCK (ICES DIVISION Vb) HAD_IND

At 3/05/2015 14:07

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

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

Table 8 Fishing mortality (F) at age

YEAR,	1965,	1966,	1967,	1968,	1969,	1970,	1971,	1972,	1973,	1974,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0017,	.0032,	.0012,	.0014,	.0024,	.0033,	.0015,	.0016,	.0114,	.0033,
2,	.0691,	.0610,	.0641,	.1261,	.0860,	.0551,	.0526,	.0253,	.1677,	.1266,
3,	.2354,	.2370,	.1873,	.2647,	.2363,	.2528,	.1936,	.4226,	.4320,	.2172,
4,	.4767,	.4515,	.2971,	.3483,	.5320,	.3344,	.4186,	.2853,	.2392,	.3730,
5,	.3678,	.5006,	.2997,	.2847,	.3330,	.3639,	.2754,	.4517,	.3143,	.1279,
6,	.5882,	.5421,	.5406,	.4540,	.4975,	.5561,	.5560,	.1495,	.2703,	.1714,
7,	.9618,	.9128,	.6906,	.8367,	.8277,	.8740,	.8385,	.6721,	.1951,	.2134,
8,	2.3618,	.7509,	.6634,	.5851,	1.0631,	.5430,	.4224,	.4066,	.2907,	.1433,
9,	.9619,	.6373,	.5022,	.5057,	.6566,	.5386,	.5061,	.3957,	.2633,	.2068,
+gp,	.9619,	.6373,	.5022,	.5057,	.6566,	.5386,	.5061,	.3957,	.2633,	.2068,
FBAR 3- 7,	.5260,	.5288,	.4031,	.4377,	.4853,	.4762,	.4564,	.3962,	.2902,	.2206,

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,	1983,	1984,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0015,	.0014,	.0000,	.0000,	.0002,	.0000,	.0000,	.0000,	.0000,	.0006,
2,	.1230,	.0908,	.0108,	.0010,	.0004,	.0325,	.0237,	.0383,	.0252,	.0329,
3,	.2650,	.1878,	.1128,	.0547,	.0458,	.0285,	.1374,	.4618,	.1917,	.1167,
4,	.2412,	.3810,	.1815,	.1665,	.1255,	.2025,	.1314,	.3709,	.3481,	.3896,
5,	.2116,	.2216,	.5273,	.2115,	.1913,	.2750,	.2112,	.2918,	.3498,	.2171,
6,	.0957,	.2871,	.7246,	.3820,	.1409,	.2136,	.2264,	.2775,	.1383,	.3336,
7,	.0859,	.1601,	.3904,	.5760,	.2721,	.1702,	.2004,	.2524,	.2991,	.0853,
8,	.1599,	.2539,	.3788,	.4969,	.3303,	.3954,	.0920,	.2266,	.3102,	.2929,
9,	.1595,	.2621,	.4437,	.3690,	.2130,	.2526,	.1730,	.2854,	.2907,	.2651,
+gp,	.1595,	.2621,	.4437,	.3690,	.2130,	.2526,	.1730,	.2854,	.2907,	.2651,
FBAR 3- 7,	.1799,	.2476,	.3873,	.2782,	.1551,	.1780,	.1814,	.3309,	.2654,	.2285,

Table 5.10 Faroe haddock. Stock number (N) at age.

Run title : FAROE HADDOCK (ICES DIVISION Vb) HAD_IND

At 3/05/2015 14:07

Terminal Fs derived using XSA (With F shrinkage)

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

YEAR,	1957,	1958,	1959,	1960,	1961,	1962,	1963,	1964,
AGE								
0,	64927,	54061,	77651,	58761,	71715,	45399,	33843,	30192,
1,	47944,	53158,	44261,	63576,	48109,	58715,	37170,	27709,
2,	35106,	39212,	43417,	35763,	51279,	38537,	47362,	30110,
3,	25440,	25003,	26445,	31954,	23796,	34806,	22837,	26515,
4,	20280,	14377,	13213,	14717,	16517,	12850,	15850,	10638,
5,	5517,	8965,	6632,	6706,	6028,	8877,	5786,	6278,
6,	2786,	3055,	4284,	3570,	3245,	3182,	5132,	2708,
7,	1377,	1472,	1326,	1839,	1512,	1476,	1332,	2809,
8,	585,	598,	466,	433,	448,	480,	423,	313,
9,	252,	274,	224,	168,	135,	153,	148,	114,
+gp,	154,	227,	106,	54,	29,	46,	45,	16,
TOTAL,	204367,	200401,	218024,	217540,	222811,	204522,	169929,	137402,

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

YEAR,	1965,	1966,	1967,	1968,	1969,	1970,	1971,	1972,	1973,	1974,
AGE										
0,	37948,	81923,	47768,	53237,	23136,	49622,	35418,	78970,	104848,	83625,
1,	24719,	31069,	67073,	39109,	43587,	18942,	40627,	28998,	64655,	85842,
2,	22644,	20203,	25356,	54851,	31975,	35600,	15457,	33213,	23702,	52333,
3,	22585,	17302,	15563,	19470,	39587,	24022,	27583,	12006,	26514,	16410,
4,	14961,	14613,	11176,	10566,	12234,	25590,	15275,	18608,	6442,	14092,
5,	5182,	7604,	7617,	6798,	6106,	5884,	14996,	8229,	11454,	4152,
6,	3005,	2937,	3774,	4622,	4187,	3583,	3348,	9322,	4288,	6849,
7,	1204,	1366,	1398,	1800,	2403,	2084,	1682,	1572,	6573,	2680,
8,	1641,	377,	449,	574,	638,	860,	712,	595,	657,	4427,
9,	77,	127,	146,	189,	262,	180,	409,	382,	325,	402,
+gp,	14,	21,	36,	33,	45,	26,	281,	319,	52,	865,
TOTAL,	133981,	177542,	180355,	191249,	164160,	166393,	155787,	192213,	249510,	271679,

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

YEAR,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,	1983,	1984,
AGE										
0,	39127,	52360,	4153,	7376,	5208,	23621,	29256,	60793,	58813,	39477,
1,	68467,	32035,	42869,	3400,	6039,	4264,	19339,	23953,	49773,	48152,
2,	70053,	55971,	26192,	35098,	2784,	4944,	3491,	15834,	19611,	40751,
3,	37750,	50715,	41847,	21213,	28707,	2278,	3918,	2791,	12476,	15657,
4,	10812,	23712,	34412,	30607,	16443,	22452,	1813,	2796,	1440,	8433,
5,	7946,	6955,	13262,	23498,	21215,	11875,	15012,	1301,	1580,	832,
6,	2992,	5265,	4562,	6408,	15570,	14345,	7385,	9951,	796,	912,
7,	4724,	2226,	3235,	1810,	3581,	11073,	9486,	4821,	6173,	567,
8,	1772,	3549,	1553,	1792,	833,	2233,	7647,	6356,	3067,	3747,
9,	3141,	1237,	2254,	870,	893,	490,	1231,	5711,	4149,	1841,
+gp,	1396,	1515,	2613,	1109,	424,	423,	249,	946,	3460,	4566,
TOTAL,	248179,	235539,	176952,	133182,	101697,	97997,	98827,	135253,	161337,	164936,

Table 5.10 Faroe haddock. Stock number (N) at age (cont.).

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

YEAR,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,
AGE										
0,	39519,	14086,	28007,	21061,	14028,	4460,	3992,	2724,	9655,	143943,
1,	48196,	32355,	11532,	22930,	17244,	11485,	3651,	3269,	2230,	7905,
2,	40768,	39437,	26490,	9442,	18773,	14118,	9403,	2990,	2676,	1826,
3,	15664,	32297,	31397,	21480,	7474,	14778,	11502,	7604,	2378,	2155,
4,	8435,	11412,	22323,	23399,	16032,	5718,	10725,	8263,	5281,	1808,
5,	833,	4678,	7356,	14248,	15932,	10897,	4086,	7043,	5160,	3621,
6,	912,	549,	2706,	4646,	8976,	10297,	6400,	2650,	4637,	3211,
7,	568,	535,	296,	1548,	2796,	5413,	6119,	3668,	1581,	2929,
8,	3749,	427,	356,	207,	789,	1859,	2644,	3283,	2007,	991,
9,	1842,	2290,	294,	174,	95,	509,	1033,	1364,	2056,	1306,
+gp,	4567,	4402,	2930,	1198,	669,	308,	410,	137,	826,	1196,
TOTAL,	165051,	142467,	133688,	120333,	102807,	79841,	59966,	42994,	38487,	170891,

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

YEAR,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,
AGE										
0,	68039,	13476,	5572,	23106,	31815,	153465,	90575,	63864,	42934,	13000,
1,	117851,	55706,	11034,	4562,	18918,	26048,	125647,	74157,	52287,	35151,
2,	6433,	96487,	45608,	9033,	3735,	15488,	21318,	102805,	60697,	42809,
3,	1393,	5016,	78269,	37046,	7326,	2962,	12523,	16132,	80206,	48324,
4,	1495,	967,	3698,	59346,	27695,	5043,	1392,	7484,	10377,	52964,
5,	1232,	946,	579,	2106,	39072,	17907,	3277,	949,	3935,	5891,
6,	2464,	870,	570,	312,	1082,	23071,	10429,	2066,	621,	2136,
7,	2142,	1634,	593,	319,	151,	482,	12900,	6109,	1283,	388,
8,	1969,	1368,	1071,	340,	150,	34,	190,	7986,	3960,	834,
9,	693,	1266,	857,	633,	194,	44,	4,	84,	5295,	2480,
+gp,	1660,	1416,	1433,	1470,	1011,	417,	296,	89,	159,	2645,
TOTAL,	205370,	179153,	149284,	138271,	131147,	244962,	278551,	281724,	261753,	206621,

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

YEAR,	2004,	2005,	2006,	2007,	2008,	2009,	2010,	2011,	2012,	2013,	2014,
AGE											
0,	11864,	5112,	4106,	3825,	9030,	23592,	2766,	2972,	11910,	17520,	0,
1,	10644,	9713,	4185,	3361,	3131,	7393,	19315,	2264,	2433,	9751,	14345,
2,	28779,	8711,	7953,	3427,	2752,	2558,	6053,	15814,	1854,	1992,	7984,
3,	34929,	23343,	7055,	6288,	2737,	2194,	2070,	4604,	12793,	1511,	1552,
4,	36455,	26781,	17599,	5373,	4259,	2056,	1498,	1292,	3070,	9606,	751,
5,	31102,	25502,	18441,	12087,	3904,	2657,	1320,	841,	765,	2049,	6800,
6,	2811,	16030,	14769,	11525,	7424,	2813,	1673,	828,	510,	485,	1469,
7,	890,	1249,	7581,	7185,	6442,	4747,	1838,	932,	510,	314,	307,
8,	170,	358,	532,	3240,	3387,	3731,	2862,	1004,	509,	306,	183,
9,	381,	59,	160,	313,	1642,	1638,	2386,	1693,	503,	332,	166,
+gp,	1837,	318,	176,	31,	199,	274,	850,	857,	332,	550,	542,
TOTAL,	159861,	117178,	82558,	56655,	44908,	53652,	42629,	33102,	35189,	44416,	34098,

Table 5.11. Faroe haddock. Stock summary of the 2015 VPA.

Run title : FAROE HADDOCK (ICES DIVISION Vb) HAD_IND

At 15/04/2014 20:12

Table 16 Summary (without SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

	RECRUIT Age 0	RECRU Age 2	TOTALBIO	TOTSPBIO	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	45399	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	81923	20203	68774	44027	18766	0.4262	0.5288
1967	47768	25356	77101	42086	13381	0.3179	0.4031
1968	53237	54851	87971	45495	17852	0.3924	0.4377
1969	23136	31975	94878	53583	23272	0.4343	0.4853
1970	49622	35600	92142	59957	21361	0.3563	0.4762
1971	35418	15457	92929	63920	19393	0.3034	0.4564
1972	78970	33213	91506	63133	16485	0.2611	0.3962
1973	104848	23702	98976	61620	18035	0.2927	0.2902
1974	83625	52333	116873	64629	14773	0.2286	0.2206
1975	39127	70053	138899	75403	20715	0.2747	0.1799
1976	52360	55971	143617	89217	26211	0.2938	0.2476
1977	4153	26192	121036	96371	25555	0.2652	0.3873
1978	7376	35098	120569	97226	19200	0.1975	0.2782
1979	5208	2784	99493	85393	12424	0.1455	0.1551
1980	23621	4944	87630	81895	15016	0.1834	0.178
1981	29256	3491	78955	75838	12233	0.1613	0.1814
1982	60793	15834	68299	56798	11937	0.2102	0.3309
1983	58813	19611	63952	51804	12894	0.2489	0.2654
1984	39477	40751	100638	53809	12378	0.23	0.2285
1985	14062	39401	93930	62578	15143	0.242	0.2762
1986	27964	26463	98463	65566	14477	0.2208	0.2238
1987	20979	9426	87580	67252	14882	0.2213	0.2645
1988	13972	18745	77348	61848	12178	0.1969	0.2011
1989	4443	14063	69448	51674	14325	0.2772	0.2856
1990	3985	9366	53449	43625	11726	0.2688	0.2734
1991	2723	2978	38624	34542	8429	0.244	0.2756
1992	9631	2671	28982	26845	5476	0.204	0.2114
1993	142543	1825	28653	23081	4026	0.1744	0.1882
1994	67164	6417	27315	21455	4252	0.1982	0.2069
1995	13338	95548	87331	22596	4948	0.219	0.227
1996	5566	45021	112309	49415	9642	0.1951	0.3203
1997	23069	8940	106913	81745	17924	0.2193	0.3739
1998	31718	3731	91874	81550	22210	0.2723	0.5315
1999	152751	15464	79481	62452	18482	0.2959	0.4545
2000	89573	21253	108826	52293	15821	0.3025	0.2796
2001	62274	102326	145120	60300	15890	0.2635	0.2875
2002	41593	60025	151861	84291	24933	0.2958	0.3011
2003	12660	41743	138708	96072	27072	0.2818	0.454
2004	11437	27881	125339	86212	23101	0.268	0.4069
2005	4618	8484	89258	72930	20455	0.2805	0.3692
2006	3859	7667	65437	58263	17154	0.2944	0.3488
2007	3502	3095	47365	43113	12631	0.293	0.3206
2008	7495	2587	34188	30308	7388	0.2438	0.2304
2009	23404	2342	25128	23295	5197	0.2231	0.2644
2010	4680	5024	22001	17988	5202	0.2892	0.377
2011	3873	15688	21451	12722	3540	0.2783	0.3612
2012	13236	3137	18756	14946	2634	0.1762	0.2886
2013	12767	2596	19643	17931	2950	0.1645	0.2595
2014	7575	8872	20870	16479	3194	0.1938	0.2853
Arith. Mean							
0 Units	37753 (Thousands)	26269 (Thousands)	82047 (Tonnes)	54257 (Tonnes)	15543 (Tonnes)	0.2875	0.3549

Table 5.12. Management options table INPUT DATA descriptions

Stock size

The stock in numbers 2015 is taken directly from the 2015 XSA. The yearclass 2014 at age 2 (in 2016) is estimated from the 2015 XSA age 1 applying a natural mortality of 0.2 in foreward calculation of the number using the standard VPA equation. The yearclass 2015 at age 2 (in 2017) is estimated as the geomean of the numbers at age 2 since 2005.

Age	2015	2016	2017
2	8558	5078	5089
3	7054		
4	1330		
5	773		
6	4548		
7	743		
8	136		
9	84		
10+	245		

Numbers in thousands (predicted values rounded).

Proportion mature at age

The proportion mature at age in 2015 is estimated as the average of the observed data in 2014 and 2015. For 2016 and 2017, the average of 2013 to 2015 is used.

Age	2015	2016	2017
2	0.17	0.16	0.16
3	0.83	0.83	0.83
4	0.99	0.99	0.99
5	1.00	1.00	1.00
6	1.00	1.00	1.00
7	1.00	1.00	1.00
8	1.00	1.00	1.00
9	1.00	1.00	1.00
10+	1.00	1.00	1.00

Table 5.12. Management options table INPUT DATA descriptions (cont.).

Catch&Stock weights at age

Catch and stock weights at age for all ages and for each of the years 2015-2017 are simply the average of the estimated point-values for 2012-2014 not re-scaled to 2014 since weights have been fluctuating without any trend during the last 3 years (no model was available to predict future mean weights at age).

Age	2015	2016	2017
2	0.581	0.581	0.581
3	0.839	0.839	0.839
4	1.128	1.128	1.128
5	1.408	1.408	1.408
6	1.673	1.673	1.673
7	1.775	1.775	1.775
8	1.811	1.811	1.811
9	1.813	1.813	1.813
10+	1.938	1.938	1.938

Exploitation pattern

The exploitation pattern 2015 is estimated like last year as the average fishing mortality matrix in the 3 preceding years (2012-2014) from the final VPA in 2015, without re-scaling to the terminal year (2014) since fishing mortalities have been fluctuating without any general trend during the last 3 years; the same exploitation pattern was used for all 3 years.

Age	2015	2016	2017
2	0.0227	0.0227	0.0227
3	0.1895	0.1895	0.1895
4	0.3203	0.3203	0.3203
5	0.2294	0.2294	0.2294
6	0.2570	0.2570	0.2570
7	0.3928	0.3928	0.3928
8	0.4028	0.4028	0.4028
9	0.3709	0.3709	0.3709
10+	0.3709	0.3709	0.3709

Table 5.13 Faroe haddock. Management option table - Input data

MFDP version 1
Run: jak
Time and date: 18:12 24/04/2015
Fbar age range: 3-7

2015

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
2	8558	0.2	0.17	0	0	0.581	0.023	0.581
3	7054	0.2	0.83	0	0	0.839	0.189	0.839
4	1330	0.2	0.99	0	0	1.128	0.320	1.128
5	773	0.2	1	0	0	1.408	0.229	1.408
6	4548	0.2	1	0	0	1.673	0.257	1.673
7	743	0.2	1	0	0	1.775	0.393	1.775
8	136	0.2	1	0	0	1.811	0.403	1.811
9	84	0.2	1	0	0	1.813	0.371	1.813
10	245	0.2	1	0	0	1.938	0.371	1.938

2016

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
2	5078	0.2	0.17	0	0	0.581	0.023	0.581
3	.	0.2	0.83	0	0	0.839	0.189	0.839
4	.	0.2	0.99	0	0	1.128	0.320	1.128
5	.	0.2	1	0	0	1.408	0.229	1.408
6	.	0.2	1	0	0	1.673	0.257	1.673
7	.	0.2	1	0	0	1.775	0.393	1.775
8	.	0.2	1	0	0	1.811	0.403	1.811
9	.	0.2	1	0	0	1.813	0.371	1.813
10	.	0.2	1	0	0	1.938	0.371	1.938

2017

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
2	5089	0.2	0.17	0	0	0.581	0.023	0.581
3	.	0.2	0.83	0	0	0.839	0.189	0.839
4	.	0.2	0.99	0	0	1.128	0.320	1.128
5	.	0.2	1	0	0	1.408	0.229	1.408
6	.	0.2	1	0	0	1.673	0.257	1.673
7	.	0.2	1	0	0	1.775	0.393	1.775
8	.	0.2	1	0	0	1.811	0.403	1.811
9	.	0.2	1	0	0	1.813	0.371	1.813
10	.	0.2	1	0	0	1.938	0.371	1.938

Input units are thousands and kg - output in tonnes

Table 5.14 Faroe haddock. Management option table - Results

MFDP version 1
Run: jak
Index file 24/04/2015
Time and date: 18:12 24/04/2015
Fbar age range: 3-7

2015				
Biomass	SSB	FMult	FBar	Landings
23279	18133	1	0.2778	3820

2016					2017	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
22390	18912	0	0	0	25383	22274
.	18912	0.1	0.0278	522	24836	21729
.	18912	0.2	0.0556	1028	24306	21202
.	18912	0.3	0.0833	1518	23791	20690
.	18912	0.4	0.1111	1995	23293	20193
.	18912	0.5	0.1389	2457	22809	19712
.	18912	0.6	0.1667	2905	22340	19245
.	18912	0.7	0.1945	3340	21884	18792
.	18912	0.8	0.2222	3762	21443	18353
.	18912	0.9	0.25	4171	21014	17927
.	18912	1	0.2778	4569	20599	17514
.	18912	1.1	0.3056	4954	20195	17113
.	18912	1.2	0.3334	5329	19804	16723
.	18912	1.3	0.3611	5692	19424	16346
.	18912	1.4	0.3889	6045	19055	15979
.	18912	1.5	0.4167	6388	18697	15624
.	18912	1.6	0.4445	6721	18350	15278
.	18912	1.7	0.4723	7044	18013	14943
.	18912	1.8	0.5001	7358	17685	14618
.	18912	1.9	0.5278	7663	17367	14302
.	18912	2	0.5556	7960	17058	13996

Input units are thousands and kg - output in tonnes

Table 5.15 Faroe haddock. Long-term Prediction - Input data

MFYPR version 1
Run: rei
Index file 24/04/2015
Time and date: 19:23 24/04/2015
Fbar age range: 3-7

Age	M	Mat	PF	PM	SWt	Sel	CWt
2	0.2	0.060	0	0	0.563	0.023	0.563
3	0.2	0.516	0	0	0.803	0.189	0.803
4	0.2	0.923	0	0	1.067	0.320	1.067
5	0.2	0.992	0	0	1.370	0.229	1.370
6	0.2	0.999	0	0	1.653	0.257	1.653
7	0.2	1.000	0	0	1.908	0.393	1.908
8	0.2	1.000	0	0	2.123	0.403	2.123
9	0.2	1.000	0	0	2.342	0.371	2.342
10	0.2	1.000	0	0	2.637	0.371	2.637

Weights in kilograms

Table 5.16 **Faroe haddock. Long-term Prediction - Results**

MFYPR version 1
Run: rei
Time and date: 19:23 24/04/2015
Yield per results

FMult	Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNosJan	SSBJan	SpwnNosSpwn	SSBSpwn
0	0	0	0	5.5167	8.2855	4.1248	7.3771	4.1248	7.3771
0.1	0.0278	0.1081	0.1877	4.978	7.0177	3.5884	6.1115	3.5884	6.1115
0.2	0.0556	0.1883	0.3116	4.5792	6.1066	3.1918	5.2025	3.1918	5.2025
0.3	0.0833	0.2504	0.3967	4.2706	5.4225	2.8853	4.5206	2.8853	4.5206
0.4	0.1111	0.3002	0.4569	4.0236	4.8914	2.6405	3.9916	2.6405	3.9916
0.5	0.1389	0.3411	0.5003	3.8208	4.468	2.4397	3.5703	2.4397	3.5703
0.6	0.1667	0.3755	0.5323	3.6507	4.1231	2.2717	3.2273	2.2717	3.2273
0.7	0.1945	0.4049	0.5561	3.5056	3.8369	2.1286	2.9431	2.1286	2.9431
0.8	0.2222	0.4303	0.5741	3.3801	3.5959	2.005	2.7041	2.005	2.7041
0.9	0.25	0.4526	0.5878	3.2702	3.3903	1.8971	2.5004	1.8971	2.5004
1	0.2778	0.4724	0.5982	3.1731	3.2129	1.8019	2.3248	1.8019	2.3248
1.1	0.3056	0.49	0.6063	3.0864	3.0583	1.7172	2.172	1.7172	2.172
1.2	0.3334	0.5059	0.6125	3.0086	2.9224	1.6412	2.0379	1.6412	2.0379
1.3	0.3611	0.5203	0.6173	2.9382	2.802	1.5727	1.9194	1.5727	1.9194
1.4	0.3889	0.5334	0.6211	2.8742	2.6947	1.5105	1.8138	1.5105	1.8138
1.5	0.4167	0.5454	0.6239	2.8157	2.5984	1.4538	1.7193	1.4538	1.7193
1.6	0.4445	0.5564	0.626	2.762	2.5116	1.4018	1.6341	1.4018	1.6341
1.7	0.4723	0.5666	0.6276	2.7125	2.4329	1.354	1.5571	1.354	1.5571
1.8	0.5001	0.5761	0.6288	2.6667	2.3613	1.3099	1.487	1.3099	1.487
1.9	0.5278	0.5849	0.6296	2.6242	2.2958	1.2691	1.4232	1.2691	1.4232
2	0.5556	0.5931	0.6302	2.5846	2.2357	1.2312	1.3646	1.2312	1.3646

Reference point	F multiplier	Absolute F
Fbar(3-7)	1	0.2778
FMax	2.2382	0.6218
F0.1	0.6571	0.1826
F35%SPR	0.8581	0.2384
Fhigh	3.1887	0.8859
Fmed	0.8397	0.2333
Flow	-99	

Weights in kilograms

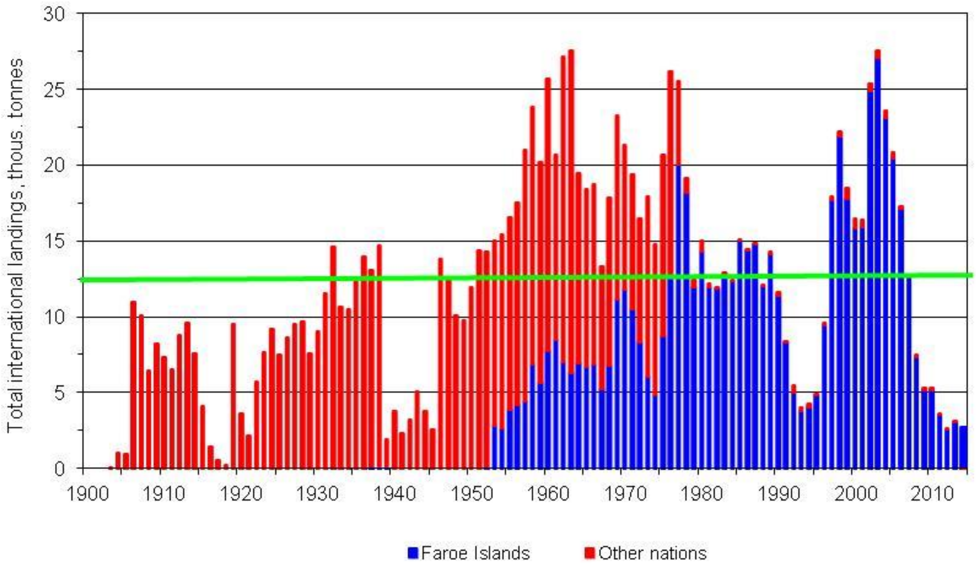


Figure 5.1. Haddock in ICES Division Vb. Landings by all nations 1904-2014. Horisontal line average for the whole period.

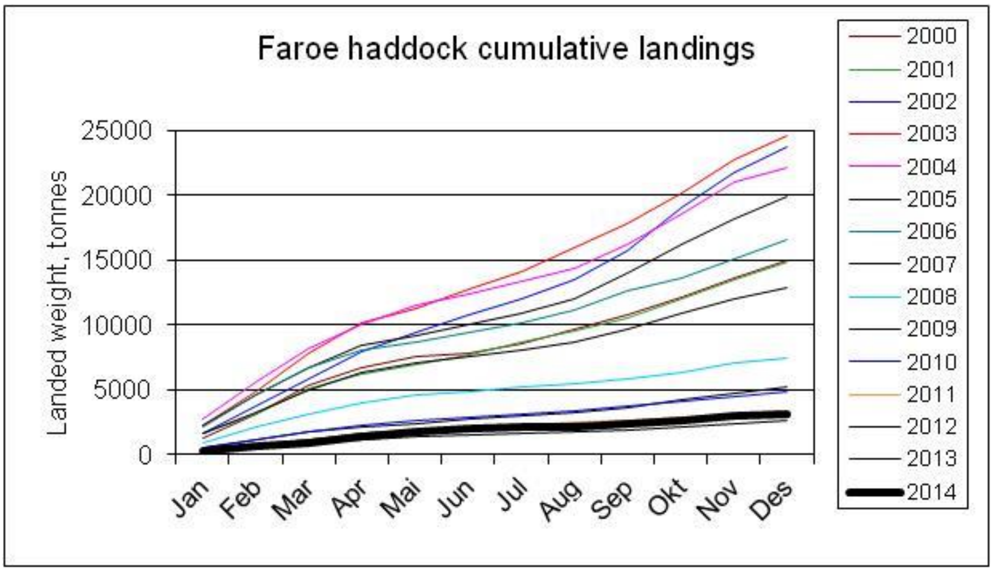


Figure 5.2. Faroe haddock. Cumulative Faroese landings from Vb.

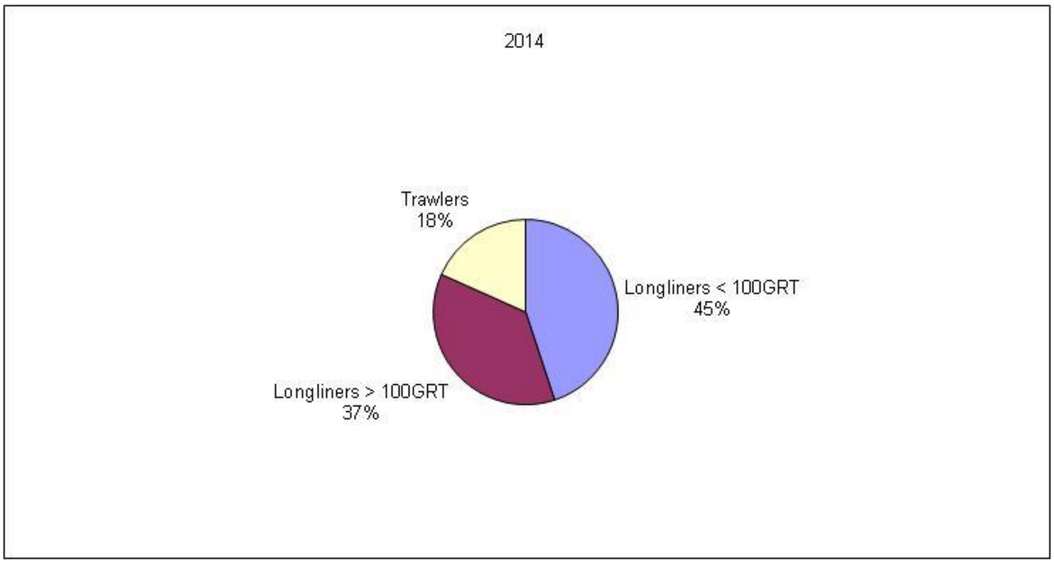


Figure 5.3. Faroe haddock. Contribution (%) by fleet to the total Faroese landings 2014.

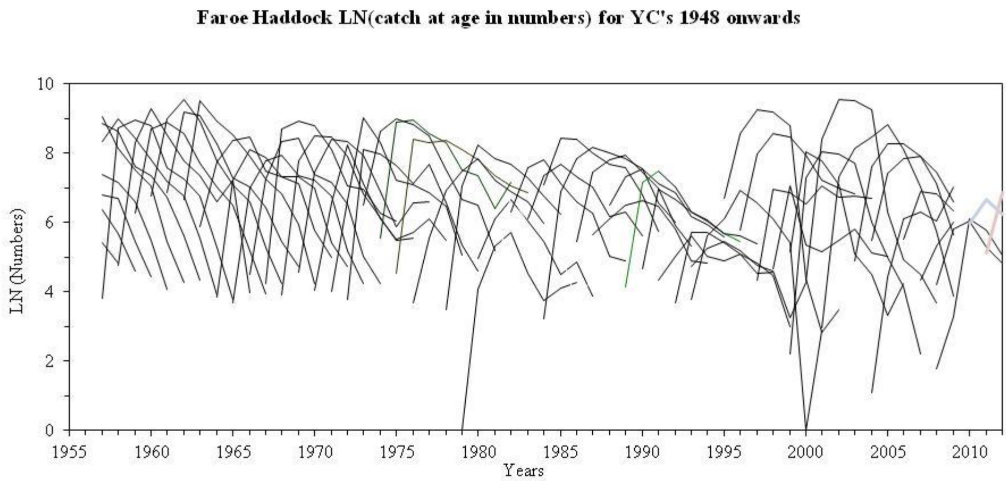


Figure 5.4.

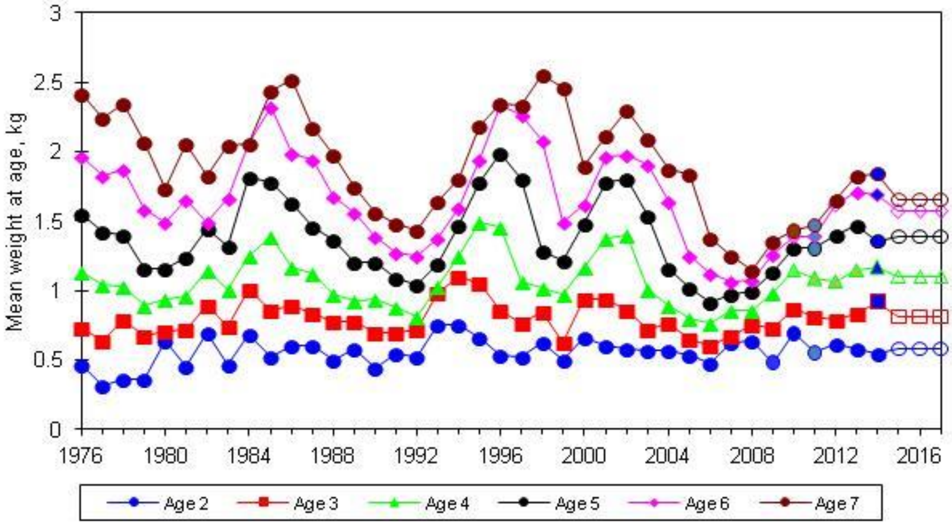


Figure 5.5. Faroe haddock. Mean weight at age (2-7). 2015-2017 are predicted values used in the short term prediction (open symbols).

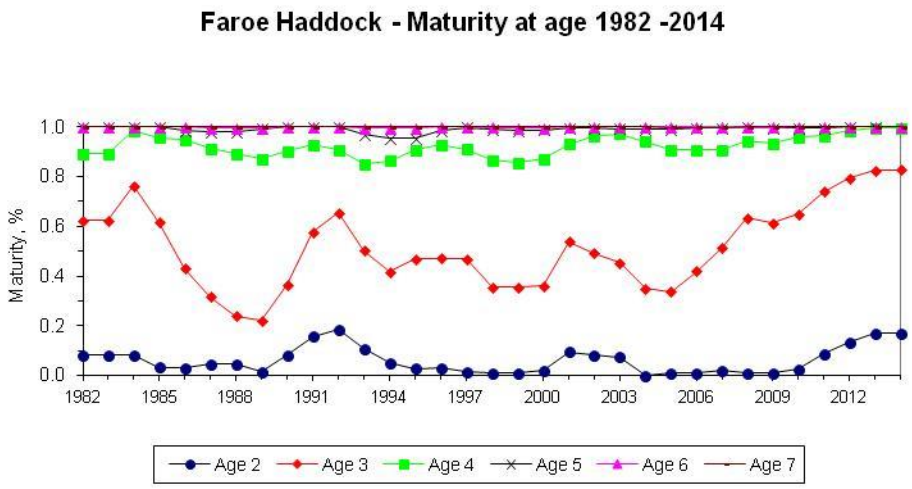


Figure 5.6. Faroe haddock. Maturity at age since 1982. Running 3-years average of survey observations.

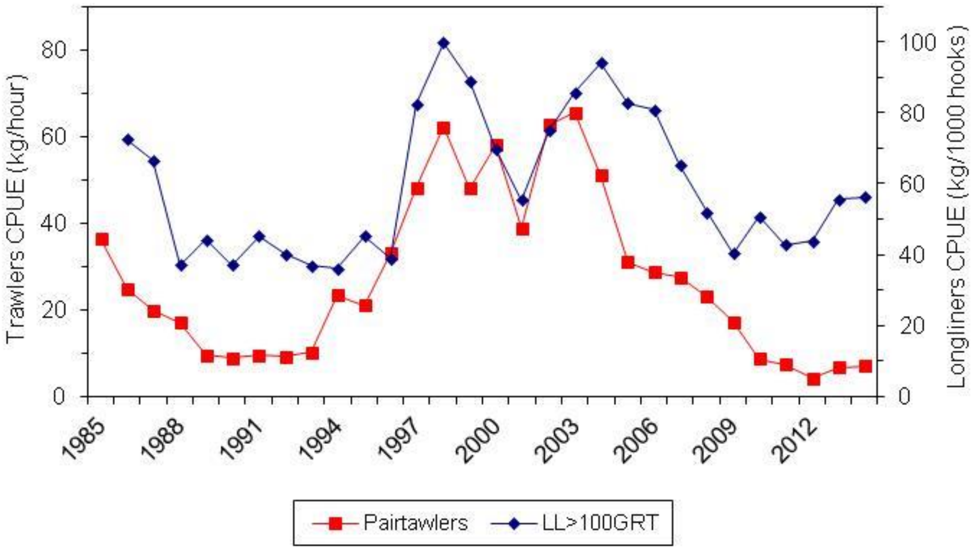


Figure 5.7. Commercial CPUE's for Pairtrawlers > 1000 HP and longliners > 100 HP.

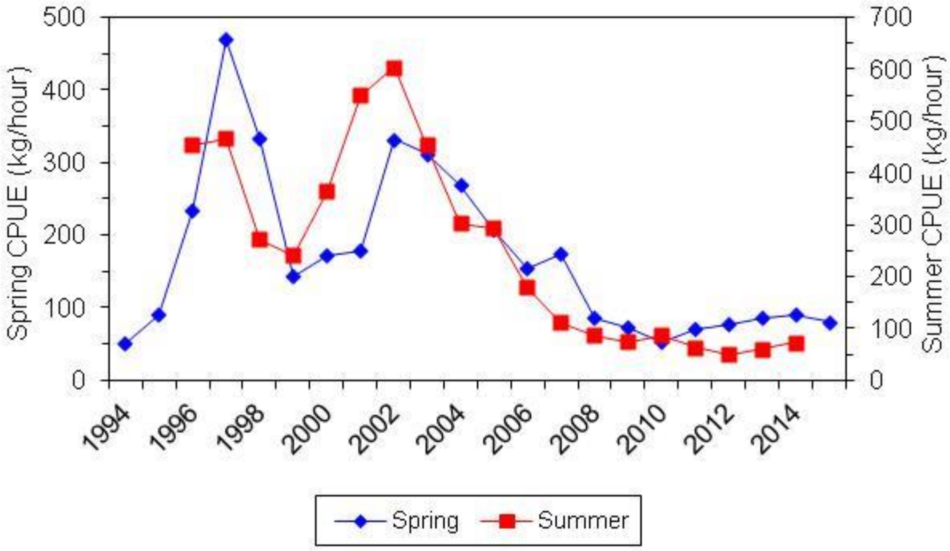
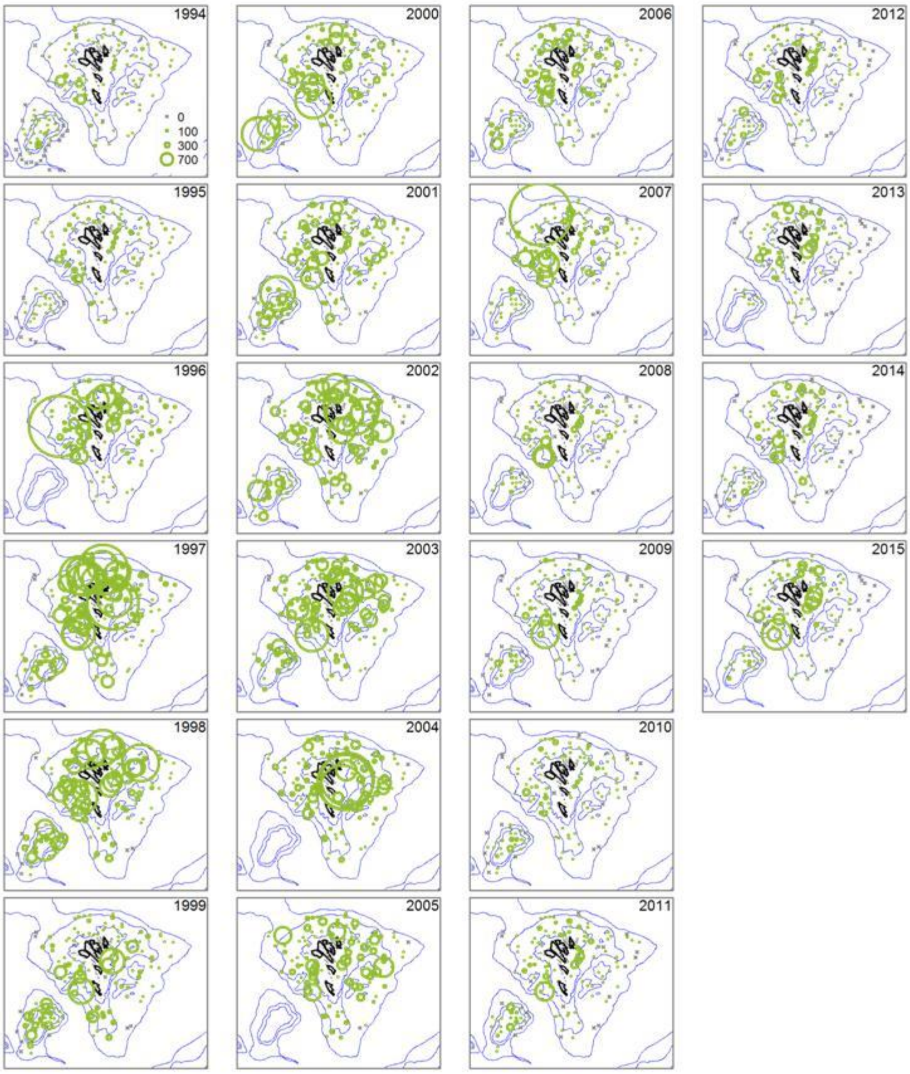


Figure 5.8. Faroe haddock. CPUE (kg/trawlhour) in the spring and summer surveys.


1994
0
100
300
700
2000
2006
2012
1995
2001
2007
2013
1996
2002
2008
2014
1997
2003
2009
2015
1998
2004
2010
1999
2005
2011

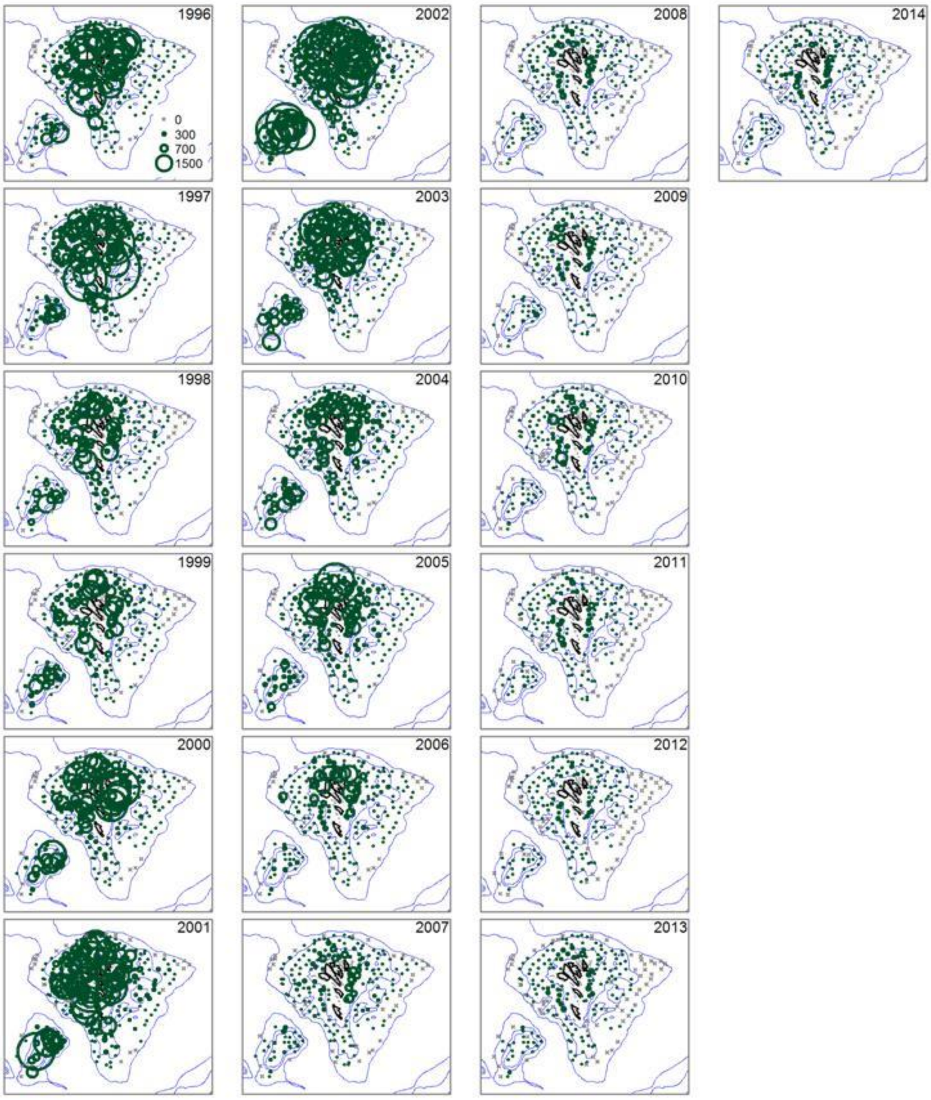


Figure 5.9. Distribution of Faroe haddock catches in the summer survey (upper page) and in the spring survey (this page).

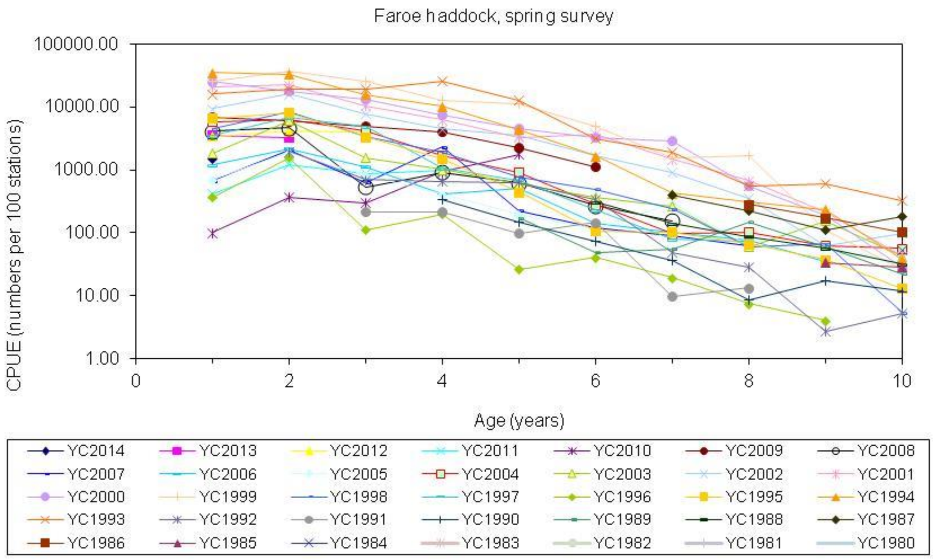


Figure 5.10. Faroe haddock. LN (catch-at-age in numbers) in the spring survey.

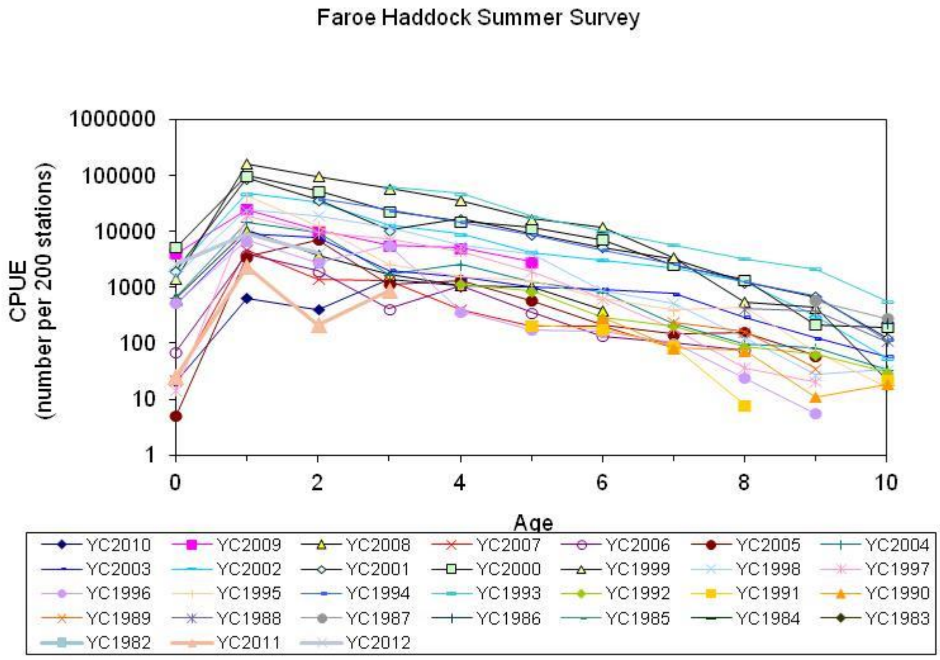


Figure 5.11. Faroe haddock. LN (catch-at-age in numbers) in the summer survey.

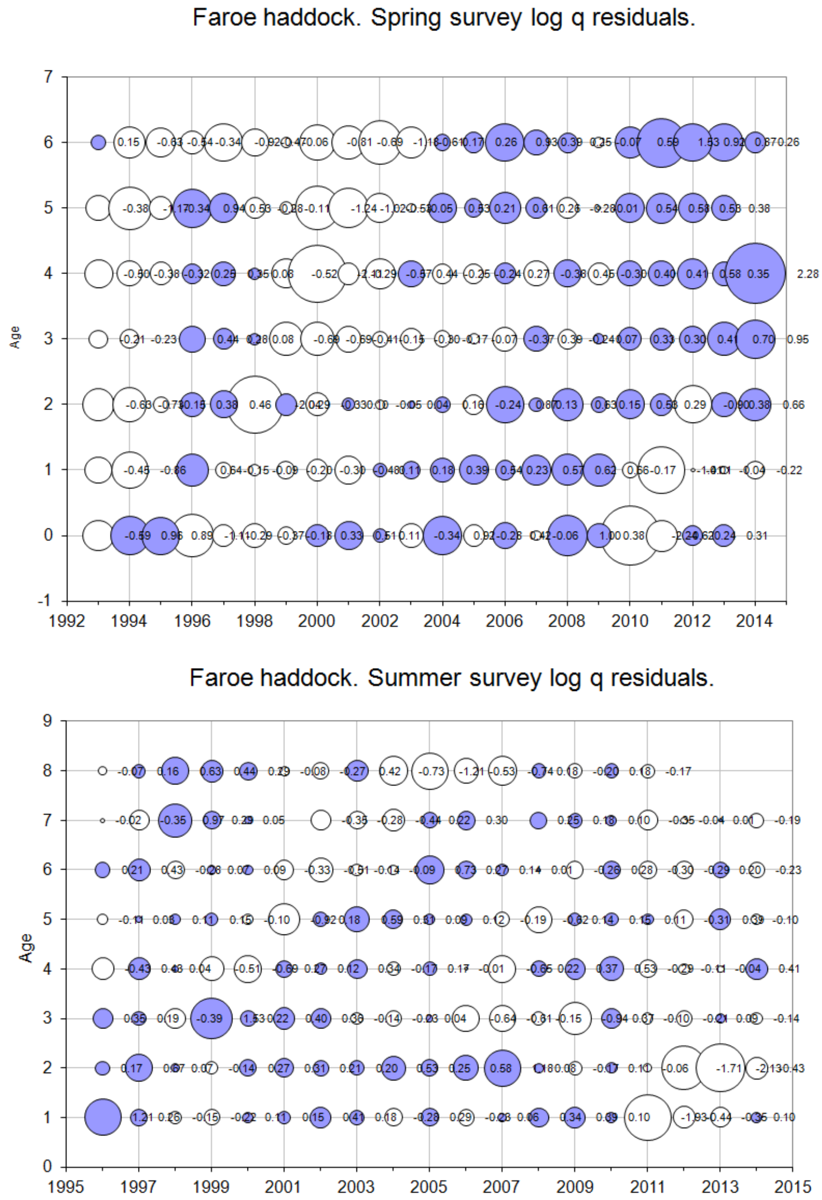


Figure 5.12. Faroe haddock survey log q residuals.

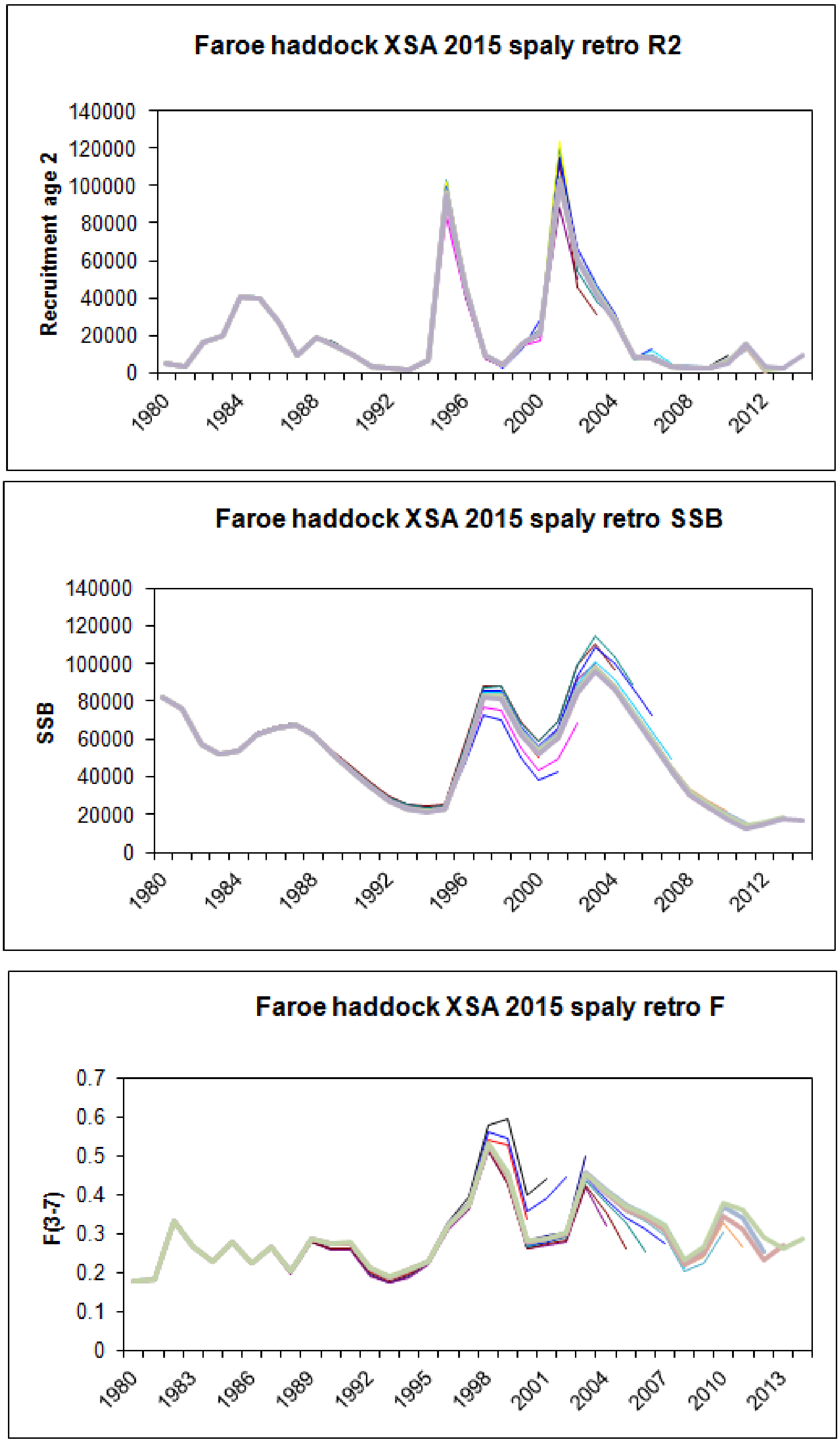


Figure 5.13. Faroe haddock. Retrospective analysis on the 2015 XSA.

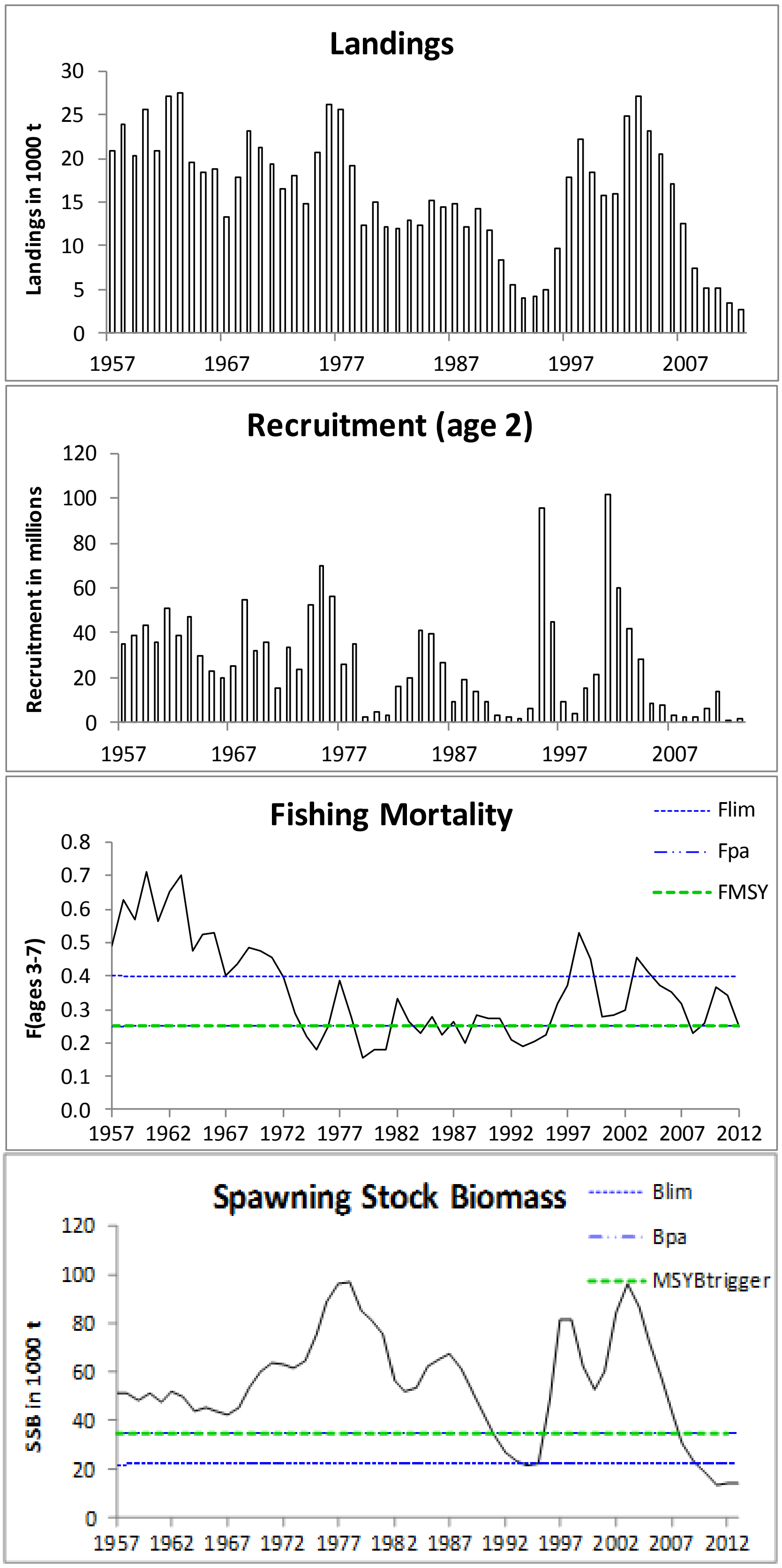


Figure 5.14. Faroe haddock (Division Vb) standard graphs from the 2015 assessment.

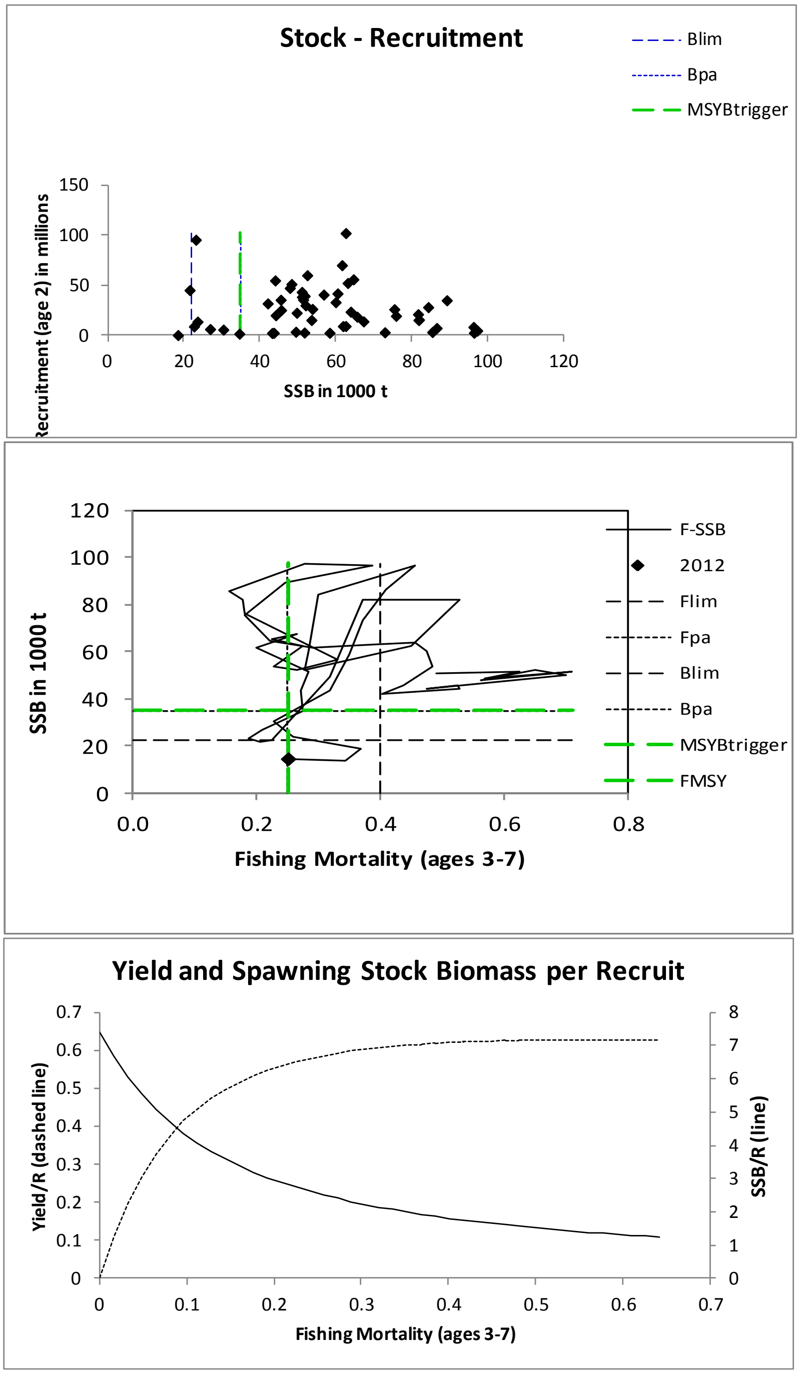
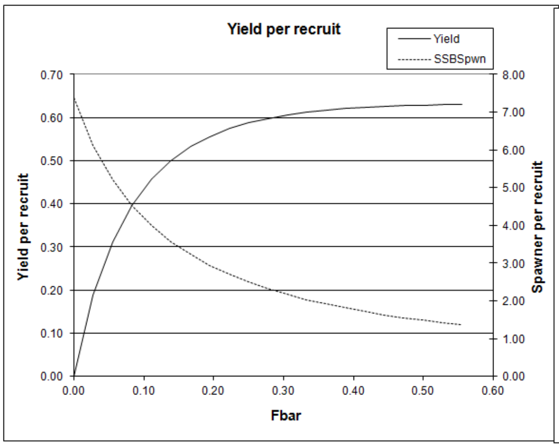
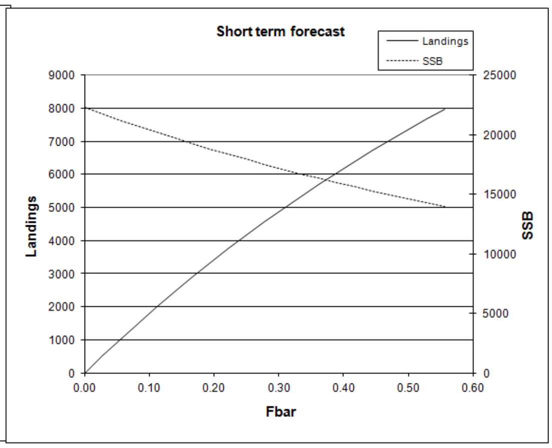


Figure 5.14 (cont.). Faroe haddock (Division Vb) standard graphs from the 2013 assessment.





MFYPR version 1
Run: rei
Time and date: 19:23 24/04/2015

Reference point	F multiplier	Absolute F
Fbar(3-7)	1	0.2778
FMax	2.2382	0.6218
F0.1	0.6571	0.1826
F35%SPR	0.8581	0.2384
Flow	-99	
Fmed	0.8397	0.2333
Fhigh	3.1887	0.8859

Weights in kilograms

MFDP version 1
Run: jak
Index file 24/04/2015
Time and date: 18:12 24/04/2015
Fbar age range: 3-7

Figure 5.16. Faroe haddock. Prediction output.

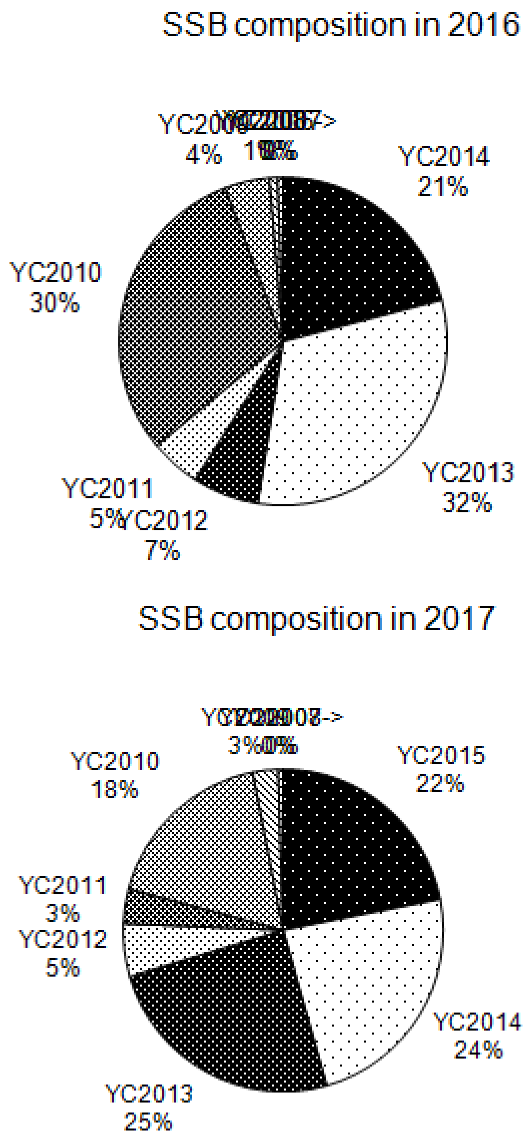


Figure 5.17. Faroe haddock. Projected composition of the number by year-classes in the SSB's in 2016 and 2017.

6 Faroe Saithe

Summary

The most recent benchmark assessment was completed in 2010.

Nominal landings decreased by more than 25% from 35 kt. in 2012 to 24 kt. in 2014. The corresponding estimate of fishing mortality in 2014 (average of ages 4-8 years) decreased to F=0.31 which is lower than the historical average (F=0.36) and very close to F_{msy}=0.30 and F_{pa}=0.28. Due to high fishing mortality SSB decreased substantially from 127 000 t. in 2005 to 48 000 t. in 2013, i.e., below $B_{trigger}$=55kt. but it increased again to 70 000 t. in 2014 as a consequence of improved weights and maturity ogives.

Numbers of the most recent year-class (2011, age 3 in 2014) has increased substantially from 36 mill. in 2013 to 62 million in 2014. However a statistical separable model suggests that the 2011 year-class is not as strong as the spaly assessment estimate and it predicts recruitment for 2014 at 20 mill.

At status-quo F_{bar}(2015)=0.31 and recruitment Rec(2015)=27 mill. the SSB is predicted to increase to 97 kt. in 2016.

Predicted landings for 2014 in the last year assessment were around 38kt while the actual measurement was 24 kt. The estimate of F_{bar} in 2014 was F_{bar}=0.53 in last year's assessment and F_{bar}=0.32 in the 2015 assessment. Recruitment strength for 2014 was predicted at 28 million while the estimate for that year in the present assessment reached 62 million. SSB was predicted exactly in 2014 SSB(2014)= 70 000 t.

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 57 000 tonnes in 2008 and 2009. After a substantial drop in landings in 2011 which was the lowest observed since 1999 (33 000 t) landings increased by 20% in 2012 up to 35 000 t. The total tonnage in 2014 is the lowest observed since 1997. The historical average landings for saithe since 1961 is 37 000 t.

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—77% of the reported landings in 1992—2011 (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—2011 period while the percentage of total landings by large single trawlers (>1000 HP) has declined drastically to just 1%. Historically the catch composition by the pair-trawler fleet has accounted for about 75% of the total tonnage for saithe but since 2007 it has increased gradually up to 96% in 2014 due mainly to the gear-shifting of single-trawlers to pair-trawling. The share of catches by the jigger fleet was about 8% in the 1985—1998 period but has decreased to less than 0.5 % since 2000 and it now accounts for only 2% of the total domestic landings for saithe in 2013. 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. Effort (measured as the ratio of nominal to used fishing days by the pair-trawl fleet segment) has diminished considerably in recent years. In the 2012/2013 fishing year only 85% and 57% of fishing days were utilized in the inner and outer areas respectively while in the 2013/2014 fishing year these ratios went down to 58% and 41%.

Cumulative landings of saithe for the domestic fleets since 2000 are shown in Figure 6.2.1.2. The period from 2011 to 2014 are among the poorest in the time series. The progression of landings in the first two months of 2015 is below monthly averages and suggest a poor fishing year.

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 is calculated for each fleet by four-month periods and the total is raised by the foreign catches. Minor adjustments were made to the catch-at-age matrix for 2013 due to revised final catch statistics (Tables 6.2.2.1 and 6.2.2.2). Most of the age-disaggregated catch matrix is comprised of catches of the pair-trawl fleet. Since 2010 catch numbers is mostly comprised of age-groups 4 to 6 whereas in the period from 2005 to 2009 it is mainly composed of age-groups 4 to 8. Numbers of 4 to 6-years old were higher in 2014 than in 2013. while catches of 3-year old saithe in increased from 721 thous. in 2013 to 878 thous. in 2014.

The sampling program and sampling intensity in 2014 as well as the approach used in compiling catch numbers is the same as in preceding years. Sampling levels of catches in both 2012 and 2013 are quite similar (5.6% and 5.4% respectively) going up to 8.9% in 2014 (Table 6.2.2.3.) The average amount sampled per tonnes landed since 2000 is 5.9%.

6.2.3 Weight at age

Mean weights at age have varied by a factor of about 2 during the 1961—2013 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. With the exception of 3-years old saithe all age groups were showing signs of increasing size since 2006. By 2011 age-classes 4 to 8 were approaching or at long term average. This trend seemed to continue for older age groups (7 and older) whereas weight of 4 to 6 years old individuals appeared to decrease again in 2012 and 2013. Mean weight of the 2011 year-class (age 3 in 2014) is estimated at 1.37 kg. which is an increase with respect to that in 2013 (1.21 kg.). Since 2001 all age groups have remained below the historical average with the only exception of 7-years old saithe, which reached the long-term mean value (3.785 kg.) in 2012 and 3-years old with size above average in 2009. In 2014 all age classes are above or just above the historical average. Mean weights at age in the stock are assumed equal to those in the catch.

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 2012 working group a model using maturity at age from the Faroese groundfish spring survey was implemented to derive smoothed trends in maturity by age and year. The fitting was done locally and the smoothing level was chosen as a trade-off between retaining the trend in maturities and reducing the data noise. For 1962 to 1982 the average maturity of predicted ogives of the 1983-2011 period was used (Table 6.2.4.1 and Figure 6.2.4.1.) Maturity ogives were low from the early and mid-1990s up to 2001 where they began to rise considerably and are above historical average since 2012.

Faroe saithe begins to mature at 3 years old, approximately 20% are mature at age 4, 50% at 5 years old and 100% are mature at age 9 and onwards.

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 series (FGFS1) are available since 1994, while the summer survey (FGFS2) was initiated in 1996. The design for both bottom-trawl surveys is depth stratified with randomised stations covering the Faroe Plateau area. The total number of stations in the summer and spring is 100 and 200 respectively. Effort is recorded in terms of minutes towed approximately 60 min. Large proportion of saithe is caught in relatively few hauls and the inter-annual variability of these hauls is considerable.

Survey catch rates (kg per hour), length composition and age-disaggregated indices are presented in figures 6.2.5.1.1 to 6.2.5.1.5. Both surveys suggest low abundances of saithe in mid- and late 1990's and increasing numbers from 2001 to 2005 although they differ in the order of this magnitude. Since 2006 the indexes show that the saithe stock is at low levels while there are indications of a slight upward trend since 2011. Both surveys agreed not only in the direction but also in the magnitude of this positive trend. Since 2011 the most recent estimate of the spring survey suggest a slightly decrease in stock biomass for 2015 but given the uncertainty associated with the index the point estimate ought to be taken with caution. Both survey at age numbers agreed in the lack of year classes present in the stock since 2007. The spring index suggest that the 2002 year class (age 3 in 2015) may be relatively strong, which is confirmed by more abundant individuals in the 35-45 cm size range from length distribution data.

Given the extreme schooling behaviour of saithe the internal consistency in the spring survey measured by the correlation of numbers in the data matrix for the same year class is reasonably good, with R^2 close to 0.85 for the best defined age groups and below $R^2 = 0.3$ for other age classes (Figure 6.2.5.1.6). Internal consistency in the age-disaggregated fall survey is displayed in figure 6.2.5.1.7. In terms of internal consistency the spring survey outperforms the fall survey.

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 survey spatial scaling factor is used to standardised the CPUE series (Stock Annex B.4., Benchmark report, WKROUND 2010.) The benchmark working group regarded this novel approach to developing the commercial series as reasonable (Benchmark report, WKROUND 2010.) Predicted annual CPUEs derived from this approach suggests that stock abundance was low in the 1990s and increased subsequently in the 2000s. and a sharp downward trend from 2006 to 2011. Since 2012 the predicted CPUE has remained remarkably stable at approximately 375 kg/hour (Figure 6.2.5.1.1)

The correlation between predicted CPUE and the spring and summer surveys is R^2=0.56 and R^2=0.68 respectively. The agreement between the survey indices measured by their correlation is estimated at R^2=0.36.

. The age composition indicates that the pair-trawl fleet targets mostly age groups 4 to 6. (Figure 6.2.5.2.1) There is a good agreement between age-disaggregated indices in the commercial index and indices of the same year class one year later (Figure 6.2.5.2.2) as measured by R^2 >0.35 for all age-classes.

6.2.5.3 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 was 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 6.3.1. Commercial catch-at age data (ages 3-14+, years 1961—2013) were calibrated in the XSA model using the commercial pair-trawl fleet (ages 3—11, years 1995—2013). XSA model diagnostics of the spaly run is presented in Table 6.3.2. Patterns in log-catchability residuals from the XSA model are relatively random but with large positive blocks in 2006—2010 for 3 to 4 age-classes (Figure 6.3.1.). Residuals from a separable statistical model predicting catch numbers at age and survey data and modelling selectivity over 3 distinct periods are also presented (Figure 6.3.3)

6.4 Reference points

6.4.1 Biological reference points and MSY framework

In 2014 at the WKMSYREF2 workshop the EqSim simulation framework was used to explore candidates to Fmsy. The work was presented at the NWWG meeting in 2014 and the results agree with the previous simulations (see above) in that estimates of Fmsy are in the range of Fmsy=0.30 and Fmsy=0.34 and not as the present level of Fmsy=0.28. In the 2014 meeting ACOM adopted the EqSim framework and agreed to set Fmsy=0.30, which agrees with the estimation of Fmed=0.31. Below it is an excerpt from the WKMSYREF2 report:

The EqSim framework fits three stock-recruit functions (Ricker, Beverton-Holt and Hockey-stick) on the bootstrap samples of the stock and recruit pairs from which approximate joint distributions of the model parameters can be made. The result of this is projected forward for a range of F's values and the last 50 years are retained to calculate summaries. Each simulation is run independently from the distribution of model and parameters. Error is introduced within the simulations by randomly generating process error about the constant stock recruit fit, and by using historical variation in maturity, natural mortality, weight at age, etc.

In the EqSim simulations the Hockey-Stick stock-recruit function were used assuming assessment and autocorrelation errors. Figures 6.4.1.1 and 6.4.1.2 illustrate the results of these simulations which suggest that candidates for FMSY are FMSY =0.34 (median yield) and FMSY =0.30 (F that gives the maximum mean yield in the long term) lie above the current FMSY = Fpa = 0.28 if autocorrelation and assessment errors are included in the simulation framework. If errors are ignored then estimates for FMSY are predicted to FMSY =0.38 (median yield), FMSY =0.35 (maximum mean yield). No Blim is defined for faroe saithe but for the purposes of the analysis a value of Blim=Bpa/1.4 was set for the simulations. A more detailed information of the simulations are available under *http://www.ices.dk/community/groups/Pages/WKMSYREF2.aspx* A summary is given in the table below.

	F	SSB	Catch	option
Flim	0.34	87327.43	36479.8	ass. Error
Flim	0.37	79116.87	35447.45	ass. Error
Flim	0.46	38905.3	22023.28	ass. Error
MSY:median	0.34	88565.78	36665.24	ass. Error
Maxmeanland	0.30	101372.9	37109.88	ass. Error
FCrash5	0.41	63312	31637.31	ass. Error
FCrash50	0.52	855.73	550.19	ass. Error
Flim	0.40	78435.72	38526.07	No ass. Error
Flim	0.42	73052.08	37660.27	No ass. Error
Flim	0.50	38910.57	24279.75	No ass. Error
MSY:median	0.38	82329.53	38694.43	No ass. Error
Maxmeanland	0.35	90688.34	39167.13	No ass. Error
FCrash5	0.43	69750.99	37114.99	No ass. Error
FCrash50	0.54	2847.53	1910.51	No ass. Error

MSY and revised precautionary reference points (Section 2. Demersal stocks in the Faroe Area, Subsection 2.1.7 Faroe saithe) for faroe saithe are listed below:

Biological reference points	NWWG 2012	NWWG2014
Btrigger	55 000 t.	55 000 t.
Blim	not defined.	
Bpa	60 000 t.	
Flim	not defined	
Fpa	0.28	
Fmsy	0.32	0.30

The Yield/R and SSB-R calculations with respect to reference fishing mortalities (Fmax, Fmed and F0.1) is presented in the table below. The SSB-R plot in relation to Fhigh, Fmed and Flow is shown in Figure 6.4.1.3.

	Fish Mort Ages 4-8	Yield/R	SSB/R
Average last 3 years	0.44	1.29	2.23
Fmax	0.42	1.29	2.36
F0.1	0.15	1.15	6.10
Fmed	0.31	1.28	3.27

6.5 State of the stock

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 (Figures 6.5.1 to 6.5.4. and Tables 6.5.1 to 6.5.3). The 1998 (88 millions) and 1999 (106 millions) are the largest observed in the time series. Since 2006 estimated recruitment has remained at low levels in comparison with the exceptionally high recruitment pulses observed from 2001 to 2005. However the 2011 year-class (numbers of age-3 saithe in 2014) is estimated at 62 million and therefore far above the historical average of 32 million. Nevertheless the most recent recruitment estimate is highly unreliable and it contradicts with the estimate from a more sophisticated statistical model, which predicts recruitment at N_3(2014)=20 million and thus in line with the present low productivity period.

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 662 000 millions, i.e. double the average from 1961 to 2014. The historically low SSB persisted in 1992-1998 and this along with low Fs caused landings to steeply decline to around 20 000 tonnes in 1996. The SSB increased since 1999 to above 128 000t in 2005 with the maturation of the 1995, 1996, 1997 and 1999 year classes and decreased to 93 000 t in 2009. The 2014 spaly assessment indicates that the point estimator of SSB(2013) is approximately 70 000 t. Since 2005 SSB has been declining sharply and at present is above $B_{trigger}$=55 000 t. Figure 6.5.6 illustrates the numbers of mature fish in the stock forage-groups from 3 to 9 in 2006, 2013 and 2014. It is quite clear that there has been a substantial increase in the numbers of mature fish over the age groups 3 to 6 a phenomenon supported by increased maturity ogives in recent years The separable catch-at-age model predicts SSB(2014)=94 000 t. and is thus at historical average.

In 2014 average fishing mortality over age groups 4 to 8 (Fbar) is estimated at F(2014)=0.32 and therefore very closed to F_{msy}=0.30 and below average for the first time since 2005. On the other hand the statistical model framework suggests that F(2014)=0.23 is even lower than that of the spaly assessment. The assessment model suggests a drop in fishing mortality from 2013 to 2014 reflecting the abrupt decline in landings from 26 kt. to 24 kt. Estimated F's have been above F_{msy}=0.30 and F_{pa}=0.28 since 1998.

The relation between stock and recruitment is presented in figure 6.5.7.

6.6 Short term forecast

6.6.1 Input data

Population numbers at age 3 for the base short term prediction is calculated as the geometric mean of estimated recruitment strength from 2008 to 2012. Natural mortality is set to constant 0.2. Weight-at-age for 3-years old saithe is predicted by the year class strength (number of 3-years old in the stock) with a 3 year time lag (Eq. 1) whereas weight for ages 4 to 8 is estimated by weight-at-age the previous year from the same year class (Eq. 2) Weight for ages 9 to 14+ is an average of the most 3 recent years. Diagnostics and results of the model are shown in Figures 6.6.1.1 and 6.6.1.2. For older age groups (9 to 14+) a 3-year average is used.

$W3,y = \alpha N3,y\text{-}3 + \beta$ for a = 3(Eq. 1)

$Wa+1,y+1 = \alpha Wa,y + \beta$ for $4 \leq a \leq 8$ (Eq. 2)

$Wa,y = (Wa\text{-}3,y\ Wa\text{-}2,y\ Wa\text{-}1,y)/3$ for $9 \leq a \leq 14+$ (Eq. 3)

Proportion mature for 2015-2017 is taken as the average of predicted maturity ogives from 2013 and 2015. The exploitation pattern used is a 3 year average rescaled to last year as specified in the stock annex.

Input data for the prediction with management options for the spaly scenario are presented in Table 6.6.1.1.

6.6.2 Projection of catch and biomass

Results from predictions with management option is presented in Table 6.6.2.1 and Figure 6.6.2.1.

At status quo F=0.32 landings would increase to 35 kt. in 2015 and 37 kt. in 2016 while spawning stock biomass is expected to around 82 kt. in 2015 and increase to 96 kt. tonnes in 2016. Landings in 2015 are predicted to rely on the 2009, 2010 and 2011 year classes (79%) while in the SSB these year-classes will contribute to around 73% of the spawning biomass in 2015 (Figure 6.6.2.2.)

6.7 Yield per recruit and medium term forecasts

No medium term projections were performed for faroe saithe.

Input data to yield per recruit

The input data to long-term prediction are shown in Table 6.7.1.1.

Mean weights-at-age for 1981—2013 were used for the long term projection. Natural mortality is set to constant 0.2. Proportion mature-at-age is taken as the average from 1983—2014.

The exploitation pattern was set equal to the average of the last five years (2005—2013) (as suggested from ACFM, 2004). Results from the yield per recruit analysis is shown in Figure 6.7.1.1.

6.8 Uncertainties in assessment and forecast

In 2014 the amount of catch sampled was 8.9%, which is regarded as adequate.

The assessment of Faroe saithe is relatively uncertain due to lack of good tuning data although the internal consistency in the commercial fleets used to calibrate the XSA model is reasonable considering the nature of the species that is highly schooling, and widely migrating. The retrospective pattern (Figure 6.8.1) reveals some of the assessment uncertainty. It shows periods of over- and underestimation in average fishing mortality and consequently under- and overestimation in spawning stock biomass. Over- and underestimation seem to occur in periods of poor and high abundances respectively. Various factors could explain this phenomenon, e.g., by changes in the vertical distribution of the stock or changes in the selection pattern that have been observed in recent years. With respect to recruitment the retrospective trend suggests an overestimation of incoming year-classes. To avoid large year-to-year fluctuations in the spawning stock biomass (also dependent on age structure) a locally fitting model was implemented in 2012 to reduce variability in maturities.

6.9 Comparison with previous assessment and forecast

The 2014 assessment predicted recruitment for 2014 to around 28 million while the observed year-class strength was 62 million (Table 6.9.1). Fishing mortality was overestimated from F=0.53 to F=0.32. The spawning stock biomass was predicted exatly. Landings for 2014 were predicted at Land(2014)=38 kt. while actual observed catches in that year reached Land(2014)=24 kt an overestimation of 40%. Landings and F estimates from the statistical model were however closer to the actual measurements F(2014)=0.23, Land(2014)=27 kt. while recruitment Rec(2014)=20 mill. was three times lower than that of the spaly run.

6.10 Management plans and evaluations

No management plan exists for saithe in Division Vb

6.11 Management considerations

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

In 2014 ACOM adopted F_{msy}=0.30 presented at the NWWG meeting for the same year and produced in the WKMSYREF2 workshop on reference points. $B_{trigger}$ is set at B_{loss} =55 kt. ($B_{trigger}$=55 kt).

6.12 Ecosystem considerations

No evidence is available to indicate that the fishery is impacting the marine environment. A Ph.D. project was initiated in 2008, with the aim of investigate the role of environmental indicators in the dynamics of Faroe saithe. The results and conclusions of the PhD will be available to the working group in future meetings.

6.13 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.

6.14 Changes in fishing technology and fishing patterns

See section 6.2.

6.15 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 6.15.1.)

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).

6.16 References

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Table 6.2.1.1. Faroe saithe (Division Vb). Nominal catches (tonnes round weight) by countries 1988-2014 as officially reported to ICES.

Country	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Denmark	94	-	2	-	-	-	-	-	-	-	-	-	-	-
Estonia	-	-	-	-	-	-	-	-	-	16	-	-	-	-
Faroe Islands	44 402	43 624	59 821	53 321	35 979	32 719	32 406	26 918	19 267	21 721	25 995	32 439		49 676
France 3	313	-	-	-	120	75	19	10	12	9	17	-	273	934
Germany	-	-	-	32	5	2	1	41	3	5	-	100	230	667
German Dem.Rep.	-	9	-	-	-	-	-	-	-	-	-	-	-	-
German Fed. Rep.	74	20	15	-	-	-	-	-	-	-	-	-	-	5
Greenland	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ireland	-	-	-	-	-	-	-	-	-	-	-	0	0	0
Netherlands	-	22	67	65	-	-	-	-	-		-	160	72	60
Norway	52	51	46	103	85	32	156	10	16	67	53	-	-	-
Portugal	-	-	-	-	-	-	-	-	-	-	-	-	20	1
UK (Eng. & W.)	-	-	-	5	74	279	151	21	53	-	19	67	32	80
UK (Scotland)	92	9	33	79	98	425	438	200	580	460	337	441	534	708
USSR/Russia 2	-	-	30	-	12	-	-	-	18	28	-	-	-	-
Total	45 027	43 735	60 014	53 605	36 373	33 532	33 171	27 200	19 949	22 306	26 065	33 207	1 161	52 131
Working Group estimate 4 5	45 285	44 477	61 628	54 858	36 487	33 543	33 182	27 209	20 029	22 306	26 421	33 207	39 020	51 786

Country	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Denmark	-	-	-	-	34	-	-	-	-	-	-	-	
Estonia	-	-	-	-	-	-	-	-	-	-	-	-	
Faroe Islands	55 165	47 933	48 222	71 496	70 696	64 552	61 117	61 889	46 686	32 056	38 175	28 609	25 440
France	607	370	147	123	315	108	97	68	46	135	40	31	
Germany	422	281	186	1	49	3	3	0					
Greenland	125	-			73	239	0	1			1		
Irland	-	-	-	-	-	-	-	-					
Iceland	-	-	-	-	-	-	-	148	-				
Netherlands	0	0	0	0	0	3	0	0	0				
Norway	77	62	82	82	35	81	38	23	28				165
Portugal	-	-	5	-	-	-	-	-					
Russia	10	32	71	210	104	159	38	44	3			1	
UK (E/W/NI)	58	89	85	32	88	4	-	-					
UK (Scotland)	540	610	748	4 322	1 011	408	400	685					
United Kingdom	-	-	-	-	-	-	-	-	706	19		1	340
Total	57 004	49 377	49 546	76 266	72 405	65 557	61 693	62 858	47 469	32 210	38 216	28 642	25 945
Working Group estimate 4 5 6 7	53 546	46 555	46 355	67 967	66 902	60 785	57 044	57 949	43 885	29 658	35 314	26 463	23 854

Table 6.2.1.2. Faroe saithe (Division Vb). Total Faroese landings (rightmost column) and the contribution (%) by each fleet category (1985-2014). Averages for 1985-2014 are given at the bottom.

year	Open boats	Long- line <100 GRT	Single trawl <400 HP	Gillnet	Jigger	Single trawl 400-1000 HP	Single trawl >1000 HP	Pair trawl <1000 HP	Pair trawl >1000 HP	Long- line >100 GRT	Industrial trawl	Others	Total round weight (tons)
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	39020
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	51786
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	53546
2003	0.0	0.0	1.9	0.0	0.9	0.4	17.4	14.7	64.7	0.1	0.0	0.0	46555
2004	0.1	0.2	3.7	0.0	1.9	0.4	15.1	14.4	63.8	0.2	0.0	0.0	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	66394
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	41341
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	27475
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	47122
2010	0.1	0.1	1.2	0.0	3.9	2.4	8.3	15.1	68.3	0.6	0.0	0.0	38293
2011	0.1	0.1	0.5	0.0	3.6	1.3	2.6	14.1	77.1	0.5	0.0	0.0	26854
2012	0.2	0.1	1.9	0.0	2.4	0.1	2.2	18.6	73.5	1.0	0.0	0.0	31633
2013	0.1	0.3	1.0	0.0	3.2	0.2	0.6	24.9	69.0	0.5	0.0	0.1	22339
2014	0.2	0.3	0.5	0.0	1.9	0.2	0.2	15.6	80.7	0.3	0.0	0.1	20793
Avg.	0.3	0.2	0.8	0.1	5.3	1.6	14.3	19.4	57.4	0.3	0.4	0.0	39121

Table 6.2.2.1. Faroe saithe (Division Vb). Catch number at age by fleet categories in 2014 (calculated from gutted weights).

Age	Jiggers	Single trawlers >1000 HP	Pair trawlers <1000 HP	Pair trawlers >1000HP	Others	Total Division Vb
0	0	0	0	0	0	0
1	0	0	0	0	0	0
2	0	0	2	6	0	8
3	9	8	135	625	10	788
4	37	55	334	1624	30	2081
5	55	90	404	2226	40	2815
6	26	41	218	1200	19	1505
7	13	20	120	613	10	775
8	12	23	40	216	4	295
9	1	1	13	72	2	89
10	0	0	11	70	2	82
11	1	2	8	50	1	63
12	0	0	8	39	1	49
13	0	0	1	13	0	14
14	0	0	0	1	0	1
15	0	0	0	0	0	0
Total No.	155	241	1294	6755	119	8564
Catch t.	411	654	3251	16774	304	21394

Table 6.2.2.2. Faroe saithe (Division Vb). Catch number at age (thousands) from the commercial fleet (1961-2014)

CN	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

CN	3	4	5	6	7	8	9	10	11	12	13	14+
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	2948	9486	16606	7099	843	810	32	102	27	3	0
2006	1475	5045	7781	7712	10296	3760	640	282	32	12	12	5
2007	831	3320	11305	6473	3781	4294	1538	406	81	11	9	3
2008	4784	3108	3598	9370	3594	2223	2048	444	159	12	6	0
2009	459	7412	4978	1842	5167	2009	1696	1069	292	41	3	1
2010	2324	2916	5298	1125	1009	2098	1248	832	376	51	22	0
2011	1897	2744	1940	1804	477	530	704	521	439	138	34	4
2012	859	9833	4142	1252	901	304	307	399	229	136	91	21
2013	721	5172	4219	2242	511	209	122	96	146	85	39	36
2014	878	2320	3139	1679	864	329	99	92	70	55	16	1

Table 6.2.2.3. Faroe saithe (Division Vb). Sampling intensity in 2001-2013.

Year		Jiggers	Single trawlers >1000 HP	Pair trawlers <1000 HP	Pair trawlers >1000 HP	Others	Total	Amount sampled pr tons landed (%)
2001	Lengths	1788	4388	5613	30341	0	42130	7.7
	Otoliths	180	450	480	3237	0	4347	
	Weights	180	420	420	3177	0	4197	
2002	Lengths	1197	9235	5049	30761	0	46242	5.8
	Otoliths	120	1291	422	3001	0	4834	
	Weights	120	420	240	2760	0	3540	
2003	Lengths	0	4959	6393	34812	1388	47552	7.0
	Otoliths	0	719	960	3719	180	5578	
	Weights	0	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	2.5
	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	
2010	Lengths	209	1442	3663	25793	151	31258	6.0
	Otoliths	5	119	480	2459	0	3063	
	Weights	5	0	3060	18749	151	21965	
2011	Lengths	583	18	1874	19990	753	23218	8.5
	Otoliths	60	0	300	2459	60	2879	
	Weights	583	18	1458	14256	753	17068	
2012	Lengths	6	0	1060	24924	211	26201	5.6
	Otoliths	6	0	120	2516	0	2642	
	Weights	6	0	1060	17593	211	18870	
2013	Lengths	0	0	1465	18015	920	20400	5.2
	Otoliths	0	0	360	1979	120	2459	
	Weights	0	0	1465	13544	1325	16334	
2014	Lengths	0	201	0	22131	920	23252	8.9
	Otoliths	0	0	0	2542	120	2662	
	Weights	0	0	0	15448	920	16368	

Table 6.2.3.1. Faroe saithe (Division Vb). Catch weights at age (kg)(equal to stock-weights) from the commercial fleet (1961-2014). The value for 2015 is used for short-term projections.

CW	3	4	5	6	7	8	9	10	11	12	13	14+
1961	1.43	2.302	3.348	4.287	5.128	6.155	7.06	7.265	7.497	8.198	9.154	9.992
1962	1.273	2.045	3.293	4.191	5.146	5.655	6.469	6.706	7.15	7.903	8.449	9.658
1963	1.28	2.197	3.212	4.568	5.056	5.932	6.259	8	7.265	8.551	9.02	9.818
1964	1.175	2.055	3.266	4.255	5.038	5.694	6.662	6.837	7.686	8.348	8.123	9.423
1965	1.181	2.125	2.941	4.096	4.878	5.932	6.321	7.288	8.074	7.878	9.479	9.849
1966	1.361	2.026	3.055	3.658	4.585	5.52	6.837	7.265	7.662	8.123	10.21	9.883
1967	1.273	1.78	2.534	3.572	4.368	5.313	5.812	6.554	7.806	7.591	8.551	9.135
1968	1.302	1.737	2.036	3.12	4.049	5.183	6.238	7.52	8.049	8.654	8.298	9.748
1969	1.188	1.667	2.302	2.853	3.673	5.002	5.714	6.405	6.554	7.591	7.951	9.096
1970	1.244	1.445	2.249	2.853	3.515	4.418	5.444	5.733	6.662	7.31	9.047	9.634
1971	1.101	1.316	1.818	2.978	3.702	4.271	5.388	5.972	6.49	7.173	7.38	9.612
1972	1.043	1.485	2.055	2.829	3.791	4.175	4.808	5.294	6.948	6.727	7.591	9.609
1973	1.306	1.754	1.899	2.7	4.426	5.264	6.156	6.334	8.076	8.777	9.782	11.115
1974	1.615	1.723	2.493	2.824	3.524	5.197	6.279	6.454	7.07	7.773	8.763	10.83
1975	1.293	1.924	2.623	3.621	4.128	4.754	5.952	7.073	8.352	9.032	9.984	11.082
1976	1.162	1.79	3.074	3.291	4.579	4.648	5.116	6.314	7.069	7.069	7.808	9.714
1977	1.223	1.641	2.66	3.79	4.239	5.597	5.35	5.912	6.837	6.727	6.948	9.258
1978	1.493	2.324	3.068	3.746	4.913	4.368	5.276	5.832	6.053	6.706	7.686	8.516
1979	1.22	1.88	2.62	3.4	4.18	4.95	5.69	6.38	7.02	7.26	8.15	9.618
1980	1.23	2.12	3.32	4.28	5.16	6.42	6.87	7.09	7.93	8.07	8.59	10.142
1981	1.31	2.13	3	3.81	4.75	5.25	5.95	6.43	7	7.47	8.14	9.43
1982	1.337	1.851	2.951	3.577	4.927	6.243	7.232	7.239	8.346	8.345	8.956	10.227
1983	1.208	2.029	2.965	4.143	4.724	5.901	6.811	7.051	7.248	8.292	9.478	10.509
1984	1.431	1.953	2.47	3.85	5.177	6.347	7.825	6.746	8.636	8.467	8.556	10.802
1985	1.401	2.032	2.965	3.596	5.336	7.202	6.966	9.862	10.67	10.46	10.202	13.055
1986	1.718	1.986	2.618	3.277	4.186	5.589	6.05	6.15	9.536	9.823	7.303	12.773
1987	1.609	1.835	2.395	3.182	4.067	5.149	5.501	6.626	6.343	10.245	8.491	10.482
1988	1.5	1.975	1.978	2.937	3.798	4.419	5.115	6.712	9.04	9.364	9.142	10.216
1989	1.309	1.735	1.907	2.373	3.81	4.667	5.509	5.972	6.939	8.543	9.514	10.484
1990	1.223	1.633	1.83	2.052	2.866	4.474	5.424	6.469	6.343	8.418	7.383	8.64
1991	1.24	1.568	1.864	2.211	2.648	3.38	4.816	5.516	6.407	7.395	8.079	8.674
1992	1.264	1.602	2.069	2.554	3.057	4.078	5.012	6.768	7.754	8.303	7.786	9.301
1993	1.408	1.86	2.323	3.131	3.73	4.394	5.209	6.54	8.403	7.275	9.414	9.64
1994	1.503	1.951	2.267	2.936	4.214	4.971	5.657	5.95	6.891	8.752	9.752	7.989
1995	1.456	2.177	2.42	2.895	3.651	5.064	5.44	6.167	7.08	7.736	7.295	7.104
1996	1.432	1.875	2.496	3.229	3.744	4.964	6.375	6.745	7.466	7.284	8.47	10.125
1997	1.476	1.783	2.032	2.778	3.598	4.766	5.982	7.658	7.882	8.539	9.488	10.413
1998	1.388	1.711	1.954	2.405	3.3	4.22	4.999	6.391	6.665	8.214	8.485	8.845
1999	1.374	1.712	1.905	2.396	2.845	4.124	5.256	5.526	6.956	8.03	8.349	8.907
2000	1.477	1.606	2.077	2.36	2.977	3.48	4.851	5.268	6.523	4.727	8.807	8.972
2001	1.33	1.59	1.785	2.586	3.059	3.871	4.374	5.565	6.703	5.776	7.745	7.773
2002	1.142	1.46	1.652	1.969	3.13	3.589	4.513	5.138	6.422	8.026	4.759	11.357
2003	1.123	1.304	1.614	1.977	2.532	3.97	4.834	5.499	6.099	6.987	5.961	10
2004	1.143	1.333	1.45	1.789	2.56	3.159	4.154	5.167	6.015	6.186	7.056	9.391
2005	1.148	1.325	1.516	1.672	2.087	2.975	3.79	6.087	6.134	6.651	7.424	10
2006	1.126	1.218	1.462	1.79	2.035	2.436	3.861	4.222	5.149	6.437	6.905	5.365
2007	1.058	1.391	1.413	1.824	2.361	2.682	3.278	4.104	4.998	6.331	7.844	7.971
2008	1.146	1.312	1.672	1.816	2.395	2.902	3.1	3.728	4.769	6.072	6.451	10
2009	0.938	1.485	1.893	2.411	2.601	3.147	3.634	4.024	5.014	5.828	6.308	9.011

CW	3	4	5	6	7	8	9	10	11	12	13	14+
2010	1.429	1.706	2.166	2.551	3.172	3.411	3.972	4.352	5.083	4.941	5.305	10
2011	1.111	1.693	2.253	2.918	3.609	4.204	4.531	5.087	5.416	6.087	6.763	7.916
2012	1.029	1.334	1.626	2.709	3.785	4.448	4.799	5.207	5.562	6.018	7.143	6.247
2013	1.208	1.466	1.778	2.069	3.553	4.292	5.191	5.742	5.919	6.417	7.941	7.138
2014	1.369	1.724	2.163	2.868	3.325	5.903	5.899	6.877	6.784	7.467	7.121	11.31
2015	1.299	1.528	1.850	2.239	2.602	4.451	5.296	5.942	6.088	6.634	7.402	8.232

Table 6.2.4.1. Faroe saithe (Division Vb). Proportion mature at age (1982-2014). Maturities-at-age from 1961 to 1981 are fixed and equal to those in 1982. The value for 2015 is used for short-term prognosis.

Mat	3	4	5	6	7	8	9	10	11	12	13	14+
1982	0.03	0.22	0.52	0.79	0.92	0.98	1.00	1.00	1.00	1.00	1.00	1.00
1983	0.03	0.27	0.61	0.91	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1984	0.04	0.28	0.60	0.88	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1985	0.05	0.29	0.59	0.85	0.97	0.99	1.00	1.00	1.00	1.00	1.00	1.00
1986	0.05	0.28	0.57	0.82	0.94	0.98	1.00	1.00	1.00	1.00	1.00	1.00
1987	0.05	0.27	0.55	0.79	0.92	0.97	1.00	1.00	1.00	1.00	1.00	1.00
1988	0.05	0.26	0.53	0.77	0.90	0.96	1.00	1.00	1.00	1.00	1.00	1.00
1989	0.04	0.23	0.51	0.76	0.89	0.96	1.00	1.00	1.00	1.00	1.00	1.00
1990	0.03	0.19	0.49	0.75	0.89	0.96	1.00	1.00	1.00	1.00	1.00	1.00
1991	0.03	0.17	0.48	0.75	0.88	0.96	1.00	1.00	1.00	1.00	1.00	1.00
1992	0.02	0.17	0.48	0.75	0.89	0.97	1.00	1.00	1.00	1.00	1.00	1.00
1993	0.02	0.17	0.49	0.77	0.91	0.99	1.00	1.00	1.00	1.00	1.00	1.00
1994	0.01	0.17	0.49	0.78	0.93	1.00	0.99	1.00	1.00	1.00	1.00	1.00
1995	0.01	0.17	0.49	0.78	0.93	1.00	0.99	1.00	1.00	1.00	1.00	1.00
1996	0.01	0.17	0.47	0.75	0.90	1.00	0.99	1.00	1.00	1.00	1.00	1.00
1997	0.01	0.16	0.44	0.70	0.87	0.98	0.99	1.00	1.00	1.00	1.00	1.00
1998	0.02	0.16	0.41	0.64	0.83	0.96	0.99	1.00	1.00	1.00	1.00	1.00
1999	0.02	0.16	0.38	0.60	0.79	0.94	0.98	1.00	1.00	1.00	1.00	1.00
2000	0.02	0.16	0.37	0.58	0.77	0.92	0.98	1.00	1.00	1.00	1.00	1.00
2001	0.01	0.17	0.37	0.56	0.75	0.91	0.98	1.00	1.00	1.00	1.00	1.00
2002	0.01	0.17	0.37	0.56	0.74	0.89	0.98	1.00	1.00	1.00	1.00	1.00
2003	0.01	0.18	0.37	0.56	0.74	0.88	0.97	1.00	1.00	1.00	1.00	1.00
2004	0.01	0.18	0.38	0.57	0.74	0.88	0.97	1.00	1.00	1.00	1.00	1.00
2005	0.00	0.18	0.39	0.59	0.76	0.89	0.97	1.00	1.00	1.00	1.00	1.00
2006	0.00	0.18	0.40	0.62	0.78	0.90	0.97	1.00	1.00	1.00	1.00	1.00
2007	0.00	0.19	0.42	0.64	0.80	0.91	0.97	1.00	1.00	1.00	1.00	1.00
2008	0.01	0.20	0.43	0.66	0.82	0.92	0.97	1.00	1.00	1.00	1.00	1.00
2009	0.01	0.21	0.45	0.68	0.84	0.94	0.97	1.00	1.00	1.00	1.00	1.00
2010	0.02	0.23	0.47	0.71	0.87	0.95	0.97	1.00	1.00	1.00	1.00	1.00
2011	0.03	0.24	0.49	0.72	0.88	0.96	0.98	1.00	1.00	1.00	1.00	1.00
2012	0.03	0.25	0.50	0.73	0.89	0.97	0.98	1.00	1.00	1.00	1.00	1.00
2013	0.04	0.25	0.50	0.74	0.90	0.97	0.98	1.00	1.00	1.00	1.00	1.00
2014	0.04	0.26	0.51	0.74	0.90	0.98	0.98	1.00	1.00	1.00	1.00	1.00
2015	0.04	0.26	0.51	0.74	0.90	0.98	0.98	1.00	1.00	1.00	1.00	1.00

Table 6.3.1. Faroe saithe (Division Vb). Effort (hours) and catch in number at age for the commercial pair trawlers (1995-2013)

year	effort	3	4	5	6	7	8	9	10	11
1995	11016	47	180	577	236	146	49	24	19	14
1996	48205	310	958	821	1119	503	282	133	127	70
1997	34828	199	533	1488	1013	768	333	73	33	10
1998	34422	107	656	1148	1486	730	325	170	40	13
1999	43528	174	487	1554	2016	2024	817	190	83	12
2000	44280	434	1566	913	2700	1333	1604	192	106	31
2001	41860	611	1438	4946	1165	1855	748	618	127	29
2002	41914	133	3976	3964	6888	520	682	246	177	25
2003	38489	141	1494	6560	2373	2263	197	212	124	35
2004	35525	43	1200	5089	5116	1035	762	113	116	53
2005	32860	188	1189	4039	7266	3130	320	291	7	43
2006	25334	140	1176	2410	2584	3700	1376	268	85	14
2007	25218	204	879	2913	1815	1034	1215	435	110	19
2008	25259	796	762	947	2641	1063	726	611	156	51
2009	68408	154	4082	3377	1283	3612	1402	1153	751	195
2010	61563	459	2019	3586	737	657	1325	814	518	245
2011	64272	397	1936	1367	1257	323	356	488	366	310
2012	57749	366	5652	2332	756	554	187	189	252	143
2013	43325	424	3047	2462	1295	293	122	71	56	83
2014	48205	625	1624	2226	1200	613	216	72	70	50

Table 6.3.2. Faroe saithe (Division Vb). Diagnostics from XSA with commercial pair trawler tuning series (spaly)

FLR XSA Diagnostics 2015-04-15 15:45:12

CPUE data from indices

Catch data for 54 years 1961 to 2014. Ages 3 to 14.

	fleet	first age	last age	first year	last year	alpha	beta
1	PairTrawlers_GLM_SD	3	11	1995	2014	<NA>	<NA>

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	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
all	1	1	1	1	1	1	1	1	1	1

Fishing mortalities

age	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
3	0.007	0.076	0.050	0.184	0.038	0.112	0.062	0.028	0.022	0.016
4	0.077	0.103	0.245	0.266	0.481	0.354	0.187	0.522	0.234	0.093
5	0.295	0.297	0.353	0.459	0.907	0.774	0.423	0.476	0.445	0.217
6	0.477	0.417	0.433	0.560	0.453	0.523	0.665	0.535	0.517	0.319
7	0.585	0.621	0.371	0.459	0.703	0.484	0.440	0.858	0.435	0.383
8	0.352	0.722	0.577	0.389	0.507	0.705	0.510	0.563	0.486	0.560
9	0.889	0.496	0.753	0.606	0.587	0.694	0.544	0.635	0.463	0.450
10	0.296	0.939	0.689	0.504	0.757	0.650	0.715	0.695	0.414	0.783
11	0.621	0.545	0.790	0.643	0.747	0.667	0.892	0.823	0.595	0.610
12	0.348	0.132	0.362	0.246	0.335	0.270	0.553	0.787	0.865	0.469
13	0.541	0.257	0.138	0.344	0.089	0.302	0.291	0.905	0.544	0.380
14	0.541	0.257	0.138	0.344	0.089	0.302	0.291	0.905	0.544	0.380

XSA population number (Thousand)

year \ age	3	4	5	6	7	8	9	10	11	12	13	14
2005	69984	44103	41005	48405	17716	3140	1520	138	244	101	8	0
2006	22222	56888	33441	24988	24605	8081	1808	512	84	107	59	24
2007	18880	16860	42011	20339	13481	10828	3214	901	164	40	77	26
2008	31507	14706	10799	24166	10795	7616	4980	1240	370	61	23	0
2009	13724	21467	9228	5586	11307	5586	4224	2224	613	159	39	13
2010	24291	10821	10869	3051	2907	4582	2756	1924	854	238	93	0
2011	34720	17785	6221	4105	1480	1467	1853	1127	822	359	149	17
2012	34440	26710	12078	3338	1729	780	721	880	451	276	169	38
2013	35951	27420	12971	6141	1600	600	364	313	360	162	103	94
2014	61619	28782	17770	6802	2999	848	302	187	169	162	56	3

Estimated population abundance at 1st Jan 2015

year \ age	3	4	5	6	7	8	9	10	11	12	13	14
2015	0	49655	21465	11708	4050	1674	396	158	70	75	83	31

Fleet: PairTrawlers_GLM_SD

Log catchability residuals.

age \ year	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
3	-0.389	0.492	0.054	0.413	-0.868	0.533	0.027	-1.689	-1.044	-1.979	-0.683	0.463	0.994	1.905	0.028	0.690	0.121	0.138	0.527	0.267
4	-0.033	-0.733	-0.518	-0.609	-0.172	-0.560	-0.059	0.066	-1.075	-0.706	-0.451	-0.444	0.552	0.554	0.955	0.985	0.326	1.250	0.763	-0.088
5	0.449	-0.659	-0.672	-0.422	-0.637	-0.190	0.041	0.400	0.078	-0.461	-0.032	-0.083	-0.092	0.189	0.813	0.759	0.157	0.159	0.415	-0.211
6	-0.194	-0.178	-0.074	-0.663	-0.047	0.014	0.349	0.654	0.210	0.056	0.097	-0.042	-0.178	0.079	-0.221	-0.034	0.221	-0.030	0.178	-0.196
7	0.152	-0.407	0.225	0.058	-0.171	-0.034	0.328	0.210	0.367	-0.006	0.173	0.287	-0.492	-0.204	0.083	-0.253	-0.350	0.320	-0.134	-0.154
8	0.096	0.150	0.113	-0.013	0.567	0.272	0.119	0.149	0.005	0.171	-0.580	0.356	-0.119	-0.367	-0.343	-0.010	-0.313	-0.194	-0.106	0.046
9	-0.039	0.395	0.003	0.260	-0.020	-0.118	0.411	-0.185	-0.151	0.498	0.282	0.119	0.144	-0.019	-0.224	0.007	-0.216	-0.074	-0.156	-0.070
10	-0.362	1.060	0.075	0.193	0.210	0.247	0.529	0.295	-0.020	0.115	-1.305	0.421	0.014	-0.038	0.062	-0.104	0.068	0.040	-0.265	0.525
11	-0.058	0.144	-0.393	-0.060	-0.560	0.074	0.046	-0.034	-0.334	0.152	0.088	0.255	0.004	0.113	-0.002	-0.034	0.291	0.195	0.068	0.215

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	-15.5347	-13.4272	-12.4482	-12.0741	-11.9394	-11.8402	-11.8402	-11.8402	-11.8402
S.E_Logq	0.4575	0.4575	0.4575	0.4575	0.4575	0.4575	0.4575	0.4575	0.4575

Terminal year survivor and F summaries:

Age 3 Year class =2011

source

	scaledWts	survivors	yrcls
PairTrawlers_GLM_SD	0.82	64821	2011
fshk	0.18	14726	2011

Age 4 Year class =2010

source

	scaledWts	survivors	yrcls
PairTrawlers_GLM_SD	0.888	19660	2010
fshk	0.112	4881	2010

Age 5 Year class =2009

source

	scaledWts	survivors	yrcls
PairTrawlers_GLM_SD	0.941	9482	2009
fshk	0.059	3377	2009

Age 6 Year class =2008

source

	scaledWts	survivors	yrcls
PairTrawlers_GLM_SD	0.97	3329	2008
fshk	0.03	2106	2008

Age 7 Year class =2007

source

	scaledWts	survivors	yrcls
PairTrawlers_GLM_SD	0.968	1435	2007
fshk	0.032	974	2007

Age 8 Year class =2006

source

	scaledWts	survivors	yrcls
PairTrawlers_GLM_SD	0.962	415	2006
fshk	0.038	398	2006

Age 9 Year class =2005

source

	scaledWts	survivors	yrcls
PairTrawlers_GLM_SD	0.966	147	2005
fshk	0.034	111	2005

Age 10 Year class =2004

source

scaledWts survivors yrcls

PairTrawlers_GLM_SD 0.891 118 2004

fshk 0.109 91 2004

Age 11 Year class =2003

source

scaledWts survivors yrcls

PairTrawlers_GLM_SD 0.96 93 2003

fshk 0.04 56 2003

Age 12 Year class =2002

source

scaledWts survivors yrcls

fshk 1 65 2002

Age 13 Year class =2001

source

scaledWts survivors yrcls

fshk 1 17 2001

Table 6.5.1. Faroe saithe (Division Vb). Fishing mortality at age (1961-2013). The value for 2015 is used for short-term prognosis.

F	3	4	5	6	7	8	9	10	11	12	13	14+
1961	0.026	0.058	0.109	0.143	0.12	0.1	0.11	0.106	0.112	0.181	0.134	0.134
1962	0.052	0.101	0.127	0.156	0.143	0.099	0.138	0.149	0.125	0.098	0.124	0.124
1963	0.035	0.04	0.085	0.118	0.185	0.142	0.185	0.25	0.178	0.491	0.308	0.308
1964	0.052	0.144	0.251	0.218	0.236	0.301	0.18	0.241	0.248	0.235	0.243	0.243
1965	0.05	0.085	0.186	0.253	0.283	0.263	0.37	0.316	0.424	0.532	0.427	0.427
1966	0.026	0.103	0.167	0.283	0.348	0.35	0.308	0.456	0.433	0.493	0.464	0.464
1967	0.027	0.053	0.125	0.158	0.332	0.354	0.349	0.335	0.407	0.384	0.378	0.378
1968	0.03	0.099	0.098	0.14	0.156	0.307	0.326	0.358	0.258	0.467	0.363	0.363
1969	0.034	0.136	0.189	0.175	0.207	0.25	0.493	0.586	0.639	0.518	0.586	0.586
1970	0.044	0.262	0.142	0.179	0.16	0.202	0.206	0.39	0.431	0.609	0.48	0.48
1971	0.086	0.135	0.373	0.128	0.144	0.117	0.13	0.157	0.277	0.534	0.325	0.325
1972	0.094	0.07	0.148	0.316	0.293	0.354	0.4	0.49	0.541	0.73	0.592	0.592
1973	0.125	0.325	0.438	0.304	0.315	0.209	0.246	0.272	0.253	0.32	0.283	0.283
1974	0.222	0.311	0.358	0.307	0.192	0.195	0.164	0.237	0.207	0.227	0.225	0.225
1975	0.141	0.345	0.528	0.293	0.18	0.141	0.132	0.12	0.205	0.198	0.175	0.175
1976	0.196	0.34	0.298	0.328	0.208	0.16	0.129	0.137	0.122	0.149	0.136	0.136
1977	0.146	0.281	0.376	0.382	0.344	0.259	0.179	0.13	0.246	0.156	0.178	0.178
1978	0.085	0.233	0.267	0.163	0.18	0.375	0.272	0.259	0.228	0.307	0.266	0.266
1979	0.037	0.18	0.283	0.251	0.261	0.31	0.338	0.49	0.329	0.172	0.333	0.333
1980	0.088	0.153	0.205	0.224	0.281	0.195	0.258	0.415	0.386	0.226	0.344	0.344
1981	0.014	0.227	0.194	0.447	0.533	0.512	0.383	0.394	0.412	0.471	0.429	0.429
1982	0.028	0.184	0.188	0.477	0.329	0.502	0.399	0.191	0.315	0.477	0.33	0.33
1983	0.07	0.103	0.366	0.419	0.486	0.552	0.736	0.221	0.275	0.711	0.405	0.405
1984	0.016	0.498	0.332	0.575	0.535	0.451	0.558	0.292	0.224	0.265	0.262	0.262
1985	0.062	0.236	0.507	0.276	0.579	0.314	0.304	0.243	0.232	0.415	0.298	0.298
1986	0.021	0.138	0.452	0.774	0.375	0.785	0.518	0.578	0.895	0.518	0.67	0.67
1987	0.037	0.138	0.423	0.57	0.476	0.372	0.598	0.32	0.503	0.141	0.323	0.323
1988	0.022	0.089	0.355	0.631	0.576	0.629	0.471	0.65	0.167	1.599	0.813	0.813
1989	0.018	0.203	0.228	0.492	0.366	0.511	0.384	0.184	0.489	0.086	0.254	0.254
1990	0.016	0.203	0.627	0.784	0.801	0.392	0.203	0.209	0.196	0.29	0.233	0.233
1991	0.047	0.414	0.768	0.875	0.799	0.658	0.689	0.756	0.903	0.415	0.698	0.698
1992	0.03	0.262	0.596	0.707	0.551	0.483	0.558	0.459	0.455	0.73	0.552	0.552
1993	0.063	0.205	0.547	0.601	0.514	0.388	0.478	0.454	0.374	0.477	0.438	0.438
1994	0.046	0.274	0.334	0.597	0.599	0.652	0.448	0.706	0.562	0.339	0.54	0.54
1995	0.011	0.089	0.411	0.406	0.684	0.623	0.778	0.565	0.563	0.595	0.579	0.579
1996	0.014	0.039	0.137	0.3	0.486	0.757	0.517	0.616	0.37	0.51	0.502	0.502
1997	0.011	0.048	0.115	0.324	0.5	0.532	0.575	0.589	0.496	0.528	0.741	0.741
1998	0.014	0.071	0.15	0.238	0.454	0.52	0.706	0.586	0.582	1.419	0.552	0.552
1999	0.006	0.073	0.181	0.302	0.492	0.627	0.623	0.694	0.361	1.681	1.151	1.151
2000	0.025	0.068	0.235	0.418	0.471	0.721	0.52	0.727	0.628	0.508	0.503	0.503
2001	0.014	0.1	0.294	0.634	0.763	0.709	1	1.206	0.998	0.612	1.927	1.927
2002	0.003	0.14	0.372	0.661	0.566	0.667	0.479	0.843	0.389	1.815	0.421	0.421
2003	0.006	0.032	0.279	0.46	0.696	0.597	0.476	0.675	0.522	1.216	0.741	0.741
2004	0.002	0.043	0.148	0.37	0.478	0.73	1.006	0.736	0.834	2.518	1.289	1.289
2005	0.007	0.077	0.295	0.477	0.585	0.352	0.889	0.296	0.621	0.348	0.541	0.541
2006	0.076	0.103	0.297	0.417	0.621	0.722	0.496	0.939	0.545	0.132	0.257	0.257
2007	0.05	0.245	0.353	0.433	0.371	0.577	0.753	0.689	0.79	0.362	0.138	0.138
2008	0.184	0.266	0.459	0.56	0.459	0.389	0.606	0.504	0.643	0.246	0.344	0.344
2009	0.038	0.481	0.907	0.453	0.703	0.507	0.587	0.757	0.747	0.335	0.089	0.089

F	3	4	5	6	7	8	9	10	11	12	13	14+
2010	0.112	0.354	0.774	0.523	0.484	0.705	0.694	0.65	0.667	0.27	0.302	0.302
2011	0.062	0.187	0.423	0.665	0.44	0.51	0.544	0.715	0.892	0.553	0.291	0.291
2012	0.028	0.522	0.476	0.535	0.858	0.563	0.635	0.695	0.823	0.787	0.905	0.905
2013	0.022	0.234	0.445	0.517	0.435	0.486	0.463	0.414	0.595	0.865	0.544	0.544
2014	0.016	0.093	0.217	0.319	0.383	0.56	0.45	0.783	0.61	0.469	0.38	0.38
2015	0.016	0.201	0.269	0.324	0.397	0.381	0.366	0.448	0.480	1.00	1.00	1.00

Table 6.3.2. Faroe saithe (Division Vb). Stock number at age (start of year) (Thousands)(1961-2013). The value for 2015 is used for short-term prognosis.

year	3	4	5	6	7	8	9	10	11	12	13	14+
1961	7827.25	7421.86	5158.38	3351.65	2113.91	1494.26	1232.82	904.51	468.22	179.78	53.02	431.33
1962	12256.25	6242.83	5733.57	3786.29	2379.45	1535.28	1106.68	904.39	666.35	342.63	122.76	592.7
1963	19837.07	9526.05	4620.77	4135.96	2652.05	1689.34	1138.44	789.35	638.21	481.32	254.28	182.18
1964	14811.79	15685.65	7491.63	3475.53	3010.73	1803.95	1200.34	774.64	503.3	437.46	241.15	224.48
1965	22362.92	11507.96	11115.89	4770.94	2287.23	1947.41	1093.3	820.79	498.49	321.58	283.06	239.61
1966	21229.27	17407.99	8652.81	7555.46	3032.95	1411.16	1226.14	618.24	490.13	266.98	154.71	232.85
1967	24897.65	16939.49	12859.01	5997.61	4660.33	1753.87	814.24	737.85	320.68	260.13	133.53	94.13
1968	22879.37	19846.09	13148.63	9293.87	4193.8	2736.99	1007.96	470.29	432.19	174.78	145.12	316.81
1969	39798.56	18176.48	14720.33	9755.39	6618.38	2937.74	1648.19	595.42	269.22	273.31	89.71	133.05
1970	37092.13	31506.65	12994.15	9976.29	6707.6	4407.06	1872.27	824.62	271.23	116.37	133.29	109.05
1971	38446.65	29060.97	19844.34	9228.97	6830.55	4678.27	2947.67	1246.96	457.08	144.25	51.84	130.67
1972	33424.45	28892.33	20792.67	11193.66	6646.68	4843.17	3405.87	2118.37	872.53	283.74	69.24	119.79
1973	23621.85	24909.9	22049.86	14681.88	6683.53	4058.35	2784.44	1868.27	1062.08	415.77	111.96	258.1
1974	19420.6	17064.27	14736.55	11651.17	8873.48	3993.51	2695.64	1782.05	1164.96	675.02	247.2	524.53
1975	17327.15	12729.69	10237.68	8435.96	7020.11	5997.32	2690.51	1874.02	1151.37	775.54	440.46	739.88
1976	19709.19	12320.5	7381.03	4942.62	5152.3	4802.02	4264.13	1929.54	1360.59	768.03	520.95	1132.94
1977	13106.08	13260.95	7176.31	4486.76	2915.63	3424.81	3351.56	3067.71	1378	986.38	541.95	815.91
1978	8332.93	9274.47	8199.64	4035.03	2508.02	1693.1	2163.37	2293.42	2205.8	882.09	690.85	837.16
1979	8686.33	6269.57	6016.16	5142.5	2807.75	1715.89	952.78	1349.56	1449.7	1437.68	531.28	1353.59
1980	13075.22	6852.07	4288.88	3712.23	3275.62	1770.37	1030.25	556.58	676.94	853.94	990.68	1390.32
1981	33145.15	9803.87	4816.46	2859.95	2430.36	2024.94	1192.48	651.67	300.96	376.88	557.99	2253.33
1982	15676.15	26765.06	6394.4	3247.57	1498.22	1168.22	993.73	665.96	359.81	163.16	192.75	3112.79
1983	40830.06	12484.37	18225.26	4335.88	1650.89	882.8	579.14	545.77	450.23	214.96	82.91	1368.13
1984	26075.32	31182.12	9223.3	10350.34	2334.72	831.36	416.04	227.14	358.16	279.95	86.42	839.91
1985	22332.2	21015.69	15515.92	5416.89	4770.65	1119.78	433.64	194.94	138.91	234.42	175.82	690.1
1986	61856.33	17176.53	13595.89	7651.66	3365.46	2188.49	669.78	261.83	125.22	90.21	126.78	154.24
1987	48619.31	49587.74	12256	7084.03	2889.6	1893.09	817.28	326.68	120.27	41.9	44	321.7
1988	44855	38375.57	35357.28	6571.55	3279.94	1470.02	1068.56	367.82	194.17	59.56	29.78	3.91
1989	28601.04	35940.58	28749.99	20302.37	2861.26	1509.1	641.64	546.41	157.28	134.54	9.85	132.25
1990	20712.55	23008.47	24013.82	18742.86	10165.26	1625.07	741.51	357.94	372.26	79	101.11	222.27
1991	24971.59	16691.98	15369.5	10503.9	7003.66	3735.08	898.88	495.8	237.86	250.49	48.39	41.25
1992	19572.3	19513.03	9028.95	5840.63	3583.45	2578.95	1583.14	369.49	190.57	78.92	135.41	48.95
1993	23780.38	15553.02	12295.94	4074.24	2357.85	1691.54	1302.54	741.5	191.21	99.02	31.14	24.69
1994	16877.27	18278.96	10371.21	5824.28	1829.15	1154.09	939.73	661.06	385.4	107.69	50.31	5.24
1995	38973.1	13193.6	11381.49	6081.64	2625.86	822.57	492.47	491.6	267.07	179.82	62.83	47.22
1996	24356.89	31548.35	9879.98	6180.4	3317.95	1084.88	361.3	185.14	228.76	124.55	81.17	22.17
1997	33517.36	19673	24846.05	7052.1	3748.97	1670.51	416.81	176.37	81.9	129.38	61.26	47.91
1998	12756.42	27130.43	15354.06	18134.42	4174.92	1861.44	803.08	191.95	80.15	40.82	62.5	54.1
1999	58813.51	10296.59	20684.24	10820.89	11702.9	2170.37	906.01	324.53	87.49	36.67	8.08	58.61
2000	35840.25	47861.07	7837.47	14133.45	6551.15	5859.93	949.02	397.94	132.69	49.91	5.59	13.84
2001	88038.88	28609.69	36624.64	5074	7618.26	3349.46	2332.02	462.11	157.51	57.97	24.58	16.29
2002	105902.44	71062.19	21204.97	22351.6	2204.31	2907.5	1349.76	702.24	113.23	47.52	25.74	3.19

year	3	4	5	6	7	8	9	10	11	12	13	14+
2003	64250.85	86432.32	50581.07	11966.52	9445.21	1024.77	1222.27	684.34	247.4	62.84	6.33	0
2004	53951.7	52305.55	68564.24	31321.53	6183.44	3854.04	461.69	621.58	285.22	120.21	15.26	2.98
2005	69984.38	44103.14	41004.54	48404.72	17715.72	3139.79	1520.38	138.22	243.79	101.41	7.94	0
2006	22222.42	56887.57	33441.14	24988.39	24604.7	8080.96	1807.87	511.87	84.21	107.3	58.6	24.27
2007	18880.03	16859.55	42010.7	20338.75	13480.66	10828.42	3213.94	901.06	163.92	39.99	77	25.56
2008	31507.33	14705.74	10799.37	24166.26	10794.95	7615.84	4980.19	1239.71	370.36	60.91	22.79	0
2009	13723.87	21467.28	9227.81	5586.17	11307.34	5586.17	4223.87	2224.33	613.24	159.36	39.01	12.96
2010	24290.81	10820.83	10869.27	3050.81	2906.86	4582.37	2755.75	1923.6	853.85	237.87	93.37	0
2011	34720.15	17784.79	6220.84	4105.17	1479.85	1466.95	1853.38	1126.98	822.09	358.86	148.6	17.37
2012	34439.89	26709.98	12078.08	3337.81	1728.71	779.99	721.48	880.41	451.27	275.85	168.94	38.35
2013	35951.06	27419.74	12971.02	6140.86	1599.91	600.09	363.53	312.91	359.79	162.26	102.79	93.87
2014	61619.17	28781.85	17769.57	6802.26	2999.07	847.52	302.2	187.24	169.32	162.46	55.94	3.47
2015	26993.00	49649.00	21472.00	11711.00	4048.00	1674.00	396.00	158.00	70.00	75.00	83.00	33.00

Table 6.3.3. Faroe saithe (Division Vb). Summary table (1961-2014). Values for 2015-2017 are estimates.

year	Recruits (age 3)	SSB (tonnes)	Yield (tonnes)	Yield/SSB	Fbar(4-8)
1961	7827	68467	9592	0.13	0.106
1962	12256	72862	10454	0.154	0.125
1963	19837	76441	12693	0.173	0.114
1964	14811	80928	21893	0.272	0.23
1965	22362	84690	22181	0.284	0.214
1966	21229	87313	25563	0.3	0.25
1967	24897	85361	21319	0.241	0.204
1968	22879	93938	20387	0.213	0.16
1969	39798	103452	27437	0.274	0.191
1970	37092	109688	29110	0.275	0.189
1971	38446	121969	32706	0.245	0.179
1972	33424	137956	42663	0.308	0.236
1973	23621	130735	57431	0.439	0.318
1974	19420	134009	47188	0.352	0.272
1975	17327	135484	41576	0.307	0.297
1976	19709	129099	33065	0.256	0.267
1977	13106	122227	34835	0.273	0.328
1978	8332	105216	28138	0.266	0.243
1979	8686	96036	27246	0.277	0.257
1980	13075	96216	25230	0.264	0.211
1981	33145	85056	30103	0.37	0.382
1982	15676	94389	30964	0.341	0.336
1983	40830	98639	39176	0.397	0.385
1984	26075	104707	54665	0.523	0.478
1985	22332	110005	44605	0.431	0.382
1986	61856	91583	41716	0.484	0.505
1987	48619	94297	40020	0.441	0.396
1988	44854	103005	45285	0.443	0.456
1989	28601	107398	44477	0.427	0.36
1990	20712	103216	61628	0.609	0.562
1991	24971	76177	54858	0.725	0.703
1992	19572	59993	36487	0.579	0.52
1993	23780	59260	33543	0.557	0.451
1994	16877	57407	33182	0.564	0.491
1995	38973	55521	27209	0.48	0.442
1996	24356	60584	20029	0.32	0.344
1997	33517	68222	22306	0.327	0.304
1998	12756	74050	26421	0.349	0.287
1999	58813	77635	33207	0.42	0.335
2000	35840	80387	39020	0.478	0.383
2001	88038	83993	51786	0.616	0.5
2002	105902	81692	53546	0.655	0.481

year	Recruits (age 3)	SSB (tonnes)	Yield (tonnes)	Yield/SSB	Fbar(4-8)
2003	64250	97221	46555	0.478	0.413
2004	53951	112980	46355	0.409	0.354
2005	69984	127585	67967	0.533	0.357
2006	22222	127123	66902	0.528	0.432
2007	18880	120818	60785	0.505	0.396
2008	31507	104362	57044	0.542	0.427
2009	13723	93278	57949	0.614	0.61
2010	24290	69401	43885	0.632	0.568
2011	34720	56238	29658	0.527	0.445
2012	34439	49174	35314	0.718	0.591
2013	35951	48637	26463	0.544	0.423
2014	61619	70026	23854	0.341	0.315
2015	26993	82089	35361		0.314
2016	26993	96782	37467		0.314
2017	26993	104194			
Avg.	31662	92151	36994	0.41	0.36

Table 6.6.1.1. Faroe saithe (Division Vb). Input data for prediction with management options for the SPALY assessment .

2015								
Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	26993	0.2	0.04	0	0	1.299	0.016	1.299
4	49649	0.2	0.26	0	0	1.528	0.201	1.528
5	21472	0.2	0.51	0	0	1.850	0.269	1.850
6	11711	0.2	0.74	0	0	2.239	0.324	2.239
7	4048	0.2	0.90	0	0	2.602	0.397	2.602
8	1674	0.2	0.98	0	0	4.451	0.381	4.451
9	396	0.2	0.98	0	0	5.296	0.366	5.296
10	158	0.2	1.00	0	0	5.942	0.448	5.942
11	70	0.2	1.00	0	0	6.088	0.480	6.088
12	75	0.2	1.00	0	0	6.634	1.000	6.634
13	83	0.2	1.00	0	0	7.402	1.000	7.402
14	33	0.2	1.00	0	0	8.232	1.000	8.232
2016								
Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	26993	0.2	0.04	0	0	1.299	0.016	1.299
4	-	0.2	0.26	0	0	1.528	0.201	1.528
5	-	0.2	0.51	0	0	1.850	0.269	1.850
6	-	0.2	0.74	0	0	2.239	0.324	2.239
7	-	0.2	0.90	0	0	2.602	0.397	2.602
8	-	0.2	0.98	0	0	4.451	0.381	4.451
9	-	0.2	0.98	0	0	5.296	0.366	5.296
10	-	0.2	1.00	0	0	5.942	0.448	5.942
11	-	0.2	1.00	0	0	6.088	0.480	6.088
12	-	0.2	1.00	0	0	6.634	1.000	6.634
13	-	0.2	1.00	0	0	7.402	1.000	7.402
14	-	0.2	1.00	0	0	8.232	1.000	8.232
2017								
Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	26993	0.2	0.04	0	0	1.299	0.016	1.299
4	-	0.2	0.26	0	0	1.528	0.201	1.528
5	-	0.2	0.51	0	0	1.850	0.269	1.850
6	-	0.2	0.74	0	0	2.239	0.324	2.239
7	-	0.2	0.90	0	0	2.602	0.397	2.602
8	-	0.2	0.98	0	0	4.451	0.381	4.451
9	-	0.2	0.98	0	0	5.296	0.366	5.296
10	-	0.2	1.00	0	0	5.942	0.448	5.942
11	-	0.2	1.00	0	0	6.088	0.480	6.088
12	-	0.2	1.00	0	0	6.634	1.000	6.634
13	-	0.2	1.00	0	0	7.402	1.000	7.402
14	-	0.2	1.00	0	0	8.232	1.000	8.232

Input units are thousands and kg - output in tonnes

Table 6.6.2.1. Faroe saithe (Division Vb). Prediction with management option for SPALY assessment.

2015						
Biomass	SSB	FMult	FBar	Landings		
199713	82089	1.000	0.314	35361		
2016					2017	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
195333	96782	0.0000	0.0000	0	232926	138536
.	96782	0.1000	0.0314	4263	228057	134572
.	96782	0.2000	0.0629	8399	223339	130737
.	96782	0.3000	0.0943	12414	218766	127027
.	96782	0.4000	0.1258	16310	214335	123437
.	96782	0.5000	0.1572	20092	210039	119962
.	96782	0.6000	0.1886	23764	205875	116600
.	96782	0.7000	0.2201	27329	201838	113345
.	96782	0.8000	0.2515	30791	197924	110195
.	96782	0.9000	0.2830	34153	194128	107146
.	96782	1.0000	0.3144	37418	190448	104194
.	96782	1.1000	0.3458	40590	186878	101335
.	96782	1.2000	0.3773	43671	183416	98567
.	96782	1.3000	0.4087	46664	180058	95887
.	96782	1.4000	0.4402	49572	176800	93292
.	96782	1.5000	0.4716	52398	173640	90778
.	96782	1.6000	0.5030	55144	170574	88344
.	96782	1.7000	0.5345	57813	167599	85986
.	96782	1.8000	0.5659	60407	164713	83701
.	96782	1.9000	0.5974	62929	161911	81488
.	96782	2.0000	0.6288	65380	159192	79345

Input units are thousands and kg - output in tonnes

Table 6.7.1.1. Faroe saithe (Division Vb). Yield per recruit input data.

Age	M	Mat	PF	PM	WeSt	Sel	WeCa
3	0.2	0.02	0	0	1.304	0.048	1.304
4	0.2	0.21	0	0	1.668	0.278	1.668
5	0.2	0.47	0	0	2.031	0.467	2.031
6	0.2	0.71	0	0	2.602	0.5118	2.602
7	0.2	0.86	0	0	3.373	0.52	3.373
8	0.2	0.95	0	0	4.318	0.5648	4.318
9	0.2	0.99	0	0	5.085	0.5572	5.085
10	0.2	1	0	0	5.904	0.6514	5.904
11	0.2	1	0	0	6.777	0.7174	6.777
12	0.2	1	0	0	7.472	0.5888	7.472
13	0.2	1	0	0	7.835	0.4844	7.835
14	0.2	1	0	0	9.388	0.4844	9.388

Table 6.9.1. Faroe saithe (Division Vb). Comparison between the current assessment (NWWG2015 SPALY) statistical assessment (NWWG2015 ADMB) and predictions from last year in the terminal year (2014).

	NWWG2014 prediction	NWWG2015 (SPALY)	NWWG2015 (ADMB)
Recruitment	28 mill.	62 mill.	20 mill.
SSB	70 000 t.	70 000 t.	94 000 t.
Fbar(4-8)	0.53	0.32	0.23
Landings	38 000 t.	24 000 t.	27 000 t.

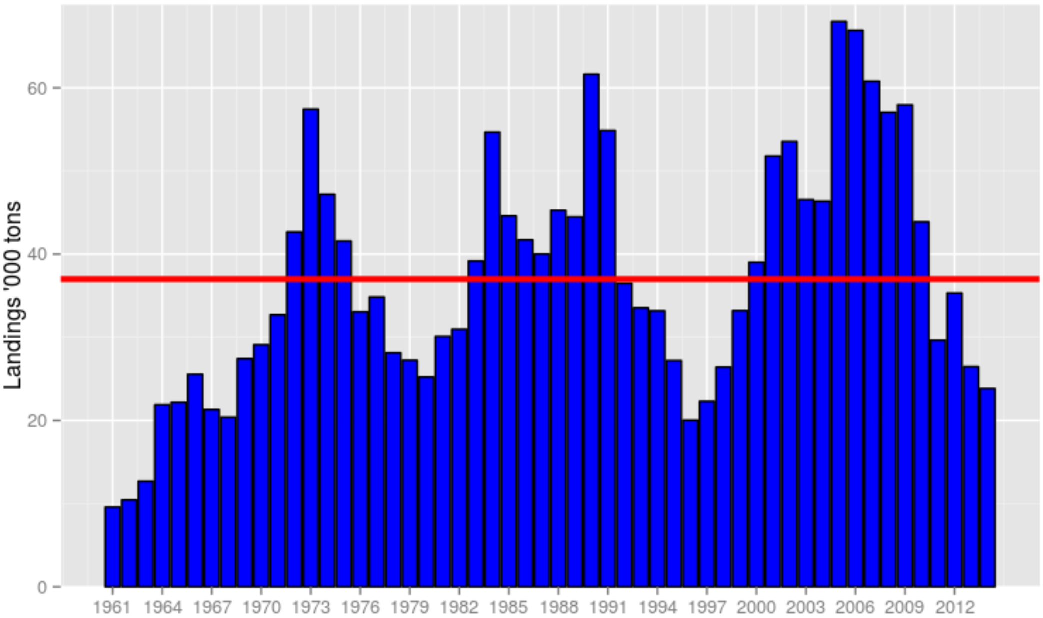

Figure 6.2.1.1. Faroe saithe (Division Vb). Landings in 1000 tonnes (1961-2014). Horizontal red line represents historical average landings.

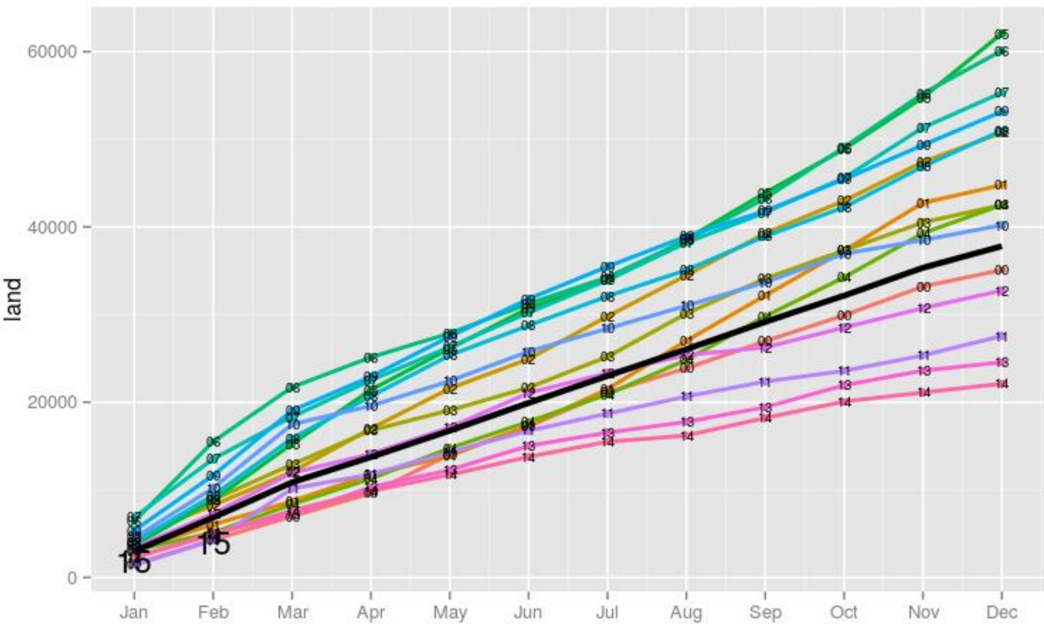

Figure 6.2.1.2. Saithe in the Faroes (Division Vb). Cumulative domestic landings (2000-2015).

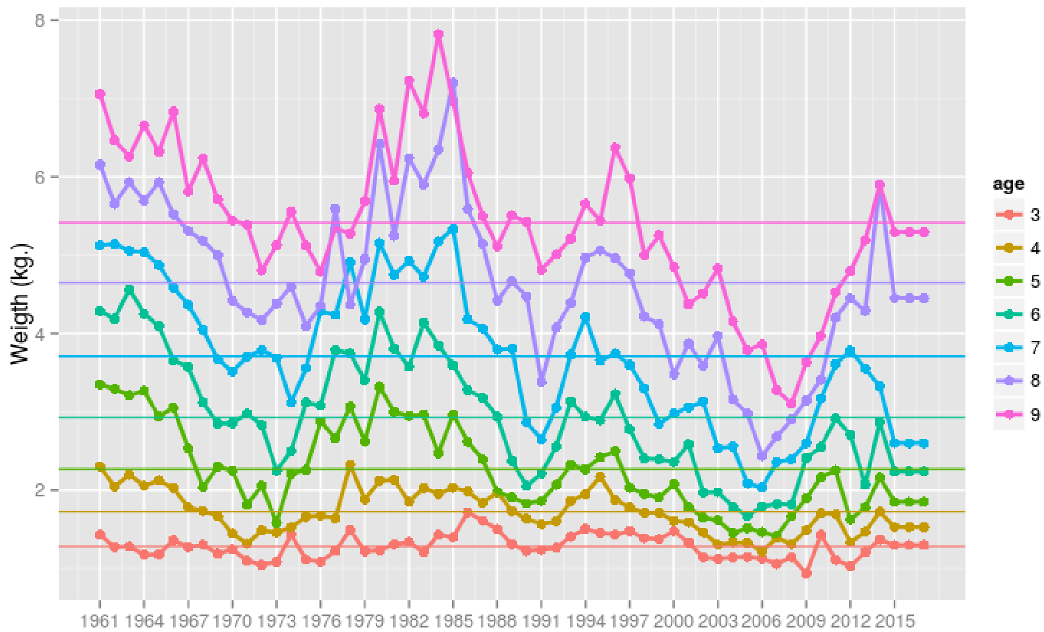

Figure 6.2.3.1. Faroe saithe (Division Vb). Mean weight at age (kg) in commercial catches (ages 3-9) (1961-2017). Weights from 2015 to 2017 are estimates. Horizontal lines show historical average.

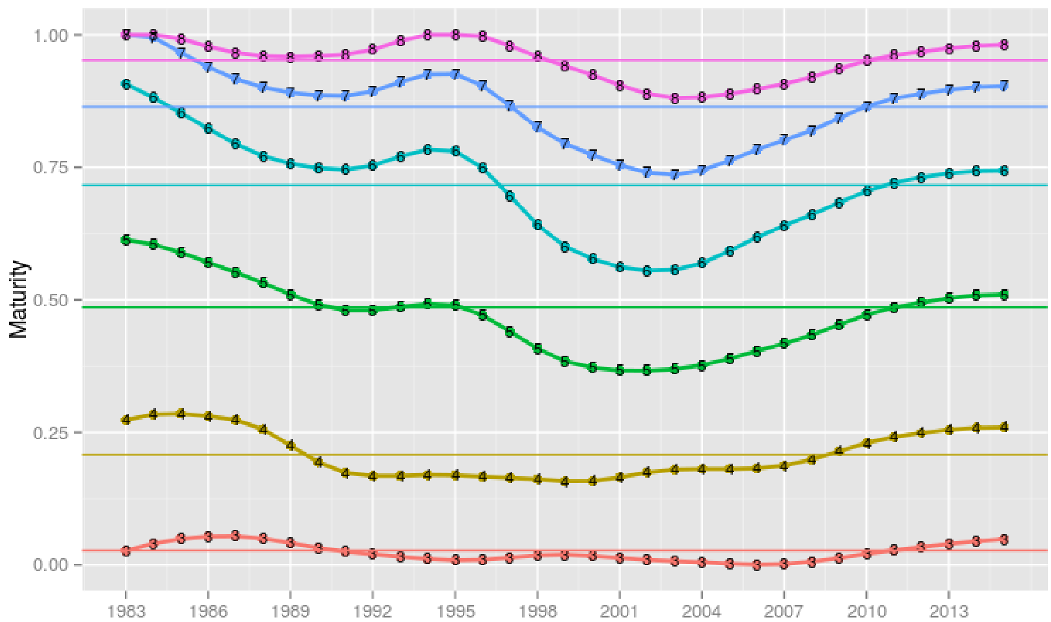

Figure 6.2.4.1. Faroe saithe (Division Vb). Smoothed maturity ogives (ages 3-8)(1983-2015) from FGFS1 (spring survey). Horizontal lines show historical average.

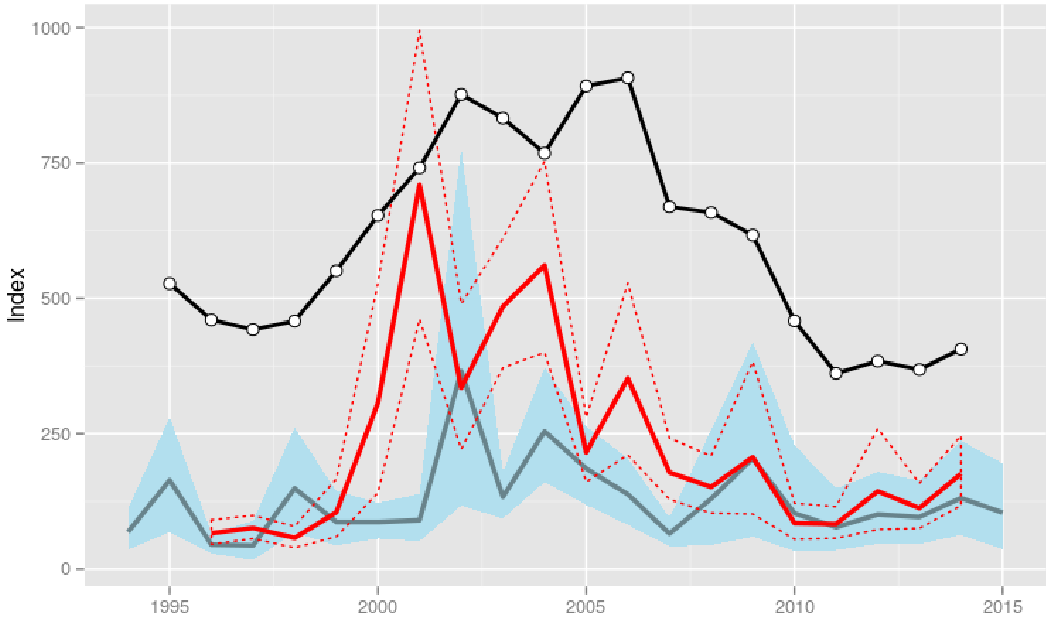

Figure 6.2.5.1.1. Faroe saithe (Division Vb). Predicted catch rates from the commercial fleet (pair-trawlers) used for tuning the assessment (black line). Catch rates (kg/hour) from the Faroese bottom-trawl fall FGFS2 (1996-2014)(red line) and spring survey FGFS1 (1994-2015)(blue line). Dotted lines and shade areas show standard errors in the estimation of indices.

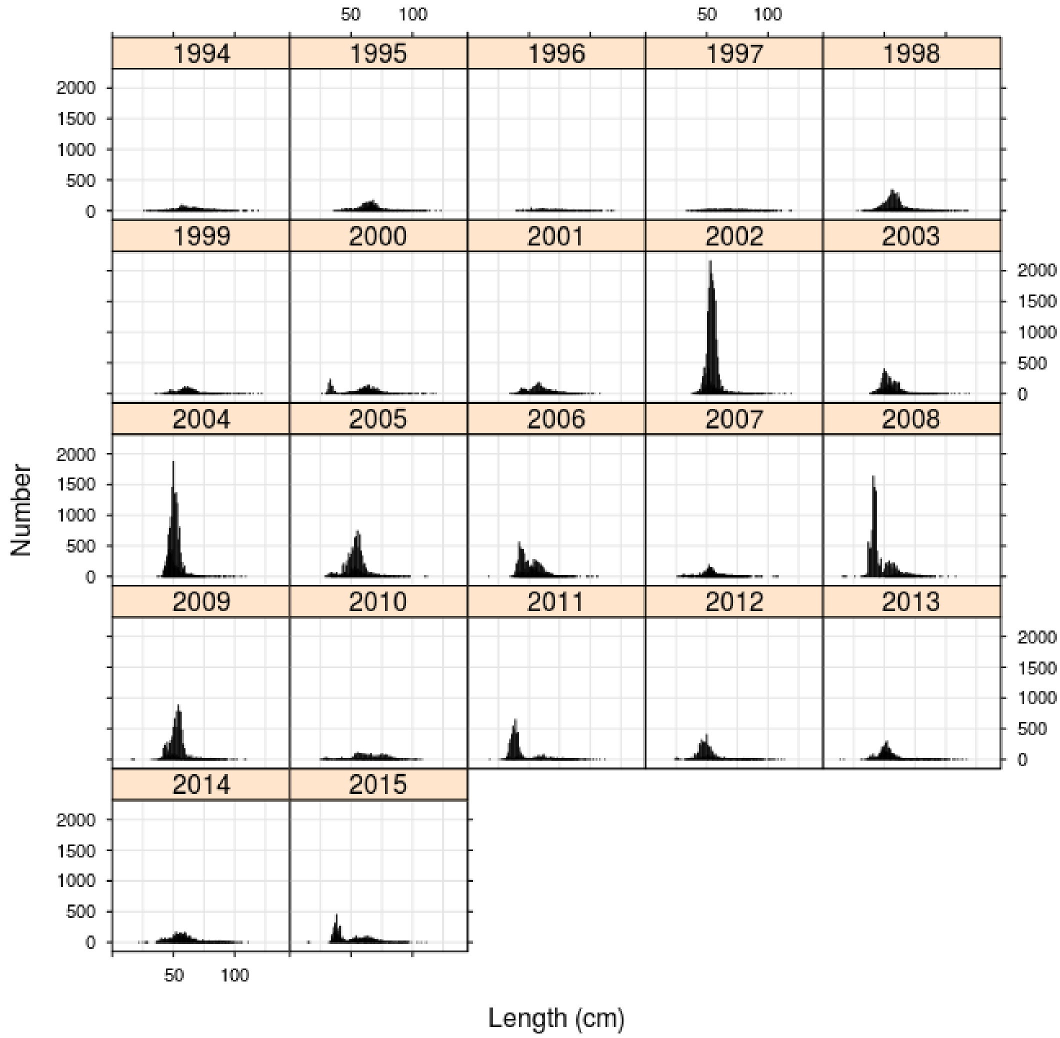

Figure 6.2.5.1.2. Faroe saithe (Division Vb). Length composition from the Faroese bottom-trawl spring survey FGFS1 (1994-2015)

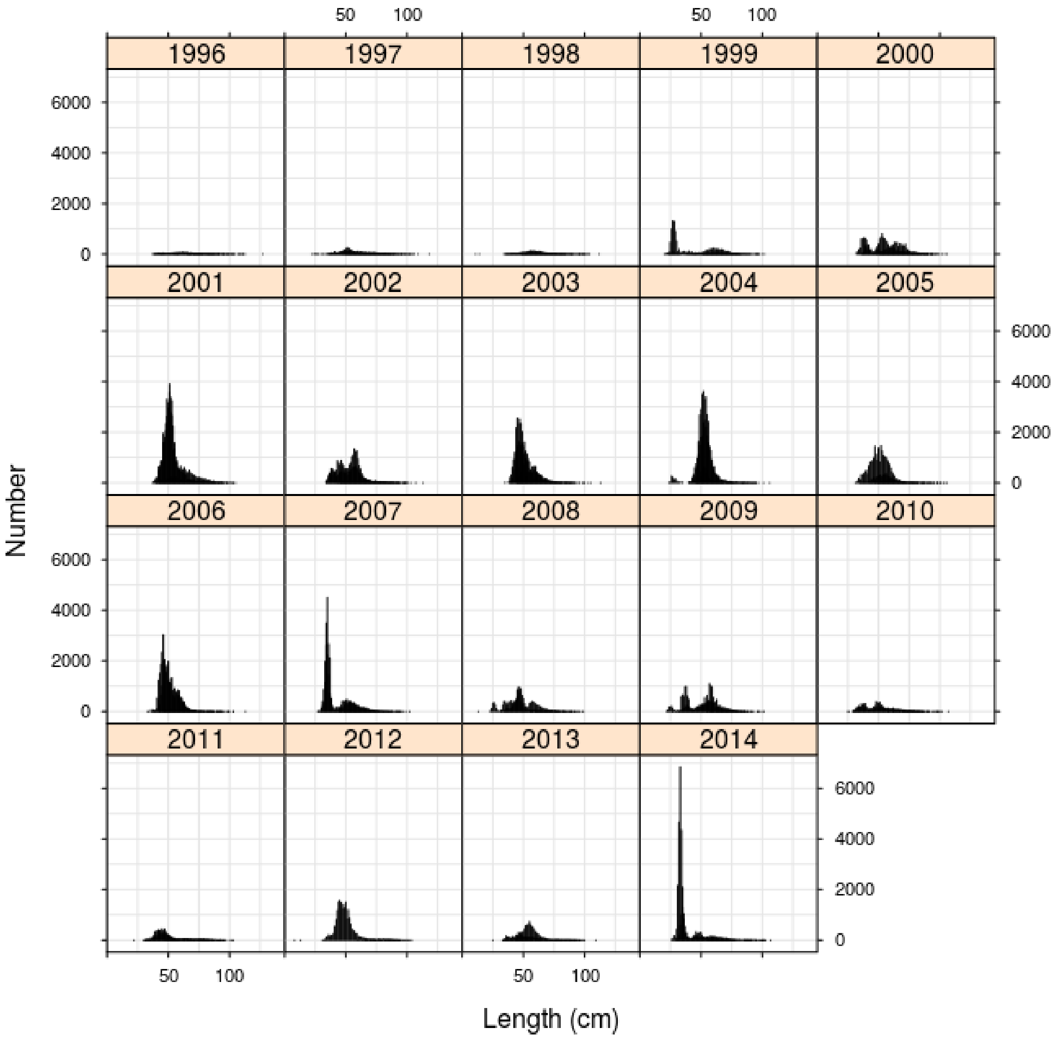

Figure 6.2.5.1.3. Faroe saithe (Division Vb). Length composition from the Faroese bottom-trawl summer survey FGFS2 (1996-2014)

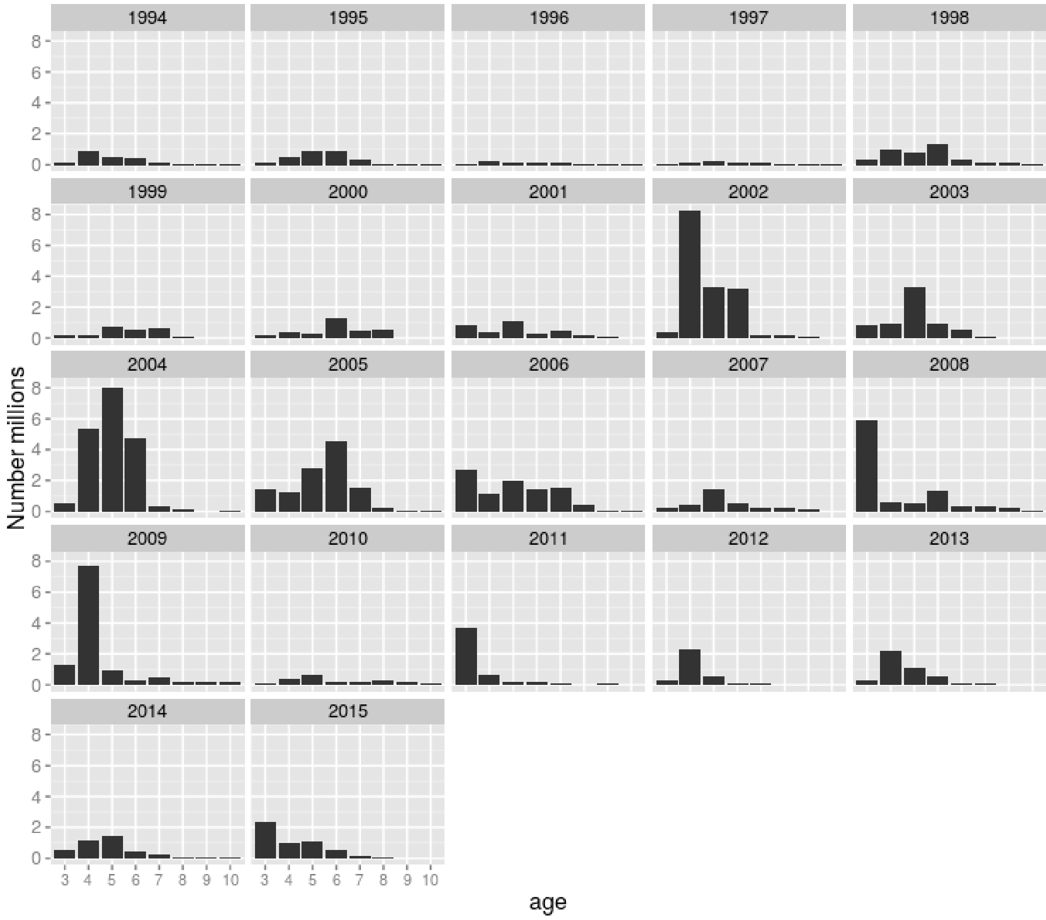

Figure 6.2.5.1.4. Faroe saithe (Division Vb). Age-disaggregated indices in the Faroese bottom-trawl spring survey FGFS1 (ages 3-10, years 1994-2015)

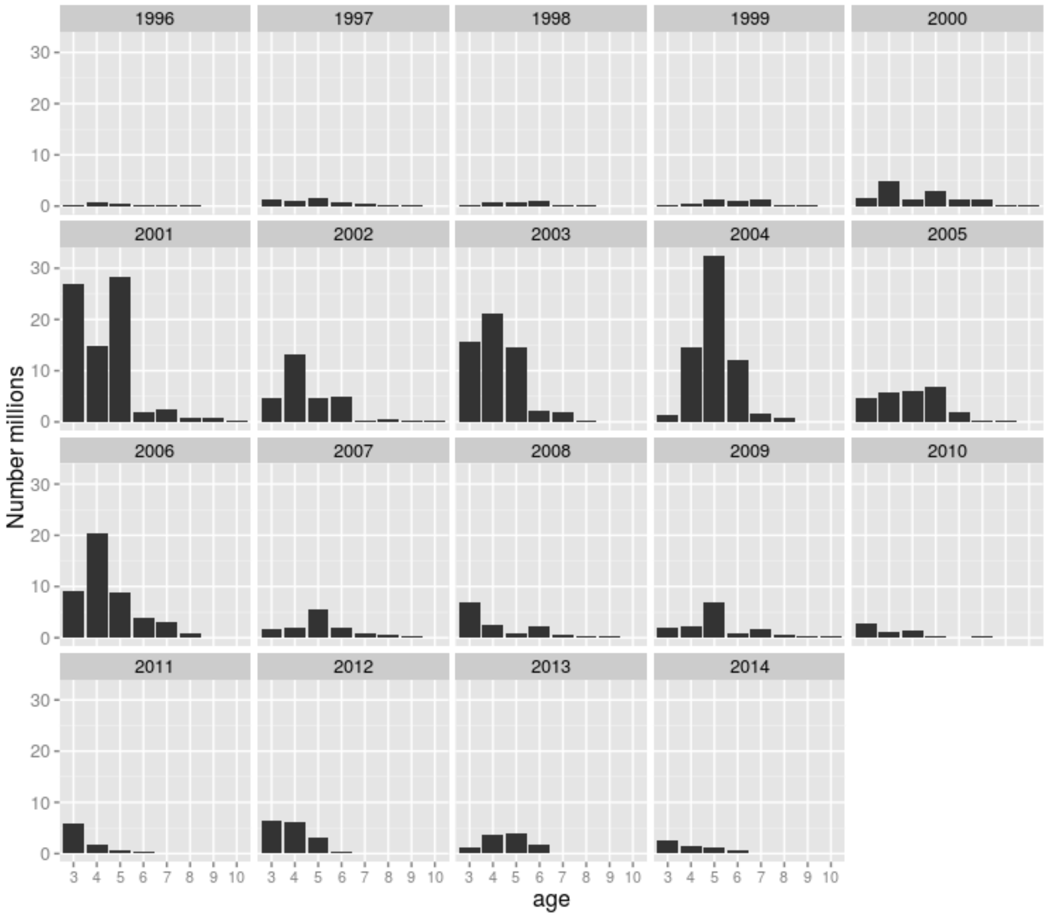

Figure 6.2.5.1.5. Faroe saithe (Division Vb). Age-disaggregated indices in the Faroese bottom-trawl fall survey FGFS2 (ages 3-10, years 1996-2014)

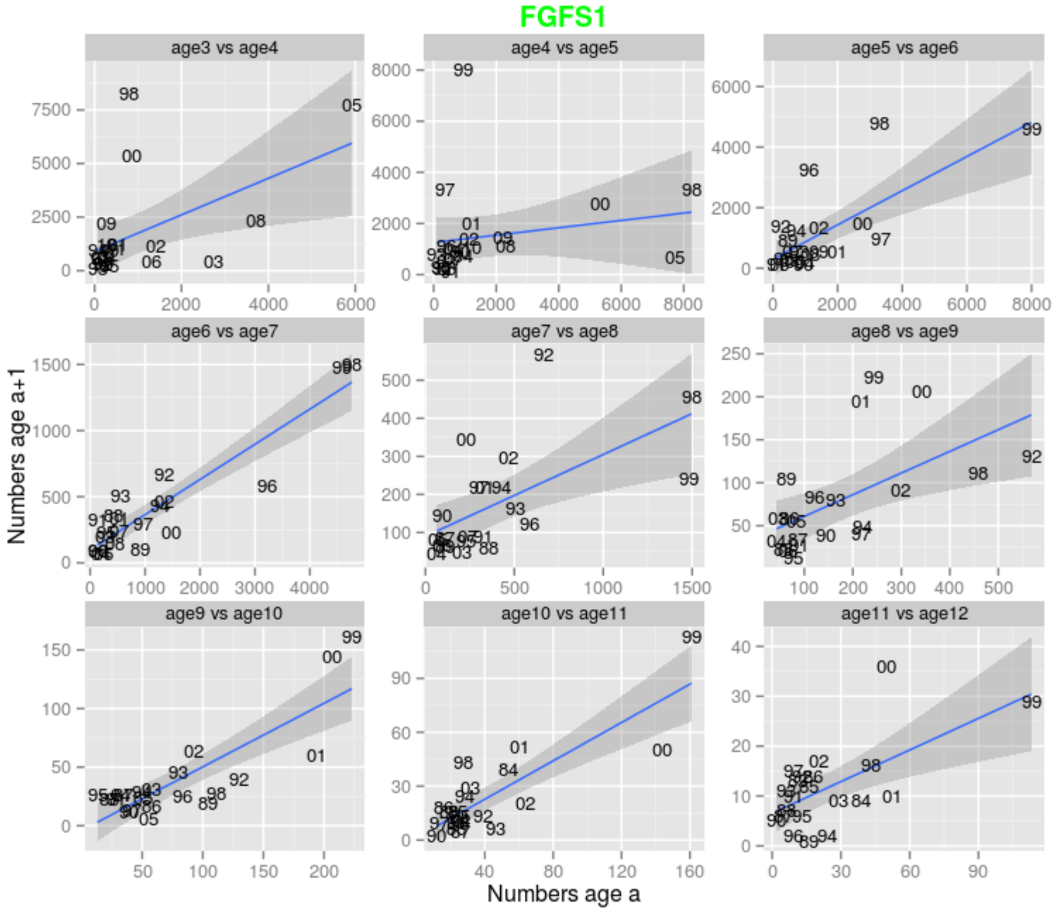

Figure 6.2.5.1.6. Faroe saithe (Division Vb). Numbers from spring survey (FGFS1) plotted against numbers of the same year class one year later. Letters in the figures represent year classes.

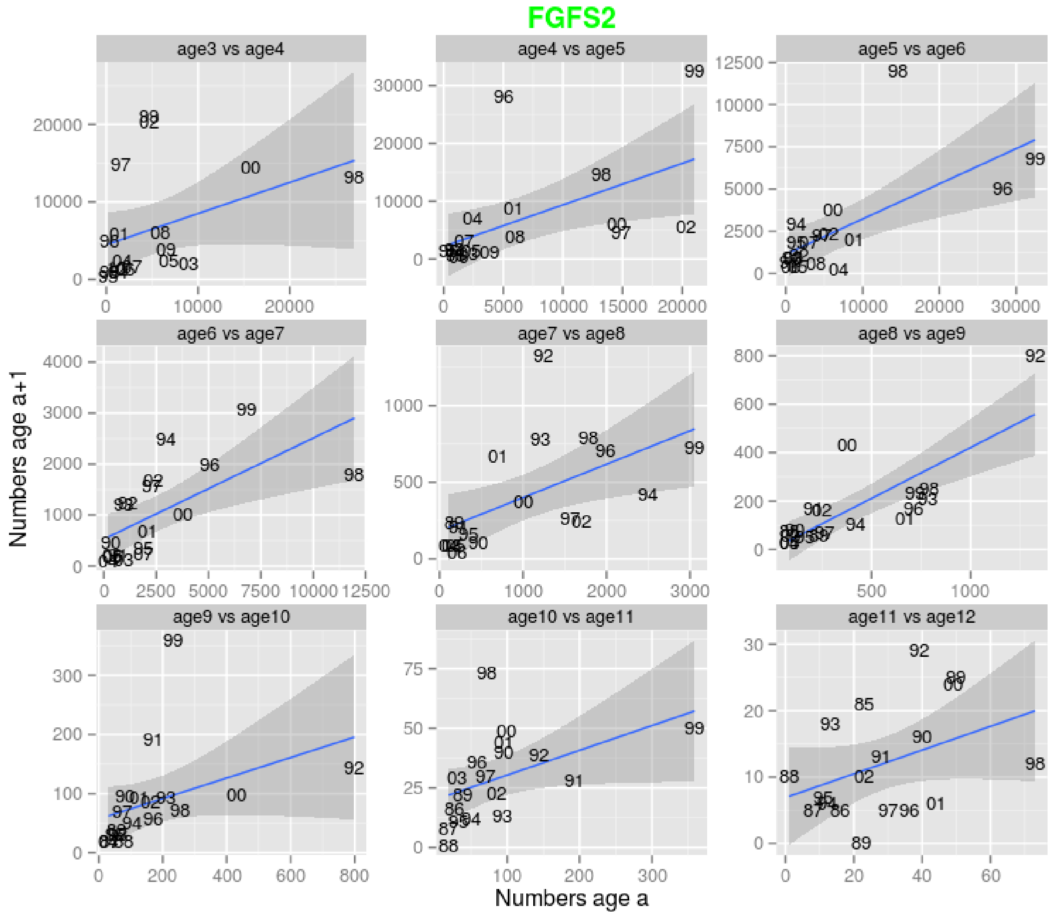

Figure 6.2.5.1.7. Faroe saithe (Division Vb). Numbers from summer survey (FGFS2) plotted against numbers of the same year class one year later. Letters in the figures represent year classes.

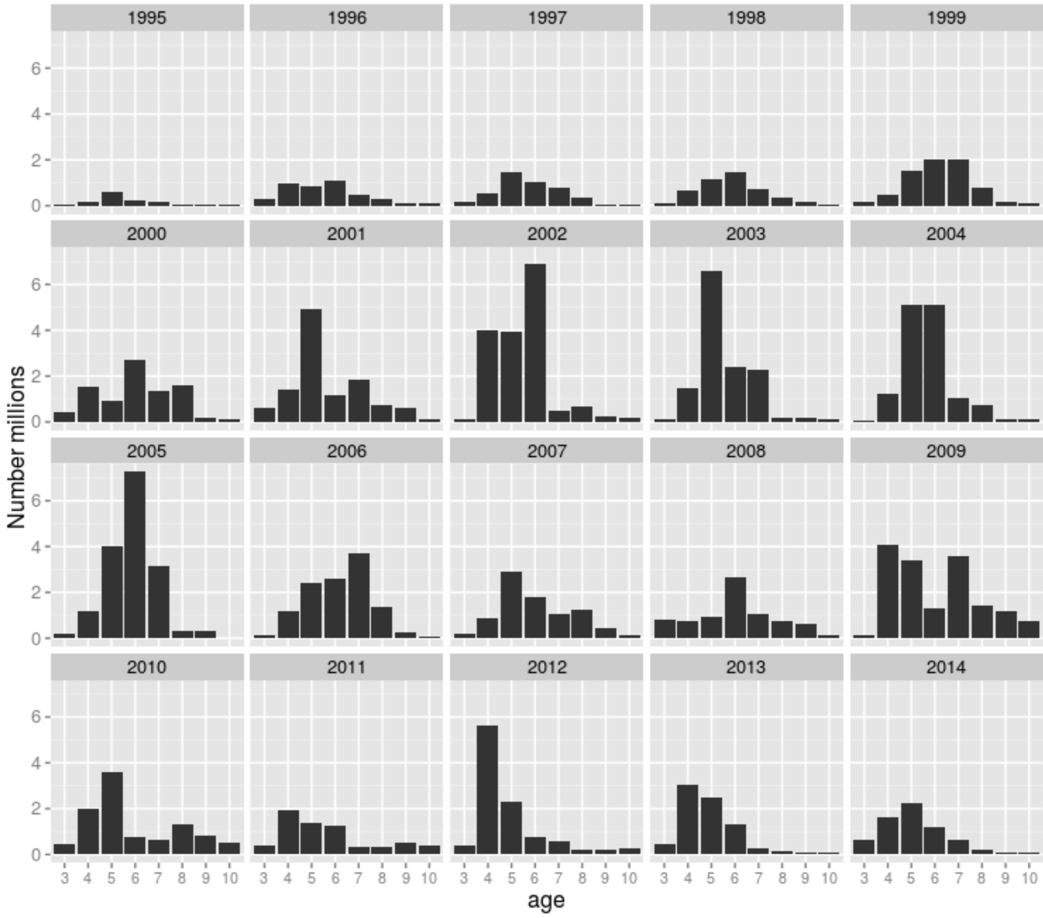

Figure 6.2.5.2.1. Faroe saithe (Division Vb). Age-disaggregated indices in the commercial pair-trawl fleet (ages 3-10, years 1995-2014)

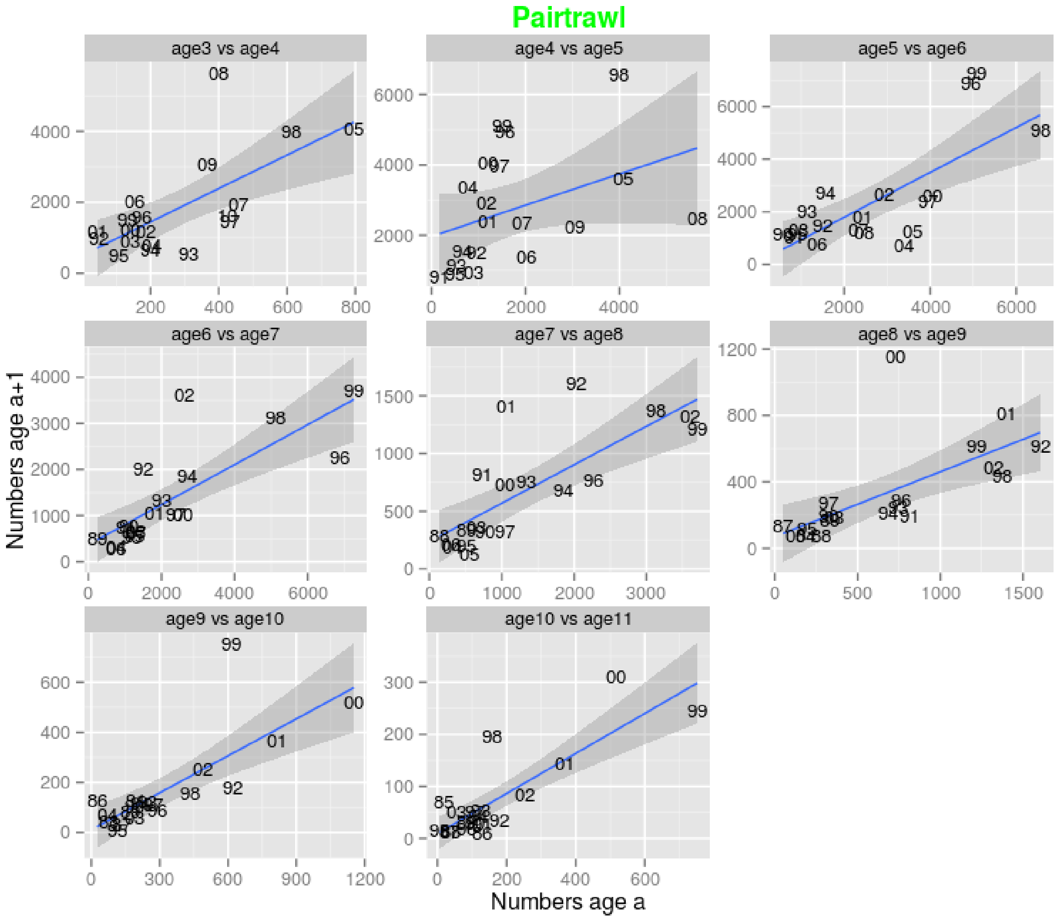

Figure 6.2.5.2.2. Faroe saithe (Division Vb). Indices from in the commercial pair-trawl plotted against indices of the same year class one year later. Letters in the figures represent year classes.

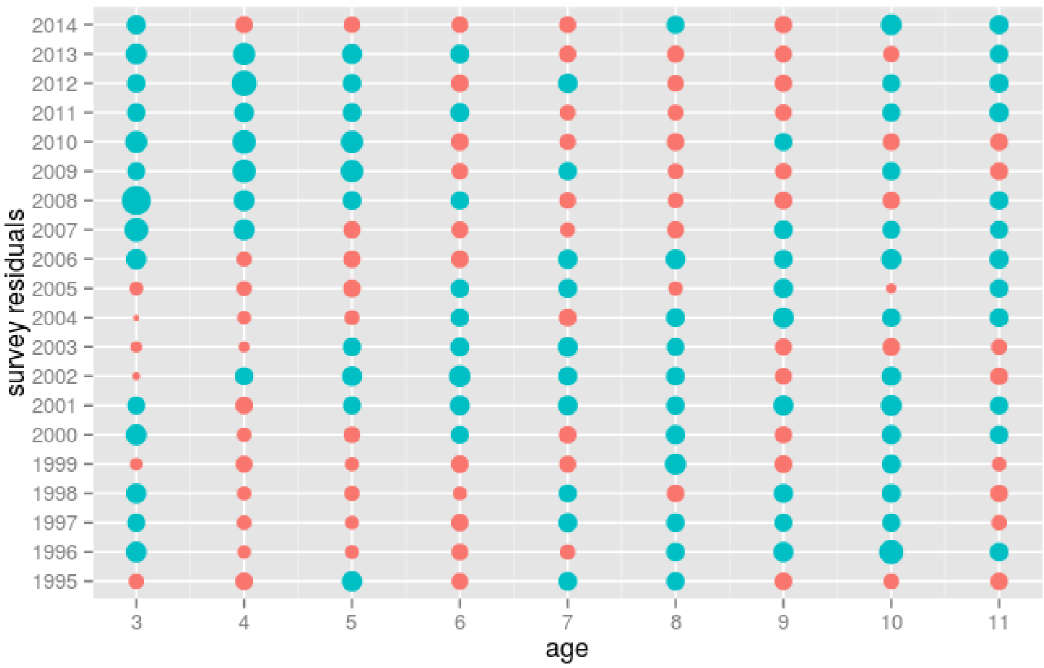

Figure 6.3.1. Faroe saithe (Division Vb). Log-catchability residuals of the spaly assessment calibrated with the commercial series (ages 3-11, years 1995-2014). Blue and red bubbles represent positive and negative residuals respectively.

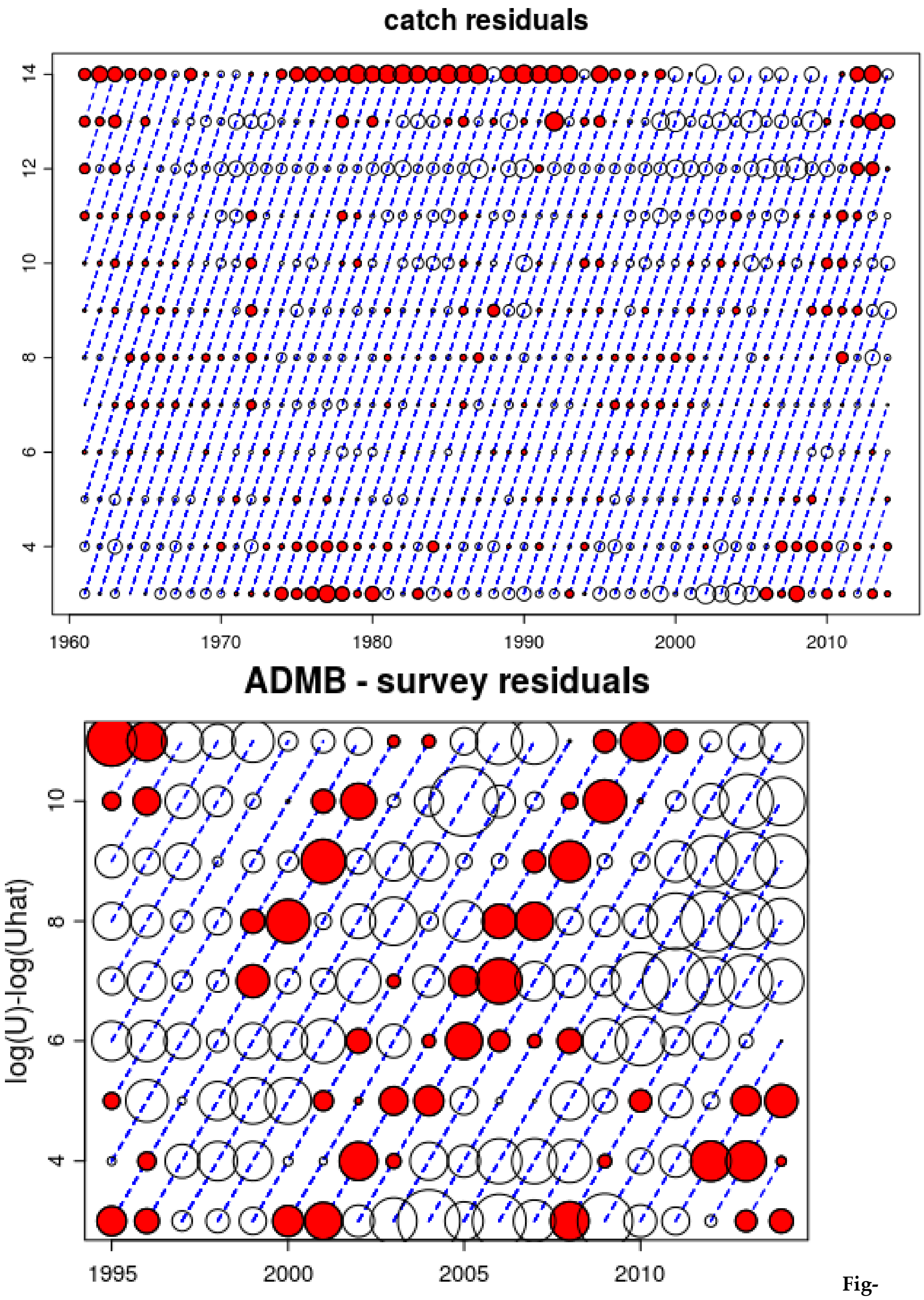

Figure 6.3.3. Faroe saithe (Division Vb). Catch- (ages 3-14+, years 1961-2014)(top plot) and survey-at-age (ages 3-11, years 1995-2014)(bottom plot) residuals from a statistical catch-at-age model. Red and white bubbles represent positive and negative residuals respectively.

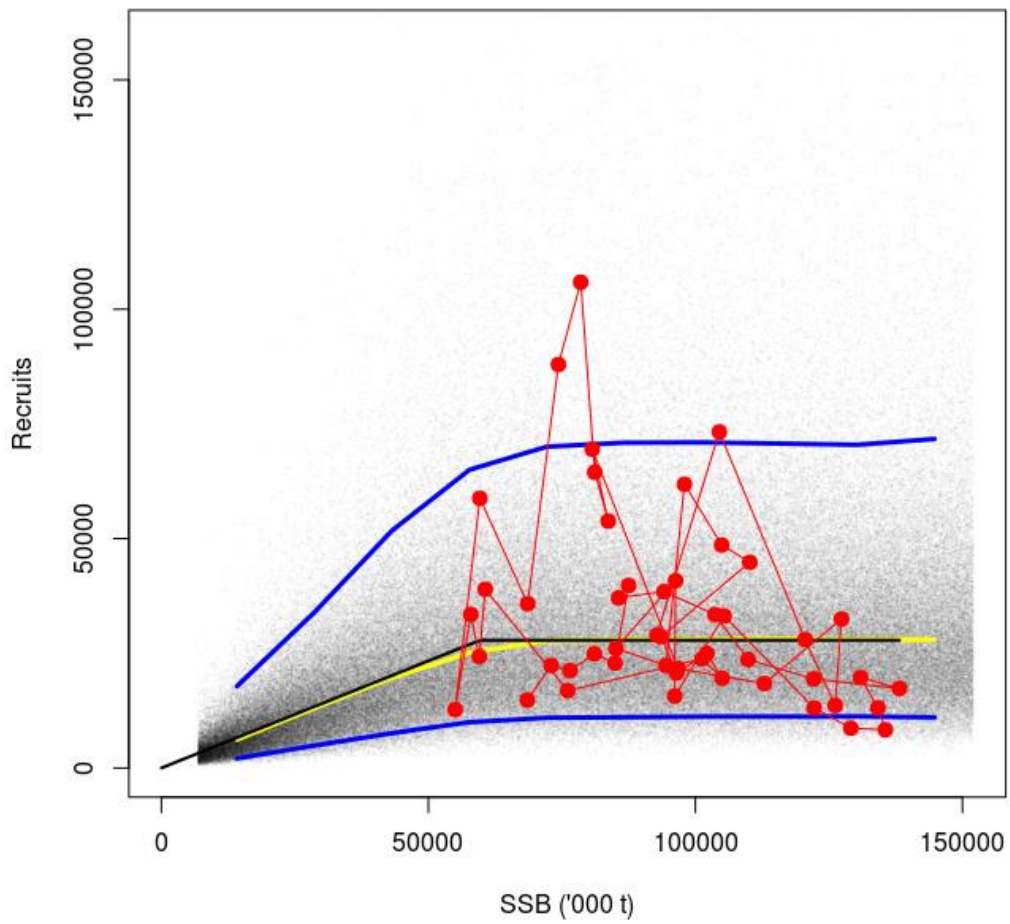

Figure 6.4.1.1. Faroe saithe (Division Vb). EqSim simulation. Stock-recruitment function used in the simulations (Hockey-stick).

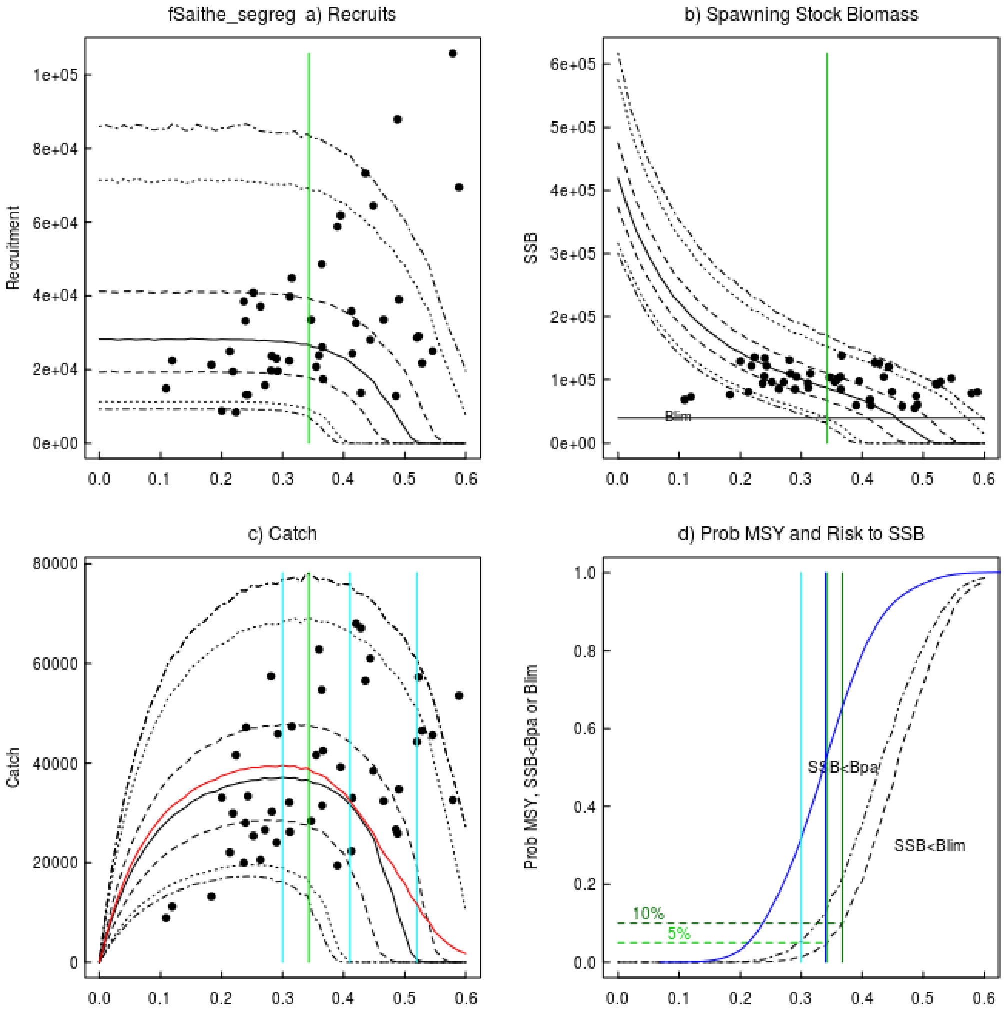

Figure 6.4.1.2. Faroe saithe (Division Vb). EqSim simulation outputs with assessment errors and Hockey-stick function from WKMSYREF2 report. Blim is undefined but was set as Blim=Bpa/1.4.

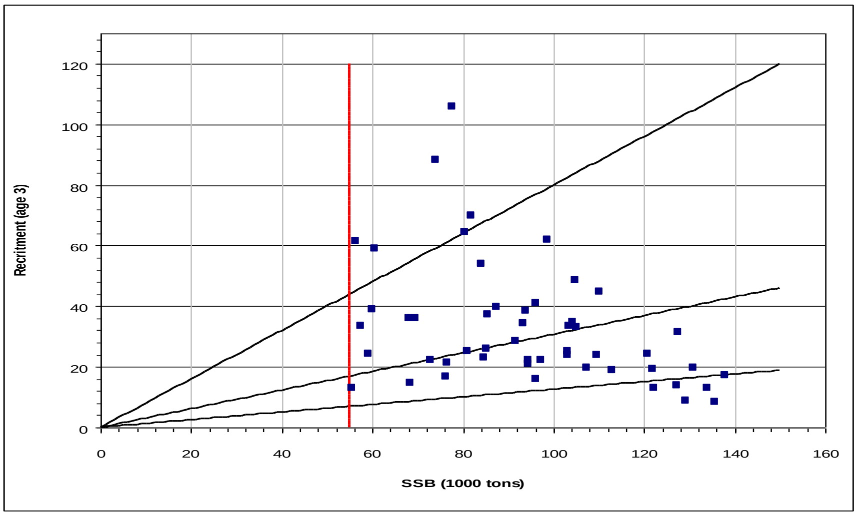

Figure 6.4.1.3. Faroe saithe (Division Vb). Stock-Recruitment plot in relation to Flow=0.13 (lowest regression line), Fmed=0.31 (middle regression line) and Fhigh=0.80 (top regression line). Vertical red line represents Btrigger= 55 000 t.

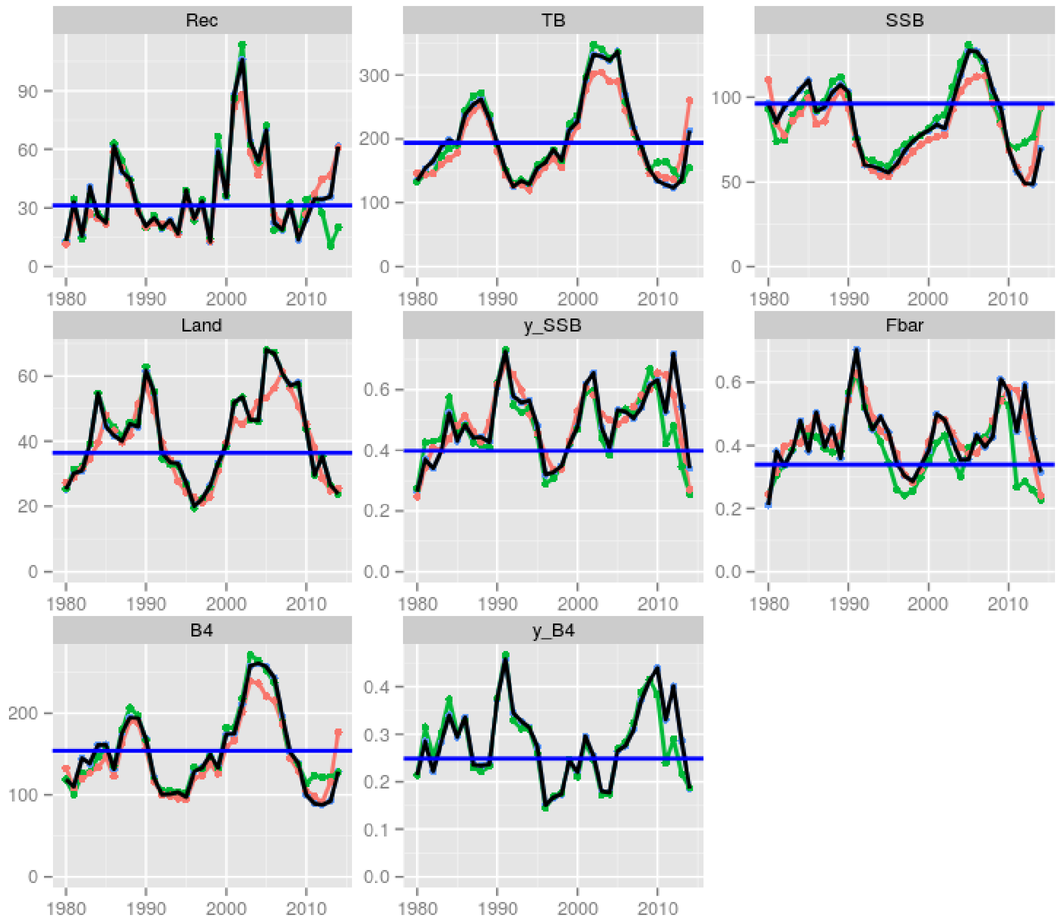

Figure 6.5.1. Faroe saithe (Division Vb). Recruitment (age 3) in millions (top-left), total stock biomass (thousand tonnes)(top-middle), spawning stock biomass (thousand tonnes) (bottom-left), landings (thousand tonnes)(middle-left), landings SSB ratio (middle-middle), Fbar (ages 4 to 8)(middle-right), reference biomass (B4+) (thousand tonnes) (bottom-left) and landings B4+ ratio (bottom-right). Black line represents the spaly run. Green lines show estimates from a catch-at-age statistical model implemented in ADMB. Red lines show a 'a4a' statistical model implemented in R. Horizontal blue lines represent historical averages.

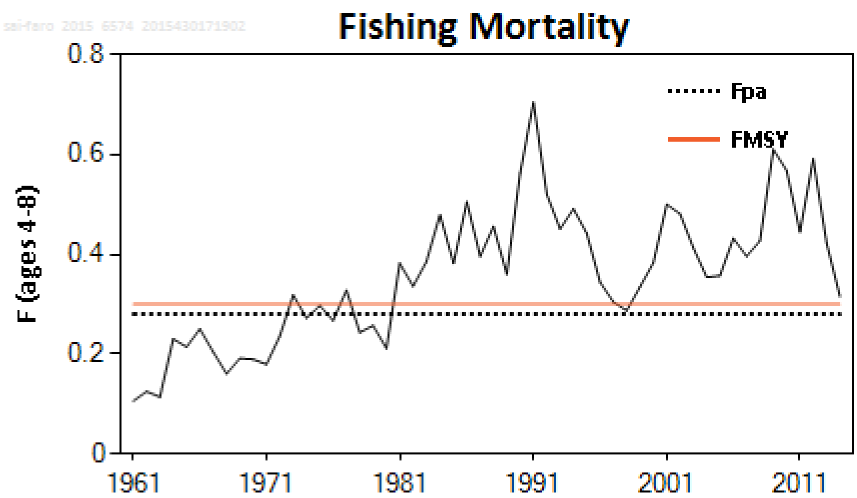

Figure 6.5.2. Faroe saithe (Division Vb). Fishing mortality (average over ages 4-8)(1961-2014)

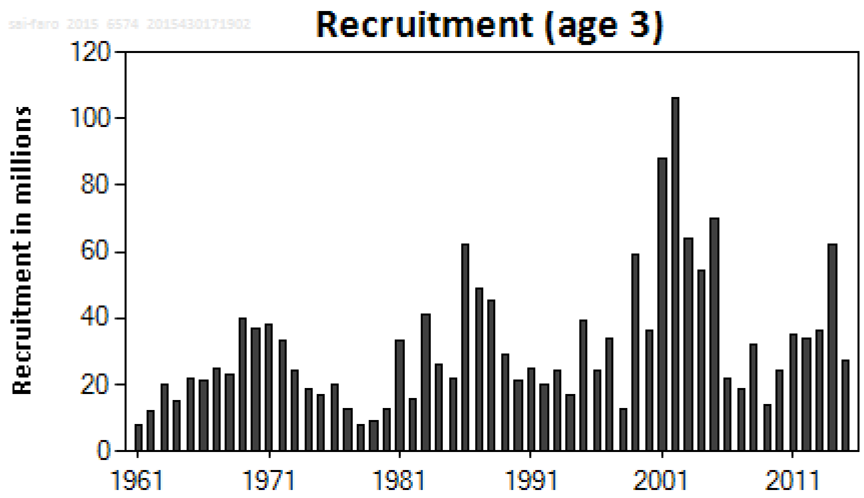

Figure 6.5.3. Faroe saithe (Division Vb). Recruitment at age 3 (millions)(1961-2015). The 2015 recruitment estimate is used in the short-term forecast.

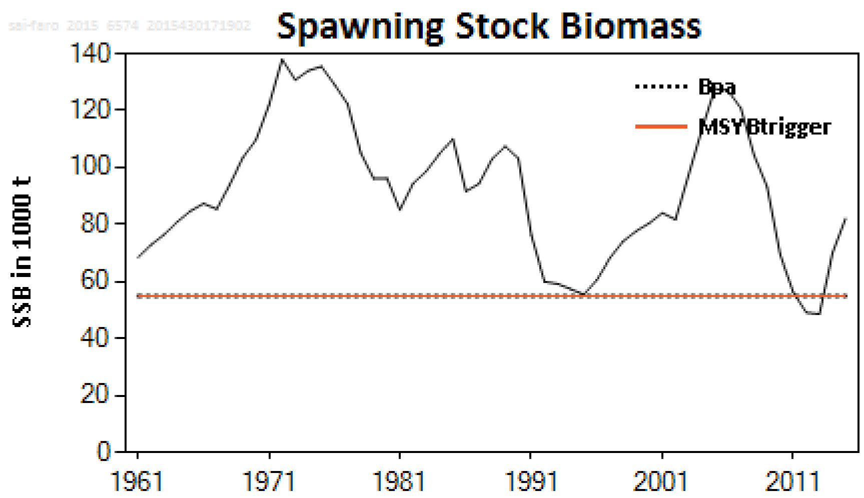

Figure 6.5.4. Faroe saithe (Division Vb). Spawning stock biomass ('000 tonnes)(1961-2015). The 2015 SSB estimate is used in the short-term forecast. Horizontal lines represent Btrigger=Bpa=55 000 t.

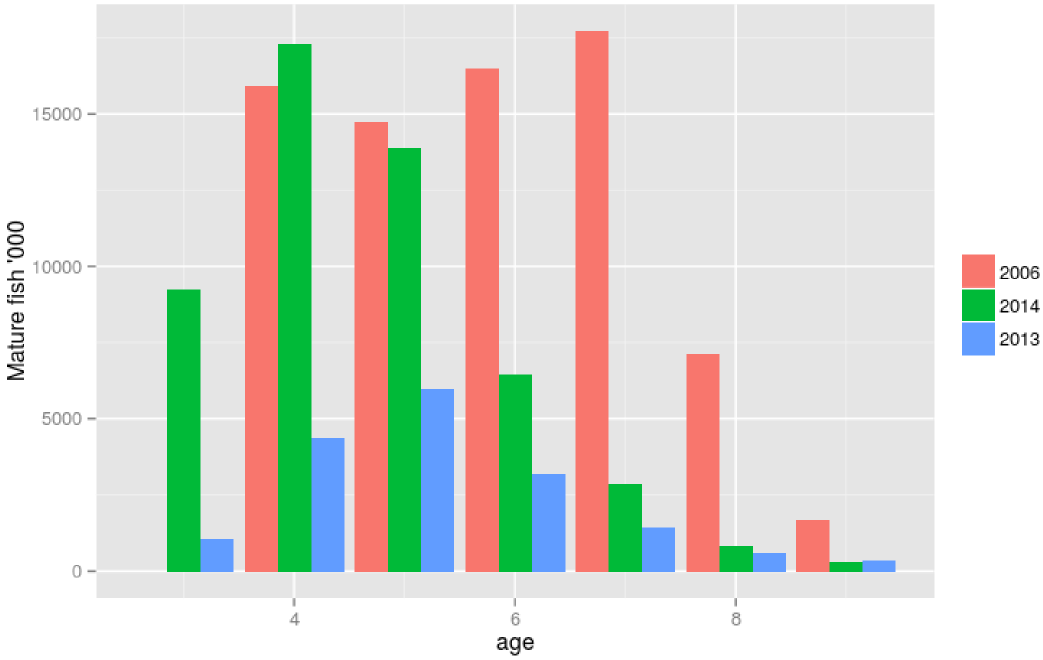

Figure 6.5.6. Faroe saithe (Division Vb). Numbers of mature fish in the stock (ages 3-9) for 2006, 2013 and 2014.

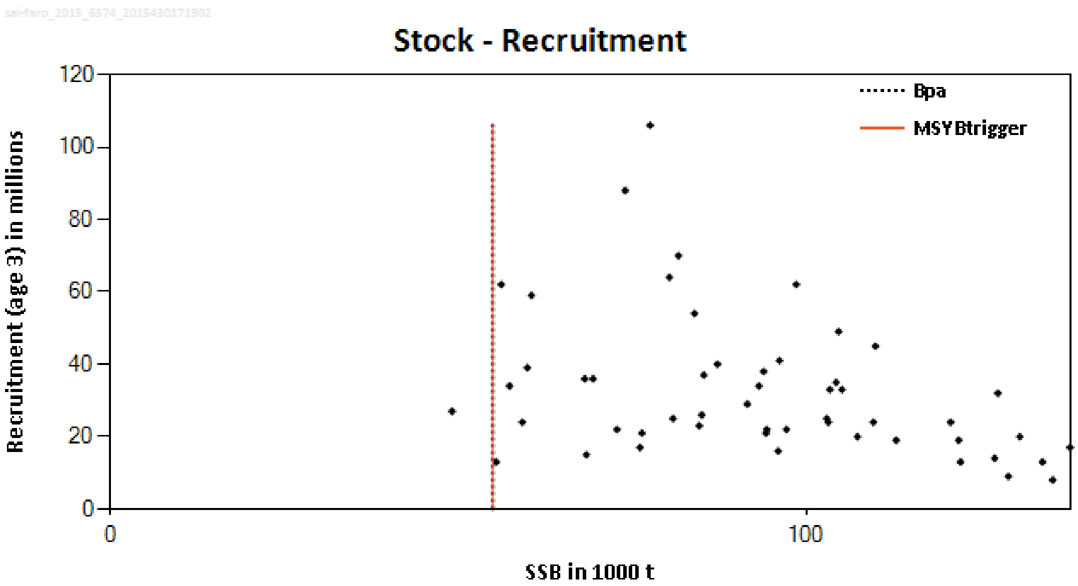

Figure 6.5.7. Faroe saithe (Division Vb). SSB - Recruitment (age 3) plot. Btrigger=Bpa=55 000 t.

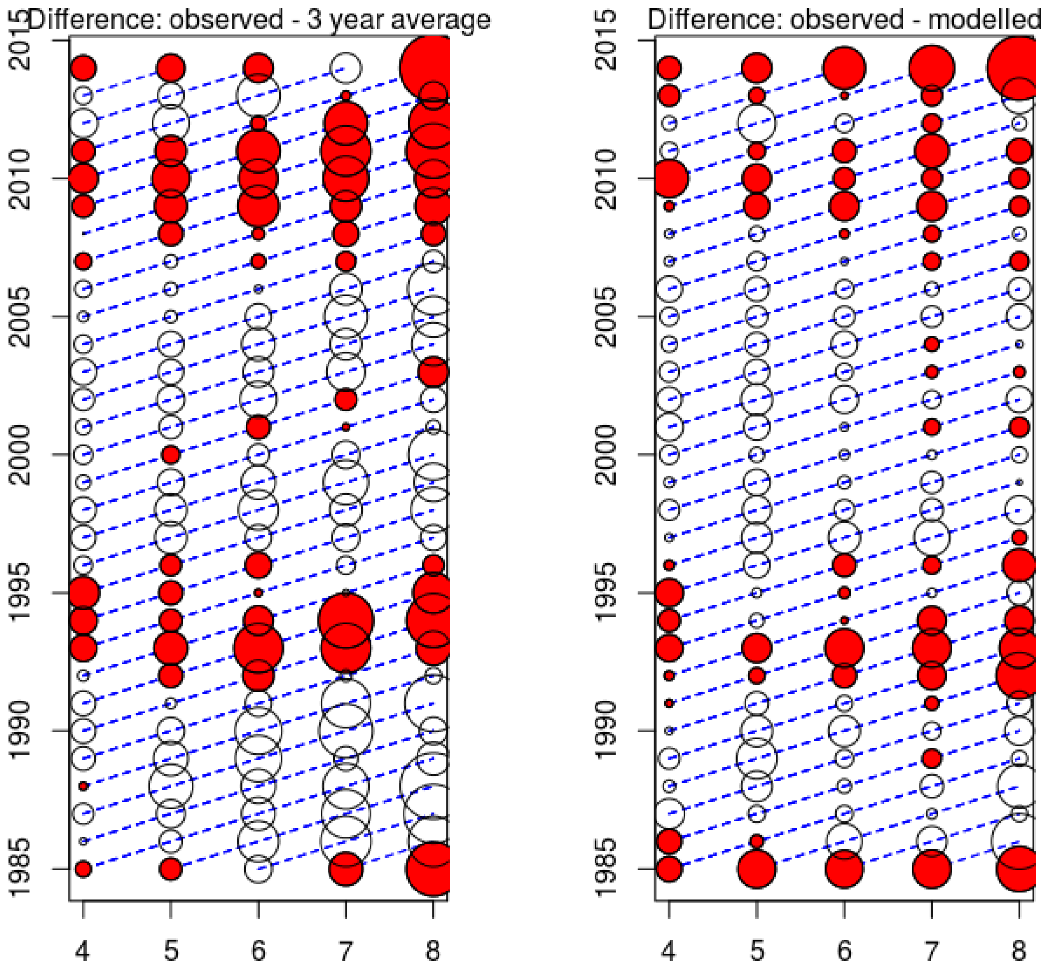

Figure 6.6.1.1. Faroe saithe (Division Vb). Residual plots from a 3-year running average weight model and the model in which weights are predicted from the previous year in the same year class. Red and white bubbles represent positive and negative residuals respectively.

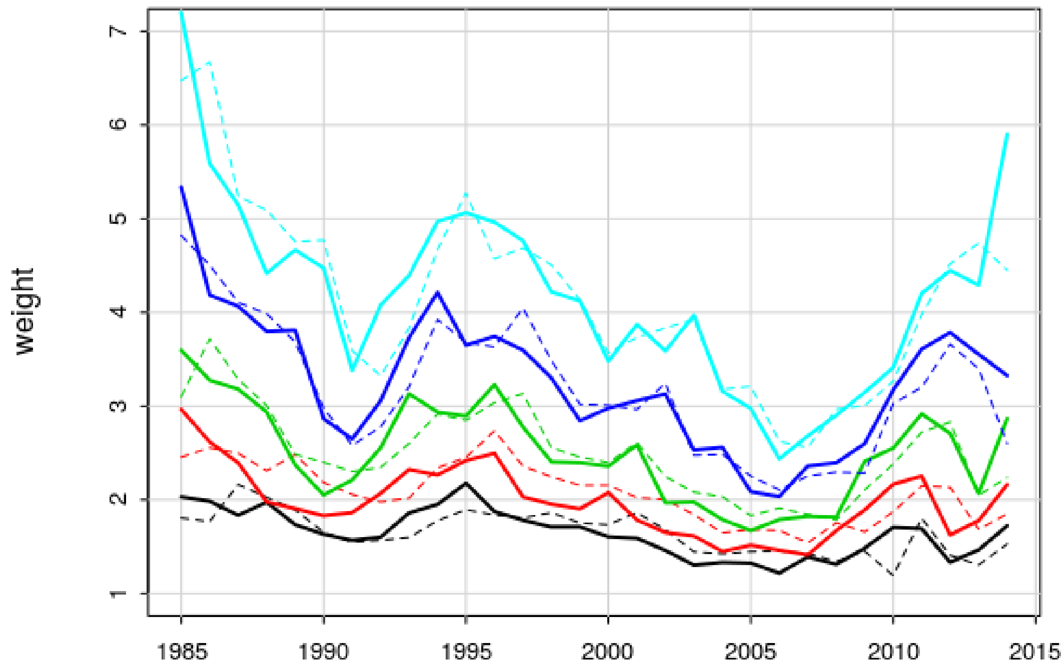

Figure 6.6.1.2. Faroe saithe (Division Vb). Observed (stapled lines) and predicted weights (solid lines)(ages 4-8, years 1985-2014)

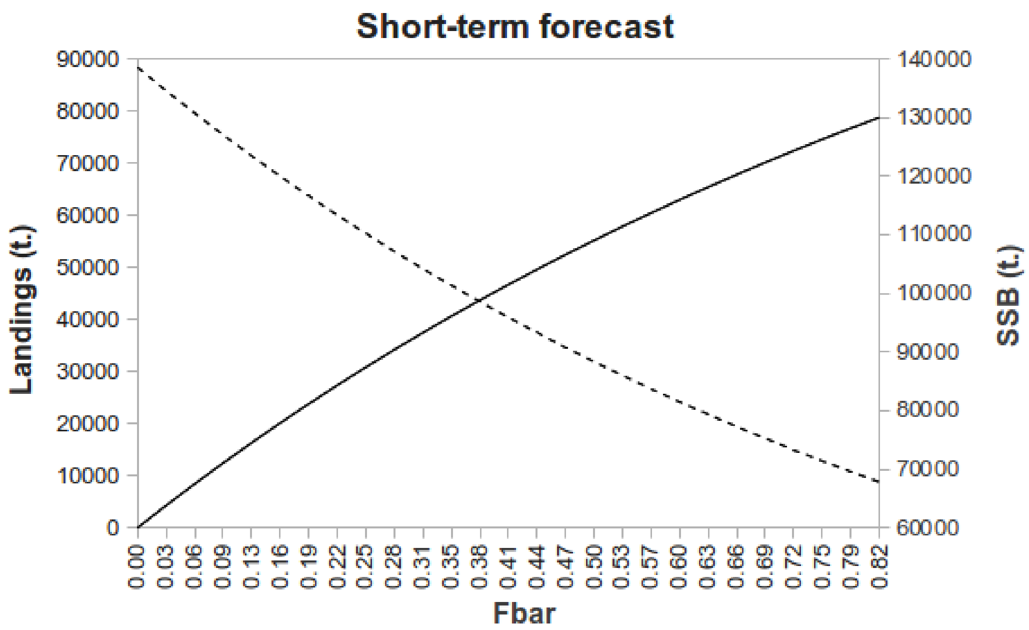

Figure 6.6.2.1. Faroe saithe (Division Vb). Short-term prediction output (spaly assessment). Solid and broken lines represent landings (t) and spawning stock biomass (t) respectively.

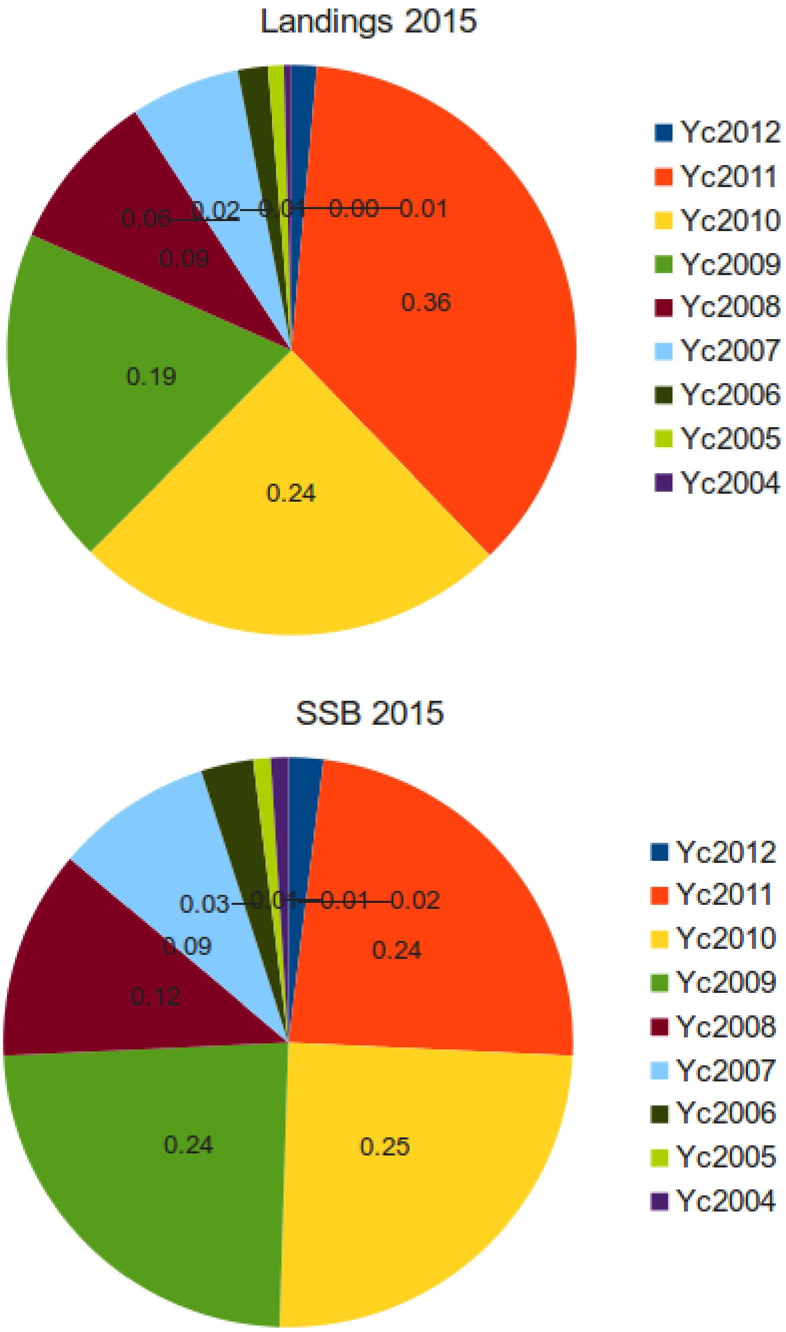

Figure 6.6.2.2 Faroe saithe (Division Vb). Composition of landings (upper figure) and SSB (lower figure) by year classes in 2015.

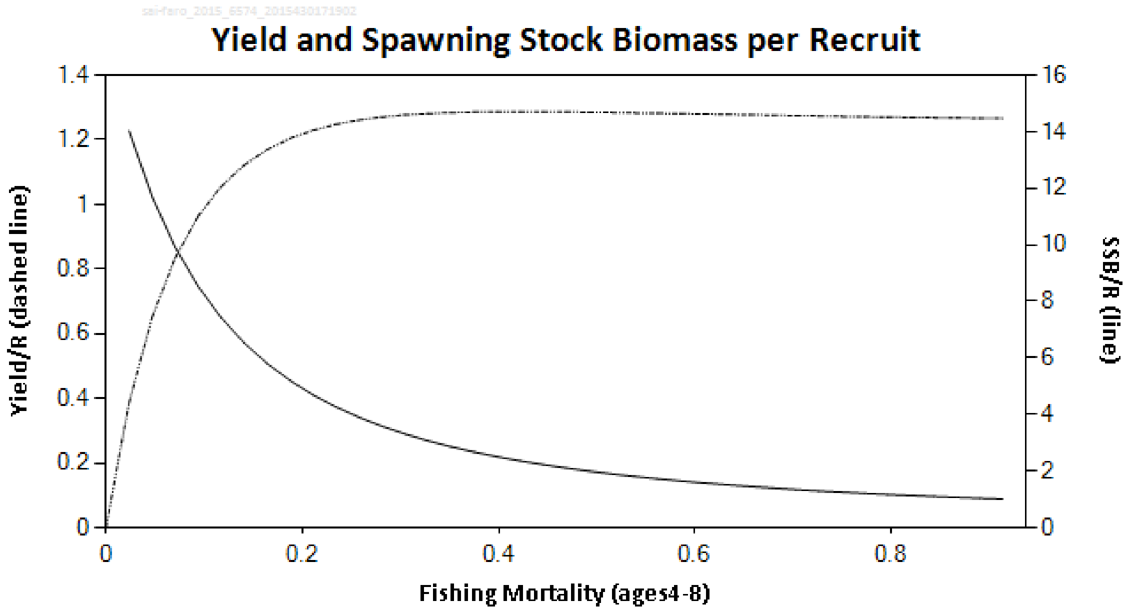

Figure 6.7.1.1. Faroe saithe (Division Vb). Yield and spawning per-recruit calculations. Dashed and solid lines represent Yield/R and SSB/R respectively.

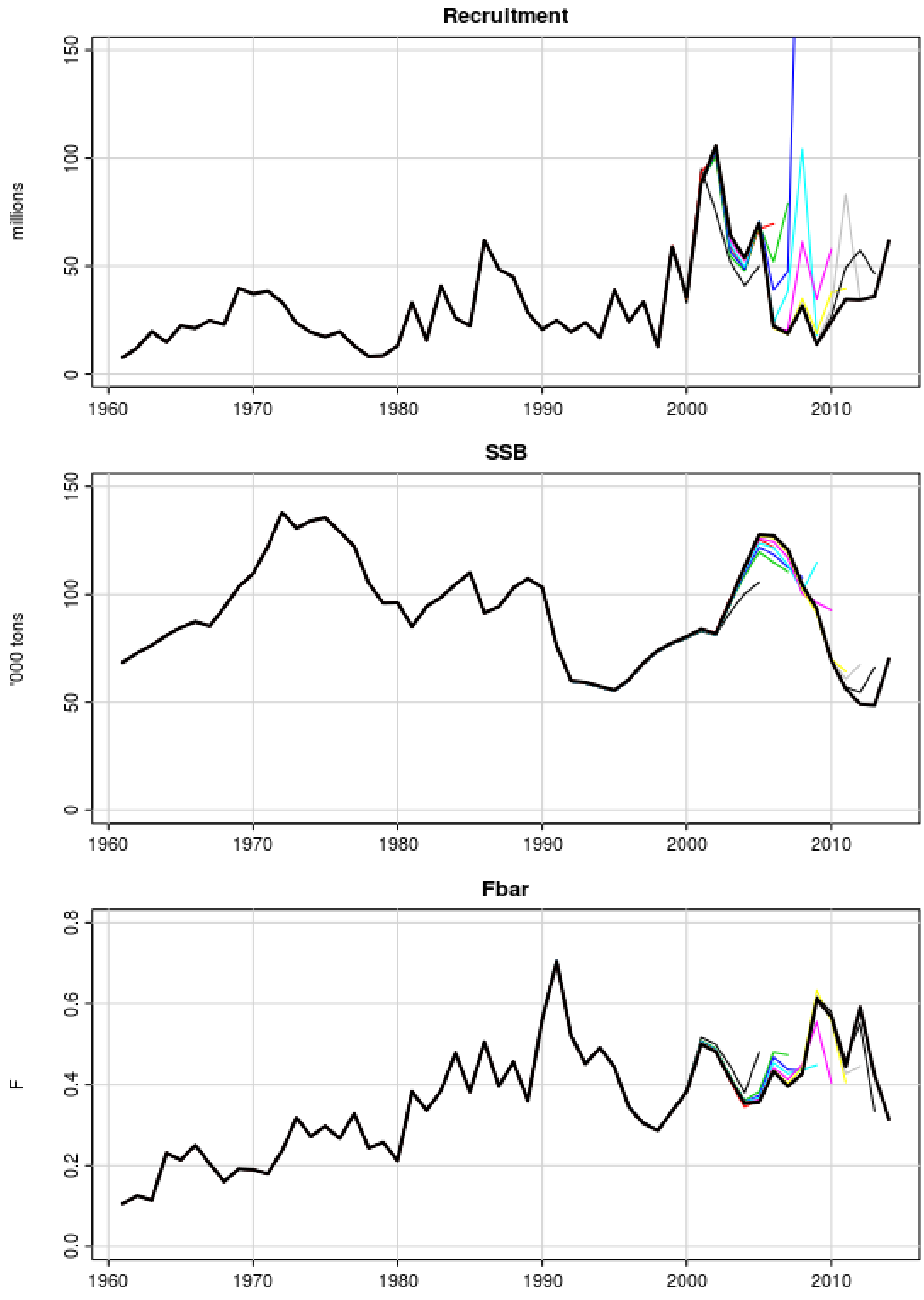

Figure 6.8.1. Faroe saithe (Division Vb). Retrospective analysis of recruitment at age 3 (millions)(top figure), spawning stock biomass ('000 tonnes)(middle figure) and average fishing mortality over age groups 4-8 (bottom figure) from the spaly assessment.

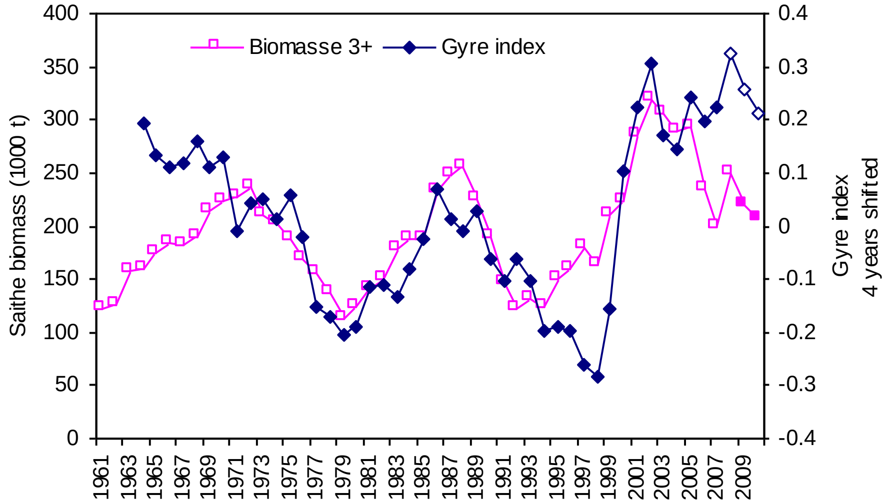

Figure 6.15.1. Faroe saithe (Division Vb). Relationship between the Gyre index (4 years shifted) and saithe biomasse (age 3+) in Faroese waters.

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

This section gives a very broad and general overview of the marine 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 Icelandic EEZ covers partly the IIa2, Va1, Va2, Vb1b, XIIa4, XIVa and XIVb2 ICES statistical regions. In practice however, 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 (ICES 2008).

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 and this is reflected in the topography around the country. Substrate characteristics can be largely influenced by depth. Hard bottom is more often found in shallower waters compared to deep waters. In deeper waters, hard bottom is often confined to abrupt features such as ridges and seamounts. Soft sediments often dominate in the troughs and outside the continental slope. The shelf around Iceland is narrowest off the south coast (Figure 7.3.4) and is cut by submarine canyons around the country (Figure 7.3.4).

The Polar Front lies west and north off Iceland and separates the cold and southward flowing waters of Polar origin from the northward flowing waters of Atlantic origin. South and east off 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 break. In the Denmark Strait it divides into a branch that flows northeastward and eastward to the waters north off Iceland, as the North Icelandic Irminger Current, and another branch that flows south-westward along the East Greenland Current. In the Iceland Sea north off Iceland, a branch originating from 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. This current subsequently 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 abundance, copepods dominate the mesozooplankton within 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 structure of benthic communities in Icelandic waters is likely to be influenced by a large number of factors. Amongst these, water mass characteristics will have profound effects on species composition and spatial distribution patterns at the largest spatial scales (e.g. >50 km) whereas substrate characteristics (e.g. sediment type and rugosity) and topography will have profound effects on smaller scales (e.g. meters to kilometers), (e.g. Weisshappel and Svavarsson 1998). Shrimp biomass in Icelandic waters, both in inshore and offshore waters, has been declining in recent years. Consequently the fishing effort was reduced and is now banned in most inshore areas. The causes for 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 cold-water coral areas were known to exist close to the shelf break off the northwest towards southeast Iceland around 1970. During the 70s and 80s, more coral areas were found by fishermen as a direct consequence of the bottom trawling fisheries extending into deeper waters. More recently there has been a considerable effort in mapping cold-water coral habitats in Icelandic waters and to investigate their biology using the state of the art technology such as unmanned submersibles. At present, large cold-water coral areas have been located on the Reykjanes Ridge and on the shelf break south and southeast Iceland (Steingrímsson and Einarsson 2004). Many of the cold-water coral areas that have been surveyed have already been destroyed. Currently, 5 areas with relatively undisturbed cold-water corals have received full protection and several other areas are under consideration for further protection.

The database of the BIOICE programme provides information on the spatial distribution of benthic organisms within the Icelandic territorial waters based on samples collected from 579 locations, including horny corals (Gorgonacea) and seapens (Pennatulacea) that are considered sensitive to fishing. Gorgonian corals occur all around Iceland but these are relatively uncommon on the shelf (< 500 m depth) but can be found in relatively high numbers in deep waters (> 500 m) off south, west and north coasts of Iceland, given the right environmental conditions. Similar distribution patterns were observed in the distribution of pennatulaceans, these being common in deeper waters, especially off South Iceland (Guijarro *et al*. 2007).

About 25 species of stocks of fish and marine invertebrates are exploited commercially on a regular basis in Icelandic waters.

Icelandic waters are comparatively rich in species and contain around 30 commercially exploited stocks of fish and marine invertebrates. The most important commercial species are 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 subsequently 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 900 Kt in 2012/13 (Anon. 2013). Herring were very abundant in the early 1960s until the stock collapsed in the nineteen sixties due to overfishing. From 1970 onwards the stock size has increased until attaining historical high levels in the last decade. Abundance of demersal species have been generally trending downward since the 1950s with total catches dropping from over 800 Kt to less than 500 Kt in the early 2000s.

A number of species of sharks and skates are known to be caught as a by-catch in Icelandic waters, but information on amount of the 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.

The seabird community in Icelandic waters is composed of relatively few but mostly abundant species, accounting for roughly ¼ of total number and biomass of seabirds within the whole ICES area (ICES 2002). Auks and petrels are the most important groups, comprising almost 3/5 and 1/4 of the total 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, the minke whale (*Balaenoptera acutorostrata*) probably has the largest biomass. Based on the 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). In the 2007 aerial survey the abundance of minke whales was estimated at around 21 000 animals on the Icelandic shelf. The reasons for this decrease are not known. Two species of seals, common seal (*Phoca vitulina*) and grey seal (*Halichoerus grypus*) breed in Icelandic waters, while 5 other species are found as vagrants (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 was used as a predictor of weights in the landings in 1991—2007. In 1981—1982, cod 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 and have not been used for predictions. The reasons for these changes are most likely 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 2013.

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 on average (Figure 7.3.1.) and these changes can therefore be regarded as conspicuous. Off central N-Iceland, similar trends have been observed although with higher inter-annual variability. This period has been characterized with an increase of temperature and salinity in the winter north of Iceland in the last 12—14 years which is on average above 1˚C and 1 salinity units. (Figure 7.3.2)

It appears that these changes in seawater temperature have had considerable effects on the spatial distribution of fish species in Icelandic waters with many species now found further northwards. The most obvious examples of such changes is the increased abundance of haddock, mackerel, whiting, monkfish, lemon sole and witch in the mixed water area north of Iceland.

On the other hand, coldwater species like Greenland halibut and northern shrimp have become scarcer. Capelin have shifted their larval drift and nursing areas westwards to the colder waters off E-Greenland. Furthermore, the arrival of adult capelin to 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 are currently located farther off N- and E-Iceland and do not reach as far west along the south coast as was the rule in most earlier years (Figure 7.3.3. and 7.3.4.). These changes in the spatial distribution patterns of capelin 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 was very abundant during the last warm epoch, which began around 1920 and lasted until 1965. By the early 1980s the cod stock had been fished down to much lower levels 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 during 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 when compared with the years prior to 2000. Further, despite the overall low recruitment, this reduction in fishing mortality has almost resulted in almost doubling of the spawning stock biomass. This increase in the SSB biomass has however not resulted in significant increase in recruitment in recent years, although year classes 2008 and 2009 are now estimated around average size.

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. Tag returns, survey estimates in Greenlandic waters as well as anomalies in the catch-at-age matrix in Iceland indicate that a portion of the moderate 2003 year class that has been observed in Greenlandic waters in recent years may have migrated to Icelandic waters in 2009.

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, cod, tusk, ling and, with some bycatch of other 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 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 about 1 month after the day of fishing operation. Since 2009 increasing proportion of vessels are using electronic logbooks. Fisheries scientists have direct access to the logbook database.

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 in recent decades 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 2010 amounted to around 1 million tonnes where pelagic fishes amounted to 0.5 million tonnes. Spatial distributions of the catches are shown in figure 7.4.1. Detailed information of landings by species and gear type are given in Table 7.1. Spatial overviews of the removal of the some important species by different gear are given in Figures 7.4.2.—7.4.5.

A simple categorization of boats among the different fisheries types is impossible as many change gear depending on fish availability in relation to season, quota status of the individual companies, fish availability both in nature and on the quota exchange market, market price, etc. E.g. larger trawl vessels may operate both on demersal species using bottom trawls as well as using purse seine and pelagic trawls on pelagic species. Total number of vessels within each fleet category in 2010 is thus limited to the broad categories given below:

Type	No. vessels1)	Gear type used
Trawlers	57	Pelagic and bottom trawl
Vessels > 100 t	140	Purse seine, longline, trawl, gillnet
Vessels < 100 t	621	Gillnet, longline, danish seine, trawl, jiggers
Open boats	807	Jiggers, longliners (including recreational fishers)
Total	1625	
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. 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 2010, 113 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 in the range of 0.2—2.2% of the reported landings over the time investigated (Figure 7.5.2.). The discard estimates for haddock are somewhat higher ranging between 0.7—5% annually. Discarding of saithe and golden redfish has been negligible over time period of investigation. Estimates of discards of cod and haddock in 2010 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 bycatch of the other species even though they take place in the same area. Small differences in the location of setting are also known to affect the catch composition. This has for example been documented in the long line fisheries in Faxabay, where in adjacent areas cod catches and wolfish catches are known to consistently dominate the catches in individual setting. There are however numerous species in Icelandic waters that can be classified as "bycatch species" in some fisheries. E.g. in the bottom trawl fisheries 75 % of the annual plaice yield is caught in hauls where plaice is minority of the catches. In a proper fisheries based advice taking mixed fisheries issues into account, such stocks may have a greater influence on the advice on the main stocks that are currently assessed by ICES than fisheries linkage among the latter.

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

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Table 7.1 Overview of the 2010 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 thous. tonnes.

Species/gear	Long line	Gillnets	Jiggers	Danish seine	Bottom trawl	Nephros trawl	Pelagic trawl	Purse seine	Shrimp trawl	Dredge	Other	Total
Herring	0.000	0.000	0.000	0.000	0.112	0.000	213.528	40.836	0.000	0.000	0.000	**254.476**
Cod	57.493	16.552	3.721	8.285	82.996	1.581	0.923	0.009	1.006	0.000	0.784	**173.349**
Mackerel	0.000	0.001	0.180	0.000	0.164	0.000	121.680	0.001	0.000	0.000	0.000	**122.028**
Capelin	0.000	0.000	0.000	0.000	0.000	0.000	3.187	112.328	0.000	0.000	0.000	**115.515**
Blue whiting	0.000	0.000	0.000	0.000	0.124	0.000	87.784	0.000	0.000	0.000	0.000	**87.908**
Haddock	23.916	0.380	0.012	10.137	29.481	0.212	0.630	0.000	0.041	0.000	0.028	**64.836**
Saithe	0.594	4.453	2.383	1.093	42.441	0.404	1.216	0.000	0.007	0.000	0.068	**52.660**
Golden redfish	1.080	0.194	0.058	0.513	35.777	0.932	0.594	0.000	0.014	0.000	0.014	**39.176**
Pearlside	0.000	0.000	0.000	0.000	0.000	0.000	17.912	0.000	0.000	0.000	0.000	**17.912**
Atlantic argentine	0.000	0.000	0.000	0.000	16.321	0.001	0.256	0.000	0.000	0.000	0.000	**16.579**
Golden redfish	0.000	0.000	0.000	0.000	1.921	0.000	12.872	0.000	0.000	0.000	0.000	**14.794**
Deepwater redfish	0.052	0.002	0.000	0.000	14.149	0.000	0.181	0.000	0.000	0.000	0.000	**14.384**
Greenland halibut	0.033	0.000	0.000	0.000	12.147	0.000	0.263	0.000	0.861	0.000	0.001	**13.305**
Atlantic catfish	6.915	0.020	0.002	1.032	4.490	0.083	0.033	0.000	0.000	0.000	0.027	**12.602**
Ling	6.529	0.363	0.011	0.404	1.538	0.981	0.011	0.000	0.000	0.000	0.028	**9.865**
Shrimp	0.000	0.000	0.000	0.000	0.000	0.000	0.155	0.000	7.607	0.000	0.000	**7.762**
Tusk	6.760	0.052	0.003	0.000	0.093	0.005	0.000	0.000	0.000	0.000	0.001	**6.915**
Blue Lling	3.978	0.091	0.000	0.092	1.901	0.283	0.013	0.000	0.002	0.000	0.015	**6.375**
Plaice	0.105	0.118	0.006	3.640	2.020	0.003	0.015	0.000	0.001	0.000	0.077	**5.984**
Monkfish	0.079	0.176	0.001	0.430	0.452	0.556	0.000	0.000	0.001	0.000	1.586	**3.281**
Whiting	0.425	0.030	0.002	0.191	2.037	0.155	0.000	0.000	0.001	0.000	0.001	**2.842**
Redfish	0.001	0.000	0.000	0.000	2.446	0.000	0.154	0.000	0.000	0.000	0.000	**2.601**
Nephrops	0.000	0.000	0.000	0.000	0.000	2.541	0.000	0.000	0.000	0.000	0.000	**2.541**
Sea cucumber	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.246	0.000	**2.246**
Lumpfish roe	0.000	0.000	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.133	**2.135**
Lemon sole	0.000	0.002	0.001	0.992	0.886	0.078	0.007	0.000	0.000	0.000	0.001	**1.968**
Leopardfish	1.045	0.003	0.000	0.004	0.805	0.002	0.022	0.000	0.037	0.000	0.003	**1.922**
Witch	0.000	0.000	0.000	0.733	0.075	0.514	0.000	0.000	0.000	0.000	0.002	**1.325**
Starry ray	0.776	0.005	0.000	0.188	0.057	0.001	0.000	0.000	0.001	0.000	0.001	**1.029**
Common dab	0.007	0.002	0.004	0.574	0.025	0.000	0.000	0.000	0.000	0.000	0.000	**0.612**
Halibut	0.377	0.004	0.000	0.034	0.114	0.014	0.001	0.000	0.000	0.000	0.008	**0.552**
Lumpfish	0.000	0.017	0.001	0.002	0.002	0.000	0.037	0.000	0.000	0.000	0.333	**0.391**
Megrim	0.000	0.000	0.000	0.089	0.052	0.111	0.000	0.000	0.000	0.000	0.000	**0.252**
Long rough dab	0.009	0.004	0.000	0.173	0.031	0.000	0.000	0.000	0.001	0.000	0.000	**0.220**
Sea-urchins	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.146	0.000	**0.146**
European whelk	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.142	**0.142**
Skate	0.042	0.007	0.000	0.026	0.024	0.008	0.000	0.000	0.000	0.000	0.009	**0.117**
Black scabbard-fish	0.002	0.000	0.000	0.000	0.107	0.000	0.000	0.000	0.000	0.000	0.000	**0.109**
Boston hake	0.109	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.109**
Blue mussel	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.077	0.000	**0.077**
Dogfish	0.011	0.039	0.000	0.004	0.006	0.000	0.000	0.000	0.000	0.000	0.002	**0.062**
Rat-tail	0.000	0.000	0.000	0.000	0.058	0.000	0.001	0.000	0.000	0.000	0.000	**0.059**
Squid	0.000	0.000	0.000	0.000	0.000	0.000	0.051	0.000	0.000	0.000	0.000	**0.051**
Greenland shark	0.000	0.000	0.000	0.000	0.043	0.000	0.000	0.000	0.000	0.000	0.000	**0.043**
Norway pout	0.000	0.000	0.000	0.000	0.000	0.000	0.039	0.000	0.000	0.000	0.000	**0.039**
onioin eye	0.000	0.000	0.000	0.000	0.023	0.000	0.000	0.000	0.000	0.000	0.000	**0.023**
Fuller's ray	0.018	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.019**
Arctiv wolffish	0.000	0.000	0.000	0.000	0.017	0.000	0.000	0.000	0.000	0.000	0.000	**0.017**
sailray	0.012	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.012**
Deal fish	0.000	0.000	0.000	0.000	0.000	0.000	0.011	0.000	0.000	0.000	0.000	**0.011**
Gurnard	0.000	0.000	0.000	0.001	0.000	0.000	0.010	0.000	0.000	0.000	0.000	**0.010**
Black dogfish	0.001	0.000	0.000	0.000	0.009	0.000	0.000	0.000	0.000	0.000	0.000	**0.010**
Total	**110.370**	**22.520**	**6.386**	**28.638**	**252.947**	**8.466**	**461.586**	**153.175**	**9.579**	**2.470**	**5.263**	**1,061.401**

Table 7.2. Estimates of discard of cod and haddock in the Icelandic fisheries in 2008. Source: Ólafur K. Pálsson, Höskuldur Björnsson, Eyþór Björnsson, Guðmundur Jóhannesson og Þórhallur Ottesen 2009. Discards in demersal Icelandic fisheries 2009. Marine Research Institute, 2009, report series no. 154 .

	Gear	*Landings (tonnes)*	*Discards*		
			Numbers (thous.)	*Weight (tonnes)*	% Weight
COD	Longline	61008	509	308	0.51
	Gillnet	21859	0	0	0.00
	Danish Seine	10369	28	18	0.18
	Bottom trawl	77172	690	635	0.82
	Total	**170408**	**1227**	**961**	**0.56**
HADDOCK	Longline	26573	155	79	0.30
	Danish Seine	15126	36	9	0.06
	Bottom trawl	38822	1042	465	1.20
	Total	**808521**	**1233**	**553**	**0.69**

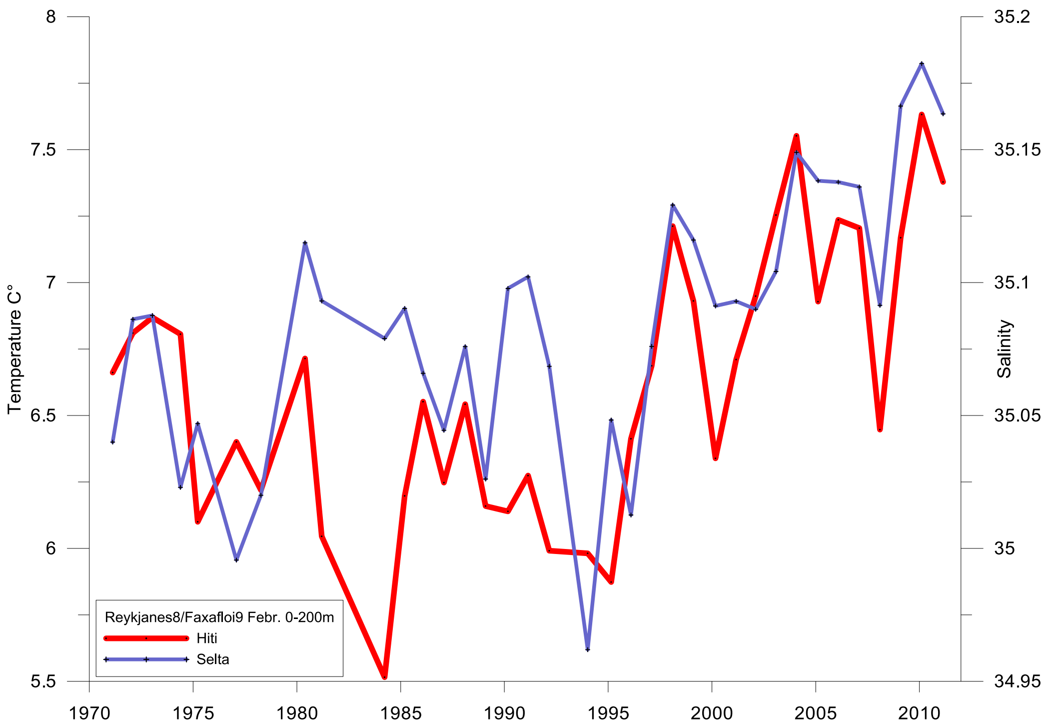


Figure 7.3.1. Temperature and salinity in winter west of Iceland 1971-2011. Mean 0-200m

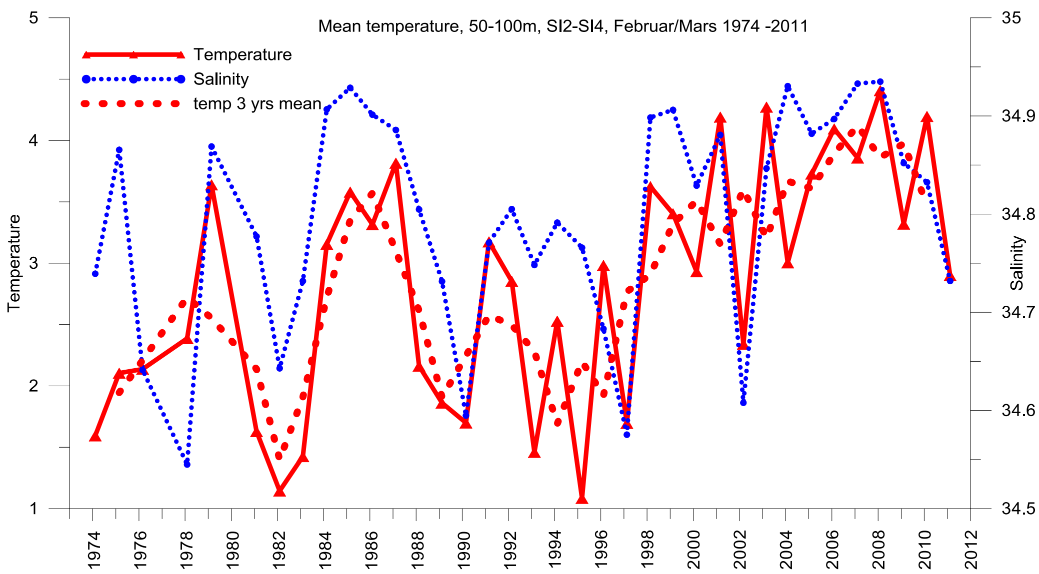


Figure 7.3.2. Temperature and salinity off central North-Iceland 1974-2011.

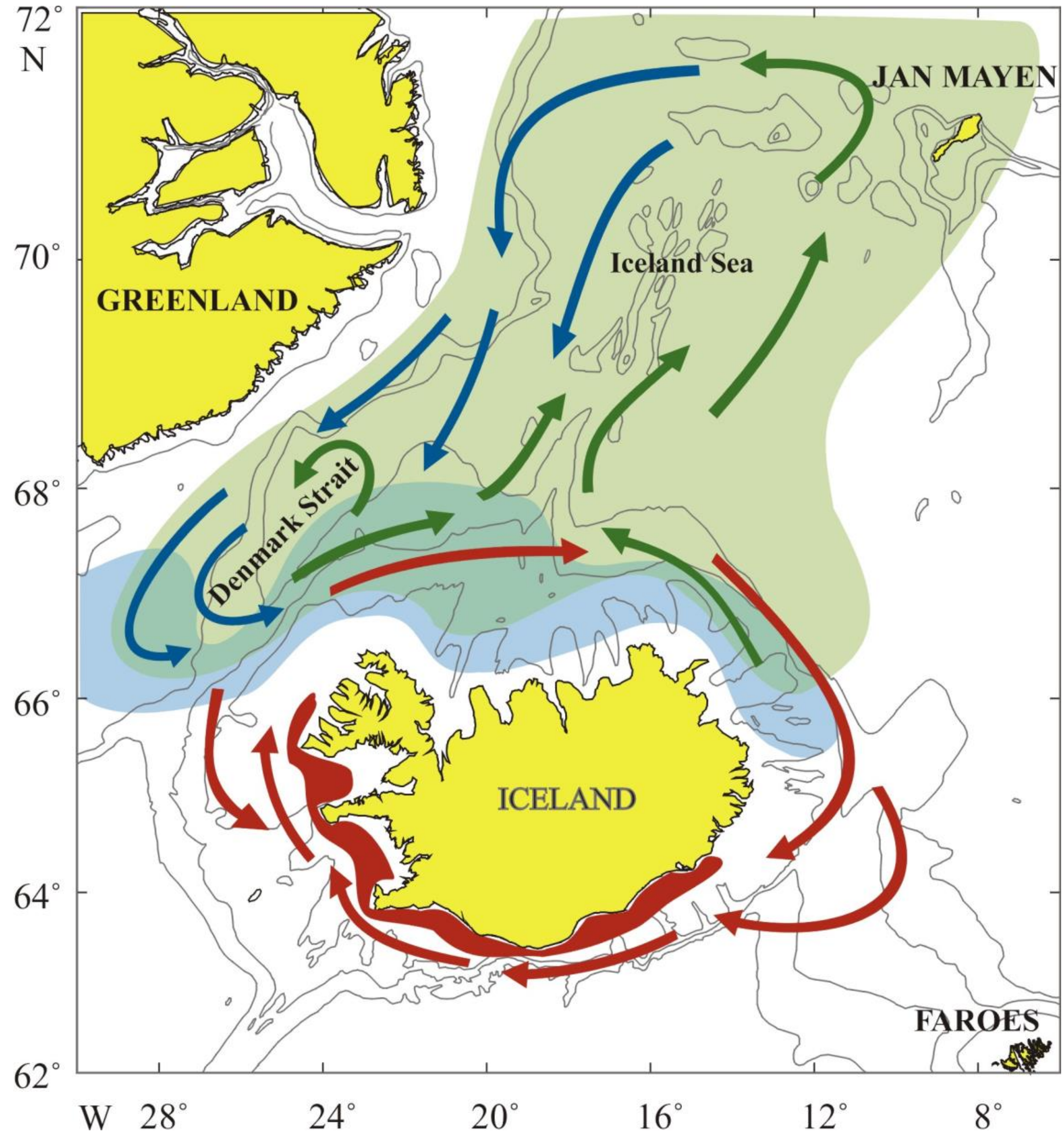


Figure 7.3.3. Distribution and migrations of capelin in the Iceland/East-Greenland/Jan Mayen area before 2001. Red: Spawning grounds; Green: Adult feeding area; Blue: Distribution and feeding area of juveniles; Green arrows: Adult feeding migrations; Blue arrows: Return migrations; Red arrows: Spawning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

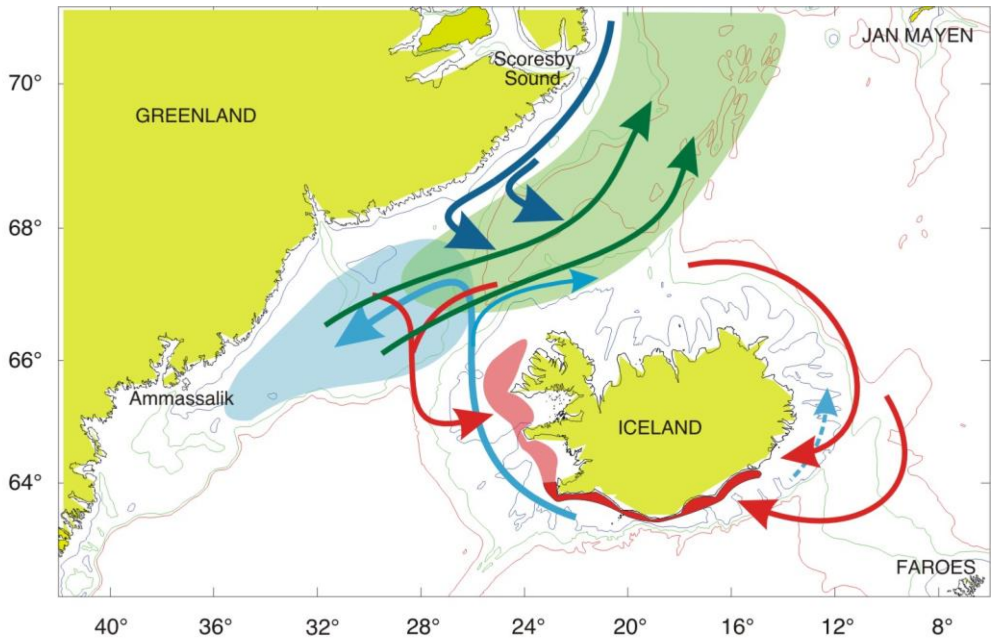


Figure 7.3.4. Likely changes of distribution and migration routes of capelin in the Iceland/Greenland/Jan Mayen area in the last 3-4 years. Green: Feeding area; Light blue: Juvenile area; Red area: Main spawning grounds; Lighter red colour: Lesser importance of W-Iceland spawning areas; Light blue arrows: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

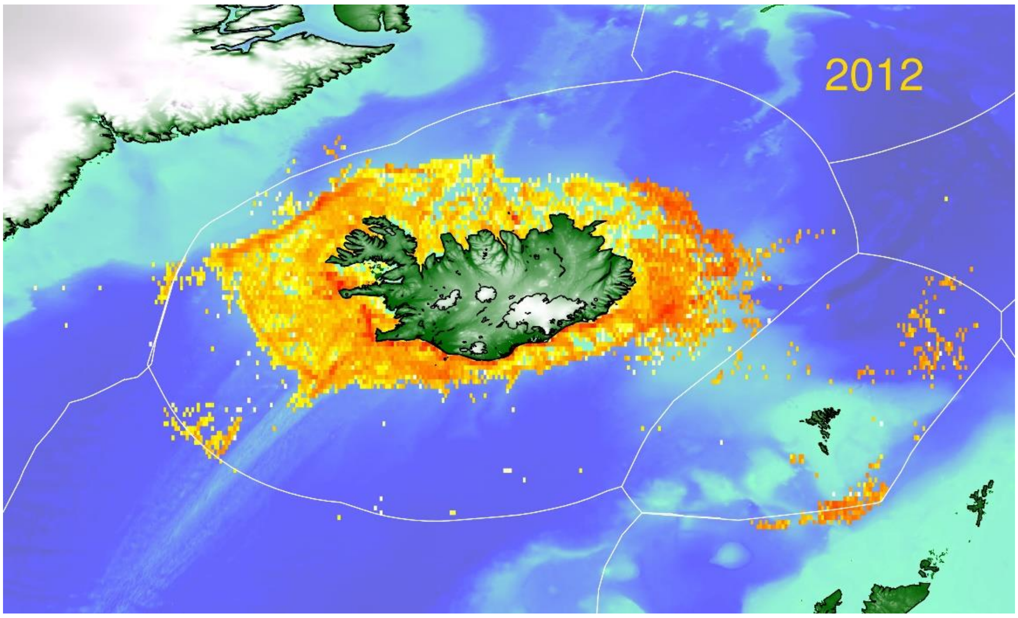


Figure 7.4.1. Distribution of total catch of all species by the Icelandic fishing fleet in Icelandic EEZ and adjacent waters in 2012. The EEZs are shown as white lines.

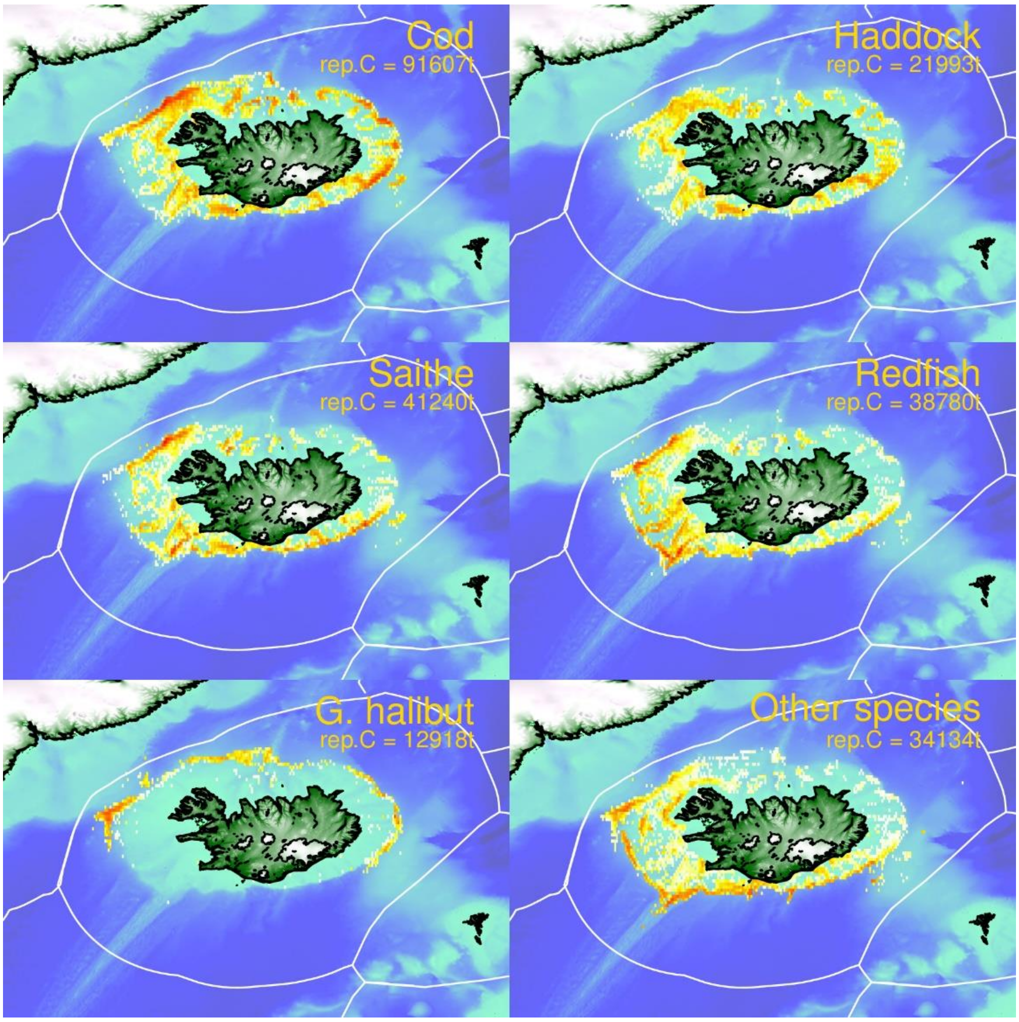


Figure 7.4.2. Location of catches of cod, saithe, haddock, redfish, Greenland halibut and others caught with bottom trawl in 2012.

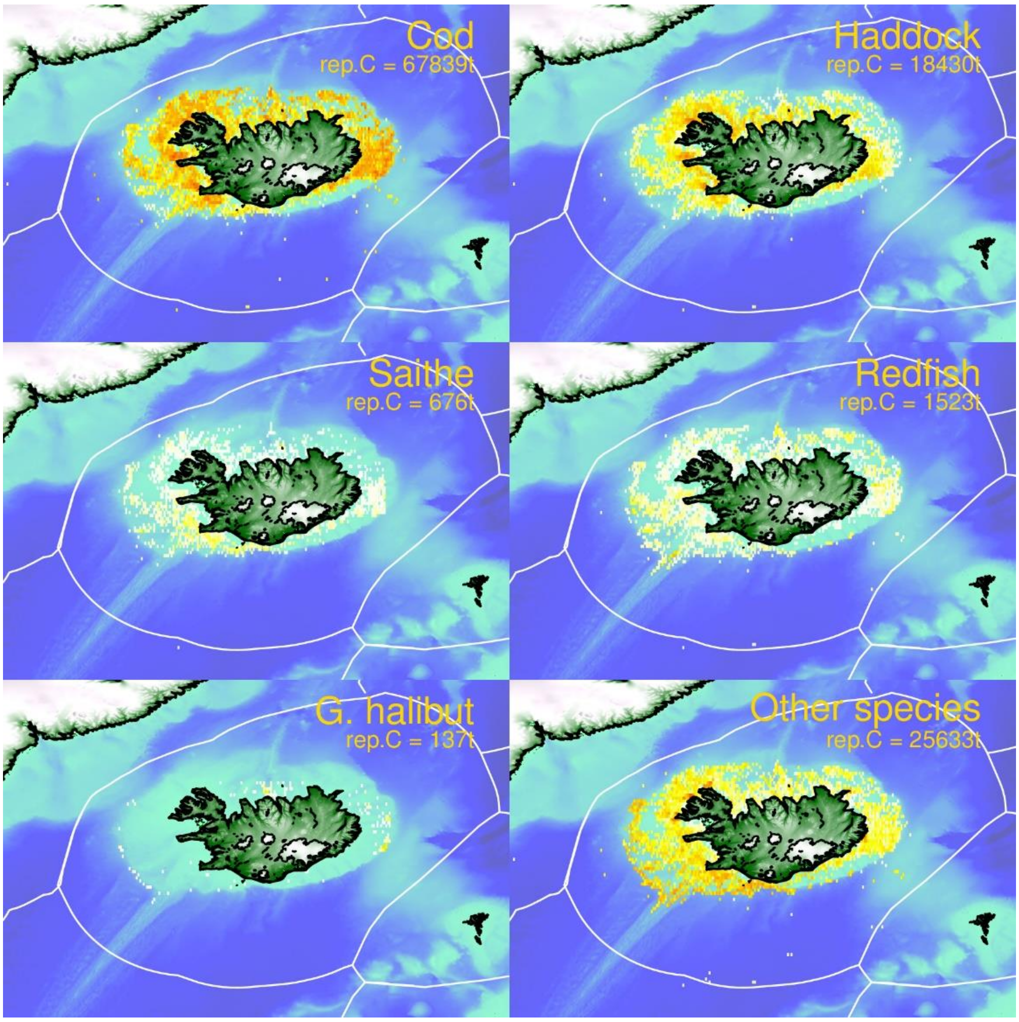


Figure 7.4.3. Location of catches of cod, saithe, haddock, redfish, Greenland halibut and others caught with long-line in 2012.

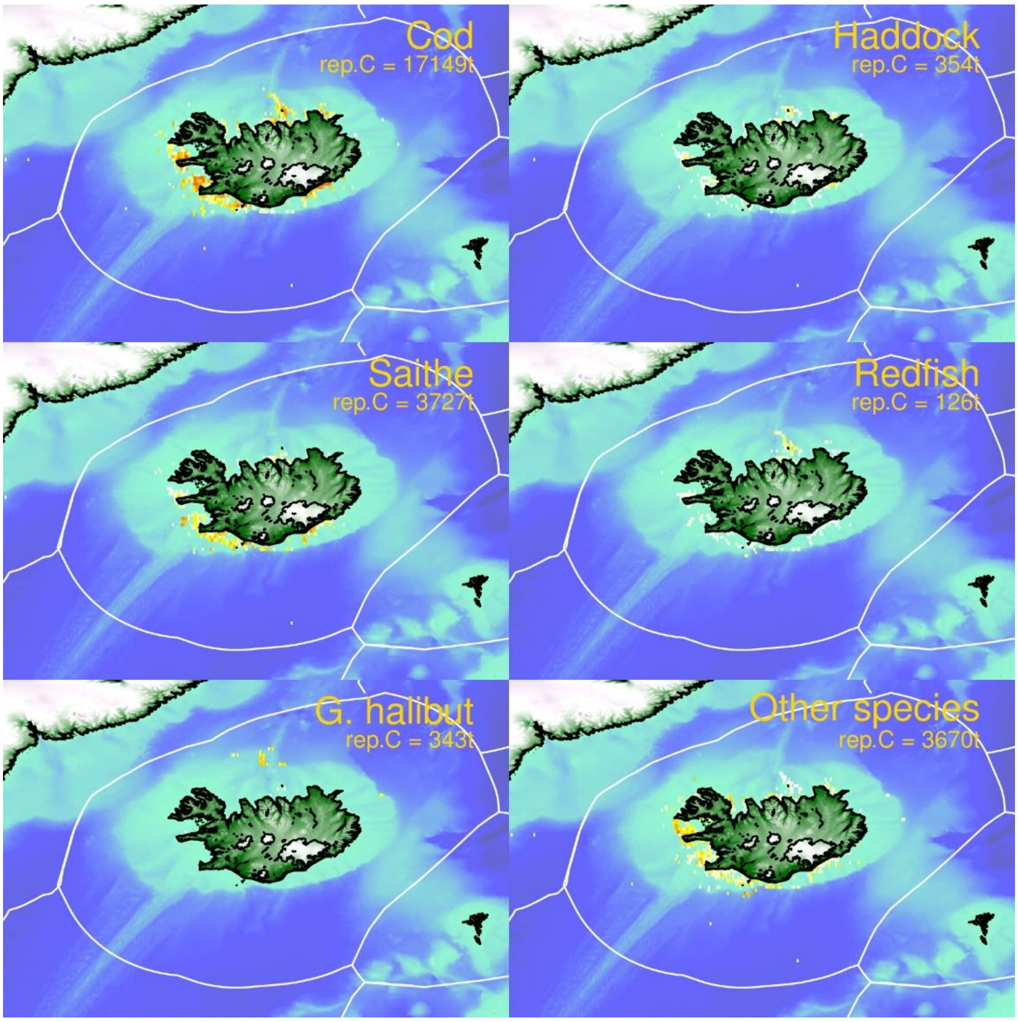


Figure 7.4.4. Location of catches of cod, saithe, haddock, redfish, Greenland halibut and others caught with gillnets in 2012.

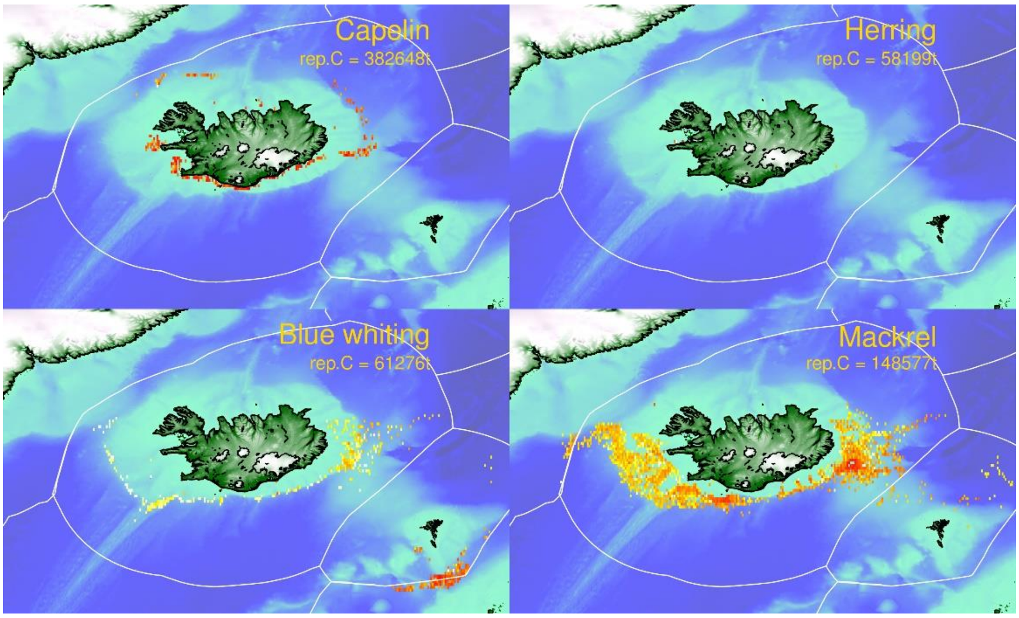


Figure 7.4.5. Location of catches of capelin, Icelandic summer spawning herring, blue whiting and mackerel with purse seine and pelagic trawls in 2012.

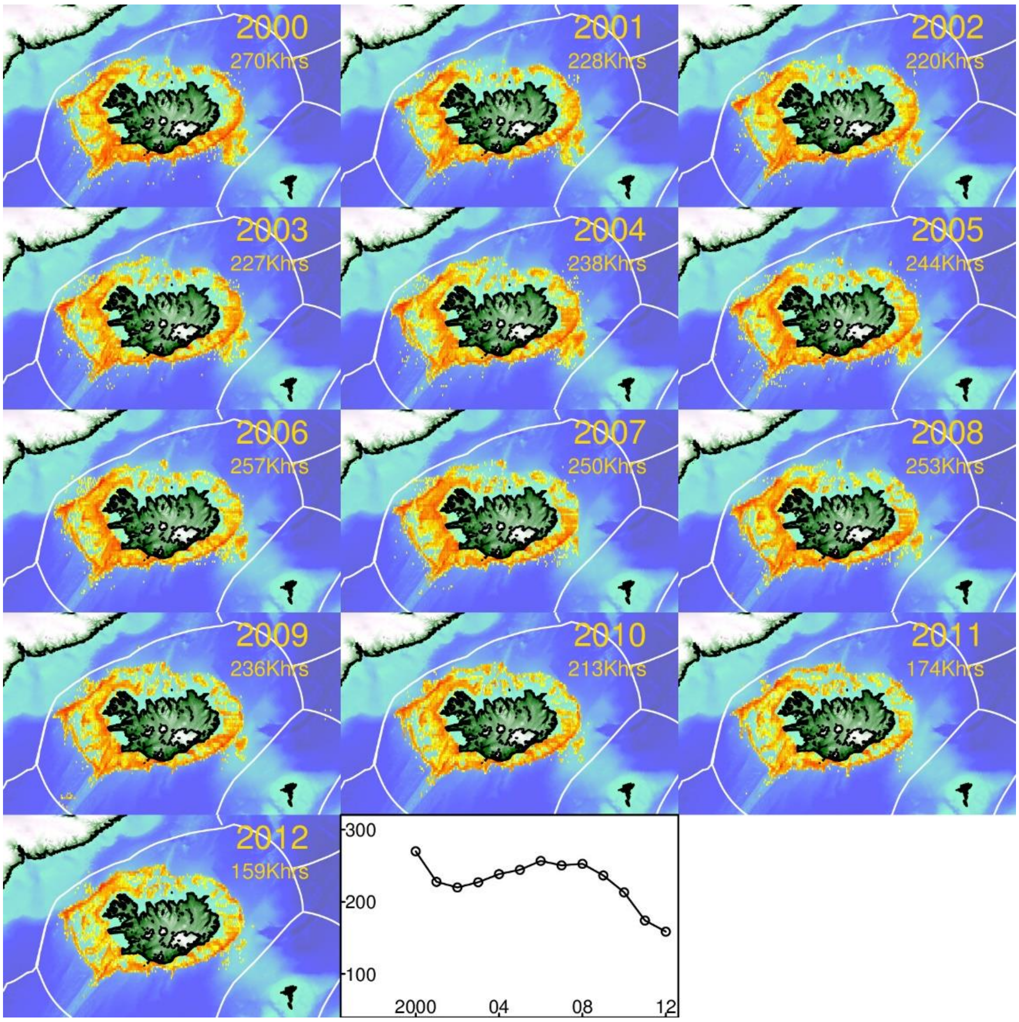


Figure 7.4.6 Spatial distribution of the trawler fleet effort (in hours trawled) in 2000-2012 and as a time-series.

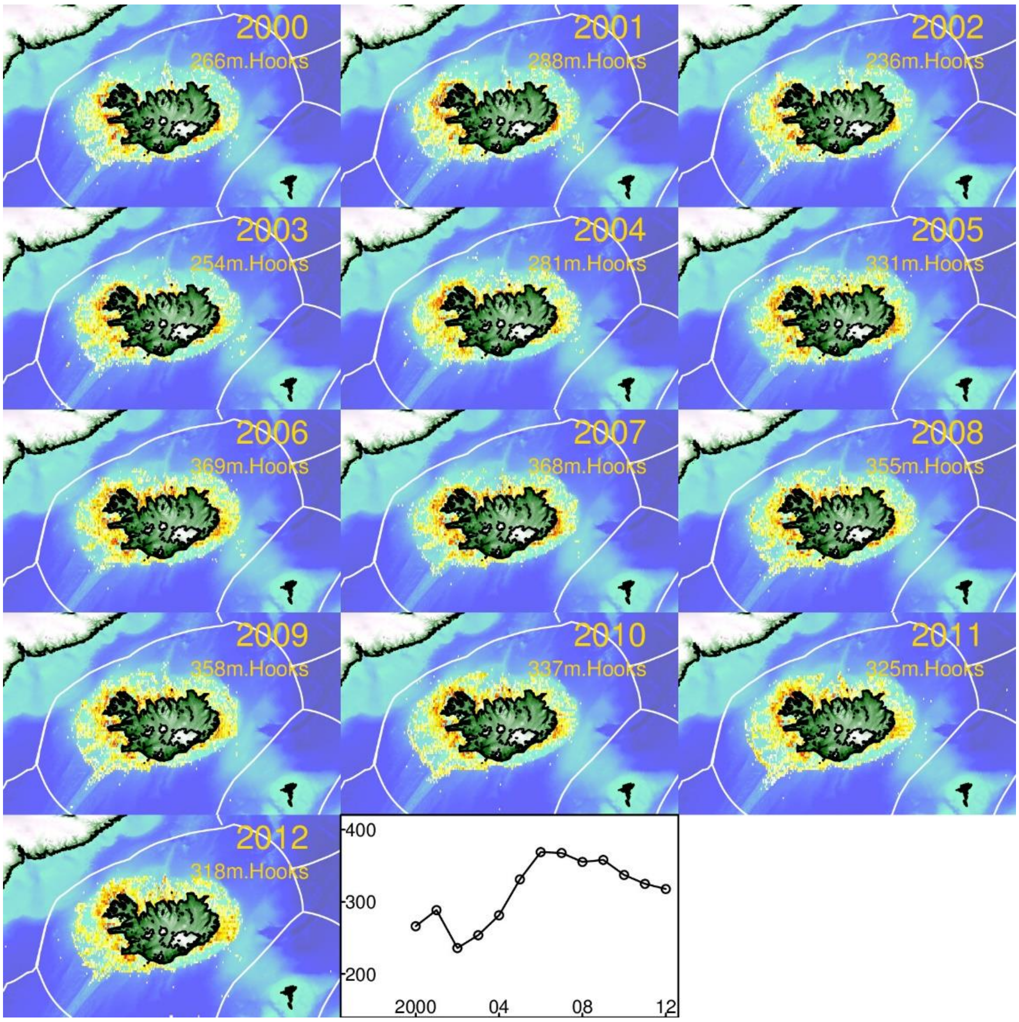


Figure 7.4.7. Spatial distribution of the longlinefleet effort (in number of hooks) in 2000-2012. The main targeted species for longline fishing are cod, haddock, catfish, tusk, ling and blue ling.

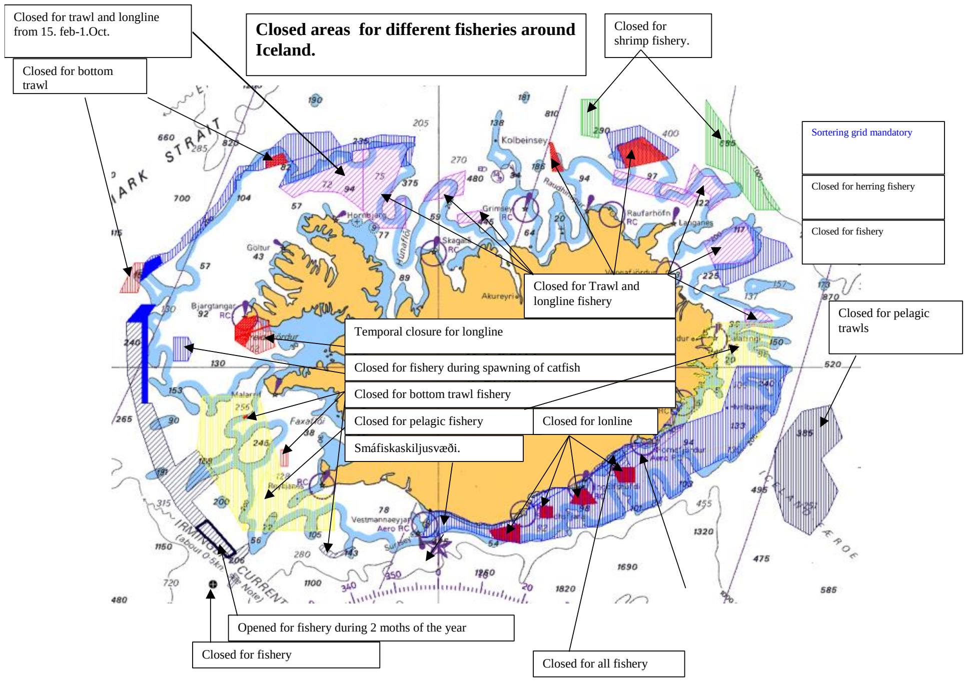
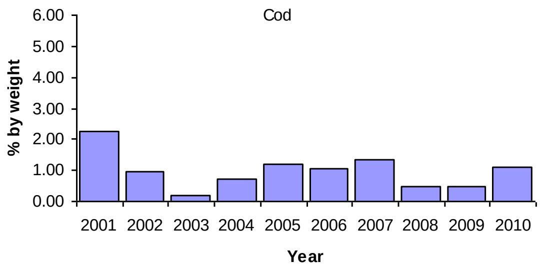


Figure 7.5.1. Overview of closed areas around Iceland in 2006 . The boxes are of different nature and can be closed for different time period and gear type.



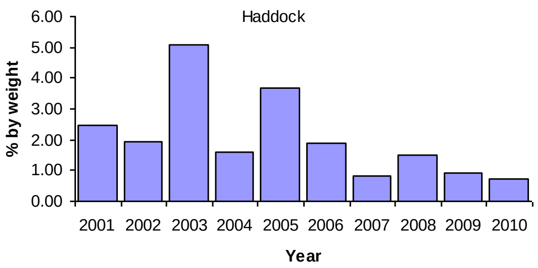


Figure 7.5.2. Estimates of discard percentage by weight for cod and haddock. Source: Ólafur K. Pálsson, Höskuldur Björnsson, Eyþór Björnsson, Guðmundur Jóhannesson , og Þórhallur Ottesen 2009. Discards in demersal Icelandic fisheries 2009. Marine Research Institute, report series Nr. 154. 2010 figures are preliminary .

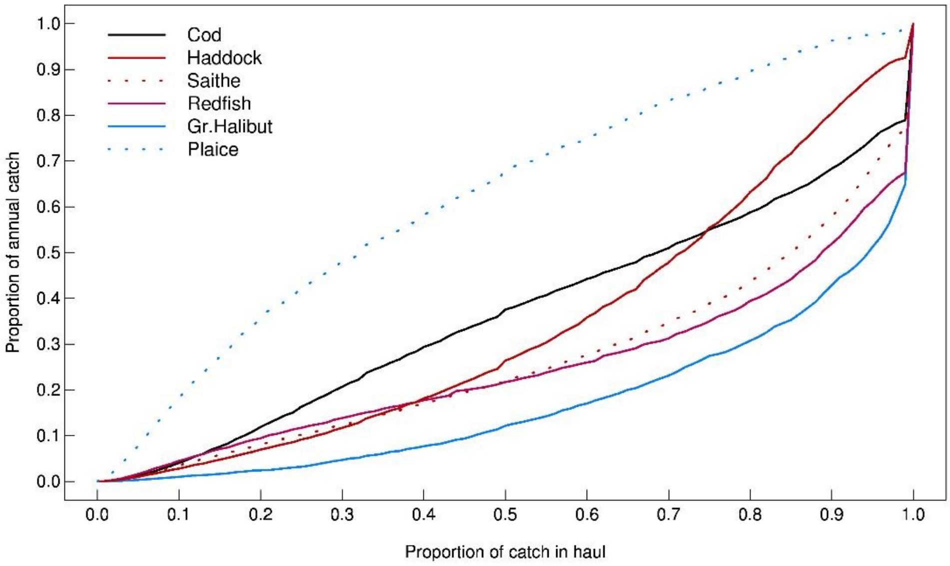


Figure 7.6.1. Cumulative plot for bottom trawl in 2008. An example describes this probably best. Looking at the figure above it can be seen from the dashed lines that 30% of the catch of haddock comes from hauls where haddock is less than 60% of the total catch while only 4% of the catch of greenland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

Summary

The 2015 reference biomass (B_{4+}) is estimated as 255 kt, around the average in the assessment period (1980 to the present). Spawning biomass is estimated as 139 kt, above the average in the assessment period and well above $B_{trigger}$ = 65 kt and B_{lim} = 61 kt.

Harvest rate has been around the HCR target of 20% since 2011, with fishing mortality rate between 0.19 and 0.25. Year classes 2008 and 2009 are above average, but recruitment has declined below average since then.

Weights of ages 3-6 have been low in recent years, but older ages are close to average weight. Maturity at ages 4-9 has decreased in recent years and is currently around average.

The assessment model is a separable statistical catch-at-age model implemented in AD Model Builder. Selectivity is age-specific and varies between three periods: 1980-1996, 1997-2003, and 2004 onwards.

The default separable model (ADSEP) estimates a slightly larger stock size than alternative diagnostic models (ADAPT, TSA, SAM). The estimates of this year's B_{4+} range from 209 (TSA) to 255 kt (ADSEP).

In 2013, the Icelandic government adopted a harvest control rule for managing the Icelandic saithe fishery, evaluated by ICES (2013). It is similar to the 20% rule used for the Icelandic cod fishery. When the population is above $B_{trigger}$, the TAC set in year t equals the average of 0.2 B_{4+} in year t and last year's TAC.

According to the adopted harvest control rule, the TAC will be 55 kt in the next fishing year.

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 2014 are estimated to have been 46 500 t (Table 8.1 and Figure 8.1). Of the landings, 38 600 t were caught by trawl, 2 400 t by gillnets, and the rest caught by other fishing gear. The domestic as well as ICES advice for the fishing year 2014/2015 was based on the 20% harvest control rule and was 58 kt. The TAC issued was also 58 kt. The trajectory of the landings in the current fishing year and calendar year is shown in Figure 8.2.

Most of the catch is caught in bottom trawl (80% in 2010-2014), with gillnet and jiggers taking the majority of the rest. The share taken by the gillnet fleet was larger in the past, 26% in 1982-1996 compared to 9% in 1997-2014 (Figure 8.1).

8.2.2 Landings by age

Catch in numbers by age based on landings are listed in Table 8.2. Discarding is not considered to be a problem in the Icelandic saithe fisheries, with an estimated discard proportion of 0.1% (annual reports by Palsson et al. 2003 and later). Comparison of sea and harbour samples indicate that discards have been small 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 discards 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 assessment.

The sampling program was slightly revised in 2013 and 2014, but the approach used for calculating catch in numbers has not changed. In 2013, the sampling frequency was reduced for bottom trawl, while the sampling frequency was increased for gillnets, jiggers, and demersal seine in 2014. Also in 2014, the number of otoliths from each sample was halved from 50 to 25 for all fishing gears. These revisions in the sampling program were based on the analysis of Thordarson (2012). The age and length sampling in 2014 is indicated in the following table:

Fleet	Landings (t)	No. of otolith samples	No. of otoliths read	No. of length samples	No. of length measurements
Gillnets	2355	9	250	10	1036
Jiggers	2115	14	370	15	1601
Demersal seine	1005	4	150	4	471
Bottom trawl	38634	52	1625	224	32251
Other gear	1624	-	-	189	2354
Foreign landings	750	-	-	-	-
Total	46483	79	2395	442	37713

Two age-length keys are used to calculate catch at age, one key for the gillnet catch and another key for other gears combined. The same length-weight relationship ($W = 0.02498 * L$^2.75674) is applied to length distributions from both fleets.

8.2.3 Mean weight and maturity at age

Weights of ages 3-6 have been low in recent years, but older ages are close to average weight (Table 8.3 and Figure 8.3). The long-term trend since 1980 has been a gradual decline in the weight of all ages. Weight at age in the landings is also used as weight at age in the stock. Weights for the current calendar year are predicted by applying a linear model using survey weights and the weight of a year class in the previous year as predictors (Magnusson 2012).

Maturity at ages 4-9 has decreased in recent years and is currently around average (Table 8.4 and Figure 8.4). A model using maturity at age from the Icelandic groundfish spring survey is used to derive smoothed trends in maturity by age and year (see stock annex).

8.2.4 Logbook 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 (ICES 2010), as the trends in CPUE are considered unreliable as an indicator of changes in abundance.

8.3 Scientific surveys

In the benchmark, spring survey data were considered superior to the autumn survey for calibrating the assessment. Saithe is among the most difficult demersal fishes to get reliable information on from bottom trawl surveys. In the spring survey, which has 500-600 stations, a 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 fluctuated greatly in 1985-1995, but were consistently low in 1995-2001, high in the period around 2005, declining to a relatively low level in 2007-2011. The 2012 and 2013 survey biomass indices were relatively high (Table 8.5 and 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 poor, with R^2 close to 0.3 for the best-defined age groups, and much lower for some other.

Young saithe tend to live very close to shore, so it is not surprising that survey indices for ages 1 and 2 are poor measures of recruitment, and the number of young saithe caught in the survey is very low.

8.4 Assessment method

In accordance with the recommendation from the benchmark (ICES 2010), a separable forward-projecting statistical catch-age model, developed in AD Model Builder, is used to fit commercial catch at age (ages 3-14 from 1980 onwards) and survey catch at age (ages 2-10 from 1985 onwards). The selectivity pattern is constant within each period (Figure 8.6). Natural mortality is set at 0.2 for all ages.

The commercial catch-at-age residuals (Table 8.6 and Figure 8.7) are relatively small in recent years, owing to the model flexibility provided by the two recent selectivity periods 1997-2003 and 2004 onwards. The survey catch-at-age residuals (Table 8.7 and Figure 8.7) have year blocks with all residuals being only negative or only positive in some years. The survey residuals are modelled as multivariate normal distribution with the correlation estimated (one coefficient).

8.5 Reference points and HCR

In April 2013, the Icelandic government adopted a management plan for managing the Icelandic saithe fishery (Ministry of Industries and Innovation 2013). ICES evaluated this management plan and concluded that it was in accordance with the precautionary approach and the ICES MSY framework. In the harvest control rule (HCR) evaluation (ICES 2013) B_{lim} was defined as 61 kt, based on B_{loss} as estimated in 2010, and B_{trigger} was defined as 65 kt, based on an estimated hockey-stick recruitment function.

The TAC set in year t is for the upcoming fishing year, from 1 September in year t, to 31 August in year t+1. The 20% HCR consists of two equations, as follows.

When $SSB \geq B_{\text{trigger}}$, the TAC set in year t equals the average of 0.20 times the current biomass and last year's TAC:

$$TAC_t = 0.5 \times 0.20\, B_{t,4+} + 0.5\, TAC_{t-1} \quad \text{(Eq. 1)}$$

When SSB is below B_{trigger}, the harvest rate is reduced below 0.20:

$$TAC_t = SSB_t/B_{\text{trigger}}\, [\, (1 - 0.5\, SSB_t/B_{\text{trigger}})\, 0.20\, B_{t,4+}) + 0.5\, TAC_{t-1}\,] \quad \text{(Eq. 2)}$$

Equation 1 is a plain average of two numbers. Equation 2 is continuous over SSB_t/B_{trigger}, so the rule does not lead to very different TAC when SSB_t is slightly below or above B_{trigger} (Magnusson 2013).

8.6 State of the stock

The results of the principal stock quantities (Table 8.8 and Figure 8.8) show that the reference biomass has historically ranged from 410 to 130 kt (in 1988 and 1999), but this range has been narrower since 2003, between 220 and 320 kt. The current stock size of 255 kt is around the average in the assessment period (1980 to the present). Spawning biomass is estimated as 139 kt, above the average in the assessment period and well above B_{trigger} and B_{lim}.

The harvest rate peaked around 30% in the mid 1990s, but has fluctuated around the HCR target of 20% since 2011, with fishing mortality rate between 0.19 and 0.25. SSB has been stable at a relatively high level during the last ten years, having declined to its historical minimum in the mid 1990s.

Year classes 2008 and 2009 are above average, but recruitment has declined below average since then. The details of the fishing mortality and stock in numbers are presented in Tables 8.9 and 8.10.

8.7 Short-term forecast

The input for the short-term forecast is shown in Table 8.11. Future weights, maturity, and selectivity are assumed to be the same as in the assessment year, as described in the stock annex. Recruitment predictions are based on the segmented stock-recruitment function estimated in the assessment model.

The landings for the ongoing calendar year are predicted based on the 20% HCR, with the calendar year landings consisting of 2/3 of the ongoing fishing year's TAC and 1/3 of the next fishing year's TAC.

Following the HCR, the predicted landings in 2016 are 54 kt and the resulting SSB in 2017 is predicted to be 130 kt.

8.8 Uncertainties in assessment and forecast

The assessment of Icelandic saithe is relatively uncertain due to fluctuations in the survey data, as well as irregular changes in the fleet selectivity. The internal consistency in the spring bottom trawl survey is very low for saithe. This is not surprising, considering the nature of the species that is partly pelagic, schooling, and relatively widely migrating. There are also indications of time-varying selectivity, so changes in the commercial catch at age may not reflect changes in the age dstribution of the population. The retrospective pattern (Figure 8.9) reveals some of the assessment uncertainty. The harvest control rule evaluation incorporated uncertainties about assessment estimates, among other sources of uncertainty (ICES 2013).

The results from the default separable assessment model (ADSEP) are compared to alternative diagnostic model runs, involving ADAPT, TSA, and SAM, in order to explore the overall uncertainty in the assessment. The comparison involved four models which differ mainly in the way the commercial catch-at-age variability and F-matrix is modelled:

	Model	Family	CA variability	F matrix
1	ADSEP (default)	separable	observation error	multiplicative in 3 periods
2	ADAPT	vpa	process error	no constraints
3	TSA	state-space (kalman filter)	observation & process error	orthogonal polynomials

4	SAM	state-space (random effects)	observation & process error	correlated random walk

The results from the model comparison (Figure 8.10) show that the default model estimates a slightly larger stock size than the other models, which has also been the case for saithe assessments in recent years. The estimates of this year's B_{4+} range from 209 (TSA) to 255 kt (ADSEP).

8.9 Comparison with previous assessment and forecast

Compared to last year's assessment the estimated reference biomass B_{4+} in 2014 has decreased from 296 to 265 kt, SSB 2014 has decreased from 150 to 132 kt, and the harvest rate u_{2013} has increased from 19% to 22% (fishing mortality 0.22 to 0.25). Stock numbers at age 5 have increased slightly, while stock numbers at ages 6 and 7 have decreased as shown below.

	NWWG 2014	NWWG 2015
B4+(2014)	296	265
SSB(2014)	150	132
u(2013)	19%	22%
F4-9(2013)	0.22	0.25
N5(2014)	24	26
N6(2014)	21	17
N7(2014)	11	9

8.10 Ecosystem considerations

Changes in the distribution of large pelagic stocks (blue whiting, mackerel, Norwegian spring-spawning herring, Icelandic summer-spawning herring) may affect the propensity of saithe to migrate off shelf and between management units. Saithe is a migrating species and makes both vertical and long-distance feeding and spawning migrations (Armannsson et al. 2007, Armannsson and Jonsson 2012, i Homrum et al. 2013). The evidence from tagging experiments (ICES 2008) show some migrations along the Faroe-Iceland Ridge, as well as onto the East Greenland shelf.

8.11 Changes in fishing technology and fishing patterns

According to the stock assessment model fit to the commercial catch-at-age data, the fleet is targeting younger fish since around 2004, compared to earlier years. This can be partly explained by reduced use of gillnets in the saithe fishery.

8.12 References

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Table 8.1. Saithe in division Va. Nominal catch (t) by countries, as officially reported to ICES.

	Belgium	Faroes	France	Germany	Iceland	Norway	UK (E/W/NI)	UK (Scot)	UK	Total
1980	980	4 930			52 436	1				58 347
1981	532	3 545			54 921	3				59 001
1982	201	3 582	23		65 124	1				68 931
1983	224	2 138			55 904					58 266
1984	269	2 044			60 406					62 719
1985	158	1 778			55 135	1	29			57 101
1986	218	2 291			63 867					66 376
1987	217	2 139			78 175					80 531
1988	268	2 596			74 383					77 247
1989	369	2 246			79 796					82 411
1990	190	2 905			95 032					98 127
1991	236	2 690			99 811					102 737
1992	195	1 570			77 832					79 597
1993	104	1 562			69 982					71 648
1994	30	975		1	63 333					64 339
1995		1 161		1	47 466	1				48 629
1996		803		1	39 297					40 101
1997		716			36 548					37 264
1998		997		3	30 531					31 531
1999		700		2	30 583	6	1	1		31 293
2000		228		1	32 914	1	2			33 146
2001		128		14	31 854	44	23			32 063
2002		366		6	41 687	3	7	2		42 071
2003		143		56	51 857	164			35	52 255

	Belgium	Faroes	France	Germany	Iceland	Norway	UK (E/W/NI)	UK (Scot)	UK	Total
2004		214		157	62 614	1	105			63 091
2005		322		224	67 283	2			312	68 143
2006		415		33	75 197	2			16	75 663
2007		392			64 008	3			30	64 433
2008		196			69 992	2				70 190
2009		269			61 391	3				61 663
2010		499			53 772	1				54 272
2011		735			50 386	2				51 123
2012		940			50 843					51 783
2013		925			57 077					58 002
2014		746			45 733	4				46 483

Table 8.2. Saithe in division Va. Commercial catch at age (millions).

	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	2.284	4.363	4.031	2.472	1.942	0.285	0.438	0.289	0.196	0.028	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
2010	2.146	6.284	3.058	0.997	1.644	1.571	0.514	0.656	0.522	0.231	0.114	0.064
2011	2.004	4.850	4.006	1.502	0.677	1.065	1.145	0.323	0.433	0.244	0.150	0.075
2012	1.183	4.816	3.514	2.417	0.903	0.432	0.883	1.015	0.354	0.277	0.173	0.099
2013	1.163	5.538	6.366	2.963	1.610	0.664	0.375	0.537	0.460	0.124	0.118	0.078
2014	0.668	3.499	4.867	2.805	1.276	0.725	0.347	0.241	0.312	0.199	0.128	0.074

Table 8.3. Saithe in division Va. Mean weight at age (g) in the catches and in the spawning stock, with predictions in gray.

	3	4	5	6	7	8	9	10	11	12	13	14
1980	1428	1983	2667	3689	5409	6321	7213	8565	9147	9617	10066	11041
1981	1585	2037	2696	3525	4541	6247	6991	8202	9537	9089	9351	10225
1982	1547	2194	3015	3183	5114	6202	7256	7922	8924	10134	9447	10535
1983	1530	2221	3171	4270	4107	5984	7565	8673	8801	9039	11138	9818
1984	1653	2432	3330	4681	5466	4973	7407	8179	8770	8831	11010	11127
1985	1609	2172	3169	3922	4697	6411	6492	8346	9401	10335	11027	10644
1986	1450	2190	2959	4402	5488	6406	7570	6487	9616	10462	11747	11902
1987	1516	1715	2670	3839	5081	6185	7330	8025	7974	9615	12246	11656
1988	1261	2017	2513	3476	4719	5932	7523	8439	8748	9559	10824	14099
1989	1403	2021	2194	3047	4505	5889	7172	8852	10170	10392	12522	11923
1990	1647	1983	2566	3021	4077	5744	7038	7564	8854	10645	11674	11431
1991	1224	1939	2432	3160	3634	4967	6629	7704	9061	9117	10922	11342
1992	1269	1909	2578	3288	4150	4865	6168	7926	8349	9029	11574	9466
1993	1381	2143	2742	3636	4398	5421	5319	7006	8070	10048	9106	11591
1994	1444	1836	2649	3512	4906	5539	6818	6374	8341	9770	10528	11257
1995	1370	1977	2769	3722	4621	5854	6416	7356	6815	8312	9119	11910
1996	1229	1755	2670	3802	4902	5681	7182	7734	9256	8322	10501	11894
1997	1325	1936	2409	3906	5032	6171	7202	7883	8856	9649	9621	10877
1998	1347	1972	2943	3419	4850	5962	6933	7781	8695	9564	10164	10379
1999	1279	2106	2752	3497	3831	5819	7072	8078	8865	10550	10823	11300
2000	1367	1929	2751	3274	4171	4447	6790	8216	9369	9817	10932	12204
2001	1280	1882	2599	3697	4420	5538	5639	7985	9059	9942	10632	10988
2002	1308	1946	2569	3266	4872	5365	6830	7067	9240	9659	10088	11632
2003	1310	1908	2545	3336	4069	5792	7156	8131	8051	10186	10948	11780
2004	1467	1847	2181	2918	4017	5135	7125	7732	8420	8927	10420	10622
2005	1287	1888	2307	2619	3516	5080	6060	8052	8292	8342	8567	10256
2006	1164	1722	2369	2808	3235	4361	6007	7166	8459	9324	9902	9636
2007	1140	1578	2122	2719	3495	4114	5402	6995	7792	9331	9970	10738
2008	1306	1805	2295	2749	3515	4530	5132	6394	7694	9170	9594	11258
2009	1412	1862	2561	3023	3676	4596	5651	6074	7356	8608	9812	10639
2010	1287	1787	2579	3469	4135	4850	5558	6289	6750	7997	9429	10481
2011	1175	1801	2526	3680	4613	5367	5685	6466	6851	7039	8268	8958
2012	1160	1668	2369	3347	4430	5486	6161	6448	7220	8054	8147	8901
2013	1056	1675	2219	3244	4529	5628	6397	7055	7378	7955	8400	8870
2014	1211	1575	2229	2983	4378	5598	6773	8023	7875	8646	9179	9749
2015	1142	1726	2217	3071	4030	5532	6846	7175	7491	8218	8575	9173
2016	1142	1726	2217	3071	4030	5532	6846	7175	7491	8218	8575	9173
2017	1142	1726	2217	3071	4030	5532	6846	7175	7491	8218	8575	9173

Table 8.4. Saithe in division Va. Maturity at age used for calculating the SSB.

	3	4	5	6	7	8	9	10	11	12	13	14
1985	0	0.089	0.197	0.380	0.604	0.792	0.905	1	1	1	1	1
1986	0	0.080	0.178	0.351	0.575	0.772	0.894	1	1	1	1	1
1987	0	0.072	0.162	0.325	0.547	0.751	0.883	1	1	1	1	1
1988	0	0.065	0.148	0.303	0.521	0.731	0.871	1	1	1	1	1
1989	0	0.060	0.138	0.285	0.499	0.714	0.862	1	1	1	1	1
1990	0	0.057	0.131	0.273	0.484	0.701	0.854	1	1	1	1	1
1991	0	0.055	0.127	0.266	0.475	0.694	0.850	1	1	1	1	1
1992	0	0.055	0.127	0.266	0.476	0.694	0.850	1	1	1	1	1
1993	0	0.057	0.131	0.274	0.485	0.702	0.855	1	1	1	1	1
1994	0	0.062	0.141	0.290	0.505	0.718	0.864	1	1	1	1	1
1995	0	0.069	0.157	0.317	0.537	0.743	0.879	1	1	1	1	1
1996	0	0.081	0.181	0.355	0.579	0.775	0.896	1	1	1	1	1
1997	0	0.097	0.212	0.402	0.627	0.807	0.913	1	1	1	1	1
1998	0	0.117	0.248	0.451	0.673	0.837	0.928	1	1	1	1	1
1999	0	0.137	0.284	0.497	0.712	0.860	0.939	1	1	1	1	1
2000	0	0.154	0.313	0.532	0.740	0.877	0.947	1	1	1	1	1
2001	0	0.165	0.331	0.552	0.755	0.885	0.951	1	1	1	1	1
2002	0	0.169	0.337	0.560	0.760	0.888	0.952	1	1	1	1	1
2003	0	0.168	0.335	0.557	0.759	0.887	0.952	1	1	1	1	1
2004	0	0.163	0.328	0.549	0.753	0.884	0.950	1	1	1	1	1
2005	0	0.157	0.318	0.538	0.744	0.879	0.948	1	1	1	1	1
2006	0	0.152	0.309	0.527	0.736	0.874	0.946	1	1	1	1	1
2007	0	0.146	0.300	0.517	0.728	0.870	0.943	1	1	1	1	1
2008	0	0.141	0.291	0.506	0.719	0.865	0.941	1	1	1	1	1
2009	0	0.136	0.282	0.495	0.710	0.859	0.939	1	1	1	1	1
2010	0	0.130	0.272	0.483	0.700	0.853	0.936	1	1	1	1	1
2011	0	0.124	0.261	0.469	0.688	0.847	0.932	1	1	1	1	1
2012	0	0.118	0.250	0.455	0.676	0.839	0.929	1	1	1	1	1
2013	0	0.112	0.239	0.440	0.662	0.830	0.924	1	1	1	1	1
2014	0	0.106	0.228	0.424	0.648	0.821	0.920	1	1	1	1	1
2015	0	0.100	0.217	0.409	0.633	0.812	0.915	1	1	1	1	1
2016	0	0.100	0.217	0.409	0.633	0.812	0.915	1	1	1	1	1
2017	0	0.100	0.217	0.409	0.633	0.812	0.915	1	1	1	1	1

Table 8.5. Saithe in division Va. Survey catch at age.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1985	0.05	0.61	0.58	2.99	5.11	1.74	1.06	0.50	1.37	0.16	0.08	0.08	0.07	0.07
1986	0.02	2.33	2.40	2.06	2.09	1.42	0.62	0.28	0.19	0.32	0.09	0.07	0.03	0.00
1987	0.10	0.39	11.52	12.93	6.42	3.95	3.07	0.79	0.36	0.26	0.33	0.05	0.01	0.03
1988	0.69	0.31	0.49	2.72	2.81	1.71	0.95	0.40	0.07	0.08	0.10	0.05	0.01	0.00
1989	0.20	1.43	3.96	5.05	6.57	2.49	1.77	0.91	0.40	0.00	0.02	0.00	0.03	0.00
1990	0.01	0.35	1.69	4.86	6.37	12.33	3.30	1.21	0.64	0.12	0.06	0.02	0.01	0.03
1991	0.01	0.22	1.40	1.72	2.22	1.13	2.50	0.30	0.02	0.03	0.00	0.01	0.00	0.01
1992	0.01	0.15	0.91	5.73	5.52	2.79	2.68	1.91	0.28	0.06	0.06	0.02	0.00	0.00
1993	0.00	1.27	11.04	2.00	6.80	2.41	2.25	1.02	4.02	0.64	0.05	0.00	0.02	0.00
1994	0.04	0.82	0.73	1.89	1.74	1.95	0.53	0.84	1.00	3.62	0.41	0.18	0.00	0.04
1995	0.06	0.48	1.98	1.12	0.51	0.28	0.34	0.10	0.15	0.15	0.33	0.02	0.00	0.00
1996	0.03	0.13	0.51	3.76	1.12	0.99	0.58	1.00	0.05	0.09	0.10	0.25	0.03	0.00
1997	0.16	0.32	0.90	4.72	3.96	0.94	0.40	0.16	0.10	0.05	0.02	0.02	0.02	0.00
1998	0.01	0.11	1.64	2.33	2.53	1.23	0.71	0.31	0.08	0.07	0.04	0.03	0.05	0.03
1999	0.57	0.75	3.71	0.93	1.25	1.64	0.57	0.17	0.02	0.02	0.02	0.00	0.00	0.02
2000	0.00	0.38	2.02	2.54	0.61	0.84	0.53	0.47	0.07	0.03	0.01	0.00	0.01	0.01
2001	0.00	0.89	1.90	2.64	1.60	0.20	0.23	0.40	0.13	0.07	0.04	0.01	0.00	0.00
2002	0.02	1.05	2.23	2.97	3.08	2.15	0.42	0.49	0.32	0.22	0.02	0.03	0.00	0.00
2003	0.01	0.05	9.62	5.06	2.94	1.34	0.77	0.21	0.05	0.10	0.02	0.03	0.00	0.00
2004	0.01	0.91	1.38	9.39	6.04	4.35	1.48	0.81	0.17	0.16	0.12	0.06	0.02	0.00
2005	0.00	0.26	4.32	2.39	7.42	4.66	2.31	0.86	0.44	0.12	0.05	0.08	0.03	0.00
2006	0.01	0.00	2.18	6.69	1.98	8.91	3.52	1.21	0.29	0.25	0.03	0.04	0.04	0.00
2007	0.00	0.06	0.31	1.73	3.22	0.81	1.62	0.70	0.29	0.16	0.11	0.08	0.02	0.00
2008	0.01	0.08	2.25	1.79	2.85	4.01	0.61	0.78	0.34	0.15	0.09	0.13	0.04	0.02

2009	0.01	0.21	2.43	1.80	0.68	0.91	0.84	0.12	0.26	0.15	0.03	0.04	0.00	0.02
2010	0.00	0.07	1.23	4.99	2.49	0.63	0.60	0.48	0.07	0.13	0.07	0.07	0.07	0.02
2011	0.00	0.15	3.83	4.20	3.06	1.15	0.41	0.39	0.44	0.17	0.10	0.09	0.06	0.05
2012	0.02	0.02	1.75	12.04	6.86	2.75	0.62	0.17	0.38	0.50	0.13	0.12	0.06	0.08
2013	0.01	0.12	4.27	7.43	6.78	4.65	2.57	1.12	0.30	0.44	0.36	0.26	0.13	0.01
2014	0.01	0.03	0.39	3.84	3.78	2.04	0.86	0.42	0.15	0.11	0.18	0.18	0.07	0.09
2015	0.06	0.04	1.07	1.90	3.16	1.72	0.81	0.72	0.68	0.45	0.26	0.23	0.21	0.15

Table 8.6. Saithe in division Va. Commercial catch-at-age residuals log(obs/fit).

	3	4	5	6	7	8	9	10	11	12	13	14
1980	-0.79	-0.60	0.25	0.16	-0.08	0.22	-0.05	0.22	-0.30	-0.41	-0.70	-0.04
1981	-0.51	-0.26	-0.56	0.36	-0.16	0.06	0.12	0.28	-0.85	0.93	1.19	1.88
1982	0.84	-0.25	0.13	-0.37	0.24	-0.03	0.37	-0.36	-1.20	-1.15	-0.53	-0.10
1983	-2.48	0.94	-0.67	0.11	0.46	0.20	-0.01	-0.80	-2.43	-2.79	-5.17	-3.83
1984	-4.23	-1.61	-1.29	0.22	0.47	0.79	-0.45	0.43	0.96	1.03	3.47	4.90
1985	-0.28	1.23	0.58	0.08	0.27	-0.19	-1.16	-0.75	-1.41	-3.07	0.65	2.46
1986	2.28	-0.72	0.24	-0.32	-0.09	0.10	-0.41	0.93	-1.09	-1.39	-1.83	-1.75
1987	-0.99	0.16	0.32	0.22	0.09	0.07	0.06	-0.18	-0.08	-2.91	-1.91	-0.24
1988	0.92	-0.31	0.06	0.04	-0.14	0.20	0.79	-0.66	0.48	-1.69	-3.27	-6.88
1989	-0.84	0.61	0.01	0.23	-0.58	0.04	0.27	-0.18	0.71	0.37	-1.13	-3.73
1990	-1.78	-0.54	0.07	0.01	0.34	0.06	0.11	-0.37	0.07	-0.78	0.16	-1.61
1991	-1.96	-1.11	0.06	0.33	0.03	-0.08	0.01	0.72	0.23	-1.38	-3.92	-3.95
1992	-0.22	0.58	1.05	0.43	0.06	-0.83	-0.25	-0.40	-0.28	-1.17	0.48	-0.88
1993	0.98	-0.16	-0.33	-0.14	-0.20	-0.08	0.40	0.04	0.33	0.75	0.65	-1.28
1994	1.09	0.98	-0.12	-0.69	-0.43	-0.46	0.20	0.41	0.51	0.80	1.87	1.79
1995	1.59	0.28	0.10	-0.02	0.04	-0.08	-0.20	-0.19	-0.26	-0.87	-0.68	-1.83
1996	1.45	0.17	-0.12	-0.51	-0.34	0.19	0.27	0.03	0.39	-0.15	1.33	2.41
1997	0.25	0.33	-0.30	0.08	-0.03	0.29	-0.10	-0.40	-0.30	0.37	-1.12	0.20
1998	-0.36	-0.07	-0.47	-0.76	0.18	0.00	0.84	0.70	1.24	1.15	1.57	0.84
1999	0.38	0.03	0.00	0.08	0.00	-0.20	-0.35	0.33	-0.65	-0.57	0.31	0.17
2000	-0.07	-0.20	0.11	0.07	-0.16	0.48	-0.49	-0.27	-0.22	-0.93	-0.09	-1.12
2001	-0.09	0.23	-0.27	-0.14	-0.03	-0.18	0.39	0.06	0.13	0.04	0.37	1.00
2002	-0.62	-0.08	0.18	0.36	-0.17	0.12	-0.26	-0.35	-0.09	-1.20	-0.10	-0.36
2003	0.40	-0.28	0.42	-0.02	-0.02	-0.61	0.04	-0.20	0.04	-1.24	0.24	1.21
2004	-0.16	-0.39	-0.11	0.27	-0.10	0.28	0.61	0.41	-0.05	-0.47	0.75	-0.26
2005	-0.39	-0.32	-0.31	0.44	0.34	-0.23	-0.13	-0.01	0.31	-0.07	-0.31	-0.43
2006	-0.69	-0.16	-0.35	-0.03	0.56	0.07	-0.33	-0.10	0.76	0.95	1.05	0.12
2007	0.79	0.22	0.14	0.25	-0.13	-0.04	-0.40	-0.48	-0.82	0.30	0.25	-0.26
2008	0.11	0.36	0.18	0.23	-0.11	-0.23	-0.24	-0.30	-0.60	0.10	2.71	1.70
2009	0.75	0.49	-0.11	-0.27	-0.16	0.29	-0.34	-0.12	0.10	0.42	1.08	2.54
2010	0.46	0.28	0.11	-0.46	0.03	-0.12	0.47	-0.43	0.07	-0.06	0.84	1.18
2011	0.14	-0.06	-0.05	-0.30	-0.04	0.29	0.14	0.36	-0.24	-0.01	0.48	1.41
2012	-0.57	-0.37	-0.27	-0.20	-0.24	0.06	0.66	0.55	1.38	0.12	0.55	0.91
2013	-0.50	-0.04	0.33	-0.02	-0.19	-0.11	0.28	0.12	-0.36	0.35	-0.53	0.01
2014	0.16	-0.20	0.50	-0.04	-0.22	-0.37	-0.24	0.45	0.28	-0.38	1.99	0.16

Table 8.7. Saithe in division Va. Survey catch-at-age residuals log(obs/fit).

	2	3	4	5	6	7	8	9	10
1985	-0.43	-1.53	-0.46	0.55	0.20	0.36	-0.17	0.83	-1.01
1986	0.78	-0.61	-0.69	-0.80	-0.50	-0.35	-0.47	-0.68	-0.39
1987	-0.62	0.87	0.73	0.74	0.44	1.13	0.74	0.53	0.25
1988	-0.35	-2.15	-1.48	-0.96	-0.29	-0.46	-0.39	-1.31	-0.59
1989	1.95	0.86	-0.05	-0.34	-0.60	0.50	0.33	0.35	-5.74
1990	-0.12	0.36	0.45	0.33	0.91	0.48	0.88	0.65	-0.47
1991	0.15	-0.28	-0.27	-0.36	-1.18	-0.62	-1.45	-3.10	-2.26
1992	-0.64	0.03	0.74	1.23	0.46	0.66	-0.02	-0.70	-1.15
1993	2.00	2.63	0.31	1.07	0.80	1.02	0.44	1.69	0.97
1994	0.88	-0.44	-0.09	0.29	0.18	-0.12	0.84	1.31	2.32
1995	0.43	0.12	-0.56	-1.48	-1.24	-0.96	-1.03	-0.21	-0.09
1996	-0.62	-1.29	0.24	-0.41	-0.09	0.52	1.34	-0.87	0.00
1997	1.22	-0.13	0.70	0.44	-0.07	-0.32	-0.04	-0.47	-0.15
1998	-1.50	1.36	0.36	0.11	-0.41	0.34	0.23	-0.06	-0.18
1999	0.72	0.85	0.06	-0.24	0.09	-0.64	-0.57	-2.24	-1.04
2000	-0.72	0.10	-0.23	-0.30	-0.21	-0.55	-0.07	-0.87	-1.14
2001	0.10	-0.62	-0.22	-0.64	-1.11	-1.04	-0.08	-0.84	-0.22
2002	0.13	-0.61	-0.72	0.08	0.18	0.42	0.60	0.34	0.36
2003	-2.22	0.95	-0.28	-0.61	-0.41	-0.34	0.38	-1.36	-0.40
2004	-0.05	-0.12	0.31	0.07	0.34	0.37	0.45	0.80	0.59
2005	-0.87	0.00	-0.06	0.26	0.33	0.29	0.40	0.25	0.83
2006	-6.50	-0.16	-0.07	-0.03	1.07	0.72	0.23	-0.33	0.06
2007	-2.08	-1.51	-1.01	-0.67	-0.48	-0.20	-0.47	-0.90	-0.54
2008	-2.23	0.39	-0.03	-0.17	0.19	-0.09	-0.36	-0.77	-1.19
2009	-1.10	0.00	-0.45	-0.90	-0.89	-0.90	-1.27	-1.08	-1.22
2010	-2.62	-0.81	0.25	0.18	-0.39	-0.66	-0.85	-1.35	-1.41
2011	-1.60	0.30	0.04	-0.10	-0.17	-0.21	-0.50	-0.45	0.12
2012	-3.77	-0.50	1.04	0.82	0.31	-0.24	-0.60	-0.05	0.11
2013	-0.95	0.71	0.60	0.56	0.88	0.87	1.09	0.54	0.52
2014	-2.84	-1.35	-0.03	0.00	-0.32	-0.45	-0.62	-0.80	-0.24
2015	-2.74	-0.45	-0.10	-0.09	-0.43	-0.80	-0.06	0.38	0.85

Table 8.8. Saithe in division Va. Main population estimates. The recruitment column is aligned so that the 2000 cohort is shown in the year 2000, but that cohort size is the estimated N at age 3 in 2003.

	B4+	SSB	Cohort	Y	F4-9	HR
1980	312	122	32	58	0.29	19%
1981	304	130	42	59	0.26	19%
1982	294	148	35	69	0.30	23%
1983	270	147	67	58	0.24	22%
1984	287	149	91	63	0.23	22%
1985	299	139	50	57	0.25	19%
1986	318	137	32	65	0.28	20%
1987	335	128	21	81	0.35	24%
1988	415	125	29	77	0.32	19%
1989	397	127	15	82	0.31	21%
1990	377	134	20	98	0.35	26%
1991	336	143	18	102	0.37	30%
1992	288	135	30	80	0.37	28%
1993	230	112	25	72	0.40	31%
1994	187	93	17	64	0.45	34%
1995	152	70	9	49	0.46	32%
1996	148	61	30	40	0.41	27%
1997	155	62	31	37	0.37	24%
1998	153	68	53	32	0.30	21%
1999	131	72	63	31	0.31	24%
2000	141	74	72	33	0.33	23%
2001	161	80	26	32	0.28	20%
2002	217	96	72	42	0.31	19%
2003	276	118	42	52	0.30	19%
2004	316	137	19	65	0.26	20%
2005	282	147	27	69	0.29	25%
2006	307	156	41	76	0.31	25%
2007	278	152	41	64	0.28	23%
2008	248	149	50	70	0.32	28%
2009	224	137	45	61	0.30	27%
2010	227	127	39	54	0.27	24%
2011	239	122	21	51	0.24	21%
2012	253	122	26	52	0.23	20%
2013	268	128	32	58	0.25	22%
2014	265	132	33	46	0.19	18%
2015	255	139	33	57	0.26	22%

Table 8.9. Saithe in division Va. Stock in numbers.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1980	32.2	24.6	28.2	46.8	30.9	10.3	8.1	3.7	1.3	0.7	0.7	0.5	0.3	0.1
1981	47.9	26.4	20.2	22.7	35.2	21.2	6.3	4.6	2.0	0.7	0.4	0.4	0.3	0.2
1982	62.4	39.3	21.6	16.3	17.2	24.6	13.3	3.7	2.6	1.1	0.4	0.2	0.2	0.2
1983	52.8	51.1	32.1	17.4	12.2	11.8	14.8	7.5	1.9	1.4	0.6	0.2	0.1	0.1
1984	99.7	43.2	41.8	26.0	13.3	8.6	7.5	9.0	4.3	1.1	0.8	0.4	0.1	0.1
1985	136.4	81.6	35.4	33.8	19.9	9.4	5.6	4.6	5.2	2.5	0.7	0.5	0.2	0.1
1986	75.3	111.7	66.8	28.6	25.8	14.0	6.0	3.4	2.6	3.0	1.4	0.4	0.3	0.1
1987	47.6	61.7	91.4	53.9	21.6	17.8	8.7	3.5	1.8	1.5	1.6	0.8	0.2	0.2
1988	31.0	39.0	50.5	73.4	39.8	14.3	10.2	4.6	1.7	0.9	0.7	0.9	0.4	0.1
1989	44.0	25.4	31.9	40.6	54.7	26.8	8.5	5.6	2.3	0.9	0.5	0.4	0.5	0.2
1990	22.1	36.0	20.8	25.7	30.4	37.2	16.2	4.7	2.9	1.2	0.5	0.3	0.2	0.3
1991	29.5	18.1	29.5	16.7	19.0	20.2	31.4	8.6	2.3	1.5	0.6	0.2	0.1	0.1
1992	26.3	24.2	14.8	23.6	12.3	12.4	11.3	16.2	4.0	1.1	0.7	0.3	0.1	0.1
1993	44.3	21.5	19.8	11.9	17.4	8.0	7.0	5.9	7.7	2.0	0.5	0.4	0.2	0.1
1994	38.0	36.3	17.6	15.9	8.7	11.2	4.4	3.5	2.7	3.6	0.9	0.3	0.2	0.1
1995	25.0	31.1	29.7	14.1	11.4	5.4	5.8	2.1	1.5	1.2	1.5	0.4	0.1	0.1
1996	12.8	20.5	25.5	23.7	10.1	7.0	2.8	2.7	0.8	0.6	0.5	0.7	0.2	0.1
1997	44.9	10.5	16.8	20.4	17.3	6.5	3.8	1.4	1.2	0.4	0.3	0.2	0.4	0.1
1998	46.2	36.8	8.6	13.3	14.5	11.2	3.9	2.1	0.7	0.6	0.2	0.1	0.1	0.2
1999	79.7	37.8	30.1	6.8	9.6	9.8	7.1	2.3	1.1	0.3	0.3	0.1	0.1	0.1
2000	93.4	65.2	31.0	23.9	5.0	6.5	6.1	4.1	1.2	0.6	0.2	0.1	0.0	0.0
2001	106.8	76.5	53.4	24.6	17.2	3.3	4.0	3.5	2.1	0.6	0.3	0.1	0.1	0.0
2002	38.1	87.5	62.6	42.6	18.0	11.8	2.1	2.4	1.9	1.1	0.3	0.1	0.0	0.0
2003	107.7	31.2	71.6	49.8	30.9	12.2	7.4	1.2	1.3	1.0	0.6	0.2	0.1	0.0
2004	62.2	88.2	25.5	57.0	36.2	20.9	7.7	4.3	0.7	0.6	0.5	0.3	0.1	0.0
2005	28.1	50.9	72.2	19.9	38.0	22.8	13.0	4.8	2.7	0.4	0.4	0.3	0.2	0.0
2006	40.4	23.0	41.7	56.2	13.0	23.3	13.8	7.9	3.0	1.6	0.2	0.2	0.1	0.1
2007	61.0	33.1	18.8	32.4	36.2	7.9	13.8	8.2	4.8	1.7	0.9	0.1	0.1	0.1
2008	61.1	50.0	27.1	14.7	21.2	22.3	4.8	8.5	5.1	2.8	0.9	0.4	0.1	0.0
2009	74.2	50.0	40.9	21.0	9.3	12.6	13.0	2.8	5.0	2.9	1.5	0.5	0.2	0.0
2010	66.6	60.8	41.0	31.8	13.6	5.6	7.5	7.8	1.7	2.9	1.6	0.7	0.2	0.1
2011	58.4	54.5	49.7	32.0	21.1	8.5	3.5	4.7	4.9	1.0	1.6	0.8	0.4	0.1
2012	30.6	47.8	44.6	39.0	21.7	13.6	5.4	2.2	3.0	3.0	0.6	0.9	0.5	0.2
2013	39.3	25.1	39.2	35.1	26.7	14.1	8.7	3.5	1.4	1.9	1.8	0.3	0.5	0.3
2014	47.6	32.1	20.5	30.7	23.6	17.0	8.9	5.5	2.2	0.9	1.1	1.0	0.2	0.3
2015	48.8	39.0	26.3	16.2	21.6	16.0	11.4	6.0	3.7	1.5	0.6	0.7	0.6	0.1

Table 8.10. Saithe in division Va. Fishing mortality rate.

	3	4	5	6	7	8	9	10	11	12	13	14
1980	0.02	0.09	0.18	0.30	0.36	0.44	0.41	0.44	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	0.34	0.36	0.30	0.30	0.30	0.30
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	0.37	0.34	0.37	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	0.49	0.52	0.43	0.43	0.43	0.43
1988	0.02	0.09	0.19	0.32	0.40	0.48	0.45	0.48	0.39	0.39	0.39	0.39
1989	0.02	0.09	0.19	0.31	0.38	0.46	0.43	0.46	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	0.43	0.43	0.43	0.43
1991	0.02	0.11	0.23	0.38	0.46	0.56	0.52	0.56	0.46	0.46	0.46	0.46
1992	0.02	0.11	0.22	0.37	0.45	0.55	0.51	0.55	0.45	0.45	0.45	0.45
1993	0.02	0.12	0.24	0.40	0.49	0.59	0.55	0.59	0.49	0.49	0.49	0.49
1994	0.03	0.13	0.27	0.45	0.56	0.67	0.63	0.67	0.55	0.55	0.55	0.55
1995	0.03	0.13	0.28	0.46	0.57	0.69	0.64	0.69	0.56	0.56	0.56	0.56
1996	0.02	0.12	0.25	0.41	0.50	0.60	0.56	0.60	0.49	0.49	0.49	0.49
1997	0.04	0.14	0.23	0.31	0.42	0.53	0.57	0.55	0.56	0.56	0.56	0.56
1998	0.03	0.12	0.19	0.26	0.34	0.43	0.46	0.45	0.46	0.46	0.46	0.46
1999	0.03	0.12	0.20	0.27	0.36	0.45	0.49	0.47	0.48	0.48	0.48	0.48
2000	0.03	0.13	0.21	0.28	0.38	0.47	0.51	0.50	0.51	0.51	0.51	0.51
2001	0.03	0.11	0.18	0.24	0.32	0.40	0.43	0.42	0.43	0.43	0.43	0.43
2002	0.03	0.12	0.19	0.26	0.35	0.44	0.47	0.46	0.47	0.47	0.47	0.47
2003	0.03	0.12	0.19	0.26	0.34	0.43	0.47	0.45	0.46	0.46	0.46	0.46
2004	0.05	0.21	0.26	0.28	0.27	0.26	0.30	0.37	0.43	0.43	0.43	0.43
2005	0.05	0.22	0.29	0.31	0.29	0.29	0.32	0.40	0.47	0.47	0.47	0.47
2006	0.05	0.24	0.31	0.33	0.31	0.31	0.35	0.43	0.51	0.51	0.51	0.51
2007	0.05	0.22	0.28	0.30	0.29	0.28	0.32	0.39	0.46	0.46	0.46	0.46
2008	0.06	0.25	0.32	0.34	0.33	0.33	0.37	0.45	0.53	0.53	0.53	0.53
2009	0.05	0.24	0.30	0.32	0.31	0.30	0.34	0.42	0.50	0.50	0.50	0.50
2010	0.05	0.21	0.27	0.28	0.27	0.27	0.30	0.37	0.44	0.44	0.44	0.44
2011	0.04	0.19	0.24	0.26	0.25	0.24	0.27	0.34	0.40	0.40	0.40	0.40
2012	0.04	0.18	0.23	0.25	0.23	0.23	0.26	0.32	0.38	0.38	0.38	0.38
2013	0.04	0.20	0.25	0.27	0.25	0.25	0.28	0.35	0.41	0.41	0.41	0.41
2014	0.03	0.15	0.19	0.20	0.20	0.19	0.22	0.27	0.32	0.32	0.32	0.32
2015	0.05	0.20	0.26	0.28	0.26	0.26	0.29	0.36	0.43	0.43	0.43	0.43

Table 8.11. Saithe in division Va. Input values for short-term projections. Same weights are used for catch weights and stock weights.

2015	3	4	5	6	7	8	9	10	11	12	13	14
N	26.3	16.2	21.6	16.0	11.4	6.0	3.7	1.5	0.6	0.7	0.6	0.1
M	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
mat	0.000	0.100	0.217	0.409	0.633	0.812	0.915	1.000	1.000	1.000	1.000	1.000
w	1.142	1.726	2.217	3.071	4.030	5.532	6.846	7.175	7.491	8.218	8.575	9.173
sel	0.106	0.476	0.608	0.648	0.621	0.611	0.687	0.846	1.000	1.000	1.000	1.000
pF	0	0	0	0	0	0	0	0	0	0	0	0
pM	0	0	0	0	0	0	0	0	0	0	0	0
2016	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
N	31.9											
M	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
mat	0.000	0.100	0.217	0.409	0.633	0.812	0.915	1.000	1.000	1.000	1.000	1.000
w	1.142	1.726	2.217	3.071	4.030	5.532	6.846	7.175	7.491	8.218	8.575	9.173
sel	0.106	0.476	0.608	0.648	0.621	0.611	0.687	0.846	1.000	1.000	1.000	1.000
pF	0	0	0	0	0	0	0	0	0	0	0	0
pM	0	0	0	0	0	0	0	0	0	0	0	0
2017	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
N	32.7											
M	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
mat	0.000	0.100	0.217	0.409	0.633	0.812	0.915	1.000	1.000	1.000	1.000	1.000
w	1.142	1.726	2.217	3.071	4.030	5.532	6.846	7.175	7.491	8.218	8.575	9.173
sel	0.106	0.476	0.608	0.648	0.621	0.611	0.687	0.846	1.000	1.000	1.000	1.000
pF	0	0	0	0	0	0	0	0	0	0	0	0
pM	0	0	0	0	0	0	0	0	0	0	0	0

Table 8.12. Saithe in division Va. Output from short-term projections.

2015						
B4+	SSB	Fbar	Landings			
255	139	0.26	57			
2016				2017		
B4+	SSB	Fbar	Landings	B4+	SSB	Rationale

238	138	0.26	54	227	130	20% HCR

20% HCR = average between 0.2 B4+ (current year) and last year's TAC

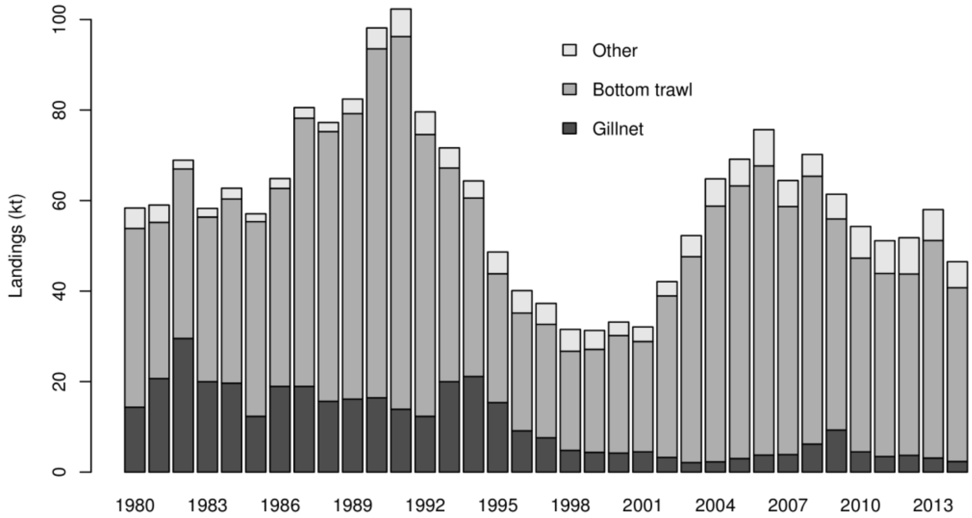

Figure 8.1 Saithe in Division Va. Landings by gear.

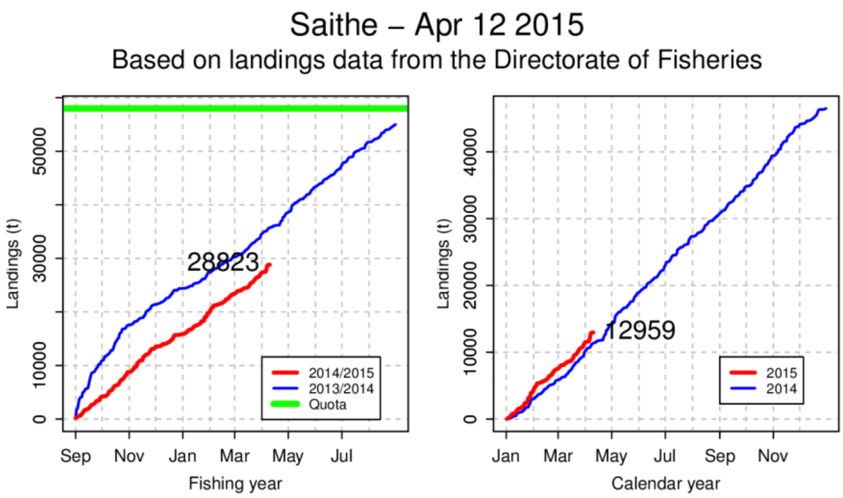

Figure 8.2 Saithe in division Va. Cumulative landings in the current fishing year (left) and calendar year (right). The vertical (green line) in the left figure shows the quota for the current fishing year.

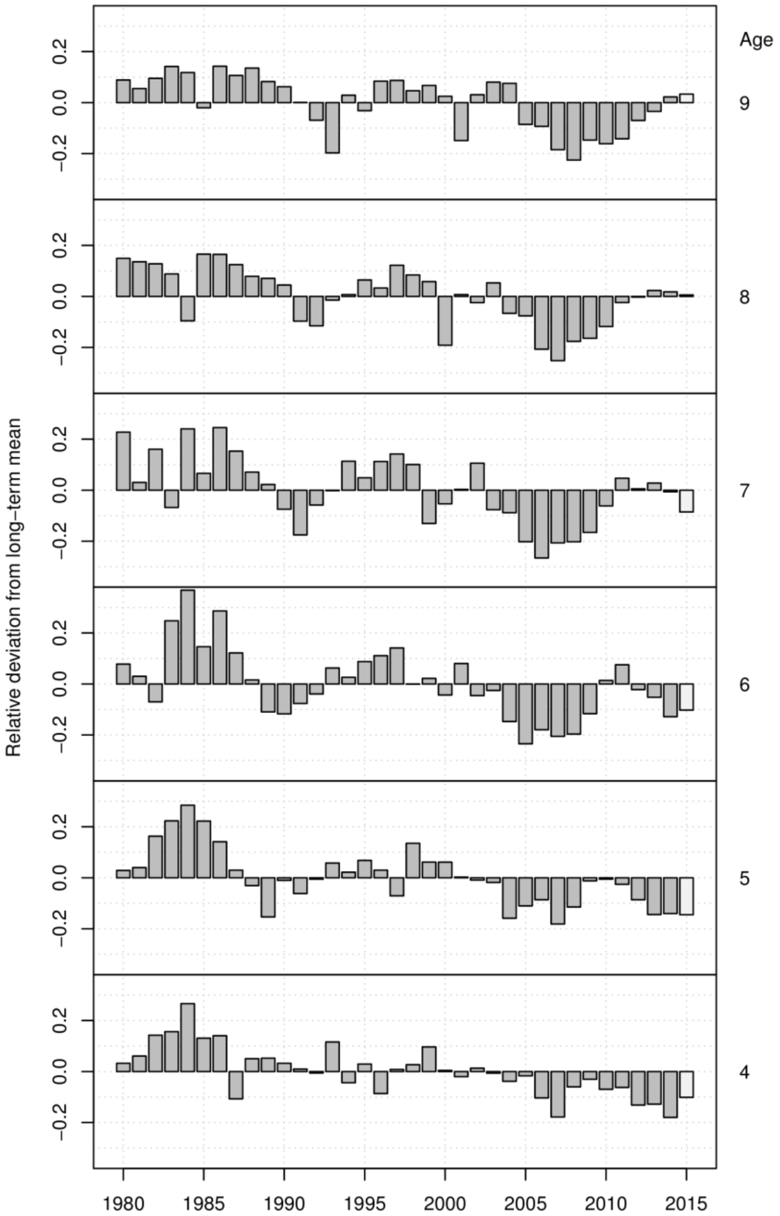

Figure 8.3 Saithe in division Va. Weight at age in the catches, as relative deviations from the mean. The current year's deviation is a preliminary prediction.

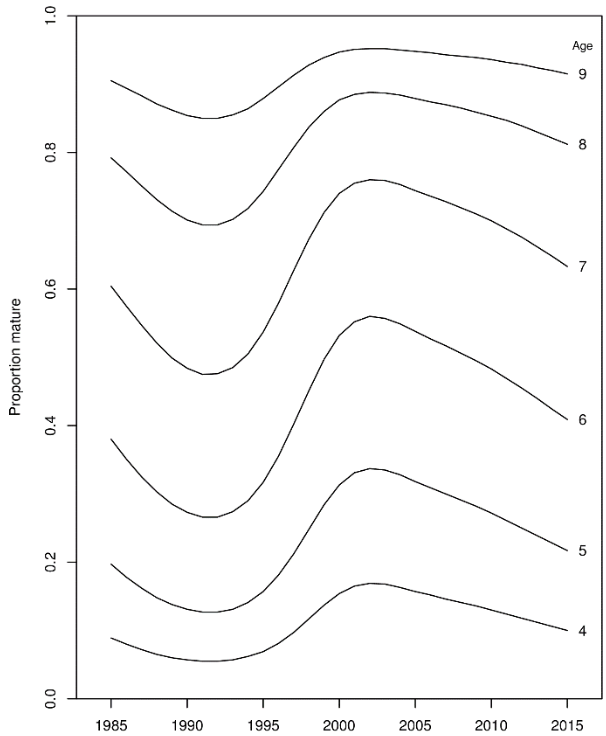

Figure 8.4 Saithe in division Va. Maturity at age used for calculating the SSB.

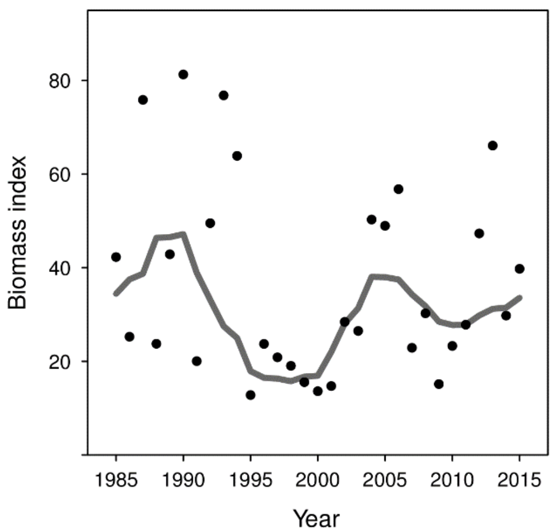

Figure 8.5 Saithe in division Va. Spring survey biomass index and model fit.

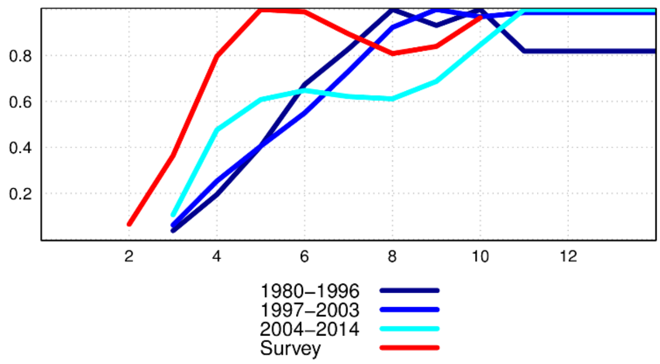

Figure 8.6. Estimated selectivity patterns for the 3 periods.

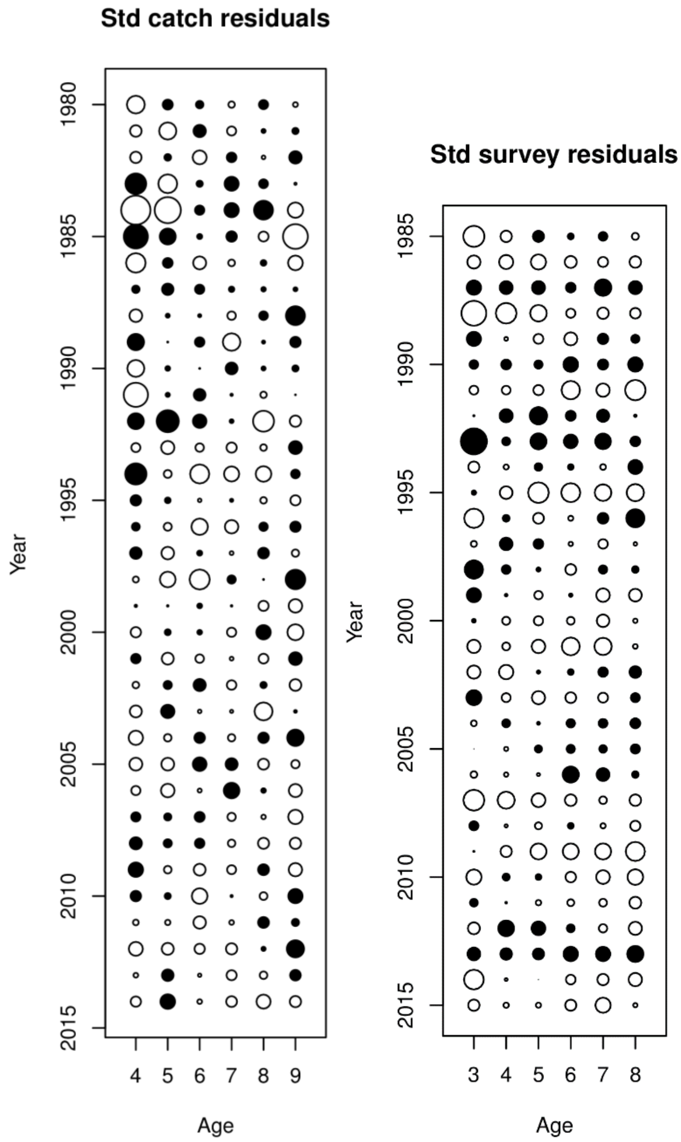

Figure 8.7. Saithe in division Va. Commercial and survey catch-at-age residuals from the fitted model. Filled circles are positive log residuals and hollow circles are negative log residuals.

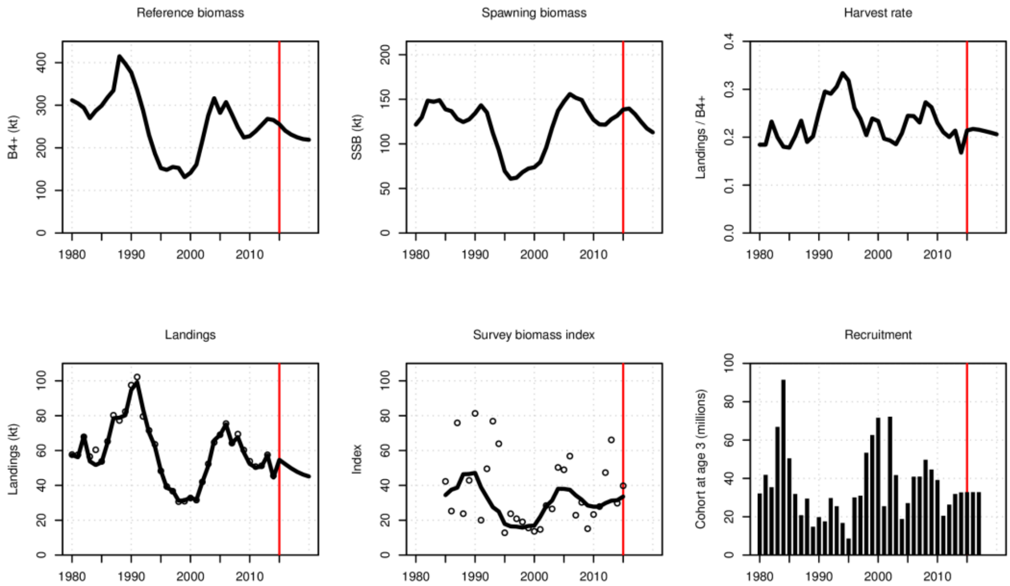

Figure 8.8. Saithe in division Va. Results from the fitted model and short-term forecast. The red line indicates the time of the current assessment.

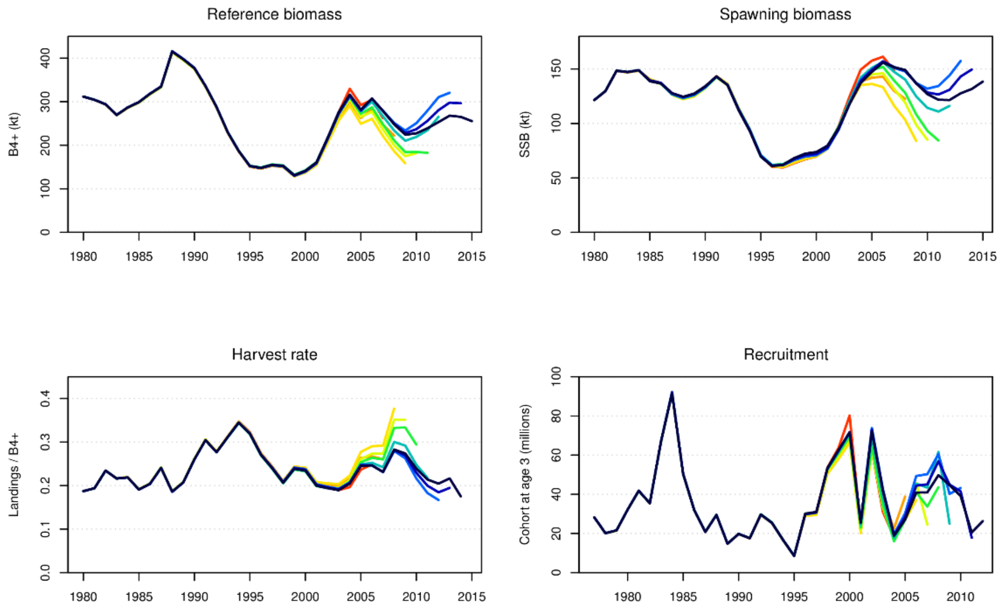

Figure 8.9. Saithe in division Va. Retrospective pattern for the assessment model.

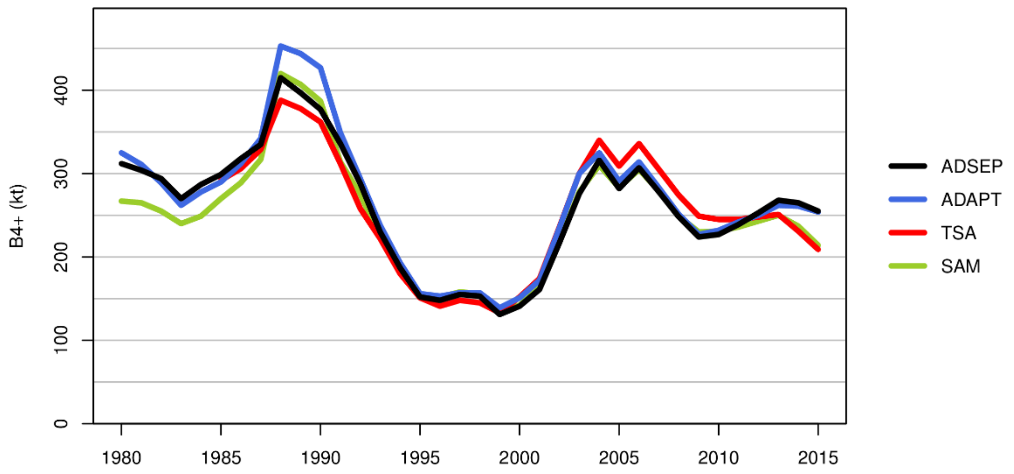

Figure 8.10. Saithe in division Va. Comparison between the default separable model (ADSEP) and alternative assessment models.

9 Icelandic Cod

9.1 Summary

The spawning stock (SSB_{2015}) is estimated to be 547 kt and is higher than has been observed over the last five decades. The reference biomass ($B_{4+,2015}$) is estimated to be 1302 kt, the highest observed since the late 1970's. Fishing mortality, being 0.3 in 2014, has declined significantly in recent years and is presently the lowest observed in last 6 decades. Year classes since the mid-1980s are estimated to be relatively stable but with the mean around the lower values observed in the period 1955 to 1985.

According to the adopted management harvest rule the TAC will be 239 kt in the next fishing season. ICES has evaluated the plan and concludes that it is in accordance with the precautionary approach and the ICES MSY framework.

Mean weight at age in the stock and the catches that were record low in 2006—8 have been increasing in recent years and are now around the long term mean.

The input in the analytical assessments are catch at age 1955—2014 and spring groundfish survey (SMB) indices at age from 1985-2015 and fall survey groundfish survey (SMH) indices at age from 1996—2014. The results from the AD-Model builder statistical Catch at Age Model (ADCAM) as was used as the final run. This framework has been the basis for the advice since 2002.

The reference stock (B_{4+}) in 2014 is now estimated to be 1181 kt compared to 1106 kt last year. The SSB in 2014 is now estimated to be 425 kt compared to 427 kt estimated last year. Fishing mortality in 2013 is now estimated 0.29 compared to 0.3 estimated last year. Year classes 2011—2013 were estimated to be 181, 160 and 109 million in last years assessment and are now estimated to be 181, 161 and 115 millions.

9.2 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 homogeneous unit in the assessment. Spawning takes place in late winter mainly off the south west 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 behavioral 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-ambiguous 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 south west 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 periods. This pattern was quite prevalent prior to 1970, while condition in Greenlandic waters are thought to have been favorable for cod productivity. Periodic immigrations have been estimated in the assessment from anomalies in the catch at age matrix with timing and age of such events being based on expert judgement using external information. The most recent of such migration was from the 1984 year class in 1990, the number estimated around 30 millions. Recent tagging experiments as well as abnormal 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. In the current assessment the immigration at age 6 in 2009 is estimated around 9.7 millions corresponding an additional biomass of around 31 kt in 2009. The influence of this immigration on the current biomass estimate is minimal.

Extensive tagging experiments spanning with some hiatuses over the last 100 year indicate that significant emigration from Iceland to other areas may be rare. In recent years it has been observed that cod tagged in Iceland has been recaptured inside Faroese waters close to the EEZ line separating Iceland and the Faroes islands. Anecdotal information from the fishing industry indicates that may be some exchange of cod across the Denmark Strait. These migrations may be of different nature than the hypothesized net "life history" immigration of cod described above.

9.3 Data

The data used for assessing Icelandic cod landings, catch-at-age composition and indices from standardized bottom trawl surveys. The sampling programs i.e log books, surveys, sampling from landings etc. have been described in previous reports.

9.4 Landings

Landings of Icelandic cod in 2014 are estimated to have been 221.343 kt of which 219.682 kt were taken by Icelandic fleet. The landings by gear and month were as follows:

	1	2	3	4	5	6	7	8	9	10	11	12	Total	Proportion
Longline	8544	6053	6553	5695	6666	4065	2591	3338	8364	10047	11468	5424	78809	0.36
Gill net	2526	4837	6522	2825	790	76	62	142	294	237	482	250	19043	0.09
Hooks	28	161	1178	1448	2872	3665	3603	1874	709	189	100	4	15831	0.07
Danis seine	574	1754	2440	1206	952	363	229	286	1032	768	573	176	10353	0.05
Trawl	8489	6883	8514	7052	9094	6168	4041	4577	9881	11913	11601	9094	97307	0.44
	20161	19688	25207	18226	20374	14337	10526	10217	20280	23154	24224	14948	221343	1.00

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 within a period of 5 years, and have been just above 40% of the total landings in the last decade. (Figure 9.1). 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.

The trawl fishery is high aggregated with large proportion of the catches taken along the northeast and southeast continental shelf slope boundary (Figure 9.2) while the long line fishery is much more dispersed (Figure 9.3).

The trend in landings in last two decades is largely a reflection of the TAC that is set for the fishing year (starting 1. September and ending 31 august).

According to the HCR the TAC for the fishing year 2013/14 was supposed to be capped to 215 kt. Landings of the Icelandic fleet was however 225.081. Including additional landings from the foreign fleet this amounts to an overshoot of some 4.7%.

The estimate of landings for the current fishing year is 220 thousand tones, this being based on the following:

Category	Amount
ITQ holders	204.552
Shell and shrimp	1.385
Village support	5.094
Long line allowance	3.375
Beach fishing	7.500
Sport fishing	0.200
Village support II	2.404
Recalled	-8.200
Estimated foreign	2.000
Miscallaneous	2.000
Total	220.310

The catches in the first four months of the current fishing year (September – December 2014) were 83 kt. The remainder of the estimated catch in the fishing year (220 kt) is 137 kt. Assuming that the same proportion of the allowable catch for the next fishing year is taken in the first four months (September–December 2014) as last year landings (some 0.38), the catch in 2015 is estimated to be 234 kt.

Mean annual discard of cod over the period 2001—2012 is around 1% of landings (Ólafur Pálsson *et al.* 2013). The method used for deriving these estimates assumes that discarding only occurs as high grading.

9.5 Catch in numbers and weight by age

9.5.1 Catch in numbers by age

Sampling protocol for estimating the age composition of the cod has been in effect since 1991 and has been described previous reports. The method for deriving the catch at age are described in the stock annex. The catch at age matrix is reasonably consistent (Table 9.1), with CV estimated to be approximately 0.2 for age groups 4—10 based on a Shepherd-Nicholson model.

9.5.2 Mean weight at age in the landings

The mean weight age in the landings (Table 9.2 and Figure 9.4) declined from 2001 to 2007, reaching then a historical low in many age groups. The weight at age have been increasing in recent years and are in 2014 around the average weights observed over the period from 1985 and close to the long term mean (1955-2014). The variation in the pattern of weight at age in the catches is in part a reflection of the variation in the weight in the stock as seen in the measurements from the spring survey (Table 9.5 and Figure 9.5). The latest spring survey weight measurements (in 2015) are below average in younger ages but above average in older ages.

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 weight measurements in that year using the slope and the intercept from a linear relationship between survey and catch weights in preceding year. The same approach was used this year for predicting weight at age in the catches for 2015. I.e. the $alpha$ and $beta$ were estimated from :

$$cW_{a,2014} = alpha + beta \quad sW_{a,2014}$$

and the catch weights for 2015 then from:

$$cW_{a,2015} = alpha + beta \quad sW_{a,2015}$$

Based on this the mean weights at age in the catches in 2015 are predicted to be at or above average (Figure [fig:cW01]).

9.6 Surveys

9.6.1 Length based indices

The total biomass indices from the spring (SMB) and the fall (SMH) surveys (Figure 9.6) indicate that the stock biomass has been increasing substantially in recent years and is in the last 4 years among highest since the start of the spring survey in 1985. The increase in biomass is most pronounced in larger fish.

9.6.2 Age based indices

Abundance indices by age from the spring and the fall surveys (Tables 9.6 and 9.8). Indices of older fish are all relatively high in recent years despite the indices of these year classes when younger are low or moderate in size (Figure 9.7).

The variance of age groups 5—9 was abnormally high in the spring 2012 survey but the value for the last three years being normal (Table 9.9). This high cv is in part attributed to one haul having extremely high cod catches. In previous NWWG report it was shown that the influence of the large haul did not have a significant effect on the assessment, this being attributed to survey residuals in a given year being modeled by a multivariate normal distribution (see stock annex).

9.7 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.

9.8 Assessment

Last year, the results from a statistical catch at age model (sometimes refer to as ADCAM) tuned with the spring and the fall survey was used as the final point estimator upon which advice was based (referred to as the SPALY model in the text that follows). In this framework the catch at age are modelled and the fishing mortality changes gradually over time, constrained by a random walk (further explanation of the model setup are provided in the stock annex). In addition to the above model, the data have also been extensively explored in the TSA framework, using a Time Series Analysis developed and run by Guðmundur Guðmundsson (1994, 2004, details of model description are given in WD 29, NWWG 2013). Models where the catch/fishing mortality is not modelled (ADAPT) and where the fishing pattern is not considered to change each year (SEPARABLE) are also routinely run for comparative purpose.

The SPALY framework from last year, i.e. tuning with both the spring and the fall survey using ADCAM show similar diagnostics as that observed last years (see Tables 9.19, 9.11 and 9.12 and Figure 9.8 for the residuals). A negative residual block for spring survey indices age groups 2 to 5 in recent years may indicate that there may have been some change in catchability. The detailed result from the SPALY ADCAM run are provided in Tables 9.13, 9.14 and the stock summary in Table 9.15 and Figure 9.9. The reference biomass is estimated to be 1302 kt in 2015 and the fishing mortality 0.28 in 2014.

Assessment based on ADCAM tuning with the spring and the fall survey separately have in recent years shown that the fall survey gives a higher estimate than the spring survey (Figure 9.11). Tuning with spring survey only this year resulted in a reference biomass of 1186 kt in 2015 and a fishing mortality of 0.32 in 2014. An assessment based on the fall survey only gave reference biomass of 1378 kt in 2015 and fishing mortality of 0.32 in 2014. There is hence some conflict with respect to the extent of the increase in the biomass and reduction in fishing mortality in recent years between the two survey input sources. In addition there are conflict in the signals between the surveys on one hand and the catch at age matrix, the year classes declining at somewhat faster rate in the fisheries than in the surveys.

Although there are indication that there may be violation in the SPALY ADCAM setup it was considered premature to base the advice this year on one of the alternative models setup and assumptions. If the true reference biomass in 2015 is around 1000 kt and the TAC is set at 239 kt it is equivalent to the decision being based on a 0.24 harvest rate. If this becomes the realized harvest in 2017 it is still among the lowest observed historical rates.

9.9 Reference points and stock classification

In 2010 ACOM set the B_{lim} as 125 kt based on recommendation of the NWWG. The basis for B_{lim} is B_{loss} and/or the SSB_{break} in a segmented regression based on recruitment from year classes 1952-1984 on one hand and recruitment from year classes 1985 onwards on the other hand (Figure 9.11). The splitting of the recruitment time series is based on the hypothesis that recruitment productivity as a function of spawning stock biomass, as it is presently measured, is lower in latter period compared with the former period.

An harvest rate limit point derived deterministically from B_{lim} according to the methodology outlined in SGMAS 2006 indicates that it is in the vicinity of 0.35.

B_{pa} and F_{pa} have never been set for this stock. Based on the ICES default methodology for the derivation of B_{pa} and F_{pa} from B_{lim} and F_{lim} these reference points would be somewhere in the vicinity of: B_{pa} = 1.4 B_{lim} = 175 kt HR_{pa} = HR_{lim}/1.4 = 0.25

The $B_{trigger}$ and the HR_{HCR} in the HCR are thus respectively above and below the default candidate PA-reference points. Given the current ICES MSY framework, upon which the HCR for iCod has been evaluated, definition of PA-reference points may be deemed as redundant. The NWWG does not suggest a formal establishment of PA-points for iCod at this point.

F_{msy} or HR_{msy} point estimate, to be used in stock status classification in the advisory text has not been defined for this stock. The harvest rate in the management control rule upon which the TAC is based (landings being based on 20% of the reference biomass (B_{4+}) and the TAC in the current fishing year) has been deemed by ICES to be in conformity with the ICES PA and MSY approach. The distribution of the realized harvest rate when the HCR is followed show that the 90% expected range are within a harvest rate of 0.15—0.27 (Figure 9.13). The recent realized harvest rates are within that range.

The harvest rate (no $B_{trigger}$) upon which the a catch advise is based that results in maximum sustainable yield has been estimated to be 0.22, with a 90% realized range of

0.16-0.31. Note that the method used in the derivation of these statistics are not that same as that used to define F_{msy} ranges in the WKMSYREF3.

9.10 State of the stock

The spawning stock reached a historical low in 1993 (120 kt point estimates) but has since then increased and estimated to be 547 kt at present 9.9, Table 9.15). A spawning stock biomass above the current estimates has not been observed since the early the 1960's. This increase in biomass of older fish occurs despite productivity in terms of recruitment of the year classes now contributing to the spawning stock (2001—2010) having been relatively low (geometric mean = 129). The driving factor is hence attributed to a significant decline in fishing mortality/exploitation rate in recent years, being at present within the same order as observed in the beginning of the time series. The average size of the most recent year classes that are estimated (2011—2014) is 158 millions, this being close to the long term mean (164 million).

9.11 Short term deterministic forecast

Input: The stock in numbers in 2015 (Table 9.16) for year classes 2014 and older are obtained from the current assessment (Table 9.14). Given the current harvest control rule, where the TAC 2015/2016 is determined from the $B_{4+,2015}$, the only additional prediction needed is the estimates of weights in 2015. These were described in section 9.3.2. Hence there is no need to carry through a short term prediction so what follows is just to keep up with the ICES convention.

Additional assumptions used in the deterministic predictions are as usual: Weights and proportion mature in the spawning stock from 2015 onwards were kept constant. The fishing pattern used is the average of the years 2011—2014. The estimated landings for the calendar year 2015 is 227 kt as discussed in section 9.3.1. Details of the inputs values are provided in Table 9.16.

Output: The estimated reference biomass in 2015 is 1302 kt. The TAC in the current fishing year is 218 kt. According to the management harvest control rule, given that the current SSB estimates are above the $SSB_{trigger}$ (220 kt), the TAC in the next fishing year is:

$$TAC_{2015/2016} = 0.5 \quad 218 + 0.10 \quad 1300 = 239kt$$

9.12 Stochastic forecast

Medium term forecasts up to year 2019 was run on the three ADCAM runs, both surveys in the tuning (SPALY), spring survey only and fall survey only. The platform used is the same as used in the assessment. Harvest rate of 0.20 (for the SPALY assessment), 0.22 (for the SMB tuned assessment) and 0.18 (for the SMH tuned assessment) were used in the future, the latter two to accounting for potential under or overestimation of the stock.

The analysis indicate there is high probability that the spawning stock size is and will remain above $B_{trigger}$ (220 kt) and B_{lim} (125 kt) (Figure 9.10).

9.13 Uncertainties in assessment and forecast

Alternative model assumptions indicate that the reference biomass may be around range from 1000—1300 kt in 2014, compared with the 1100 kt estimated from the SPALY model. The lower alternative state of nature implies that the reference biomass upon which the TAC is set may be 20% lower than used and that the realized harvest rate could materialize to be 24% given a TAC of 218 kt. According to the HCR evaluation (ICES 2009), this is close to the upper bounds of expected harvest rates.

9.14 Comparison with previous assessment, forecast and advise

The reference stock (B_{4+}) in 2014 is now estimated to be 1181 kt compared to 1106 kt last year. The SSB in 2014 is now estimated to be 425 kt compared to 427 kt estimated last year. Fishing mortality in 2013 is now estimated 0.29 compared to 0.3 estimated last year. Year classes 2011-2013 were estimated to be 181, 160 and 109 million in last years assessment and are now estimated to be 181, 161 and 115 millions.

A standard ICES retrospective plots (Figure 9.12) show estimates of key metrics in recent years compared with current estimates.

The basis for the advice this year is the same as last year: the management plan/MSY/precautionary approach.

9.15 Management considerations

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, including any landings arising from new regulations.

9.16 Regulations and their effects

Exploitation rate and fishing mortality have been reduced significantly after the implementation of the catch rule in 1995 compared with the past. I.e. management measures by restricting landings based on the HCR are manifested in lower fishing mortality and higher stock biomass for the iCod.

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 activity of fish. In 2005, the maximum allowed mesh size in gill nets was decreased to 8 inches in order to protect the largest spawners.

The mesh size in the cod-end in the trawling fishery was increased from 120 mm to 155 mm in 1977. Since 1998 the minimum cod-end 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.

9.17 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 is likely to have resulted in overall shift in the fishing pattern away from the largest fish. The increase in the long line fishery in the north was partly the reason for the decline in the observed mean weight at age of oldest fish in the catches.

9.18 Environmental influence on the stock

Environmental influence on the stock are partly integrated in the annual input data for the analytical assessment, both in terms of weight and stock indices. The causation is however poorly understood.

An increased inflow of Atlantic water has been observed in Icelandic waters since 1997, resulting in higher temperature and higher salinity. A northward shift in distribution of immature capelin may be linked to these hydrographical changes, resulting in lower availability of capelin for cod. In the past low weights-at-age of cod have been related to a low biomass of capelin. The increase in mean weight-at-age in cod in recent years may, however, have more to do with reduction in fishing mortality than with changes in availability of capelin.

Table 9.1: Icelandic cod in Division Va. Estimateded catch in numbers by year and age in millions of fish in 1955-2013.

year	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	3.174	7.219	9.385	8.692	10.695	5.588	1.599	1.095	0.337	0.197	0.071	0.016
2011	4.780	7.257	9.284	10.735	6.032	6.152	2.361	0.666	0.459	0.151	0.041	0.010
2012	3.839	10.010	10.400	9.435	8.866	4.834	3.206	1.269	0.369	0.218	0.101	0.030
2013	5.141	12.299	14.846	11.212	7.358	5.643	2.688	1.930	0.675	0.289	0.156	0.052
2014	5.263	7.371	13.304	12.984	8.831	4.829	3.112	1.570	1.027	0.360	0.100	0.089

Table 9.2: Icelandic cod in Division Va. Estimated mean weight at age in the landings (kg) in period the 1955-2014. The weights for age groups 3 to 9 in 2015 are based on predictions from the 2015 spring survey measurements. The weights in the catches are used to calculate the reference biomass (B_{4+}).

year	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	1.131	1.769	2.334	3.161	4.422	5.498	6.552	7.945	8.913	10.090	10.417	13.489
2011	1.163	1.795	2.615	3.471	4.469	5.850	6.742	7.850	8.810	9.797	13.534	13.033
2012	1.256	1.667	2.448	3.728	4.713	5.894	7.616	8.358	9.543	10.916	10.884	11.758
2013	1.245	1.721	2.477	3.557	4.930	6.161	7.517	8.412	9.332	9.923	11.194	12.687
2014	1.222	1.790	2.535	3.431	4.565	6.043	7.544	9.178	9.713	10.513	11.437	12.979
2015	1.421	1.814	2.757	3.542	4.673	6.039	8.145	9.187	9.722	10.523	11.448	12.992

Table 9.3: Icelandic cod in Division Va. Estimated weight at age in the spawning stock (kg. These weights are used to calculate the spawning stock biomass (SSB).

year	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	1.306	1.382	1.752	2.710	3.443	4.675	7.220	10.320	12.197	14.683	16.175	19.050
1986	1.306	1.604	2.892	3.234	4.572	5.805	7.247	9.084	10.356	15.283	14.540	15.017
1987	1.706	1.589	2.426	3.516	4.879	6.459	7.656	9.243	10.697	10.622	15.894	12.592
1988	0.929	1.480	2.263	3.273	4.387	4.566	8.275	8.822	9.977	11.732	14.156	13.042
1989	0.822	1.501	2.346	3.428	4.676	7.388	8.506	9.831	11.986	10.003	12.611	16.045
1990	0.725	1.043	2.179	2.809	4.421	6.359	9.230	10.592	10.993	14.570	15.732	17.290
1991	0.114	1.286	2.042	2.752	3.404	6.091	9.152	9.804	9.754	14.344	14.172	20.200
1992	0.448	1.344	2.096	3.029	3.755	5.143	7.562	8.127	12.679	13.410	15.715	11.267
1993	0.773	1.363	2.309	3.236	4.111	5.710	6.352	8.641	10.901	12.517	14.742	16.874
1994	1.611	1.728	2.253	3.341	4.515	6.535	10.039	8.896	10.847	12.874	14.742	17.470
1995	0.514	1.636	2.346	3.186	4.488	5.528	8.620	10.273	11.022	11.407	13.098	15.182
1996	0.543	1.754	2.491	3.534	4.254	5.634	8.300	9.772	10.539	13.503	13.689	16.193
1997	1.112	1.347	2.267	3.746	5.426	5.972	6.958	8.537	10.797	11.533	10.428	12.788
1998	1.112	1.821	2.261	3.263	4.468	5.784	6.812	9.304	10.759	14.903	16.651	18.666
1999	1.307	1.467	1.933	2.997	3.961	5.120	6.494	9.946	11.088	12.535	14.995	15.151
2000	0.496	1.355	1.916	2.881	4.318	5.580	8.497	9.203	10.240	11.172	13.172	17.442
2001	0.816	1.583	2.108	2.700	4.086	6.202	6.907	9.055	8.769	9.526	11.210	13.874
2002	0.780	1.590	2.259	3.120	3.985	5.958	9.234	9.002	10.422	13.402	9.008	16.893
2003	1.149	1.324	2.239	3.052	4.231	5.057	6.838	7.819	8.802	10.712	12.152	13.797
2004	1.149	1.430	2.099	3.049	3.743	5.319	5.682	7.397	10.808	11.569	13.767	12.955
2005	0.649	1.120	1.898	2.962	3.875	4.806	7.281	5.495	7.211	9.909	12.944	18.151
2006	0.907	1.384	1.999	2.907	4.384	5.122	6.536	5.769	6.258	5.688	7.301	15.412
2007	1.403	1.264	2.022	2.582	4.081	5.725	6.736	6.481	7.142	6.530	9.724	10.143
2008	0.912	1.842	2.232	2.925	3.915	5.462	7.075	7.648	8.282	11.181	14.266	17.320
2009	0.644	1.441	2.028	2.873	3.913	4.919	7.046	8.505	10.126	12.108	12.471	15.264
2010	0.644	1.588	2.153	3.131	4.173	5.197	6.356	7.945	8.913	10.090	10.417	13.489
2011	0.794	2.377	2.651	3.203	4.517	6.000	6.866	7.850	8.810	9.797	13.534	13.033
2012	1.403	1.698	2.594	3.683	4.483	5.921	7.988	8.358	9.543	10.916	10.884	11.758
2013	0.944	2.282	2.983	3.827	5.206	6.543	8.298	8.415	9.336	9.926	11.195	12.691
2014	0.944	1.333	2.539	3.307	4.460	6.424	8.225	8.413	9.713	10.513	11.437	12.979
2015	0.710	1.047	3.311	3.833	4.902	6.240	8.728	9.705	9.722	10.523	11.448	12.992

Table 9.4: Icelandic cod in Division Va. Estimated maturity at age.

year	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		0.021	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		0.055	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		0.061	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		0.038	0.246	0.549	0.626	0.843	0.816	0.990	1.000	1.000	1.000	1.000
2005	0.003	0.109	0.281	0.493	0.792	0.805	0.951	0.908	1.000	1.000	1.000	1.000
2006	0.002	0.023	0.294	0.448	0.752	0.871	0.743	0.747	1.000	1.000	1.000	1.000
2007	0.012	0.032	0.159	0.501	0.693	0.785	0.836	0.924	1.000	1.000	1.000	1.000
2008	0.001	0.041	0.276	0.549	0.727	0.827	0.846	0.954	1.000	1.000	1.000	1.000
2009	0.002	0.015	0.132	0.456	0.688	0.883	0.741	0.631	1.000	1.000	1.000	1.000
2010		0.016	0.058	0.377	0.822	0.869	0.923	0.802	1.000	1.000	1.000	1.000
2011	0.002	0.012	0.135	0.431	0.734	0.926	0.940	0.958	1.000	1.000	1.000	1.000
2012	0.004	0.029	0.126	0.411	0.728	0.882	0.961	0.830	1.000	1.000	1.000	1.000
2013	0.003	0.008	0.061	0.343	0.738	0.923	0.957	1.000	1.000	1.000	1.000	1.000
2014		0.026	0.068	0.236	0.614	0.893	0.967	0.957	1.000	1.000	1.000	1.000
2015	0.004	0.007	0.109	0.353	0.638	0.908	0.979	0.988	1.000	1.000	1.000	1.000

Table 9.5. Icelandic cod in Division Va. Estimated spring survey weight at age.

year	1	2	3	4	5	6	7	8	9	10
1985	14	137	388	1117	1733	2578	3222	4671	5866	7035
1986	15	159	616	1219	2246	2962	4328	5588	7226	8314
1987	14	117	467	1198	1751	2981	4197	6336	6943	10048
1988	11	122	495	1076	1964	3096	3554	4365	8133	9439
1989	22	150	548	1140	1932	3049	4387	6264	7014	12540
1990	19	135	459	1039	1814	2595	3873	6045	8158	9583
1991	18	147	553	1166	1842	2586	3267	5735	7612	14448
1992	24	134	500	1012	1845	2567	3652	5049	7443	13540
1993	12	171	576	1166	1944	2991	3961	5378	5984	9335
1994	13	174	686	1412	2044	3181	4133	6273	8310	9890
1995	10	134	605	1377	2284	2989	4449	5323	8068	9251
1996	11	155	551	1350	2082	3321	4044	5263	7478	9965
1997	18	140	546	1194	2168	3220	4864	5508	6458	6901
1998	15	158	485	1208	2041	3017	4253	5437	6347	8384
1999	14	140	578	1070	1847	2867	3820	4981	5626	8193
2000	16	124	486	1195	1817	2771	4066	5349	8503	8401
2001	17	152	531	1186	1852	2641	3760	5452	6442	8174
2002	11	132	510	1206	1998	2920	3780	5759	6264	6285
2003	16	131	466	1179	1918	2788	4139	4678	6260	9595
2004	20	147	481	1062	1873	2803	3458	4989	5314	7794
2005	11	118	451	1029	1760	2644	3646	4362	7248	6672
2006	13	105	417	982	1689	2600	4050	4750	5623	8380
2007	14	101	410	969	1663	2342	3635	5017	6122	7747
2008	11	121	376	937	1805	2612	3592	4933	6395	8407
2009	12	113	413	845	1602	2633	3659	4683	5769	6289
2010	13	98	391	1008	1697	2570	4021	4912	6101	7753
2011	12	102	395	1126	2114	2986	4225	5876	6645	7904
2012	12	142	477	1143	1929	3180	4249	5718	7826	7609
2013	13	113	495	1054	1785	3022	4772	6381	8053	9537
2014	11	114	359	1078	1710	2632	3987	6168	8068	10117
2015	13	150	418	898	2054	3016	4401	6074	8653	9620

Table 9.6. Icelandic cod in Division Va. Survey indices of the spring bottom trawl survey (SMB).

year	1	2	3	4	5	6	7	8	9	10
1985.00	16.54	110.43	35.40	48.20	64.15	22.57	14.85	4.85	3.21	1.76
1986.00	15.05	60.24	95.89	22.42	21.21	26.34	6.63	2.48	0.83	0.73
1987.00	3.65	28.21	103.74	81.99	21.08	12.21	12.00	2.55	0.89	0.38
1988.00	3.44	6.96	72.09	101.50	66.58	7.82	5.91	6.29	0.58	0.24
1989.00	4.04	16.38	21.97	77.79	67.59	34.20	4.20	1.45	1.14	0.24
1990.00	5.56	11.78	26.08	14.07	27.05	32.38	14.21	1.50	0.52	0.41
1991.00	3.95	16.00	18.20	30.17	15.24	18.09	20.93	4.24	0.79	0.29
1992.00	0.71	16.80	33.54	18.89	16.34	6.54	5.70	5.12	1.29	0.22
1993.00	3.57	4.75	30.78	36.48	13.22	9.90	2.13	1.75	1.17	0.36
1994.00	14.38	14.94	9.01	26.66	21.90	5.77	3.63	0.70	0.48	0.47
1995.00	1.08	29.13	24.75	8.98	23.88	17.69	3.78	1.80	0.35	0.17
1996.00	3.72	5.42	42.58	29.44	12.89	14.62	14.02	3.80	1.04	0.18
1997.00	1.18	22.18	13.55	56.31	29.10	9.50	8.78	6.61	0.56	0.21
1998.00	8.06	5.36	29.92	16.04	61.73	28.58	6.50	5.24	3.03	0.66
1999.00	7.39	32.98	7.01	42.25	13.00	23.66	11.12	2.35	1.32	0.70
2000.00	18.85	27.60	54.99	6.94	30.00	8.28	8.18	4.14	0.51	0.30
2001.00	12.13	21.74	36.38	38.04	4.95	15.11	3.30	1.96	0.81	0.29
2002.00	0.91	37.85	41.22	40.13	36.25	7.09	8.32	1.49	0.72	0.30
2003.00	11.17	4.17	46.35	36.58	28.42	16.89	3.82	4.34	1.03	0.20
2004.00	6.57	24.43	7.87	61.79	35.00	24.83	14.44	2.82	2.88	0.47
2005.00	2.56	14.54	38.70	9.68	43.57	22.97	10.84	5.77	0.93	0.92
2006.00	8.79	6.39	22.67	38.44	10.83	27.74	10.05	3.55	1.38	0.25
2007.00	5.61	18.21	8.58	21.09	27.60	9.06	9.75	5.08	2.11	0.75
2008.00	6.40	11.77	22.08	9.31	20.43	20.40	8.10	6.63	2.47	0.60
2009.00	21.27	11.62	15.80	21.82	14.59	23.45	14.59	4.18	2.73	1.02
2010.00	18.29	20.00	18.00	17.73	23.75	13.27	16.60	8.93	2.71	1.70
2011.00	3.57	21.49	26.63	19.90	22.48	25.32	13.51	12.31	4.55	0.91
2012.00	19.94	9.75	37.59	56.57	41.59	30.22	26.99	9.96	6.30	2.76
2013.00	10.80	31.40	17.68	43.76	46.47	25.24	16.50	13.81	6.94	3.33
2014.00	3.31	23.97	38.00	23.48	47.17	37.60	17.31	8.18	4.26	2.22
2015.00	20.84	10.66	27.42	41.87	20.93	40.85	28.14	16.41	4.99	3.13

Table 9.7. Icelandic cod in Division Va. Survey cv of the spring bottom trawl survey (SMB).

year	1	2	3	4	5	6	7	8	9	10
1985.00	0.08	0.44	0.19	0.11	0.11	0.10	0.10	0.10	0.14	0.16
1986.00	0.09	0.10	0.10	0.10	0.09	0.08	0.09	0.07	0.08	0.07
1987.00	0.13	0.11	0.09	0.10	0.10	0.10	0.09	0.11	0.10	0.14
1988.00	0.19	0.18	0.10	0.10	0.11	0.10	0.09	0.09	0.12	0.12
1989.00	0.12	0.10	0.15	0.21	0.16	0.12	0.10	0.10	0.12	0.13
1990.00	0.14	0.09	0.13	0.13	0.10	0.09	0.09	0.11	0.13	0.17
1991.00	0.12	0.10	0.07	0.12	0.12	0.10	0.10	0.11	0.16	0.31
1992.00	0.11	0.08	0.07	0.09	0.10	0.09	0.08	0.09	0.12	0.23
1993.00	0.20	0.10	0.09	0.11	0.11	0.10	0.10	0.10	0.09	0.10
1994.00	0.26	0.12	0.09	0.12	0.14	0.14	0.13	0.11	0.14	0.16
1995.00	0.17	0.08	0.09	0.10	0.10	0.10	0.10	0.12	0.15	0.16
1996.00	0.12	0.10	0.11	0.15	0.14	0.11	0.10	0.10	0.15	0.22
1997.00	0.14	0.08	0.08	0.10	0.10	0.09	0.10	0.11	0.15	0.25
1998.00	0.12	0.15	0.09	0.12	0.17	0.15	0.11	0.11	0.13	0.17
1999.00	0.11	0.08	0.07	0.10	0.10	0.09	0.09	0.10	0.08	0.10
2000.00	0.07	0.07	0.08	0.08	0.09	0.09	0.08	0.10	0.10	0.08
2001.00	0.09	0.10	0.10	0.15	0.17	0.20	0.15	0.12	0.10	0.16
2002.00	0.18	0.09	0.13	0.16	0.18	0.15	0.15	0.10	0.14	0.11
2003.00	0.10	0.11	0.07	0.12	0.11	0.10	0.10	0.15	0.19	0.19
2004.00	0.10	0.08	0.10	0.16	0.15	0.16	0.15	0.13	0.17	0.21
2005.00	0.12	0.12	0.07	0.09	0.12	0.12	0.12	0.12	0.15	0.19
2006.00	0.09	0.11	0.08	0.10	0.10	0.11	0.12	0.15	0.13	0.20
2007.00	0.09	0.12	0.10	0.10	0.11	0.09	0.08	0.09	0.11	0.18
2008.00	0.11	0.09	0.07	0.09	0.10	0.10	0.10	0.09	0.10	0.09
2009.00	0.10	0.10	0.09	0.10	0.13	0.13	0.12	0.11	0.09	0.10
2010.00	0.08	0.10	0.12	0.10	0.11	0.10	0.10	0.09	0.08	0.09
2011.00	0.11	0.12	0.10	0.12	0.14	0.14	0.12	0.14	0.11	0.09
2012.00	0.09	0.14	0.08	0.32	0.41	0.34	0.24	0.17	0.11	0.14
2013.00	0.06	0.13	0.08	0.11	0.13	0.12	0.10	0.11	0.14	0.16
2014.00	0.13	0.35	0.11	0.13	0.13	0.12	0.11	0.13	0.19	0.30
2015.00	0.08	0.15	0.08	0.09	0.09	0.10	0.14	0.18	0.17	0.18

Table 9.8. Icelandic cod in Division Va. Survey indices of the fall bottom trawl survey (SMH).

year	1	2	3	4	5	6	7	8	9	10
1996.00	6.69	3.57	20.00	13.98	5.40	7.44	6.26	1.60	0.31	0.09
1997.00	0.66	16.89	6.71	28.82	15.86	5.19	3.60	2.07	0.30	0.11
1998.00	5.92	2.63	15.62	7.36	16.01	16.03	5.20	2.24	1.27	0.20
1999.00	8.61	14.54	5.68	23.38	7.42	9.94	4.05	0.59	0.34	0.36
2000.00	4.60	13.17	15.25	3.71	11.15	3.49	2.61	1.11	0.34	0.28
2001.00	7.11	11.51	19.53	21.13	3.30	6.73	1.60	0.76	0.17	0.03
2002.00	0.92	13.72	16.11	23.39	15.94	5.41	4.77	1.11	0.61	0.08
2003.00	5.16	2.68	25.66	16.98	13.22	8.99	1.89	2.55	0.38	0.10
2004.00	3.67	16.27	6.91	29.82	18.84	11.73	7.38	1.88	1.65	0.23
2005.00	2.15	9.03	20.37	6.82	25.62	10.88	3.86	1.91	0.29	0.31
2006.00	4.51	4.52	16.28	23.04	7.67	13.93	6.12	2.05	1.02	0.16
2007.00	3.73	9.82	4.93	11.73	15.68	6.34	5.91	3.14	0.76	0.50
2008.00	5.30	11.88	15.19	7.66	17.57	18.51	5.67	5.61	1.50	0.79
2009.00	7.04	8.30	13.14	18.11	12.39	16.46	10.22	3.15	2.75	0.84
2010.00	10.78	18.82	16.18	15.52	17.96	9.81	11.21	6.81	2.29	1.20
2012.00	7.43	9.43	23.38	20.66	12.72	10.82	9.53	5.31	3.33	1.55
2013.00	6.25	19.28	13.41	27.13	21.99	12.60	7.72	5.94	2.93	1.87
2014.00	3.57	16.01	23.57	13.85	23.73	19.83	8.54	5.91	4.02	2.50

Table 9.9. Icelandic cod in Division Va. Survey cv of the fall bottom trawl survey (SMH).

year	1	2	3	4	5	6	7	8	9	10
1996.00	0.35	0.18	0.11	0.14	0.13	0.13	0.17	0.23	0.27	0.33
1997.00	0.34	0.54	0.22	0.26	0.21	0.15	0.11	0.12	0.12	0.15
1998.00	0.16	0.12	0.12	0.11	0.13	0.19	0.32	0.35	0.38	0.34
1999.00	0.32	0.14	0.24	0.30	0.32	0.23	0.20	0.19	0.19	0.21
2000.00	0.18	0.26	0.14	0.14	0.15	0.18	0.16	0.18	0.33	0.31
2001.00	0.17	0.14	0.14	0.11	0.11	0.11	0.17	0.33	0.41	0.79
2002.00	0.16	0.12	0.12	0.13	0.12	0.11	0.11	0.12	0.15	0.50
2003.00	0.13	0.14	0.12	0.11	0.11	0.09	0.10	0.14	0.19	0.32
2004.00	0.14	0.17	0.13	0.14	0.11	0.10	0.09	0.08	0.08	0.09
2005.00	0.27	0.10	0.11	0.10	0.12	0.11	0.10	0.08	0.09	0.10
2006.00	0.15	0.14	0.13	0.13	0.11	0.11	0.11	0.10	0.09	0.16
2007.00	0.21	0.14	0.11	0.14	0.14	0.14	0.13	0.11	0.11	0.12
2008.00	0.17	0.11	0.10	0.10	0.11	0.11	0.15	0.20	0.24	0.22
2009.00	0.17	0.11	0.13	0.14	0.13	0.12	0.11	0.11	0.11	0.14
2010.00	0.17	0.16	0.11	0.13	0.13	0.11	0.15	0.17	0.19	0.20
2012.00	0.15	0.11	0.12	0.13	0.14	0.14	0.12	0.12	0.14	0.15
2013.00	0.16	0.14	0.14	0.14	0.12	0.11	0.11	0.12	0.13	0.14
2014.00	0.24	0.13	0.12	0.14	0.13	0.11	0.10	0.13	0.20	0.28

Table 9.10: Icelandic cod in Division Va. Catch at age residuals from the ADCAM model tuned with the spring (SMB) and the fall (SMH) surveys.

year	3	4	5	6	7	8	9	10	11	12	13	14
1955	-0.122	-0.207	0.078	0.115	0.208	-0.115	-0.163	0.132	-0.099	-0.451	-0.206	-0.001
1956	-0.026	-0.047	0.027	-0.005	-0.134	-0.199	-0.006	0.008	0.174	0.094	0.229	0.219
1957	0.092	0.018	-0.015	0.168	-0.133	0.092	0.063	-0.147	-0.098	-0.115	-0.381	0.520
1958	0.153	0.176	-0.265	-0.072	0.060	0.079	0.133	-0.231	0.232	0.001	-0.228	0.392
1959	-0.214	0.211	0.260	-0.242	-0.218	-0.061	-0.069	0.280	-0.264	0.380	-0.229	-0.405
1960	0.100	-0.356	0.140	0.188	0.063	0.074	-0.026	-0.113	-0.041	0.033	-0.640	0.903
1961	0.051	0.040	-0.403	0.118	-0.016	0.272	0.202	-0.142	0.087	-0.191	-0.974	0.828
1962	0.089	-0.008	0.125	-0.243	0.116	-0.295	0.091	0.260	-0.064	0.034	-0.401	0.697
1963	-0.058	0.295	-0.175	0.012	-0.030	-0.070	-0.376	0.209	0.349	0.063	0.073	-0.617
1964	-0.127	-0.016	0.126	-0.252	-0.118	0.378	-0.102	-0.455	-0.012	0.267	-0.158	0.006
1965	-0.031	-0.114	0.085	0.163	-0.128	0.049	0.474	-0.481	-0.055	-0.507	-0.361	0.635
1966	-0.042	-0.043	-0.179	0.096	-0.070	0.124	-0.346	0.592	-0.828	0.279	0.009	1.057
1967	0.191	-0.129	0.023	-0.199	0.025	-0.373	0.490	0.046	0.672	-0.725	-0.836	-0.184
1968	0.035	-0.021	-0.273	-0.120	0.232	0.157	-0.418	0.367	-0.124	0.600	-0.658	0.654
1969	-0.090	-0.027	0.153	-0.011	0.052	-0.149	-0.326	-0.246	-0.041	-0.258	-0.810	-0.144
1970	-0.096	0.136	-0.053	-0.136	0.054	-0.162	0.478	-0.581	-0.119	0.246	0.294	0.451
1971	-0.103	0.071	0.091	0.177	-0.184	0.283	-0.170	0.055	-0.452	-0.021	0.122	0.360
1972	-0.167	-0.126	0.069	-0.033	0.117	-0.052	-0.104	0.293	-0.070	0.170	0.523	-2.764
1973	0.275	-0.022	-0.098	0.028	-0.004	-0.241	0.087	0.172	0.157	-0.195	-1.254	-2.096
1974	-0.159	0.210	-0.021	-0.177	-0.006	-0.003	-0.222	0.289	0.011	0.186	-0.436	0.805
1975	0.188	-0.073	0.041	-0.054	0.030	-0.152	-0.208	-0.005	0.407	-0.016	-0.123	0.092
1976	0.098	0.002	-0.169	0.077	-0.092	0.252	-0.157	-0.155	0.056	0.272	-0.234	0.237
1977	-0.400	-0.062	0.046	-0.093	0.126	0.052	0.307	0.029	-0.702	-0.478	-1.224	-2.495
1978	0.079	-0.014	0.038	-0.096	0.043	-0.206	0.120	-0.188	0.015	-0.051	0.527	1.201
1979	0.157	0.094	-0.217	0.103	-0.046	0.031	-0.312	-0.078	0.045	-0.146	0.406	-0.200
1980	0.211	0.010	0.078	0.061	-0.010	-0.090	0.125	-0.486	0.295	0.097	0.153	-1.085
1981	-0.301	-0.206	0.082	-0.136	0.071	0.090	0.021	0.326	-0.076	0.599	-0.020	1.169
1982	0.009	0.152	0.072	-0.055	-0.221	0.192	0.177	0.136	-0.230	-0.868	0.046	-0.860
1983	-0.321	-0.357	0.111	0.142	0.043	0.009	-0.038	-0.028	0.004	0.373	-0.197	0.586
1984	0.347	0.025	-0.059	-0.045	-0.098	-0.005	0.054	-0.138	-0.353	0.165	0.709	0.102
1985	0.039	0.182	-0.103	0.122	-0.098	-0.021	-0.139	0.133	0.027	-0.346	0.470	0.469
1986	0.147	-0.118	0.014	-0.015	0.179	-0.046	0.117	-0.212	0.077	0.052	-0.598	0.182
1987	-0.147	0.122	0.013	-0.165	0.064	0.038	-0.027	0.112	-0.380	-0.115	0.116	-0.303
1988	-0.085	-0.059	-0.054	0.136	-0.086	0.069	0.157	0.028	0.477	0.016	0.535	0.109
1989	-0.212	0.044	0.147	-0.071	-0.003	-0.152	-0.325	-0.093	-0.024	0.516	-0.031	-1.426
1990	-0.002	-0.138	-0.108	0.003	0.038	0.093	-0.085	-0.231	0.288	0.112	-0.223	0.068
1991	0.070	0.041	-0.132	-0.067	0.094	-0.074	0.116	-0.075	-0.315	0.403	-0.573	0.113
1992	-0.227	0.080	0.043	0.028	0.103	-0.003	-0.043	-0.067	-0.746	-0.768	-0.573	-0.158
1993	0.255	0.046	-0.203	-0.056	-0.073	-0.123	0.068	0.486	0.500	-0.209	-0.988	0.423
1994	0.031	0.246	-0.135	-0.194	-0.040	0.067	-0.193	-0.136	0.427	0.522	0.514	-0.397
1995	0.275	-0.033	0.083	-0.035	-0.040	-0.117	-0.128	-0.293	-0.214	0.733	1.110	0.611
1996	0.003	-0.053	-0.177	0.077	0.041	0.016	0.125	0.172	-0.383	-0.401	0.601	-0.063
1997	-0.156	0.025	-0.029	-0.125	-0.095	0.207	0.173	0.257	0.411	-0.728	-0.233	0.169
1998	-0.181	-0.169	0.064	0.073	0.019	-0.166	0.242	0.047	0.091	0.284	0.154	-0.728
1999	-0.101	0.033	0.034	0.026	0.088	-0.044	-0.244	-0.185	-0.259	-0.394	-0.476	-0.901
2000	0.173	-0.239	0.106	-0.040	0.013	0.108	0.035	-0.113	-0.001	0.155	-0.130	-0.068
2001	0.189	0.195	-0.162	-0.007	0.026	-0.182	0.097	0.280	-0.037	0.153	-0.517	-0.004
2002	-0.020	0.085	0.032	-0.078	-0.025	-0.008	-0.153	0.290	0.277	-0.308	0.387	-1.110
2003	-0.230	0.030	-0.011	-0.034	0.175	0.007	0.224	-0.311	0.068	0.167	0.157	0.496
2004	-0.221	0.109	0.099	-0.087	-0.059	0.235	0.027	0.233	-0.486	0.010	0.247	-0.332
2005	0.196	-0.293	0.144	-0.058	-0.119	-0.087	0.321	0.098	0.335	0.104	0.052	-0.817
2006	-0.065	0.030	-0.138	0.064	0.052	-0.084	-0.082	0.177	-0.003	0.117	-0.187	-1.639
2007	-0.108	0.181	-0.038	-0.012	-0.149	0.055	-0.030	0.178	0.764	0.367	0.775	-0.346
2008	0.023	-0.195	0.077	-0.113	0.080	-0.179	0.013	0.062	-0.000	0.080	-0.001	-0.539
2009	0.138	-0.061	0.075	0.138	-0.052	0.259	-0.202	-0.248	-0.061	-0.420	0.010	-0.545
2010	0.005	0.015	-0.132	0.075	0.026	-0.061	0.175	-0.126	-0.127	0.318	0.293	0.566
2011	0.125	-0.043	0.020	0.026	-0.033	0.007	-0.128	0.040	-0.055	-0.133	-0.259	-0.888
2012	-0.128	-0.015	0.027	-0.010	-0.012	0.170	0.001	-0.219	0.177	-0.270	0.180	-0.135
2013	0.133	0.048	0.033	0.035	-0.099	-0.055	0.184	-0.034	-0.198	0.376	0.005	-0.156
2014	-0.041	-0.002	-0.016	-0.015	0.037	-0.061	0.004	0.187	0.097	-0.239	0.082	-0.065

Table 9.11: Icelandic cod in Division Va. Spring survey (SMB) at age residuals from the ADCAM model, assessment tuned with both the spring and the fall survey.

year	1	2	3	4	5	6	7	8	9	10
1985	-0.481	0.034	0.226	0.450	0.136	0.263	0.405	0.184	0.317	0.663
1986	0.434	-0.061	-0.383	-0.224	-0.072	0.002	-0.159	-0.273	-0.248	-0.046
1987	0.648	0.007	0.137	-0.449	-0.020	-0.071	0.045	-0.087	-0.093	-0.008
1988	-0.191	0.032	0.502	0.163	-0.110	-0.339	0.090	0.486	-0.115	-0.102
1989	0.380	0.069	0.529	0.563	0.250	0.190	-0.118	-0.105	0.216	0.106
1990	-0.474	0.128	0.074	0.061	-0.143	-0.148	0.081	-0.150	-0.039	0.157
1991	-0.163	-0.447	0.103	0.164	0.262	0.041	0.136	-0.151	0.226	0.195
1992	-0.233	0.032	-0.185	0.123	-0.078	-0.128	-0.137	-0.141	-0.104	-0.006
1993	-0.505	-0.023	0.190	-0.040	0.062	-0.036	-0.209	-0.155	-0.219	-0.213
1994	0.534	-0.245	0.028	0.120	-0.183	-0.316	-0.159	-0.217	-0.179	-0.048
1995	-0.220	0.142	-0.217	-0.041	0.178	-0.011	-0.215	-0.086	-0.060	-0.201
1996	-0.631	-0.100	0.104	-0.114	0.218	-0.038	0.260	0.398	0.210	0.058
1997	0.193	-0.046	0.138	0.286	-0.021	-0.039	-0.030	0.253	-0.343	-0.288
1998	-0.096	0.135	-0.176	0.134	0.518	0.299	0.097	0.207	0.438	0.501
1999	-0.025	0.184	-0.033	0.058	-0.036	0.086	0.033	-0.017	-0.012	0.141
2000	0.895	0.139	0.287	-0.159	-0.076	-0.203	-0.189	-0.003	-0.239	-0.225
2001	0.202	0.029	0.017	-0.086	-0.442	-0.217	-0.367	-0.552	-0.322	0.209
2002	-0.153	0.251	0.153	0.073	0.058	-0.142	-0.171	-0.273	-0.397	-0.131
2003	0.013	-0.117	0.053	-0.033	-0.107	-0.203	-0.190	-0.061	0.177	-0.516
2004	-0.091	0.177	-0.108	0.275	0.117	0.231	0.201	0.145	0.428	0.286
2005	-0.143	0.076	0.203	-0.109	0.098	0.109	0.009	0.046	0.034	0.244
2006	0.173	-0.047	-0.027	0.070	-0.083	0.162	-0.094	-0.314	-0.334	-0.220
2007	0.017	0.145	-0.312	-0.233	-0.160	-0.175	-0.297	-0.049	0.052	-0.073
2008	-0.034	0.000	-0.087	-0.409	-0.274	-0.105	0.126	-0.042	0.114	-0.170
2009	0.382	-0.123	-0.171	-0.236	-0.165	-0.078	-0.070	0.031	-0.188	-0.102
2010	0.157	-0.187	-0.207	-0.239	-0.209	-0.192	-0.073	-0.048	0.349	0.027
2011	-0.408	-0.182	-0.365	-0.293	-0.110	0.048	0.110	0.094	-0.035	-0.111
2012	0.186	-0.103	-0.093	0.188	0.317	0.291	0.394	0.261	0.114	0.081
2013	-0.109	0.104	-0.111	-0.085	0.037	0.047	0.028	0.205	0.512	-0.019
2014	-0.363	0.033	-0.140	-0.009	0.018	0.158	-0.019	-0.195	-0.306	-0.050
2015	0.141	-0.037	-0.227	-0.159	-0.184	0.211	0.179	0.364	-0.069	-0.079

Table 9.12: Icelandic cod in Division Va. Fall survey (SMH) at age residuals from the ADCAM model, assessment tuned with both the spring and the fall survey.

year	1	2	3	4	5	6	7	8	9	10
1996	0.035	-0.078	-0.010	-0.184	-0.012	-0.062	0.179	0.190	-0.166	-0.047
1997	-0.167	0.112	-0.018	0.250	0.057	-0.152	-0.125	-0.036	-0.323	-0.057
1998	-0.204	-0.011	-0.188	0.033	-0.031	0.368	0.519	0.113	0.276	0.044
1999	0.266	-0.097	0.113	0.111	0.079	0.008	-0.092	-0.290	-0.329	0.104
2000	-0.262	-0.075	-0.261	-0.081	-0.221	-0.210	-0.363	-0.310	0.029	0.206
2001	-0.121	-0.148	0.041	-0.011	-0.217	-0.236	-0.223	-0.490	-0.530	-0.329
2002	-0.177	-0.201	-0.123	0.155	0.005	0.128	0.010	0.019	0.011	-0.380
2003	-0.102	-0.104	0.092	-0.146	-0.108	-0.138	-0.122	0.062	-0.047	-0.437
2004	-0.121	0.152	0.101	0.131	0.173	0.116	0.232	0.319	0.451	0.171
2005	0.073	-0.078	0.100	0.077	0.255	0.011	-0.256	-0.295	-0.234	-0.155
2006	0.074	-0.068	0.096	0.100	0.074	0.060	0.046	-0.214	-0.078	-0.098
2007	0.137	-0.008	-0.331	-0.265	-0.101	-0.016	-0.176	0.024	-0.261	0.048
2008	0.269	0.275	0.045	-0.129	0.090	0.232	0.280	0.236	0.048	0.320
2009	-0.057	-0.081	0.092	0.069	0.142	0.059	0.135	0.216	0.253	0.108
2010	0.279	0.097	0.140	0.117	0.079	-0.007	0.107	0.187	0.513	0.038
2011										
2012	-0.128	0.161	0.014	-0.227	-0.223	-0.161	0.028	0.182	-0.118	-0.110
2013	-0.016	0.039	0.104	-0.010	-0.038	-0.072	-0.087	-0.058	0.159	-0.154
2014	0.166	0.078	0.000	0.029	-0.001	0.072	-0.078	0.030	0.117	0.483

Table 9.13: Icelandic cod in Division Va. Estimates of fishing mortality 1955-2014 based on ACAM using catch at age and spring and fall bottom survey indices.

year	3	4	5	6	7	8	9	10	11	12	13	14
1955	0.040	0.170	0.253	0.274	0.302	0.304	0.283	0.324	0.324	0.308	0.324	0.324
1956	0.051	0.182	0.249	0.259	0.290	0.303	0.295	0.342	0.355	0.335	0.332	0.332
1957	0.081	0.215	0.274	0.272	0.301	0.328	0.327	0.363	0.364	0.331	0.298	0.298
1958	0.114	0.248	0.302	0.291	0.324	0.371	0.397	0.439	0.443	0.385	0.323	0.323
1959	0.091	0.233	0.282	0.257	0.299	0.341	0.351	0.399	0.382	0.320	0.229	0.229
1960	0.101	0.233	0.295	0.292	0.338	0.398	0.428	0.476	0.475	0.385	0.270	0.270
1961	0.094	0.225	0.259	0.262	0.334	0.399	0.418	0.459	0.440	0.349	0.227	0.227
1962	0.112	0.248	0.282	0.264	0.347	0.424	0.467	0.513	0.488	0.378	0.239	0.239
1963	0.130	0.283	0.328	0.309	0.383	0.492	0.587	0.646	0.625	0.462	0.285	0.285
1964	0.126	0.290	0.372	0.361	0.435	0.570	0.740	0.810	0.835	0.609	0.388	0.388
1965	0.121	0.284	0.385	0.403	0.471	0.602	0.744	0.848	0.879	0.654	0.425	0.425
1966	0.094	0.253	0.341	0.382	0.491	0.622	0.780	0.915	1.007	0.784	0.532	0.532
1967	0.077	0.229	0.303	0.338	0.484	0.610	0.749	0.878	0.928	0.723	0.460	0.460
1968	0.077	0.247	0.342	0.405	0.576	0.765	1.036	1.200	1.360	1.081	0.739	0.739
1969	0.056	0.232	0.322	0.354	0.505	0.608	0.719	0.837	0.871	0.714	0.444	0.444
1970	0.069	0.270	0.389	0.426	0.551	0.650	0.760	0.891	0.950	0.801	0.515	0.515
1971	0.088	0.309	0.478	0.532	0.620	0.717	0.800	0.957	1.034	0.881	0.580	0.580
1972	0.088	0.302	0.480	0.553	0.649	0.730	0.791	0.959	1.060	0.912	0.602	0.602
1973	0.119	0.321	0.488	0.564	0.668	0.754	0.799	0.953	1.042	0.902	0.591	0.591
1974	0.113	0.325	0.499	0.575	0.699	0.832	0.921	1.056	1.180	1.027	0.697	0.697
1975	0.108	0.310	0.502	0.601	0.722	0.884	1.022	1.127	1.253	1.101	0.772	0.772
1976	0.066	0.258	0.428	0.552	0.695	0.852	0.948	1.009	1.063	0.943	0.654	0.654
1977	0.030	0.195	0.330	0.428	0.610	0.721	0.728	0.739	0.698	0.626	0.407	0.407
1978	0.027	0.174	0.281	0.354	0.525	0.603	0.547	0.549	0.484	0.447	0.281	0.281
1979	0.028	0.171	0.274	0.344	0.503	0.567	0.496	0.491	0.419	0.391	0.246	0.246
1980	0.028	0.175	0.306	0.386	0.538	0.620	0.557	0.546	0.469	0.439	0.291	0.291
1981	0.023	0.176	0.353	0.488	0.648	0.819	0.850	0.818	0.751	0.691	0.519	0.519
1982	0.028	0.192	0.395	0.558	0.699	0.898	0.958	0.869	0.747	0.671	0.510	0.510
1983	0.023	0.179	0.377	0.555	0.706	0.881	0.914	0.852	0.734	0.671	0.523	0.523
1984	0.039	0.200	0.378	0.531	0.675	0.805	0.752	0.702	0.596	0.559	0.432	0.432
1985	0.050	0.230	0.422	0.578	0.714	0.832	0.764	0.699	0.594	0.559	0.437	0.437
1986	0.061	0.261	0.517	0.713	0.824	0.953	0.872	0.767	0.658	0.613	0.486	0.486
1987	0.055	0.272	0.555	0.816	0.905	1.058	0.991	0.847	0.742	0.691	0.568	0.568
1988	0.047	0.258	0.523	0.794	0.921	1.102	1.077	0.939	0.871	0.822	0.713	0.713
1989	0.041	0.242	0.464	0.653	0.794	0.894	0.796	0.716	0.642	0.620	0.506	0.506
1990	0.050	0.250	0.472	0.662	0.789	0.856	0.745	0.683	0.614	0.595	0.484	0.484
1991	0.086	0.302	0.566	0.812	0.884	0.945	0.838	0.764	0.704	0.677	0.569	0.569
1992	0.102	0.320	0.600	0.871	0.924	1.002	0.885	0.795	0.732	0.699	0.596	0.596
1993	0.138	0.313	0.556	0.805	0.889	1.030	1.017	0.923	0.887	0.841	0.753	0.753
1994	0.088	0.242	0.384	0.532	0.678	0.765	0.713	0.691	0.642	0.627	0.538	0.538
1995	0.061	0.196	0.319	0.422	0.569	0.625	0.556	0.566	0.518	0.518	0.433	0.433
1996	0.036	0.161	0.283	0.412	0.558	0.624	0.576	0.591	0.545	0.538	0.460	0.460
1997	0.025	0.145	0.276	0.422	0.584	0.668	0.654	0.673	0.634	0.616	0.543	0.543
1998	0.029	0.154	0.332	0.522	0.666	0.780	0.808	0.814	0.796	0.765	0.707	0.707
1999	0.044	0.177	0.395	0.656	0.751	0.871	0.918	0.891	0.874	0.834	0.789	0.789
2000	0.058	0.181	0.393	0.630	0.754	0.891	0.962	0.950	0.947	0.905	0.877	0.877
2001	0.066	0.188	0.381	0.580	0.698	0.856	0.983	1.001	1.018	0.970	0.962	0.962
2002	0.043	0.164	0.338	0.485	0.595	0.704	0.807	0.859	0.856	0.826	0.802	0.802
2003	0.031	0.149	0.332	0.496	0.571	0.645	0.693	0.747	0.731	0.716	0.681	0.681
2004	0.031	0.144	0.332	0.528	0.579	0.650	0.685	0.729	0.711	0.699	0.666	0.666
2005	0.030	0.126	0.292	0.480	0.547	0.624	0.662	0.703	0.693	0.684	0.651	0.651
2006	0.029	0.119	0.264	0.461	0.534	0.625	0.678	0.712	0.708	0.695	0.666	0.666
2007	0.027	0.108	0.229	0.383	0.486	0.593	0.672	0.717	0.732	0.717	0.697	0.697
2008	0.021	0.087	0.177	0.292	0.398	0.472	0.491	0.516	0.486	0.477	0.427	0.427
2009	0.030	0.093	0.182	0.300	0.397	0.466	0.473	0.477	0.429	0.416	0.361	0.361
2010	0.027	0.086	0.159	0.253	0.350	0.405	0.390	0.397	0.343	0.336	0.279	0.279
2011	0.027	0.084	0.151	0.230	0.316	0.356	0.323	0.326	0.265	0.256	0.200	0.200
2012	0.028	0.085	0.154	0.234	0.316	0.353	0.320	0.321	0.258	0.247	0.192	0.192
2013	0.042	0.096	0.166	0.244	0.321	0.359	0.333	0.339	0.275	0.262	0.205	0.205
2014	0.034	0.090	0.153	0.226	0.309	0.345	0.321	0.330	0.262	0.242	0.187	0.187

Table 9.14: Icelandic cod in Division Va. Estimates of numbers at age in the stock 1955-2015 based on ACAM using catch at age and spring and fall bottom survey indices.

year	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1955	170.63	152.80	151.99	217.61	211.93	115.44	36.04	24.57	12.95	87.57	9.20	7.81	8.13	2.64
1956	220.71	170.63	152.80	119.55	150.28	134.76	71.84	21.81	14.84	7.99	51.87	5.45	4.70	4.82
1957	289.05	220.71	170.63	118.88	81.58	95.88	85.20	44.02	13.18	9.05	4.65	29.78	3.19	2.76
1958	154.36	289.05	220.71	128.81	78.52	50.80	59.83	51.65	35.18	7.78	5.16	2.64	17.50	1.94
1959	192.90	154.36	289.05	161.18	82.26	47.54	31.10	35.44	51.54	19.36	4.11	2.71	1.47	10.37
1960	128.94	192.90	154.36	216.11	104.52	50.78	30.11	18.89	20.63	37.50	10.63	2.30	1.61	0.96
1961	177.51	128.94	192.90	114.27	140.14	63.72	31.06	17.59	10.39	11.00	19.06	5.42	1.28	1.01
1962	204.04	177.51	128.94	143.78	74.70	88.53	40.16	18.22	23.60	5.60	5.69	10.05	3.13	0.83
1963	216.37	204.04	177.51	94.42	91.85	46.14	55.68	23.25	9.76	12.11	2.74	2.86	5.64	2.02
1964	229.14	216.37	204.04	127.66	58.25	54.17	27.74	31.08	11.64	4.44	5.20	1.20	1.48	3.47
1965	320.13	229.14	216.37	147.31	78.18	32.87	30.93	14.70	14.38	4.54	1.62	1.85	0.54	0.82
1966	171.90	320.13	229.14	157.00	90.79	43.57	17.99	15.81	6.59	5.60	1.59	0.55	0.79	0.29
1967	247.44	171.90	320.12	170.76	99.77	52.85	24.36	9.01	6.95	2.47	1.83	0.48	0.21	0.38
1968	180.46	247.44	171.90	242.76	111.19	60.32	30.86	12.29	4.01	2.69	0.84	0.59	0.19	0.11
1969	188.59	180.46	247.44	130.34	155.31	64.68	32.92	41.21	4.68	1.17	0.66	0.18	0.16	0.07
1970	139.26	188.59	180.46	191.59	84.59	92.10	37.16	32.91	18.36	1.87	0.41	0.23	0.07	0.09
1971	273.05	139.26	188.59	137.94	119.79	46.92	49.26	17.53	14.06	7.03	0.63	0.13	0.08	0.03
1972	178.96	273.05	139.25	141.35	82.92	60.78	22.56	21.69	23.28	5.18	2.21	0.18	0.04	0.04
1973	260.74	178.96	273.05	104.45	85.58	42.03	28.62	9.65	8.56	8.64	1.62	0.63	0.06	0.02
1974	367.20	260.74	178.96	198.53	62.06	42.99	19.57	12.02	3.71	3.15	2.73	0.47	0.21	0.03
1975	143.27	367.20	260.74	130.82	117.50	30.85	19.81	7.96	4.28	1.21	0.90	0.69	0.14	0.09
1976	227.53	143.27	367.20	191.59	78.59	58.23	13.85	7.88	2.69	1.26	0.32	0.21	0.19	0.05
1977	243.31	227.53	143.27	281.34	121.16	41.95	27.46	5.66	2.75	0.85	0.38	0.09	0.07	0.08
1978	139.94	243.31	227.53	113.78	189.47	71.34	22.38	12.22	2.25	1.09	0.33	0.15	0.04	0.04
1979	140.35	139.94	243.31	181.28	78.28	117.08	40.97	10.84	5.48	1.07	0.51	0.17	0.08	0.02
1980	131.63	140.35	139.94	193.66	125.12	48.71	71.85	20.29	5.03	2.73	0.54	0.28	0.09	0.05
1981	232.93	131.63	140.35	111.39	133.11	75.43	27.11	47.08	8.93	2.36	1.29	0.27	0.15	0.06
1982	139.03	232.93	131.63	112.32	76.48	76.57	37.90	11.61	16.99	3.13	0.85	0.50	0.11	0.07
1983	140.29	139.03	232.93	104.83	75.87	42.18	35.89	15.42	3.87	5.33	1.07	0.33	0.21	0.06
1984	329.65	140.29	139.03	186.28	71.79	42.60	19.83	14.51	5.23	1.27	1.86	0.42	0.14	0.10
1985	260.38	329.65	140.29	109.52	124.82	40.28	20.51	8.27	5.31	2.02	0.52	0.84	0.20	0.07
1986	175.50	260.38	329.65	109.26	71.25	66.99	18.51	8.22	2.95	2.02	0.82	0.23	0.39	0.10
1987	89.19	175.50	260.38	253.82	68.87	34.80	26.88	6.65	2.60	1.01	0.77	0.35	0.10	0.20
1988	130.60	89.19	175.50	201.67	158.38	32.37	12.59	8.90	1.89	0.79	0.35	0.30	0.14	0.05
1989	106.87	130.60	89.19	137.09	127.58	76.85	11.98	4.10	2.42	0.53	0.25	0.12	0.11	0.06
1990	174.57	106.87	130.60	70.11	88.14	100.05	32.73	4.43	1.37	0.89	0.21	0.11	0.05	0.05
1991	135.55	174.57	106.87	101.69	44.69	45.02	42.25	12.18	1.54	0.53	0.37	0.09	0.05	0.03
1992	77.73	135.55	174.57	80.31	61.57	20.77	16.37	14.29	3.88	0.55	0.20	0.15	0.04	0.02
1993	151.18	77.73	135.55	129.10	47.75	27.67	7.12	5.32	4.30	1.31	0.20	0.08	0.06	0.02
1994	165.62	151.18	77.73	96.66	77.30	22.43	10.13	2.40	1.55	1.27	0.43	0.07	0.03	0.02
1995	88.26	165.62	151.18	58.25	62.15	43.09	10.79	4.21	0.91	0.62	0.52	0.18	0.03	0.01
1996	161.54	88.26	165.62	116.40	39.21	36.98	23.14	5.00	1.85	0.43	0.29	0.25	0.09	0.02
1997	70.80	161.54	88.26	130.78	81.16	24.19	20.05	10.84	2.19	0.85	0.19	0.14	0.12	0.05
1998	171.61	70.80	161.54	70.44	92.62	50.43	12.99	9.16	4.55	0.93	0.36	0.08	0.06	0.06
1999	161.43	171.61	70.80	128.52	49.45	54.43	24.49	5.47	3.44	1.66	0.34	0.13	0.03	0.02
2000	158.89	161.43	171.61	55.44	88.17	27.28	23.13	9.46	1.87	1.12	0.56	0.12	0.05	0.01
2001	178.28	158.89	161.43	132.54	37.86	48.71	11.89	8.91	3.18	0.59	0.36	0.18	0.04	0.02
2002	80.20	178.28	158.89	123.70	89.96	21.18	22.33	4.84	3.10	0.97	0.18	0.11	0.05	0.01
2003	154.41	80.20	178.28	124.62	85.99	52.52	10.68	10.08	1.96	1.13	0.34	0.06	0.04	0.02
2004	135.22	154.41	80.20	141.47	87.90	50.53	26.18	4.94	4.33	0.80	0.44	0.13	0.02	0.02
2005	97.21	135.22	154.41	63.66	100.32	51.62	24.39	12.02	2.11	1.79	0.32	0.18	0.05	0.01
2006	133.86	97.21	135.22	122.63	45.93	61.31	26.14	11.56	5.27	0.89	0.72	0.13	0.07	0.02
2007	119.41	133.86	97.21	107.57	89.13	28.89	31.66	12.55	5.07	2.19	0.36	0.29	0.05	0.03
2008	130.26	119.41	133.86	77.50	79.07	58.06	16.13	15.94	5.68	2.12	0.88	0.14	0.12	0.02
2009	172.28	130.26	119.41	107.28	58.14	63.88	35.48	8.87	8.14	2.85	1.03	0.44	0.07	0.06
2010	176.98	172.28	130.26	94.88	80.02	39.68	38.74	19.54	4.56	4.16	1.45	0.55	0.24	0.04
2011	120.90	176.98	172.28	103.79	71.27	55.87	25.23	22.36	10.67	2.53	2.29	0.84	0.32	0.15
2012	180.79	120.90	176.98	137.24	78.14	50.15	36.32	15.06	12.82	6.32	1.49	1.44	0.53	0.22
2013	160.72	180.79	120.90	140.96	103.19	54.85	32.48	21.68	8.66	7.62	3.76	0.94	0.92	0.36
2014	115.38	160.73	180.79	94.92	104.83	71.55	35.18	19.30	12.39	5.08	4.44	2.34	0.59	0.61
2015	186.27	115.38	160.72	143.06	71.05	73.64	46.72	21.15	11.19	7.36	2.99	2.80	1.50	0.40

Table 9.15: 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 ratio.

Year	Yield	F5-10	SSB	Reference biomass	Recruits	Harvest rate
1955	545.250	0.290	941.981	2361.190	151.988	0.222
1956	486.909	0.290	795.988	2085.480	152.797	0.228
1957	455.182	0.311	775.735	1881.630	170.633	0.240
1958	517.359	0.354	875.551	1867.800	220.714	0.271
1959	459.081	0.322	853.637	1829.410	289.052	0.249
1960	470.121	0.371	708.947	1753.890	154.360	0.269
1961	377.291	0.355	467.292	1496.600	192.903	0.253
1962	388.985	0.383	568.921	1492.510	128.941	0.262
1963	408.800	0.458	507.766	1315.590	177.514	0.313
1964	437.012	0.548	451.023	1219.020	204.038	0.352
1965	387.106	0.575	317.608	1022.480	216.371	0.356
1966	353.357	0.589	277.232	1031.370	229.142	0.333
1967	335.721	0.560	256.458	1102.690	320.125	0.300
1968	381.770	0.721	221.565	1222.540	171.900	0.314
1969	403.205	0.558	313.603	1325.290	247.444	0.307
1970	475.077	0.611	331.007	1336.640	180.463	0.345
1971	444.248	0.684	242.420	1097.650	188.594	0.393
1972	395.166	0.694	221.685	996.656	139.255	0.401
1973	369.205	0.705	245.326	843.598	273.048	0.431
1974	368.133	0.764	186.955	918.054	178.957	0.393
1975	364.754	0.810	168.249	895.165	260.742	0.407
1976	346.253	0.747	138.466	955.181	367.198	0.359
1977	340.086	0.593	198.573	1288.760	143.272	0.261
1978	329.602	0.477	212.192	1296.860	227.531	0.259
1979	366.462	0.446	303.839	1396.080	243.309	0.260
1980	432.237	0.492	356.551	1489.030	139.936	0.288
1981	465.032	0.663	263.850	1241.260	140.346	0.363
1982	380.068	0.730	167.079	969.996	131.631	0.384
1983	298.049	0.714	129.989	790.639	232.927	0.367
1984	282.022	0.641	140.961	913.010	139.028	0.316
1985	323.428	0.668	163.443	926.811	140.289	0.350
1986	364.797	0.774	195.872	853.810	329.650	0.421
1987	389.915	0.862	150.765	1029.860	260.379	0.372
1988	377.554	0.893	167.899	1031.580	175.504	0.368
1989	363.125	0.719	172.633	1001.710	89.187	0.358
1990	335.316	0.701	213.825	840.680	130.600	0.407
1991	307.759	0.802	164.307	697.921	106.873	0.443
1992	264.834	0.846	150.513	550.430	174.568	0.472
1993	250.704	0.870	121.063	595.107	135.552	0.423
1994	178.138	0.627	156.469	576.020	77.726	0.313
1995	168.592	0.510	176.977	556.752	151.183	0.298
1996	180.701	0.507	158.996	670.328	165.618	0.269
1997	203.112	0.546	189.069	782.972	88.259	0.258
1998	243.987	0.653	200.247	720.515	161.541	0.330
1999	260.147	0.747	178.018	731.021	70.798	0.352
2000	235.092	0.763	165.971	590.023	171.607	0.385
2001	234.229	0.750	159.861	687.596	161.433	0.333
2002	208.487	0.631	197.402	728.295	158.887	0.284
2003	207.543	0.581	189.739	738.905	178.277	0.279
2004	226.762	0.584	200.710	798.720	80.200	0.279
2005	213.403	0.551	228.099	721.935	154.405	0.296
2006	196.077	0.545	222.803	698.554	135.220	0.279
2007	170.300	0.513	207.394	679.381	97.208	0.251
2008	146.104	0.391	269.852	703.665	133.857	0.217
2009	181.151	0.382	254.908	798.690	119.407	0.221
2010	168.880	0.326	293.057	843.149	130.256	0.201
2011	170.425	0.284	367.435	936.570	172.277	0.184
2012	194.795	0.283	410.695	1055.700	176.983	0.184
2013	223.277	0.294	452.691	1175.500	120.903	0.189
2014	221.340	0.281	424.930	1180.980	180.786	0.187
2015		0.248	546.658	1302.040	160.725	

Table 9.16: Icelandic cod in Division Va. Inputs in the deterministic predictions.

Age	Parameter	2015	2016	2017
3	Catch weights	1.421	1.421	1.421
4	Catch weights	1.814	1.814	1.814
5	Catch weights	2.757	2.757	2.757
6	Catch weights	3.542	3.542	3.542
7	Catch weights	4.674	4.674	4.674
8	Catch weights	6.039	6.039	6.039
9	Catch weights	8.145	8.145	8.145
10	Catch weights	9.187	9.187	9.187
11	Catch weights	9.722	9.722	9.722
12	Catch weights	10.523	10.523	10.523
13	Catch weights	11.448	11.448	11.448
14	Catch weights	12.992	12.992	12.992
3	SSB weights	0.710	0.709	0.709
4	SSB weights	1.047	1.047	1.046
5	SSB weights	3.311	3.310	3.309
6	SSB weights	3.833	3.832	3.830
7	SSB weights	4.902	4.900	4.898
8	SSB weights	6.240	6.238	6.235
9	SSB weights	8.728	8.726	8.722
10	SSB weights	9.705	9.703	9.698
11	SSB weights	9.722	9.720	9.715
12	SSB weights	10.523	10.520	10.515
13	SSB weights	11.448	11.445	11.440
14	SSB weights	12.992	12.988	12.982
3	Maturity	0.004	0.004	0.004
4	Maturity	0.007	0.007	0.007
5	Maturity	0.109	0.109	0.109
6	Maturity	0.353	0.353	0.353
7	Maturity	0.638	0.638	0.638
8	Maturity	0.908	0.908	0.908
9	Maturity	0.979	0.979	0.979
10	Maturity	0.988	0.988	0.988
11	Maturity	1.000	1.000	1.000
12	Maturity	1.000	1.000	1.000
13	Maturity	1.000	1.000	1.000
14	Maturity	1.000	1.000	1.000
3	Selection	0.121	0.121	0.121
4	Selection	0.316	0.316	0.316
5	Selection	0.552	0.552	0.552
6	Selection	0.822	0.822	0.822
7	Selection	1.103	1.103	1.103
8	Selection	1.232	1.232	1.232
9	Selection	1.136	1.136	1.136
10	Selection	1.154	1.154	1.154
11	Selection	0.791	0.791	0.791
12	Selection	0.791	0.791	0.791
13	Selection	0.791	0.791	0.791
14	Selection	0.791	0.791	0.791
3	Stock numbers	160.726	115.383	186.271
4	Stock numbers	143.066		
5	Stock numbers	71.055		
6	Stock numbers	73.645		
7	Stock numbers	46.722		
8	Stock numbers	21.149		
9	Stock numbers	11.189		
10	Stock numbers	7.362		
11	Stock numbers	2.992		
12	Stock numbers	2.799		
13	Stock numbers	1.501		
14	Stock numbers	0.404		

Table 9.17: Icelandic cod in Division Va. Output of the deterministic predictions.

Year	B4.	Fmult	Fbar	SSB	Landings	2017.B4.	2017.SSB	SSB.change	TAC.change
2015	1302		0.26	544	228				
2016	1371	0.00	0.00	660	0	1622	896	36%	-100%
		0.23	0.06	643	60	1553	823	28%	-74%
		0.27	0.07	640	70	1542	812	27%	-69%
		0.31	0.08	637	79	1531	801	26%	-65%
		0.34	0.09	634	89	1520	789	24%	-61%
		0.38	0.10	632	98	1509	778	23%	-57%
		0.42	0.11	629	108	1499	768	22%	-53%
		0.46	0.12	626	117	1488	757	21%	-49%
		0.50	0.13	623	126	1478	746	20%	-45%
		0.54	0.14	621	135	1467	736	19%	-41%
		0.57	0.15	618	144	1457	726	17%	-37%
		0.61	0.16	615	153	1447	716	16%	-33%
		0.65	0.17	613	162	1437	706	15%	-29%
		0.69	0.18	610	171	1427	696	14%	-25%
		0.73	0.19	607	180	1417	686	13%	-21%
		0.76	0.20	605	188	1407	677	12%	-17%
		0.80	0.21	602	197	1397	668	11%	-14%
		0.84	0.22	599	205	1388	658	10%	-10%
		0.88	0.23	597	214	1378	649	9%	-6%
		0.92	0.24	594	222	1369	640	8%	-3%
		0.96	0.25	592	230	1359	632	7%	1%
		0.99	0.26	589	239	1350	623	6%	5%
		1.03	0.27	586	247	1341	614	5%	8%
		1.07	0.28	584	255	1332	606	4%	12%
		1.11	0.29	581	263	1322	598	3%	15%
		1.15	0.30	579	271	1313	590	2%	19%
		1.19	0.31	576	279	1305	582	1%	22%
		1.22	0.32	574	286	1296	574	-0%	26%
		1.26	0.33	571	294	1287	566	-1%	29%
		1.30	0.34	569	302	1278	558	-2%	32%
		1.34	0.35	566	309	1270	551	-3%	36%
		1.38	0.36	564	317	1261	543	-4%	39%
		1.41	0.37	561	324	1253	536	-5%	42%
		1.45	0.38	559	332	1244	529	-5%	45%
		1.49	0.39	557	339	1236	521	-6%	49%
		1.53	0.40	554	346	1228	514	-7%	52%
		1.57	0.41	552	353	1220	508	-8%	55%
		1.61	0.42	549	361	1212	501	-9%	58%
		1.64	0.43	547	368	1204	494	-10%	61%
		1.68	0.44	545	375	1196	487	-11%	64%
		1.72	0.45	542	382	1188	481	-11%	67%
		1.76	0.46	540	389	1180	474	-12%	70%

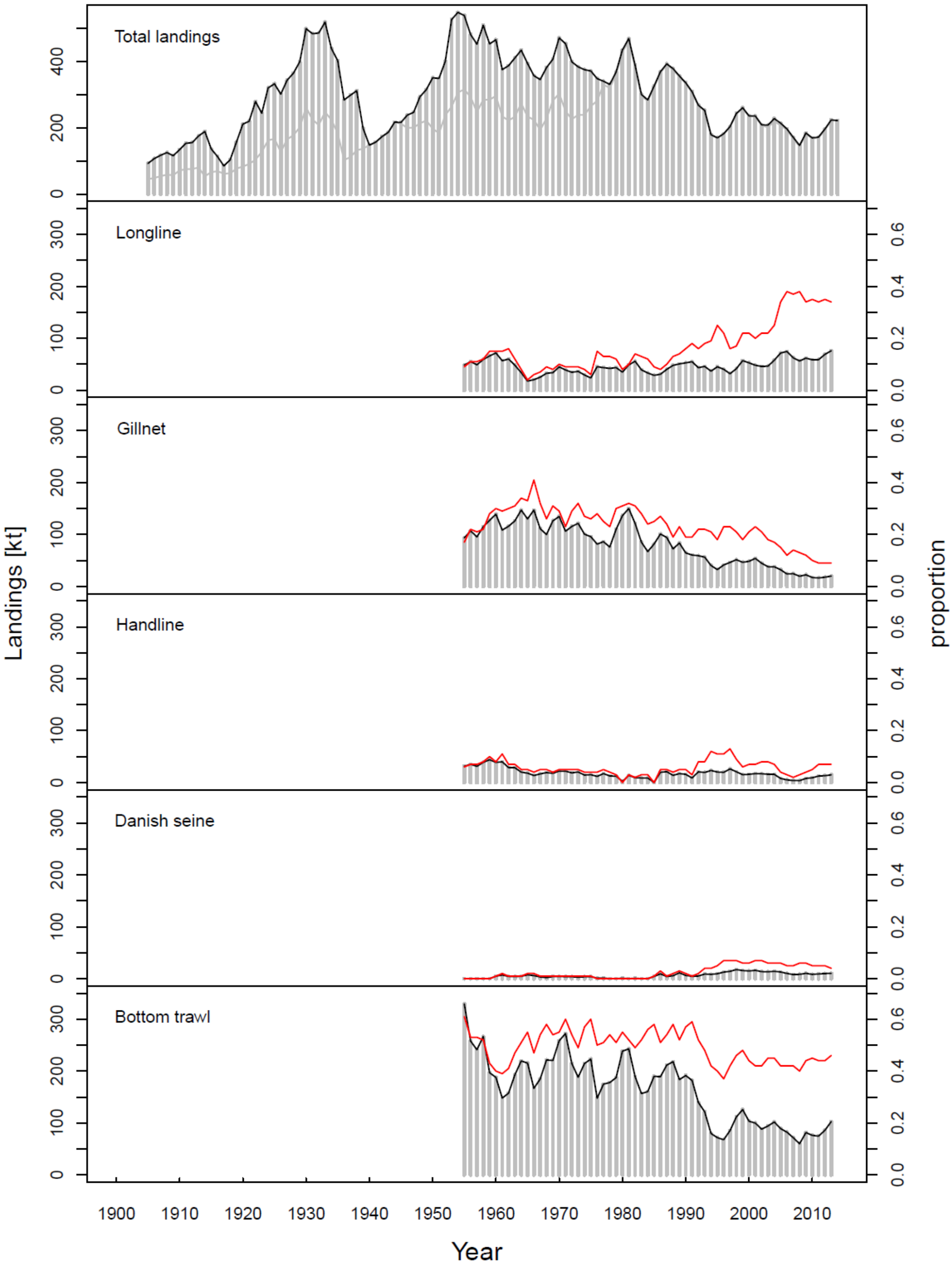

Figure 9.1: Icelandic cod division Va. Total landings from 1905 to 2014 and landings by principal gear from 1955 to 2014. The proportion of landings by each gear is shown by the red line.

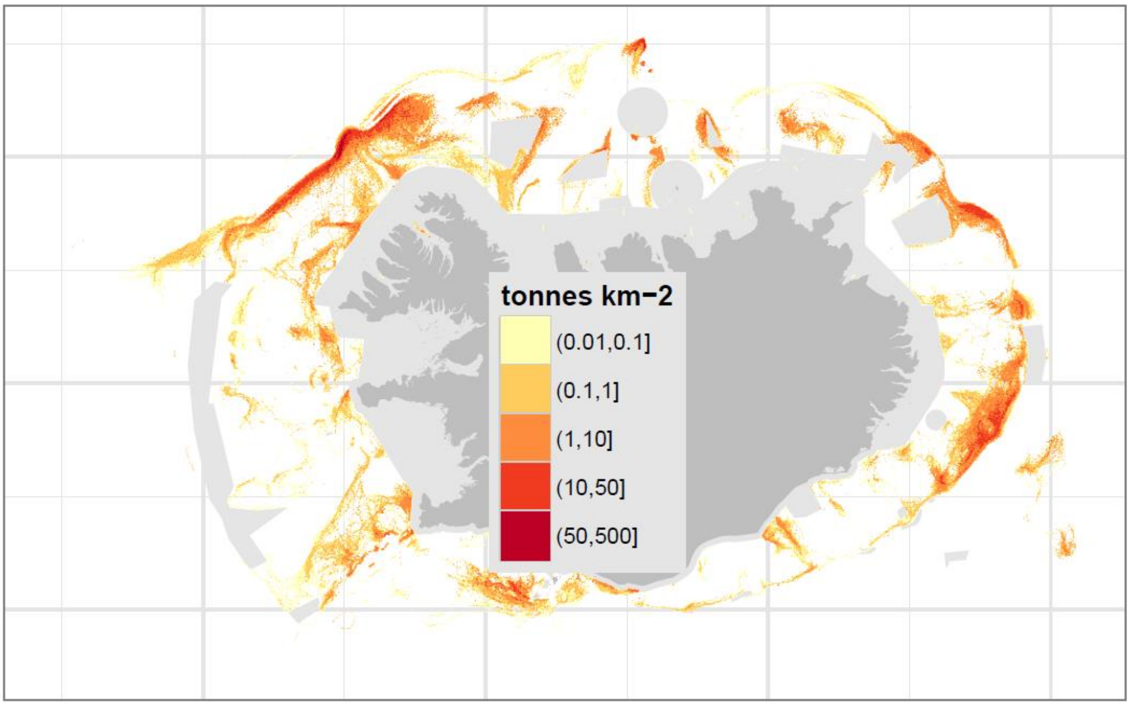

Figure 9.2: Icelandic cod division Va. Distribution of bottom trawl catches (tonnes per square km) in 2014. Shaded areas represent permanent areas closed to bottom trawl fishing.

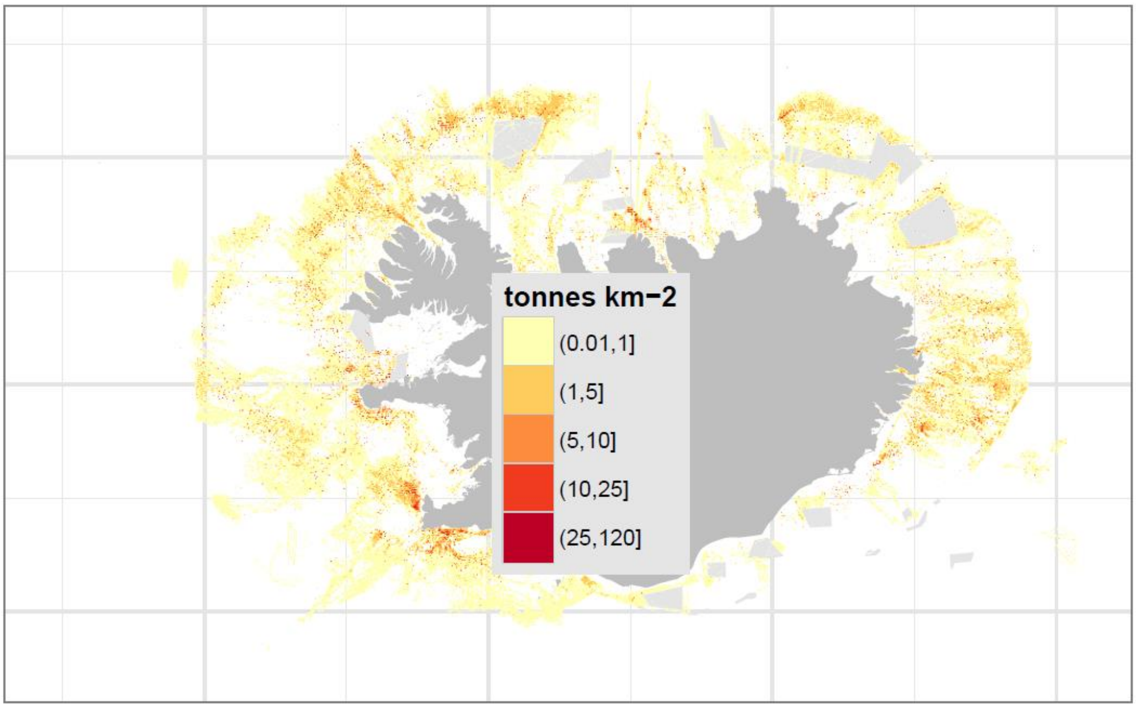

Figure 9.3: Icelandic cod division Va. Distribution of long line catches (tonnes per square km) in 2014. Shaded areas represent permanent areas closed to long line fishing.

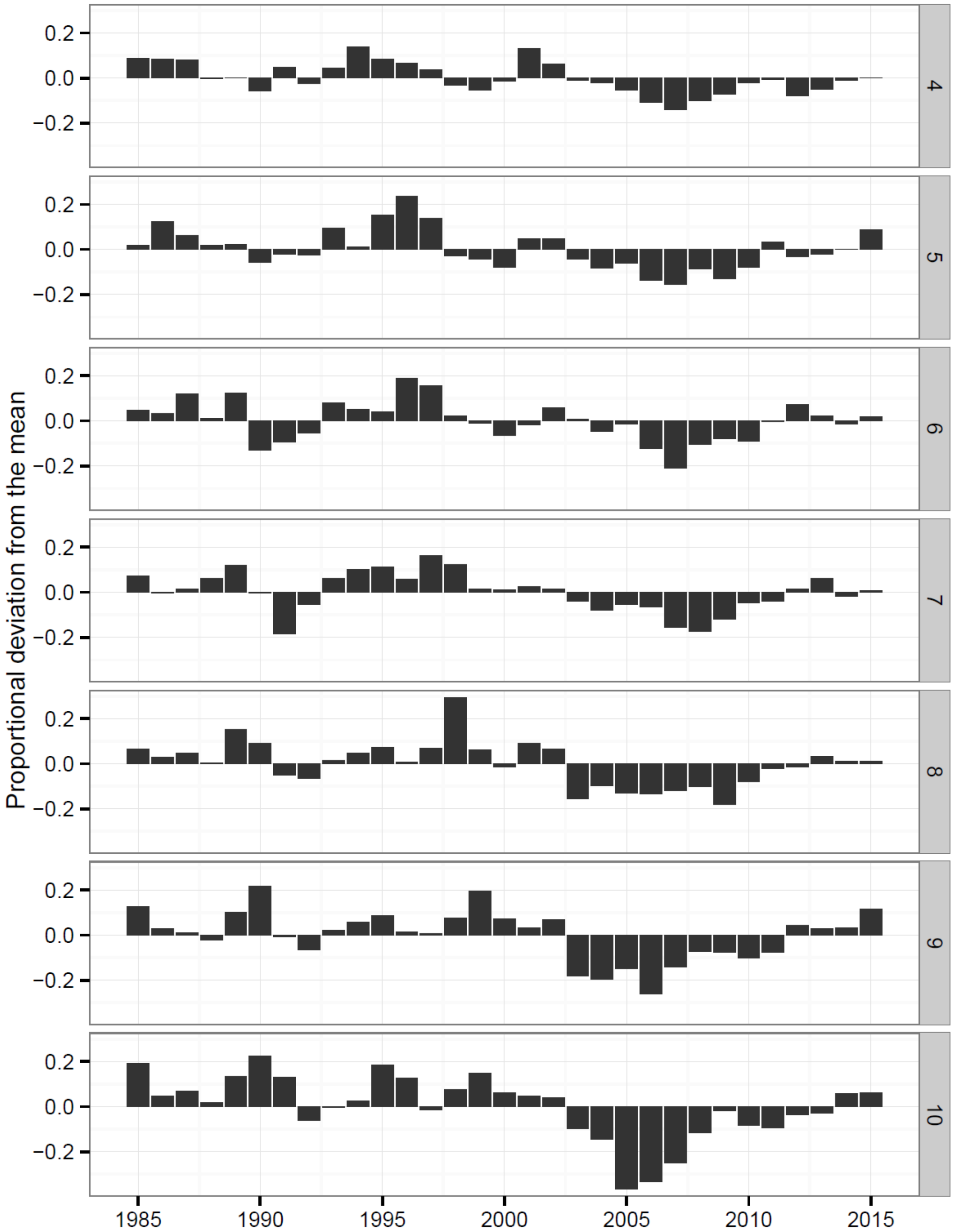

Figure 9.4: Icelandic cod division Va. Estimated weight at age (numbers in panels indicate age classes) in the catches 1985-2015 expressed as deviation from the mean. Weights at age in 2015 are predicted from 2015 spring survey weights. Note that values that are equal to the mean are not visible in this type of a plot.

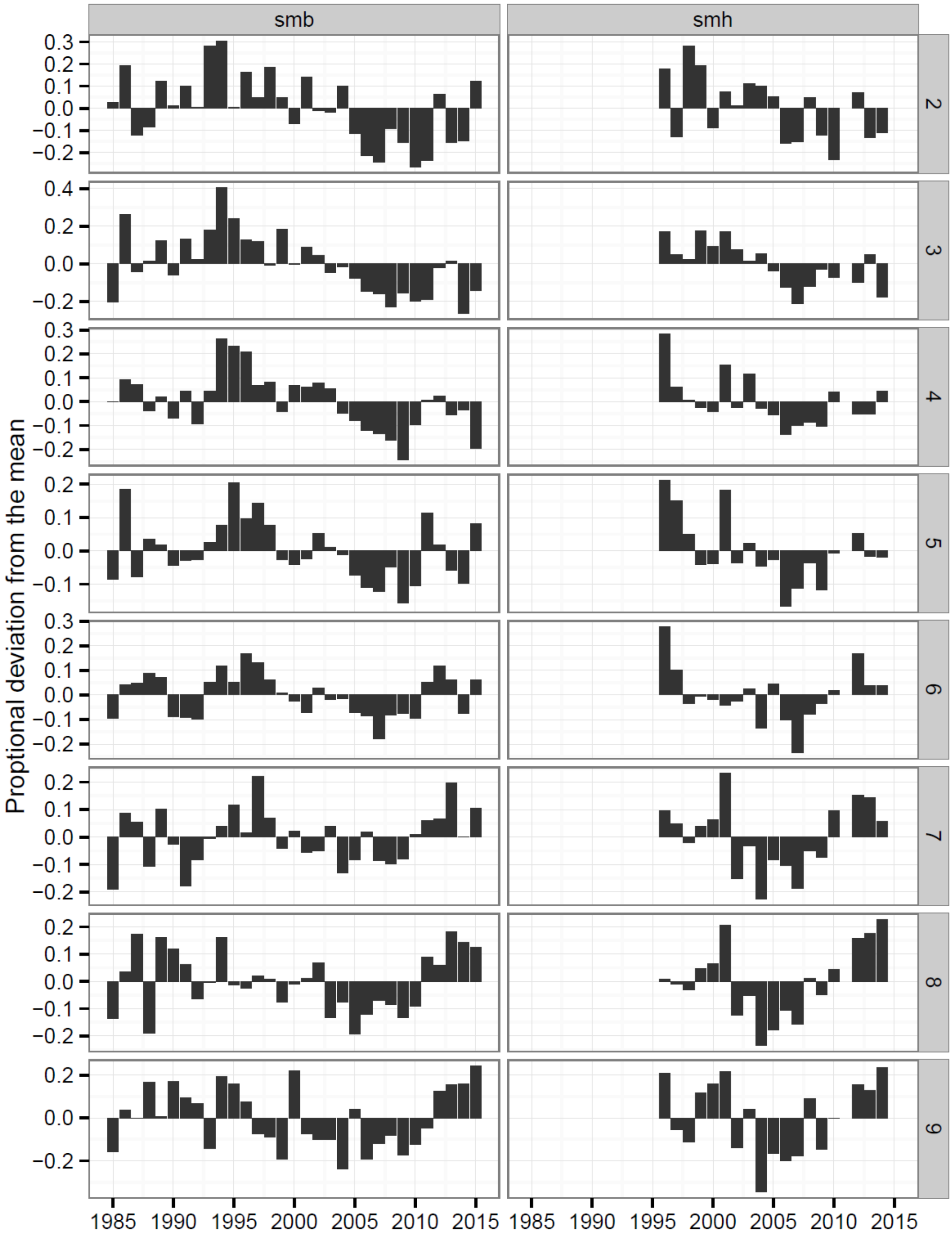

Figure 9.5: Icelandic cod division Va. Estimated weight at age (numbers in panel indicate age classes) in the spring survey 1985-2014 (SMB) and fall survey 1996-2013 (SMH) expressed as proportional deviations from the mean. No fall survey was conducted in 2011. Note that values that are equal to the mean are not visible in this type of a plot.

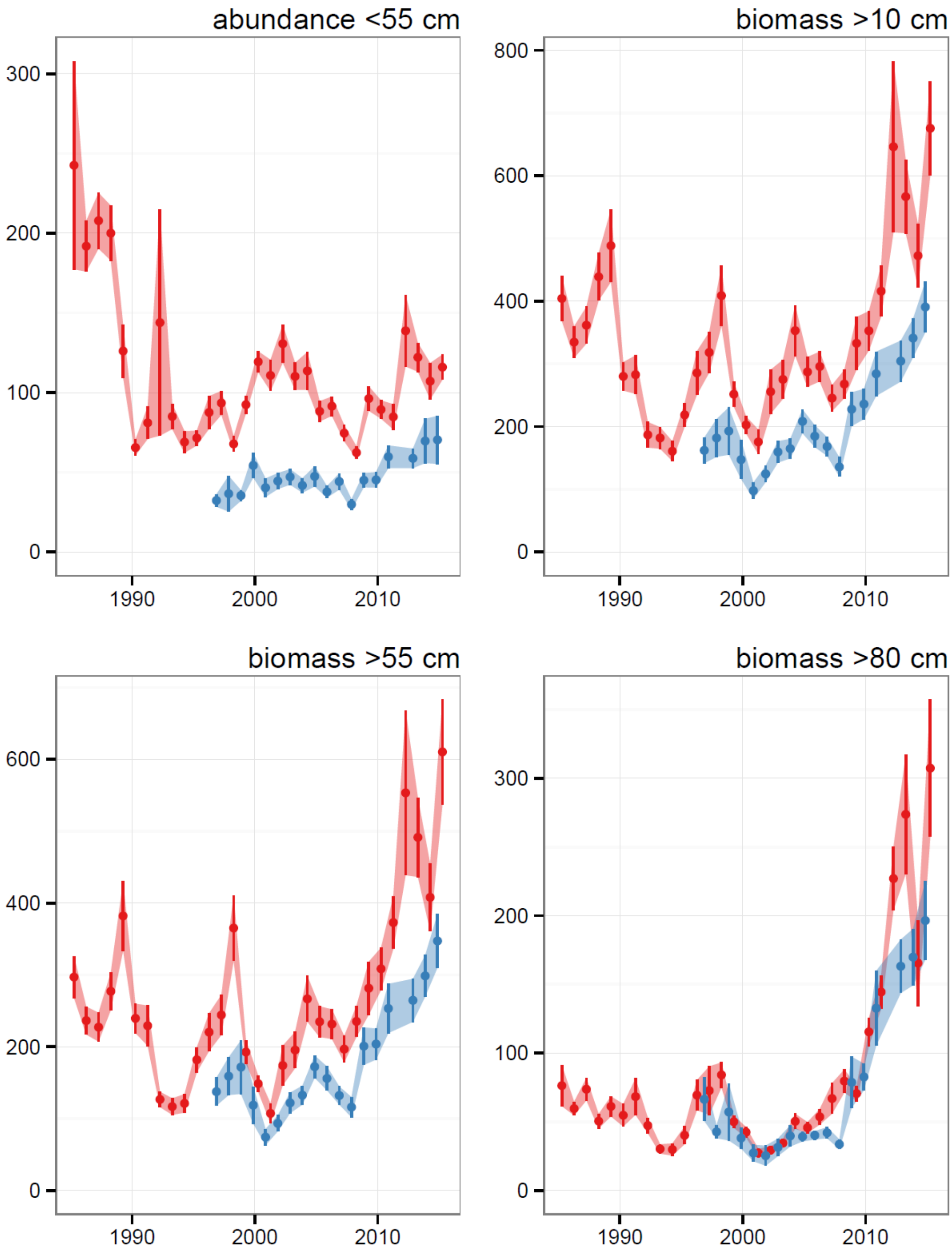

Figure 9.6: Icelandic cod division Va. Abundance indices of cod in the groundfish survey in spring 1985-2014 (SMB red, longer time series) and fall 1996-2013 (SMH blue, shorter time series). Bottom left) Biomass index of 55 cm and larger, bottom right) Biomass index 80 cm and larger, top right) Abundance index of < 55 cm, top left) Abundance index of < 18 cm fish. The shaded area and the vertical bar show 1 standard error of the estimate.

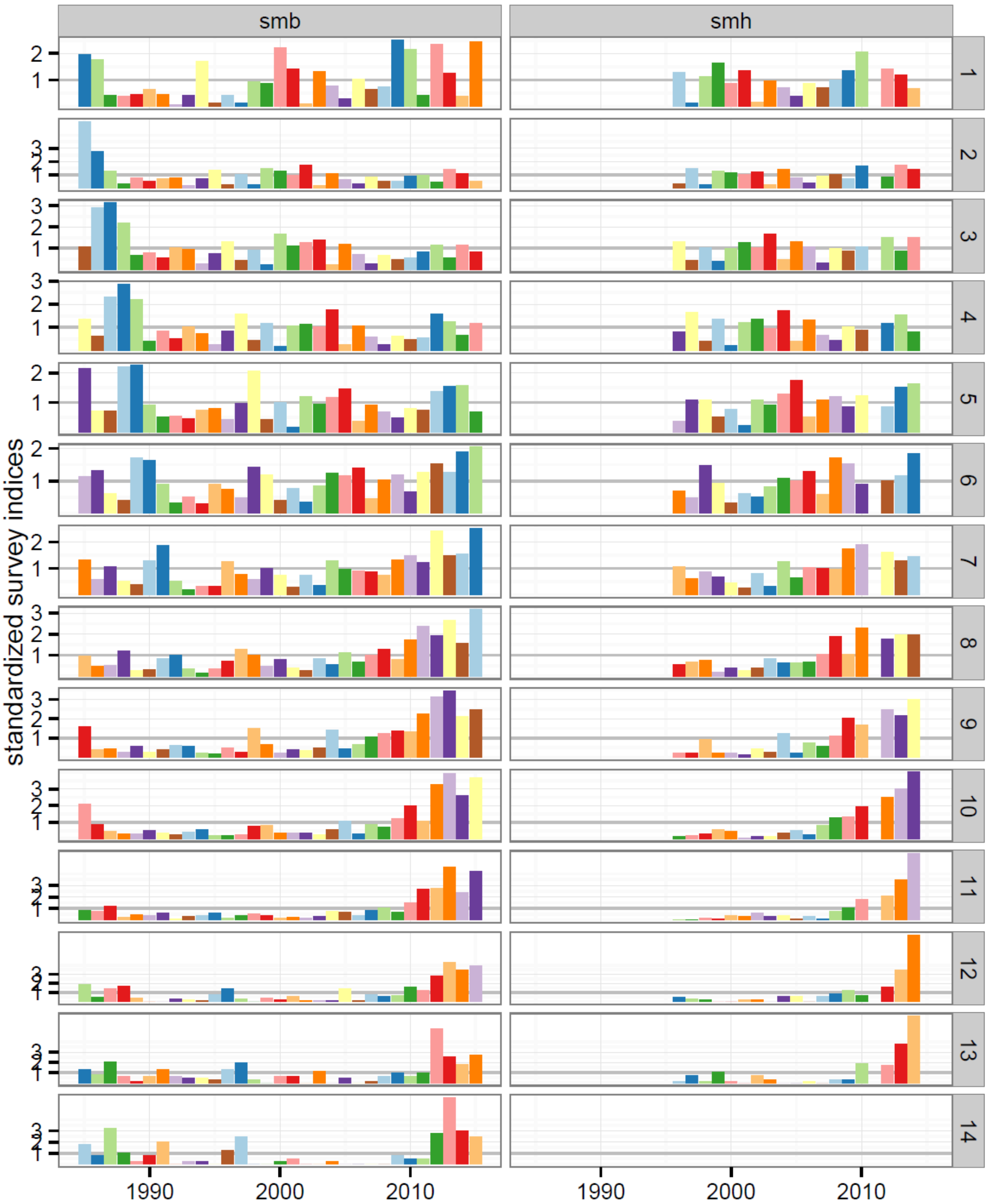

Figure 9.7: Icelandic cod division Va. Age based abundance indices of cod in the groundfish survey in spring 1985-2015 (SMB) and fall 1996-2014 (SMH). The indices are standardized within each age group and within each survey.

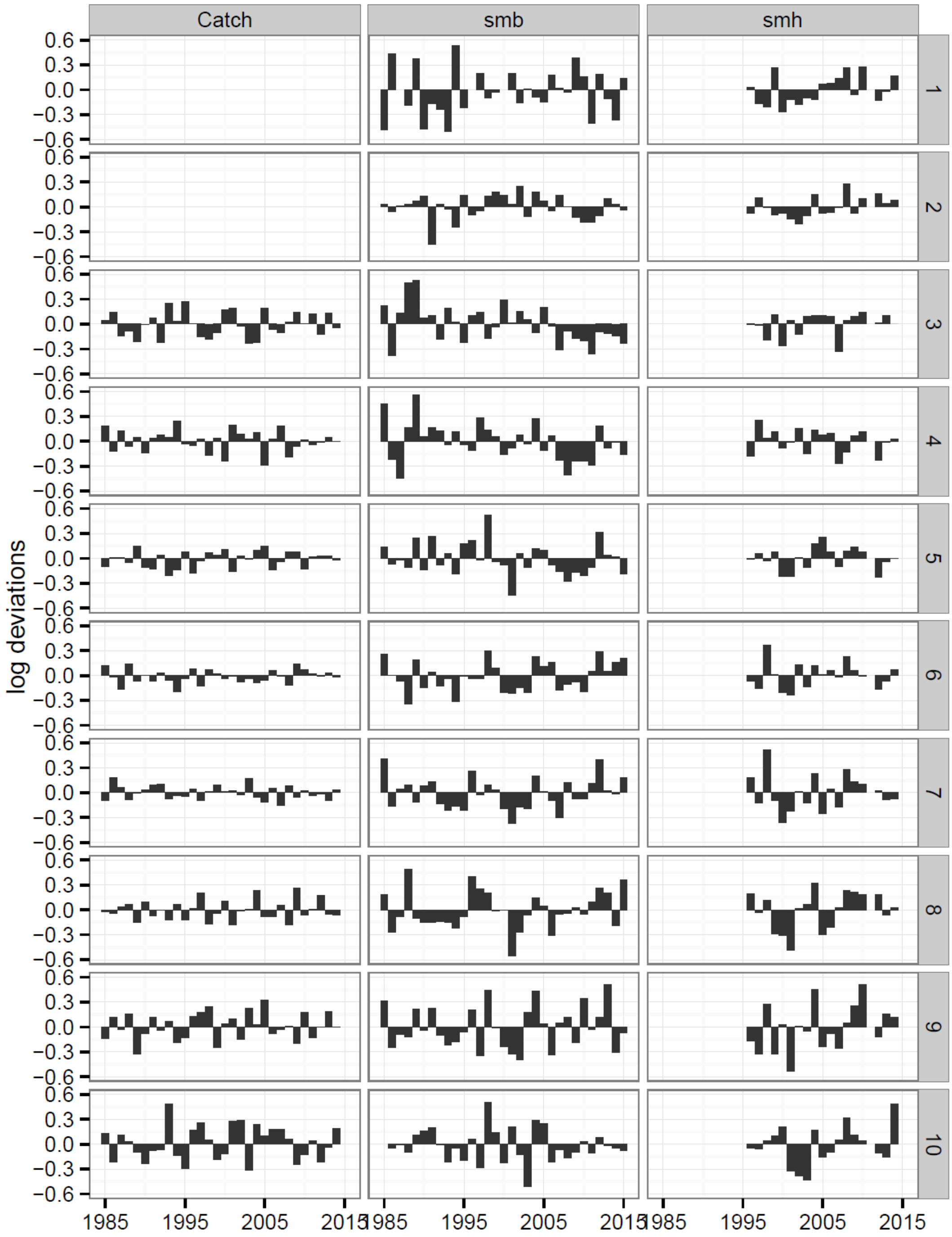

Figure 9.8: Catch residuals (left), spring survey residuals (SMB, middle) and fall survey residuals (SMH, right) by year and age from the spaly ADCAM run. Note that values that are equal to the mean are not visible in this type of a plot and that no survey was carried out in the fall 2011.

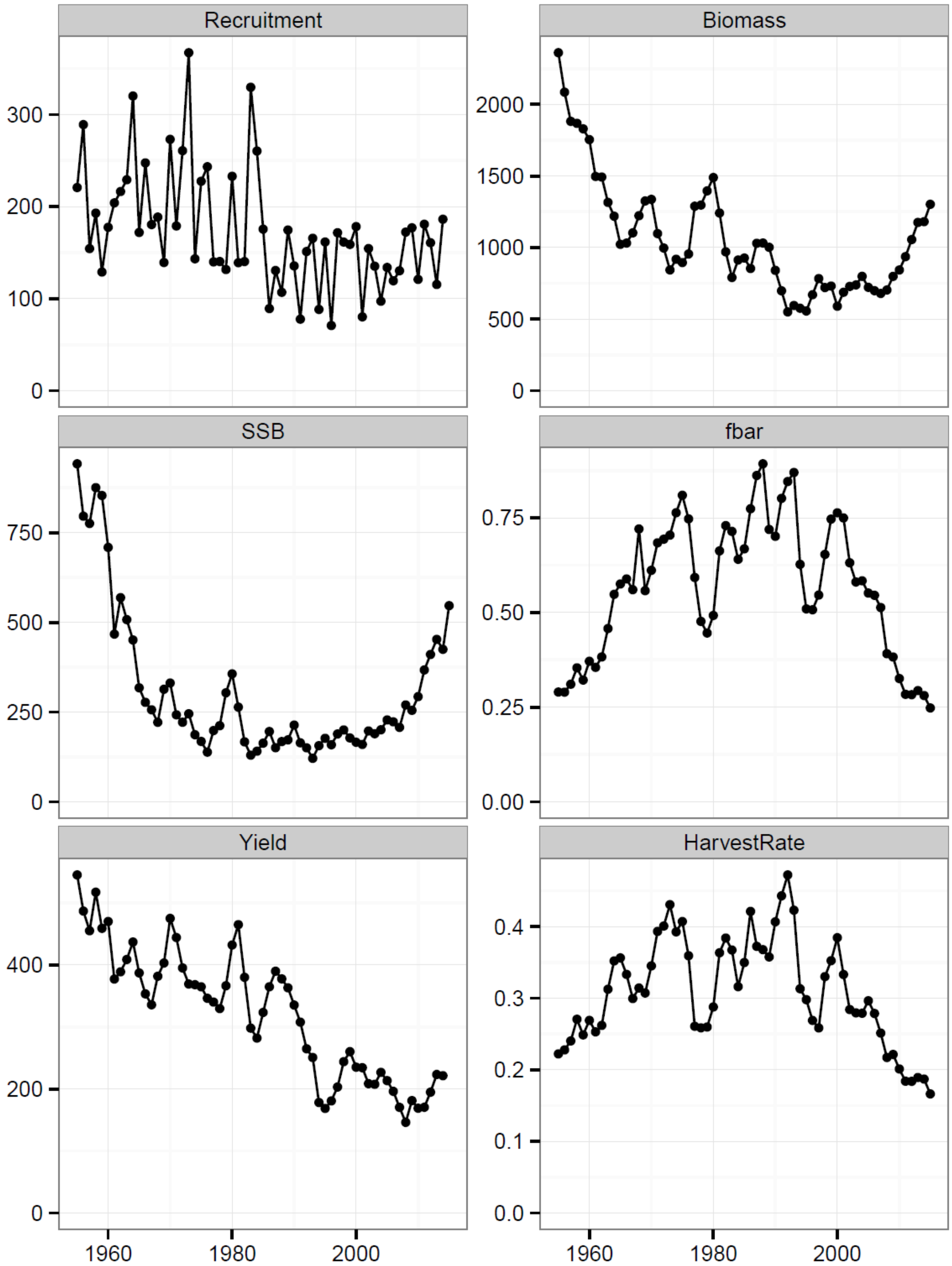

Figure 9.9: Icelandic cod in division Va. Assessment summary based ADCAM tuned with the spring and the fall survey.

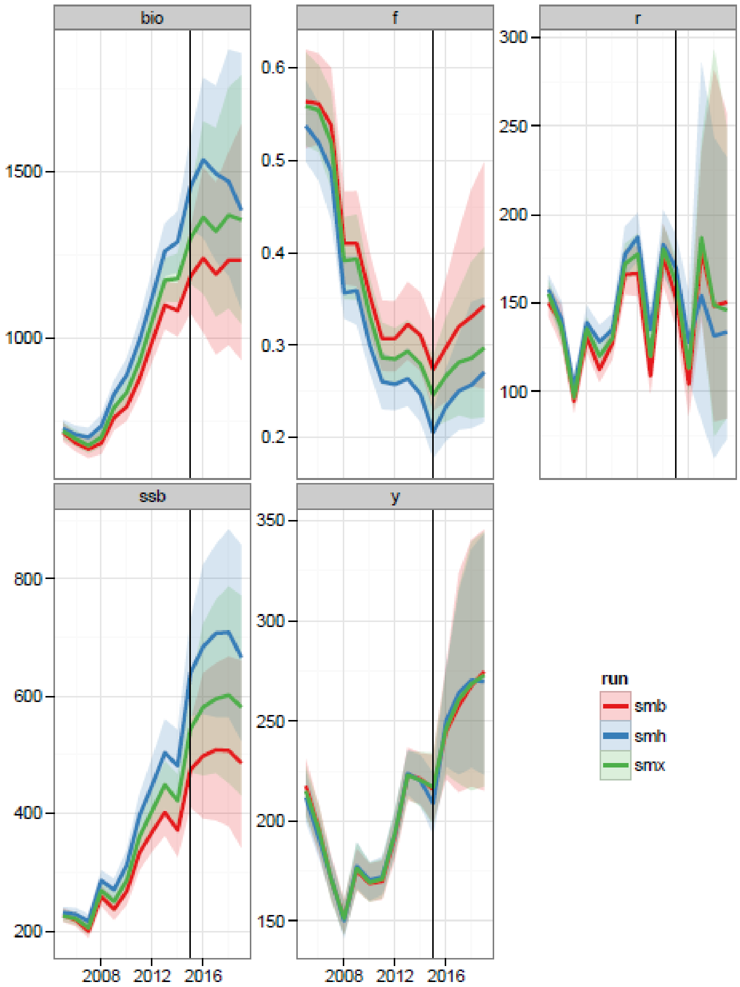

Figure 9.10: Icelandic cod in division Va. Comparison of different stock trajectories using alternative model frameworks, input and assumptions. The medium term simulations are based on the following harvest rates: 0.22 (smb), 0.20 (smx) and 0.18 (smh).

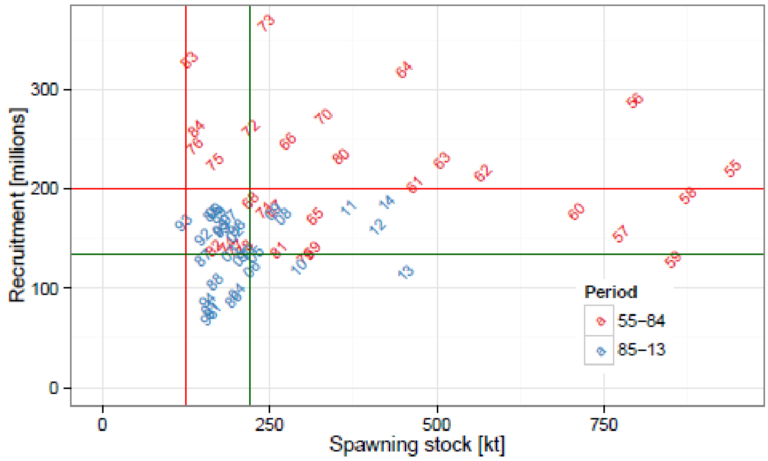

Figure 9.11: Icelandic cod in division Va. Spawning stock biomass and corresponding recruitment at age 3. The numerical values refer to year class with the horizontal lines referring to geometric mean recruitment for year classes 1954-1984 (red line) and 1985-2014 (green line). Vertical lines refer to Blim (Bloss, red) and Btrigger (green).

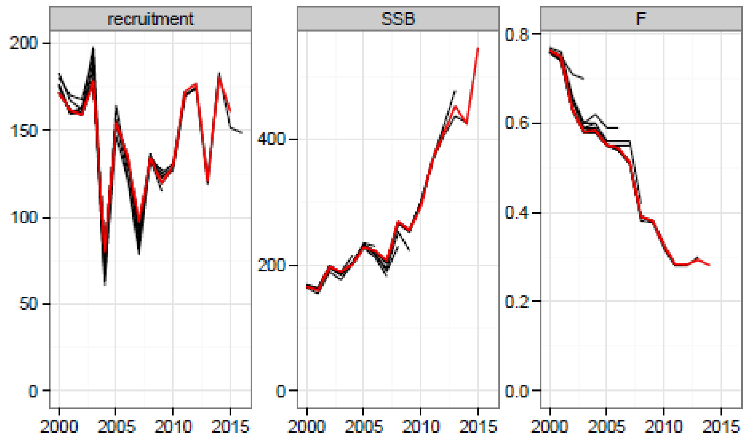

Figure 9.12: Icelandic cod in division Va. Empirical retrospective patterns from the 2004 to 2015 (this years assessment, marked in red) assessments as summarized in ICES annual advisory sheet.

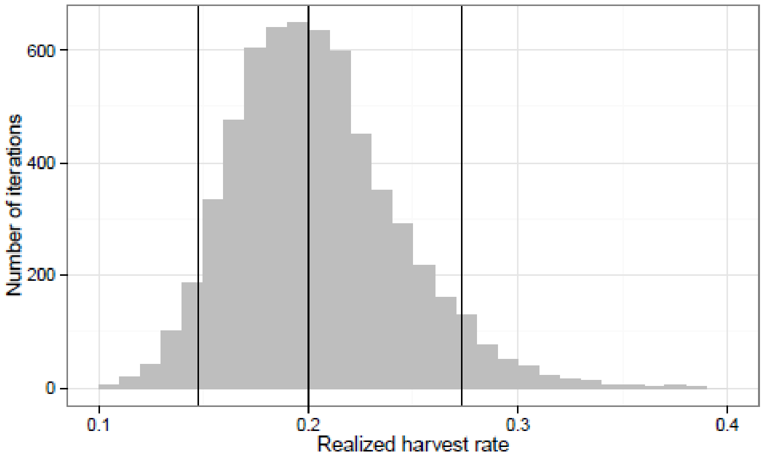

Figure 9.13: Icelandic cod in division Va. Distribution of realized harvest rate when TAC is based on the current catch rule (20% harvest rate and the catch stabilizer). The upper and lower 5% of the realized harvest rate is 0.15 and 0.27. The distribution is based on the last 5 years in the simulations, the number of iterations being 1225.

10 Icelandic haddock

The 2014 year class is estimated to be large, after 6 consecutive small year class from 2008-2013. The Current assessment shows some upward revision of the stock compared to last years assessment, mostly caused by more growth than predicted. The main features are though the same that recruitment is poor and the stock is predicted to decrease somewhat in next two years before the 2014 year-class recruits to the stock.

Growth in 2014 was above average since 1985 and more than predicted and the mean weight of young fish is above average while old fish are close to average. The assessment procedure was the same as last year (SPALY), an Adapt type model tuned with both the surveys.

There are differences in the perception of the state of stock in assessment based on either the spring or autumn survey with autumn survey indicating a larger stock. It has been like that since 2009. Different models using the same tuning data show similar results.

Advice is given according to the adopted Harvest Control Rule, and the advice for the fishing year 2014/2015 (September 1st 2015 – August 31st 2016) is 36 400 tonnes. The advice for the following fishing year is predicted to be approximately 31 000 tonnes but increasing after that when the 2014 year class comes in.

No environmental drivers or ecosystem effects are known that can help in prediction of the development of the haddock stock. Some effect of the environment on the stock can though not be excluded.

10.1 Data

Landings of Icelandic haddock in 2014 are estimated to have been 33 900 tonnes, see Figure 10.1.1 and Table 10.1.1., the lowest since World War II. Of the landings, 33 000 tonnes are caught by Iceland and 900 tonnes by the Faeroese. The landings have decreased from 100 thous. tonnes between 2005-2008. The proportion of haddock caught by longliners was 48% in 2014, the highest ever (Figure 10.1.2). On longer time scale the share of longlines increasing in last 15 years, while the proportion of haddock caught in gillnets is now very small. Spatial distribution of the landings does not change very much from year to year but catches from the area north of Iceland have increased gradually over the last 10-15 years. (Figure 10.1.3 and 10.1.8).

Catch in numbers at age is shown in Table 10.1.2 and Figure 10.1.4. Age 7 accounted for 35% of the landings and age 9 and older for 17.5 % while the average contribution of age 9 and older is 4.5%. The results for are close to expectation (Figure 10.1.5).

The index of total biomass from the groundfish surveys in March and October is shown in Figure 10.1.8. Both surveys show much increase between 2002 and 2005 but considerable decrease from 2007—2010. The difference in perception of the stock between the surveys is that the autumn survey shows less contrast between periods of large and small stock. In recent years the assessment has predicted reduced biomass while the reality has been unchanged biomass in the March survey and some increase in the autumn survey, causing upwards revision of the stock in each assessment compared to earlier assessments.

Age disaggregated indices from the March survey are given in Table 10.1.3 and indices from the autumn survey in Table 10.1.4. Abundance of age groups 2—5 and in the 2015 March survey is low while age 8 is among the highest indices observed (Figure 10.1.9). The index of age 12 (2003 cohort) is much higher than seen before (large part of 11+), but that cohort will though not contribute much to the landings. Year classes 2008 and 2009 (age 7 and 6) are now close to average, mostly due to reduced fishing mortality in recent years but those year classes were originally small.

The survey results indicate that in recent decade higher and higher proportion of the haddock stock has gradually been inhabiting the waters north of Iceland (Figures 10.1.7 and 10.1.8.).

Mean weight at age in the catch is shown in Table 10.1.6 and Figure 10.1.10. Mean weight at age in the stock is given in Table 10.1.5 and Figure 10.1.9. Those data are obtained from the groundfish survey in March and are also used as mean weight at age in the spawning stock.

Both stock and catch weights have been increasing in recent years, after being very low when the stock was large between 2005—2009. Higher mean weight at age is most apparent for the younger haddock from the small cohorts (2008 and later), but mean weight of the old fish is now near average.

Mean weight of the 2007 year class that will be the most important year class in the fisheries in next years (≈25% by weight 2015 and 15% in 2016) is close average since 1985. Mean weight of the youngest, small year classes is now above the average since 1985. Mean weight at age in the March survey 2015 was on the average higher than predicted last year, but growth in 2014 was approximately 10% better than in 2013 (Figures 10.2.8, and 10.4.2). In recent year's growth has shown interannual variability, indicating that short term prediction should rather been based on average growth of last two years instead of only last year's growth.

Maturity at age data are given in Table 10.1.7 and Figure 10.1.11. Those data are obtained from the groundfish survey in March. Maturity by age of the youngest age groups has been decreasing in recent years while mean weight at age has been increasing so maturity by size has been decreasing. The most likely explanation is high proportion of those age groups north of Iceland where proportion mature has always been low.

Catch per unit effort data (figure 10.1.12) give somewhat different picture of the development of the stock from the surveys and assessment, much less increase after 2000 but much less decrease in recent years (figures 10.1.8 vs 10.1.15). The interesting thing for the current assessment is the relatively high CPUE, in recent years, confirming fishermen's view that catching haddock in now very easy. The discrepancy observed between CPUE and stock size has not been explained, but a number of plausible reasons mentioned.

- Area inhabited by the stock increased so the density in the traditional fishing area did not increase in relation to the stock size.
- When the stock was large slower growth lead to higher proportion of the stock below "fishable size" 45cm limiting the areas where large haddock could be caught without too much bycatch of small haddock.
- The opposite is happening in recent years, faster growth and poor recruitment lead to the fisheries not limited by small haddock.

- Bycatch issues, but haddock is often caught as bycatch or one of the species in mixed fisheries where the goal is certain mixture of species.

10.2 Assessment.

From 2007 to 2014 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.

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. From 2004 to 2008 models calibrated with the October survey indicated smaller stock. In the last five years things have changed and models calibrated with the October survey indicate a better state of the stock, the difference increased with addition of the most recent data points i.e. October 2014 and March 2015. This behaviour is in line with what is seen in the surveys where the contrast in biomass is higher in the March survey (Figure 10.1.8).

The stock was benchmarked in February 2013, (WKROUND 2013) and the assessment procedure used since 2007 was recommended for few more years, if major problems do not show up (see stock annex). This year the method described by WKROUND was changed by basing prediction of growth on the average of last 2 years instead of only the last year. The effect on TAC in next fishing year is reducing it by 2000 tonnes from 38.400 tons to 36.400 tons.

The results of the assessment indicate that the stock decreased from 2008-2011 when large year classes disappeared from the stock and were replaced by smaller yea classes. (Figure 10.2.1) Since 2011 the rate of reduction has slowed down as fishing mortality has been low. The spawning stock has though decreased more than the reference biomass as proportion mature by age/size has been decreasing. Fishing mortality is now estimated to be low and should continue to be so if the adopted HCR will be followed and the stock size not overestimated. Still the stock is predicted to decrease somewhat in next two years before the 2014 year class starts having effects.

The main features of the current assessment are the same as in the assessments 2011 to 2014. The current indicates larger stock than the 2014 assessment (Figures 10.2.7 and 10.2.8). Most of the difference is explained by higher than predicted mean weight at age (Figure 10.2.8). The tendency has been to underestimate recruitment and stock size in recent years.

Residuals from the assessment model are positive for the most recent October survey but close to zero for the most recent March survey. (Figures 10.2.2 and 10.2.3). The March surveys 2011-2014 are on the other hand below predictions. Similar thing seem to be happening in the fishery in 2012-2013 (Fig. 10.1.15) so there are indication that the stock might be underestimated or availability of haddock is unusually high.

Analysis by the TSA model (WD 38 2014) indicate increased natural mortality after age 6. This increase will not have large effect on the harvest rate in the HCR which is mostly selected based on precautionary criteria, i.e low probability of $SSB<B_{loss}$ in periods of poor recruitment. Higher M of older age groups will reduce the possibility of storing old spawners through periods of poor recruitment. To get maximum yield per recruit increased M would call for higher harvest ratio. Increased M of old fish will be investigated further in coming years, but reduced availability with age leads to similar observations.

Standard errors in estimates of SSB in 2015 from the Adapt model are 9 thous. tons for the March survey and 16 thous. for the autumn survey. The difference between the stock biomass is 65 thous. tonnes (125 vs 60 thous. tonnes) that does not fit within the confidence intervals (less than 1% probability of 65 thous tonnes or more difference between autumn survey and March survey results). This is an indication that the estimated confidence intervals are too narrow. The same observation was made last 3 years. The spawning stock according to the model tuned with both the surveys is 79 thous. tonnes.

Plot of observed vs. predicted biomass from the surveys (figure 10.2.3) indicates that historically the autumn survey biomass has been closer to prediction than corresponding values from the March survey where the contrast in observed biomass is more than predicted from the assessment. When the stock was small in 2000 and 2001, the March survey indicated considerably smaller stock while the autumn survey values were reasonably correct and from 2003-2007 the March survey overestimated the stock.

Figure 10.2.5 shows the estimated "catchability" and CV as a function of age for the surveys, showing that estimated CV is lower in the autumn survey for ages 2 to 6. Therefore, the autumn survey gets more weight for those age groups. The figure also indicates that estimated CV and "catchability" have not changed much for the March survey since 2008, but catchability of the autumn survey increased as has CV of the oldest age groups. This observation does partly have to do with the length of the series in.

To summarize there are indications from the autumn survey that the stock might be larger than predicted but from the March survey that it is smaller. CPUE data, not used directly in the assessment support that the stock might be larger.

10.3 Reference points

In March 2013, ICES evaluated a proposed Harvest Control Rule for Icelandic haddock (Björnsson 2013) and the Icelandic government adopted it in April 2013. The Harvest control rule is

The annual total allowable catch (TAC) will be set by applying the following harvest control rule (HCR):

1. When spawing stock biomass in the year following the assessment year (SSB_{y+1}) is equal to or greater than $SSB_{trigger}$:

$$TAC_{y/y+1} = \alpha\ B_{45+,y+1}$$

2. When SSB_{y+1} is below $SSB_{trigger}$:

$$TAC_{y/y+1} = \alpha\ SSB_{y+1}/\ SSB_{trigger}\quad B_{45+,y+1}$$

Where:

y the assessment year,

y/y_{+1} the fishing year starting 1 September in year y and ending 31 August in year y+1

y_{-1}/y the fishing year starting 1 September in year y-1 and ending 31 August in year y

$B_{45+,y+1}$ the reference biomass of 45cm and larger haddock in the year following the assessment year

and were α=0.40 and $SSB_{trigger}$ =45000 t.

B_{45+}, is on the average close to the spawning stock, but is not affected by changes in proportion mature by size/age. Large variability in size at age (Figure 10.1.12) is the reason for basing reference biomass on size rather than age. Proportion of a cohort above 45cm (B_{45+}) is calculated from stock weights by the green curve in Figure 10.4.3.

B_{lim} for Icelandic haddock was defined by ICES in 2011 as 45 000 tonnes or B_{loss}. From the simulations done to test the Harvest Control Rule H_{msy} the harvest ratio giving maximum yield was estimated as 0.52 and H_{PA} harvest ratio giving 5% probability of SSB < $B_{\lim}$ as 0.46, compared to the target harvest rate of 0.4. These numbers do though not have any meaning when the HCR has been adopted.

10.4 Short term forecast

Prediction of weight at age in the stock, weight at age in the catches, maturity at age and selection has been similar since 2006 (WD #19 in 2006). The procedure is described in the advice part of the report of ADGISHA (Björnsson 2013) and also in the stock annex.

To summarize, TAC for the fishing year 2015/2016 is a function of the biomass of 45cm and larger haddock and the spawning stock in the beginning of 2016. To be able to predict the stock size in 2016, catch 2015, mean weight at age in the catch 2015, selection at age in the catch 2015, stock weights in 2016 and maturity at age in 2016 must be predicted. The prediction of these values is described in Björnsson (2013) and the stock annex, but to summarize, catch in the assessment year (2015) is the TAC left in the current fishing year in the beginning of the assessment year plus 1/3 of the predicted TAC next fishing year. The TAC for the fishing year 2014/2015 was 30 400 tonnes. The landings in September – December 2014 were 11 400 tonnes or 37% of the TAC. The average contribution of the first 4 month of of the Fishing year is on the other hand around 33%. Landings for the fishing year 2013/2014 are now estimated to be 39 600 tonnes while the TAC issued was 38 thous. tonnes. Looking at the rate of landings (Figure 10.4.1) they indicate that the TAC for the current fishing year will not be exceeded. .

In the Icelandic fishery management system certain relatively small transfer is allowed between species, to increase flexibility in mixed fisheries. Currently net transfer is towards haddock, probably because haddock is easy to catch, as demonstrated by high CPUE in 2014. The haddock quota does also seem to be limiting in some mixed fisheries. Looking over longer period quota transfer towards/from haddock has on the average been close to zero. In predictions for current fishing year 1000 transfer towards haddock is assumed.

On January 1st 2015 , 19 thous. tonnes of quota were left To this are added 1/3rd of next years TAC (12 100) and 1000 ton transfer . This leads to 32 100 tonnes catch in the calendar year 2015.

In current fishing year 45% of the quota is caught in September-December leading to 4 500 tonnes extra catch in 2013 compared to if 1/3rd of the quota was caught in that period. It can be argued that when in the fishing year the TAC is caught is not crucial for development of the stock as long as the total catch is according to the TAC. Therefore the predictions are based on catching 1/3rd of the TAC in September - December.

Mean weight and maturity at age in 2015 are available and are used to predict catch weights and selection at age (Figure 10.4.2). Growth in 2015 is predicted by the equation

$$\log \frac{W_{a+1,t+1}}{W_{a,t}} = \alpha + \beta \log W_{a,t} + \delta_{year}$$

Where according to the stockannex the factor δ_{year} for the year 2014 (figure 10.4.2) is used for 2015 and onwards. Looking at the development of the annual growth in recent years considerable interannual variability can be seen. Therefore, it is proposed to predict growth in the assessment year based on the average of the growth in the 2 preceeding years. This change will not change the average harvest ratio but will reduce variability in advice compared to the method described in the stock annex.

Maturity, selection, catch weights at age and proportion of the biomass above 45cm are then predicted from stock weights 2016. When those values have been estimated the prediction is done by the same model as used in the assessment.

The model works iteratively as the estimated TAC for the fishing year 2015/2016 has some effect of the biomass in the beginning of 2016, which the TAC is based on. Advice for the following fishing year is predicted to be approximately 31 000 tonnes but increasing after that when the 2014 year class comes in

Results of the short term prediction are shown in figure 10.2.1 assuming that the harvest control rule is followed. TAC for the fishing year 2015/2016 will be 36 400 tons. Short term prognosis based on the traditional ICES approach are shown in table 10.4.1

10.5 References

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Table 10.1.1 Haddock in Division Va 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
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						
Total	60819	56891	43585	41434	45481	42167	39647	50469

Country	2003	2004	2005	2006	2007	2008	2009	2010	2011
Belgium									
Faroe Islands	833	1035	1372	1499	1780	828	625	311	207
Iceland	59970	83791	95859	96115	108175	101651	81418	63868	49231
Norway	30	9			11	11			
Total	60884	84835	97231	97614	109966	102490	82043	64179	49437

Country	2012	2013	2014
Belgium			
Faroe Islands	303	600	800
Iceland	45888	43500	33100
Norway			
Total	46191	44100	33900

Table 10.1.2 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	112
1980	595	1385	11481	4298	3798	3732	544	91	37
1981	10	514	4911	16900	5999	2825	1803	168	57
1982	107	245	3149	10851	14049	2068	1000	725	201
1983	34	1010	1589	4596	9850	8839	766	207	280
1984	241	1069	4946	1341	4772	3742	4076	238	80
1985	1320	1728	4562	6796	855	1682	1914	1903	296
1986	1012	4223	4068	4686	5139	494	796	897	400
1987	1939	8308	6965	2728	2042	1094	132	165	339
1988	237	9831	15164	5824	1304	1084	609	66	213
1989	188	2474	22560	9571	3196	513	556	144	141
1990	1857	2415	8628	23611	6331	816	150	67	74
1991	8617	2145	5397	7342	14103	2648	338	40	27
1992	5405	10693	5721	4610	3691	5209	999	120	16
1993	769	12333	12815	2968	1722	1425	2239	343	38
1994	3198	3343	28258	10682	1469	726	358	647	108
1995	4015	7323	5744	23927	5769	615	290	187	331
1996	3090	10552	7639	4468	12896	2346	208	79	125
1997	1364	3939	10915	4895	2610	5035	719	64	69
1998	279	8257	5667	7856	2418	1422	1897	261	45
1999	1434	1550	17243	4516	4837	915	620	481	64
2000	2659	6317	2352	13615	1945	1706	324	222	192
2001	2515	11098	6954	1446	6262	675	478	105	94
2002	1082	10434	15998	5099	1131	3149	262	169	100
2003	401	6352	16265	12548	2968	748	1236	91	70
2004	1597	4063	17652	19358	8871	1940	471	489	155
2005	2405	9450	6929	25421	13778	4584	809	251	237
2006	241	10038	21246	6646	18840	7600	2180	323	202
2007	782	3884	42224	22239	3354	9952	2740	519	181
2008	2316	4508	9706	53022	11014	1717	3033	815	192
2009	1066	3185	4886	8892	35011	5733	726	1381	509
2010	121	6032	7061	4806	6766	17503	1874	354	528
2011	253	1584	11797	5080	2853	3983	6220	494	183
2012	196	1322	3421	13107	2223	1231	2480	2662	370
2013	250	1042	2865	4008	9222	1206	668	1248	1599
2014	238	1478	1751	2725	2737	4742	447	387	1403

Table 10.1.3 Icelandic haddock. Age disaggregated survey indices from the groundfish survey in March .

Year/ Age	1	2	3	4	5	6	7	8	9	10	11+
1985	28.14	32.68	18.33	23.58	26.39	3.7	10.86	4.8	5.54	0.49	0.19
1986	123.87	108.48	58.97	12.79	16.31	13.12	0.97	2.71	1.22	2.25	0.19
1987	21.82	338.29	147.5	44.15	7.68	7.47	4.72	0.39	0.61	0.44	0.86
1988	15.77	40.73	184.79	88.87	22.86	1.34	2.18	1.76	0.16	0.22	0.31
1989	10.58	23.33	41.16	146.61	45.09	12.88	0.79	0.81	0.41	0.28	0.23
1990	70.48	31.8	26.73	38.84	92.82	30.89	3.44	0.88	0.23	0	0.02
1991	89.73	145.95	41.43	17.73	20.19	32.85	7.63	0.3	0.1	0.08	0.08
1992	18.15	211.43	137.77	35.38	16.91	13.77	16.32	2.22	0.18	0.07	0
1993	29.99	37.8	244.96	87.19	11.23	3.85	1.66	4.46	0.88	0	0
1994	58.54	61.34	39.83	142.35	42.18	6.9	2.87	1.42	4.44	0.17	0
1995	35.89	82.47	47.03	19.75	69.52	7.66	1.31	0.11	0.34	0	0
1996	95.25	66.21	119.86	36.78	19.58	40.63	5.78	0.59	0.13	0.12	0.15
1997	8.6	119.35	50.81	53.33	10.88	7.37	10.9	1.35	0.07	0.03	0.13
1998	23.08	18	107.93	28.23	23.49	4.9	3.54	4.56	0.33	0	0
1999	80.73	85.46	25.53	98.73	12.99	9.85	1.42	1.77	1.03	0.09	0
2000	60.58	90.07	44.63	8.45	25.22	3.14	1.59	0.4	0.15	0.52	0.04
2001	81.27	147.71	115.4	22.15	4.09	10.63	0.93	0.57	0	0.1	0
2002	20.75	298.67	200.74	112.49	23.24	3.51	7.49	0.31	0.3	0.08	0.15
2003	111.59	97.54	282.28	244.81	113.45	18	2.55	4.48	0.48	0.82	0.15
2004	325.9	291.65	70.75	208.74	109.33	33.96	6.79	1.24	0.82	0	0.31
2005	57.96	698.48	289.43	44.58	157.2	57.52	15.72	3.35	0.32	0.25	0.02
2006	39.29	88.69	575.93	179.11	19.13	62.94	16.43	6.74	0.7	0.29	0
2007	34	65.6	88.63	436.41	85.68	7.9	21.6	4.74	2.15	0.07	0
2008	88.53	68.05	71.7	75.57	222.79	29.99	3.53	7.47	1.64	0.27	0.03
2009	10.46	111.21	53.82	41.48	41.91	105.64	12.94	2.23	3.11	0.44	0.23
2010	15.15	27.71	138.2	29.95	18.28	20.59	31.59	2.92	0.46	0.69	0.2
2011	8.79	27.65	24.75	77.43	14.03	5.9	9.4	14.89	1.22	0.31	0.3
2012	12.47	14.9	31.27	27.22	58.3	5.23	2.92	5.3	6.87	0.8	0.49
2013	13.91	23.32	19.72	22.9	22.51	41.93	4.78	2.52	3.83	4.52	1.02
2014	14.01	24.78	30.27	17.74	16.44	14.79	16.44	1.33	1.05	1.68	1.63
2015	62.58	19.59	26.56	34.23	12.58	11.18	9.63	9.96	1.14	0.56	2.29

Table 10.1.4 Icelandic haddock. Age disaggregated survey indices from the groundfish survey in October

Year/ Age	0	1	2	3	4	5	6	7	8	9	10
1996	16.1	461.3	109.4	85.6	18.5	7.8	18.3	1.6	0	0	0
1997	52.9	32.4	212.9	54.5	38.7	7	5.7	6.1	0.3	0	0
1998	209.1	81.1	32.5	133.4	19.8	15.7	5.3	5.4	1.9	0	0.1
1999	178.6	397.4	66.9	28.6	97.1	11.9	10.4	0.5	2.1	0.3	0
2000	56.2	161.9	260.1	46.3	8.2	28.7	2	3.2	0.1	0.3	0.6
2001	47	387.5	281.6	170.2	35.7	4.1	13.9	0.7	1	0	0.2
2002	150.6	85.2	237.8	197.5	98.5	19.3	3	2.3	1	0.1	0
2003	316.5	345.5	146.9	251.9	169.1	56.6	9.5	2.4	0.7	0	0
2004	189.4	714.2	347.3	51.2	160.3	70.6	17	4	0.8	0.5	0
2005	91.1	74.2	560.4	182.1	27.3	96.5	26.7	10.4	1.9	0	0.1
2006	85.9	124.1	117.6	510.4	108.5	13.8	40.4	9.8	3.9	1.5	0
2007	203.4	93	78.4	92.8	341.4	58.6	8.5	12.3	3.8	0.6	0.3
2008	95.3	201.8	93.9	68.4	87.9	198.9	16.8	2.9	3.5	0.2	0.1
2009	52.8	47.5	269.5	68.1	31	48.5	96.5	9.5	1.5	2.2	0.4
2010	37.2	43.3	56.6	143.4	30.5	14.4	23.7	37.2	4.8	0.9	1.1
2012	26.8	53.8	29.1	34.3	37.7	70.3	9.3	3.6	9.8	10.3	1.7
2013	27.1	91.9	131.4	37.3	38.6	39.3	44.8	6.2	2.3	5.8	4.9
2014	250.2	35.1	41.3	67.3	24.1	27.2	24.4	26.3	2.3	1.5	5

Table 10.1.5 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	2730
2011	35	175	442	757	1129	1304	1583	1865	2107	3094
2012	28	202	482	801	1145	1480	1909	2072	2353	2350
2013	33	201	589	967	1312	1710	1999	2265	2764	2709
2014	36	222	570	1005	1372	1751	2141	2298	2653	3104
2015	32	255	614	1073	1637	1926	2452	2774	3170	3173
2016	32	184	609	1117	1643	2200	2461	2908	3167	3472
2017	32	182	486	1111	1689	2205	2698	2915	3272	3470

Table 10.1.6 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	447	756	1092	1294	1448	1685	2188	2366	2657
2011	588	905	1122	1455	1688	1914	2094	2455	2919
2012	668	978	1222	1492	1903	2164	2366	2704	2765
2013	678	1084	1358	1675	2036	2400	2554	3097	3111
2014	536	1080	1433	1793	2121	2504	2624	3178	3272
2015	559	1018	1491	1989	2223	2621	2852	3124	3126
2016	447	1013	1533	1994	2434	2628	2945	3122	3324

Table 10.1.7 Haddock in division Va Sexual maturity at age in the stock. (from the March survey). Predicted values are shaded. The numbers for age 10 only apply to the spawning stock.

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	0.958
2011	0.045	0.176	0.426	0.823	0.816	0.838	0.899	0.974	1
2012	0.106	0.167	0.445	0.627	0.819	0.903	0.852	0.911	1
2013	0.046	0.223	0.381	0.714	0.793	0.92	0.986	0.974	0.992
2014	0.107	0.192	0.391	0.567	0.675	0.735	0.925	0.906	0.883
2015	0.138	0.283	0.445	0.667	0.795	0.772	0.892	1	0.889
2016	0.067	0.417	0.696	0.827	0.894	0.912	0.935	1	1
2017	0.066	0.317	0.694	0.835	0.894	0.925	0.935	1	1

Table 10.2.1 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	80923	162177	96072	55330	0.576	0.521
1980	37390	192244	116521	51110	0.439	0.398
1981	10426	206988	141628	63558	0.449	0.542
1982	42788	180380	136817	69428	0.507	0.444
1983	29306	148112	112589	65942	0.586	0.508
1984	20574	112797	82961	48282	0.582	0.515
1985	42788	102394	66652	51102	0.767	0.537
1986	86501	96480	59837	48859	0.817	0.739
1987	164036	105395	46298	40760	0.88	0.584
1988	48742	153708	69391	54204	0.781	0.675
1989	29778	168184	99537	62885	0.632	0.676
1990	27094	145507	110745	67198	0.607	0.611
1991	92280	122708	89825	54692	0.609	0.664
1992	175094	106310	66379	47121	0.71	0.728
1993	38437	130461	71000	48123	0.678	0.669
1994	46842	127836	83295	59502	0.714	0.641
1995	72857	124042	85054	60884	0.716	0.661
1996	36341	108036	70008	56890	0.813	0.675
1997	102509	87152	58993	43764	0.742	0.624
1998	17976	97121	64203	41192	0.642	0.627
1999	50160	91024	64439	45411	0.705	0.685
2000	117423	90674	63509	42105	0.663	0.636
2001	156535	115046	70366	39654	0.564	0.462
2002	187267	168427	99344	50498	0.508	0.461
2003	50154	219757	147519	60883	0.413	0.404
2004	151983	252717	181270	84828	0.468	0.491
2005	385734	259074	176986	97225	0.549	0.522
2006	90259	299329	143539	97614	0.68	0.578
2007	42302	297983	162862	109966	0.675	0.556
2008	44042	250161	158820	102872	0.648	0.476
2009	119817	193067	142937	82045	0.574	0.495
2010	38892	168462	114292	64168	0.561	0.471
2011	28567	152264	97645	49433	0.506	0.411
2012	19641	141018	93636	46208	0.493	0.345
2013	34400	131953	96665	44097	0.456	0.347
2014	23914	114966	72366	33900	0.468	0.307
2015	20253	112462	78319			
Mean79-2014	74703	155038	99792	58753	0.61	0.541

Table 10.2.2 Haddock in division Va. Number in stock from the SPALY run using both the surveys. Shaded cells are input to prediction. . Predictions shown are based on HCR.

Year/Age	1	2	3	4	5	6	7	8	9	10
1979	45.7	80.9	117.3	27.7	19.6	20.44	3.41	0.77	0.15	0.05
1980	12.7	37.4	66.1	94.3	19.3	10.54	8.57	1.21	0.23	0.07
1981	52.3	10.4	30.1	52.9	66.8	11.91	5.19	3.64	0.5	0.11
1982	35.8	42.8	8.5	24.2	38.9	39.42	4.33	1.69	1.35	0.26
1983	25.1	29.3	34.9	6.8	16.9	21.99	19.56	1.67	0.48	0.45
1984	52.3	20.6	24	27.7	4.1	9.7	9.09	8.02	0.68	0.21
1985	105.7	42.8	16.6	18.6	18.2	2.14	3.63	4.06	2.88	0.34
1986	200.3	86.5	33.8	12.1	11.1	8.75	0.98	1.45	1.59	0.63
1987	59.5	164	69.9	23.9	6.2	4.88	2.51	0.35	0.46	0.49
1988	36.4	48.7	132.6	49.7	13.2	2.59	2.15	1.07	0.17	0.23
1989	33.1	29.8	39.7	99.6	27	5.58	0.94	0.78	0.32	0.08
1990	112.7	27.1	24.2	30.3	61.1	13.43	1.68	0.31	0.14	0.13
1991	213.9	92.3	20.5	17.6	17	28.7	5.27	0.63	0.12	0.05
1992	47	175.1	67.8	14.8	9.6	7.25	10.74	1.92	0.21	0.06
1993	57.2	38.4	138.5	45.8	7	3.65	2.59	4.08	0.67	0.07
1994	89	46.8	30.8	102.2	25.9	3.03	1.43	0.83	1.31	0.23
1995	44.4	72.9	35.5	22.2	58.1	11.54	1.15	0.52	0.36	0.49
1996	125.2	36.3	56	22.4	12.9	25.93	4.23	0.38	0.16	0.13
1997	22	102.5	27	36.3	11.4	6.56	9.56	1.34	0.13	0.06
1998	61.3	18	82.7	18.5	19.9	4.93	3.01	3.27	0.45	0.05
1999	143.4	50.2	14.5	60.2	10	9.15	1.85	1.18	0.96	0.13
2000	191.2	117.4	39.8	10.4	33.7	4.12	3.11	0.69	0.4	0.35
2001	228.7	156.5	93.7	26.9	6.4	15.28	1.61	1.01	0.27	0.13
2002	61.3	187.3	125.9	66.7	15.7	3.95	6.85	0.71	0.39	0.12
2003	185.6	50.1	152.3	93.6	40.1	8.23	2.21	2.76	0.34	0.17
2004	471.1	152	40.7	119	61.9	21.5	4.05	1.13	1.14	0.2
2005	110.2	385.7	123	29.6	81.4	33.19	9.58	1.56	0.5	0.49
2006	51.7	90.3	313.6	92.1	18	43.68	14.71	3.7	0.55	0.18
2007	53.8	42.3	73.7	247.7	56.2	8.73	18.71	5.17	1.05	0.16
2008	146.3	44	33.9	56.8	164.6	25.9	4.11	6.31	1.75	0.39
2009	47.5	119.8	34	23.7	37.7	86.78	11.24	1.81	2.43	0.7
2010	34.9	38.9	97.1	24.9	15	22.84	39.37	4.02	0.83	0.74
2011	24	28.6	31.7	74.1	14	7.92	12.58	16.4	1.59	0.36
2012	42	19.6	23.2	24.6	50	6.88	3.9	6.7	7.8	0.86
2013	29.2	34.4	15.9	17.8	17	29.05	3.62	2.08	3.24	3.98
2014	24.7	23.9	27.9	12.1	11.9	10.29	15.44	1.87	1.1	1.52
2015	130.8	20.2	19.4	21.5	8.3	7.32	5.95	8.35	1.13	0.55
2016	66.8	107.1	16.3	14.3	14.1	4.91	4.19	3.25	4.53	0.61
2017	66.8	54.7	87.5	11.7	8.8	7.72	2.51	2.08	1.6	2.24

Table 10.2.3 Haddock in division Va. Fishing mortality from the SPALY run using the March and October surveys for tuning. Predictions based on F4-7 = 0.3 are highlighted.

Year/Age	2	3	4	5	6	7	8	9	10
1979	0.002	0.018	0.162	0.419	0.669	0.833	0.99	0.553	0
1980	0.018	0.023	0.144	0.282	0.508	0.657	0.685	0.561	0.724
1981	0.001	0.019	0.108	0.328	0.813	0.92	0.793	0.463	0.569
1982	0.003	0.032	0.156	0.369	0.501	0.751	1.056	0.903	1.288
1983	0.001	0.032	0.301	0.357	0.683	0.692	0.706	0.643	1.051
1984	0.013	0.051	0.22	0.449	0.784	0.607	0.825	0.493	0.369
1985	0.035	0.122	0.315	0.532	0.582	0.719	0.737	1.314	1.184
1986	0.013	0.148	0.467	0.625	1.048	0.816	0.937	0.976	0.918
1987	0.013	0.141	0.389	0.669	0.62	0.657	0.53	0.5	0.685
1988	0.005	0.086	0.411	0.665	0.811	0.815	0.998	0.557	0.557
1989	0.007	0.071	0.288	0.498	1.003	0.917	1.552	0.682	0.632
1990	0.079	0.117	0.379	0.556	0.736	0.772	0.769	0.794	0.467
1991	0.109	0.123	0.413	0.651	0.783	0.811	0.89	0.473	0.25
1992	0.035	0.192	0.555	0.762	0.827	0.768	0.858	0.973	0.204
1993	0.022	0.104	0.37	0.635	0.736	0.934	0.933	0.842	0.383
1994	0.078	0.128	0.365	0.608	0.769	0.821	0.643	0.786	0.575
1995	0.063	0.259	0.337	0.607	0.804	0.895	0.971	0.856	0.926
1996	0.099	0.233	0.473	0.48	0.798	0.95	0.912	0.79	0.756
1997	0.015	0.176	0.404	0.641	0.579	0.873	0.9	0.819	0.253
1998	0.017	0.117	0.413	0.575	0.781	0.738	1.025	1.041	0.53
1999	0.032	0.126	0.38	0.689	0.878	0.792	0.87	0.806	0.776
2000	0.025	0.193	0.286	0.591	0.737	0.93	0.74	0.933	0.807
2001	0.018	0.14	0.337	0.286	0.603	0.62	0.745	0.568	0.44
2002	0.006	0.096	0.308	0.445	0.381	0.71	0.523	0.65	0.468
2003	0.009	0.047	0.213	0.424	0.508	0.469	0.685	0.345	0.383
2004	0.012	0.117	0.179	0.424	0.609	0.753	0.616	0.645	0.71
2005	0.007	0.089	0.299	0.423	0.614	0.753	0.849	0.809	0.653
2006	0.003	0.036	0.294	0.524	0.648	0.846	1.056	1.057	0.829
2007	0.021	0.06	0.209	0.575	0.553	0.886	0.882	0.787	0.58
2008	0.06	0.159	0.209	0.44	0.635	0.62	0.757	0.723	0.636
2009	0.01	0.109	0.259	0.302	0.59	0.829	0.585	0.992	0.987
2010	0.003	0.071	0.376	0.438	0.396	0.676	0.725	0.642	0.963
2011	0.01	0.057	0.194	0.512	0.508	0.431	0.543	0.42	0.428
2012	0.011	0.065	0.167	0.342	0.442	0.429	0.526	0.474	0.372
2013	0.008	0.075	0.196	0.302	0.432	0.459	0.439	0.555	0.478
2014	0.011	0.06	0.175	0.29	0.348	0.415	0.306	0.494	0.554
2015	0.018	0.106	0.224	0.326	0.358	0.406	0.411	0.411	0.411
2016	0.003	0.128	0.288	0.402	0.471	0.5	0.505	0.505	0.505
2017	0.002	0.093	0.295	0.421	0.486	0.52	0.52	0.52	0.52

Table 10.4.1 Output from short term predictions. Numbers here apply to calendar years.

The adopted HCR lead to TAC of 30.4 kt for the fishing year 2014/2015 and landings of 29.0 thous. tonnes in the calendar year 2015.

2015				
Bio 3+	SSB	Fmult	F4-7	Landings
113	78	1.072	0.329	32

		2016		2017		
Fmult	F4-7	Bio 3+	SSB	Landings	Bio 3+	SSB
0.1	0.031	101	85	3	148	108
0.2	0.061	101	85	6	145	105
0.3	0.092	101	85	9	142	102
0.4	0.123	101	85	12	139	100
0.5	0.153	101	85	14	137	97
0.6	0.184	101	85	17	134	95
0.7	0.215	101	85	20	131	93
0.8	0.245	101	85	22	129	90
0.9	0.276	101	85	24	127	88
1	0.307	101	85	27	124	86
1.1	0.337	101	85	29	122	84
1.2	0.368	101	85	31	120	82
1.3	0.399	101	85	33	118	80
1.4	0.429	101	85	35	116	78
1.5	0.46	101	85	37	114	77
1.6	0.491	101	85	39	112	75
1.7	0.521	101	85	41	110	73
1.8	0.552	101	85	43	108	72
1.9	0.582	101	85	45	107	70
2	0.613	101	85	47	105	68

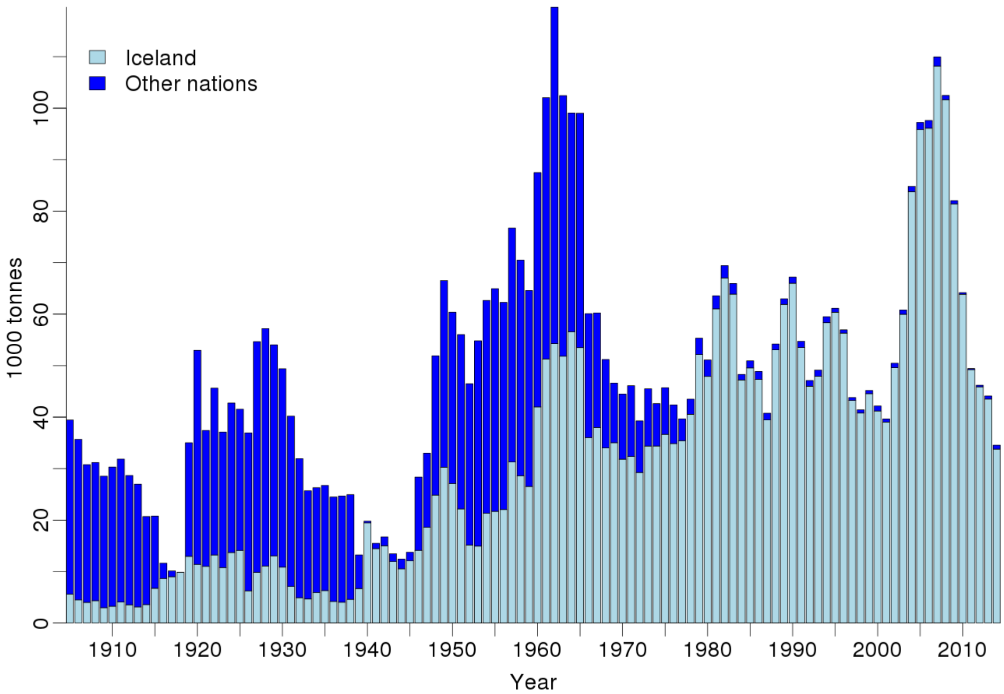


Figure 10.1.1 Haddock in division Va. Landings 1905 – 2013

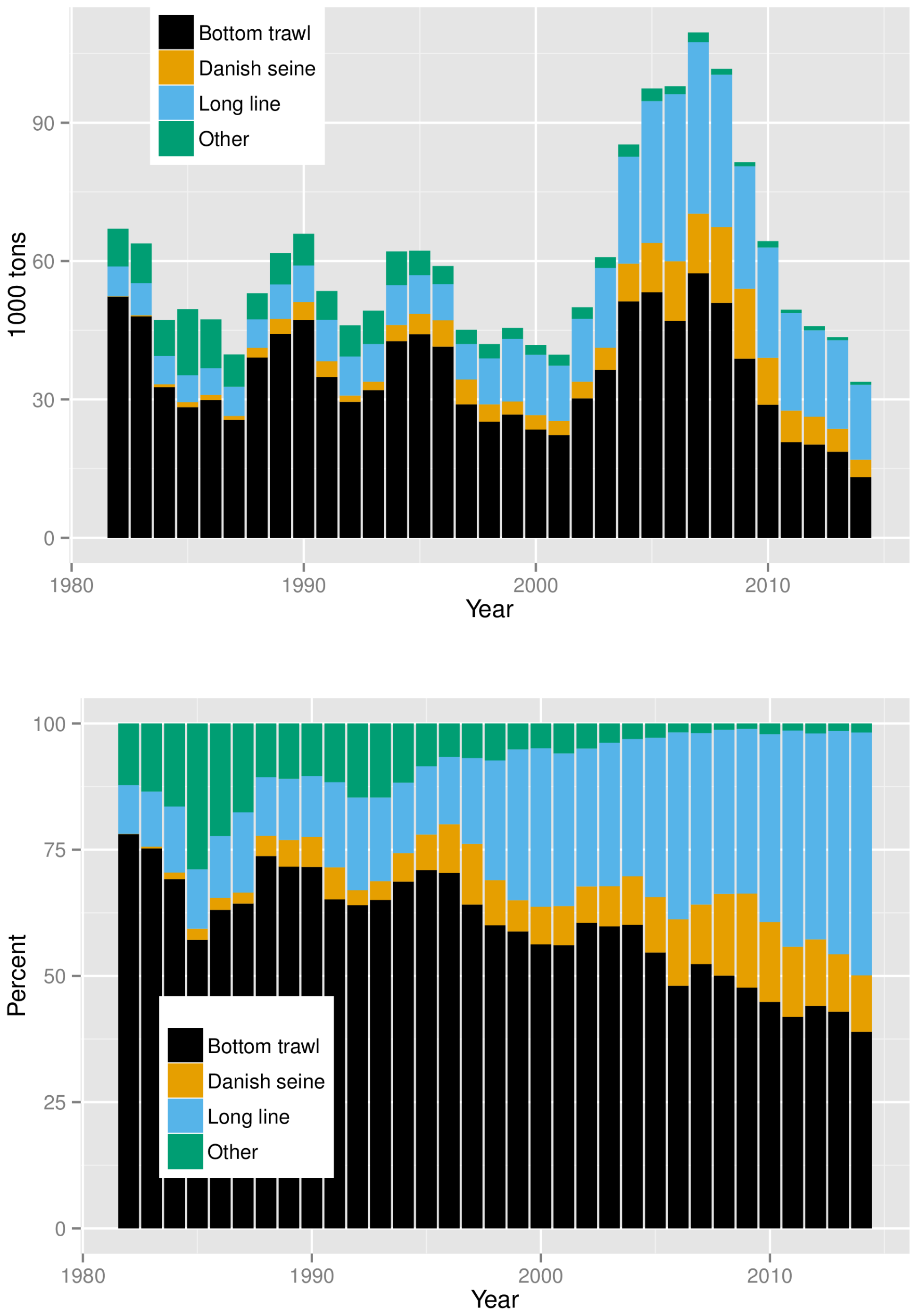


Figure 10.1.2 Haddock Division VA. Landings in tons and percent of total by gear and year.

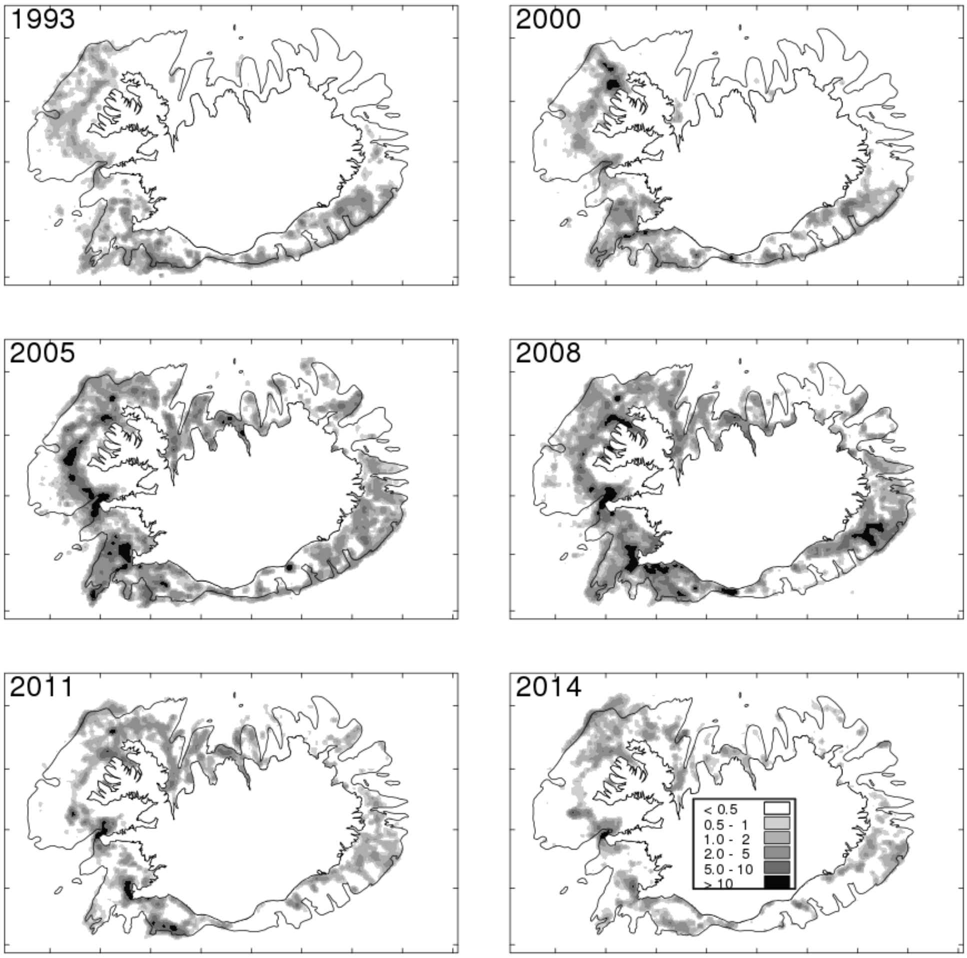


Figure 10.1.3 Haddock Division VA. Spatial distribution af landings. The legend show tonnes per square mile.

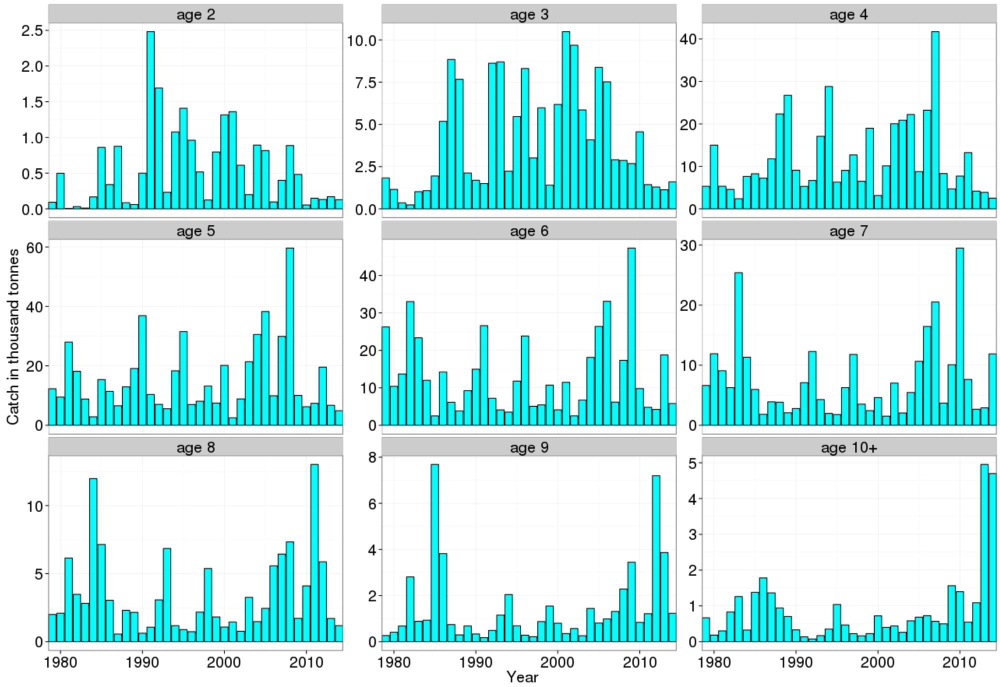


Figure 10.1.4 Haddock in division Va. Age disaggregated catch in tons.

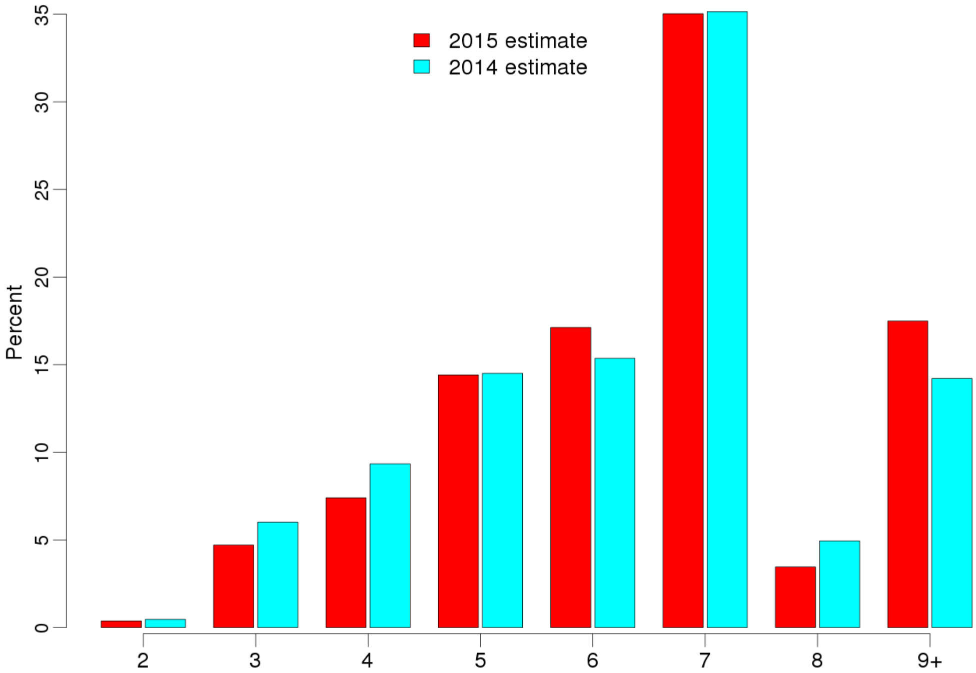


Figure 10.1.5 Haddock in division Va. Percent of catch in tonnes 2014 compared to last years predictions.

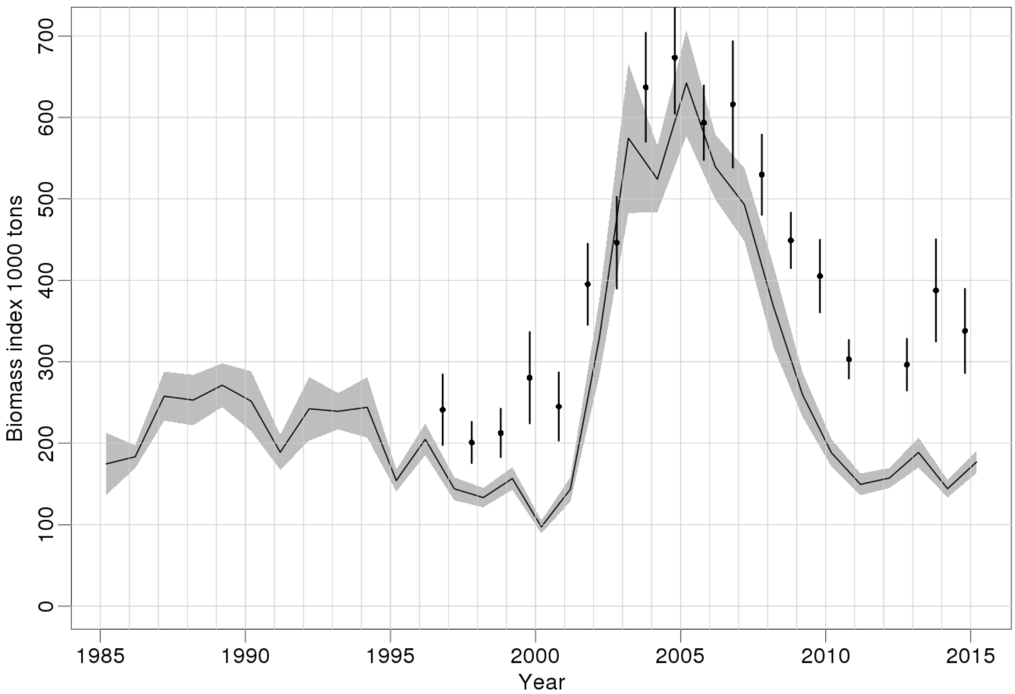


Figure 10.1.6 Icelandic haddock. Total biomass indices from the groundfish surveys in March (lines and shading) and the groundfish survey in October vertical segments. The standard error in the estimate of the indices is shown in the figure. Due to a strike the autumn survey was not conducted in October 2011.

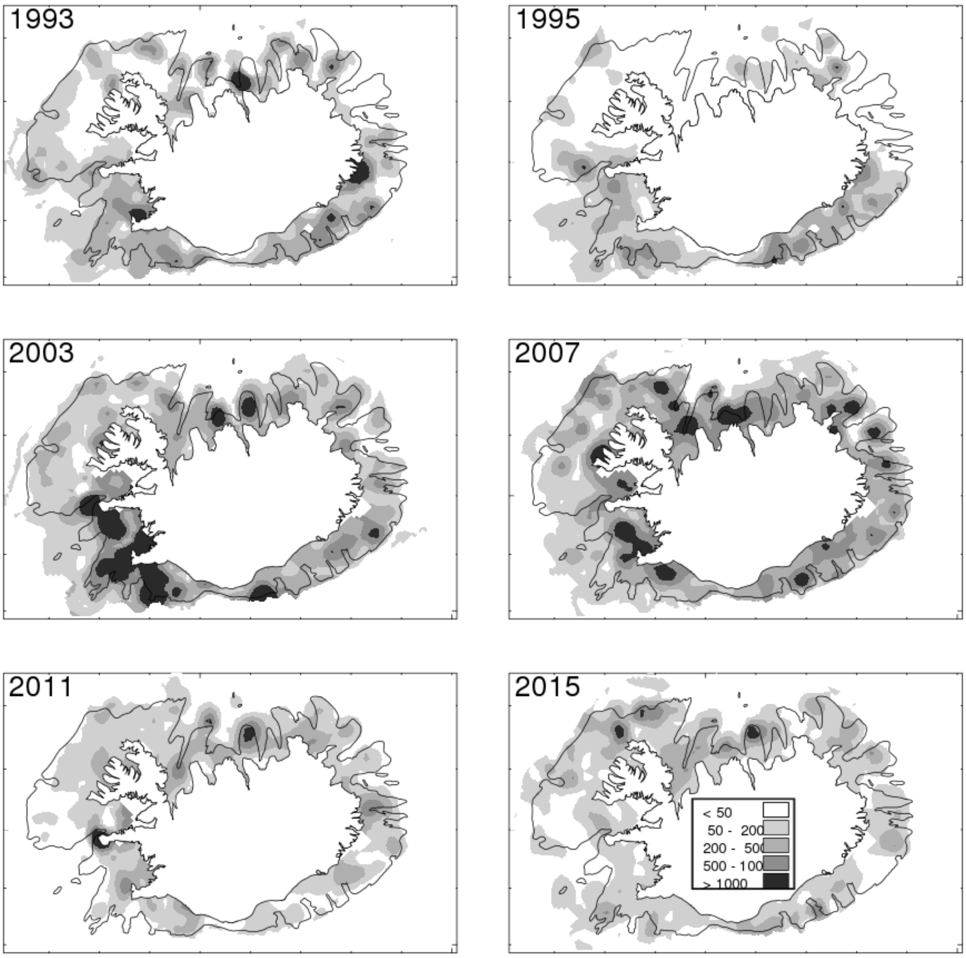


***Figure 10.1.7. Spatial distribution of haddock in the groundfish survey in March. The legend show kg per hour towed.**

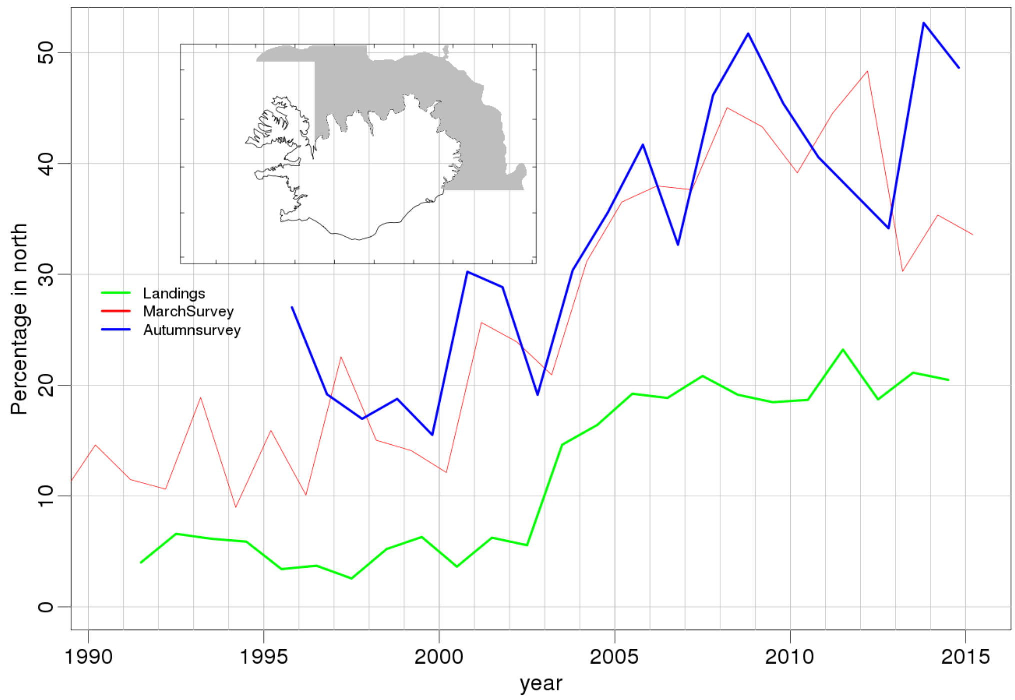


Figure 10.1.8. Proportion of the landings and the biomass of 42cm and larger haddock that is in the north area. The small figure shows the northern area.

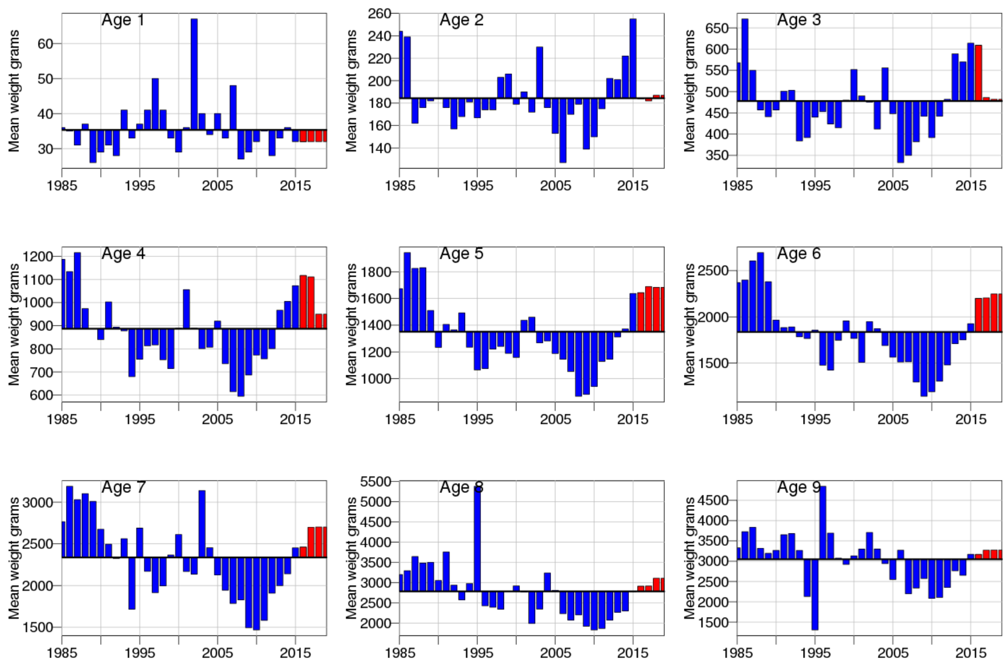


Figure 10.1.9 Haddock in division Va. Mean weight at age in the survey. Predictions are shown as red. The values shown are used as weight at age in the stock and spawning stock.

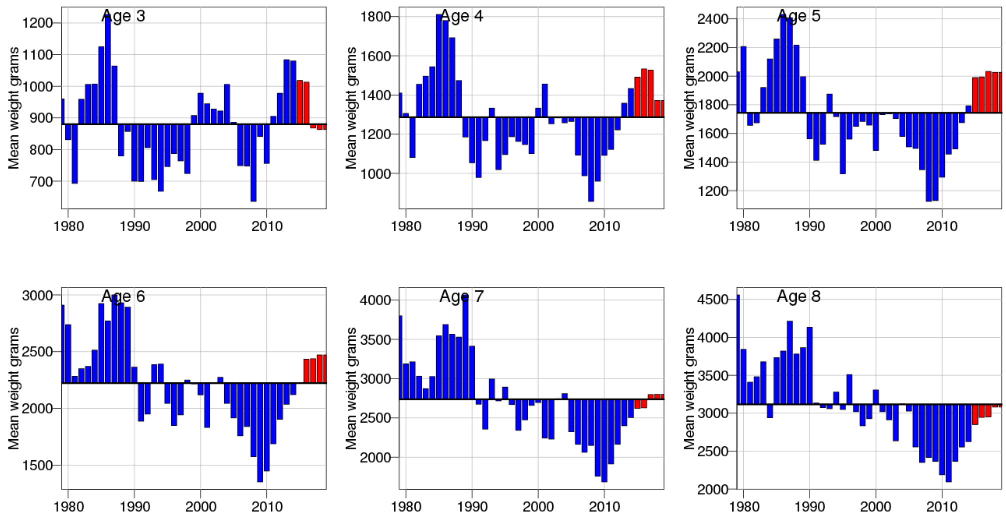


Figure 10.1.10 Haddock in division Va. Mean weight at age in the catches. Predictions are shown as red.

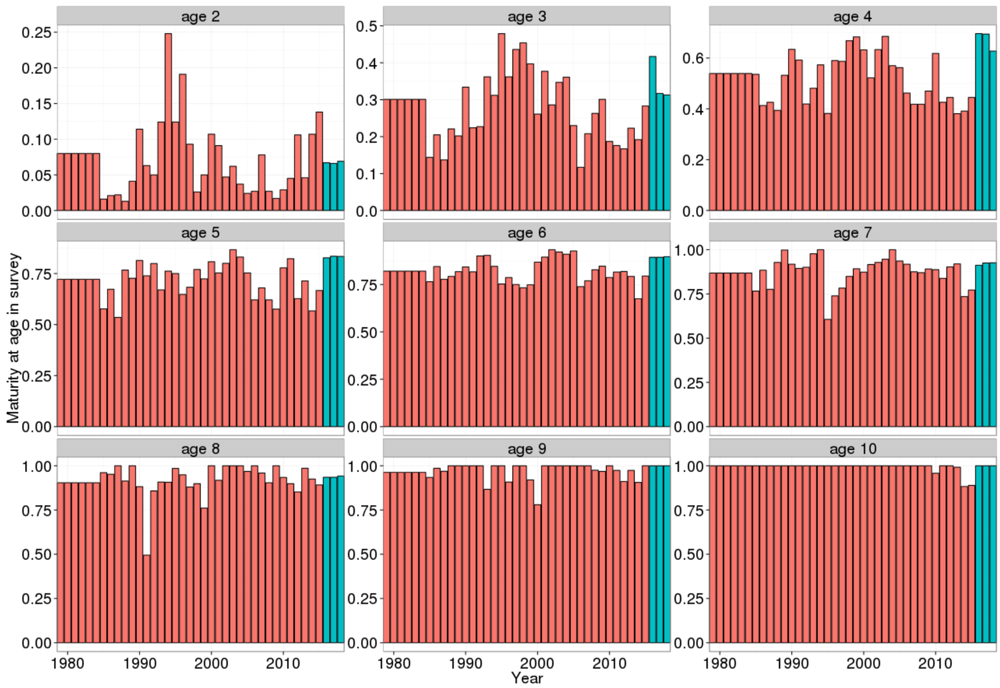


Figure 10.1.11 Haddock in division Va. Maturity at age in the survey. The blue bar indicates predictions. The values are used to calculate the spawning stock.

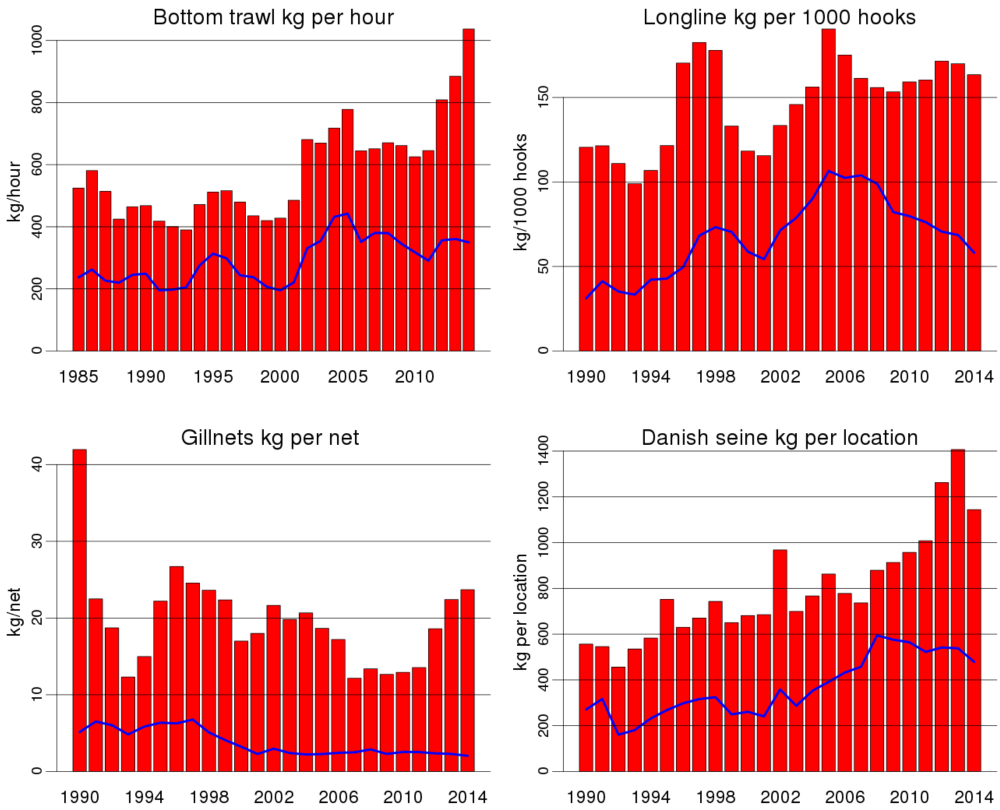


Figure 10.1.12. Catch per unit effort in the most important gear types. The bars are based on locations where more than 50% of the catch is haddock and the lines on all records where haddock is caught. A change occurred in the longline fleet starting September 1999. Earlier only vessels larger than 10 BRT were required to return logbooks but later all vessels were required to return logbooks. Not updated

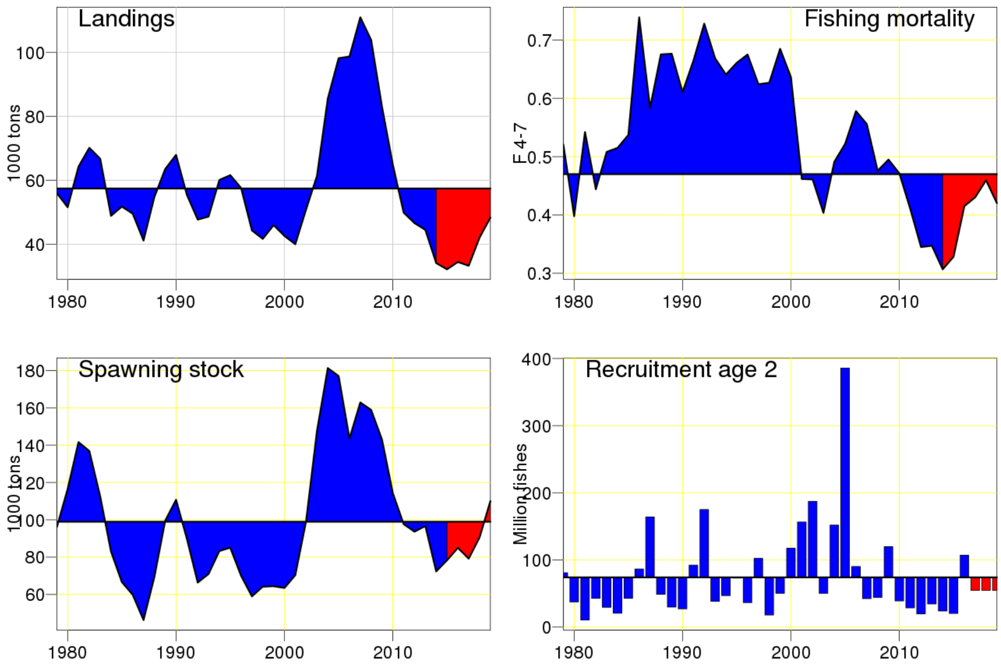


Figure 10.2.1 Haddock in division Va. Summary from assessment. Red colours in lower figure indicates predicted values.

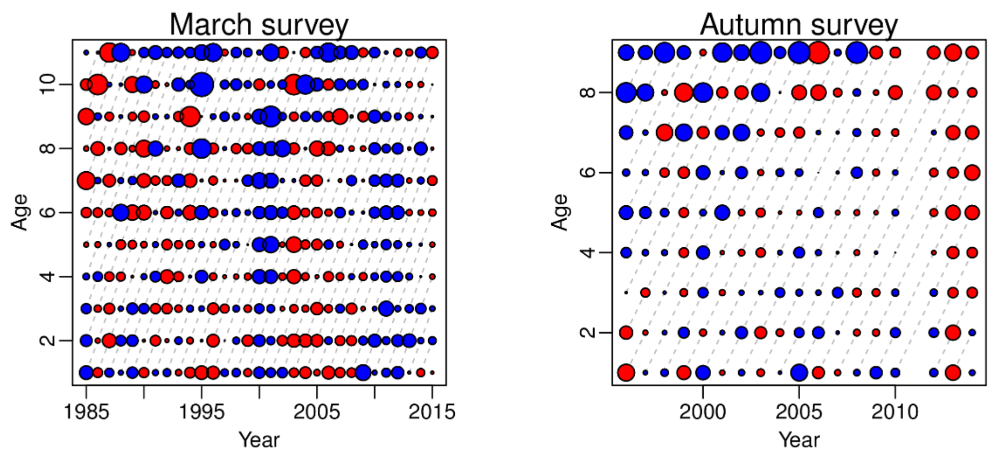


Figure 10.2.2. Haddock in division Va. Residuals from the fit to survey data . from Adapt run based on the both the surveys. Coloured circles indicate positive residuals (observed > modelled). The largest circle corresponds to a value of 0.87. Residuals are proportional to the area of the circles. Lage efri harvest ratio

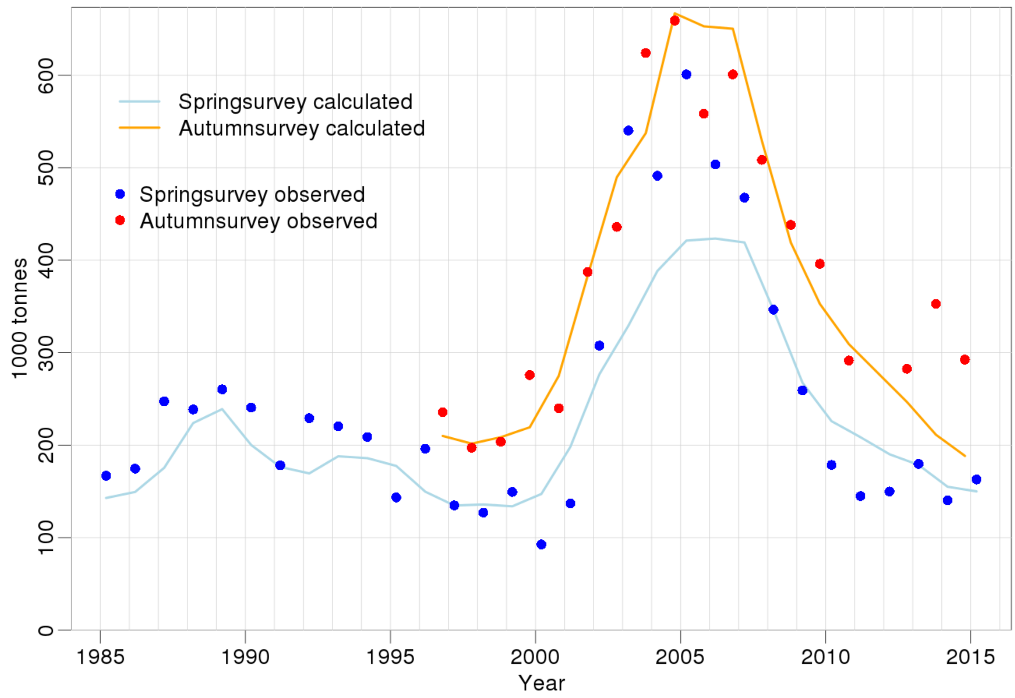


Figure 10.2.3. Haddock in division Va. Observed and predicted biomass from the surveys according to the SPALY run.

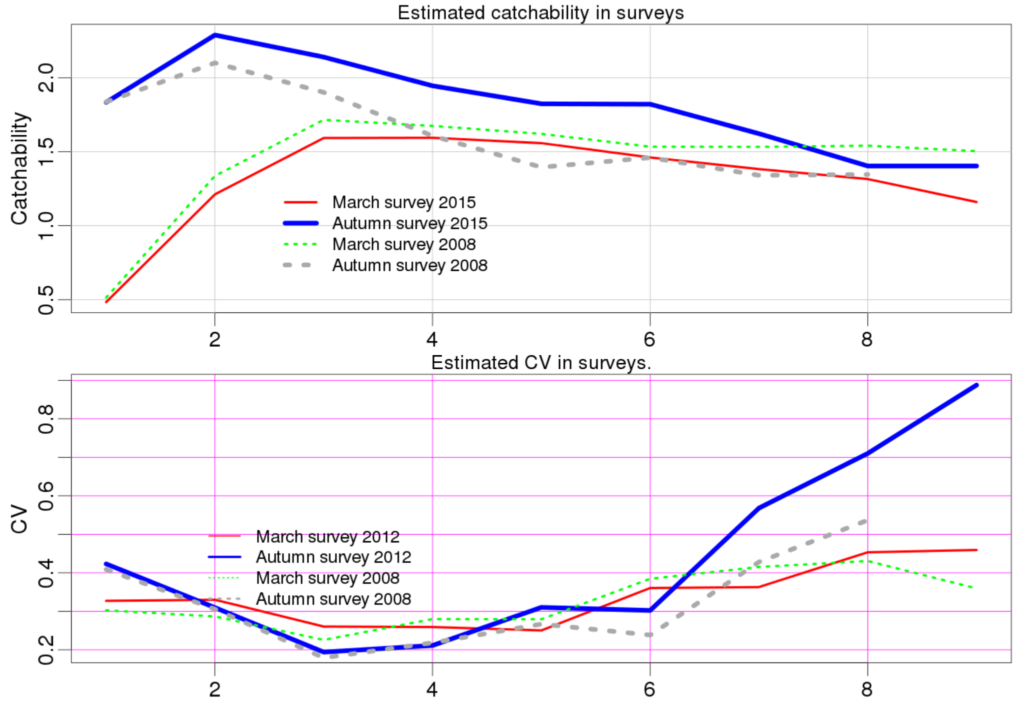


Figure 10.2.4. Haddock in division Va . Results from the spaly run. Catchability and CV from the autumn survey (wide lines) and March survey (thinner lines). Estimates from 2008 shown dashed.

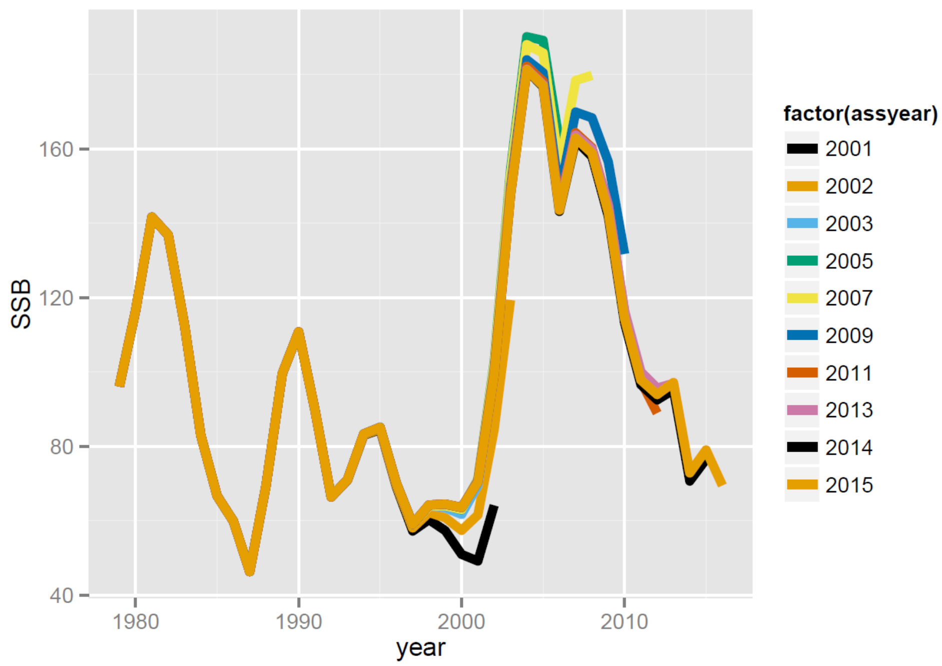
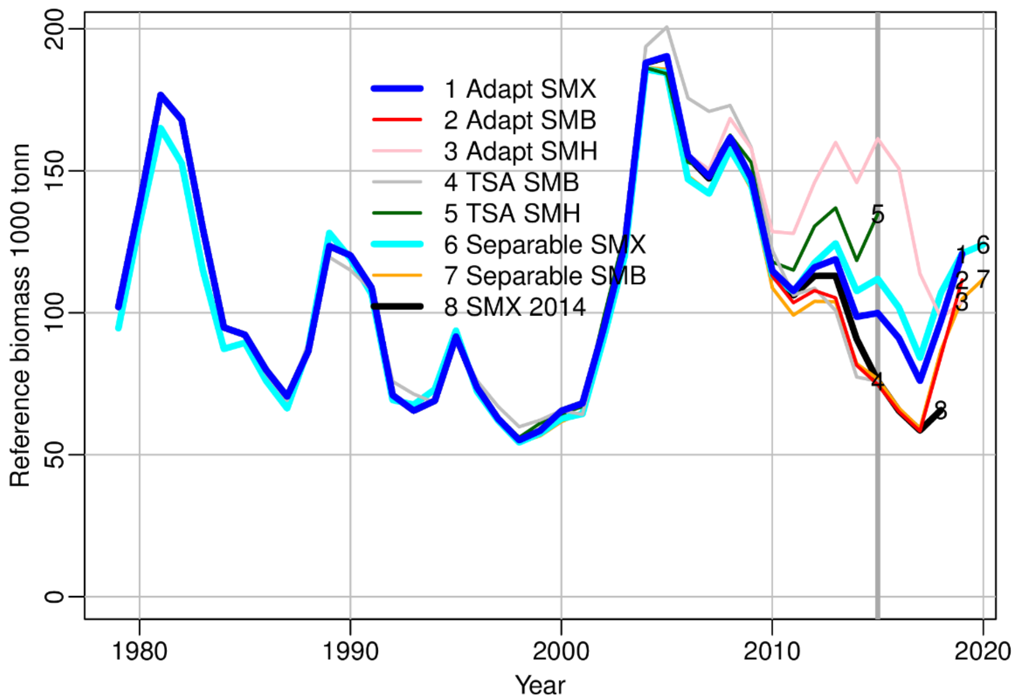
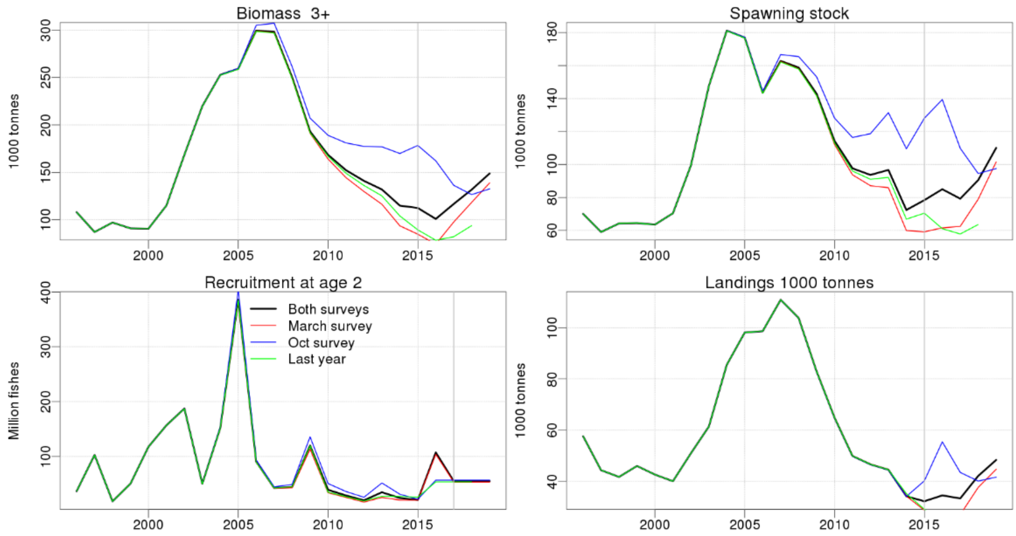


Figure 10.2.5. Haddock in division Va . Retrospective pattern of SSB from the SPALY run. Each retro ends one year after the assesemt, but the biomass in the beginning of the year after the assessment year is the basis for advice. Errors in prediction of weight and maturity at age are not included.



10.2.6 Haddock in division Va. Estimate of the reference biomass 45cm and larger from some different assessment models and tuning data. (SMB refers to March survey, SMH autumn survey and SMX both.



10.2..7 Haddock in division Va. Comparison of some of the results of 2014 assesement based on different tuning data and 2013 assessment tuned with both the surveys. .

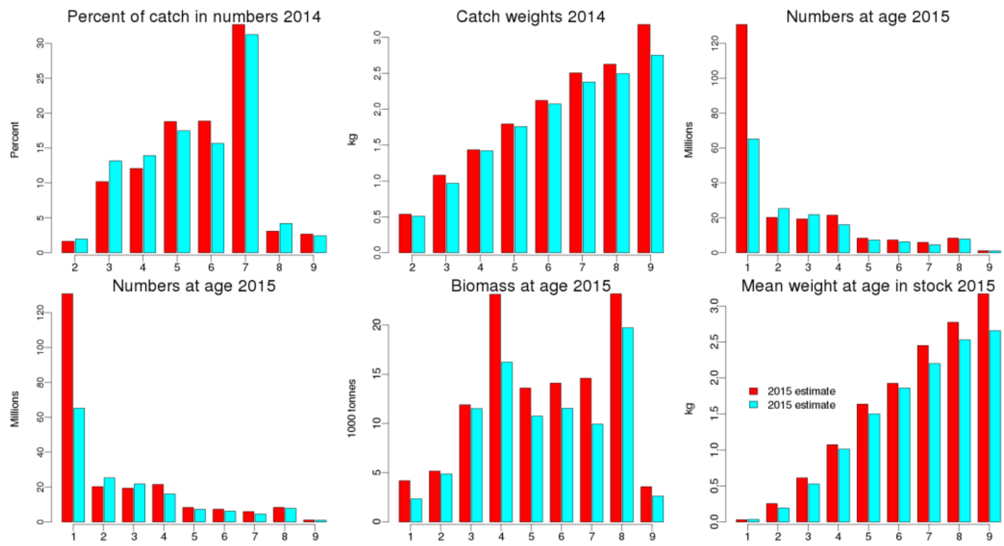


Figure 10.2.8. Comparison of 2013 and 2014 assessment

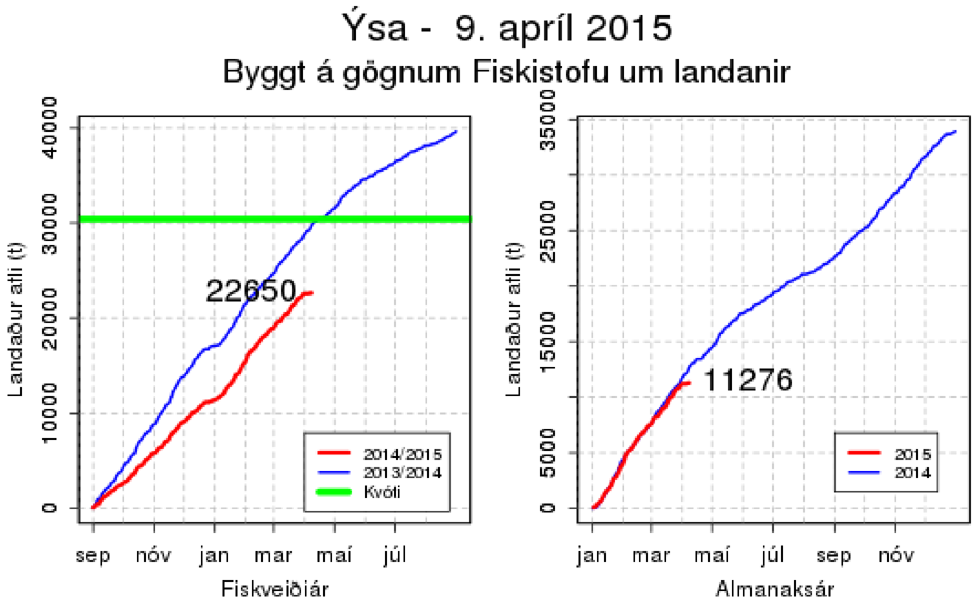


Figure 10.4.1 Haddock in division Va. Development of the landings during the fishing year 2013/2014 (left side) and calendar year (2014) on the left. Fishing year 2012/2013 and calendar year 2013 shown for comparison. Tac (kvóti) for the fishing year shown in the left figure.

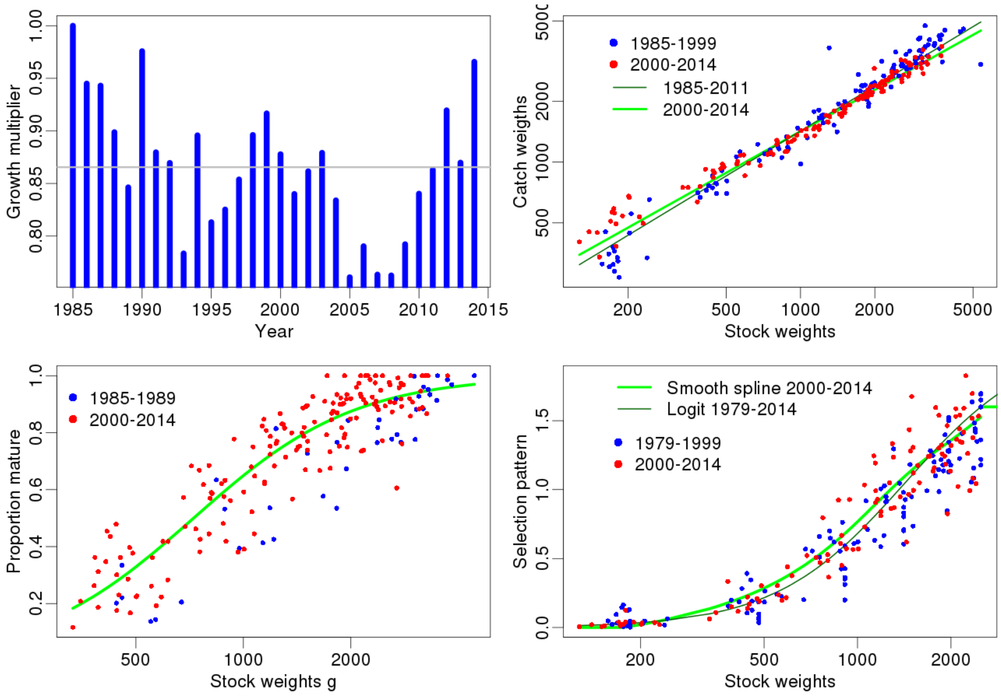


Figure 10.4.2 Haddock in division Va. Input data to prediction. Predictions are based on the period since 2000. . Exponential of the yearfactor (growth multiplier) in the equation

$$\log \frac{W_{a+1,t+1}}{W_{a,t}} = \alpha + \beta \log W_{a,t} + \delta_{year}$$

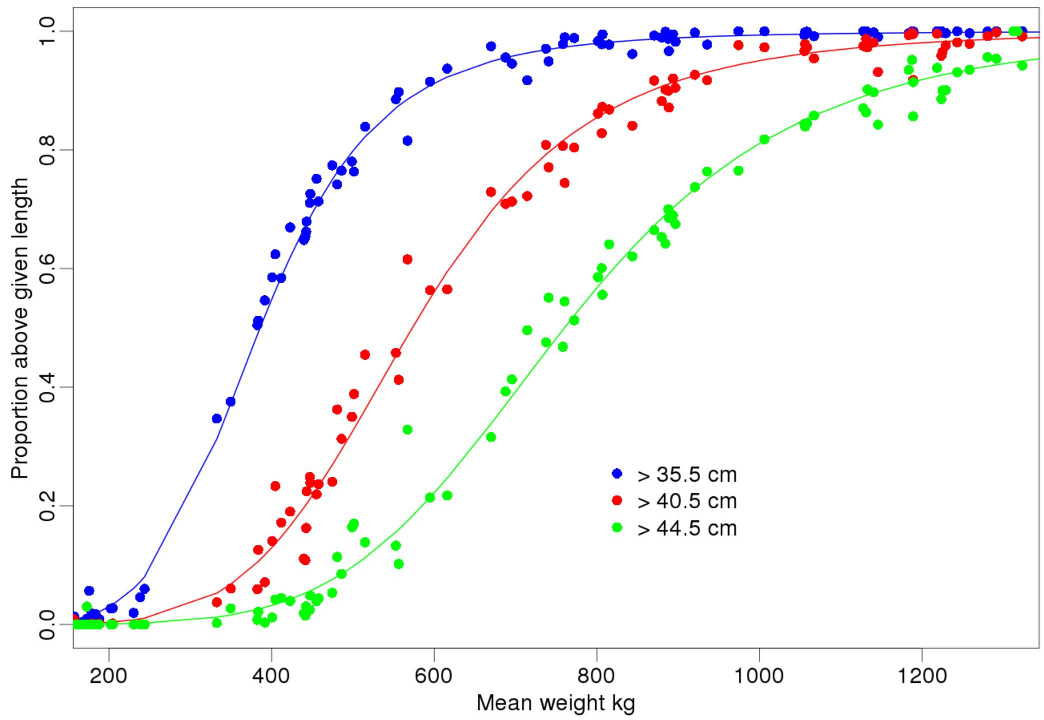


Figure 10.4.3 Haddock in division Va. Proportion of the biomass of a yearclass above certain size. The points show data, compiled from the March survey and the lines a curve fitted to the data and used in simulations.

11 Icelandic summer spawning herring

Executive summary

The total reported landings in 2014/15 fishing season were 95.5 kt but the TAC was set at 83 kt –the difference being caused by a transfer of quota between years. The fishable stock (age 4+) in the winter surveys 2014/15 was estimated at 433 kt, compared to 410 kt in the winter 2013/14. The 2013 year class (age 1 in 2014) appears small.

This is an update assessment where the 2014 data have been added to the input data and no revisions of last year's data. The analytical assessment model, NFT-Adapt, indicates that the biomass of age 3+ is 438 kt and SSB is 342 kt in the beginning of 2015. Record small year class from 2011 entering the spawning stock in 2015, causes a decline in SSB but it is still above B_{PA}. Fishing at $\mathbf{F}_{0.1}$= 0.22 in the fishing season 2015/16 will give a catch of 71 thousands tons. SSB in 2016 is expected to be 327 kt.

Changes in the predictions approach, where the geometric mean for number at age-3 in the assessment year (2015) was replaced by a projection of number at age 3 from a survey estimate at age-1 of the year class, has decreased the uncertainty and has minor impacts on the advice (3% lower). This year's results support that additional natural mortality in the stock due to *Ichthyophonus* infection should only be applied for the first two years of the outburst.

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 (IS-Her-Aco-4Q/1Q)., 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 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 but is considered to cover the whole stock each year.

The acoustic abundance index for the adult stock in the winter 2014/2015 derives from three dedicated acoustic surveys in the autumn 2014 (Table 11.1.1.2). During 24 November to 6 December, RV Bjarni Sæmundsson covered areas west, south and southeast off Iceland. The acoustic index for Breiðafjörður, which has been the main over wintering areas of the stock in last eight winters, was then derived from two surveys there (Óskarsson and Reynisson 2015).

Like last six winters, but different from subsequent years, the nursery grounds of the stock were covered on RV Dröfn in a survey during November 13-23. The objective was to get an acoustic estimate of juveniles at age 1 and estimate their prevalence of *Ichthyophonus* infection (see Óskarsson and Pálsson 2015).

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 fishable part of the herring stock was observed in four main areas, in an offshore area west of Iceland (Kolluáll), in Breiðamerkurdjúp southeast of Iceland, near Vestmannaeyjar south of Iceland and in Kolgrafafjörður in Breiðafjörður west of Iceland (see locations on Fig. 11.1.2.1). During the winters 2006/07 to 2012/2013, most of the stock was measured acoustically in the southern part of the bay Breiðafjörður, however, that changed in last winter and was more extreme this winter. The total amount of the adult stock (age 4+) in Breiðafjörður (Kolgrafafjörður) came to only 10 kt, while in Kolluáll on the shelf outside of Breiðafjörður, 345 kt were measured. Then, like in recent years, around 92 kt were measured in Breiðamerkurdjúp and around 10 kt near Vestmannaeyjar. The total estimate of the adult stock (age 4+) was therefore 433 kt, compare to 410 kt in the autumn 2013. The total biomass was 474 kt in comparison to 473 kt in the autumn 2013.

Figure 11.1.2.2 shows the total estimated biomass of age 3+ in the acoustic survey since 1973, how the eastern part of the stock generally decreased in size and the western part increased during around 1995—2007, and then the opposite from 2007—2014.

The 2010 year class (age 4 in the autumn 2014) was the most numerous in the survey or 16% of the total number of herring and was both off the south and west coast of Iceland (Table 11.1.1.1). The 2008 and 2009 year classes were also numerous (12%), and were mostly off the west coast (Kolluáll).

The number of juvenile herring (i.e. age 1) observed acoustically amounted to 438 million fish. Around 86% of it derived from unconventional nursery grounds west of Iceland (Jökuldjúp) and the rest in Eyjafjörður off the mid northcoast. Applying the linear-regression provided by Gudmundsdottir *et al.* (2007) implied that the 2013 year class will be 464 millions at age 3 in 2016, or below average year class size (575 millions at age 3). This number is used in the forecast in the 2015 assessment below.

The length composition of the adult part of the stock in the acoustic estimation in 2014/15 was based on total 10 samples, 8 taken west of Iceland while only 2 samples were obtained south and southeast of Iceland (Table 11.1.2.1). The age composition was then derived from length-at-age key from the same samples. The total number of aged scales from these samples was 534. While the number of samples in the west is considered adequate, the number of samples in the east was not. The low sampling number there was due to combination of bad weathers, restrictions of survey time and behaviour of the fish (Óskarsson and Pálsson 2015). This adds uncertainty to the estimated length/age composition in that area.

11.1.3 Prevalence of *Ichthyophonus* infection in the stock

In a working document to NWWG 2013, Óskarsson and Pálsson (2013) addressed the development and nature of the massive and long-lasting *Ichthyophonus hoferi* outbreak in Icelandic summer-spawning herring since the autumn 2008 to 2013. Their main conclusions were that the infection was only causing significant additional mortality in the first two years, despite a high prevalence of infection for five years. It indicated that the infection to be less lethal for herring than had been assumed in previous assessments. This was followed in the 2013 and 2014 assessments (ICES 2013a; 2014), where additional natural mortality because of the infection, and estimated from catch samples (e.g. Óskarsson *et al.* 2012a; ICES. 2012), was only be applied for the years 2009 and 2010, but not the following years.

The results of this year's investigations are supporting this main conclusion of not significant infection mortality since 2010.

The prevalence of infection in the Icelandic summer-spawning herring in the winter 2014/2015 in Breiðafjörður and Kolluáll was highest for the 2006, 2005, 2004 and 2013 year classes (Figure 11.1.3.1). This is comparable to results in recent years where the prevalence of infection has been in the range of 35-55% (Figure 11.1.3.2). The prevalence of infection of the younger age groups continues to be low, suggesting a low rate, if any, of new infection in the stock. For the yearclasses 2006 and older, the prevalence of infection seems to be going slowly down.

11.2 Information from the fishing industry

The total landings of Icelandic summer-spawning herring in 2014/2015 season were about 95 kt with no discards reported (Table 11.2.1 and in Figure 11.2.1). Note that the total landings include also bycatches in the mackerel fishery in June-August 2014, even if they belong to the official fishing season 2013/2014. This is a traditional method in assessment of the stock. 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. The recommended TAC, provided in the spring 2014, was 83 kt and allowable TAC 83 kt. The difference between the landings and TAC is due to transfer of quota from the previous fishing season (7 kt) and the next season (~5 kt).

The direct fishery started in end of October in Kolluáll, an offshore area west of Iceland. Most of the catches were taken there in October to December in pelagic trawls, or 83% of the total catch (Fig. 11.2.2). In January around 4% were taken in the same area, while the remaining catch (13%) was taken as bycatch in the fishery for the Norwegian spring-spawning herring, NSSH, and Atlantic mackerel during June to October. Because of the location of the main fishery, and the bycatch fishery, 99.6% of the catch was taken in pelagic trawls. This winter, drift nets were used in this fishery for the fourth time since mid 1980s. It was because of allocation of catch quota to small fishing vessels (<200 bt) that were allowed to catch some limited catches. The total catch in drift nets amounted though to only 50 tons.

Like in some of the previous winters, spring-spawning herring (Icelandic spring spawners or NSSH) was mixed with the Icelandic summer-spawning herring stock in the catches in the winter 2014/2015. Based on maturity stage of the herring in catch samples, 3% of the herring west of Iceland were spring spawners.

11.2.1 Fleets and fishing grounds

The herring fishing season has taken minor changes in the last three decades as detailed in the stock annex. All seasonal restricted landings, catches and recommended TACs since 1984 are given in thousands tonnes (kt) in Table 11.2.1.

Around 99.6% of the catch in 2014/15 was taken with purse-seines, and the rest with pelagic trawls and by drift nets (Figure 11.2.1.1). During all fishing seasons since 2007/2008, most of the catches (~90%) have been taken west off Iceland in Breiðafjörður, while prior to that they were mainly taken off the south-, southeast-, and the east coast. In 2013/2014 there was an indication for changes in this pattern, with less proportion in Breiðafjörður, and then in 2014/2015 almost all of the overwintering west of Iceland took place offshore. These changes in distribution explain the dominating pelagic trawl fishery, which is preferred by the fleet over purse seine in offshore areas.

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. Oktober 1992). No closure was enforced in this herring fishery in 2014/15. Normally, the age of first recruitment to the fishery is age-3, which is fish at length around 26-29 cm.

11.2.2 Catch in numbers, weight at age and maturity

Catch at age in 2014/2015:

The procedure for the catch at age estimations, as described in the Stock Annex, was followed for the 2014/15 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 five cells confined by season and area as detailed in Óskarsson and Pálsson (2015). In the same way, five weight-at-length relationships derived from the length and weight measurements of the catch samples were used and one length-at-age relations. The catches of the Icelandic summer spawners in number-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.

The age compositions of the catches during the overwintering and the bycatch of herring in the mackerel and NSS-herring were similar. The main difference was for the composition of age 3 (2011 year class), which was in higher proportion in the bycatch (4%) than at the small overwintering areas in Kolluáll (1%). The bycatch was well sampled over a wide area and is considered to give a better representation of the age class strength, in contrast to the small area of the overwintering grounds. Thus, the age 3 herring was to a less degree overwintering on west of Iceland, and more in the south, and as a result not targeted in the main fishery. This might cause some underestimation of the year class in the assessment, even if all measures indicate that it is small.

Weight at age:

As stated in the stock annex, the mean weight-at-age of the stock is derived from the catch samples (Table 11.2.2.3). The total number of fish weighed from the catch in 2014/15 was 3093 and 2450 of them were aged from their fish scales.

Proportion mature:

The fixed maturity ogives were used in this year's assessment, as introduced in the stock annex, 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 relative contribution of the different year (age) classes was somewhat different from what was predicted in the analytical assessment in 2014 (Figure 11.2.2.2). The biggest difference was for age 3 (2011 year class) where the prediction was based on geometric mean but not survey results. Otherwise the contribution of the age 5 and 6 (the 2009 and 2008 year classes, respectively) was less than predicted while the other way around for other age groups.

11.3 Analytical assessment

11.3.1 Analysis of input data

Examination of catch curves for the year classes from 1984 to 2011 (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. In recent years the effort has changed a lot because of the infection and spatial distribution of the stock, and the mass mortality in 2012/2013, which makes any strong deductions from the catch curves for those recent years meaningless.

Catch curves were also plotted using the age disaggregated survey indices for each year class from 1984—2011 (Figure 11.3.1.2). Even if the total mortalities look at bit noisy for some year classes, 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.

Mortality in the stock because of the *Ichthyophonus* outbreak can not be detected clearly from the catch curves of the surveys. There is possibly a small change in level of the curve around 2009 for the big 1999 year classes. However, it should be noted that the highest prevalence of infection has been in the 2004, 2005 and 2006 year classes and they were not all fully in the survey prior to the infection outbreak. Further work on this matter is ongoing.

The year class strength was evaluated independently from the analytical assessment, by sum the total catch of each year class (Figure 11.3.1.3). The 1999 year class is apparently the largest in the time series. For the most recent five year classes, only 2008 and 2009 might become close to average size, where around 50% and 30%, respectively, of their expected total catch have been already caught considering their current total catch in relation to the cumulative fishing of the age 4 and 5 as estimated from the year classes 1978—1996 (Figure 11.3.1.4).

11.3.2 Exploration of different assessment models

In order to explore the data this year, only one assessment tool was used, NFT-ADAPT (VPA/ADPAT version 3.3.0 NOAA Fisheries Toolbox). The NFT-Adapt has been used as the basis for the assessments since 2005 and it was considered appropriate as the principal assessment tool for the stock at benchmark assessment in January 2011 (ICES 2011a). The catch data used were from 1987/88-2014/15 (Table 11.2.2.2) and survey data from 1987/88-2014/15 (Table 11.1.1.1). Other input data consisted 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 in all years, except for 2009, where it was set 0.49 because of the *Ichthyophonus* infection, and for 2010 where M was for same reasons age dependent (Table 11.3.2.1; Óskarsson and Pálsson 2013); (iv) proportion of M before spawning was set to 0.5; and (v) proportion of F before spawning was set to 0. Thus, no changes in the input data from last except for one more year of data.

NFT-Adapt:

The estimated parameters in NFT Adapt are the stock in numbers at age. The parameters are output by the Levenburg-Marquardt Non-Linear Least Squares minimization algorithm (see VPA/ADAPT Version 3.3.0, Reference Manual). The estimated parameters were stock numbers for ages 4 to 12 in the end of year 2014, while the stock numbers at age 3 were set to the geometric mean from 1991—2011. Like in last years' assessments, 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. The age groups 3—10 were used for tuning (Table 11.1.1.1 as decided at the benchmark in ICES (2011).

The output and model settings of the NFT-Adapt run (the adopted final assessment model; see below) are shown in Table 11.3.2.2. Stock numbers and fishing mortalities derived from the run are shown in Table 11.3.2.3 and Table 11.3.2.4, respectively, and summarized in Table 11.3.2.5 and Figure 11.3.2.2.

Residuals of the model fit are shown in Figure 11.3.2.3 and Table 11.3.2.6, and shows both cohort and year affects. The main pattern is the same as presented in recent assessments. Positive residuals, where the model estimates is smaller than seen in the survey, can be seen for 1994 and 1999 year classes for almost all age groups and a negative residuals for the 2001 year class. Year blocks of positive residuals are apparent for the years ~2000 to 2006 (i.e. referring to January 1st), indicating that the model estimated the age groups smaller than observed in the surveys. During these years, the stock was overwintering in offshore areas off the east and west coast, compare to mainly easterly distribution before and overwintering in inshore areas there after (from ~2006—2012). These positive blocks could therefore reflect changes in catchability of the survey for these years. Positive residuals, even if relatively weaker, were also observed for 2012. A block of negative residuals was however observed for 2009 (survey in the autumn 2008).

Retrospective analysis (Figure 11.3.2.4) indicate a more stability in the most recent years than often before, i.e. adding new data to the model does not change the present perception of the stock size. The same applies correspondingly to the fishing mortality. Furthermore, to sustain the high M in the input data for 2009 and 2010 because of the infection, SSB of the most recent four years lifts in comparison to the preceding years. It required also an increase in recruitment estimates as apparent on the retrospective plots of number-at-age 3. A revision of the number at age 3 of the 2008 and 2009 year classes (in 2011 and 2012) is also apparent retrospectively, which is related to their high survey indices at age 3. Note that the high F in 2012 (Figure 11.3.2.4) is due to the mass mortality, which was added to the catches that year in the assessment as presented earlier (ICES 2014).

Like described before (ICES 2014), the main difference between observed and predicted survey values from the NFT-Adapt model was for the period 1999-2004, where the observed values were well above the predicted (Figure 11.3.2.5), otherwise they fitted relatively well. Like seen in the residual plot (Figure 11.3.2.3), the observed value for the 2009 survey was lower than predicted and the vice versa for the 2012 survey (referring to the beginning of the year; Figure 11.3.2.5). The low survey value in 2009 is likely underestimate due to distribution of the stock that year in Breiðafjörður (Óskarsson *et al.* 2010), while the reason for the positive block during 2000-2004 is not fully known even if mainly caused by the large 1999 year class and possibly changes in the catchability of the survey as suggested above. However, an exploratory run in NFT-Adapt done in the 2011 assessment (ICES 2011b) where these years were excluded in the tuning, did not change the point estimate of the stock size in the latest year (January 1st 2011), implying that the terminal point estimates in the final run was not driven by this residual block.

Comparisons of model run from previous year:

As pointed out above, only NFT-Adapt was run in this year's assessment. Thus, the comparisons here are limited to the final NFT-Adapt runs in 2014 and 2015 with respect to recruitment, biomass, and N weighed average $F_{5\text{-}10}$ (Figure 11.3.2.2). The results of the final NFT run in 2015 were in a good agreement the run in 2014. The main difference is related to the number at age 3 in 2014, which was based on geometric mean in the 2014 assessment while estimated in the 2015 assessment. This single difference is apparent when the estimates of number at age in 2014 are compared (Figure 11.3.2.6).

11.3.3 Final assessment

This is an update assessment so the results of the NFT-Adapt were adopted as point estimator for the prediction and thus the basis for the advice as in recent years. The model settings and outputs are shown in Table 11.3.2.2 to Table 11.3.2.4 and Figure 11.3.2.2.

The assessment (Table 11.3.2.5 and Figure 11.3.2.2) indicates that the fishing mortality (weighed average for age 5-10) was 0.26 in 2014 or above F_{pa}=0.22, while only 0.16 in 2013. This reflects partly a transfer of 7 kt of quota not caught in 2013 to 2014. The low F during 2009 to 2011 was related to cautious TAC and apparently overestimation of the mortality caused by the *Ichthyophonus* outburst.

As mention above, the estimated number of herring that died in Kolgrafafjörður in the two incidents of the mass mortalities there (Óskarsson *et al.* 2013) were added to the catches in 2012 and is also included in the high F that year (Table 11.3.2.5 and Figure 11.3.2.2). The F related only to landings in 2012 came to 0.22.

11.4 Reference points

Precautionary reference points:

The Working Group has pointed out that managing this stock at an exploitation rate at or above $F_{0.1}$ 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 F_{pa}= $F_{0.1}$= 0.22, B_{pa}= B_{lim} * $e^{1.645\sigma}$= 300 000 t where 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 B_{lim} from 200 000 t. The WG have not dealt with this issue.

The fishing mortality during 1987 to 2008 was on average 0.31 (weighed $F_{5\text{-}10}$), 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 period the SSB has remained above B_{lim} and reached a record high level around 2008.

MSY based reference points:

The MSY based reference points have not been set for Icelandic summer-spawning herring, but exploratory work was present at the NWWG meeting in 2011 in a form as requested by ICES (ICES 2011b). The HCS program Version 10.3 (Skagen, 2012) was used to evaluate possible points based on the MSY framework that could be a basis for a management plan and Harvest Control Rule later.

Number of different runs was made with varying settings. The results implied that the MSY framework was confirmative with the currently used precautionary reference points. It means that the currently used $F_{0.1}$=0.22 could be a valid candidate for F_{MSY}. This however, needs to be explored more thoroughly later.

11.5 State of the stock

The stock was at high levels until 2008 but since then a substantial reduction took place despite a low fishing mortality. The reduction was caused by mortality induced by *Ichthyophonus* infection in the stock in 2008 and 2009. However, the observed high prevalence of infection for all the years since then is not considered to be causing further mortality in the stock and the negative trend in the stock size has reversed due to incoming of year classes at near and just below average size. Record small year class from 2011 entering the spawning stock in 2015 causes a decline in SSB even if still above B_{PA}.

11.6 Short term forecast

11.6.1 The input data

The final adopted model, NFT-Adapt, which gave the number-at-age on January 1st, 2015, was used for the prognosis. All input values for the prognosis are given in Table 11.6.1.1. Note that different from previous four assessments, the number at age 3 in the assessment year (2012 year class) was not set equal to the geometric mean. Instead the predicted number from juvenile survey was used as detailed below.

The weights were estimated from the last year catch weights (see Stock Annex) and as in the recent years, the weights are expected to continue to be high (Figure 11.6.1.1). The selection pattern used in the prognosis was based on averages over 2012 to 2014 from the final run (Figure 11.6.1.2) (see Stock Annex). 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 2012 year class</u>: An acoustic survey aimed for getting an abundance index for this year class took place in November 2013 (ICES 2014), and using a relation obtained by Gudmundsdóttir *et al.* (2007) provides estimate of 477 millions at age 3 in 2015.

<u>The 2013 year class</u>: An acoustic survey aimed for getting an abundance index for this year class took place in November-December 2014 (Óskarsson and Reynisson 2015), and using a relation obtained by Gudmundsdóttir *et al.* (2007) provides estimate of 464 millions at age 3 in 2016.

<u>The 2014 year class</u>: No acoustic estimates are available for the year class yet thus the number-at-age 3 in 2017 was set to the geometrical mean for age-3 over 1987-2011, which give 602 millions.

11.6.2 Prognosis results

SSB and biomass of age 3+ are estimated to be 325 kt and 417 kt, respectively, in the beginning of the fishing season 2015/16 (approximately the same as at spawning in July 2015). The results of the short term prediction from the final NFT-Adapt run (Table 11.6.1.2) indicate that fishing at 0.22 (= $F_{0.1}$; the stock is managed at F=0.22~F_{MSY}) would correspond to TAC in 2015/2016 of 71 kt and SSB at the spawning season in 2016 would be 327 kt.

The proposed composition of the catch in the season 2015/16 consists mainly of the 2008, 2009 and 2010 year classes, each contributing to 21—23% in total biomass of the catch (Figure 11.6.2.1). The small 2011 year class is only believed to give 4% of the catches.

11.7 Medium term predictions

Prognosis was made for the stock until the spawning season 2018 (Table 11.6.1.3) and the input data were the same as introduced above in section 11.6.1. The main features are that fishing at target F=0.22 will give relatively constant catches and the SSB will increase slightly throughout the period.

11.8 Uncertainties in assessment and forecast

11.8.1 Assessment

There are several factors that could lead to uncertainty in the assessment. As done in the recent two assessments, additional natural mortality caused by the *Ichthyophonus* infection is only set for the first two years instead of all years since 2009. While this approach is considered to reduce the uncertainty in the assessment, quantification of the infection mortality needs to be improved in the future, and is ongoing currently. However, it should be noted that an exercise in last year's assessment (ICES 2014) showed that changing M for 2009 and 2010 changed the historical perception of the stocks size but had insignificant impacts on the assessment of the final year and the resulting advice.

The 2011 year class is small according to available measures. However, considering both the lower proportions of it in the winter catches taken in a small area compare to the bycatch during the summer over a wide area, and inadequate sample number in the survey southeast of Iceland (Breiðamerkurdjúp), the size of the year class might be underestimated somewhat in the assessment.

11.8.2 Forecast

The uncertainties mentioned above regarding the assessment apply also for the forecast, both regarding the mortality due to the *Ichthyophonus* infection and the size of the 2011 year class.

The number-at-age 3 in the beginning of 2015 used in the prognosis (477 millions) was predicted from a survey estimate of number at age 1 in 2013 but not as geometric mean from NFT-Adapt (602 millions), as done in previous years. This new approach had minor impact on the advice for 2015/16 (2 kt reduction in TAC), is considered to reduce the uncertainty in the forecast and is in accordance with the approach described in the Stock Annex.

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 assessments in 2007—2009 there was observed an improvement in the pattern from NFT-Adapt, while in 2010—2011, a retrospective pattern appeared again which was both related to the high M because of the *Ichthyophonus* infection but also due to new and more optimistic information about incoming year classes to the fishable stock (particularly the 2008 year class) and fishing pattern in recent year. The retrospective pattern in the last two and this year's assessment are less than seen for many years for SSB and F. That could be interpreted as an indication for improvements in the assessment quality in comparison to recent years.

11.9 Comparison with previous assessment and forecast

This year's assessment was conducted in the same way as in last year. In the current assessment, SSB in the beginning of the year 2014 is 5% lower (409 kt versus 430 kt), size of the 2009 year class 6% lower, size of the 2010 year class 6 higher, and $WF_{5\text{-}10}$ in 2013 is the same (0.16 in both cases), compare to the 2014 assessment.

11.10 Management plans and evaluations

The practice has been to manage fisheries on this stock at $F = F_{0.1}$ ($= 0.22 = F_{pa}$) for more than 20 years. However, no formal management strategy has been adopted.

11.11 Management consideration

Inspections indicate still a high prevalence of heart lesions related to *Ichthyophonus hoferi* in the herring stock, as in the last six years. This average prevalence of 15% for fish at age 3+ in 2014/2015 (Óskarsson and Pálsson 2014) is believed to remain for some years but decrease as the infected year classes gets older and disappear from the stock. No indications are for significant new infection in the stock since 2010 and mortality due to the infection is considered insignificant during 2011–2015.

11.12 Ecosystem considerations

The reason for the outbreak of *Ichthyophonus* infection in the herring stock that was first observed in the autumn 2008 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. However, with respect of the impacts of the outbreak on the herring stock, significant additional mortality was estimated to have taken place only in the first two years (ICES 2014; Óskarsson and Pálsson 2013), despite a high prevalence of infection for now seven years. Thus, the infection that is still found in the stock (average prevalence of 15% for fish at age 3+; Óskarsson and Pálsson 2014) will decrease and disappear over some years as the fish gets older.

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 observations of higher number of recruits per SSB during warm years and relatively high mean weight-at-age during recent 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 2012), has therefore probably positive effects on the stock, possibly apart from the *Ichthyophonus* outbreak.

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 is 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 2014/2015 was different than in last seven seasons. Instead of fishing near only in a small inshore area off the west coast in purse seine, the whole directed fishery took place in offshore areas west of Iceland by pelagic trawls. These changes are not considered to affect the selectivity of the fishery because the fishery is still targeting dense schools of overwintering herring in large fishing gears, getting huge catches in each haul and is by none means size selective.

The fishing pattern varies annually as noted in section 11.2 and it is related to variation in distribution of the different age classes of the stock. This variation can have consequences for the catch composition but it is impossible to provide a forecast about this variation.

11.15 Species interaction effects and ecosystem drivers

The WG have not dealt with this issue in a thoroughly and dedicated manner. However, some work has been done in this field in recent years in one way or another.

Regarding relevant researches on species interaction, the main work relates to the increasing amount of North East Atlantic mackerel (NEAM) feeding in Icelandic waters since 2007 (Astthorsson *et al.* 2012; ICES. 2013b). Surveys in the summers since 2010 indicate a high overlap in spatial and temporal distribution of NEAM and Icelandic summer-spawning herring (Nøttestad *et al.* 2014). Moreover, the diet composition of NEAM in Icelandic waters showed a clear overlap with those of the two herring stocks, i.e. Icelandic summer-spawning herring and Norwegian spring-spawning herring (Óskarsson *et al.* 2012b). Even if Copepoda was important diet group for all the three stocks its relative contribution to the total diet was apparently higher for NEAM than the two herring stocks. Considering former studies of herring diet, this finding was unexpected, and particularly how little the Copepoda contributed to the herring diet. This difference in the stomach content of NEAM and the two herring stocks indicated that there could be some difference in feeding ecology between them in Icelandic waters, where NEAM preferred Copepoda, or feed in the water column where they dominate over other prey groups, while the opposite would be for the herring and the prey Euphausiacea. Recent studies in the Nordic Seas have shown similar results (Langøy *et al.* 2012; Debes *et al.* 2012). The indication for difference in feeding ecology of the species is further supported by the fact that the body condition of the two herring stocks showed no clear decreasing trend since the invasion of NEAM started into Icelandic waters. On the contrary the mean weights-at-age of the summer spawners have been high, for example record high in the autumn 2014 (Figure 11.6.1.1), and the mean weight-at-length have also been relatively high in recent years (Óskarsson and Pálsson 2015). It should though be noted that comparison of the diet composition of herring in recent years to earlier studies, mainly on NSS herring, indicate that the herring might have shifted their feeding preference towards Euphausiacea instead of Copepoda. That is possibly a consequence of increased competition for food with NEAM, where the herring is overwhelmed and shifts towards other preys.

The WG is not aware of documentations of strong signals from ecosystem or environmental variables that impact the herring stock and could possibly be a basis for implementing ecosystem drivers in the analytical basis for its advice. For example, recruitment in the stock has been positively, but weakly, linked to NAO winter index (North Atlantic Oscillation) and sea temperature (Óskarsson and Taggart 2010), while indices representing zooplankton abundance in the spring have not been found to impact the recruitment (Óskarsson and Taggart 2010) or body condition and growth rate of the adult part of the stock (Óskarsson 2008).

11.16 Comments on the PA reference points

The WG have not dealt with this issue recently.

11.17 Comments on the assessment

The assessment implies that the stock size has been rather unvarying in recent years following a period of depletion related to the *Ichthyophonus* infection. This is related to average size recruiting year classes entering the fishable stock, no infection mortality, and moderate fishing mortality. The assessment follows fairly well the pattern in the tuning series for recent years (Figure 11.3.2.5). However, small year class from 2011 entering the spawning stock in 2015 causes a decline in SSB even if it still above B_{PA}. The size of the year class is possibly somewhat too pessimistic in this assessment but the downward trend is foreseen anyway.

This year's research on the *Ichthyophonus* infection in the stock supports the approach taken since 2013 (ICES 2013a; Óskarsson and Pálsson 2013) that additional natural mortality in the stock due to *Ichthyophonus* infection should only be applied for the first two years of the outburst. Further research is ongoing to quantify the infection mortality for these two years, but it is important to note that changing the mortality has mainly impacts on the historical perspective of the stock size and insignificant impacts on the present stock status.

In conclusion of the review group for NWWG 2011 (ICES 2011b), the suggestion was "*to improve the assessment in order to get a better fitting for the years 2000-2005 and to work on the reference points*". In this year's assessment, it was not dealt with these aspects specifically, but they still require attention. The years 2000—2005 fit still poorly to the tuning series and no satisfactory explanation exists for this pattern. The models recently used for the stock (NFT-Adapt, TSA and Coleraine (in Benchmark assessment in 2011; Gudmundsdottir 2011)) are not able to follow this trend in the tuning series. It should be noted that this same pattern was observed in the benchmark assessment in 2011 (Gudmundsdottir 2011) where input data were limited to the period before the infection so assumptions related to the natural mortality-infection are probably only responsible for this pattern to small degree if any. As mention above (section 11.3.2), the discrepancy could be related to the fact that during these years, the stock was overwintering in offshore areas off the east and west coast, compare to mainly easterly distribution before and overwintering in inshore areas there after (from ~2006—2013). These positive blocks could therefore reflect changes in catchability of the survey for these years. This must be kept in mind for the years to come since the stock has now started again to overwinter in offshore areas.

11.18 References

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Table 11.1.1.1. Icelandic summer-spawning herring. Acoustic estimates (in millions) in the winters 1973/74-2014/15 (age refers to the autumns). Years without surveys are marked with*.

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	154
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*															
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*															
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*															
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*															
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

Year\age	2	3	4	5	6	7	8	9	10	11	12	13	14	15+	Total
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
2010/11	106.178	280.582	228.857	304.885	296.254	138.686	301.285	60.997	141.323	97.412	37.006	0.000	4.019	0.000	1997
2011/12	704.863	977.323	434.876	313.742	272.140	239.320	154.581	175.088	84.582	92.435	89.376	17.638	6.808	4,989	3676
2012/13	178.500	781.083	631.421	166.627	126.961	142.044	110.084	97.000	74.340	69.473	43.376	38.450	7.458	0.773	2468
2013/14	15.919	314.865	218.715	344.981	151.631	132.767	120.756	118.377	89.555	74.602	48.695	44.637	31.096	11.598	1718
2014/15	152.422	90,269	330.084	260.919	259.079	187.905	111.955	91.629	37.855	76.680	30.366	10.619	22.799	10.108	1667

11.1.1.2. Overview of acoustic surveys conducted in the winter 2014/15 that contributed to the abundance estimates of the fishable stock and juveniles (age-1) of Icelandic summer-spawning herring.

No.	Survey code	Period	Area	The target	Used in 2015 abundance indices
1	B7-2014	24 November – 6 December 2014	West, south and southeast of Iceland	The fishable stock and juvenile herring	Yes
2	D9-2014	13 November – 23 November 2014	Breiðafjörður (adults) and then fjords and bays west, north and east of Iceland (juveniles)	The fishable stock and juvenile herring	Yes, the juvenile part
3	Bolli-1-2014	4 December 2014	Kolgrafafjörður (inner part) in Breiðafjörður	The fishable stock	Yes

Table 11.1.2.1. Icelandic summers-spawning herring. Number of scales by ages and number of samples taken in the annual acoustic surveys in the seasons 1987/88-2014/15 (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
2010/11	35	74	102	157	139	61	119	22	52	36	13	0	1	0	811	11	8	3
2011/12	229	330	134	115	100	106	74	87	45	48	51	10	3	3	1335	15	9	6
2012/13‡	42	266	554	273	220	252	198	165	126	114	69	61	12	2	2370	60	55‡	5
2013/14	26	472	275	414	199	200	199	208	163	138	90	85	60	23	2552	45	37‡	8
2014/15	83	50	96	71	72	53	32	26	11	22	8	3	6	4	534	10	8	2

***No survey**

‡Samples in the western part were mainly from the commercial catch as there was impossible to secure a usable research survey samples from Kolgrafafjörður where most of the herring was observed.

Table 11.2.1. Icelandic summer spawners. Landings, catches, recommended TACs, and set National TACs in thousand tonnes.

Year	Landings	Catches	Recom. TACs	Nat. TACs	Year	Landings	Catches	Recom. TACs	Nat. TACs
1972	0.31	0.31			2007/2008	158.9	158.9	130	150
1973	0.254	0.254			2008/2009	151.8	151.8	130	150
1974	1.275	1.275			2009/2010	46.3	46.3	40	47
1975	13.28	13.28			2010/2011	43.5	43.5	40	40
1976	17.168	17.168			2011/2012‡	49.4	49.4	40	45
1977	28.925	28.925			2012/2013‡	72.0	72.0	67	68.5
1978	37.333	37.333			2013/2014‡	72.0	72.0	87	87
1979	45.072	45.072			2014/2015‡§	95.0	95.0	83	83
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					

***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.**

‡Landings and catches include bycatch of Icelandic summer-spawning herring in the mackerel and NSS herring fishery during the preceding summer (i.e. from the fishing season before in June-August).

§ The landings and catches in 2014/2015 consist of transfer of 7 kt from the year before and 5 kt from the year to come, which explains the discrepancy to the TACs.

Table 11.2.2.1. Overview of number of catch samples and fish measurements of Icelandic summer-spawning herring during June 2014 to March 2015.

	June–October (cells 1–2)		October–March on the main fishing grounds west of Iceland (cells 3–5)		Total	
Catch (tonnes)	12482		82493		94975	
	Number	# per 1000 t	Number	# per 1000 t	Number	# per 1000 t
Number of samples	40	3.2	52	0.6	92	1.0
Length measured	728	58	2711	33	3439	36
Age determined	383	31	2067	25	2450	26
Weighed	600	48	2493	30	3093	33

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
2010	1.476	8.843	22.674	29.492	24.293	14.419	17.407	10.045	7.576	8.896	1.764	1.105	0.672	0.555	43.533
2011	0.521	9.357	24.621	20.046	22.869	23.706	13.749	16.967	10.039	7.623	7.745	1.441	0.618	0.785	49.446
2012*	0.403	17.827	89.432	51.257	43.079	51.224	41.846	34.653	27.215	24.946	15.473	13.575	2.595	0.253	125.369
2013	6.888	46.848	24.833	35.070	17.250	18.550	19.032	21.821	15.952	15.804	10.081	9.775	6.722	2.486	72.058
2014	0.000	3.537	53.241	50.609	70.044	34.393	22.084	22.138	13.298	17.761	7.974	4.461	2.862	1.746	94.975

*** Includes both the catches and the herring that died in the mass mortality in the winter 2012/13 in Kolgrafafjörður'**

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
2010	87	204	243	271	297	315	329	335	341	351	367	366	405	416
2011	97	187	245	283	309	328	343	352	356	364	375	386	378	432
2012	65	206	244	282	301	320	333	344	350	359	364	367	373	391
2013	95	182	238	271	300	322	337	349	360	365	362	375	377	394
2014		202	259	288	306	328	346	354	362	366	367	380	383	403

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
2010	0	0.2	0.85	1	1	1	1	1	1	1	1	1	1	1
2011	0	0.2	0.85	1	1	1	1	1	1	1	1	1	1	1
2012	0	0.2	0.85	1	1	1	1	1	1	1	1	1	1	1
2013	0	0.2	0.85	1	1	1	1	1	1	1	1	1	1	1
2014	0	0.1	0.85	1	1	1	1	1	1	1	1	1	1	1

Table 11.3.2.1. Icelandic summer-spawning herring. Natural mortality at age where the deviation from the fixed M=0.1 is due to the *Ichthyophonus* infection (1981 refers to season 1981/1982 etc).

Year\age	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1987-2008	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
2009	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49
2010	0.458	0.74	0.74	0.69	0.63	0.6	0.58	0.57	0.56	0.54	0.53	0.52	0.56	0.58
2011-2014	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10

Table 11.3.2.2. Model settings and results of model parameters from the NFT-Adapt run in 2014 for Icelandic summer spawning herring.

VPA Version 3.3.0

Model ID: Run2. Final last yeat + one year more data.

Input File: C:\USERS\ASTA\NFT\VPA\2015\RUN2\RUN2.DAT

Date of Run: 10-APR-2015 Time of Run: 16:42

Levenburg-Marquardt Algorithm Completed 5 Iterations

Residual Sum of Squares = 50.2737

Number of Residuals = 216

Number of Parameters = 9

Degrees of Freedom = 207

Mean Squared Residual = 0.242868

Standard Deviation = 0.492817

Number of Years = 28

Number of Ages = 11

First Year = 1987

Youngest Age = 3

Oldest True Age = 12

Number of Survey Indices Available = 10

Number of Survey Indices Used in Estimate = 8

VPA Classic Method - Auto Estimated Q's

Stock Numbers Predicted in Terminal Year Plus One (2015)

Age	Stock Predicted	Std. Error	CV
4	88460.210	0.444726E+05	0.502741E+00
5	248124.780	0.960257E+05	0.387006E+00
6	229312.373	0.765804E+05	0.333957E+00
7	249087.051	0.793252E+05	0.318464E+00
8	98087.946	0.310708E+05	0.316764E+00
9	57259.569	0.186145E+05	0.325090E+00
10	40071.703	0.141892E+05	0.354095E+00
11	26023.962	0.956065E+04	0.367379E+00
12	11004.627	0.930594E+04	0.845639E+00

Catchability Values for Each Survey Used in Estimate

INDEX	Catchability	Std. Error	CV
1	0.102045E+01	0.104443E+00	0.102350E+00

2	0.125781E+01	0.120301E+00	0.956428E-01
3	0.125774E+01	0.875790E-01	0.696322E-01
4	0.134448E+01	0.951709E-01	0.707864E-01
5	0.147853E+01	0.117278E+00	0.793206E-01
6	0.169227E+01	0.160301E+00	0.947256E-01
7	0.180443E+01	0.212041E+00	0.117511E+00
8	0.171735E+01	0.211353E+00	0.123069E+00

-- Non-Linear Least Squares Fit --

Maximum Marquadt Iterations = 100
Scaled Gradient Tolerance = 6.055454E-05
Scaled Step Tolerance = 1.000000E-18
Relative Function Tolerance = 1.000000E-18
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 11
- Calculation of Population of Age 3 In Year 2015
  = Geometric Mean of First Age Populations
    Year Range Applied = 1991 to 2011
- Survey Weight Factors Were Used

Stock Estimates:
Age 4
Age 5
Age 6
Age 7
Age 8
Age 9
Age 10
Age 11
Age 12

Full F in Terminal Year = 0.3953
F in Oldest True Age in Terminal Year = 0.5133
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	0.500	0.040	0.0373	NO	Stock Estimate in T+1
4	0.800	0.200	0.1854	NO	Stock Estimate in T+1
5	1.000	0.206	0.1902	YES	Stock Estimate in T+1
6	1.000	0.256	0.2365	YES	Stock Estimate in T+1
7	1.000	0.310	0.2871	YES	Stock Estimate in T+1
8	1.000	0.337	0.3117	YES	Stock Estimate in T+1
9	1.000	0.455	0.4210	YES	Stock Estimate in T+1
10	1.000	0.427	0.3949	YES	Stock Estimate in T+1
11	1.000	1.000	0.9255	YES	Stock Estimate in T+1
12	**1.000**	**0.555**	**0.5133**		**F-Oldest**

Table 11.3.2.3. Icelandic summer spawners stock estimates (from NFT-Adapt in 2014) in numbers (thousands) by age (years) at January 1st during 1987-2015.

Age	3	4	5	6	7	8	9	10	11	12	13+	Total
Year												
1987	529937	989084	300694	84605	69140	107466	42635	38034	26408	34264	34292	2256559
1988	271093	476517	852580	214871	56994	43836	53489	24150	21192	14258	36997	2065977
1989	447691	240772	391903	677068	128726	29843	20627	18028	10184	9485	26105	2000432
1990	301186	383582	192547	280755	433772	75629	19307	13073	9410	4695	26465	1740421
1991	842220	258379	292963	140442	178424	243589	39800	9723	7687	5314	24864	2043403
1992	1035186	677832	187209	183286	94077	109103	116243	26453	4866	4365	24199	2462818
1993	637975	846555	496934	132973	110308	58658	62328	54949	12969	2768	23679	2440096
1994	694264	528661	597305	361681	100580	72727	40446	37806	35246	7705	22930	2499351
1995	204385	500441	370860	404938	244544	67379	46557	21168	19355	17999	23159	1920786
1996	182845	164995	322700	253168	262915	148509	40725	27700	11069	8424	27594	1450645
1997	778409	150274	111059	210265	163721	157672	96765	22883	17084	4503	22258	1734894
1998	324799	667040	107370	75536	155382	116158	113228	66424	12627	12248	10153	1660965
1999	564125	250789	437111	75622	60167	101813	80490	72071	46206	9411	13652	1711458
2000	407064	456945	174950	261987	53156	41628	62301	54008	44332	29854	12024	1598249
2001	495361	313934	284286	111572	164429	37143	29796	40852	39496	29366	26182	1572417
2002	1566444	408028	202118	168549	72190	97153	23772	18655	25359	26342	34059	2642668
2003	1180030	1340526	301992	139617	101148	45214	47984	12152	12415	16762	28045	3225884
2004	802061	866987	941576	218095	99779	67251	27451	33035	8879	7987	31310	3104411
2005	1159326	665538	652005	678821	158911	77249	51980	19365	23229	5064	27416	3518904
2006	863161	1024198	562181	478041	487590	117623	58434	38298	12618	16165	24057	3682366
2007	912519	668468	720197	456624	386656	386823	93509	47180	30570	10564	32005	3745114
2008	877954	736676	526781	499891	352810	264864	261386	62397	31536	20686	27825	3662807
2009	802971	757499	580211	400936	350186	262605	180662	184944	39272	20721	32849	3612856
2010	646270	475008	436837	330794	231071	196984	152817	103558	105922	22330	30882	2732474
2011	629267	302381	211388	198742	158833	116336	97522	79001	53528	55051	28057	1930107
2012	421941	560489	250212	172228	158108	121209	92207	72136	61949	41195	65143	2016818
2013	413974	364844	422246	177763	114981	94524	70034	50619	39502	32441	65992	1846920
2014	101479	330081	306527	348744	144459	86428	67468	42689	30685	20783	61516	1540860
2015*	476547	88460	248125	229312	249087	98088	57260	40072	26024	11005	58307	1582287

*** Number at age 3 in 2015 is predicted from an survey index of number at age 1 in 2012 (see section 11.6.1)**

Table 11.3.2.4. Estimated fishing mortality at age of Icelandic summer-spawning herring (from NFT-Adapt in 2015) by age (years) during 1987-2014 and weighed average F by numbers for age 5-10.

Year\age	3	4	5	6	7	8	9	10	11	12	13+	WF 5-10
1987	0.006	0.049	0.236	0.295	0.356	0.598	0.468	0.485	0.516	0.517	0.517	0.347
1988	0.019	0.096	0.131	0.412	0.547	0.654	0.988	0.764	0.704	0.777	0.506	0.266
1989	0.055	0.124	0.234	0.345	0.432	0.336	0.356	0.550	0.674	0.479	0.111	0.322
1990	0.053	0.170	0.216	0.353	0.477	0.542	0.586	0.431	0.471	0.508	0.071	0.400
1991	0.117	0.222	0.369	0.301	0.392	0.640	0.309	0.592	0.466	0.502	0.055	0.436
1992	0.101	0.210	0.242	0.408	0.372	0.460	0.649	0.613	0.464	0.547	0.023	0.415
1993	0.088	0.249	0.218	0.179	0.317	0.272	0.400	0.344	0.421	0.359	0.011	0.247
1994	0.227	0.255	0.289	0.291	0.301	0.346	0.548	0.570	0.572	0.509	0.090	0.311
1995	0.114	0.339	0.282	0.332	0.399	0.404	0.419	0.548	0.732	0.526	0.154	0.342
1996	0.096	0.296	0.328	0.336	0.411	0.328	0.476	0.383	0.799	0.497	0.349	0.358
1997	0.054	0.236	0.286	0.203	0.243	0.231	0.276	0.495	0.233	0.309	1.034	0.247
1998	0.159	0.323	0.251	0.128	0.323	0.267	0.352	0.263	0.194	0.269	0.572	0.276
1999	0.111	0.260	0.412	0.253	0.268	0.391	0.299	0.386	0.337	0.353	0.715	0.371
2000	0.160	0.375	0.350	0.366	0.259	0.234	0.322	0.213	0.312	0.270	0.670	0.327
2001	0.094	0.340	0.423	0.335	0.426	0.346	0.368	0.377	0.305	0.349	0.436	0.400
2002	0.056	0.201	0.270	0.411	0.368	0.605	0.571	0.307	0.314	0.449	0.876	0.392
2003	0.208	0.253	0.226	0.236	0.308	0.399	0.273	0.214	0.341	0.307	0.231	0.256
2004	0.087	0.185	0.227	0.217	0.156	0.158	0.249	0.252	0.462	0.280	0.255	0.218
2005	0.024	0.069	0.210	0.231	0.201	0.179	0.206	0.328	0.263	0.244	0.192	0.218
2006	0.156	0.252	0.108	0.112	0.132	0.129	0.114	0.125	0.078	0.112	0.140	0.118
2007	0.114	0.138	0.265	0.158	0.278	0.292	0.305	0.303	0.291	0.298	0.335	0.252
2008	0.048	0.139	0.173	0.256	0.195	0.283	0.246	0.363	0.320	0.303	0.280	0.229
2009	0.035	0.061	0.072	0.061	0.085	0.051	0.067	0.067	0.075	0.065	0.058	0.068
2010	0.020	0.070	0.098	0.104	0.086	0.123	0.090	0.100	0.114	0.107	0.102	0.100
2011	0.016	0.089	0.105	0.129	0.170	0.133	0.202	0.143	0.162	0.160	0.113	0.141
2012	0.045	0.183	0.242	0.304	0.414	0.449	0.500	0.502	0.547	0.499	0.307	0.364
2013	0.127	0.074	0.091	0.108	0.186	0.237	0.395	0.401	0.542	0.394	0.359	0.161
2014	0.037	0.185	0.190	0.237	0.287	0.312	0.421	0.395	0.926	0.513	0.168	0.255

Table 11.3.2.5. Summary table from NFT-Adapt run in 2015 for Icelandic summer spawning herring.

Year	Recruits, age 3 (millions)	Biomass age 3+ (kt)	SSB (kt)	Landings age 3+ (kt)	Yield/SSB	WFage 5-10
1987	530	504	384	75	0.20	0.35
1988	271	495	423	93	0.22	0.27
1989	448	459	386	101	0.26	0.32
1990	301	410	350	104	0.30	0.40
1991	842	424	310	107	0.34	0.44
1992	1035	503	344	107	0.31	0.41
1993	638	547	425	103	0.24	0.25
1994	694	555	442	134	0.30	0.31
1995	204	464	408	125	0.31	0.34
1996	183	350	309	96	0.31	0.36
1997	778	371	271	65	0.24	0.25
1998	325	370	302	86	0.29	0.28
1999	564	378	294	93	0.31	0.37
2000	407	396	313	100	0.32	0.33
2001	495	361	281	94	0.33	0.40
2002	1566	545	314	96	0.31	0.39
2003	1180	628	421	129	0.31	0.26
2004	802	693	542	112	0.21	0.22
2005	1159	821	610	102	0.17	0.22
2006	863	934	730	130	0.18	0.12
2007	913	875	702	158	0.23	0.25
2008	878	944	757	151	0.20	0.23
2009	803	969	642	46	0.07	0.07
2010	646	745	453	43	0.10	0.10
2011	629	519	393	49	0.13	0.14
2012*	422	555	442	125	0.28	0.38
2013	414	493	399	71	0.17	0.16
2014	101	460	410	95	0.23	0.26
2015§	477	438	342			
Mean	640	559	428	100	0.25	0.28

*** The mass mortality of 52 thousands tons in Kolgrafafjörður in the winter 2012/13 is included in the landings, yield/SSB, and WF.**

§ Number at age 3 in 2015 is predicted from an survey index of number at age 1 in 2012 (see section 11.6.1)

Table 11.3.2.6. The residuals from survey observations and NFT-Adapt 2015 results for Icelandic summer spawning herring (no surveys in 1987 and 1995) on 1st January.

Year\Age	4	5	6	7	8	9	10	11
1987								
1988	-0.192	-0.223	0.131	-0.294	-0.689	-0.251	-0.171	-0.434
1989	-0.199	-0.750	-0.803	0.085	0.051	-0.003	0.000	0.000
1990	0.515	-0.300	-0.236	0.017	0.474	-0.387	-0.001	-0.002
1991	-0.690	-0.354	-0.627	-0.228	0.356	0.164	0.008	-0.003
1992	0.417	0.409	0.328	-0.342	-0.154	0.267	-0.807	0.002
1993	-0.039	0.155	-0.052	-0.126	-0.471	-0.091	-0.026	0.097
1994	-0.065	0.161	0.087	-0.703	-0.612	0.439	-0.333	-0.514
1995								
1996	-0.230	0.629	-0.136	0.085	-0.216	0.354	-0.030	-0.158
1997	0.568	-0.044	0.572	0.204	0.334	0.283	0.812	0.637
1998	-0.123	-0.511	-0.504	0.318	-0.096	0.060	-0.125	0.492
1999	0.000	0.677	0.083	-0.446	-0.107	-0.658	-0.247	-0.386
2000	0.588	0.083	0.609	0.211	-0.350	0.452	-0.080	0.466
2001	1.105	1.303	0.308	0.780	-0.468	-1.165	-0.664	-1.555
2002	-0.372	-0.156	0.206	0.506	0.879	0.440	0.529	-0.126
2003	0.339	0.376	0.158	0.657	0.828	1.224	1.509	0.804
2004	0.484	0.553	0.187	-0.206	0.014	-0.183	-0.268	-0.008
2005	0.050	0.220	0.204	-0.221	-0.604	-0.686	-1.161	-0.511
2006	-0.856	-0.718	0.309	0.622	0.481	0.212	0.629	1.219
2007	-0.115	0.157	-0.337	-0.203	0.193	-0.500	0.374	-0.074
2008	-0.498	-0.829	-0.149	-0.427	0.028	0.463	0.677	1.508
2009	-1.372	-0.560	-0.560	-0.028	-0.375	-0.303	-0.681	-0.813
2010	-0.428	-0.113	0.288	-0.135	0.117	-0.550	-0.801	-0.148
2011	-0.095	-0.150	0.199	0.327	-0.215	0.602	-0.849	0.430
2012	0.536	0.323	0.370	0.247	0.289	-0.009	0.296	-0.229
2013	0.741	0.173	-0.294	-0.197	0.016	-0.074	0.060	0.091
2014	-0.067	-0.567	-0.240	-0.248	0.038	0.056	0.430	0.530
2015	0.000	0.056	-0.100	-0.257	0.259	0.144	0.237	-0.166

Table 11.6.1.1. The input data used for prognosis of the Icelandic summer-spawning herring in the 2015 assessment: the predicted weights, the selection pattern, M, proportion of M before spawning, and the number-at-age derived from NFT-Adapt run.

Age (year class)	Mean weights (kg)	M	Maturity ogive	Selection pattern	Mortality prop. before spawning		Number at age
					F	M	Jan. 1st 2015
3 (2012)	0.164	0.10	0.200	0.355	0.000	0.500	476.5
4 (2011)	0.247	0.10	0.850	0.599	0.000	0.500	88.5
5 (2010)	0.292	0.10	1.000	1.000	0.000	0.500	248.1
6 (2009)	0.314	0.10	1.000	1.000	0.000	0.500	229.3
7 (2008)	0.328	0.10	1.000	1.000	0.000	0.500	249.1
8 (2007)	0.345	0.10	1.000	1.000	0.000	0.500	98.1
9 (2006)	0.359	0.10	1.000	1.000	0.000	0.500	57.3
10 (2005)	0.365	0.10	1.000	1.000	0.000	0.500	40.1
11 (2004)	0.372	0.10	1.000	1.000	0.000	0.500	26.0
12 (2003)	0.375	0.10	1.000	1.000	0.000	0.500	11.0
13+ (2002+)	0.375	0.10	1.000	1.000	0.000	0.500	58.3

Table 11.6.1.2. Icelandic summer-spawning herring. Short term prediction where the basis is: SSB(2015): 342 kt; Biomass age 3+ (2015): 417 kt (at spawning time); Catch(2014/15): 95 kt; WF_{5-10}(2014)=0.255. The fishery has been managed on basis of $F_{0.1}$=0.22 for over 20 years. SSB is in the spawning seasons, which is approximately the beginning of the subsequent fishing season. Catches and SSB are in thousands tons.

Rationale	Landings (2015/16)	Basis	F (2015/2016)	SSB 2016	%SSB change [1]	% TAC change [2]
MSY approach	71	Fmsy	0.22	327	-5	-34
F0.1	71	F0.1=Fpa=0.22	0.22	327	-5	-34
Zero catch	0	F=0	0.00	496	31	
Status quo	53	F(2013)	0.16	343	0	-79
Fmult	9	0.1 × (F0.1)	0.02	383	11	-1018
	21	0.25 × (F0.1)	0.05	372	8	-352
	37	0.5 × (F0.1)	0.11	358	4	-157
	57	0.75 × (F0.1)	0.17	339	-1	-67
	65	0.9 × (F0.1)	0.20	332	-3	-46
	76	1.1 × (F0.1)	0.24	322	-6	-25
	87	1.25 × (F0.1)	0.27	312	-9	-9
	101	1.5 × (F0.1)	0.33	300	-14	6

1) SSB 2016 relative to SSB 2015.

2) TAC 2015/16 relative to landings 2014/15.

Table 11.6.1.3. Icelandic summer-spawning herring. Medium term prediction where the basis is : SSB(2015): 342 kt; Catch(2014/15): 95 kt; WF_{5-10}(2014)=0.255. The prognosis of the Icelandic summer spawning herring for the next fishing season (2015/2016) and the two subsequent seasons under five different options (F0.1=0.22, constant TAC of 60 kt, 70 kt, 80 kt and 90 kt) from the final NFT-Adapt run in 2015. SSBs are in the spawning seasons, which is approximately the beginning of the subsequent fishing season.

2015/2016		Spawning 2016		2016/2017		Spawning 2017		2017/2018		Spawning 2018	
TAC	F	Biomass 3+	SSB (kt)	TAC	F	Biomass 3+	SSB (kt)	TAC	F	Biomass 3+	SSB (kt)
(kt)	(5-10)	(kt)		(kt)	(5-10)	(kt)		(kt)	(5-10)	(kt)	
71	0.22	417	327	64	0.22	454	345	69	0.22	491	376
60	0.18	428	337	60	0.20	468	358	60	0.18	513	398
70	0.22	418	328	70	0.24	449	340	70	0.23	485	371
80	0.25	409	319	80	0.29	429	322	80	0.28	456	343
90	0.29	399	310	90	0.35	410	304	90	0.35	427	316

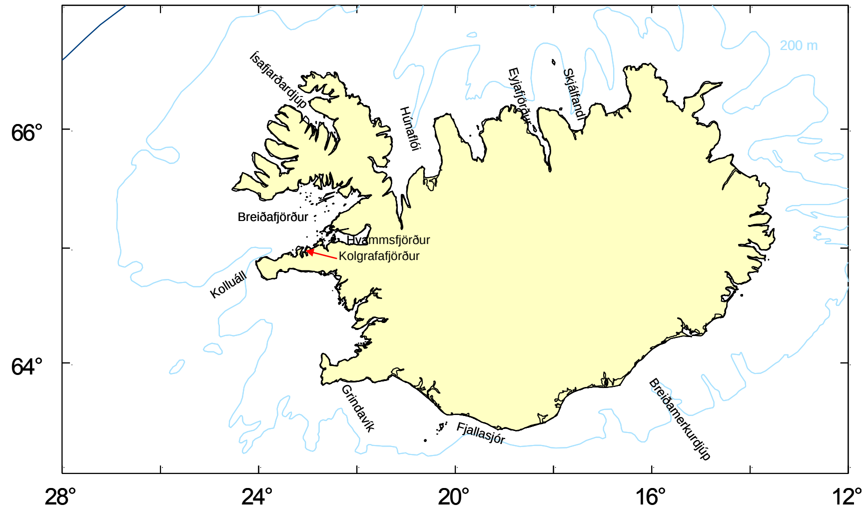


Figure 11.1.2.1. The locations of the areas that are referred to in the text.

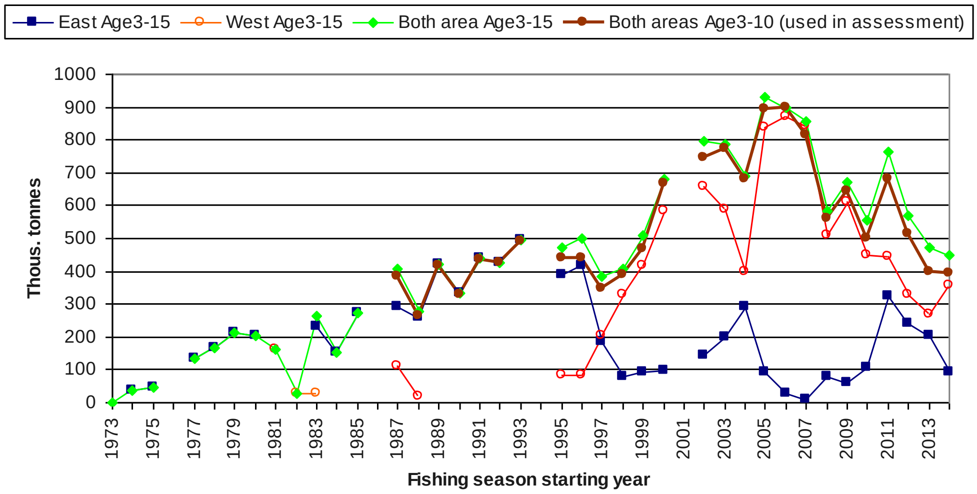


Figure 11.1.2.2 Total biomass index for Icelandic summer-spawning herring from the acoustic surveys for ages 3+ in the areas east and west of 18°W (except in 2011 and 2012 where fish outside of Breiðafjörður was set to the eastern part), combined over all areas and age 3-10 which are used in tuning of the analytical assessment. The years in the plot (1973-2014) refer to the autumn of the fishing seasons.

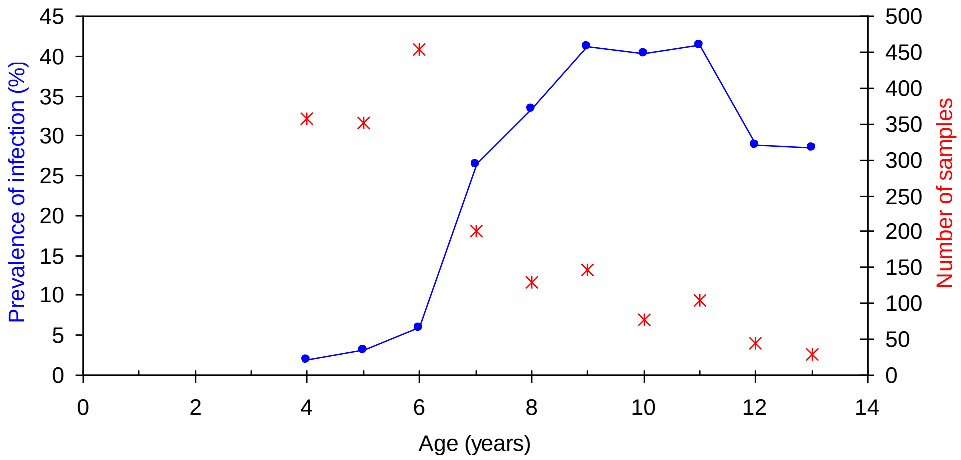


Figure 11.1.3.1. The prevalence of *Ichthyophonus* infection for the different age groups of Icelandic summer-spawning herring in Kolluáll in the winter 2014/2015.

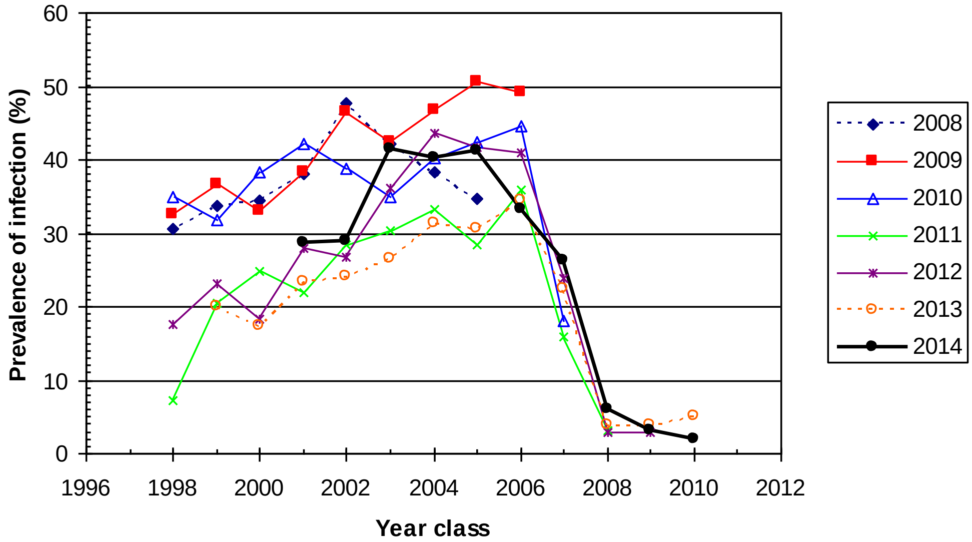


Figure 11.1.3.2. The prevalence of Ichthyophonus infection for the different year classes of Icelandic summer-spawning herring in Breiðafjörður and Kolluáll as estimated in the autumns 2008 to 2014.

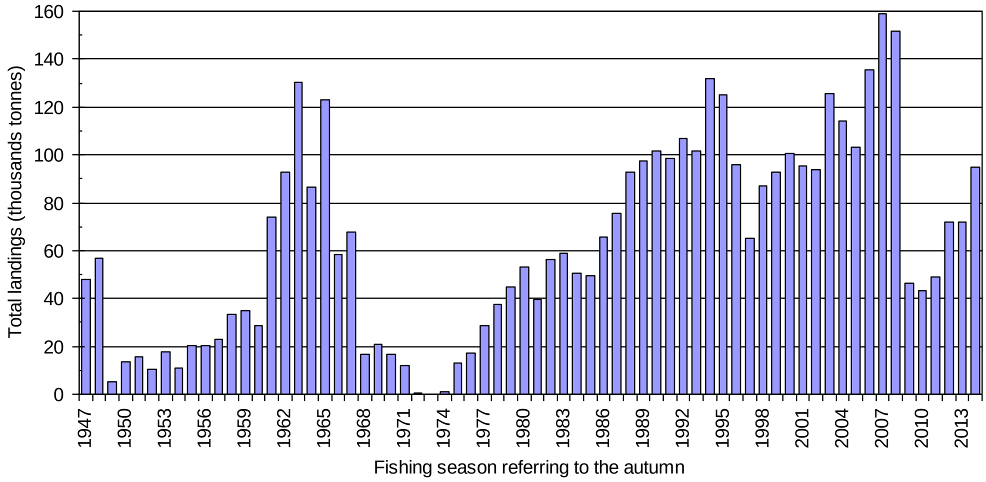


Figure 11.2.1. Icelandic summer spawning herring. Seasonal total landings (in thousand tonnes) during 1947-2014, referring to the autumns.

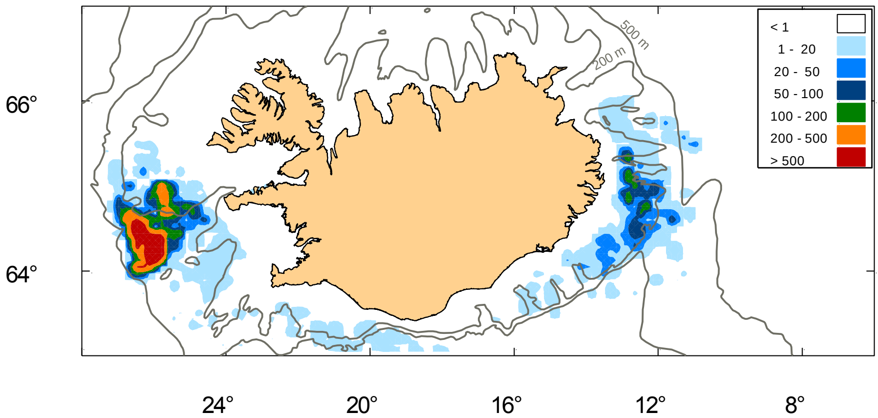


Figure 11.2.2. The distribution of the fishery (in tonnes) of Icelandic summer spawning herring during the fishing season 2014/15, including the bycatch in the mackerel fishery in June-September 2014.

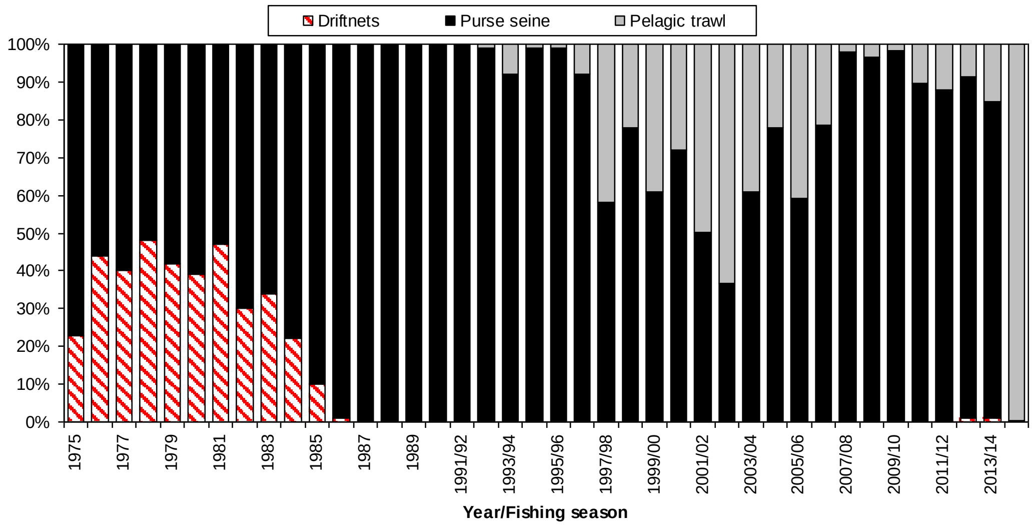
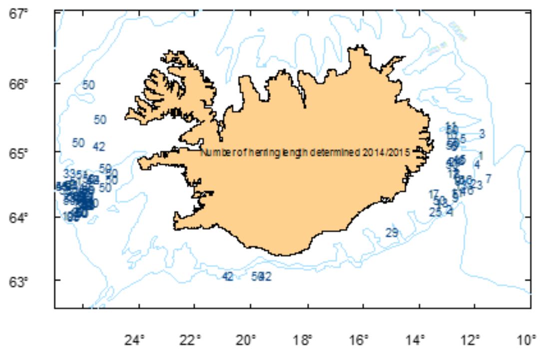


Figure 11.2.1.1. Icelandic summer spawning herring. Proportion of the total catches of the Icelandic summer-spawning herring in 1975/76-2014/15 taken by different gears.

a)



b)

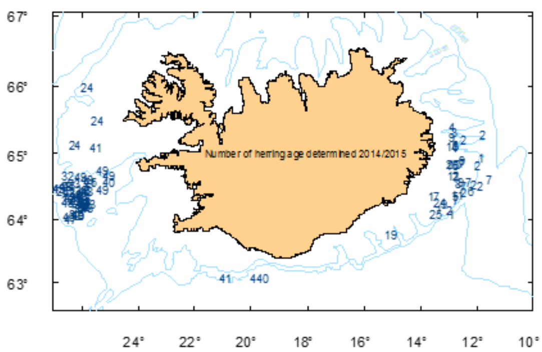


Figure 11.2.2.1. The distribution of samples, and number of fish taken for length measurements (to left) and age determination (to right) as indicated on graphs form the fishery of Icelandic summer-spawning herring in June 2014 to March 2015.

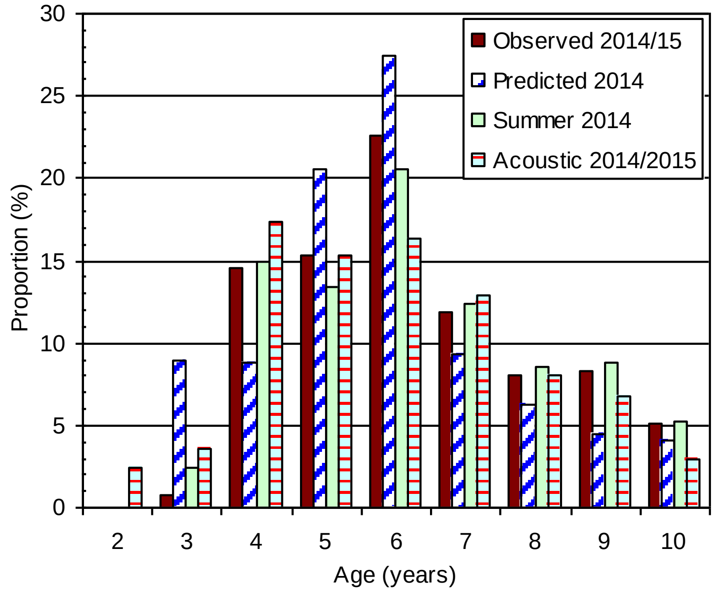


Figure 11.2.2.2. Proportion of the different age groups of Icelandic summer-spawning herring to the total catches (biomass) as observed in 2014/2015 fishing season (June 2014-March 2015), predicted in the 2014 assessment (ICES 2014) for the 2014/2015 fishing season, and the summer catches in June-September 2014 in comparison to the age composition in the stock according to the acoustic measurements in the winter 2014/2015.

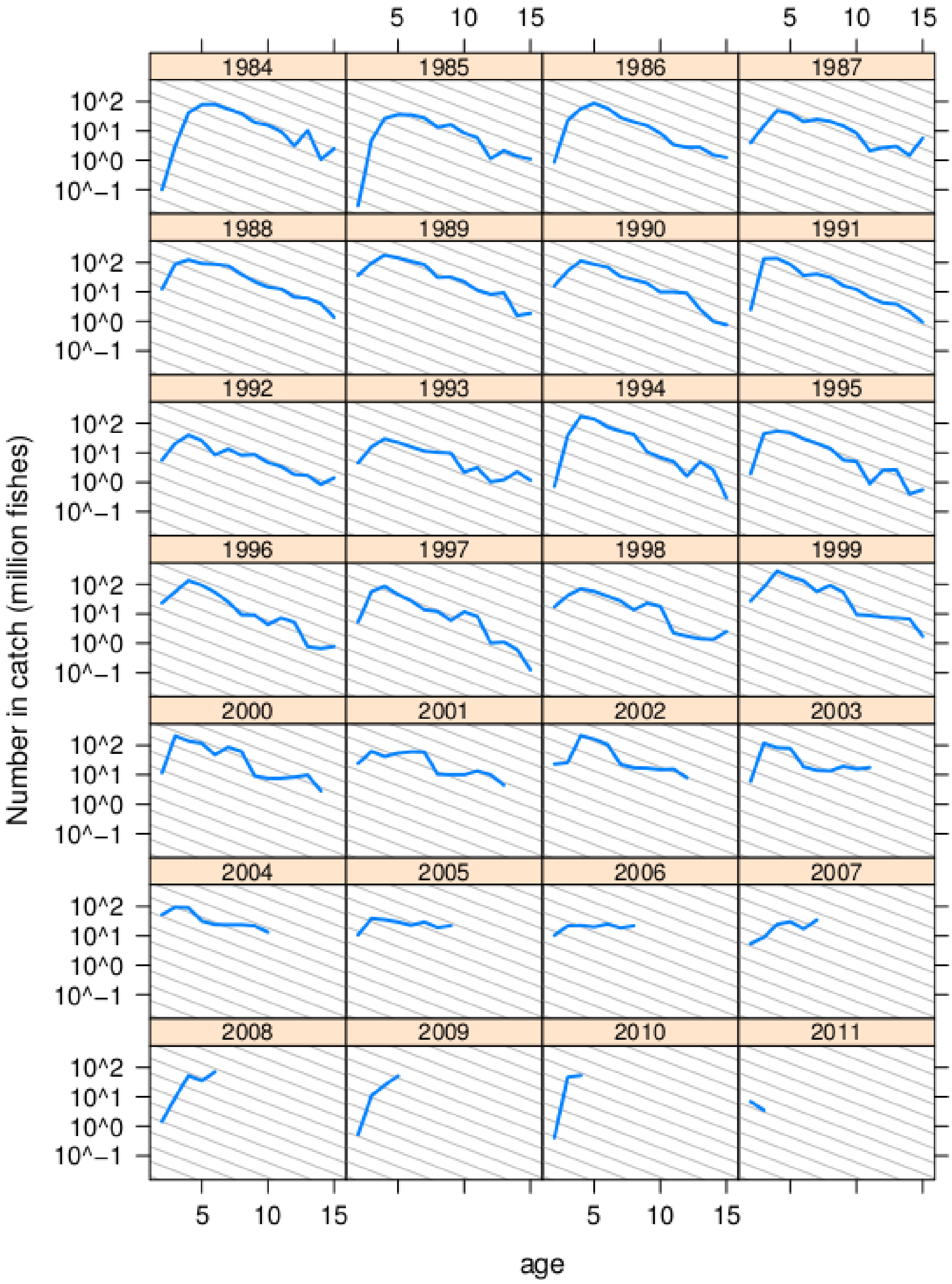


Figure 11.3.1.1. Icelandic summer-spawning herring. Catch curves by year classes 1984-2011. Grey lines correspond to Z=0.4. Note that the mass mortality in Kolgrafafjörður is added to the catches in 2012.

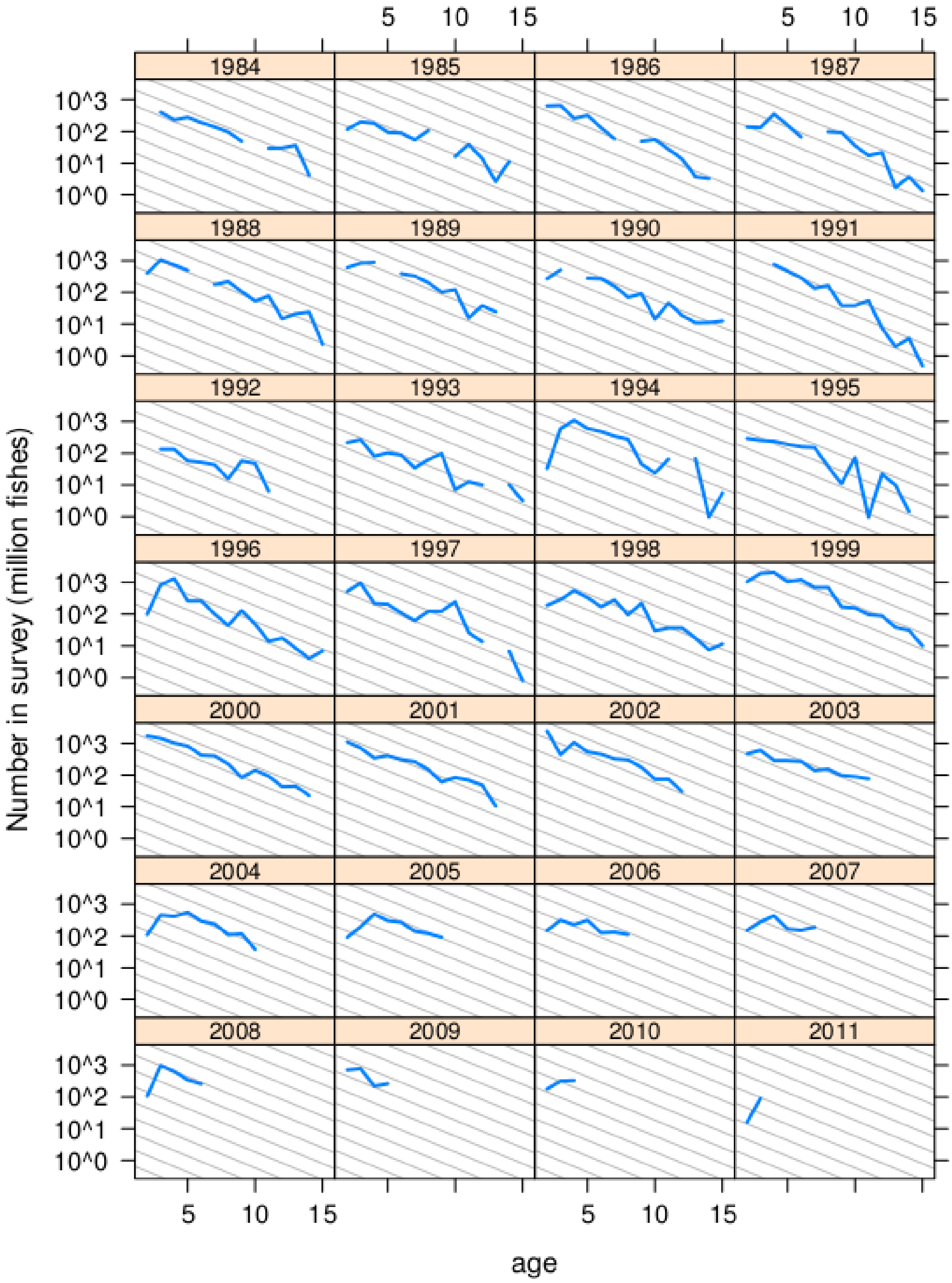


Figure 11.3.1.2. Icelandic summer spawning herring. Catch curves from survey data by year classes 1984-2011. Grey lines correspond to Z=0.4.

a)

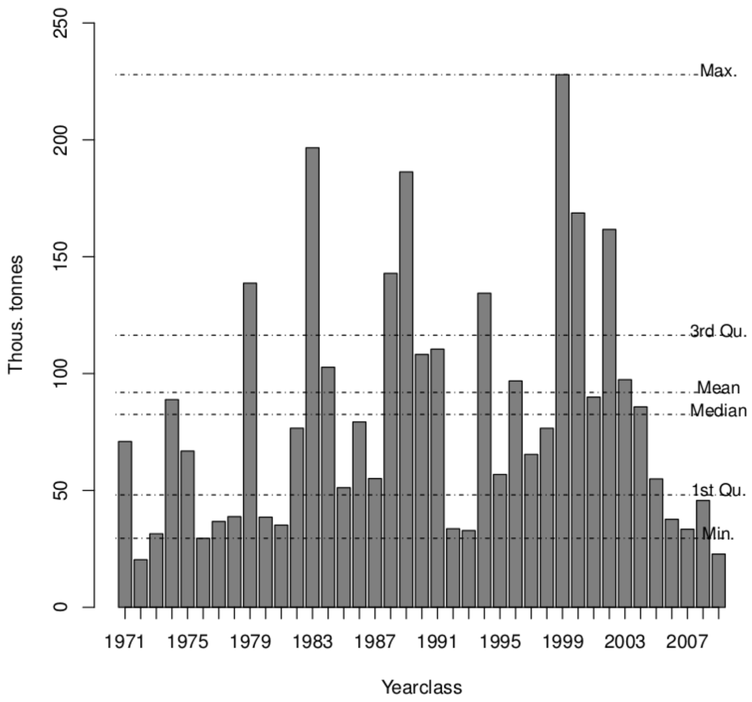


Figure 11.3.1.3. The sum of total catch of each year class of Icelandic summer-spawning herring from 1971 to 2009 based on catch data from 1975-2014. The provided summary statistic is based on year classes from 1973 to 2002.

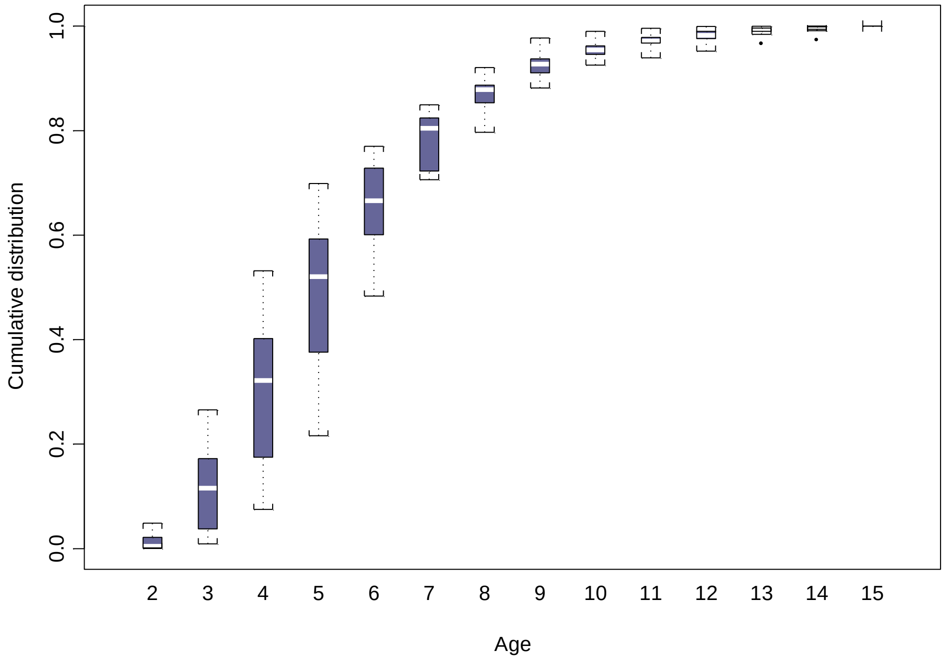


Figure 11.3.1.4. The cumulative total biomass in the catch (in proportion) of Icelandic summer-spawning herring for different age group for the year classes 1978 to 1996.

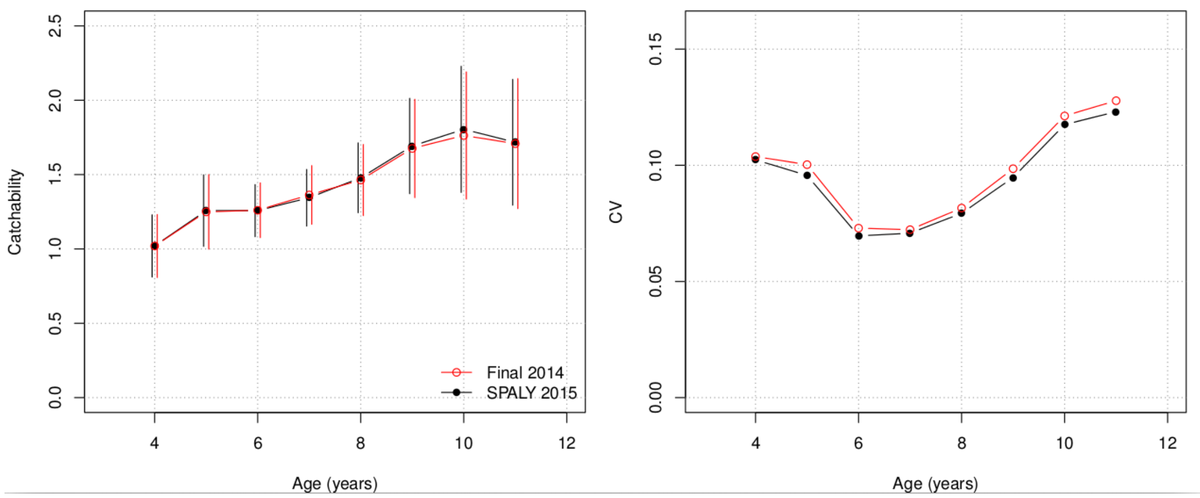


Figure 11.3.2.1. Icelandic summer-spawning herring. The catchability (± 2 SE) and its CV for the acoustic surveys used in the final Adapt run in 2015 (1987-2014) compare to the assessment in 2014.

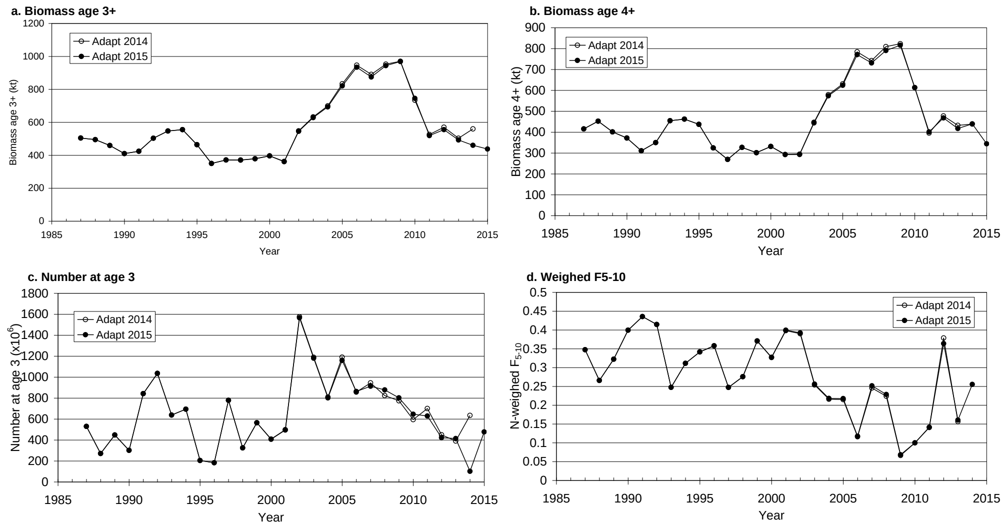


Figure 11.3.2.2. Icelandic summer-spawning herring. Comparisons of NFT-Adapt runs in 2015 and in 2014 concerning (a) biomass of age 3-12, (b) biomass of age 4-12, (c) number at age 3, and N-weighed F for age 5-10. Note that the mass mortality in Kolgrafafjörður in the winter 2012/13 is included in weighed F for that year (WF_{5-10} without the mass mortality was ~0.22) and the number at age 3 in 2014 from Adapt 2014 was geometric mean while number at age 3 in 2015 was predicted from juvenile index (see section 11.6.1).

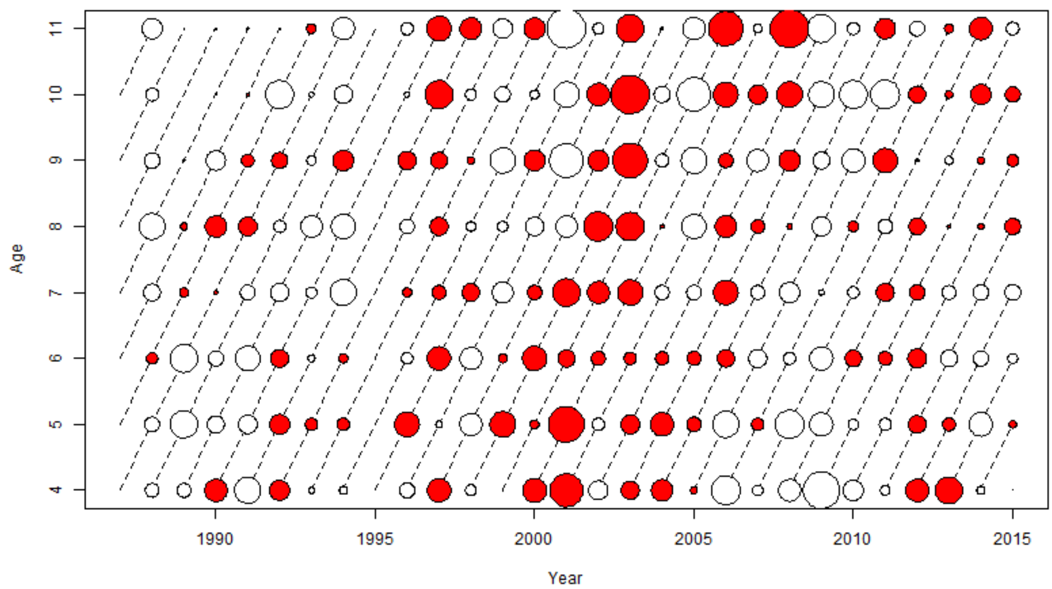


Figure 11.3.2.3. Icelandic summer spawning herring. Residuals of NFT-Adapt run in 2015 from survey observations (moved to 1st January). Filled bubbles are positive and open negative. Max bubble = 1.55.

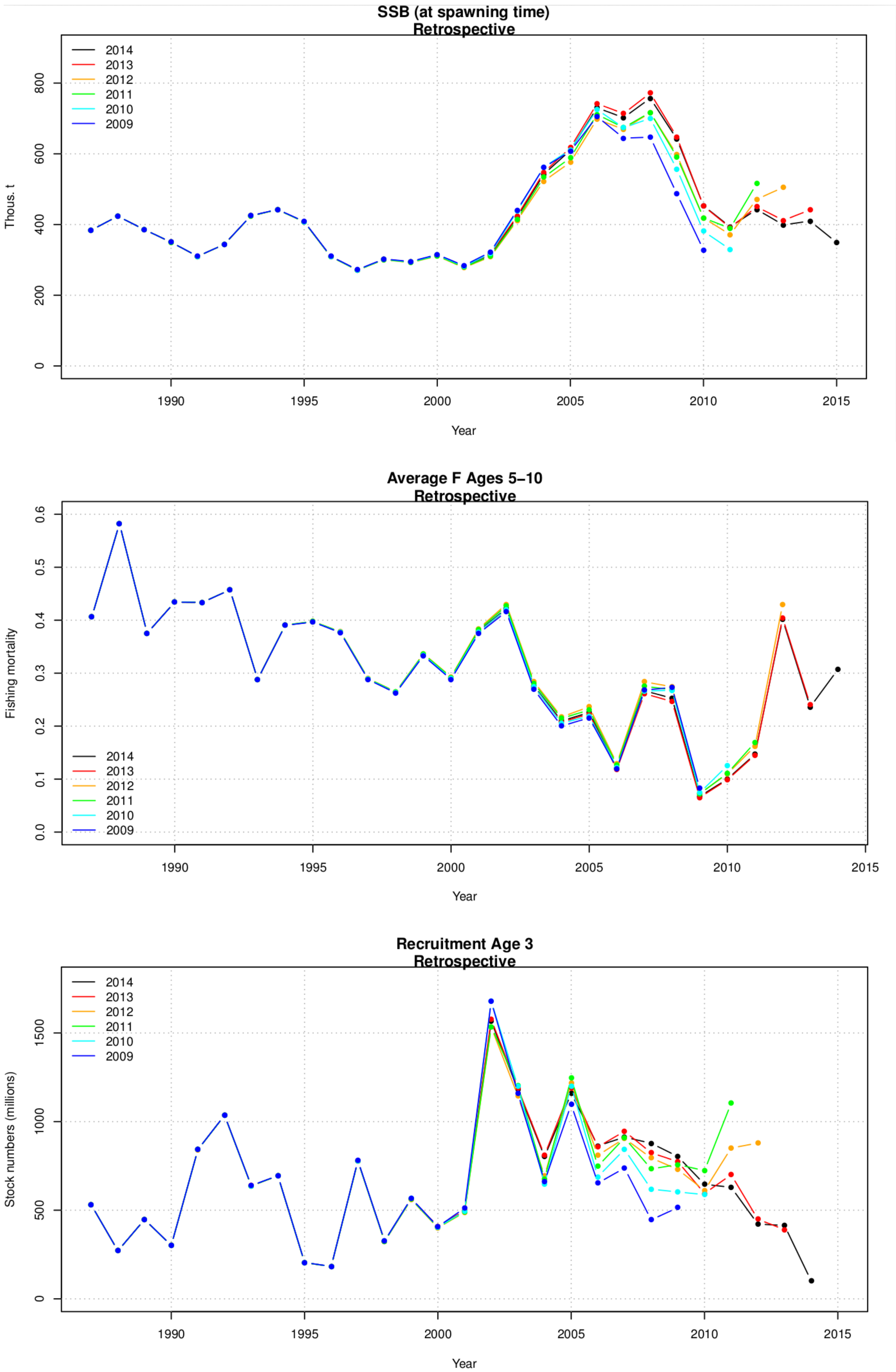


Figure 11.3.2.4. Icelandic summer spawning herring. Retrospective pattern from NFT-Adapt in 2015 in spawning stock biomass (the top panel), N weighted $F_{5\text{-}10}$ (middle panel) and recruitment as number at age 3 (lowest panel).

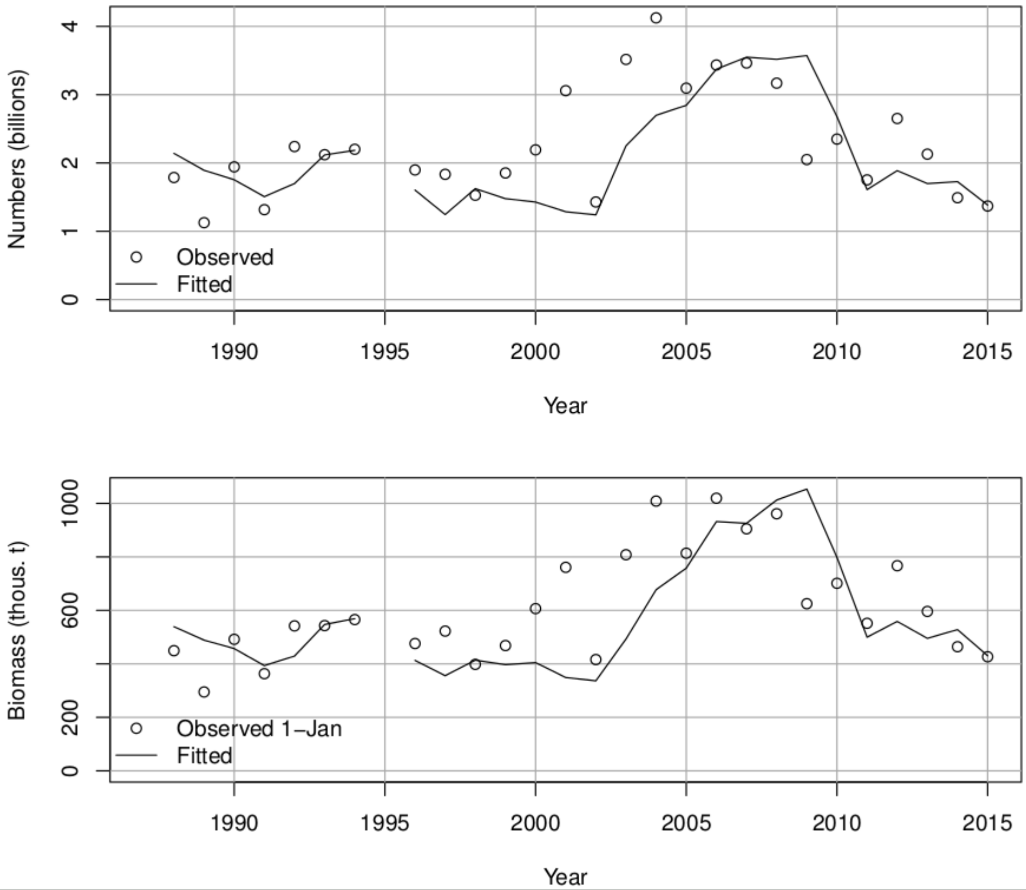


Figure 11.3.2.5. Icelandic summer-spawning herring. Observed versus. predicted survey values from NFT-Adapt run in 2015 for ages 4-11 with respect to numbers (upper) and biomass (lower).

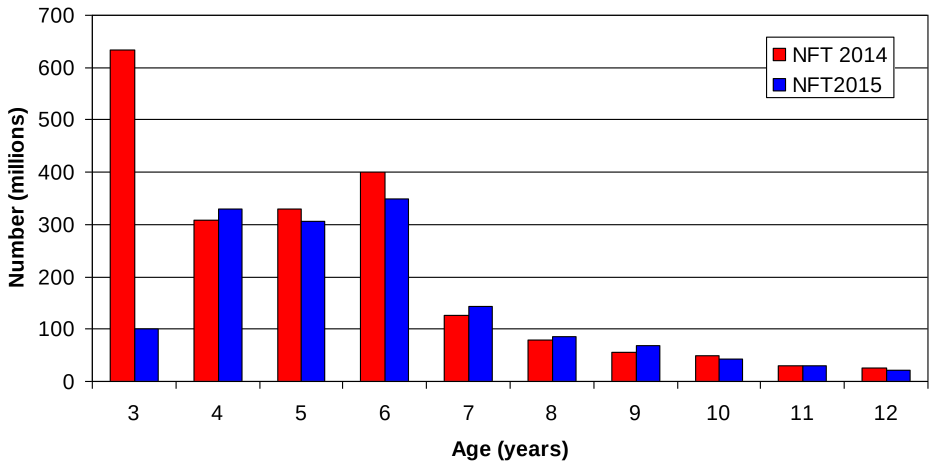


Figure 11.3.2.6. Icelandic summer-spawning herring. Comparison of number-at-age on Jan. 1st. 2014 from the final NFT model runs in 2014 and 2015 assessments.

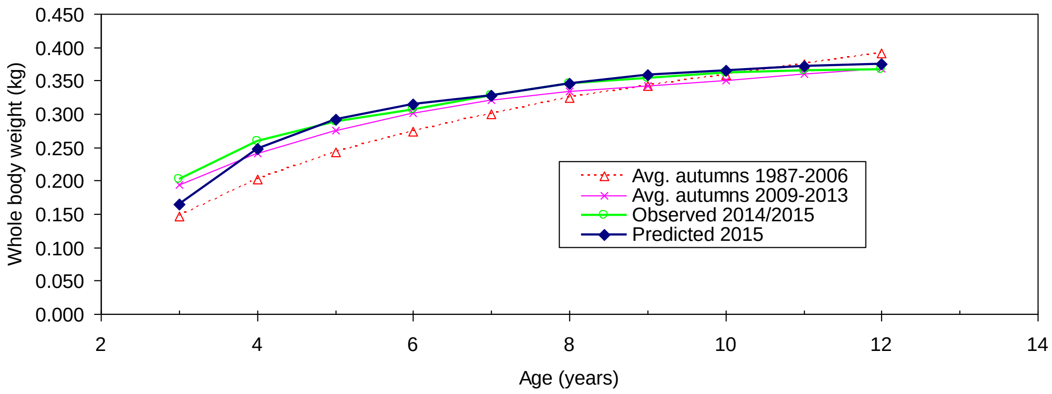


Figure 11.6.1.1. Icelandic summer spawning herring. The mean weight at age for age groups 3 to 12 (+ group) as mean weight across 1987-2006, 2009-2013, observed in the winter 2014/2015, and finally predicted weights for the autumn 2015 from the weights in 2014, which was used in the stock prognosis.

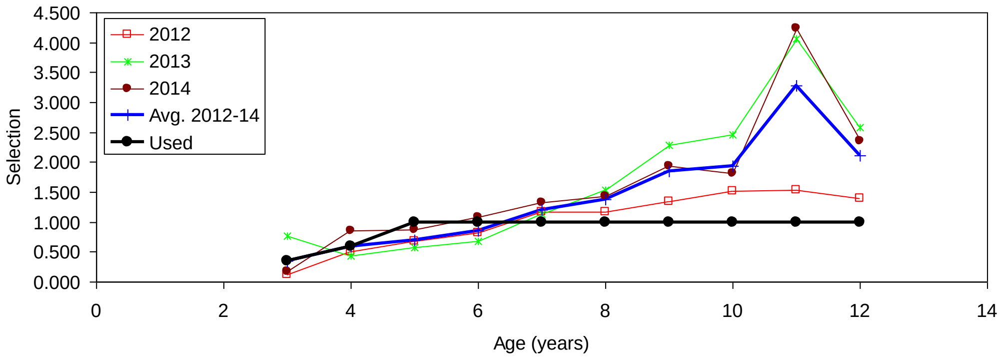


Figure 11.6.1.2. Icelandic summer spawning herring. The selection pattern for age groups 3 to 12 (+ group) for the years 2012 to 2014, the average selection across these three years, and the selection used in the prognosis (three years average for age 3 and 4, but fixed at 1.0 for age 4+).

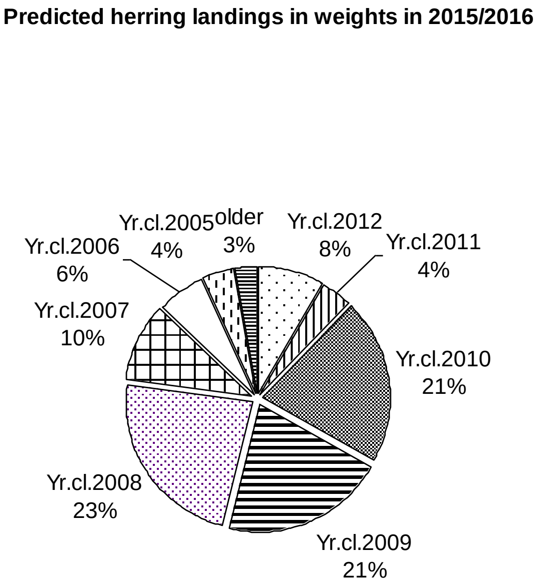


Figure 11.6.2.1. Icelandic summer spawning herring. The predicted biomass contribution of the different year classes to the catches in the fishing season 2015/2016.

12 Capelin in the Iceland-East Greenland-Jan Mayen area

Summary

In May 2014 ICES advised on the basis of precautionary considerations that the initial quota be set at the 50% of the predicted quota, implying an initial quota of 225 000 t. The quota was revised to 260 000 t after an acoustic survey in October. The final TAC of 580 000 t for the fishing season 2014/2015 was set after an acoustic survey in January 2015.

The total landings in the fishing season 2014/2015 amounted 517 thousand t (preliminary data). Around 40 000 t were taken in July 2014, 5 000 t in November 2014 and the rest during the winter months January-March 2015.

The stock was benchmarked in January 2015. New methods for setting a final TAC and an initial quota were established. They will both apply for the next fishing season. B_{lim} was defined during the meeting.

The acoustic index of 1 year old capelin from the acoustic survey is of an average size. On the basis of the new prediction model the initial quota in 2015/16 is 54 thousand t.

As the capelin increases its weight rapidly over the summer it is recommended that the fishery doesn't start until late autumn.

12.1 Stock description and management units

See stock-annex.

12.2 Scientific data

The capelin stock in Iceland-East Greenland-Jan Mayen area has been assessed by acoustics annually since 1978. The surveys have taken place in autumn (September-December) and in winter (January-February). An overview is given in the stock annex.

12.2.1 Surveys in autumn 2014

In 2014 the survey took place in the period 16 September-10 October.

The survey area extended along the shelf edge off East Greenland from about 73° 30′ N to about 65° 30' N, as well as Denmark Strait and the continental slope west and north off Iceland (Figure 12.2.1). Weather conditions during the survey were adverse for the first few days and the survey had to be discontinued several times because of storms but no drift ice was encountered during the survey.

Capelin was westerly distributed (as in recent years) and similar to last year capelin was found almost up to 73°N (Figure 12.2.1). In 2010 the northern limit was 71°N, in 2012 70°30' N, but there was no survey in 2011 (due to strike). Immature capelin dominated south of 68° 15′N, but was now also found north of Iceland. Further north, along the Greenland shelf, older, maturing capelin predominated.

The combined index of young capelin (immature at age 1 and 2) in 2014 is at the average of years 1980—2013 (Tables 12.2.1—12.2.2 and Figure 12.2.2). The index of young capelin in the autumn surveys has been the basis for the starting quota for many years, see further chapter 12.7.

In this survey around 660 thousand t of mature capelin was measured (Tables 12.2.1—12.2.3). On the basis of this estimate of the mature stock the Marine Research Institute recommended a TAC of 260 thousand t for the fishing season 2014/2015. This recommendation was in accordance with existing HCR and management plan between Iceland, Norway and Greenland.

12.2.2 Surveys in winter 2015

One survey was conducted in 5th—30th January 2014. The survey tracks are shown in Figure 12.2.3. Survey conditions were for the most part rather difficult. The survey had to be discontinued after 5 days in good recordings because of bad weather and could not be resumed again until 5 days later. The survey had to start again in the Denmark Strait because of uncertainty of migration speed and distance in the meantime. This part of the survey was done 17—29 January. The migration was not concentrated along the slope as usually but was spread over greater distances resulting in long survey transects and therefore rather slow progress of the survey. On the other hand the migration speed of the capelin appeared rather slow.

The main part of the mature capelin was situated from Denmark Strait in the west (from approx. 26°30´W) outside the shelf to the Kolbeinsey ridge (18°W). Further, there were some capelin found in a relatively small area east of Langanes in about 66°20’N and 12°30’W. In the most western part of the distribution area mixing of mature and immature capelin was common but was less prominent further east. Age, length and weight disaggregated abundance is shown in table 12.2.4. The total biomass was estimated 1071 thousand tonnes where about 970 thousand tonnes were maturing to spawn.

On the basis of this estimate of the mature stock the Marine Research Institute recommended a TAC of 580 thousand t for the fishing season 2014/2015. This recommendation was in accordance with existing HCR and management plan between Iceland, Norway and Greenland.

Since in year 2010 the autumn surveys have started in September, a month earlier than in previous years. The winter survey 2015 makes the third successful pair of autumn/winter surveys since 2010, as in 2011 there was no autumn survey in September due to a strike and in winter 2014 the survey did not give successful coverage of the capelin spawning stock. The 2014/15 pair gave 47% increase in SSB biomass following the winter survey estimate which is an extreme compared to the 14% and 9% differences of the 2010/11 and 2012/13 pairs respectively.

12.2.3 Fishery dependent data

A preliminary catch quota of 225 thousand t was recommended for the 2014/2015 fishing season. A total of 517 thousand t were caught from the final quota of 580 thousand t in the 2014/2015 fishing season.

In July 2014, around 100 nmi southwest off Scoresby, the Norwegian and Danish vessels caught 30 thousand t and 10 thousand t of capelin respectively. Further, in autumn 2014, the Greenlandic fleet caught 5 thousand t in Denmark strait, close to the midline between Iceland and Greenland.

The distribution of the winter catches, based on logbooks for the Icelandic fleet, is shown in Figure 12.3.1. The beginning of the 2015 winter fishery had a slow start where in weeks 2-4 the fleet was fishing north of the north-eastern Icelandic continental shelf from rather scattered observations of capelin, meanwhile a considerable abundance of capelin was observed further west by a research survey. During the following 3 weeks the fisheries took mainly place much closer to the shore off north Iceland with few casts east of the Eastfjords. This is unusual development of the fishery as traditionally, at this time, the fleet would be fishing east and south of Iceland from the spawning migration of capelin. However, it is not until in week 8 that the fleet starts fishing from dense schools of capelin close to shore south-east off Iceland. This migration moved fast westward and was followed by the fishery south of the coast of west-Iceland in following two weeks and ended west of Breidafjordur in weeks 11-13. The landings during winter amounted 417 thousand t (preliminary information).

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. The catches of the 2014/2015 fishing season amounted 517 thousand t, which is close to the average of catches since the beginning of the fishery.

Sampling from commercial catches is not considered to be adequate. From the fishery in winter 24 samples (2331 length measured and age read) were taken by the Icelandic fleet, 14 samples were taken by the Norwegian fleet, but no samples were taken by either the Faroes or the Greenlandic fleet. The Norwegian Fleet took 14 samples during the fishery in July and further 7 samples were taken in Iceland from Danish capelin fishery landed to Icelandic factories in summer 2014.

The total catches in numbers by age during the summer/autumn since 1985 are given in Table 12.3.2 and for the winter since 1986 in Table 12.3.3. Similar age distribution was observed in the catches 2015 as in the survey in January 2015.

Preliminary and final TAC as well as landings for the fishing seasons since 1992/93 are given in Table 12.3.4.

12.3 Growth

Seasonal growth pattern, with considerably increased growth rate during summer and autumn has been observed in this capelin stock in a study of the period 1979—1992. Where immature fish had slower growth during winter, the maturing fish had faster summer growth that continued throughout the winter until spawning in in March/April, followed by almost 100% spawning mortality (Vilhjalmsson, 1994). Further, examination of the growth of immature capelin at age 1 in autumn to mature at age 2 in autumn the year after in the period 1979—2013 showed on average almost 4 fold weight increase during one year (Gudmundsdottir and Thorsteinsson, WD in 2014). This considerable weight increase and seasonal pattern in growth the year before spawning should be taken into account when deciding the timing of the capelin fisheries.

12.4 Methods

Since early 1980s the stock has been managed according to an escapement strategy, leaving 400 thousand t to spawning. To predict the TAC for the next fishing season a model was developed early 1990s. These models were not endorsed by the benchmark working group WKSHORT 2009.

New methods for setting the final TAC and setting an initial quota were endorsed by the benchmark working group WKICE in 2015. The working frame is now a stochastic one, similar to the one for the Barents Sea capelin. The total TAC will be given so, that $p(SSB < Blim=150\ 000\ t) < 0.05$. This method will be applied for the first time in the next fishing season (2015/16).

The rationale behind the model of setting an initial quota is to set it low so that there is a minimum risk of it being higher than the final TAC. This method is used for the first time during this working group, for setting the initial quota for the fishing season 2015/16.

See WKICE (ICES, 2015) and the Stock Annex for the capelin in the Iceland-East Greenland-Jan Mayen area.

12.5 Reference points

During WKICE (ICES, 2015) B_{lim} of 150 000 t was defined. No other reference points are defined for this stock.

12.6 State of the stock

The objective of the existing HCR for the stock is to leave 400 thousand t for spawning (escapement strategy). It is estimated that 460 thousand t were left for spawning in spring 2015 (Table 12.7.1 and 12.7.2).

The acoustic indices of recruits are considered to be close to an average size.

12.7 Short term forecast

Figure 12.8.1 (taken from WKICE 2015, stock-annex) shows the relation between the index of immature capelin from an autumn survey and the estimated final advice for the fishing season starting a year later (see stock-annex). An initial quota is set on the basis of precautionary considerations (blue line). The risk of setting an initial quota exceeding the final TAC is considered very low.

By using the acoustic indices on immature capelin at age 1 and immature at age 2 from autumn 2014 (Table 12.2.2 and figure 12.2.2) the predicted TAC for the fishing season 2015/2016 is estimated as 313 600 t and the initial quota as 53 600 t (table 12.8.1).

12.8 (Medium term forecasts)

12.9 Uncertainties in assessment and forecast

The uncertainty of the acoustic estimates of the stock depends largely on the uncertainty of the echo abundance. The CV for the mature biomass was estimated by bootstrapping the SSB biomass values within the rectangles and strata used in the acoustic assessment. In the autumn 2014 survey the CV was estimated as 0.19 for the mature stock and 0.12 in the winter 2015 survey.

This fishing season there is a discrepancy between the estimate of the mature stock according to the acoustic surveys in autumn and winter, but these surveys are used to revise/set the TAC. The winter survey gives 47% higher mature stock, than the autumn survey, but both surveys are considered to have covered the mature stock. In the fishing seasons 2010/11 and 2012/13 the ratio between the corresponding pairs were 14% and 9% respectively.

The uncertainty when calculating the stock size by a deterministic method used so far is the value of M. A fixed value of M=0.035/month has been used, but it may be too low according to WKSHORT 2009.

The acoustic survey in September-October 2014 had a good coverage of the spatial distribution of the capelin stock. The uncertainty of the immature capelin estimate is considered low with a CV of 0.18. The numbers of immatures are used as input in the prediction model.

12.10 Comparison with previous assessment and forecast

For the fishing season 2014/2015 an initial quota of 225 thousand t were set. The final TAC was 580 thousand t. The landings were 517 thousand t.

According to the HCR 400 thousand t shall be left for spawning. It is assumed that around 460 thousand t spawned in spring 2015 as not all quota was taken.

12.11 Management plans and evaluations

In June 1989 Greenland, Iceland and Norway signed a management plan. It has been revised several times since then, most recently in 2003.

The fishery is managed according to a two-step management plan which requires a minimum spawning-stock biomass of 400 thousand 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 abundance of immature (age 1 and age 2) part of the capelin stock about a year before it enters the fishable stock. The preliminary TAC is set at 2/3 of the predicted TAC, calculated on the condition that 400 thousand 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 and set the final TAC, still based on the condition that 400 thousand 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

The fishing season for capelin has since 1975 started in the period from late June to July/August (when surveys on the juvenile part of the stock the year before has resulted in the setting of a preliminary catch quota). At that time the availability of plankton is at its highest and the fishable stock of capelin is feeding very actively over large areas north of Iceland between Greenland and Jan Mayen, increasing rapidly in size, weight and fatness. By late September/beginning of October this period of rapid growth is over. The growth is fasted the first two years, but the weight increase is most in the year before spawning.

Taken into account the large weight increase in the summer before spawning (section 12.4) it is clear that more catches are gained by the same effort if the fishery starts late autumn instead of summer. This is also supported by information for the Barents Sea capelin, but is has been shown for that stock that fishing during autumn would maximize the yield, but from the ecosystem point of view a winter fishery were preferable (Gjøsæter *et.al.,* 2002). As the biology of these two capelin stocks is similar and their effect on the ecosystem too, this is considered to be valid for the Icelandic capelin too.

Seasonal variation of fat content is also observed. During the summer period, the fat content rises from approximately 5% to 20% in late autumn before spawning (Figure 12.1.1, Engilbertsson et. al. 2012). In the following fall and winter the fat content slowly declines, until the spawning migration begins in early January where the fat content drops drastically from about 15% to 5% in mid-April. Immature capelin has much lower fat content, usually less than 3-4%.

During the summer and autumn, survey results show often overlap between juveniles and adult capelin. It has been reported by fishermen that while fishing with pelagic trawl in such areas, the catches are often poorer than expected from echo signals than when fishing in areas where there is only adult capelin. That might indicate greater escapement of juveniles through meshes. The effect of such escapement on the fish is unknown.

12.13 Ecosystem considerations

Capelin is an important forage fish and its dynamics are expected to have implications on the productivity of their predators (see further in section 7.3). Capelin is the main single item in the diet of Icelandic cod and a key prey to several species of marine mammals and seabirds and also important as food for several other commercial fish species (see e.g. Vilhjálmsson, 2002).

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.

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.

It is permissible to transfer catches from the purse-seine of one vessel to another vessel, in order to avoid slippage. However, if the catches are beyond the carrying capacity of the vessel and no other vessel is nearby, slippage is allowed. In recent years, reporting of such slippage has not been frequent. Industrial trawlers do not have the permission to slip capelin in order to harmonize catches to the processing.

In Icelandic waters, fishing with pelagic trawl is only allowed in limited area off the NE-coast (fishing in January) to protect capelin juveniles and to reduce the risk of affecting the spawning migration route.

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 14 cm) is enforced in Icelandic waters, using on-board observers.

12.15 Changes in fishing technology and fishing patterns

Variable amount of the catches have been taken with pelagic trawl through the fishing seasons. Total landings in 2015/16 amounted 517 kt (preliminary numbers) (88% purse-seine, 12% pelagic trawl). Discards are considered negligible.

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. It has been put forward in the 2000s that this temperature increase, may have led to displacements of the juvenile part and the spawning areas of the capelin stock (Vilhjálmsson, 2007). The acoustic surveys in autumn 2010, 2012-2014 partly confirmed this, but major part of the spawning still takes place on the usual grounds.

More detailed environmental description is in section 7.3.

12.17 Recommendations

A considerable difference was evident between SSB estimates from autumn and winter acoustic surveys during this fishing season, meanwhile both surveys are believed to have a good coverage of the maturing stock component. Hence, it is recommended that it should be evaluated if and then how the SSB estimates from autumn and winter surveys should be weighted in the future when final TAC is defined.

Studies of optimal harvesting of capelin should be conducted and presented to the NWWG. These estimates should take account of growth, mortality and gear selection in relation to the timing of the fishery (as recommended by WKICE 2015).

The NWWG should initiate a review of the role of capelin in the Icelandic Sea ecosystem and in particular whether the population size and growth of capelin predators shows a response to changes in capelin abundance (as recommended by WKICE 2015).

12.18Special request

ICES got the following request from the Coastal States of the capelin in the Iceland-East Greenland-Jan Mayen area:

"Capelin in East Greenland, Iceland and Jan Mayen area was benchmarked by ICES in January this year and consequently the basis for the TAC advice was changed to a new PA approach. I assume therefore that ICES in May will provide advice in accordance to the new approach. As you are aware, the coastal states of this stock, namely Greenland, Iceland and Norway, manage the stock according to an agreement where the main element are an escapement target and an initial TAC of 2/3 of the final TAC. The coastal states appreciate the work conducted at the benchmark and aim to follow this new approach, however, the present management agreement is likely not revised according to the benchmark before later this year. On behalf of the coastal states, Greenland, Iceland and Norway, I therefore kindly request ICES in its May 2015 advice to provide a catch option according to the present management agreement."

Short term by the old rule

WKSHORT (ICES, 2009) rejected the model that had been used since 1991 for predicting a quota for the next fishing season. The main reasoning was the value of M=0.035 per month, which is considered too low. Another issue identified by the WKSHORT was the intercept. The model predicts a quota for a fishing season starting in June in year Y, based on indices from autumn survey in year Y-1 and from winter survey in year Y, with the restriction that 400 000 t have to spawn 1 April in year Y+1 (Gudmundsdottir and Vilhjálmsson, 2002). This means that the spawning stock biomass has to be estimated around 18 months later than the estimates of the juveniles are obtained. An initial quota for the fishing season was then set as 2/3rd of the predicted quota.

Since 2011 additionally two other methods have been used to explore the SSB one and a half year after the survey takes place in autumn.

Based on the results from the models an initial quota could only be set twice; for the 2011/12 and 2014/15 fishing seasons. Then more caution was also applied, namely 1/2 instead of 2/3 of the predicted quota was set as an initial quota.

Like in the last years the three methods will be explored.

Projection model.

Based on the results from the acoustic surveys in autumn 2014 and from winter 2015 the new data was added to the time-series. Input data is given in table 12.19.1 and

12.19.2. Data from the acoustic surveys in 2004, 2005, 2007—2009 and 2011 were not used as they are not considered to be valid due to different reasons, but the main reason being lack of coverage due to drift ice in E-Greenland waters.

The updated regressions are shown in Figure 12.19.1. By applying this method a zero index for age 1 gives 19.44 million at age 2 (intercept of 19.44), resulting in a SSB of 280 thousand tonnes at spawning time one and a half year after the survey is conducted and using long term average mean weight at age.

The residuals from the regression indicate that the regression performs better at medium and high values than at low values, as then the observed values lie all below the fitted line, which makes it questionable if the regression can be used at low values. This year the index of 1 year old is at the lower range of the zone where the regression is considered to behave better.

In the last two years the predictor in regression 2 was in the lower range, contributing to the SSB only with 30 thousand tonnes in last year and nothing the year before. This time the predictor is higher than in the two preceding years, however well below the average.

This method estimates the SSB to be almost 920 thousand t in spring 2016 if no fishery takes place (Table 12.19.3). The contribution of the younger year class is 784 thousand t and the older year class 132 thousand t. Based on this model the predicted TAC for the fishing season 2015/2016 is 519 thousand t. According to the management plan 2/3rd of it is allocated as an initial quota, that is 346 thousand t. If the same ratio is used as in the last two times this method was applied, then the initial quota would be set as ½ of the predicted quota, resulting in an initial quota of 260 thousand t.

The predictor in regression 2 describes the total number of two years old in the stock in autumn Y (2014) (the number of mature and immature at age 2). The immatures are taken as the measured number of immature capelin at age 2 in the acoustic autumn survey. The mature part is however derived by projecting the number mature at age 3 in the winter survey backwards in time to autumn and adding the catches of the same year class taken before the survey. There is then a relation between the total number of capelin at age 2 in autumn to the mature number at age 3, a year later. By using this relation then higher number at age 2 gives higher number mature at age 3 (even though they are already dead). With the negative intercept, low values provide "negatively" to the SSB!

This year the biomass derived from the winter survey was 47% higher than the autumn survey. Theoretically the autumn survey could have been used for setting a final the TAC. Therefore it was decided to explore how the model would estimate the SSB in 2016 if only values from the autumn survey were applied. Applying these values the SSB in 2016 is estimated to be 800 thousand t, whereas the contribution of the younger year class is 776 thousand t and the older year class 23 thousand t. (0 index gives ~260 thousand t). Based on this model the predicted TAC for the fishing season 2015/2016 is 401 thousand t implying an initial quota of 267 thousand t (2/3rd of predicted catch) or 200 thousand t (1/2 of predicted catch).

So depending on whether the results from the acoustic surveys in autumn or in winter are used, the estimate of the SSB differ of 116 thousand t, thereof stem 109 thousand t from the older year class. The use of the regression for the older age group must be considered questionable. Using only the contributions from the younger age group the SSB in 2016 would be around 780 thousand t.

Zero intercept regressions.

An alternative procedure to the one above, is to make the regressions go through the origin (figure 12.18.3). For low indices the residuals have similar pattern as in the 'projection model', but in the opposite direction. Bigger changes are observed in the residuals for higher indices. This 'zero intercept regression' causes less problems at low index values. For the older age group the regression gives slightly higher values that in the 'projection model'. This method estimates the SSB in spring 2016 to be 863 thousand t if no fishery takes place (675 thousand t for age 2 and 188 thousand t for age 3). (Table 12.19.3). The high number at age 3 (already dead) in the survey in winter 2015 mean high number at age 2 last autumn, which again mean higher number of mature fish at age 3 next autumn!

Simple forward projection.

By using a standard ICES procedure (a simple forward projection) it is assumed that the indices are absolute. A natural mortality of M=0.035/month is used, but this assumption of M was, among other things, the reasoning for not endorsing the projection model by WKSHORT 2009 as it was considered too low. This method doesn't involve specific issues when index is low. By assuming no fishery on juveniles in 2014/15 and 2015/16 this method gives a SSB of 626 thousand t in spring 2016 (Table 12.19.3).

Summary.

The three methods above estimate the SSB in 2016 to be in the range from 626 – 920 thousand t if no fishery takes place (Table 12.19.3). According to the management plan 400 thousand t have to be left for spawning. This means that approximately 226-520 thousand tonnes are left for fishing. An initial quota is then calculated on that basis. Due to uncertainties in the projection model and the approach for calculating the TAC, it has been suggested that the fishery should not be opened until after an acoustic survey (in autumn/winter) if the predicted TAC < 500 thousand t (Gudmundsdottir and Vilhjálmsson, 2002).

12.19 References

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Table 12.2.1 Capelin. Acoustic assessment of capelin in the Iceland/Greenland/Jan Mayen area, by r/v Arni Fridriksson 16/9-10/10 2014 (Numbers in millions, biomass in tonnes).

		N Age						
Length	W	1	2	3	4	Numbers	Biomass	Total
7.5	1.3	478.1	0.0	0.0	0.0	478.1	643.9	
8	1.5	3050.3	0.0	0.0	0.0	3050.3	4706.8	
8.5	2.0	4301.5	0.0	0.0	0.0	4301.5	8458.4	
9	2.4	8007.4	0.0	0.0	0.0	8007.4	19208.3	
9.5	2.9	7183.0	0.0	0.0	0.0	7183.0	20993.4	
10	3.5	7879.0	0.0	0.0	0.0	7879.0	27671.7	
10.5	4.3	6334.5	0.0	0.0	0.0	6334.5	26997.1	
11	5.3	4567.7	0.0	0.0	0.0	4567.7	24010.5	
11.5	6.1	5106.0	0.0	0.0	0.0	5106.0	30957.0	
12	7.0	5028.4	0.0	0.0	0.0	5028.4	35211.9	
12.5	8.0	3721.8	116.1	0.0	0.0	3837.9	30773.8	
13	9.4	1930.6	617.4	0.0	0.0	2548.0	23915.3	
13.5	11.3	432.9	1806.2	107.4	0.0	2346.5	26450.2	
14	12.9	0.0	3128.8	294.3	0.0	3423.1	44099.3	
14.5	14.7	22.2	4830.1	722.5	0.0	5574.7	81888.6	
15	16.6	0.0	5492.6	938.0	9.7	6440.2	107001.5	
15.5	18.6	0.0	5512.1	1453.0	0.0	6965.1	129495.1	
16	21.5	0.0	3767.6	1556.6	11.7	5335.9	114518.3	
16.5	23.5	0.0	2785.9	1004.4	29.6	3819.9	89714.4	
17	26.3	0.0	1165.5	996.8	19.9	2182.3	57449.0	
17.5	29.6	0.0	558.6	435.4	8.3	1002.2	29650.7	
18	33.4	0.0	75.0	190.3	11.7	276.9	9258.8	
18.5	35.8	0.0	11.7	97.9	0.0	109.6	3926.7	
19	39.2	0.0	11.7	8.3	0.0	19.9	781.4	
19.5	42.6	0.0	0.0	8.3	0.0	8.3	351.6	
	Total N* 10-6	58043.3	29879.2	7813.1	90.9	95826.4		
	Total B (tt)	252027.3	528961.6	164877.4	2267.3		948133.7	
	Average W (gr)	4.3	17.7	21.1	25.0			9.9
	Average L (cm)	10.3	14.8	14.2	12.8			12.0
	%N	60.6	31.2	8.2	0.1			100.0

Immature

Age	1	2	3	Total
Total N* 10-6	57018.4	3345.7	209.6	60573.7
Total B (tt)	241896.8	42454.8	3479.9	287831.5
Average W (gr)	4.2	12.7	16.6	4.8
Average L (cm)	10.2	14.1	15.0	10.5
%N	94.1	5.5	0.3	100.0

Mature

Age	1	2	3	4	Total
Total N* 10-6	1024.9	26533.5	7603.5	90.9	35252.7
Total B (tt)	10130.5	486506.8	161397.1	2267.3	660301.7
Average W (gr)	9.9	18.3	21.2	25.0	18.7
Average L (cm)	12.9	15.3	15.9	16.7	15.4
%N	2.9	75.3	21.6	0.3	100.0

Table 12.2.2. Icelandic Capelin. Abundance of age-classes in numbers (109) measured in acoustic surveys in autumn.

Year	Mon	Day	age1	age1	age2	age2mat	age3	age3mat	age4	age5
			imm	mat	imm	mat	imm	Mat	mat	mat
1978	10	16				60.0		13.9	0.4	
1979	10	14	10.0			49.7		9.1	0.4	
1980	10	11	23.5			19.5		4.8		
1981	11	26	21.0		1.1	11.9		0.6		
1982	10	2	68.0		1.7	15.0		1.6		
1983	10	3	44.1		8.2	58.6		5.6	0.1	
1984	11	1	73.8		4.6	31.9		10.3	0.3	
1985	10	8	33.8		12.6	43.7		14.4	0.4	0.1
1986	10	4	58.6		1.4	19.9		29.8	0.3	
1987	11	18	21.3		2.5	52.0		13.5		
1988	10	6	43.9		6.7	53.0		17.0	0.4	
1989	10	26	29.2		1.8	2.9		0.6		
1990	11	8	24.9		1.3	16.4		2.7	0.1	
1991	11	15	60.0		5.3	44.7		4.2		
1992	10	13	104.6		2.3	54.5		4.3	0.1	
1993	11	18	100.4		9.8	55.1		4.9		
1994	11	25	119.0		6.9	29.2		4.4		
1995	11	30	165.0		30.1	84.6		7.0		
1996	11	27	111.9		16.4	70.0		15.9		
1997	11	1	66.8		30.8	52.5		8.5		
1998	11	13	121.0		5.9	20.5		3.3		
1999	11	15	89.8		4.4	18.1		0.9		
2000	11	10	103.7		10.9	11.6	0.1	0.6		
2001	11	12	101.8		2.4	22.1	0.0	0.7		
2002	11	12	1.0		0.5					
2003	11	6	4.9		3.1	1.7	0.1	0.2		
2004	11	22	7.9		0.1	7.3		0.8	0.0	
20053)	11									
2006	11	6	44.7		0.3	5.2		0.4		
2007	11	7	5.7		0.1	1.3		0.0		
2008	11	17	7.5	5.1	0.4	12.1		1.8		
2009	11	24	13.0	2.4		5.0		0.7		
2010	10	1	91.6	9.6	6.3	25.8	0.1	0.8	0.02	
20114)	11	29	9.0	0.6	3.6	19.9	0.05	2.1		
2012	10	3	18.5	0.9	2.0	21.2	0.07	11.4	0.1	
2013	9	17	60.1	0.6	6.9	25.0	1.3	6.9	0.1	
2014	9	16	57.0	1.0	3.3	26.5	0.2	7.6	0.1	

1987 - The number at age 1 was from survey earlier in autumn.

2005 - Scouting vessels searched for capelin. r/s ÁF measured. No samples taken for age determination. Estimated to be < 50 thous. tonnes.

2011-Only limited coverage of the traditional capelin distribution area.

Table 12.2.3. Icelandic Capelin. Mean weight (g) of age-classes measured in acoustic surveys in autumn. (imm=immature, mat=mature). See footnotes in table 12.2.2.

Year	Mon.	age1	Age1	age2	age2	age3	age3	age4	age5
		Imm.	Mat.	Imm.	Mat.	Imm.	Mat.	mat	mat
1978	10				19.8		25.4	26.3	
1979	10	6.2			15.7		23.0	20.8	
1980	10	7.3			19.4		26.7		
1981	11	3.6		12.3	19.4		22.5		
1982	10	3.8		8.5	16.5		24.1		
1983	10	5.1		9.5	16.8		22.5	23.0	
1984	11	2.9		8.3	15.8		25.7	23.2	
1985	10	3.8		8.5	15.5		23.8	29.5	31.0
1986	10	4.0		6.1	18.1		24.1	28.8	
1987	11	2.8		8.7	17.9		25.8		
1988	10	3.0		8.0	15.4		23.4	20.9	
1989	10	3.5		8.0	12.9		24.0		
1990	11	3.9		8.4	18.0		25.5	36.0	
1991	11	4.7		7.9	16.3		25.4		
1992	10	3.7		8.6	16.5		22.6	22.0	
1993	11	3.6		8.9	16.2		23.3		
1994	11	3.3		7.9	15.9		23.6		
1995	11	3.7		7.0	14.0		20.8		
1996	11	3.1		7.4	15.8		20.6		
1997	11	3.3		8.5	14.3		20.1		
1998	11	3.5		9.9	13.7		18.8		
1999	11	3.6		8.0	15.4		19.5		
2000	11	3.9		8.5	13.4	13.0	20.8		
2001	11	3.8		8.8	16.3	15.7	23.9		
2002	11								
2003	11	7.2		14.9	17.0	22.6	23.7		
2004	11	7.4		7.6	16.0		18.0	14.5	
2005									
2006	11	3.7		7.9	15.0		16.7		
2007	11	5.5		8.6	14.9		15.8		
2008	11	6.2	11.0	6.9	18.6		22.4		
2009	11	5.1	9.8		20.0		23.8		
2010	10	5.8	12.9	12.2	19.0	12.9	24.0	21.2	
2011	11	6.8	11.4	11.1	18.7	15.8	24.4		
2012	10	6.5	16.0	15.3	22.0	22.4	28.0	26.6	
2013	9	5.8	12.6	10.9	18.0	11.2	20.9	23.6	
2014	9	4.2	9.9	12.7	18.3	16.6	21.2	25.0	

Table 12.2.4. Icelandic Capelin. Assessment of mature capelin in the Iceland/EastGreenland/Jan Mayen area, by r/v Arni Fridriksson in January 2015 (Numbers in millions, biomass in tonnes).

		Age						
Length	W	2	3	4	5	Numbers	Biomass	Total
12.5	7.81	47.08	6.28	0.00	0.00	53.36	416.82	
13	9.68	11.87	62.97	5.94	0.00	80.78	781.86	
13.5	10.69	196.96	631.67	0.00	0.00	828.63	8857.17	
14	11.75	201.43	1952.63	34.86	0.00	2188.93	25718.88	
14.5	13.37	111.89	4361.83	93.76	0.00	4567.48	61044.44	
15	15.08	10.20	5957.69	274.88	0.00	6242.78	94171.64	
15.5	16.97	0.00	7542.58	625.38	0.00	8167.96	138606.44	
16	19.06	0.00	7238.85	1544.92	56.27	8840.04	168533.02	
16.5	21.51	0.00	5952.46	1869.71	23.84	7846.01	168750.78	
17	24.24	0.00	3331.39	2230.59	25.93	5587.91	135431.12	
17.5	26.84	0.00	1701.75	1877.51	0.00	3579.25	96049.73	
18	29.48	0.00	482.22	1183.13	0.00	1665.35	49098.38	
18.5	31.89	0.00	47.69	484.41	0.00	532.10	16970.87	
19	36.65	0.00	23.84	136.49	0.00	160.33	5876.87	
19.5	38.90	0.00	0.00	56.27	0.00	56.27	2188.79	
	Total N* 10^{-6}	579.4	39293.9	10417.8	106.0	50397.2		
	Total B (tt)	6604.1	715565.0	248113.8	2214.0		972496.8	
	Average W (gr)	11.4	18.2	23.8	20.9			19.3
	Average L (cm)	13.8	15.7	16.9	16.4			15.9
	%N	1.1	78.0	20.7	0.2			100.0

Table 12.3.1 Capelin. The international catch since 1964 (thousand tonnes).

	Winter season					Summer and autumn season						
Year	Iceland	Norway	Faroes	Greenland	Season total	Iceland	Noway	Faroes	Greenland	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

	Winter season					Summer and autumn season						
Year	Iceland	Norway	Faroes	Greenland	Season total	Iceland	Noway	Faroes	Greenland	EU	Season total	Total
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	5.4	-	-	-	-	5.4	156.1
2011	321.8	30.8	19.5	13.1	385.2	8.4	58.5	-	5.2	-	72.1	457.3
2012	576.2	46.2	29.7	22.3	674.4	9	-	-	1	-	10.0	684.4
2013	454.0	40.0	30.0	17.0	541.0	-	-	-	-	-	-	541.0
2014*	111.4	6.2	8.0	16.1	141.7	-	30.5	-	5.3	9.7	45.5	187.2
2015*	353.6	50.6	29.9	37.9	471.9							

***preliminary, provided by working group members.**

Table 12.3.2 Icelandic capelin. 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) since 1985.

Year	age 1	age 2	age 3	age 4	Age 5	Total number	Total weight
1985	0.8	25.6	15.4	0.2		42.0	919.7
1986	+	10.0	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	6.0	1.5	+		9.2	121.0
1990	0.8	5.9	1.0	+		7.7	111.2
1991	0.3	2.7	0.4	+		3.4	56.0
1992	1.7	14.0	2.1	+		17.8	298.1
1993	0.2	24.9	5.4	0.2		30.7	611.6
1994	0.6	15.0	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	294.0
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	92.0
2005	-	0.4	+	-		0.4	9.0
2006	-	-	-	-		-	-
2007	-	-	-	-		-	-
2008	-	-	-	-		-	-
2009	-	-	-	-		-	-
2010	0.01	0.23	0.02	-		0.25	5.4
2011	-	2.45	1.61	-	0.08	4.13	72.1
2012	-	0.2	0.2	-	-	0.4	10.4
2013	-	-	-	-	-	-	-
2014	0.01	2.22	0.6	0.02	-	2.8	45.5

Table 12.3.3 Icelandic capelin. 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) since 1986.

Year	age 1	age 2	age 3	age 4	age 5	Total number	Total weight
1986		0.1	9.8	6.9	0.2	17.0	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	+	41.0	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	+	42.0	830.3
2001		0.4	27.9	6.7	+	35.0	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
2011		0.1	16.2	0.6	-	17.0	385.2
2012	0.02	0.6	25.0	6.1	0.02	31.8	674.4
2013	-	0.3	12.1	9.7	0.2	22.3	541.0
2014	-	0.1	4.8	1.3	+	6.1	141.8
2015	-	0.3	17.5	4.7	0.1	22.7	471.9

Table 12.3.4. Initial quota and final TAC by seasons.

Fishing season	Initial quota	Final TAC	Landings
1992/93[1]	500	900	788
1993/94[1]	900	1250	1179
1994/95	950	850	842
1995/96[1]	800	1390	930
1996/97[1]	1100	1600	1571
1997/98	850	1265	1245
1998/99	950	1200	1100
1999/00	866	1000	934
2000/01	650	1090	1065
2001/02	700	1300	1249
2002/03	690	1000	988
2003/04[2]	555	900	741
2004/05[3]	335	985	783
2005/06	No fishery	235	238
2006/07	No fishery	385	377
2007/08	207	207	202
2008/09[4]	No fishery		15
2009/10	No fishery	150	151
2010/11	No fishery	390	391
2011/12	366	765	747
2012/13	No fishery	570	551
2013/14[1]	No fishery	160	142
2014/15[5]	225	580	517

1) The final TAC was set on basis of autumn surveys in the season.

2) Indices from April 2003 were projected back to October 2002.

3) The initial quota was set on a basis of an acoustic survey in June/July 2004

4) No fishery was allowed, 15 000 t was assigned to scouting vessels.

5) Preliminary landings.

Table 12.7.1 Icelandic capelin. The estimated number (billions) of capelin on 1 January since 1979 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 2	Age 3	Age 4	Age 5	Number		weight			
Year	Juv.	Imm.	Mat.	Mat.	Mat.	Mat.	Imm.	Mat.	Imm.	Mat.	SSN	SSB
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	32.4	4.0		32.5	0.7		36.3	33.2	339	619	22.2	406
2009	37.3	6.4		14.5	2.6	+	43.7	17.1	413	343	17.3	328
2010	77.0	2.9		21.5	4.2		79.9	25.2	728	548	21.5	410
2011	117.7	13.6		36.2	1.9	-	131.3	38.1	1235	765	22.3	411
2012	49.1	28.8		46.4	7.9	+	77.9	54.4	678	1112	20.7	418
2013	60.8	9.6	2.2	22.0	18.8	0.4	70.4	42.1	574	983	17.9	417
2014	69.6*	17.2*	0.6	22.5	6.3	0.1	86.8*	29.4	591*	545	21.1	424
2015	51.1*	3.0*	0.6	40.9	10.9	0.1	54.1*	52.5	254*	1013	19.5	460

*** preliminary**

Table 12.7.2 Icelandic capelin in the Iceland-East Greenland-Jan Mayen area since the fishing season 1978/79. (A fishing season e.g. 1978/79 starts in summer 1978 and ends in March 1979). Recruitment of 1 year old fish (unit 109) are given for 1 August in the beginning of the season. Spawning stock biomass ('000 t) is given at the time of spawning at the end of the fishing season. Landings ('000 t) are the sum of the total landings in the season

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	148	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	130	988	410
2003/04	160	741	535
2004/05	57	783	602
2005/06	97	238	400
2006/07	67	377	410
2007/08	39	202	406
2008/09	44	15	328
2009/10	92	151	410
2010/11	140	391	411
2011/12	58	747	418
2012/13	72	551	417
2013/14	83*	142	424
2014/15	61*	517*	460*

*** preliminary**

Table 12.8.1.

Rationale	Catches (2015/2016)	Basis
Predicted final TAC	313 600 t	Black regression line, see figure 2.3.5.2
Initial quota, precautionary considerations	53 600 t	Blue line, see figure 2.3.5.2.

Table 12.19.1. Icelandic capelin. Input data for "old" short term predictions. Abundance at age in numbers (billions). Age1.ac and Age2.imm.ac are measured in acoustic surveys in autumn, September-October. *back* are numbers 1 August, derived from stock projections from winter surveys in January-February.

Year	Age1.ac	Age2.imm.ac	Age2.back.mat	Age2.back.tot	Age3.back.mat
1980	23.5	-1	-1	-1	-1
1981	23.7	1.1	39.7	43.2	-1
1982	68	1.7	17.1	32	2.3
1983	44.1	8.2	53.7	96.2	9.8
1984	73.8	4.6	40.7	81.8	27.9
1985	33.8	12.6	64.6	164.7	27
1986	58.6	1.4	35.6	66.2	65.8
1987	70.2	2.5	65.4	102.7	20.1
1988	43.9	6.7	70.3	94.3	24.5
1989	29.2	1.8	42.8	53.1	15.8
1990	39.2	1.3	31.9	42.1	6.8
1991	60	5.3	67.7	77.4	6.7
1992	104.6	2.3	70.7	87.3	6.4
1993	100.4	9.8	86.9	107	10.9
1994	119	6.9	59.8	94.8	13.2
1995	165	30.1	102.2	147.3	23
1996	111.9	16.4	100.7	129.6	29.6
1997	128.5	30.8	90.3	125.6	19
1998	121	5.9	89.5	108.7	23.2
1999	89.8	4.4	85.9	110.3	12.6
2000	103.7	10.9	65.7	91.4	16
2001	101.8	2.4	86.7	95.7	16.9
2002	74.4	0.5	68	91.9	5.9
2003	86.4	3.1	82.1	93.5	15.7
2004	7.9	0.1	86.6	90.1	7.5
2005	-1	-1	37.2	38.9	2.3
2006	44.7	0.3	62.5	63.7	1.1
2007	5.7	0.1	38.7	43.4	0.8
2008	7.5	0.4	17.2	23.3	3.1
2009	13	-1	20.8	24.1	4
2010	91.6	6.3	41.5	58.4	2.2
2011	9	3.6	62.1	96	11.1
2012	18.5	2	26.9	38	21.7
2013	60.1	6.9	23.7	43.3	6.6

Table 12.19.2. Icelandic capelin. Mean weight at age in autumn, used in the short-term projections.

Year	age2	age3
1980	19.4	
1981	19.4	22.5
1982	16.5	24.1
1983	16.8	22.5
1984	15.8	25.7
1985	15.5	23.8
1986	18.1	24.1
1987	17.6	25.8
1988	15.4	23.4
1989	17.8	26
1990	18.1	25.5
1991	16.3	25.4
1992	16.5	22.6
1993	16.2	23.3
1994	16	23.6
1995	14	20.8
1996	15.8	20.6
1997	14.3	20.1
1998	13.7	18.8
1999	15.4	19.5
2000	13.4	20.8
2001	16.3	23.9
2002		
2003	17	23.7
2004	16	18
2005		
2006	15	16.7
2007	14.9	15.8
2008	18.6	22.4
2009	20	23.8
2010	19	24.1
2011	18.7	24.3
2012	22	28
2013	18	20.9
2014	18.3	21.2

Table 12.19.3 Icelandic capelin. Outlook for 2015/2016 based on "old" prediction model.

Method	Rationale	Landings 2015/2016	Basis	SSB 2016
Projection model	Zero catch	0	No fishing	920
Projection model – only younger age group	Zero catch	0	No fishing	784
Projection model - all data from autumn survey	Zero catch	0	No fishing	800
Zero Intercept Regression	Zero catch	0	No fishing	863
ICES Short Term Forecast	Zero catch	0	No fishing	626
Projection model	Management plan	519	Bescapement	400

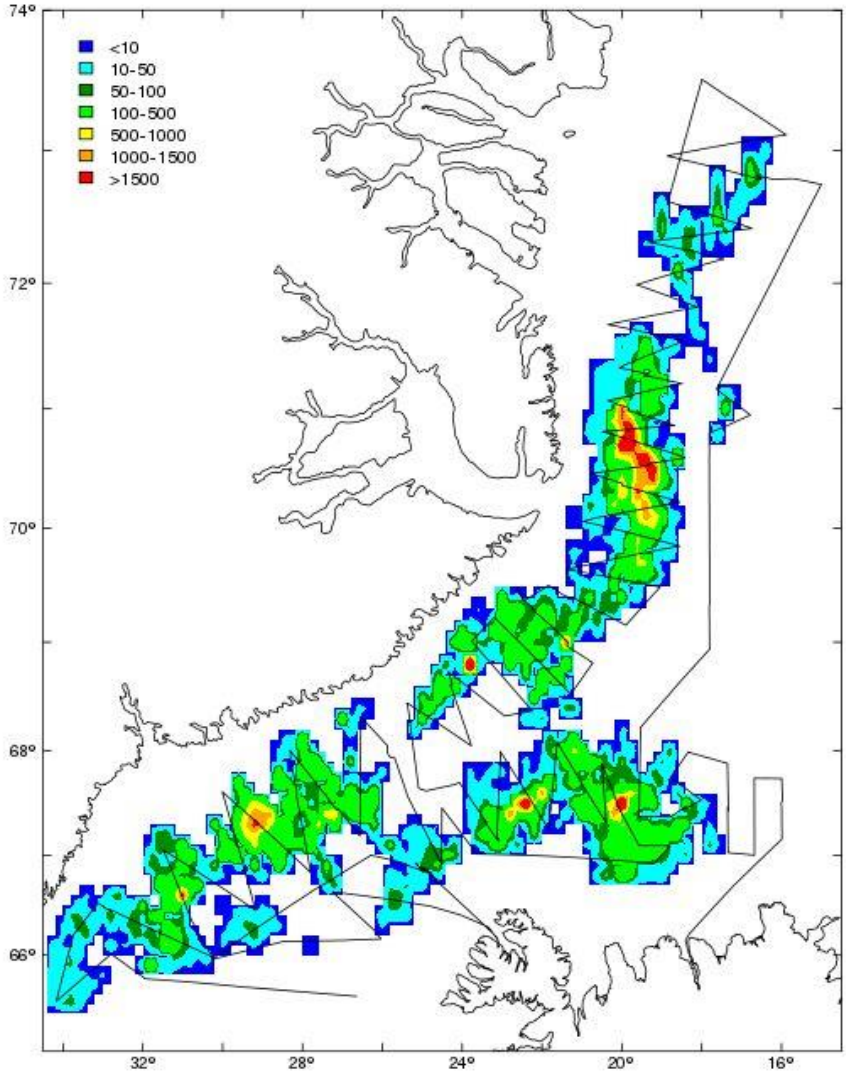


Figure 12.2.1. Icelandic capelin. Cruise tracks, relative density and distribution of capelin during an acoustic survey by r/v Arni Fridriksson during 16 September - 10 October 2014

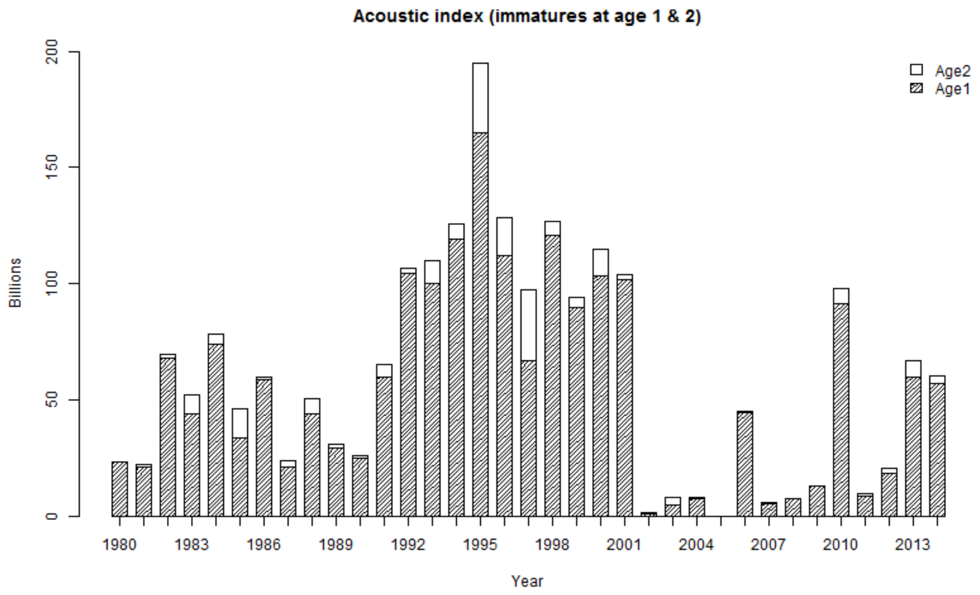


Figure 12.2.2. Icelandic capelin. Indices of immature 1 and immature 2 years old capelin from acoustic surveys in autumn since 1980.

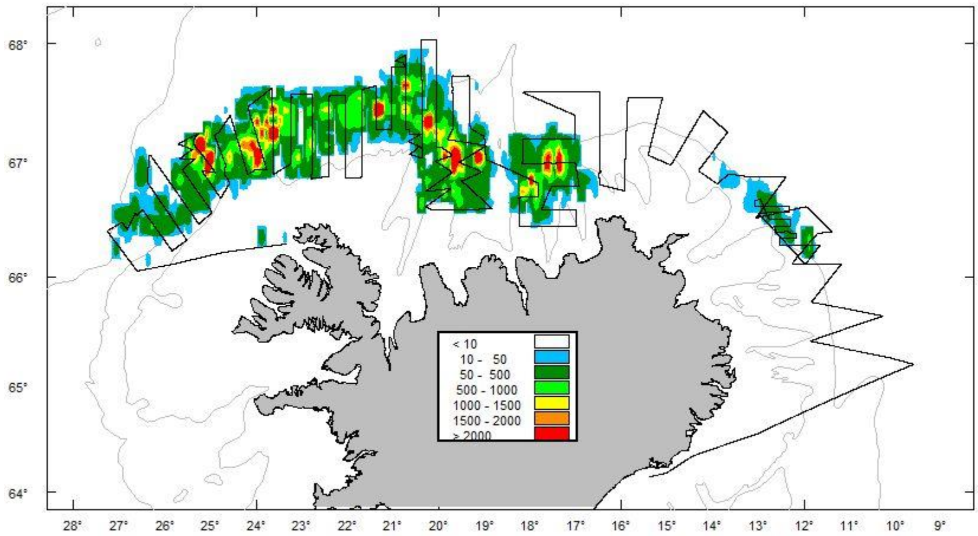


Figure 12.2.3. Icelandic capelin. Survey tracks of r/s Arni Fridriksson during 17 – 29 January 2015.

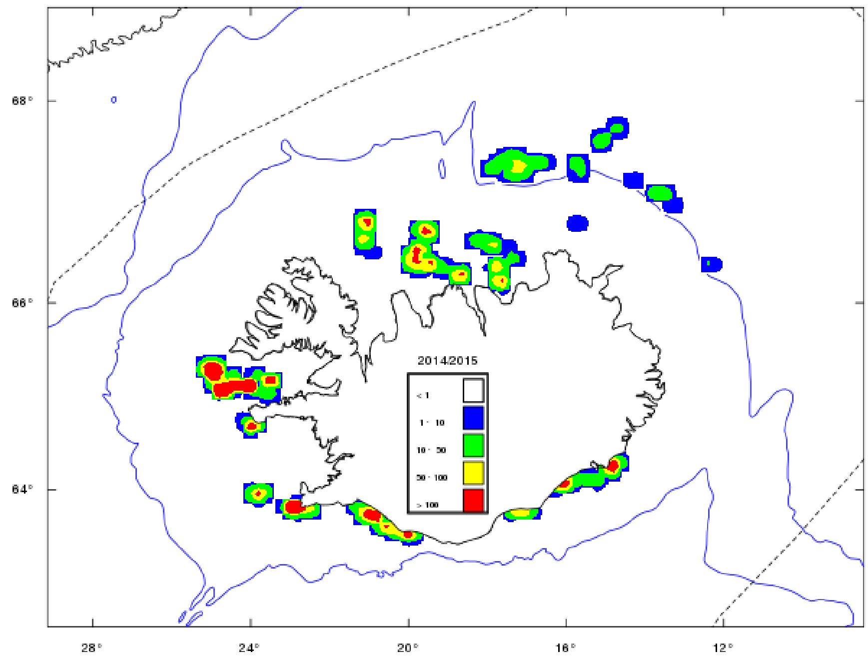


Figure 12.3.1. Icelandic capelin. Distribution of the catches in the fishing season 2014/15 based on data from logbooks of the Icelandic fleet.

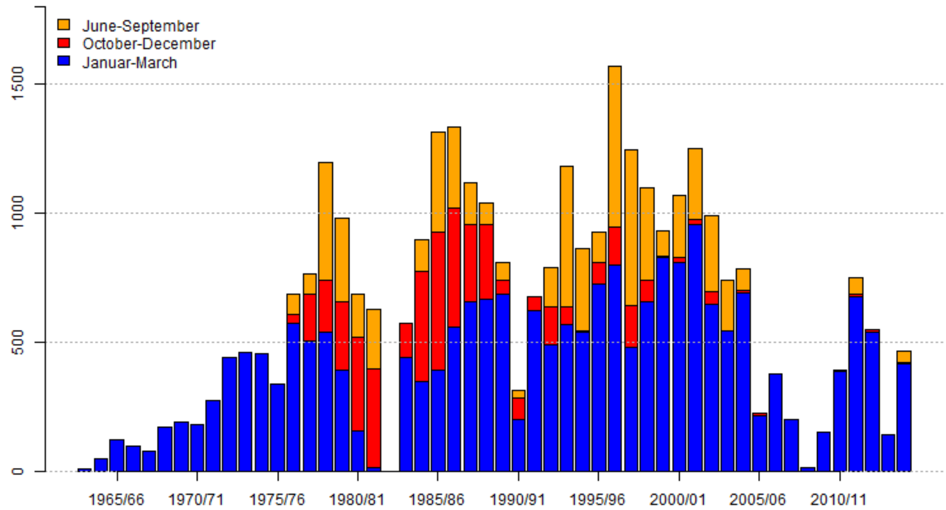


Figure 12.3.2. Icelandic capelin. The total catch (in thousand tonnes) of the Icelandic capelin since 1963/64 by season.

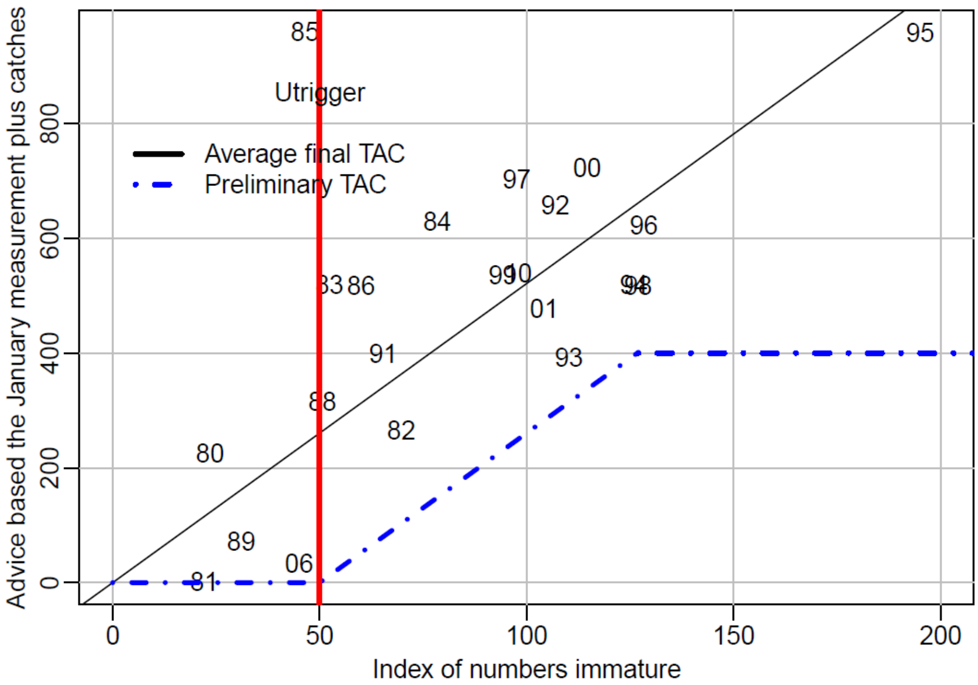
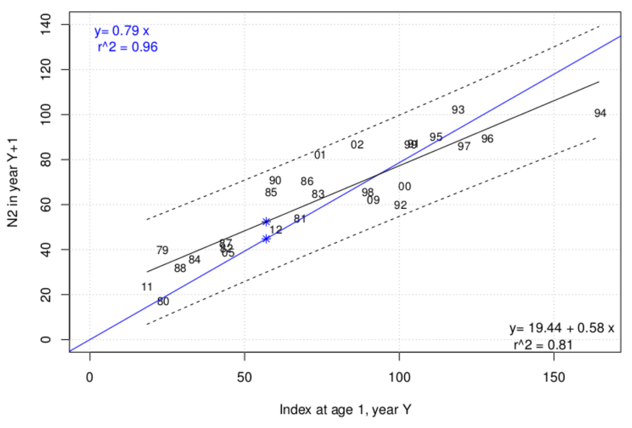
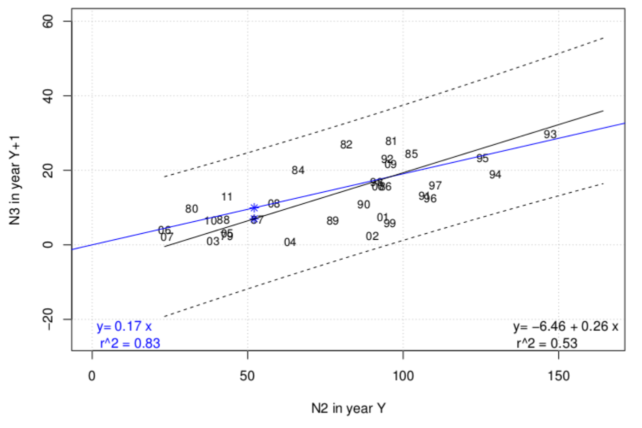


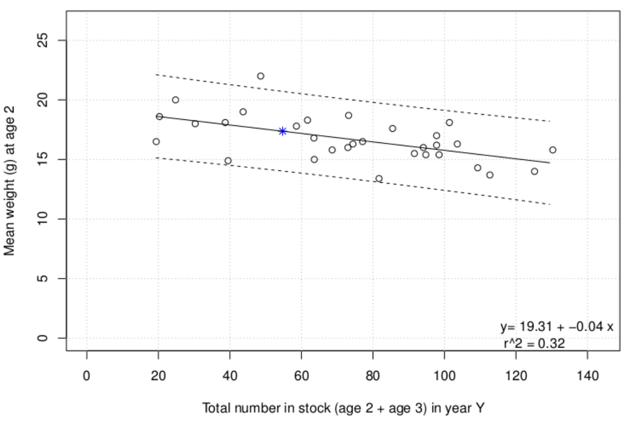
Figure 12.8.1. Estimated final advice according to the proposed stochastic HCR against the measured number of immature capelin ~15 months earlier. The lines indicate the final TAC (unbroken) and the preliminary TAC (broken) when it is set using a $U_{trigger}$ (red vertical line) of 50 billion immature fish and a cap on the initial TAC of 400 kt. (The figure is taken from the stock-annex, WKICE 2015).



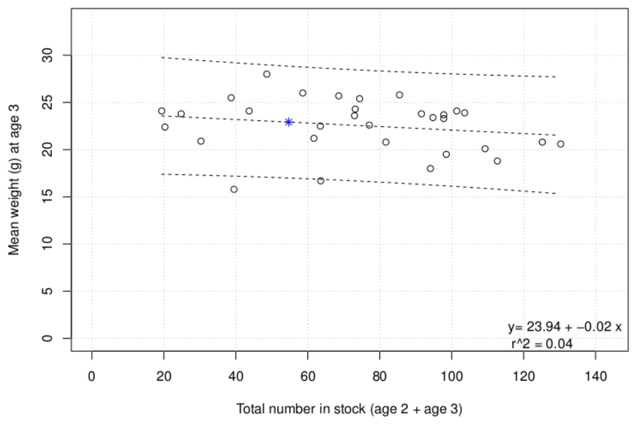
Regression 1 (black line) and prediction interval showing relation between acoustic index at age 1 and mature capelin at age 2 one year later. Blue line is the zero intercept regression.



Regression 2 (black line) and prediction interval showing relation between total number of capelin at age 2 and mature capelin at age 3 one year later. Blue line is the zero intercept regression.



Relation between total number at age 2 and 3 in the stock in year Y and mean weight for capelin at age 2 a year later.



Relation between total number at age 2 and 3 in the stock in year Y and mean weight for capelin at age 3 a year later.

Figure 12.18.1 Regressions used in "old" short-term model.

13 Overview on ecosystem, fisheries and their management in Greenland waters.

13.1 Ecosystem considerations

The marine ecosystem around Greenland is located from arctic to subarctic regions. The water masses in East Greenland are composed of the polar *East Greenland Current* and the warm and saline *Irminger Current* of Atlantic origin. As the currents round Cape Farewell at Southernmost Greenland the saline, warm Irminger water subducts the colder polar water and forms the relatively warm *West Greenland Current*. This flows along the West Greenland coast mixing extensively as it flows north. This current is of importance in the transport of larval and juvenile fish along the coast for important species such as cod and Greenland halibut. Additionally, cod from Icelandic waters spawning south and west of Iceland occasionally enters Greenland waters via the Irminger current and is distributed along both the Greenland East and West coast (Figure 1).

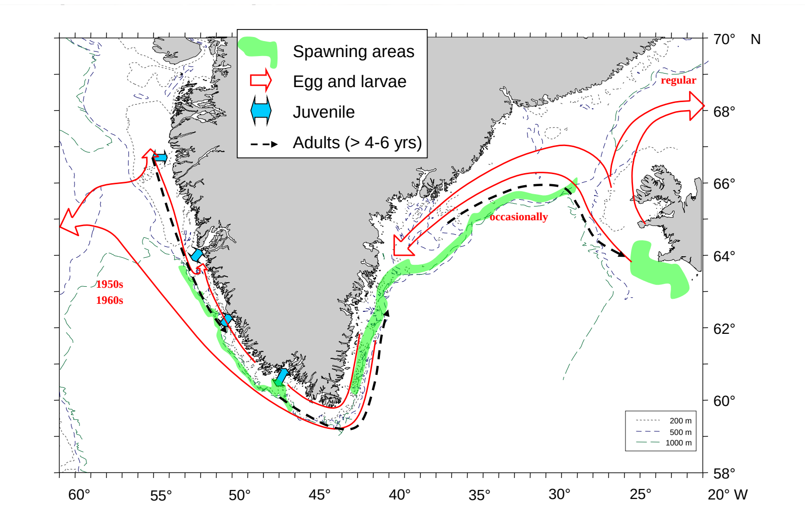


Figure 1. Spawning areas, egg and larval transport of Atlantic cod (*Gadus morhus*) in Greenlandic and Icelandic waters.

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 the hydrographical properties of the West Greenland Current. The general effects of such changes have been increased production 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 (Holger & Wieland 2008).

In recent year's temperature have increased significantly in Greenland waters. In West Greenland the sea temperature have increased particularly compared to the years in 1970'ies to mid 1990'ies and historical highs was registered in 2005 for the time series 1880—2012 (Figure 2).

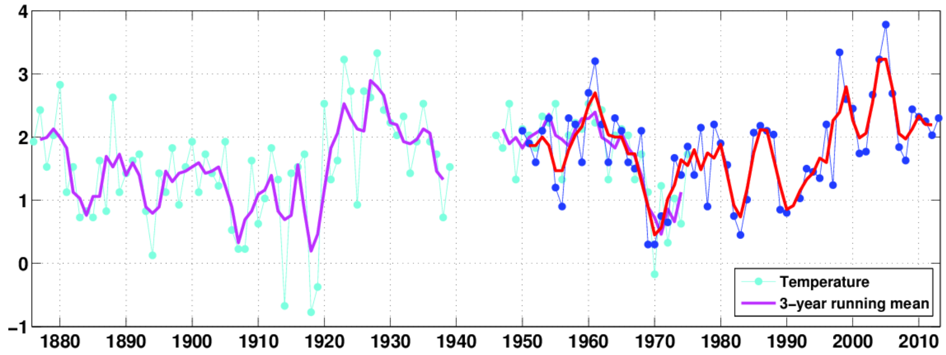


Figure 2. Mean temperature on top of Fylla Bank (located outside Nuuk Fjord, 0–40 m depth) in the middle of June for the period 1950–2013. The curves are 3 year running mean values. The magenta/purple line is extended back to 1876 using Smed-data for area A1. From Ribergaard (2014).

Temperature in the centre of the Irminger Sea, in the depth interval 200—400m, shows no such clear long-term trend (ICES 2013c). However Rudels el al. (2012) finds that between 1998 and 2010, the salinity and temperature of the deep water in the Greenland Sea increased. Furthermore increasing temperatures in salinity the Atlantic Water entering the Arctic in the Fram Strait has increased throughout the period 1996—2012, though with the highest observation in 2006 (ICES 2013c). Such environmental changes might well propagate to different trophic levels. Accordingly, shrimp biomass fluctuations in Greenland waters as a result of environmental changes could affect fish predators such as cod (Hvingel & Kingsley 2006) and the other way around.

The primary production period in Greenland is timely displaced along the coast due to increasing sea ice cover and a shorter summer period moving north (Blicher *et al.* 2007) but the main primary production takes place in May-June (Figure 3). The large latitudinal gradient spanned by Greenland, the ecosystem structure shifts moving north. For instance, the secondary producer assembly (e.g. mainly copepods) shifts from being dominated by smaller Atlantic species (*Calanus finmarchicus* and *Calanus glacialis*) to being increasingly dominated by the (sub)arctic species *Calanus hyperboreus.*

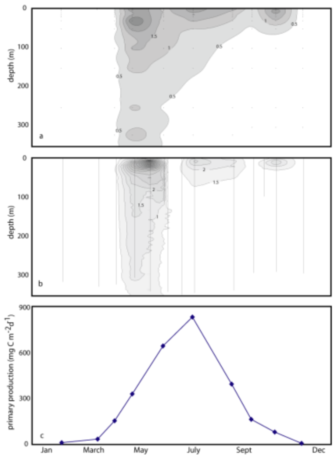


Figure 3. Annual variation in algal biomass and productivity at the inlet of Nuuk Fjord. a: chlorophyll (μg l^{-1}), b: fluorescence, c: primary production (mg C m^{-2} d^{-1}). Dots represent sampling points. From Mikkelsen *et al.* (2008).

Recently, the distribution of commercial species such as cod and shrimp has shifted considerably north. Such shifts have previously been associated with temperature, and may very well be linked to the observed increase in temperature. Additionally, changes in growth of fishes may also increase as a result of temperature changes as seen for both Greenland halibut (Sünksen *et al.* 2008) and cod (Hovgård and Wieland, 2008).

In recent years more southerly distributed species not normally seen in Greenland waters such as pearlside (*Maurolicus muelleri*), Whiting (*Merlangius merlangus*), blackbelly rosefish (*Helicolenus dactylopterus*), angler (*Lophius piscatorius*) and snake pipefish (*Entelurus aequoreus*) have been observed in surveys in offshore West and East Greenland and inshore West Greenland and their presence is possibly linked to increases in temperature (Møller *et al.* 2010).

In 2011 a mackerel (*Scomber scombrus)* fishery was initiated in East Greenland waters. Previous to this, no catches had ever been reported for this area and in 2013 mackerel was for the first time documented along the West Greenland coast. The reason(s) for the increased abundance of mackerel in Greenlandic waters has not been clarified, however factors such as changes in the regime for their usual food resources, a density dependent effect and increased temperatures have been proposed (ICES 2013a). The effects of increased pelagic fishes abundance and their distributional shifts on demersal fishes are unknown.

13.1.1 Atmospheric conditions

Cod and possibly other species recruitment in Greenland waters is significantly influenced by environmental factors such as sea surface temperatures in the important Dohrn Bank region during spawning and hence by air temperatures together with the meridional wind in the region between Iceland and Greenland (Stein and Borovkov 2004). The effect of the meridional wind component in the region off South Greenland on the first winter of the offspring appears to play a vital role for the cod recruitment process. For instance, during 2003, when the strong 2003 YC was born, negative anomalies were more than -2.0 m/sec, and that particular YC was large in East Greenland waters. In general, it seems that during anomalous east wind conditions during summer months, anomalous numbers of 0-group cod are also found in Greenland waters.

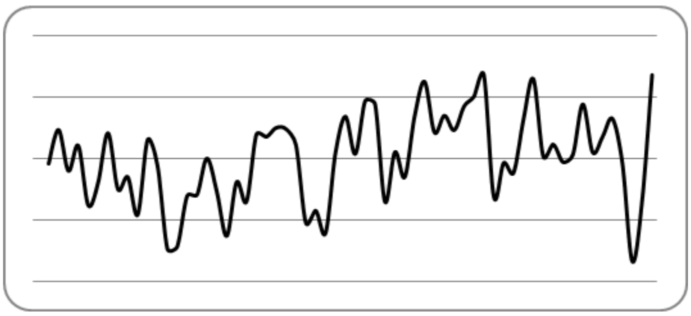


Figure 4. NAO Index (Dec-Feb) 1950-2012.

The NAO index

The NAO index, as given for 1950—2012 (Figure 4), shows negative values for winter (December-February) 2008/2009, 2009/2010 and 2010/2011. The 2009/2010 index is the strongest negative index (-1.64), encountered since 1950.

During the second half of the last century the 1960s were generally "low-index" years while the 1990s were "high-index" years. A major exception to this pattern occurred between the winter preceding 1995 and 1996, when the index flipped from being one of its most positive (1.36) values to a negative value (-0.62). The direct influence of NAO on Nuuk winter mean air temperatures is as follows: A “low-index” year corresponds with warmer-than-normal years. Colder-than-normal temperature conditions at Nuuk are linked to “high-index” years and hence indicate a negative correlation of Nuuk winter air temperatures with the NAO. Correlation between both time series is significant (r = -0.73, p << 0.001; Stein 2004). This is seen for instance in 2009, 2010 and 2011 where air temperature anomalies at Nuuk (1.0K, 4.8K and 2.9K) where associated with low NAO values (Fig. 5). The 2010 air temperature anomaly (4.0K) was the highest recorded, and was associated with the largest negative NAO anomaly (see Fig. 6).

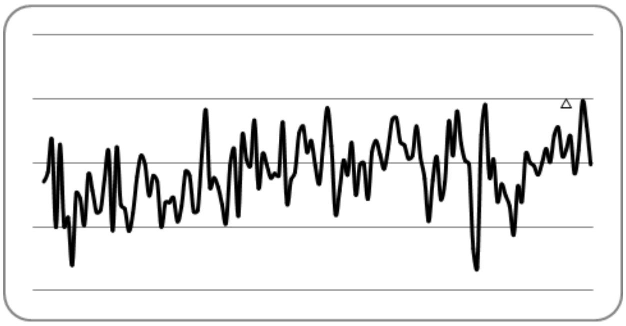


Figure 5. Time series of annual mean winter (DEC-FEB) air temperature anomalies (K) at Nuuk (1876-2012, rel. 1961-1990)

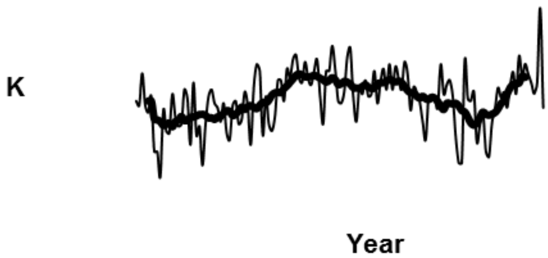


Figure 6. Time series of annual mean air temperature anomalies (K) at Nuuk (1876-2011, rel. 1961-1990), and 13 year running mean.

Zonal wind components

A negative anomaly of zonal wind components for the Northwest Atlantic is associated with atmospheric conditions in the Iceland-Greenland region enclosing strong easterly winds (Figure 7, top left panel in). These winds favour surface water transports from Iceland to East Greenland and was particularly strong in 2009, while it was completely different during the same months in 2010 (Figure 7). During May-August in 2011, the cells of negative anomalies were seen to the east of Newfoundland (anomalies < 3.0 m/sec), and to the east of Iceland.

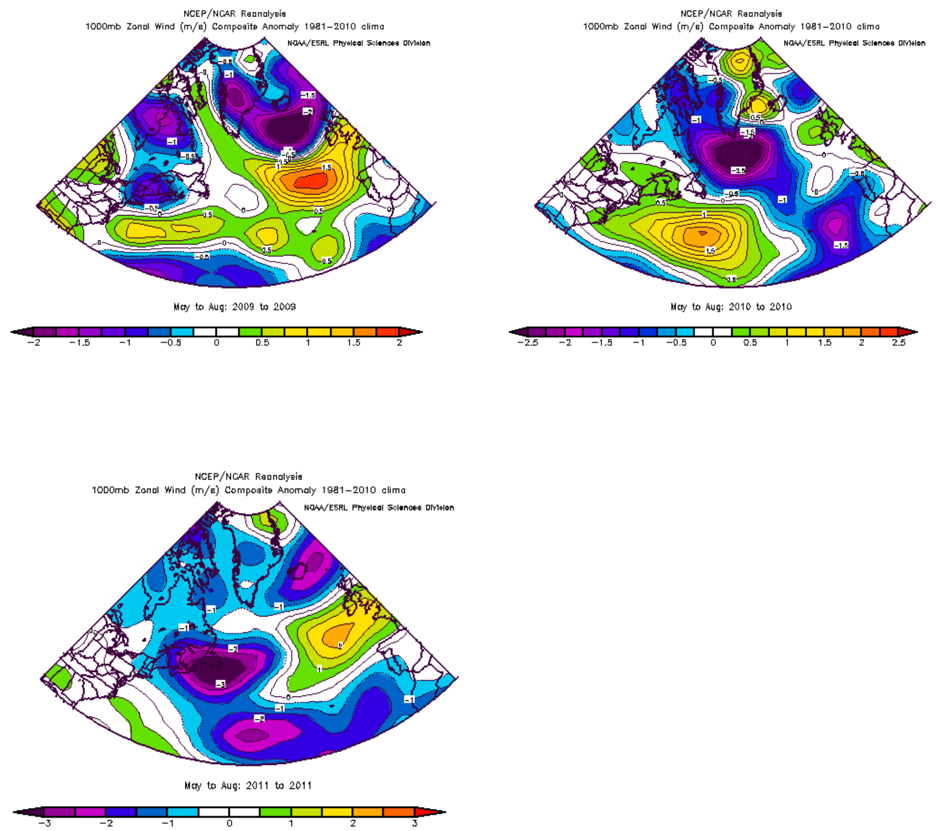


Figure 7. Zonal wind components for the North Atlantic (May-Aug), anomalies from 1981-2010. top left: 2009; top right: 2010; bottom left: 2011.

Meridional wind components

As discussed in Stein and Borovkov (2004), the meridional wind component (Dec-Jan) from the Southwest Greenland region correlated positively with the trend in Greenland cod recruitment time series (first winter of age-0 cod). During winter 2009/2010, positive meridional wind anomalies were observed Southwest Greenland (Figure 8, top left panel). During winter 2010/2011, the center of positive meridional wind anomalies had moved to the Davis Strait region (Figure 5, top right panel), and during winter 2011/2012, positive meridional wind anomalies had moved to the Northeast off Newfoundland (bottom left panel in Fig. 8).

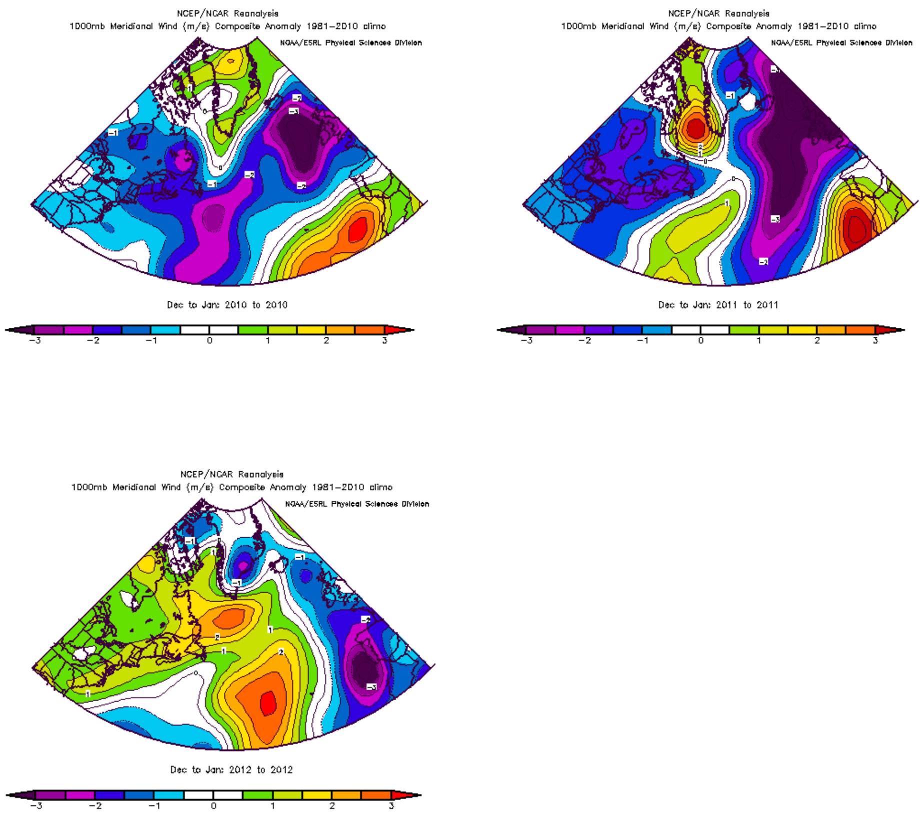


Figure 8. Meridional wind component (Dec-Jan), anomalies from 1981-2010. top left: 2009/2010; top right: 2010/2011;bottom left: 2011/2012;

13.1.2 Description of the fisheries

Fisheries targeting marine resources off Greenland can be divided into inshore and offshore fleets. The majority of the Greenland fleet has been built up through the 60s and is today comprised of approx. 450 larger vessels and a big fleet of small boats. It is estimated that around 1700 small boats are dissipating in some sort of artisanal 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 is available:

All fleet (N)	<5GRT	6-10GRT	11-20GRT	21-80GRT	>80GRT
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 has historically been important the average vessel age is 22 years, in north only 9 years as it is mostly comprised of smaller boats targeting Greenland halibut using longlines.

13.1.3 Inshore fleets

The fleet is constituted by a variety of different platforms from dog sledges used for ice fishing, to small multipurpose boats engaged in whaling or deploying passive gears such as gill nets, pound nets, traps, dredges and longlines.

In the northern areas from 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 ice fjords. The main by-catch from this fishery is redfish, Greenland shark, roughhead grenadier and in recent years cod in Disko Bay.

The coastal shrimp fisheries are distributed 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. Sorting grid is mandatory for the shrimp fishery; however several small inshore shrimp trawlers have dispensation for using sorting grid.

Cod is targeted all year, but with a peak in effort in June – July as cod in this period as accessible in shallow waters facilitating the use of the main gear types, pound and gill nets. By-catches are limited and are mainly Greenland cod (*Gadus ogac*) and wolffish.

In the recent years there has been an increasing exploitation rate for lumpfish. The fishing season is short, with the majority of the catch being caught in May-June. Lumpfish is caught along most of the West coast and is caught using gill nets. In small areas there is a substantial by catch of birds, especially common eiders (*Somateria mollissima*)

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.

Snow crabs are caught in traps in areas 62—70ºN. Problems with by-catch are at present unknown, but are believed to be insignificant.

Salmon are caught in August-October with drifting nets and gillnets. The fishery is a mix of salmon of European and North American origin.

The coastal fleets fishing for Atlantic cod, snow crab, scallops and shrimp are regulated by licenses, TAC and closed areas. Fishery for salmon and lumpfish are unregulated.

13.1.4 Offshore fleets

Apart from the Greenland fleet, the marine resources in Greenland waters are exploited by several nations, mainly EU, Iceland and Norway using bottom and pelagic trawls as well as longlines.

The demersal offshore fishery is comprised of vessels primarily fishing Greenland halibut, shrimp, redfish and cod. Greenland halibut and redfish have been targeted since 1985 using demersal otter board trawls with a minimum mesh size of 140 mm. A cod fishery has previously been conducted since 1920s in West Greenland offshore waters but was absent from 1992 to the 00ies. In 2010 the cod fishery was closed off West Greenland and catches has been insignificant since. The Greenland offshore shrimp fleet consist of 15 freezer trawlers. They exclusively target shrimp stocks off West and East Greenland with landings slightly below 100 000t. The shrimp fleet is close to or above 80 BT and 75% of the fleet process the shrimp onboard. Shrimp trawls are used with a minimum mesh size of 44 mm and a mandatory sorting grid (22 mm) to avoid by-catch of juvenile fish. The three most economically important fish species in Greenland: Greenland halibut, redfish and cod are found in relatively small proportions in the by-catch. However, when juvenile fish are caught, even small biomasses can correspond to relatively high numbers.

Longliners are operating on both the East and West coast with Greenland halibut and cod as targeted species. By-catches include roundnose grenadier, roughhead grenadier, tusk, Atlantic halibut and Greenland shark (Gordon *et al.* 2003).

The pelagic fishery in Greenland waters is conducted in East Greenland and currently targeted species are mackerel and pelagic redfish. A relatively small fishery after herring is carried out in the border area between Greenland, Iceland and Jan Mayen. A capelin fishery has previously been done but as the Greenland share of the TAC is taken in other waters. Generally, the pelagic fishery in Greenland is very clean, with small amounts of by-catch seen.

The demersal and pelagic offshore fishing, together with longlines are managed by TAC, minimum landing sizes, gear specifications and irregularly closed areas.

13.2 Overview of resources

In the last century the main target species of the various fisheries in Greenland waters have changed. A large international fleet in the 50s and 60s landed 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 conditions. Since then the stock has been low, with occasional larger YC being transported from Iceland (i.e. 1984 and 2003). Since 2010 the cod biomass has been concentrated in the spawning grounds off East Greenland. Following the cod collapse, the offshore shrimp fishery started in 1969 and has been increasing up to 2003 reaching a catch level close to 150 000 t. The stock decreased thereafter and is now at the low 1990 level with an advised TAC for 2015 of 60 000 t.

13.2.1 Shrimp

The shrimp (*Pandalus borealis)* stock in Greenland waters has been declining since 2003. The stock in East Greenland is at a low level based on available information. The 2003 West Greenland shrimp biomass was at the highest in the time series but it has since decreased.

13.2.2 Snow crab

The biomass of snow crab (*Chionoecetes opilio*) 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 since 2010 been reported at around 2 000 t a decrease from a high level in 2001 at 15 000t. After several years of decreasing CPUE it now appears to have stabilized at low levels in the majority of areas.

13.2.3 Scallops

The status of scallops in Greenland is unknown. From the mid 80s to the start 90s landings were between 4-600 t yearly, increased to around 2 000 t in late 1990ies. Catches decreased again and is below 600 tons in 2014. 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 in 10 years.

13.2.4 Squids

The status of squids in Greenland waters are unknown.

13.2.5 Cod

Since 2015 assessment and advice for cod in Greenland water take into account that 3 different stocks, based on spawning areas and genetics, are the basis for the cod fishery and the following management is therefore recommended for different 3 areas: a) inshore in Western Greenland, b) offshore Western Greenland (NAFO 1A-1E) and offshore Eastern Greenland (ICES subarea XIVb and NAFO subarea 1F). Current landings for inshore cod are 18 300t, and have steadily increased since 2009 where landings were 7 000 t. Landing from offshore Western Greenland was minor (less than 500 tons since 2006) and from offshore Eastern Greenland area 2014 landing was 7 900t, an increase from the 2011-2013 level at 5 000t.

Catches are high compared to the last three decades, however they are only a fraction of the landings caught in the 1950's and 1960's. Recruitment has been negligible since the 1984 and 1985 year class, though it has improved in the last decade, especially inshore, where the 2009 YC is the best seen since the 1984 YC. In 2007 and 2009 dense concentrations of unusual large cod were documented to be actively spawning off East Greenland, and management actions have been taken to protect these spawning aggregations. The inshore fishery has been regulated since 2009 and the offshore fishery is managed with license and minimum size (40 cm). As a response to the favourable environmental conditions (large shrimp stock, high temperatures) there is a possibility that the offshore cod will rebuild to historical levels if managed with this objective. A management plan with the objective of achieving this goal has been implemented for the fishing seasons 2014—2016. Several YC are present in the inshore fishery, and with the stable recruitment in recent years and widespread fishery there are several indications that the stock is experiencing favourable conditions and that recruitment is not impaired in spite of an increased fishing effort in later years.

13.2.6 Redfish

Redfish (*Sebastes mentella* and *Sebastes norvegicus*) are primarily caught of East Greenland. Catches have been small since 1994, but recently large year classes have given rise to a significant fishery with 2010—14 catches being around 8 000 t. This includes both redfish species, but the majority (e.g. ~80%) is most likely *S. mentella*. Recent East Greenland survey estimates indicate i decline i *S. mentella* while *S. norvegicus* is increasing.

13.2.7 Greenland halibut

Greenland halibut in the Greenland area consist of at least two stocks and several components; the status of the inshore component is not known but it has sustained catches of 15—20 000 t annually, taken primarily in the northern area (north of 68°N). The offshore stock component in West Greenland (NAFO SA 0+1) is a part of a shared stock between Greenland and Canada. The stock has remained stable in the last decade, sustaining a fishery of about 30 000 t annually (15 000 t in Greenland water). The East Greenland stock is a part of a stock complex extending from Greenland to the Barents Sea. The stock size is currently estimated as being at a historical low. Catches exceeds advice in most years with catches in Greenland waters being around 8 000t.

13.2.8 Lumpfish

The status of the lumpfish is unknown. The landing of lumpfish has increased dramatically in the last decades with catches being close to 13 000 t in 2013. Catches are highest in the southern-mid section of the Greenland west coast. There are no indications of the impact on the stock. A management plan was implemented in 2014 regulating the fishery with TAC and number of fishing days.

13.2.9 Capelin

On the Greenland Eastcoast an offshore pelagic fleet have been conducting a fishery on capelin (45 000t landed in 2014 by Greenland, EU, Norway and Iceland). The capelin has shifted distribution more west and north in recent years, and are believed to spent a substantial amount of time in Greenland waters. The west Greenland capelin stock is not fished and its size is unknown.

13.2.10 Mackerel

A mackerel fishery in Greenland waters initiated in 2011 with catches of 162 t and increased to more than 78 000t in 2014. Mackerel is known to feed on various species, including fish larvae, and it competes with others pelagic species, such as herring, for resources (Langøy *et al.* 2012). Thus it might/can have a key role on the ecosystem of many commercial important species in Greenland.

13.2.11 Herring

A fishery for Norwegian spring spawning herring in Greenland water has increased in recent years and in 2014 catches increased to 9 000 t. The herring has shifted distribution more west in recent years

13.3 Advice on demersal fisheries

ICES recommends that the offshore cod stock is protected to allow for rebuilding. Inshore cod advice is based on the DLS approach. For the offshore cod, a recovery plan is recommended to ensure a sustainable increase in SSB and recruitment. Such initiatives 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 (*Gadus morhua*) in NAFO Subdivisions 1A-1E (Offshore West Greenland)

Executive summary

From 2015 the advice for cod in Greenland offshore waters has been split in two stock components (advice year 2016). The West Greenland offshore stock component is now comprised of the NAFO subdivisions 1A-E in West Greenland. The East Greenland stock component is comprised of the area NAFO subdivision 1F in South Greenland and ICES subarea XIV in East Greenland.

Some mixing occurs between the two stocks in West Greenland which at present is considered to act as a nursing area for juveniles of the East Greenland stock component. The offshore fishery in West Greenland was closed in accordance with an implemented management plan in 2014. However, a dispensation was given to a small trawler that fished 116 tons and the 2009 YC dominated the catches.

Survey indices show that the biomass and abundance has increased due to the 2009 YC which is present in considerable numbers. This YC is distributed further south in 2012—2014 than in 2011.

The spatial distribution of the 2009 YC is different than previous year classes that usually migrate out of the area at age 4, but a large part of the 2009 YC still remains in the southern area (NAFO 1E) at age 5 in 2014.

No formal assessment is conducted and there are no biological reference points for the stock. Information from survey indices (German Groundfish survey and Greenland Shrimp and Fish survey) are used as basis for advice.

No significant spawning has been observed in the area, and fish older than 6 yrs are lacking in the area.

14.1 Stock definition

The cod found in Greenland is derived from four separate “stocks” that each is labelled by their spawning areas: I) offshore West Greenland waters; II) West Greenland fiords; III) offshore East Greenland and Icelandic waters and IV) inshore Icelandic waters (Therkildsen *et al*. 2013), (Fig. 14.1).

From 2012 the inshore component (West Greenland, NAFO Subarea 1) was assessed separately from all offshore components. From 2015 the offshore West Greenland (NAFO subdivisions 1A-E) and East Greenland (NAFO subdivision 1F and ICES subarea XIV) components was assessed separately. The Stock Annex provides more details on the stock identities including the references to the primary literature.

14.2 Fishery

14.2.1 The emergence and collapse of the Greenland offshore cod fisheries

The Greenland commercial cod fishery in West Greenland started in the 1920s. The fishery gradually developed culminating with catch levels at 400 000 tonnes annually in the 1960s. Due to overfishing and deteriorating environmental conditions the stock size declined and the fishery completely collapsed in the early 1990’s (Tab 14.2.1, Fig 14.2.1). No fishery has developed since. More details on the historical development in the fisheries are provided in the stock annex.

14.2.2 The fishery in 2014

In 2014 a management plan for the offshore fisheries for cod was implemented with the overall objective of rebuilding the stock in West Greenland by closing the area for fisheries. However a dispensation was given to a small trawler (< 75BRT/120BRT) that fished offshore on the inshore quota.

Catches in the fishery in 2014 amounted to a total of 116 t with 30 t being caught on Tovqussaq Bank (NAFO div 1C, 64°25N) and 86 t being caught primarily on Dana Bank (NAFO div 1D and 1E, between 62°00—63°00N), and a smaller amount on Fiskenæs Bank (NAFO div. 1D, 63°30N, figure 14.2.2.1 and 14.2.2.2).

The fishery occurred in spring Mar, Apr and May with 50% being caught in May (table 14.2.2.1).

14.2.3 Length, weight and age distributions in the fishery.

Length measurements were taken by Greenland Institute of Natural Resources (GINR) personal on the landings in the city of Paamiut from catches taken on Tovqussaq Bank in NAFO div. 1C (64°25N), whereas a crew member took length measurements directly on the ship from catches taken on Dana Bank in NAFO div 1D and 1E (62-63°N). In total 1 070 cod were measured.

Overall mean length in the fishery was 54 cm and 5 year olds (YC 2009) dominated the catches (figure 14.2.3.1).

Mean length differed between areas with smallest fish caught furthest to the north in NAFO 1C (mean length = 48 cm) and largest fish caught on Dana Bank (mean length = 58 cm, figure 14.2.3.2). The 2009 YC dominated the catches in both areas, but there were larger and older fish (6—8 yrs) present on Dana Bank but not on Tovqussaq bank where younger fish ages 4—5 yrs were present.

14.3 Surveys

At present, two offshore trawl surveys (Greenland and German) provide the core information relevant for stock assessment purposes. For details of survey design see stock annexes.

The German survey targets cod and has since 1982 covered the main cod grounds off West Greenland up to 67°N at depths down to 400 m, thus including periods of both high and low cod abundance. The Greenland survey targets shrimp and cod off West Greenland up to 72°N and from 0 to 600 m from 1992, hereby extending into northern areas where large cod concentrations are not expected. Although most of the effort has previously been allocated towards shrimp the recent addition of additional fish stations implies a fair coverage of the West Greenland cod habitat in this survey.

14.3.1 Results of the Greenland Shrimp and Fish survey

The numbers of valid trawl hauls in 2014 was 194 (table 14.3.1.1).

The 2014 survey abundance index of Atlantic cod in West Greenland was estimated at 110 million individuals and the survey biomass at 84 900 tons. Survey abundance and biomass increased with 58 % and 147 % respectively compared to 2013 (table 14.3.1.2 & 14.3.1.3). Abundance and biomass was primarily in NAFO Div. 1C and E (figure 14.3.1.1 and 14.3.1.2).

The survey catches were dominated by the 2009 YC in 2011, 2012 and 2013 accounting for 84%, 64% and 52% of the total abundance respectively (table 14.3.1.4, figure 14.3.1.3). In 2014 the 2010 YC dominated the abundance with 51% of the total abundance followed by the 2009 YC accounting for 33% of the total abundance. The 2010 YC was primarily found in one large haul (in NAFO 1C) that accounted for 66% of the abundance estimate, whereas the 2009 YC was also found in other hauls (NAFO 1E) (figure 14.3.1.4 and 14.3.1.5).

The 2009 was mainly found in the northern part of the survey (NAFO 1B) at age 2 in 2011 (figure 14.3.1.5). In 2012 and 2013 this YC was however mainly found in the southern part of the survey (NAFO Div. 1D and 1E) (table 14.3.1.5, figure 14.3.1.4 and 14.3.1.5). The 2010 YC show the same distribution pattern of being in the northern part of the survey area (NAFO 1A and 1B) at ages 1 and 2, and moving further to the south at ages 3 and 4. Younger year classes (2011- and 2012 YC) were primarily found in the northern part of the survey area (NAFO Div. 1A and 1B).

The majority of cod found offshore in West Greenland are younger than 7 years, and the 2014 survey confirmed that older and larger cod barely exist offshore in West Greenland (figure 14.3.1.5 and 14.3.1.6).

The B4+ biomass has increased in recent years, but prior to 2013 the B4+ was much lower than the total biomass indicating that until 2012 cod younger than 4 yrs were dominating the area (table 14.3.1.6).

The offshore cod start to spawn at age 5-6 yrs and the spawning stock biomass in the survey show an increasing trend in recent years with spawning stock being concentrated in the southern area (NAFO 1E, figure 14.3.1.7 and 14.3.1.8). The spawning stock estimate for NAFO 1C is based on one large haul.

The 2014 survey shows a very high increase in both abundance and biomass compared to previous years. However, one station constituted 66% of the abundance estimate and 61% of the biomass estimate, which is also reflected in a high index uncertainty (CV=67). This haul was located in NAFO division 1C resulting in higher abundance index in this area compared to other areas (figure 14.3.1.4) and high spawning stock biomass in this area compared to other areas in the survey (figure 14.3.1.7). The large haul was taken on Tovqussaq Bank where a small trawl fishery also took place in May. The length of fish caught in the commercial fishery was similar to the length found in the survey (figure 14.2.3.2).

14.3.2 Results of the German groundfish survey

In 2014, 45 valid trawl stations were sampled during autumn in the German Greenland offshore groundfish survey in West Greenland NAFO 1C-1E (Table 14.3.2.1).

Overall, abundance increased by 24% from 2013 to 2014 (Table 14.3.2.2) and biomass increased by 57% (Table14.3.2.3). The main reason for the increase in abundance and biomass was one very large haul, located in NAFO 1D (figure 14.3.2.2) which contributed with 69% of the biomass estimate and resulted in high SD (table 14.3.2.3). The hauls resulted in increased numbers of the 2009 and 2010 YC in 2014 compared to 2013 (Table 14.3.2.4). Since 2012 the 2009 YC has dominated the catches and the 2010 has been the second most abundant YC in the survey. These two year classes are mainly observed in NAFO div. 1C and 1D in 2014 (figure 14.3.2.3) which is further to the north for the 2009 YC than in the Greenland survey.

The survey time series shows three abundance peaks: one in 1987—1989 caused by the 1984 and 1985 YC, one in 2006 caused by the 2003 YC and one in 2012 caused by the

2009 YC (figure 14.3.2.4). Biomass indices show the same peaks, although an increase in biomass in the period 2012-2014 compared to the previous periods (figure 14.3.2.5).

Overall findings are the same in the Greenland and the German survey: the 2009 YC dominates catches in recent years, followed by the 2010 YC.

14.4 Information on spawning

No spawning of significance has been documented on the banks in West Greenland, and few large cod are found in the survey. Spawning is therefore assumed to be limited.

14.5 Tagging experiments

A total of 16 030 cod have been tagged in different regions of Greenland in the period of 2003—2014 (table 14.5.1). 3 884 cod have been tagged in the offshore area in West Greenland NAFO 1D+1E (primarily on Dana Bank) in 2007, 2012 and 2013.

Offshore recaptures are found both in West- and East Greenland and Iceland (table 14.5.2). Tagged fish in the offshore area in West Greenland are more often caught in the same area (21 individuals), but some also migrate eastward (5 individuals recaptured in East Greenland, and 13 in Iceland, table 14.5.2). Limited fishing in several areas influences the signal from the recaptures, and more analysis needs to be performed taking the fishing effort into account in order to investigate magnitude of the eastward migration rate.

14.6 State of the stock

The West Greenland offshore stock component has been severely depleted since the 1970ies and collapsed in the 1990ies. The surveys show only a minor increase in biomass in recent years. Abundance however has fluctuated since 2005, indicating that small fish enter the survey but are not caught at older ages. This is caused by an eastward migration out of the area, and the area is presently considered to act mainly as a nursing area for the East Greenland and Icelandic stock components.

Recently the 2009 YC has been caught in considerable numbers and is believed to be of East Greenland and/or Icelandic origin and will probably migrate out of West Greenland when reaching maturity. However, at age 5 a part of this YC still remains in the southern part of the area (NAFO 1E), which has not been the typical pattern observed with the recent larger than average YC's from 2003, 2005 and 2007.

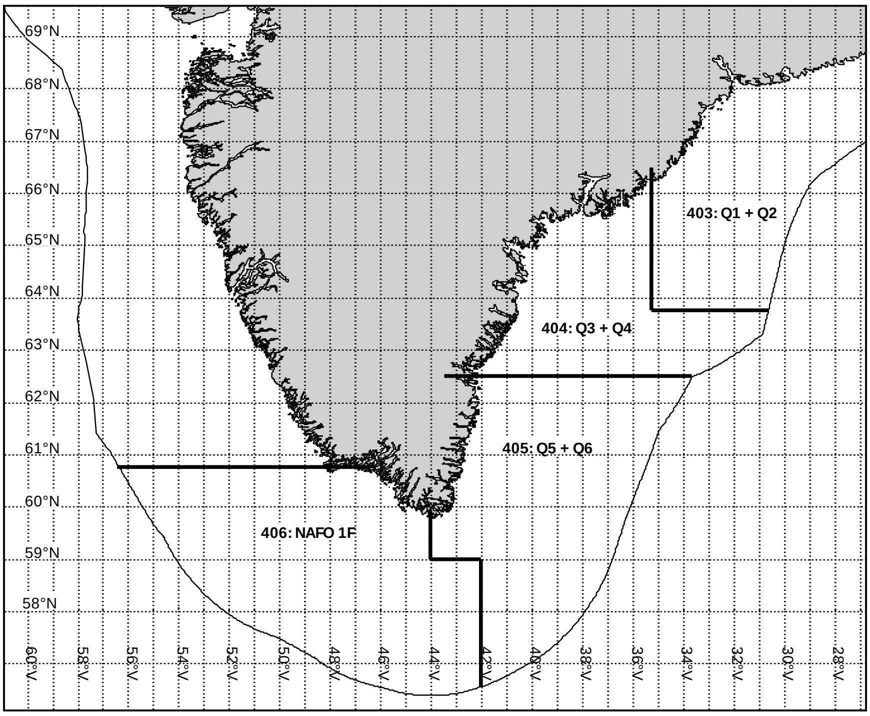
The stock is considered to be at a very low level compared to historic.

14.7 Implemented management measures for 2015

According to a management plan implemented in 2014 no offshore fishery is to take place in NAFO subdivision 1A-1E in 2015.

14.8 Management plan

In 2014 a management plan was implemented for the offshore cod fishery in Greenland (2014-2016). The management plan is built on the distinction between the inshore and two offshore stocks components.



Management area West Greenland covers NAFO Subdivisions 1A-E and management area SouthEast Greenland covers ICES Subarea XIVb (survey area Q1-6) + NAFO Subdivision 1F corresponding to the ICES distinction.

According to the management plan, management area West TAC should be 0 t for the period 2014-2016 in order to protect the West offshore stock component. The TAC in management area South East is 10 000 t/year between 2014 and 2016.

The management plan has not been evaluated by ICES.

14.9 Management considerations.

The fishery in West Greenland should be considered a mixed stock fishery, containing fish from both Greenland and Iceland stocks. There is currently no standardized procedure to determine the proportional contribution of each stock to the landings. However, given the current state of the stock, catches taken in West Greenland waters will primarily consist of fish from other cod stocks.

The traditional spawning grounds in West Greenland are well described and if any fishing is allowed such areas should be protected. This will both protect any present spawning stock and minimize the proportion of the West Greenland stock in the catches.

14.10 References

Retzel, A. 2015. Greenland Shrimp and Fish survey results for Atlantic cod in NAFO subareas 1A-1E (West Greenland) in 2014. ICES North Western Working Group (NWWG) April 28- May 5, 2015, WD 19.

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Therkildsen, N.O.,Hemmer-Hansen, J., Hedeholm, R.B., Wisz, M.S., Pampoulie, C., Meldrup, D., Bonanomi, S., Retzel, A., Olsen, S.M., Nielsen, E.E. 2013. Spatiotemporal SNP analysis reveal pronounced biocomplexity at the northern renge margin of Atlantic cod *Gadus morhua*. Evoltutionary Applications. DOI 10.1111/eva. 12055

Table 14.2.1. Offshore catches (t) divided into NAFO divisions in West Greenland. 1924-1991: Horsted 2000, 2004-present: Greenland Fisheries License Control.

Year	NAFO 1A	NAFO 1B	NAFO 1C	NAFO 1D	NAFO 1E	NAFO 1F	Unknown NAFO div.	NAFO 1A – 1E
1924							200	
1925							1871	
1926							4452	
1927							4427	
1928							5871	
1929							22304	
1930							94722	
1931							120858	
1932							87273	
1933							54351	
1934							88422	
1935							65796	
1936							125972	
1937							90296	
1938							90042	
1939							62807	
1940							43122	
1941							35000	
1942							40814	
1943							47400	
1944							51627	
1945							45800	
1946							44395	
1947							63458	
1948							109058	
1949							156015	
1950							179398	
1951							222340	
1952	0	261	2996	18188	707	37905	257488	117126 *
1953	4546	46546	10611	38915	932	25242	98225	180220 *
1954	2811	97306	18192	91555	727	15350	60179	266682 *
1955	773	50106	32829	87327	3753	4655	68488	241499 *
1956	15	56011	38428	128255	8721	4922	66265	296315 *
1957	0	58575	32594	62106	29093	16317	47357	225836 *
1958	168	55626	41074	73067	21624	26765	75795	258062 *
1959	986	74304	10954	30254	12560	11009	67598	191343 *
1960	35	58648	18493	35939	16396	9885	76431	200522 *
1961	503	78018	43351	70881	16031	14618	90224	293104 *
1962	1017	122388	75380	57972	25336	17289	125896	400719 *
1963	66	70236	73142	76579	46370	16440	122653	381917 *
1964	96	49049	49102	82936	33287	13844	99438	307878 *
1965	385	80931	66817	71036	15594	15002	92630	321829 *
1966	12	99495	43557	62594	19579	18769	95124	313044 *
1967	361	58612	78270	122518	34096	12187	95911	385949 *
1968	881	12333	89636	94820	61591	16362	97390	350870 *
1969	490	7652	31140	65115	41648	11507	35611	179055 *
1970	278	3719	13244	23496	23215	15519	18420	78775 *
1971	39	1621	28839	21188	9088	20515	26384	80501 *

Year	NAFO 1A	NAFO 1B	NAFO 1C	NAFO 1D	NAFO 1E	NAFO 1F	Unknown NAFO div.	NAFO 1A – 1E
1972	0	3033	42736	18699	7022	4396	20083	90410 *
1973	0	2341	17735	18587	10581	2908	1168	50347 *
1974	36	1430	12452	14747	8701	1374	656	37999 *
1975	0	49	18258	12494	6880	3124	549	38188 *
1976	0	442	5418	10704	8446	2873	229	25215 *
1977	127	301	4472	7943	8506	2175	35477 [1]	53546 *
1978	0	0	11856	2638	3715	549	34563 [1]	51760 *
1979	0	16	6561	4042	1115	537	51139 [1]	60635 *
1980	0	1800	2200	2117	1687	384	7241 [1]	14705 *
1981	0	0	4289	4701	4508	255	0	13498
1982	0	133	6143	10977	11222	692	1174	29621 *
1983	0	0	717	6223	16518	4628	293	23703 *
1984	0	0	0	4921	5453	3083	0	10374
1985	0	0	0	145	1961	1927	2402	3360 *
1986	0	0	0	2	72	24	1203	982 *
1987	0	0	5	815	67	43	3041	3787 *
1988	0	0	919	17463	10913	6466	8101	35931 *
1989	0	0	0	11071	48092	14248	2	59165
1990	0	0	2	563	21513	10580	7503	27151 *
1991	0	0	0	0	104	1942	0	104
1992	0	0	0	0	0	0	0	0
1993	0	0	0	0	0	0	0	0
1994	0	0	0	0	0	0	0	0
1995	0	0	0	0	0	0	0	0
1996	0	0	0	0	0	0	0	0
1997	0	0	0	0	0	0	0	0
1998	0	0	0	0	0	0	0	0
1999	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0
2004	0	0	0	5	3	1	0	8
2005	0	0	1	0	0	71	0	1
2006	0	0	0	0	0	414	0	0
2007	0	0	0	31	435	2011 [2]	0	466
2008	0	0	0	23	526	11370 [2]	0	549
2009	0	0	0	0	6	3323 [2]	0	6
2010	0	0	0	0	2	281	0	2
2011	0	0	0	0	8	542	0	8
2012	0	0	1	95	236	1470	0	332
2013	0	0	0	209	270	1405	0	479
2014	0	0	30	68	18	1833	0	116

1) **Estimates for assessment include estimates of unreported catches. The total estimated value for West Greenland (inshore + offshore) was 73000 t in 1977 and 1978, 1979: 99000 t, 1980: 54000 t. The value given in the table are these values minus the inshore catches minus known offshore NAFO division catches.**

2) **Include catches taken with small vessels and landed to a factory in South Greenland (Qaqortoq), 2007:597 t, 2008: 2262 t, 2009: 136 t.**

***)** **Unknown NAFO division catches added accordingly to the proportion of known catch in NAFO divisions 1A-1E to known total catch in all NAFO divisions.**

Table 14.2.2.1: 2014 cod catches (t) divided into month and NAFO areas, caught by the offshore fisheries.

NAFO	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	%
1C				28	2								30	26%
1D	2		15	4	47								68	58%
1E			7	0.4	11								18	16%
Total	2		22	33	59								116	
%	2%		19%	29%	51%									

Table 14.3.1.1. Number of hauls in the Greenland Shrimp and Fish survey in West Greenland by year and NAFO subdivisions.

West Greenland							
Year/NAFO	0A	1A	1B	1C	1D	1E	Total
1992		92	44	18	18	11	183
1993		69	49	21	15	12	166
1994		76	58	23	8	9	174
1995		83	61	29	13	14	200
1996		71	57	29	12	9	178
1997		84	56	32	12	12	196
1998		77	80	27	19	14	217
1999		84	81	33	16	14	228
2000		56	62	37	23	14	192
2001		60	75	36	24	15	210
2002		50	80	32	18	20	200
2003		51	63	30	18	15	177
2004		54	55	24	22	20	175
New Survey Gear Introduced							
2005	6	65	56	26	19	23	195
2006	5	86	60	26	20	21	218
2007	8	73	58	26	27	31	223
2008	6	69	61	28	23	25	212
2009	8	74	75	28	22	24	231
2010	10	95	76	30	23	25	259
2011	0	73	64	24	18	12	191
2012	0	73	64	21	18	18	194
2013	4	73	52	20	13	21	183
2014	0	78	57	19	17	23	194

Table 14.3.1.2 Cod abundance indices ('000) from the Greenland Shrimp and Fish survey in West Greenland by year and NAFO subdivisions.

West Greenland								
Year	0A	1A	1B	1C	1D	1E	Total	CV
1992		4	53	243	345	0	645	
1993		2	16	54	135	286	493	
1994		10	41	87	0	6	144	
1995		0	51	380	44	62	537	
1996		0	0	46	68	87	201	
1997		0	7	31	0	0	38	
1998		0	4	0	26	26	56	
1999		32	136	16	23	6	213	
2000		585	437	71	58	9	1160	
2001		26	305	110	448	305	1194	
2002		13	203	78	3294	114	3702	
2003		492	1395	351	727	214	3179	
2004		197	152	379	2630	1538	4896	
New Survey Gear Introduced								
2005	143	198	871	1845	4796	6683	14537	25
2006	453	371	4454	2564	15703	3359	26905	45
2007	737	1318	3302	7353	3624	3296	19628	31
2008	1209	897	4185	4068	9008	11553	30913	27
2009	881	889	4195	3272	2788	1252	13277	12
2010	338	720	2837	2712	8295	2745	17647	23
2011		8756	47092	2179	26510	1013	85549	14
2012		7661	10228	3017	1270	27081	49258	54
2013	4613	8951	12864	5673	7887	29924	69911	43
2014		6911	5670	78854	2456	16254	110145	67

Table 14.3.1.3. Cod biomass indices (tons) from the Greenland Shrimp and Fish survey in West Greenland by year and NAFO subdivisions.

West Greenland								
	0A	1A	1B	1C	1D	1E	Total	CV
1992		23	54	75	118	0	270	
1993		2	5	25	39	124	195	
1994		3	9	38	0	1	51	
1995		5	6	120	23	3	157	
1996		0	0	15	23	27	65	
1997		0	2	53	0	0	55	
1998		1	1	0	47	50	99	
1999		29	28	1	17	1	76	
2000		226	130	21	9	2	388	
2001		140	155	56	178	98	627	
2002		67	128	41	1489	42	1767	
2003		444	323	264	453	118	1602	
2004		542	53	176	680	685	2136	
New Survey Gear Introduced								
2005	38	69	364	458	1084	1141	3155	26
2006	114	62	677	537	5131	525	7046	64
2007	247	387	872	1562	628	659	4355	31
2008	413	377	2046	929	1633	3227	8625	28
2009	208	230	1251	711	439	253	3092	14
2010	180	263	999	543	2426	908	5319	22
2011		1569	9654	408	5316	191	17140	14
2012		1932	2938	1125	464	14103	20562	69
2013	2395	2692	3960	1732	4551	19017	34345	53
2014		2639	2305	56061	2511	21381	84897	64

Table 14.3.1.4: Abundance indices ('000) by year-class/age from the Greenland Shrimp and Fish survey in West Greenland (NAFO 1A-1E).

West Greenland											
Year/age	0	1	2	3	4	5	6	7	8	9	10+
2005	134	815	10247	1604	1514	186	35	2	0	0	0
2006	249	6543	3577	12677	3395	401	47	16	0	0	0
2007	152	270	13792	3439	1934	37	4	0	0	0	0
2008	31	3472	2692	18780	4904	868	121	44	0	0	0
2009	0	124	9442	1666	1717	326	3	0	0	0	0
2010	209	2703	2094	10566	1252	775	42	7	0	0	0
2011	19	4940	71837	4453	3735	391	175	0	0	0	0
2012	0	204	11264	31593	3648	2427	116	7	0	0	0
2013	0	2904	8912	15168	36226	5665	848	142	22	25	0
2014	0	471	4792	8088	56469	35839	2597	1718	125	35	11

Table 14.3.1.5 Abundance indices ('000) by age from the Greenland Shrimp and Fish survey in West Greenland by NAFO divisions, 2014.

West Greenland											
Year-class	2014	2013	2012	2011	2010	2009	2008	2007	2006	2005	<2005
Age	0	1	2	3	4	5	6	7	8	9	10+
Div. 0A											
Div. 1A	0	135	2328	2532	1323	352	148	47	34	0	11
Div. 1B	0	336	1308	2032	1451	494	48	0	0	0	0
Div. 1C	0	0	1015	2826	49297	24238	1245	233	0	0	0
Div. 1D	0	0	140	306	994	843	41	119	13	0	0
Div. 1E	0	0	0	391	3403	9912	1115	1319	78	35	0

Table 14.3.1.6 Biomass of ages 4+ of cod from the Greenland Shrimp and Fish survey in West Greenland (NAFO 1A-1E).

Year	B4+
2005	1197
2006	2057
2007	1233
2008	3588
2009	1512
2010	1882
2011	3152
2012	5879
2013	28671
2014	83027

Table 14.3.2.1 ***German survey*****. Numbers of valid hauls by stratum in West Greenland (NAFO 1C-E).**

	NAFO 1C		NAFO 1D		NAFO 1E		
year	Str 1.1	Str 1.2	Str 2.1	Str 2.2	Str 3.1	Str 3.2	Sum
1981	1	1	13	2	3	1	21
1982	20	11	16	7	9	6	69
1983	26	11	25	11	17	5	95
1984	25	13	26	8	19	6	97
1985	10	8	26	10	17	5	76
1986	27	9	21	9	16	7	89
1987	25	19	21	4	18	4	91
1988	34	21	28	5	18	5	111
1989	25	14	30	9	8	3	89
1990	19	7	23	8	16	3	76
1991	19	11	23	7	13	6	79
1992	6	6	6	5	6	6	35
1993	9	7	9	6	10	8	49
1994	16	13	13	8	10	6	66
1995	.	.	3	.	10	7	20
1996	5	5	8	5	12	5	40
1997	5	6	5	5	6	5	32
1998	9	5	10	7	11	6	48
1999	8	7	14	8	13	6	56
2000	13	6	15	6	14	5	59
2001	.	.	15	7	15	5	42
2002	.	.	7	2	5	6	20
2003	.	.	7	6	7	7	27
2004	8	8	11	9	9	5	50
2005	.	.	9	7	8	6	30
2006	6	5	7	5	7	7	37
2007	5	5	7	5	6	5	33
2008	5	.	7	7	7	9	35
2009	2	.	5	5	6	6	24
2010	5	5	10	5	7	9	41
2011	.	.	5	5	5	5	20
2012	5	5	10	8	9	7	44
2013	6	6	8	6	10	7	43
2014	5	5	10	8	10	7	45

Table 14.3.2.2 ***German survey*****. Cod abundance indices ('000) from the German survey in West Greenland (NAFO 1C-1E) by year and stratum.**

	NAFO 1C		NAFO 1D		NAFO 1E			
year	str1_1	str1_2	str2_1	str2_2	str3_1	str3_2	Sum	SD
1982	2364	408	27594	920	7401	1801	40488	18605
1983	177	196	7079	2230	8678	1230	19590	7266
1984	189	90	2524	98	2666	364	5931	3629
1985	8094	1107	7237	2348	4984	840	24610	10809
1986	14716	630	22985	108	16570	609	55618	29631
1987	173517	482	115172	3790	72349	186	365496	331763
1988	46027	1106	186523	43090	21037	51	297834	216925
1989	1362	483	16280	325	129005	678	148133	65933
1990	619	299	2279	235	3827	61	7320	5462
1991	142	116	88	92	474	387	1299	412
1992	274	334	72	127	57	38	902	314
1993	327	243	105	109	53	21	858	195
1994	95	53	16	17	34	11	226	79
1995	.	.	27	.	72	34	133	60
1996	82	70	42	20	65	0	279	80
1997	0	24	17	0	57	3	101	45
1998	793	0	23	28	7	0	851	573
1999	103	33	33	11	197	7	384	171
2000	205	250	50	174	288	9	976	383
2001	.	.	584	36	3020	9	3649	3481
2002	.	.	238	21	342	23	624	257
2003	.	.	625	99	1625	73	2422	945
2004	503	213	1522	123	2709	638	5708	1592
2005	.	.	1586	264	5666	419	7935	3115
2006	495	485	87439	858	4481	1323	95081	99523
2007	1430	3261	3417	687	9861	71	18727	8645
2008	2666	.	916	911	23527	616	28636	26712
2009	72	.	1370	850	1068	378	3738	879
2010	2644	464	4451	631	5148	274	13612	6231
2011	.	.	716	375	1242	337	2670	782
2012	99609	1253	6007	442	8455	1251	117017	68441
2013	4457	1585	20122	221	7138	252	33775	22438
2014	9952	2008	28102	413	1261	86	41822	38616

Table 14.3.2.3 ***German survey,*** **Cod biomass indices (tons) from the German survey in West Greenland (NAFO 1C-1E) by year and stratum.**

	NAFO 1C		NAFO 1D		NAFO 1E			
year	str1_1	str1_2	str2_1	str2_2	str3_1	str3_2	Sum	SD
1982	1113	163	37404	1280	9970	4483	54413	26014
1983	144	87	9052	3381	12953	5015	30632	10295
1984	406	104	3998	137	3643	551	8839	5507
1985	1046	112	6543	1181	4700	506	14088	18209
1986	4858	254	11787	36	12381	651	29967	13885
1987	148896	156	93292	2446	54178	107	299075	299459
1988	47085	579	190073	39548	19663	54	297002	227428
1989	384	124	15061	211	113614	710	130104	55334
1990	130	66	1948	123	3652	56	5975	4986
1991	45	38	36	28	549	374	1070	529
1992	65	104	15	33	10	7	234	97
1993	77	45	27	27	30	6	212	53
1994	13	17	3	12	11	5	61	17
1995	.	.	14	.	13	7	34	12
1996	13	35	12	11	28	0	99	29
1997	0	21	11	0	50	3	85	43
1998	38	0	1	7	1	0	47	25
1999	16	11	6	3	63	5	104	57
2000	54	71	11	83	73	5	297	117
2001	.	.	163	17	1024	5	1209	1212
2002	.	.	89	16	136	7	248	108
2003	.	.	98	44	736	32	910	461
2004	172	83	274	45	547	186	1307	342
2005	.	.	605	124	1796	146	2671	1057
2006	102	138	45616	250	2046	614	48766	52298
2007	319	885	1579	244	7804	43	10874	7524
2008	872	.	193	206	11479	175	12925	13686
2009	19	.	309	293	372	153	1146	255
2010	1012	244	2234	312	2703	173	6678	3057
2011	.	.	189	128	1040	194	1551	602
2012	52497	588	4185	240	8203	848	66561	35693
2013	2703	1670	17316	142	11251	544	33626	18801
2014	10597	2154	35741	422	3561	397	52872	47451

Table 14.3.2.4 ***German survey*****, West Greenland (NAFO 1C-1D). Age disaggregated abundance indices ('1000).**

Year	0	1	2	3	4	5	6	7	8	9	10	11+	TOTAL
1982		77	505	14266	5195	14798	4144	908	178	344	35	34	40484
1983*)													
1984	80	3	13	709	604	3495	289	628	32	61	13	0	5927
1985	202	16823	623	330	2271	1100	2982	112	164	2	3	0	24612
1986		3600	45772	1686	321	2386	652	1098	22	74	3	1	55615
1987		147	22578	318948	13977	2930	4603	649	1506		131	13	365482
1988		124	1357	44364	247618	2660	311	521	318	529	12	15	297829
1989	0	163	1293	3821	79642	62126	1008		47	7	24	0	148131
1990	11	17	595	1242	368	4089	990	6	0	0		1	7319
1991		86	94	193	350	36	461	57	2			0	1279
1992		88	672	100	17	25		0				0	902
1993		8	499	318	12	21						0	858
1994		98	18	90	14	3		2				0	225
1995			111	6	16							0	133
1996		76	6	193	5		0					0	280
1997		6	13	7	76							0	102
1998	0	845		3	3	0						0	851
1999	8	165	166	36	3		3					0	381
2000		60	524	328	62							0	974
2001		266	2753	527	65	20						0	3631
2002	0	6	309	290	17							0	622
2003		1368	205	511	284	36	9					0	2413
2004	132	3078	2008	307	108	55	15	0				0	5703
2005	91	156	6893	653	40	16	14	0	0			0	7863
2006	157	1949	6961	83106	2708	45	51	67	0			0	95044
2007	139	229	9402	1655	6989	227	35	38	12			0	18726
2008	8	1224	2317	20080	3747	1235	20	3	2	0	0	0	28636
2009	36	326	2513	363	406	37	40	14				0	3735
2010	208	1531	1726	9201	577	259	51	48	3	3		5	13612
2011		195	1572	385	368	68	33	26	24	0	0	0	2671
2012	142	1191	37872	66947	7682	2847	227	76	8	18		0	117010
2013		152	1562	12824	15859	1783	1135	234	86	23	18	4	33680
2014			880	4629	17021	17863	1080	277	32	0	4	0	41786

***) calculated proportionally using age compositions reported by the ICES Working Group on Cod Stocks off East Greenland (ICES, 1984).**

Table 14.5.1. Number of tagged cod in the period of 2003 to 2014 in different regions. Bank (West) = NAFO division 1D+1E. East Greenland = NAFO division 1F + ICES division XIVb.

Tagged			
Year	Fjord	Bank (West)	East Greenland
2003	599		
2004	658		
2005	565		
2006	41		
2007	1140	721	1387
2008	231		1296
2009	633		525
2010	88		
2011	28		403
2012	86	1563	2359
2013	183	2321	
2014			1203

Table 14.5.2: Number of recaptured cod in the period of 2003 to 2014 in different regions. Bank (West) = NAFO division 1D+1E. East Greenland = NAFO division 1F + ICES division XIVb.

Recaptures			
	Fjord (West)	Bank (West)	East Greenland
Fjord (West)	436	8	3
Bank (West)		21	2
East Greenland		5	89
Fjord (East)			1
Iceland	3	13	98

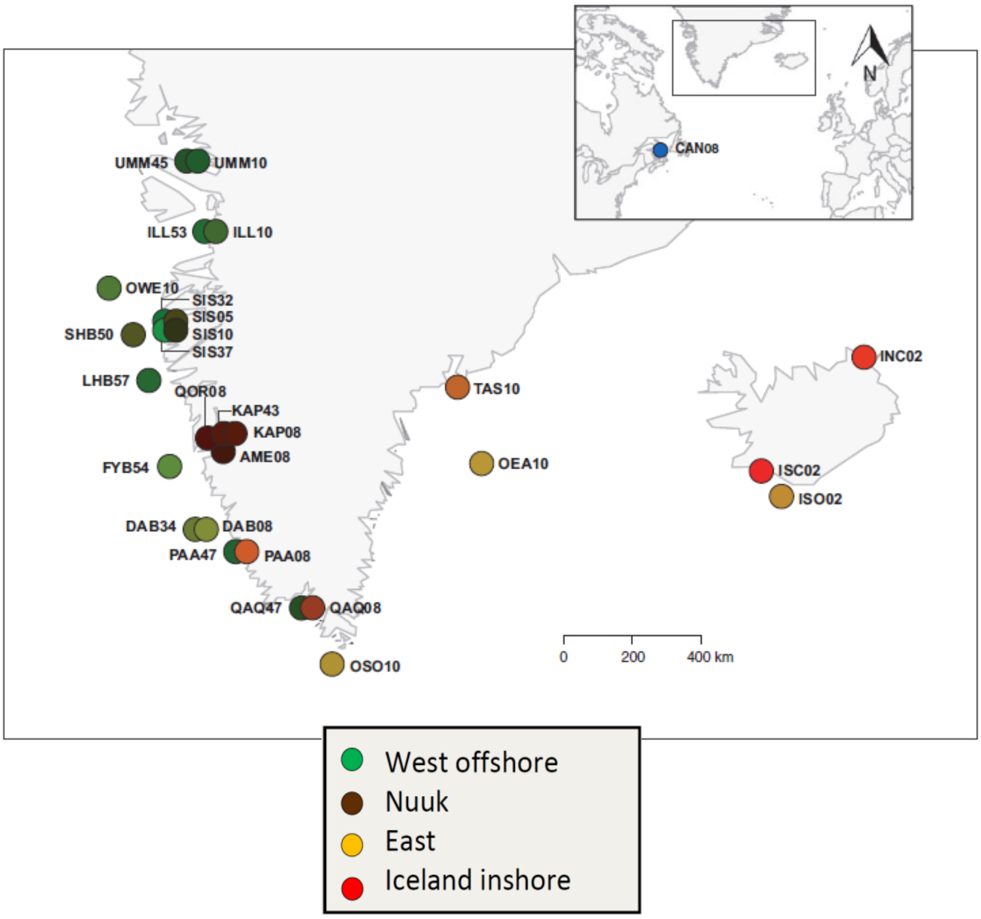

Figure. 14.1. Sampling location of spawning cod in Greenland and Iceland in the genetic project. The colours of the dots represent the blends of sample mean of the different spawning population: West offshore, Nuuk (inshore), East (Greenland and offshore Iceland) and Iceland inshore as signal intensities of green and red respectively. After Therkildsen et al. 2013.

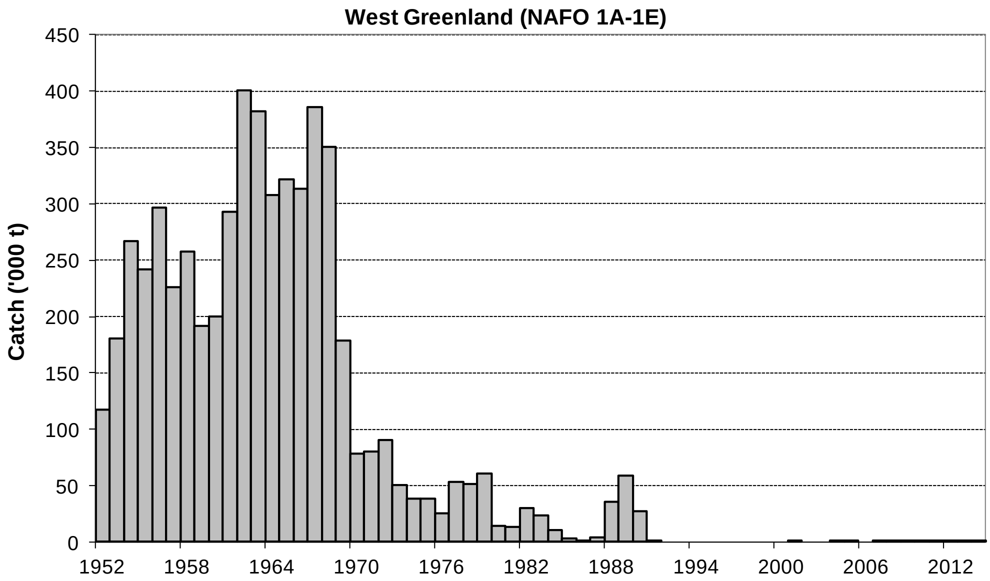

Figure 14.2.1. Annual catch of cod in offshore West Greenland (NAFO subdivisions 1A-1E) used by the Working Group.

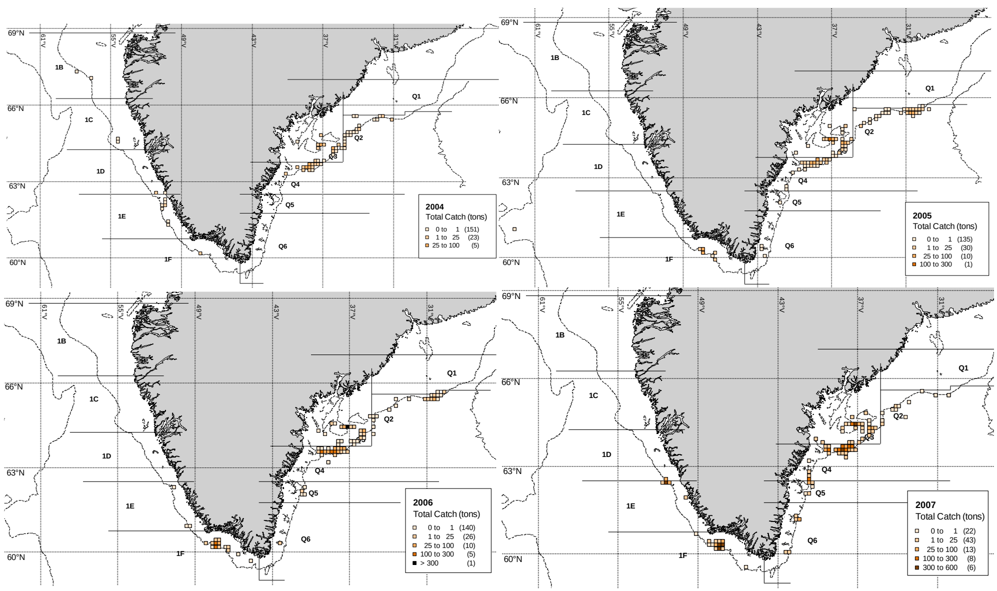

Figure 14.2.2.1: Annual distribution of total catches of Atlantic cod in West and East Greenland. Q1-Q6 illustrates survey areas (strata) in the East Greenland shrimp and fish survey.

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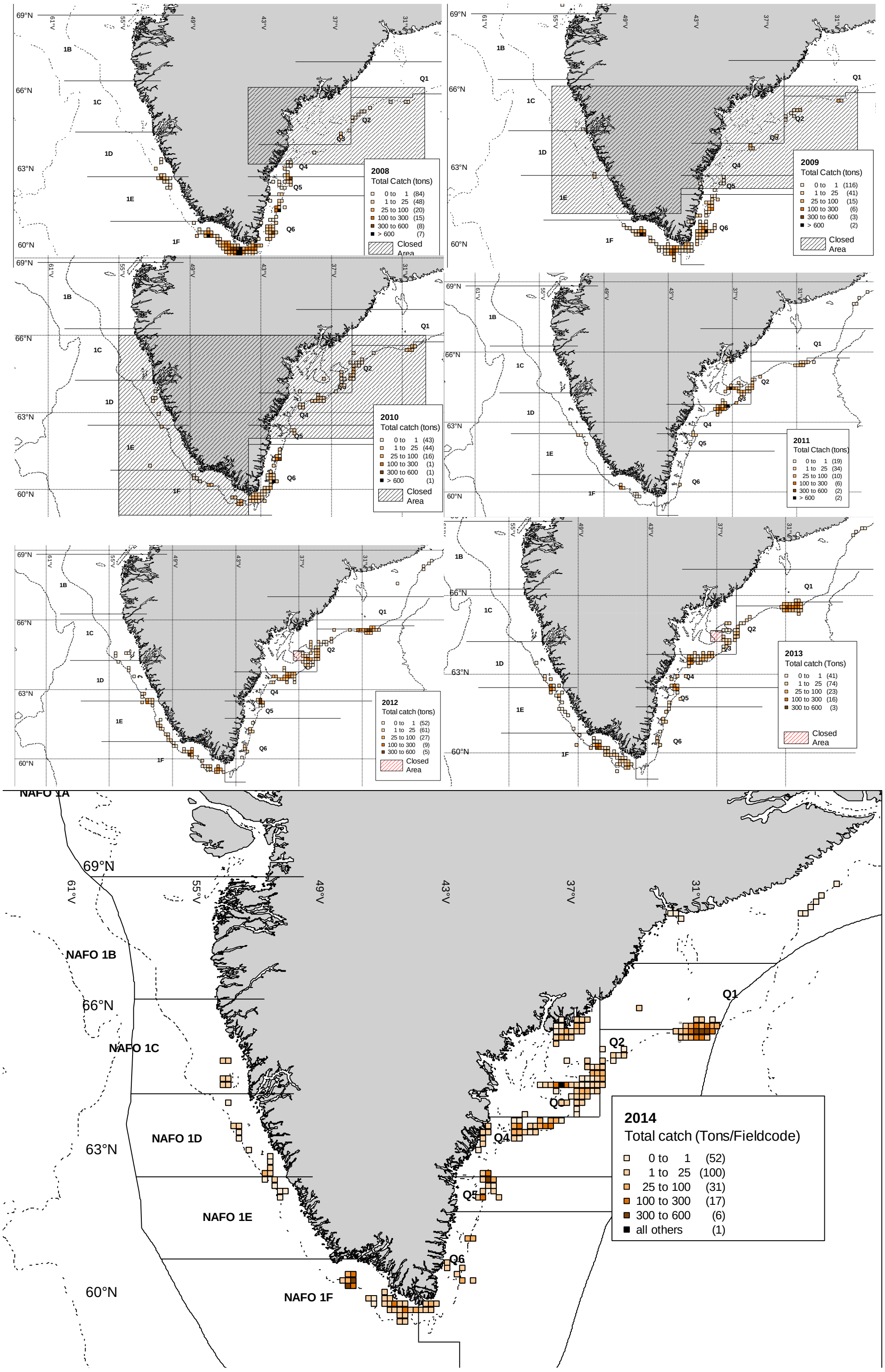


Figure 14.2.2.1: Continued. Annual distribution of total catches of Atlantic cod in West and East Greenland. Q1-Q6 illustrates survey areas (strata) in the East Greenland shrimp and fish survey.

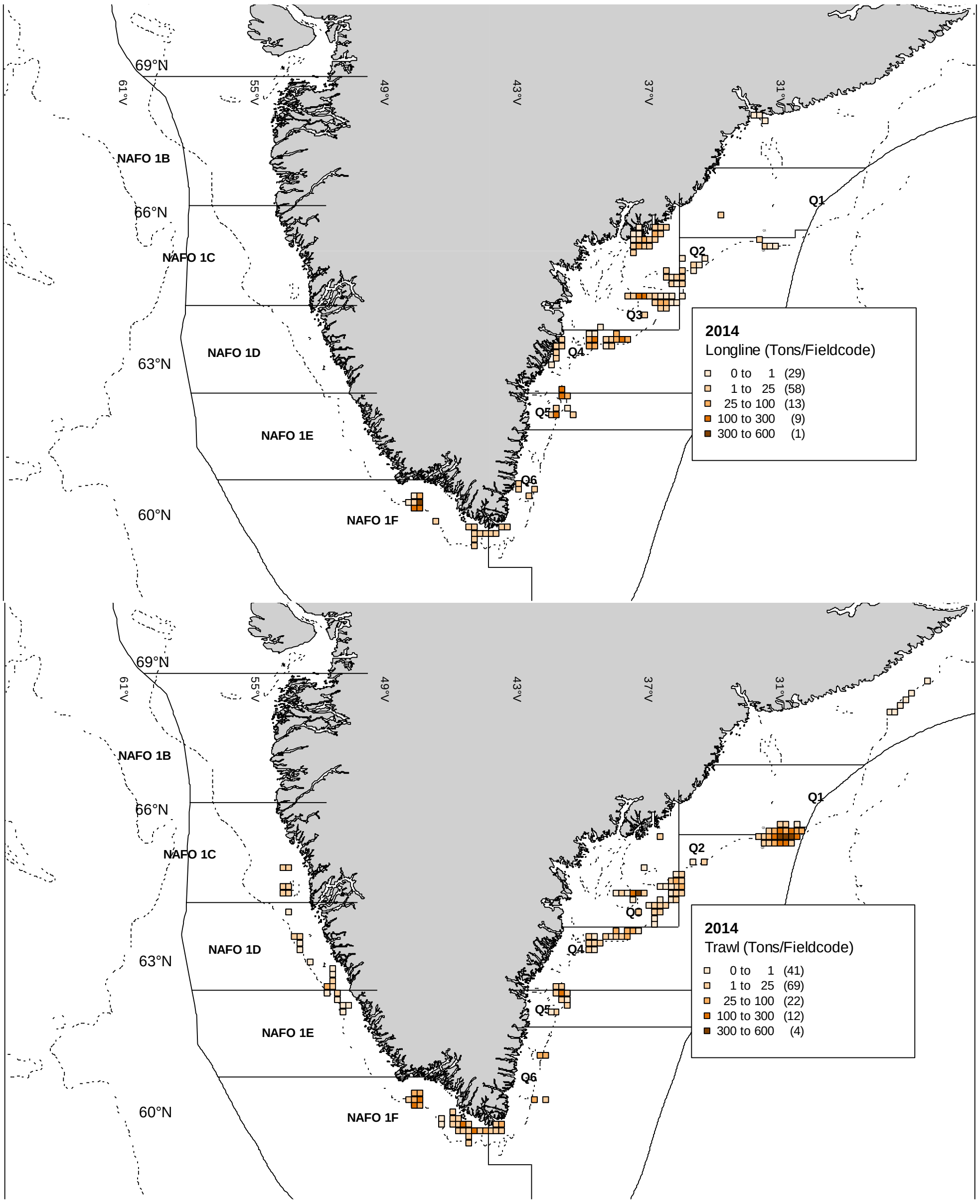


Figure 14.2.2.2: Distribution of Longline and Trawl catches of Atlantic cod in West and East Greenland 2014. Q1-Q6 illustrates survey areas (strata) in the East Greenland shrimp and fish survey.

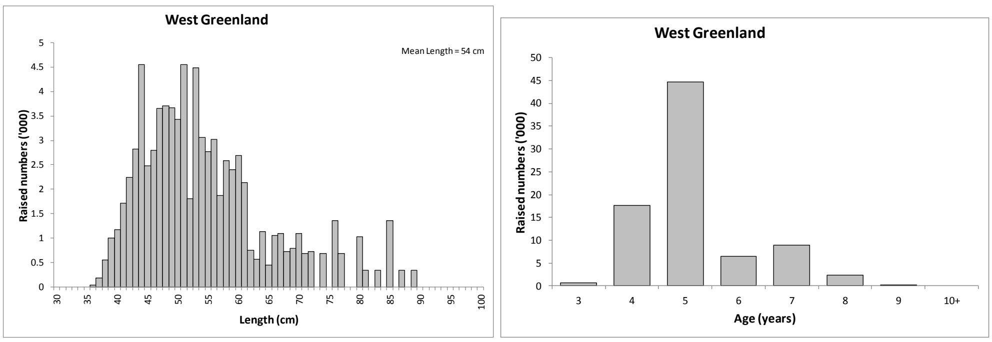


Figure 14.2.3.1: Total length and age distributions of commercial cod catches in the West Greenland (NAFO 1A-1E) offshore fishery in 2014.

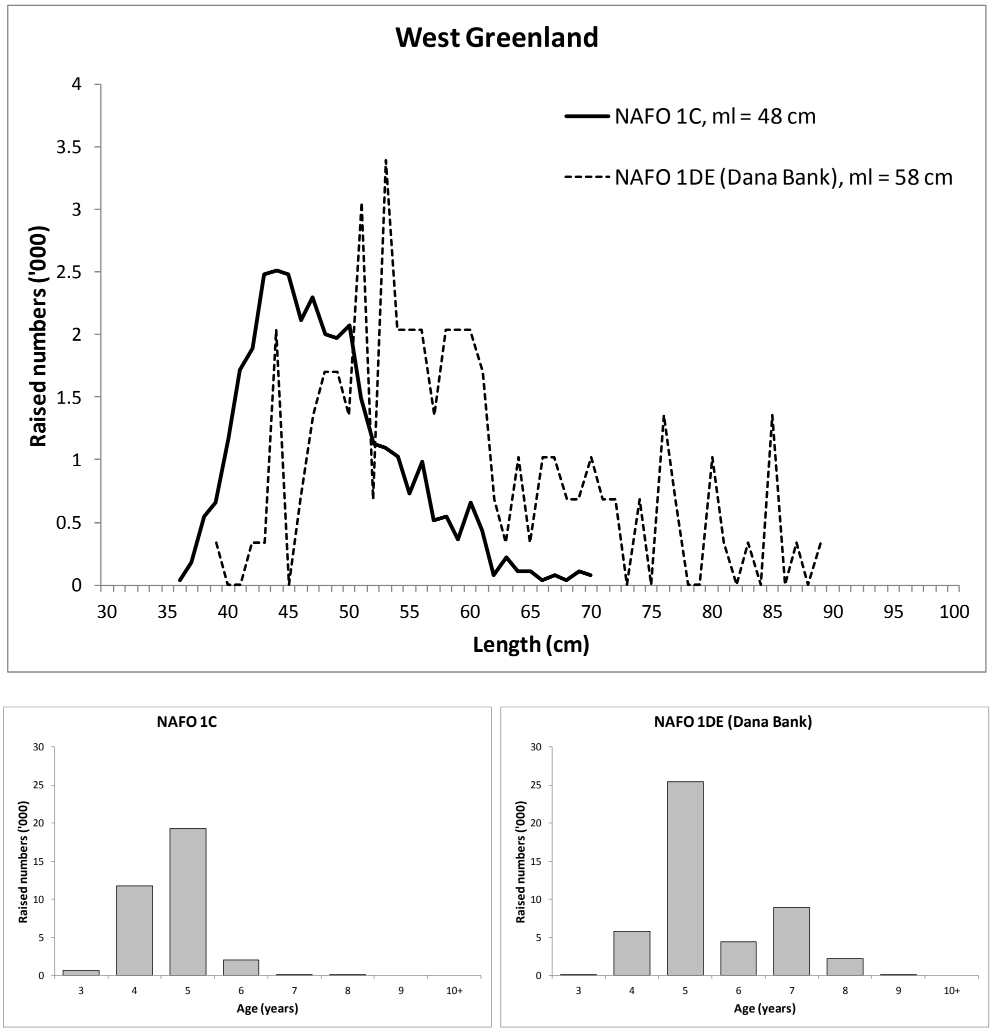


Figure 14.2.3.2: Length and age distributions of commercial cod catches in different NAFO divisions in West Greenland in 2014. NAFO 1C is furthest to the north.

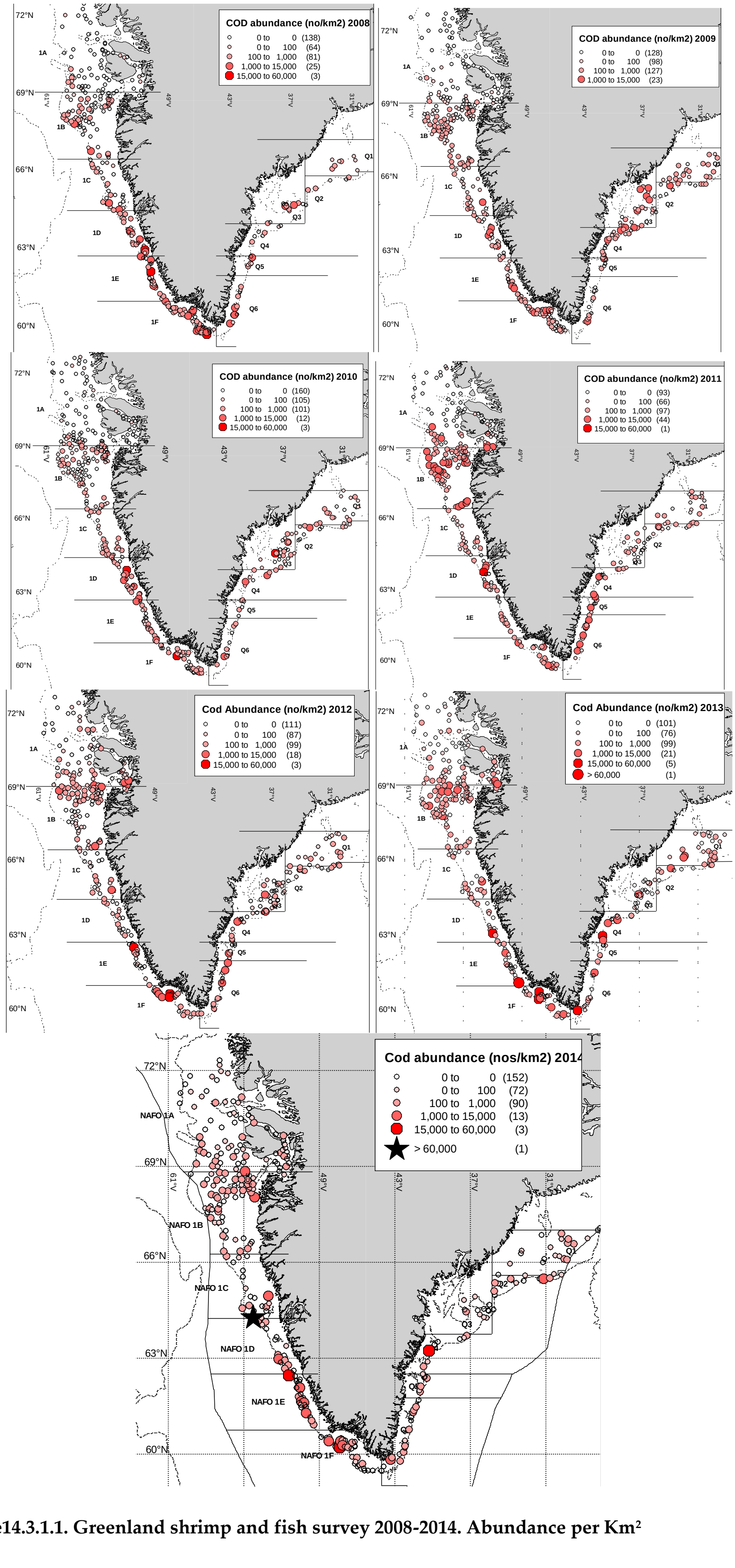


Figure14.3.1.1. Greenland shrimp and fish survey 2008-2014. Abundance per Km²

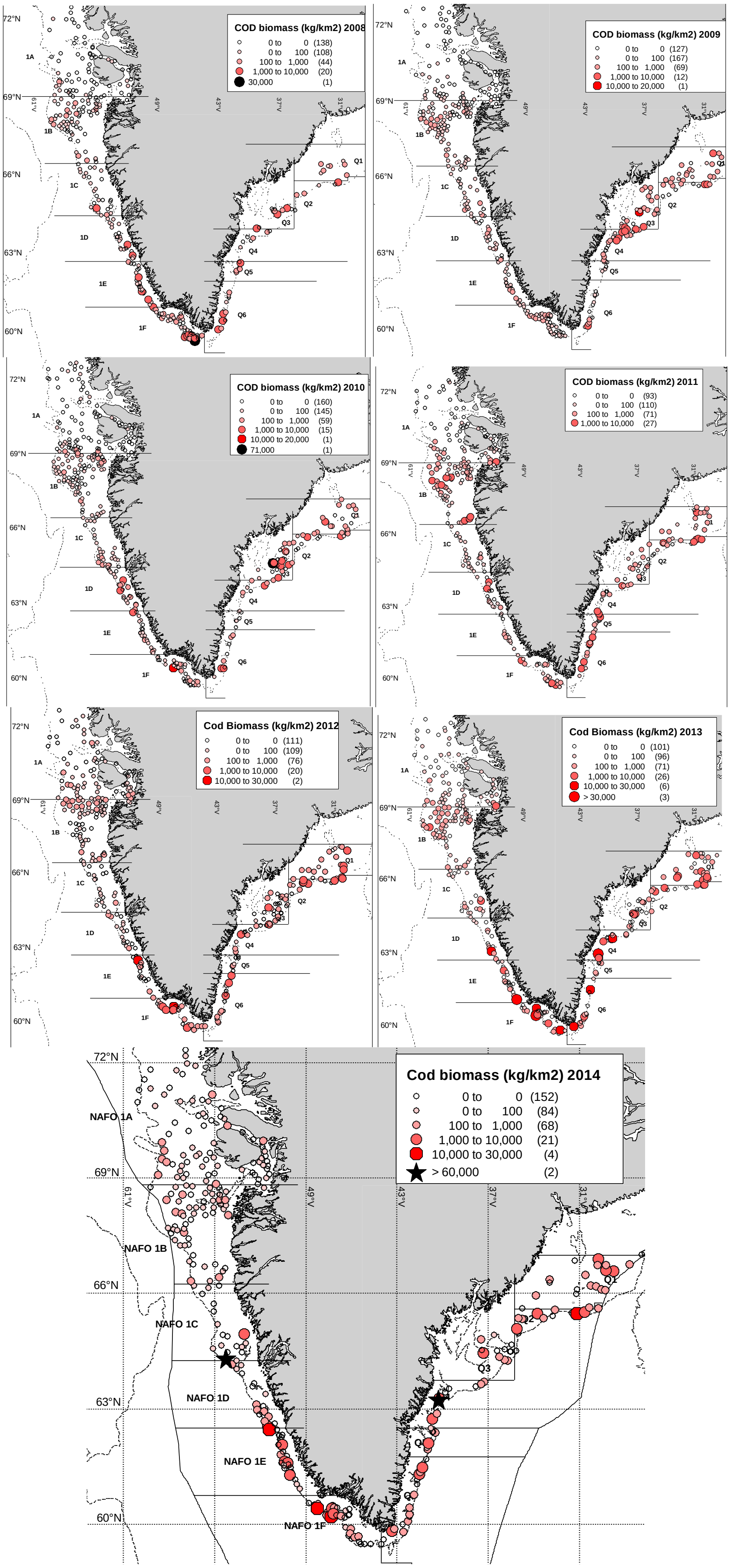


Figure 14.3.1.2. Greenland shrimp and fish survey 2008-2014. Catch weight kg per Km²

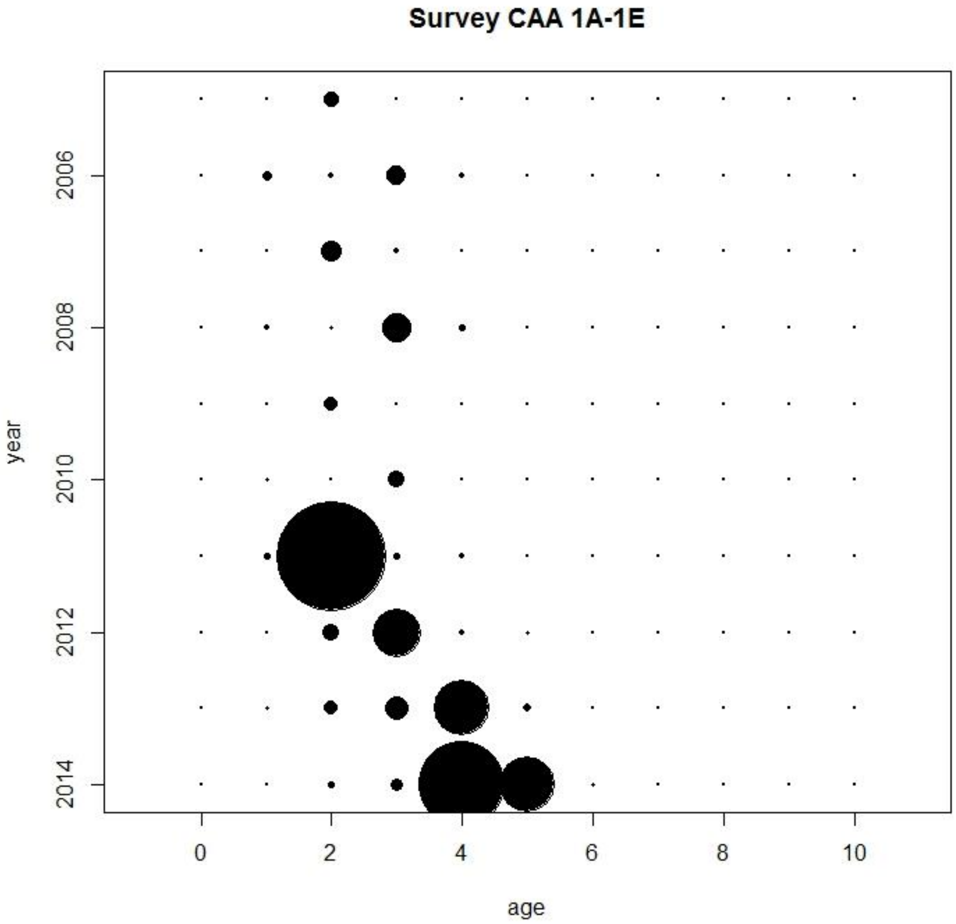


Figure 14.3.1.3: Abundance index by age in NAFO 1A-1E combined. Size of circles represents index value.

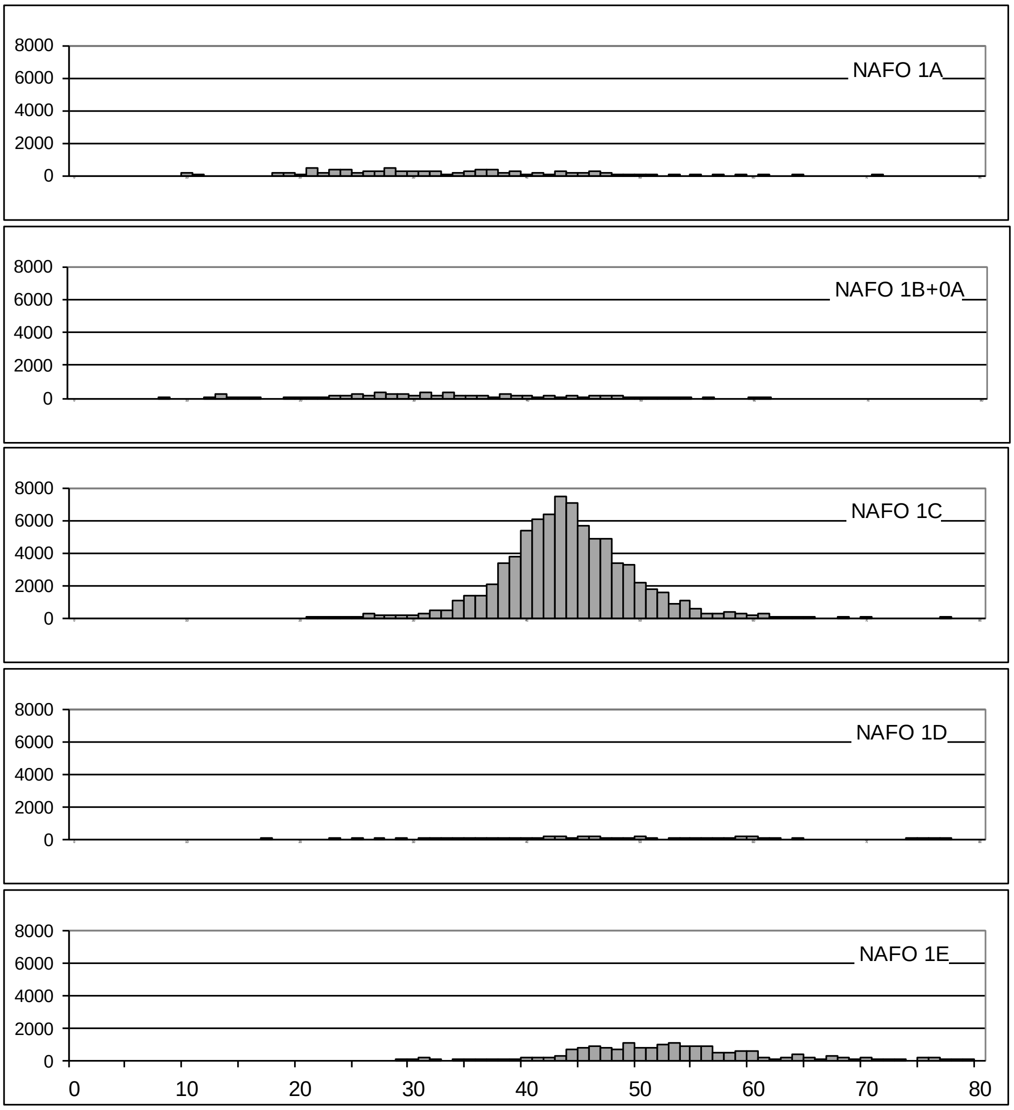


Figure 14.3.1.4: West Greenland Shrimp and fish survey, 2014. Abundance index by length (cm) and area . Areas from north (top) to south (bottom) are: NAFO div. 1A ; 1B+0A; 1C, 1D, 1E.

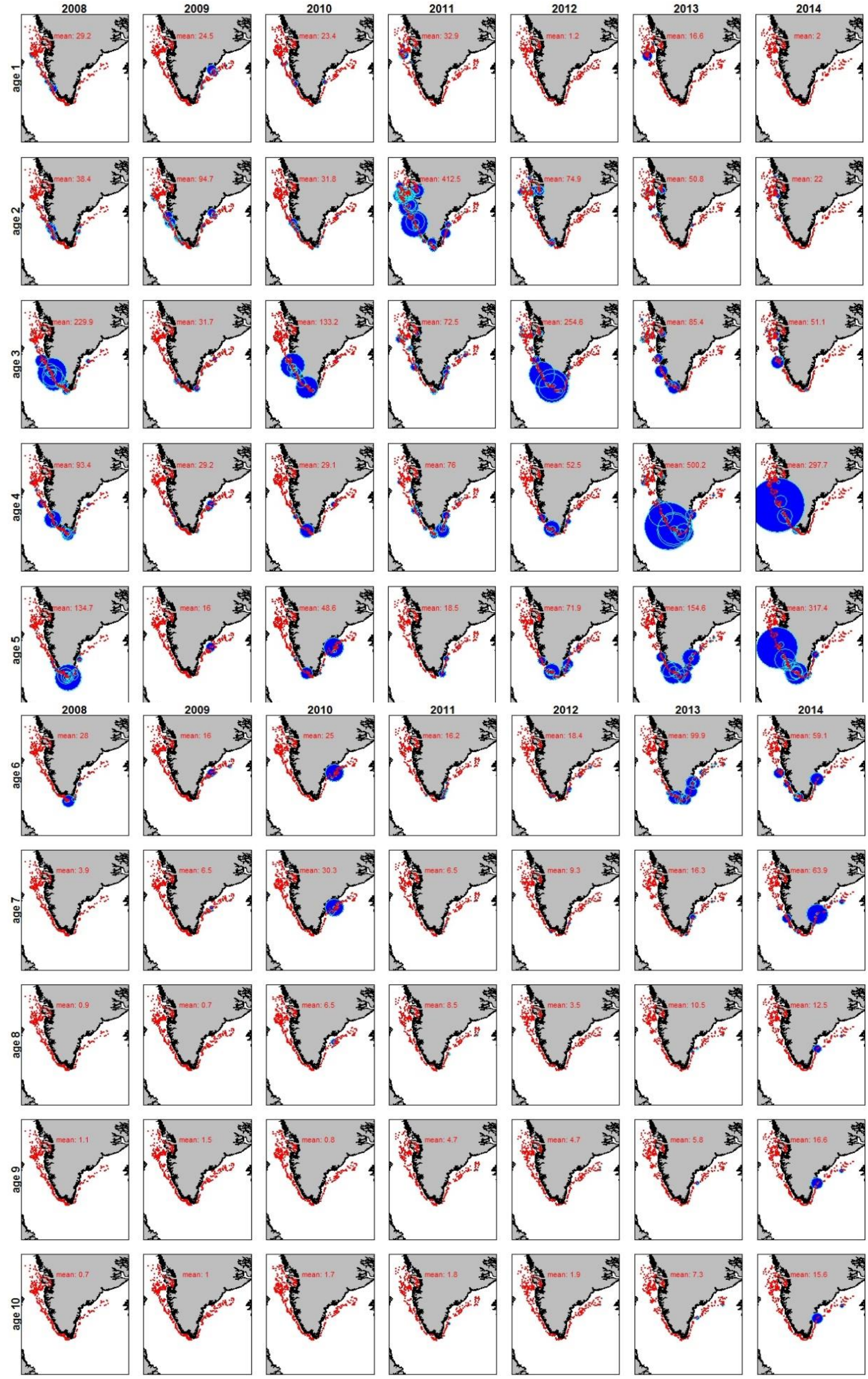


Figure 14.3.1.5. Abundace (no/km²) pr. station of ages 1-10 in the years 2008-2014.

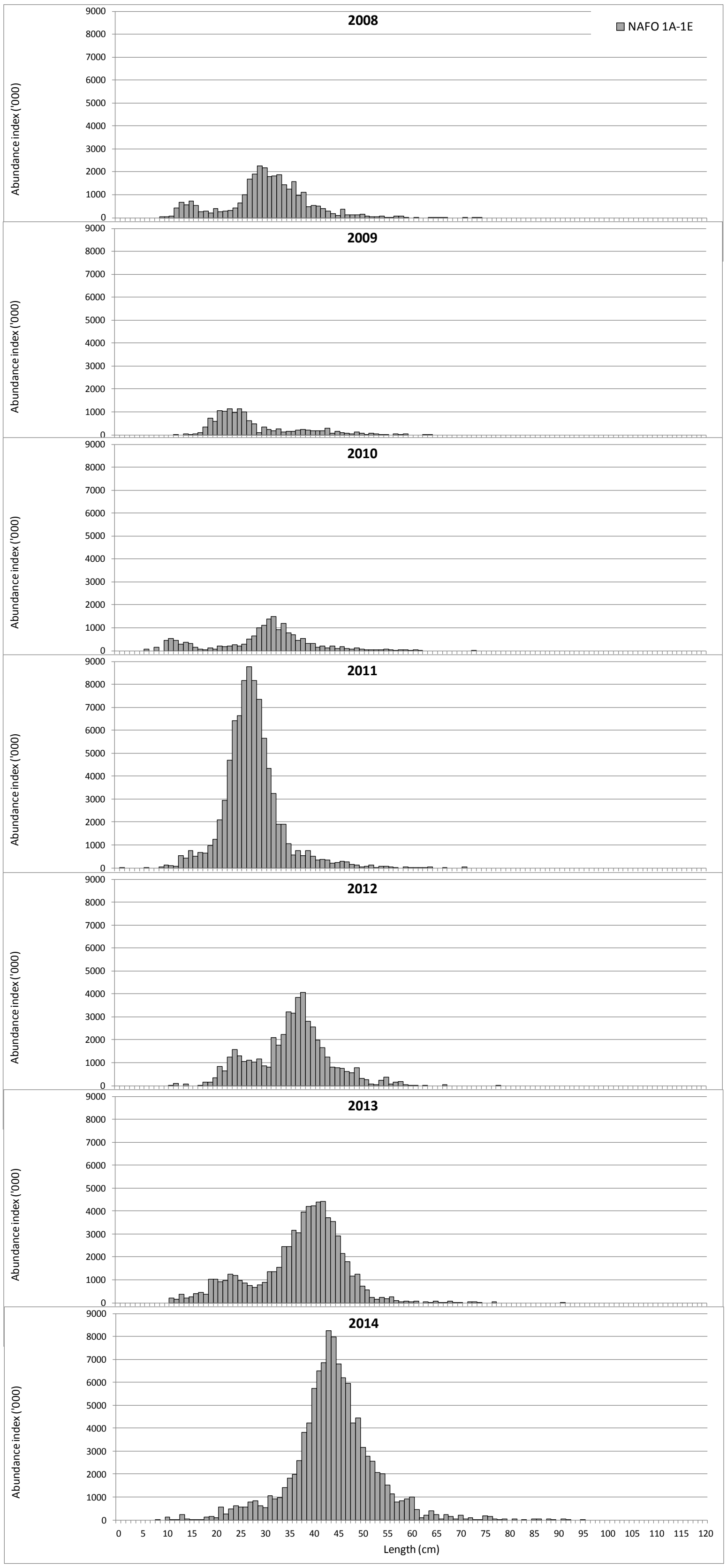


Figure 14.3.1.6: Total abundance indices by length in West Greenland shrimp and fish survey (NAFO 1A-1E).

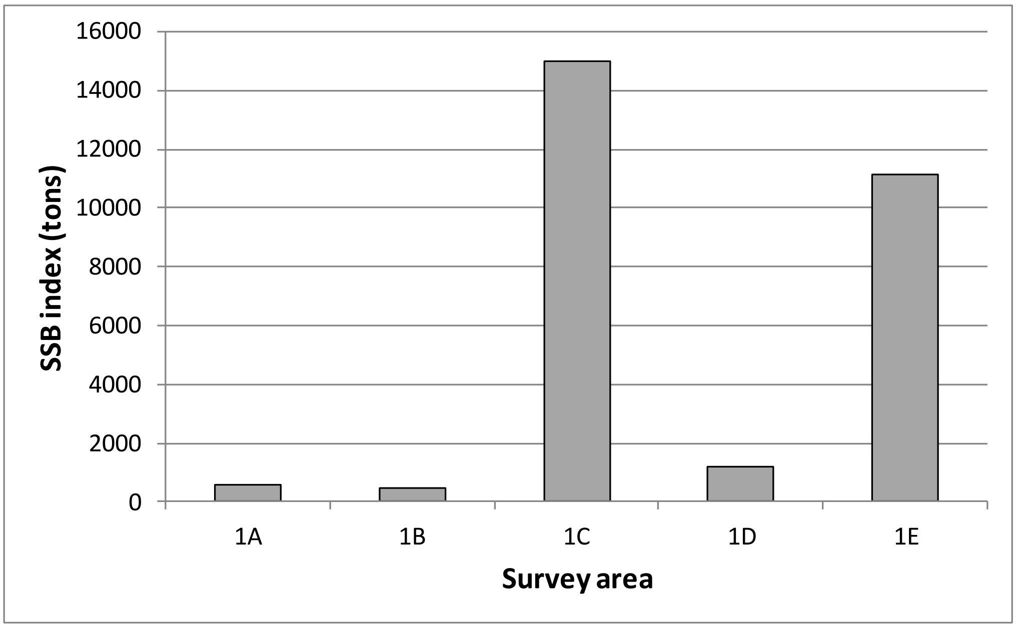


Figure 14.3.1.7: Estimated SSB (tons) by NAFO subdivisions from the West Greenland Shrimp and Fish survey, 2014. Maturity taken from proportion mature by length as recorded on observer trips off East Greenland in 2007.

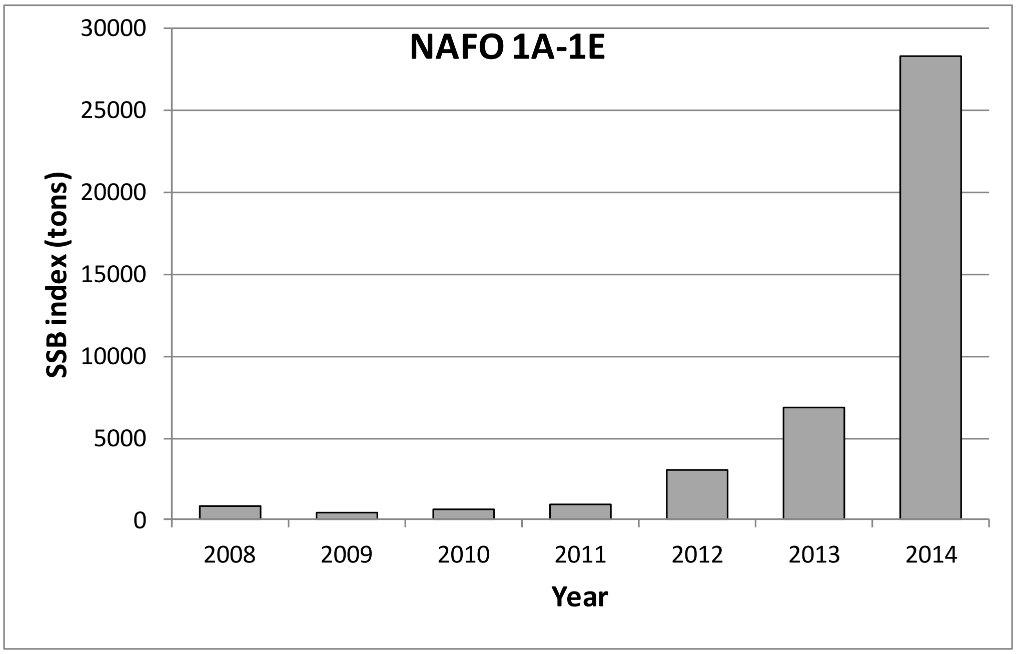


Figure 14.3.1.8: Estimated SSB (tons) by year from the West Greenland Shrimp and Fish survey (NAFO 1A-1E).

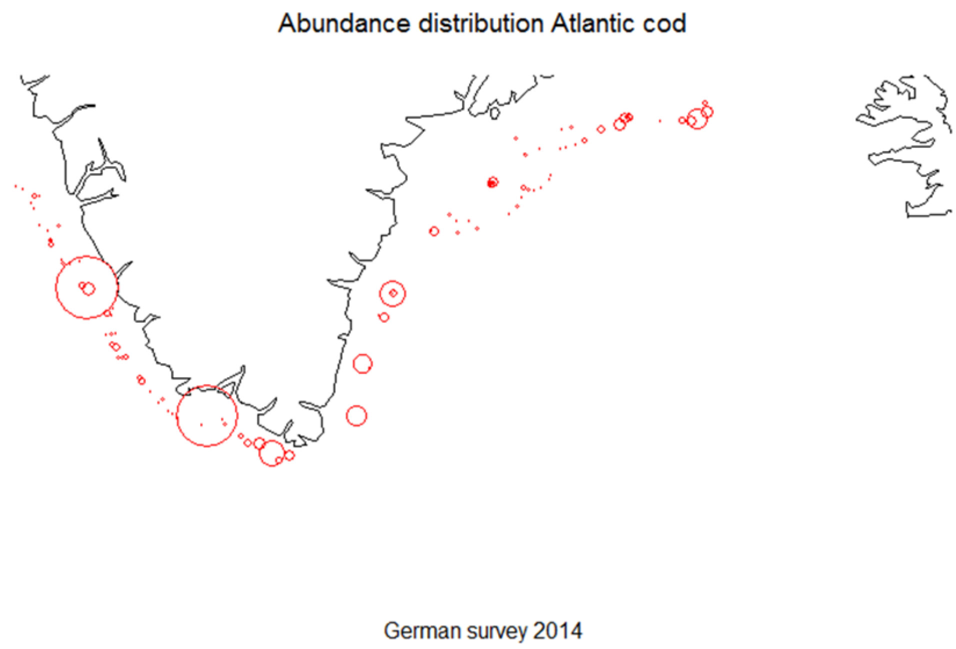


Figure 14.3.2.1 German survey, 2014. Abundance (num per km2) pr haul.

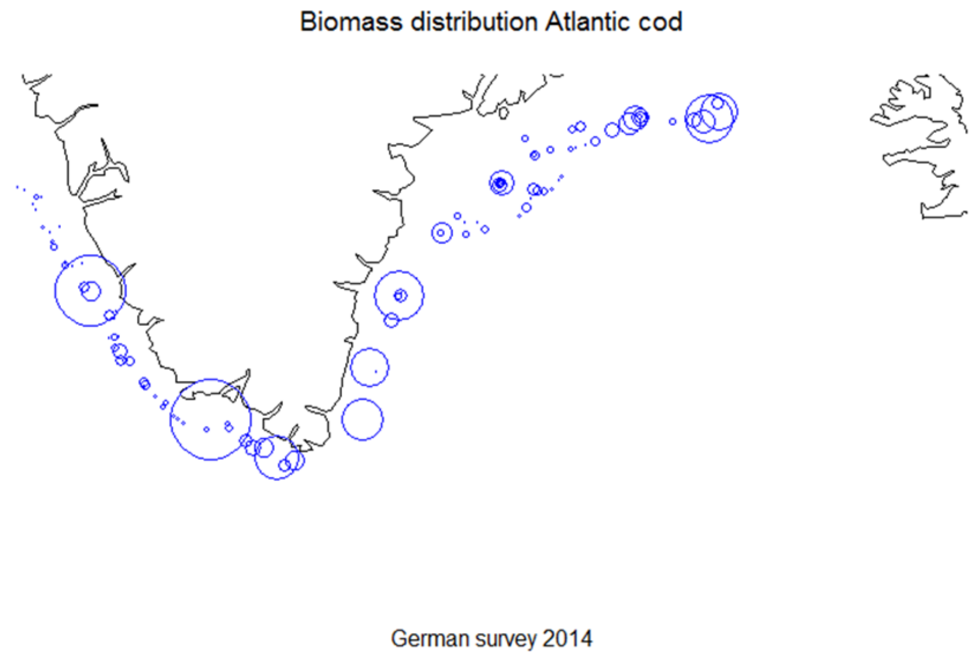


Figure 14.3.2.2 German survey, 2014. Biomass (kg per km2) pr haul.

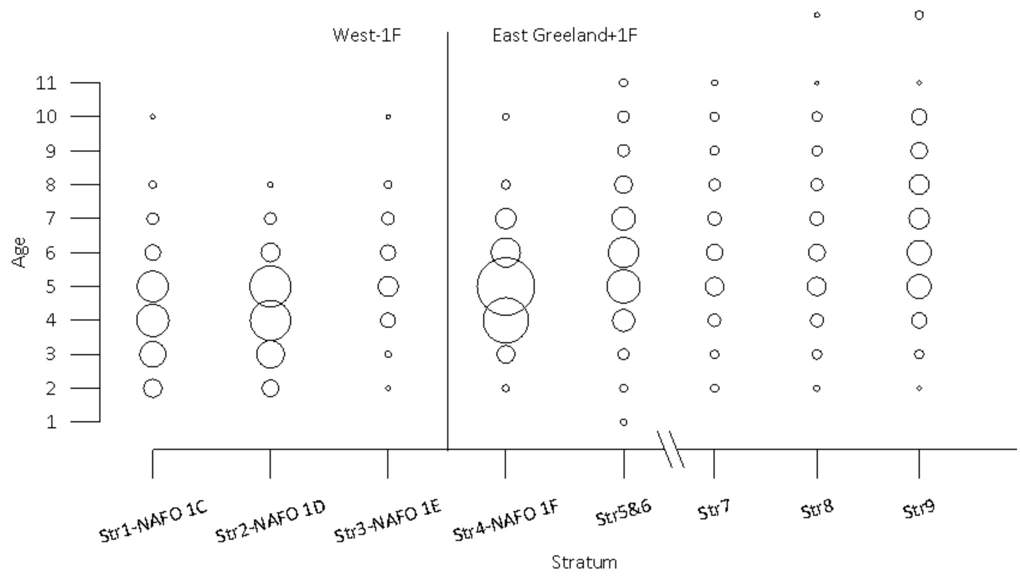


Figure 14.3.2.3 German survey, Cod off Greenland. Abundance per age group and stratum. Strata 1 –4 is West Greenland from north to south; strata 5-9 is East Greenland from south to north.

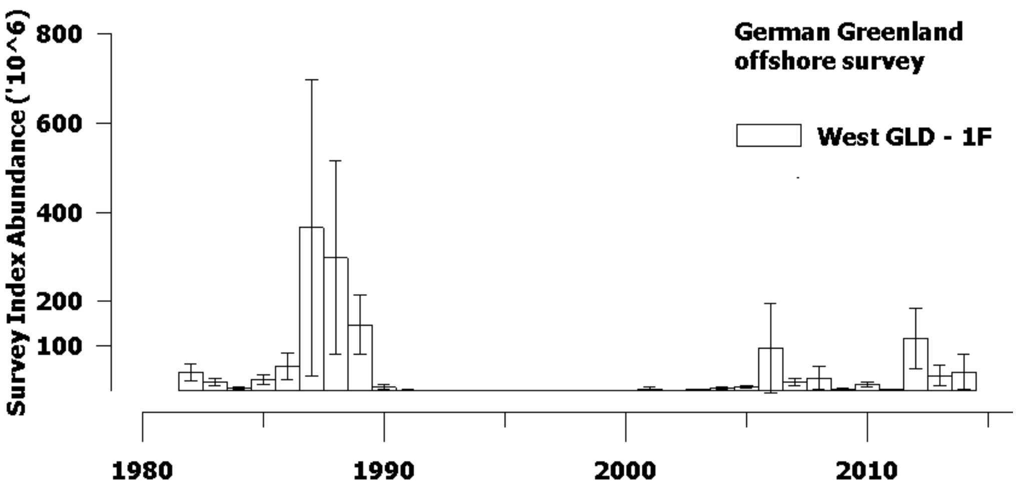


Figure 14.3.2.4 German survey, Cod off Greenland. Abundance indices for West Greenland (NAFO subdivisions 1C-1E).

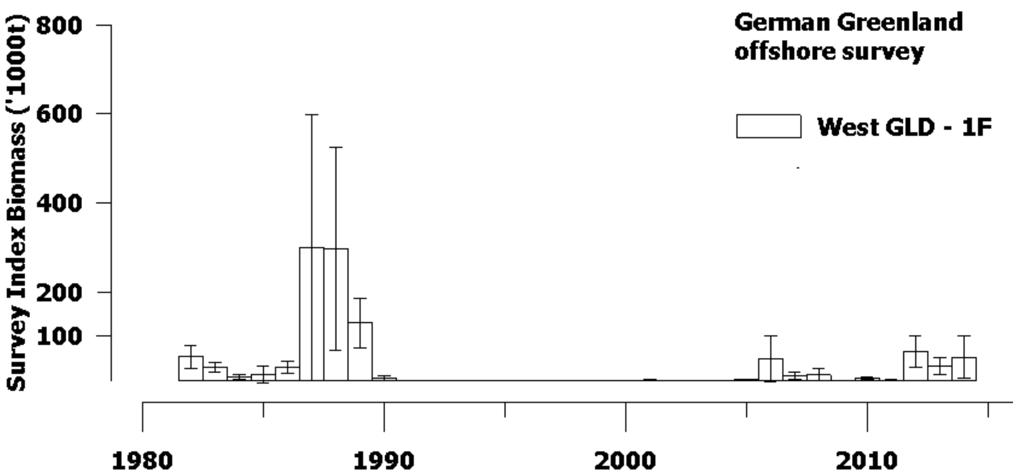


Figure 14.3.2.5 German survey, Cod off Greenland. Biomass indices for West Greenland (NAFO subdivisions 1C-1E).

15 Cod in inshore waters of NAFO Subarea 1 (Greenland cod)

Executive Summary

Total catches from the inshore fishery were 18 331 t in 2014 which is the highest since early 1990'ies. Several year-classes were caught in the fishery but catches were dominated by the 2009 YC.

he mean length in the fisheries has increases from 44 cm in 2006 to 58 cm in 2014. Survey recruitment indices from the inshore area show that incoming year classes (2011 and 2012) are below average.

The stock was benchmarked in 2015 and a new procedure for making catch advice was adopted. The procedure is based on a linear regression on pairs of survey values (ages 3-8) and catches in the following year. The advice is based on the average of the 2013 and 2014 survey values for ages 3-8 multiplied by a scaling factor.

15.1 The fishery

Details on the historical development in the fisheries are provided in the stock annex.

15.1.1 The present fishery

The original TAC for the coastal fishery in 2014 was set at 15 000 tons. During the season first 1 500 tons was added in October and another 2 000 tons were added in November resulting in a total TAC of 18 500 t. Further a dispensation was given to three small vessels to fish offshore on the inshore quota. Only one vessel used its license and caught 166 t.

The coastal fishery took 18 400 tons in 2014, which is an increase of 39% compared to 2013 (table 15.1.1.1, figure 15.1.1.1). The majority of the catches (79%) were taken in Mid Greenland in NAFO Div. 1B, 1C and 1D (table 15.1.1.1, figure 15.1.1.2). The most important fishery is the pound net fishery that takes place during summer followed by the fishery with jigs that takes place in autumn (table 15.1.1.2 and 15.1.1.3). In 2014 half of the total catch was taken by pound net which is a decrease compared to 2013 where 2/3 of the total catch where taken by pound net and 2012 where 3/4 of the total catch was taken by pound net (Fig. 15.1.1.1). Since 2012 jigs have become more dominant from 7% of the total catch in 2012 to 25% of the total catch in 2014. Gillnets and longlines constitutes the rest of the total catch.

The commercial fishery for the inshore cod is carried out along the entire coastline of West Greenland from Disko bay to Cap Farewell (Figure 15.1.1.3). Gillnets and Jigs are used more often in mid Greenland (NAFO 1B and1C) compared to other areas where they comprised 29% of the total catches (table 15.1.1.3). The pound-net fishery is the dominating gear (especially in the Nuuk area, NAFO 1D), although to a lesser extent in Disko bay (NAFO 1A, figure 15.1.1.3) due to the fishing industry being concentrated on Greenland Halibut, therefore cod is mostly caught as bycatch in the longline and gillnet settings for Greenland Halibut. Cod catches in the Disko Bay area, especially in the southern part of Disko Bay, have however increased in recent years and 17% of the total inshore catches was taken in Disko Bay in 2014. The cod fishery is now larger in Disko Bay than in South Greenland (NAFO 1E and 1F). The catches in South Greenland were the lowest recorded since 2004 (table 15.1.1.1) and comprised only 0.4% of the total inshore catches in 2014 (table 15.1.1.2).

15.1.2 Length, weight and age distributions

In 2014 the Greenland inshore length frequencies were measured from 49 inshore samples (6 446 cod measured).

everal year-classes were caught in the inshore fishery in 2014 and ages 4-6 (YC 2008-2010) comprised the catches in 2014, with the 2009 YC dominating the catches (figure 15.1.2.1, table 15.1.2.1). Mean length in catches have increased from 53 cm in 2010-2013 to 58 cm in 2014. This increase is caused by the 2009 YC being the dominating YC at age 4 in 2013 and age 5 in 2014. The 2010 YC does not seem to be as abundant as the 2009 YC and therefore the mean length has increased (figure 15.1.2.2).

15.1.3 Information on spawning

In 2011 a survey was conducted in spring in order to investigate the extent of spawning in fjords not traditionally surveyed. The results show that spawning occurs in most fjords and is especially pronounced between Sisimiut (NAFO 1B) and Paamiut (NAFO 1E).

15.1.4 Results of the West Greenland gillnet survey

The numbers of valid net settings in 2014 was 41 in NAFO 1B and 60 in NAFO 1D (Table 15.1.4.1). Area and site specific catch rates can be seen in Fig. 15.1.4.1.

In 1B age 2 and 3 fish (2011 and 2012 YC's), which the survey mainly targets, appear to be small cohorts, and are smaller than the time series mean (Table 15.1.4.2, Fig. 15.1.4.2). The 2009 YC that has been large the most resent years in 1B is no longer observed as a particular strong YC at the age of 5 (Table 15.1.4.2, Fig. 15.1.4.3). Overall, the NAFO 1B index (including all age groups) declined from 2013 by 64%.

The 2014 catches in NAFO 1D were dominated by 3 year old cod (2011 YC, Table 15.1.4.2). Catch rates of this YC was the second highest in the time series. The 2009 YC was not an outstanding cohort at age 2 and 3 in 2011 and 2012 in 1D but the index increased for age 4 in 2013 and was one of the highest recorded indices in 2013, and at age 5 in 2014. The overall index for NAFO 1D (including all age groups) is the second highest in the time series, but decreased by 26% compared to 2013.

Combining the two NAFO divisions in a joint index shows an overall decline of 49 % in total index for all ages from 2013 and it has not been as low since 2006 (Fig.15.1.4.4). This overall trend is driven by the development in NAFO 1B, where the catch rates and index values are normally higher than 1D (Table 15.1.4.2, Fig. 15.1.4.3). However this has changed in 2014 with the total index being higher in 1D. This is caused by the index being higher in 1D for especially ages 3 and 4 (2011 and 2010 YC). The combined index for 1B and 1D for age 2 and 3 jointly has decreased by 61% compared to the average of the preceding four years.

The combined 1B and 1D index for ages 3-8 that are used together with catch data for making catch advice for the inshore management area (ICES 2015) is very similar to the index for all age groups (Fig. 15.1.4.4) and has also decreased compared to the most recent years. But the decrease is more moderate, 41% compared to 2013 and 30% compared to the preceding four years.

Recruitment in all three areas (one is no longer surveyed) declined from the start of the survey period until the late 1990's where recruitment was very low in the inshore areas. Around 2000, recruitment started to increase, and has been stable and occasionally very high since (Table 15.1.4.2).

In NAFO 1B, namely the 2009 YC resulted in high catch rates and the combined survey index was the highest observed in the years it was dominant. The catch rates of this YC in 1B was the highest recorded in the time series at ages 1, 2 and 3, but was not an outstanding cohort at age 5 in 2014. In 2014 the YC was "gone" from 1B which can be an effect of the survey design (bad at catching older fish) and some emigration to offshore areas which was seen for the 1984 YC. In 1D the 2009 YC has not been extraordinarily large before it reached the age of 4 in 2013 and in 2014 it still remains large. This might be an effect of immigration from the offshore area to the inshore area as the 2009 YC is also registered as a large year class offshore (Retzel 2015, a) and a southwards migration from the northern inshore regions (1B).

As the larger cohorts have disappeared from the survey, especially in NAFO 1B, and no new cohorts are entering, the index in 1B has decreased to a very low level compared to the increasing trend which has been the case in recent years. Historically, the combined index has mainly been driven by dynamics in 1B. The 2 and 3 year old fish (2011 and 2012 YC) in 1D are well above average recruitment. However, in 1B it was substantially lower, leading to a reduction of the combined index compared to 2010-2013.

15.1.5 State of the stock

There have been several years of steady and relatively high recruitment and the biomass estimate is increasing and has been doing so for more than ten years. Several year classes are in the catches, and the large 2009 YC has now entered the fishery. However after the 2009 YC has entered the fishery no new incoming yearclasses of the same size has been observed. Spawning has been documented in most fjords on the west coast, with key areas in NAFO 1B and 1D. Hence the overall state of the stock is considered good, but the lack of incoming large yearclasses is cause for concern.

15.1.6 Implemented management measures for 2015

Until 2009 the inshore fishery was unregulated by a TAC. The TAC in 2009-2014 can be seen in figure 15.1.1.2. The TAC for 2014 is set at 25 000 t. No other management measures have been taken.

15.1.7 Management plan

No management plan currently exists for the inshore cod stock.

15.1.8 Management considerations

When managing this stock, it should be taken into consideration that the inshore cod tend to form very dense spawning aggregations in limited areas. It could be considered to limit the fishery in certain areas or certain periods, especially if the stock shows a declining trend. These areas include specifically certain areas in the Nuuk and Sisimiut fjord systems.

Genetic and tagging results indicate limited migration between fjords and management should therefore ensure that not all catches are taken in a limited area. This is especially important in areas that are considered to have maintained the stocks in periods of overall stock decline in Greenland (i.e. Nuuk and Sisimiut fjords).

15.1.9 Basis for advice

The survey index in a given year was related to the catch in the next year (Figure D.1.1). The advice is then based on the survey index multiplied by a factor. The validity of this approach rests on a number of assumptions. Among others, the fishery has been at a stable sustainable level (ideally the same across years). Based on model outputs and catch curves (Hedeholm and Post, 2015) this seems to be a reasonable assumption, at least during the last 15 years. Some years in the 1980s did not follow the overall trend, and were most likely subjected to a very high fishing intensity and a very high offshore input to the fishery, and these years are therefore excluded from the regression analyses. The fish enter the fishery at age 4. Accordingly the survey index of ages 3–8 was used to generate advice.

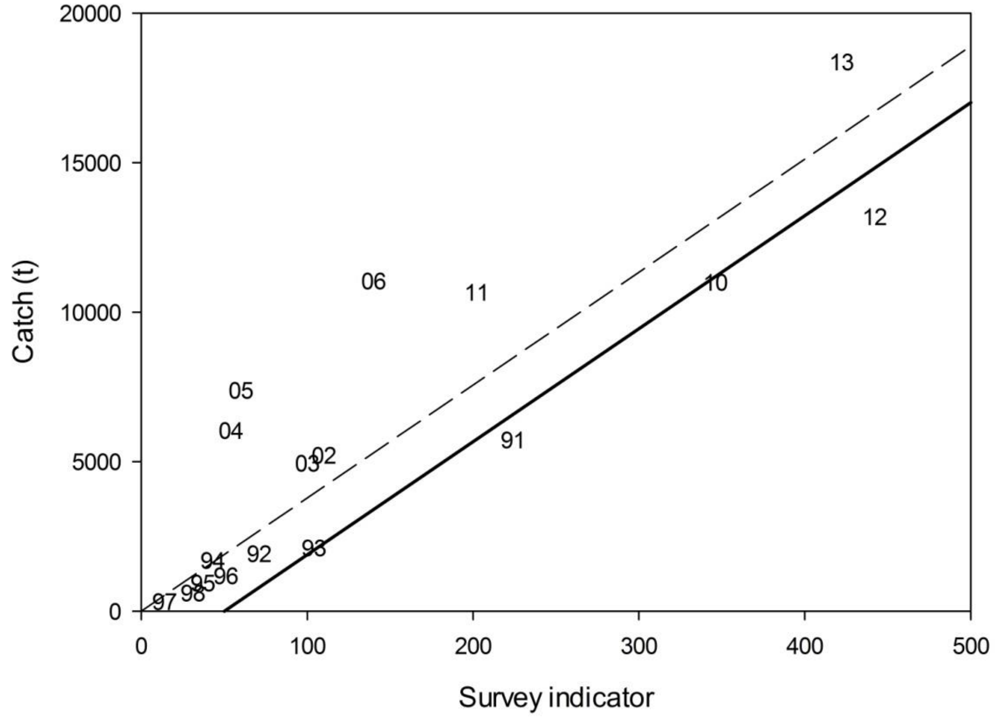


Figure D.1.1. Survey index of 3–8 year olds vs. the catch the following year. $r^2 = 0.76$. Based on data from 1991–2014. Points are labelled by survey year.

Given that this approach is based on variable data a precautionary approach should be taken. So rather than having the regression pass through the origin, the intercept with the x-axis is set at a survey index value of 50 and slope is 37.9. The survey tends to vary considerably between years, and to avoid having the advice fluctuate accordingly the average of the last two years survey index values were used when calculating the catch advice. Consequently, the advice is generated as follows:

$C_{y+1}=37.9 * (U_{3\text{–}8y}–U_{trigger})$ (1)

where $U_{3\text{–}8y}$ is the combined survey value for ages 3–8 and $U_{trigger}$ is 50.

15.1.10 References

Retzel, A. 2015.a Greenland Shrimp and Fish survey results for Atlantic cod in NAFO subareas 1A-1E (West Greenland) in 2014. ICES North Western Working Group (NWWG) April 28- May 5, 2015, WD 19.

Retzel, A. 2015.b Greenland commercial data for Atlantic cod in Greenland inshore waters for 2014. ICES North Western Working Group (NWWG) April 28- May 5, 2015, WD 18.

Retzel, A., Post, S. L. 2015. Greenland Shrimp and Fish survey results for Atlantic cod in ICES subarea XIVb (East Greenland) and NAFO subarea 1F (SouthWest Greenland) in 2014. ICES North Western Working Group (NWWG) April 28- May 5, 2015, WD 21.

Table 15.1.1.1. Cod catches (t) divided into NAFO divisions, caught in the inshore fishery (1911-1993: Horsted 2000, 1994-2006: ICES 2007, Statistic Greenland, 2007-present: Greenland Fisheries License Control). ICES XIVb=inshore East Greenland.

	NAFO divisions								
Year	1A	1B	1C	1D	1E	1F	Unknown NAFO div	Total WestGreenland	ICES XIVb
1911				19				19	
1912				5				5	
1913				66				66	
1914				60				60	
1915		47	6	45				98	
1916		66	24	103				193	
1917		67	28	59				154	
1918		106	26	140		169		441	
1919		39	37	140	148	137		501	
1920		117	32	187	23	95		454	
1921		116	92	97	7	196		508	
1922		82	178	144	40	158		602	
1923		120	116	147	0	307		690	
1924		131	223	221	1	267		843	
1925		122	371	318	45	168		1024	
1926		97	785	673	170	499		2224	
1927		282	974	982	305	1027		3570	
1928		426	888	1153	497	1199		4163	
1929		1479	1572	1335	642	2052		7080	
1930	137	2208	2326	1681	994	2312		9658	
1931	315	1905	2026	1520	835	2453		9054	
1932	358	1713	2130	1042	731	3258		9232	
1933	304	1799	1743	1148	948	2296		8238	
1934	451	2080	1473	652	921	3591		9168	
1935	524	1870	1277	769	670	2466		7576	
1936	329	2039	1199	705	717	2185		7174	
1937	135	1982	1433	854	496	2061		6961	
1938	258	1743	1406	703	347	1035		5492	
1939	416	2256	1732	896	431	1430		7161	
1940	482	2478	1600	1061	646	1759		8026	
1941	636	3229	1473	823	593	1868		8622	
1942	879	3831	2249	1332	1003	2733		12027	
1943	1507	5056	2016	1240	1134	2073		13026	
1944	1795	4322	2355	1547	1198	2168		13385	
1945	1585	4987	2844	1207	1474	2192		14289	
1946	1889	5210	2871	1438	1139	2715		15262	
1947	1573	5261	3323	2096	1658	4118		18029	
1948	1130	5660	3756	1657	1652	4820		18675	
1949	1403	4580	3666	2110	2151	3140		17050	
1950	1657	6358	4140	2357	2278	4383		21173	
1951	1277	5322	3324	2571	2101	3605		18200	
1952	646	4443	2906	2437	2216	4078		16726	
1953	1092	5030	3662	5513	3093	4261		22651	

Table 15.1.1.1. continued

	NAFO divisions								
Year	1A	1B	1C	1D	1E	1F	Unknown NAFO div	Total WestGreenland	ICES XIVb
1954	950	6164	3118	3275	1773	3418		18698	
1955	591	5523	3225	4061	2773	3614		19787	
1956	475	5373	3175	5127	3292	3586		21028	
1957	277	6146	3282	5257	4380	5251		24593	
1958	19	6178	3724	5456	3975	6450		25802	
1959	237	6404	5590	5009	3767	6570		27577	
1960	188	6741	6230	3614	3626	6610		27009	
1961	601	6569	6726	4178	6182	9709		33965	
1962	315	7809	6269	3824	5638	11525		35380	
1963	295	4877	3178	2804	3078	9037		23269	
1964	275	3311	2447	8766	2206	4981		21986	
1965	325	5209	4818	6046	2477	5447		24322	
1966	483	8738	5669	7022	2335	4799		29046	
1967	310	5658	6248	6747	2429	6132		27524	
1968	142	1669	2738	6123	2837	7207		20716	
1969	57	1767	4287	7540	2017	5568		21236	
1970	136	1469	2219	3661	2424	5654		15563	
1971	255	1807	2011	3802	1698	3933		13506	
1972	263	1855	3328	3973	1533	3696		14648	
1973	158	1362	1225	3682	1614	1581		9622	
1974	454	926	1449	2588	1628	1593		8638	
1975	216	1038	1930	1269	964	1140		6557	
1976	204	644	1224	904	1367	831		5174	
1977	216	580	2505	2946	3521	4231		13999	
1978	348	1587	3244	2614	4642	7244		19679	
1979	433	1768	2201	6378	9609	15201		35590	
1980	719	2303	2269	7781	10647	14852		38571	
1981	281	2810	3599	6119	7711	11505	7678	39703	
1982	206	2448	3176	7186	4536	3621	5491	26664	
1983	148	2803	3640	7430	5016	2500	7205	28742	
1984	175	3908	1889	5414	1149	1333	6090	19958	
1985	149	2936	957	1976	1178	1245		8441	
1986	76	1038	255	1209	1456	1268		5302	
1987	77	2366	423	6407	3602	1326	403	14604	
1988	333	6294	1342	2992	3346	4484		18791	
1989	634	8491	5671	8212	10845	4676		38529	
1990	476	9857	1482	9826	1917	5241		28799	
1991	876	8641	917	2782	1089	4007		18312	
1992	695	2710	563	1070	239	450		5727	
1993	333	327	168	970	19	109		1926	
1994	209	332	589	914	11	62		2117	
1995	53	521	710	332	4	81		1701	
1996	41	211	471	164	11	46		944	
1997	18	446	198	99	13	130	282	1186	
1998	9	118	79	78	0	38		322	

Table 15.1.1.1. continued

	NAFO divisions								
Year	1A	1B	1C	1D	1E	1F	Unknown NAFO div	Total WestGreenland	ICES XIVb
1999	68	142	55	336	8	4		613	
2000	154	266	0	332	0	12		764	
2001	117	1183	245	54	0	81		1680	
2002	263	1803	505	214	24	813		3622	
2003	1109	1522	334	274	3	479	1494	5215	
2004	535	1316	242	116	47	84	2608	4948	
2005	650	2351	1137	1162	278	382	83	6043	
2006	922	1682	577	943	630	1461	1173	7388	
2007	416	2547	1195	1842	659	4391		11050	42
2008	870	3066	1539	3172	225	1133		10005	6
2009	325	1288	1189	2009	1142	1581		7534	2
2010	559	2990	1607	1795	1458	859		9268	2
2011	567	2364	2850	2905	1274	1047		11007	0
2012	546	1376	2061	4375	1989	325		10672	0.02
2013	1506	2552	2784	4711	1450	198		13202	35
2014	3084	6142	3710	4629	684	82		18331	38

Table 15.1.1.2: Catches (t) divided into month and NAFO Divisions, caught by the coastal fisheries.

NAFO	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	%
1A	96	108	91	78	65	172	406	419	400	601	425	223	3084	17%
1B	36	43	195	193	400	1051	1255	548	561	833	566	460	6142	33%
1C	104	51	33	57	372	813	460	312	475	386	382	264	3710	20%
1D	85	53	73	38	343	693	1245	356	878	507	135	223	4629	25%
1E	0.01	2	6	0.1	4	17	256	224	126	27	20	4	684	4%
1F	0.3	0.03	0.4	2	3	8	1	3	3	30	28	4	82	0.4%
ICES XIVb	0.2	0.2						17	21				38	0.2%
Total	322	257	397	369	1186	2753	3624	1879	2463	2384	1556	1177	18369	
%	2%	1%	2%	2%	6%	15%	20%	10%	13%	13%	8%	6%		

Table 15.1.1.3: Landings (%) divided into month and gear and NAFO Divisions and gear.

Gear/Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Poundnet	0.001		0.002	0.3	6	13	15	4	5	2	1	1	47
Gillnet	1	1	1	1	0.4	0.4	0.3	0.2	1	4	3	3	18
Jig	0.1	0.1	0.4	0.1	0.2	1	4	6	6	5	2	0.4	25
Longline	1	0.3	0.3	0.2	0.3	0.5	1	0.2	1	2	2	2	10
Total	2	1	2	2	6	15	20	10	13	13	8	6	100

Gear/NAFO	1A	1B	1C	1D	1E	1F	ICES XIVb	Total
Poundnet	3	13	9	19	3	0.1		47
Gillnet	5	9	2	1	0.03	0.2		18
Jig	5	11	7	2	0.3	0.1	0.2	25
Longline	4	1	3	3	0.1	0.1		10
Total	17	33	20	25	4	0.4	0.2	100

Table 15.1.2.1. Estimated catches in numbers ('000) at age, and total catch by year (t).

Year/age	3	4	5	6	7	8	9	10+	Catch
1976	2508	924	556	287	38	31	11	7	5174
1977	467	5437	1100	883	179	7	142	46	13999
1978	97	1262	9904	132	68	7	3		19679
1979	323	2297	2380	8281	170	96	4	14	35590
1980	4343	4334	1646	806	6492	106	29	37	38571
1981	87	15793	5225	725	499	2906	61	17	39703
1982	3013	1587	6309	1545	798	152	610	154	26664
1983	229	16877	1381	4352	368	139	65	75	28742
1984	520	4451	9269	346	634	18	42	12	19958
1985	5	2400	1028	2229	196	363	14	78	8441
1986	286	178	896	460	721	16	102	38	5302
1987	5503	1334	228	710	340	1084	46	265	14604
1988	419	15588	150	51	39	90	161	12	18791
1989	15	5962	23956	271	46	2	93	176	38529
1990	212	2997	15403	6732	33	11	7	16	28799
1991	124	6022	4910	5695	330	0			18312
1992	8	2408	2344	452	139	46	13	5	5727
1993	28	661	575	206	34	41	10	7	1926
1994	22	1468	342	62	45	8	11	1	2117
1995	1	834	773	37	5	0	0		1701
1996	2	165	362	130	25	3	1	0	944
1997	1	397	311	179	31	0			1186
1998*									322
1999	87	465	105	1	0	0			613
2000	4	228	336	7	0	0			764
2001*									1680
2002	532	2243	657	29	9	1	0	0	3622
2003	152	581	1547	258	51	16	15	11	5215
2004	530	1669	1095	228	37	3			4948
2005	1387	2400	941	185	36	10	4		6043
2006	4256	3363	680	22	0	0	0		7388
2007	1945	7913	1010	116	38	13	8	4	11050
2008	1177	5015	2794	319	36	6	2		10005
2009	487	3540	2372	194	13	3	0	4	7534
2010	301	1091	2475	1524	141	32	21	27	9268
2011	129	2929	2567	1480	255	90	12	7	11007
2012	735	1725	2681	850	182	21	13	13	10672
2013	143	3806	2477	1083	361	115	67	9	13202
2014	40	1394	4033	2296	330	169	103	52	18369

Table 15.1.2.2. West Greenland inshore cod. Estimated weight at age (kg).

y	3	4	5	6	7	8	9	10+
1976	0.811	1.114	1.662	2.738	3.226	4.062	5.831	12.747
1977	0.674	1.382	2.201	2.649	3.322	6.363	3.92	4.616
1978	0.668	0.965	1.801	2.472	2.845	3.649	4.733	
1979	0.8	1.309	2.111	3.153	3.696	4.371	6.861	8.007
1980	0.753	1.017	1.884	2.58	3.823	4.107	5.715	7.902
1981	0.308	1.045	1.576	2.19	2.59	4.029	3.529	7.831
1982	0.844	1.118	1.604	2.605	3.875	5.495	5.425	6.278
1983	0.552	0.937	1.337	2.039	2.795	3.378	4.218	4.109
1984	0.624	0.967	1.385	1.869	2.469	3.286	3.985	4.433
1985	0.42	0.754	1.134	1.662	2.065	2.669	3.486	4.337
1986	0.582	1.248	1.414	2.043	2.689	3.188	3.893	8.401
1987	0.872	1.187	2.043	2.302	2.963	3.294	4.114	5.107
1988	0.659	1.106	1.251	1.691	2.677	3.046	3.478	5.111
1989	0.558	0.855	1.308	1.821	3.161	4.252	4.397	5.862
1990	0.649	0.889	1.031	1.452	2.614	3.765	5.846	10.868
1991	0.802	0.966	1.088	1.146	1.595	3.964		
1992	0.567	0.869	1.028	1.697	1.849	2.845	3.253	4.402
1993	0.585	0.82	1.239	1.83	1.802	2.873	3.976	8.777
1994	0.43	0.883	1.359	1.706	3.103	3.9	4.976	16.271
1995	0.768	0.93	1.093	1.799	2.493	4.13	6.49	
1996	0.501	0.814	1.201	2.176	2.955	4.151	5.507	6.577
1997	0.560	0.956	1.397	1.767	1.830	3.239		
1998*								
1999	0.739	0.895	1.24	2.254	3.387	4.556		
2000	0.642	1.121	1.453	2.378	2.621	2.409		
2001*								
2002	0.708	0.999	1.397	2.318	1.884	2.853	3.560	3.356
2003	1.046	1.391	2.069	2.565	3.3	3.988	5.095	6.958
2004	0.988	1.236	1.584	2.158	3.149	6.132		
2005	0.811	1.106	1.728	2.415	2.81	6.955		
2006	0.724	0.944	1.560	3.102	4.522	9.931	9.931	
2007	0.703	0.95	1.543	2.574	4.003	5.136	6.541	10.25
2008	0.615	0.884	1.406	2.332	3.709	5.463	7.263	
2009	0.641	0.898	1.461	2.348	4.055	5.132	5.869	14.181
2010	0.659	0.976	1.517	2.12	3.204	4.872	6.929	9.796
2011	0.657	0.918	1.466	2.013	3.305	5.396	7.527	10.366
2012	0.764	1.109	1.81	2.7	3.554	5.964	6.91	14.345
2013	0.766	1.258	1.623	2.235	3.059	3.636	4.114	7.43
2014	0.691	1.226	1.934	2.534	3.407	5.326	5.745	7.772

Table 15.1.4.1: Survey effort in the Greenland Inshore Gill-net survey (nos. of valid net settings).

Division	1B	1D	1F	Total
1985	3	38	27	68
1986	26	22	23	71
1987	24	27	26	77
1988	21	24	24	69
1989	28	19	32	79
1990	18	21	18	57
1991	23	24	20	67
1992	27	29	23	79
1993	23	25	19	67
1994	20	29	17	66
1995	24	21	20	65
1996	26	25	-	51
1997	20	23	-	43
1998	24	26	22	72
1999	-	24	-	24
2000	-	27	20	47
2001	-	-	-	-
2002	21	20	-	41
2003	33	27	-	60
2004	27	31	-	58
2005	25	28	-	53
2006	45	51	-	96
2007	52	-	39	91
2008	-	58	60	118
2009	-	58	18	76
2010	66	52	-	118
2011	57	44	-	101
2012	54	52	-	106
2013	58	52	-	110
2014	41	60	-	101

Table 15.1.4.2 : 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.

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
2010	138	155	120	58	12	1	0	0	484
2011	20	526	106	44	19	1	0	0	717
2012	7	184	304	30	8	3	0	0	536
2013	4	158	105	104	27	8	1	1	408
2014	7	46	45	25	19	4	0	1	146

Table 15.1.4.2, *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.

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
2010	1	33	107	18	27	3	0	0	189
2011	10	45	3	18	6	4	1	0	88
2012	2	52	46	21	28	2	0	1	151
2013	0	91	61	77	25	8	3	2	267
2014	0	41	74	46	27	6	1	0	196

Table 15.1.4.2, *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.

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
2010-2014	na	na	na	na	na	na	Na	na	na

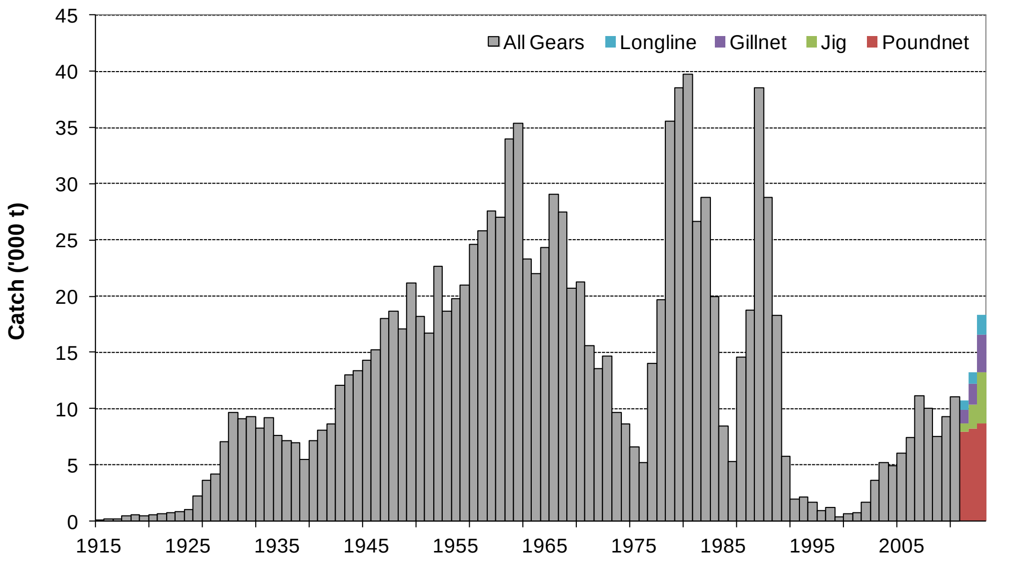


Figure 15.1.1.1 Inshore landings from West Greenland (Horsted 1994, 2000).

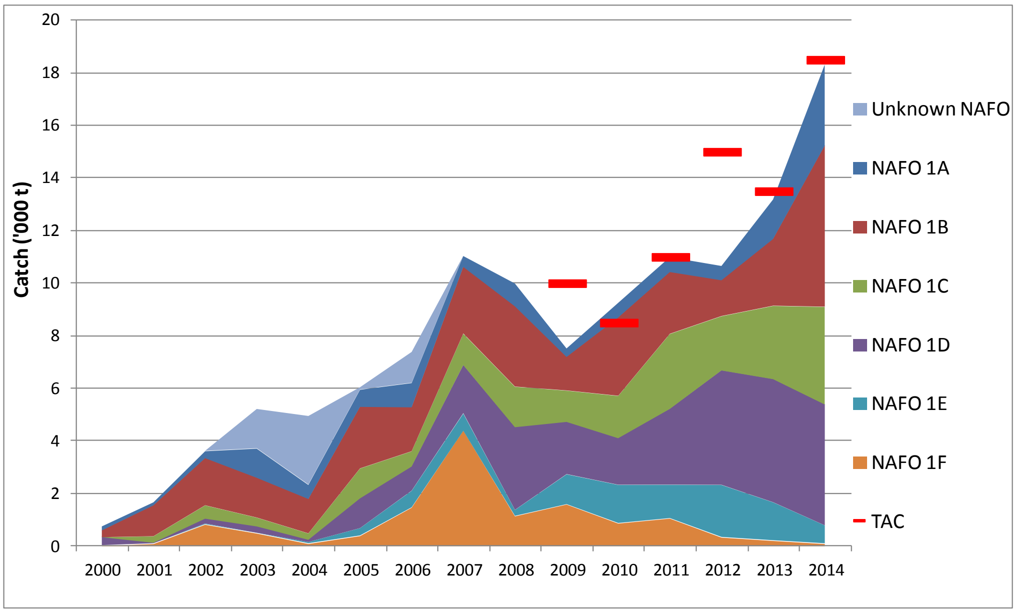


Figure 15.1.1.2. Total catches and TAC in the inshore fishery by NAFO Divisions from 2000-2014.

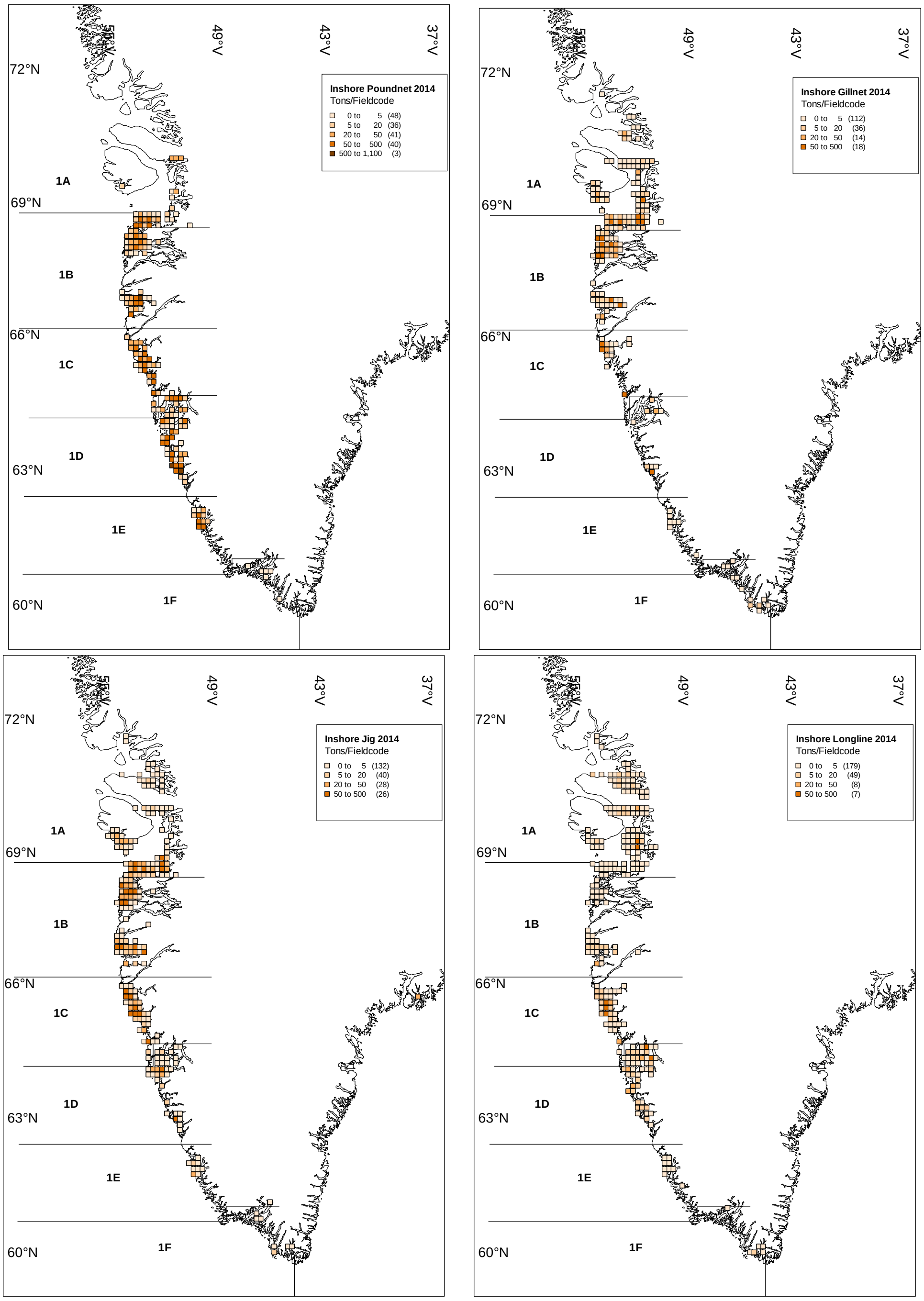


Figure 15.1.1.3. Distribution of the inshore commercial fishery by gear.

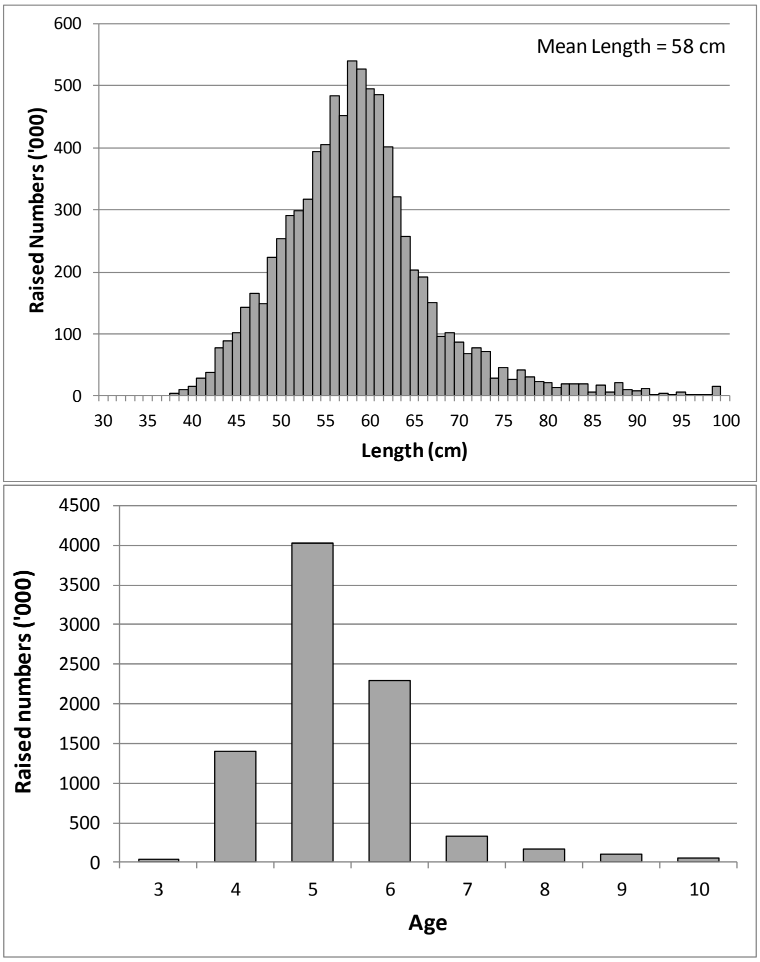


Figure 15.1.2.1. Total length and age distributions of inshore cod catches

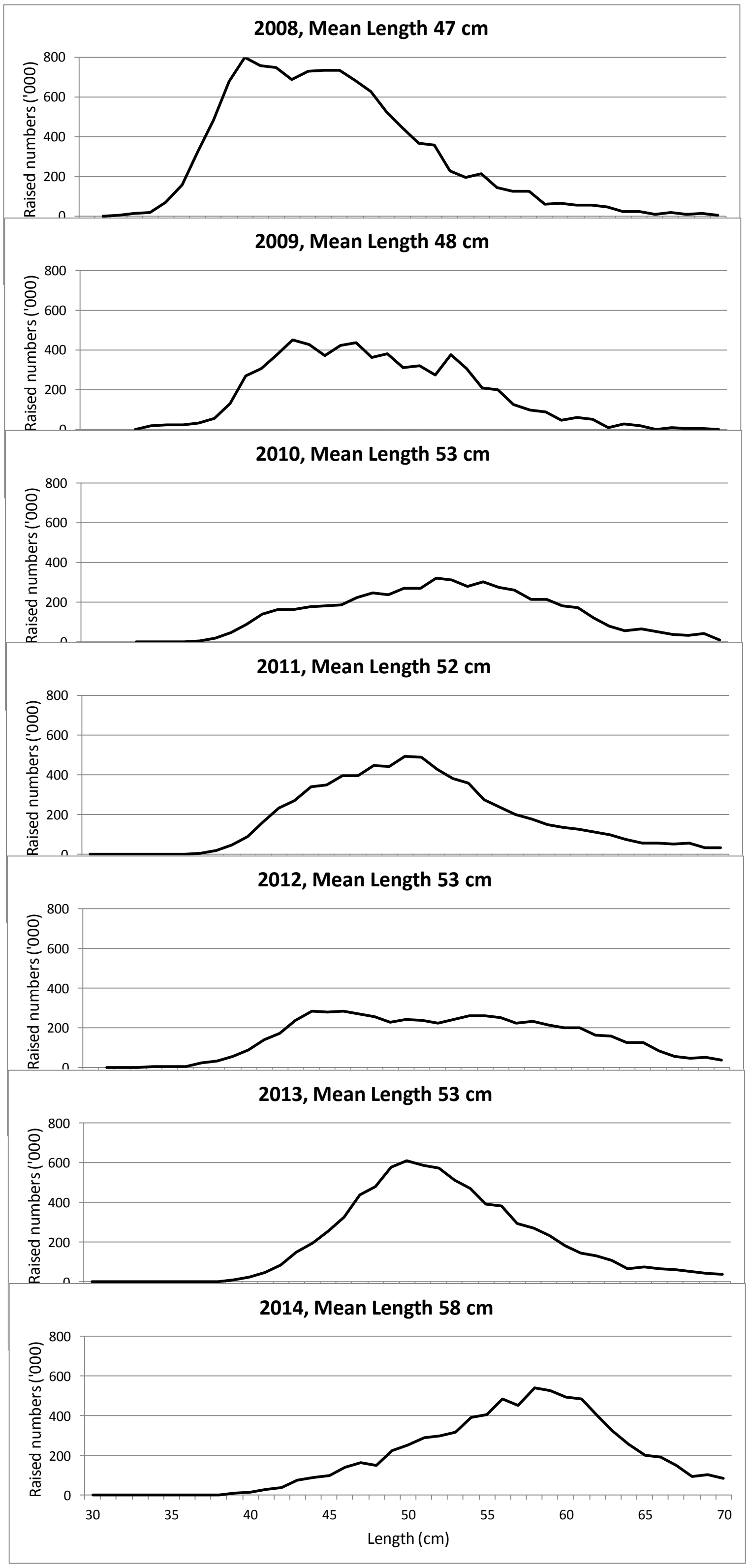


Figure 15.1.2.2. Length distribution in the inshore fishery in the period 2006-2014.

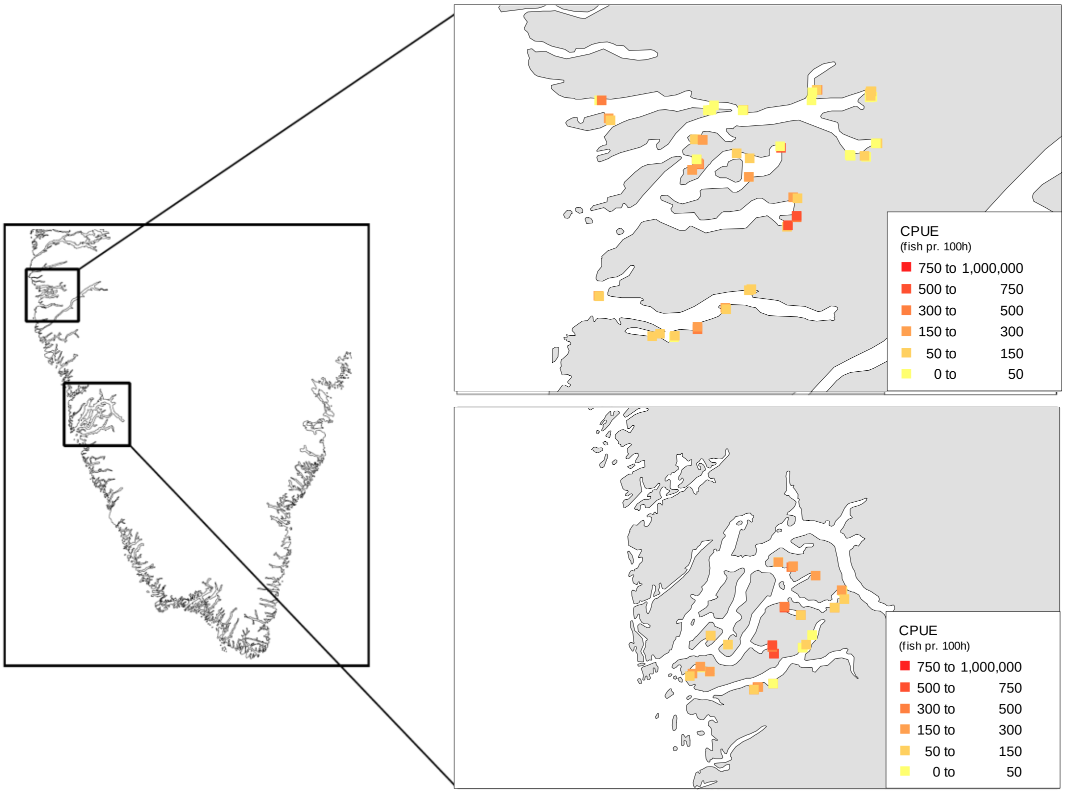


Figure 15.1.4.1 The inshore gill net survey area on the Greenland West coast. Top picture is the Sisimiut fjord system in NAFO 1B and bottom picture is the Nuuk fjord system in NAFO 1D. Survey estimates of catch rates are indicated on both maps as #caught/100h.

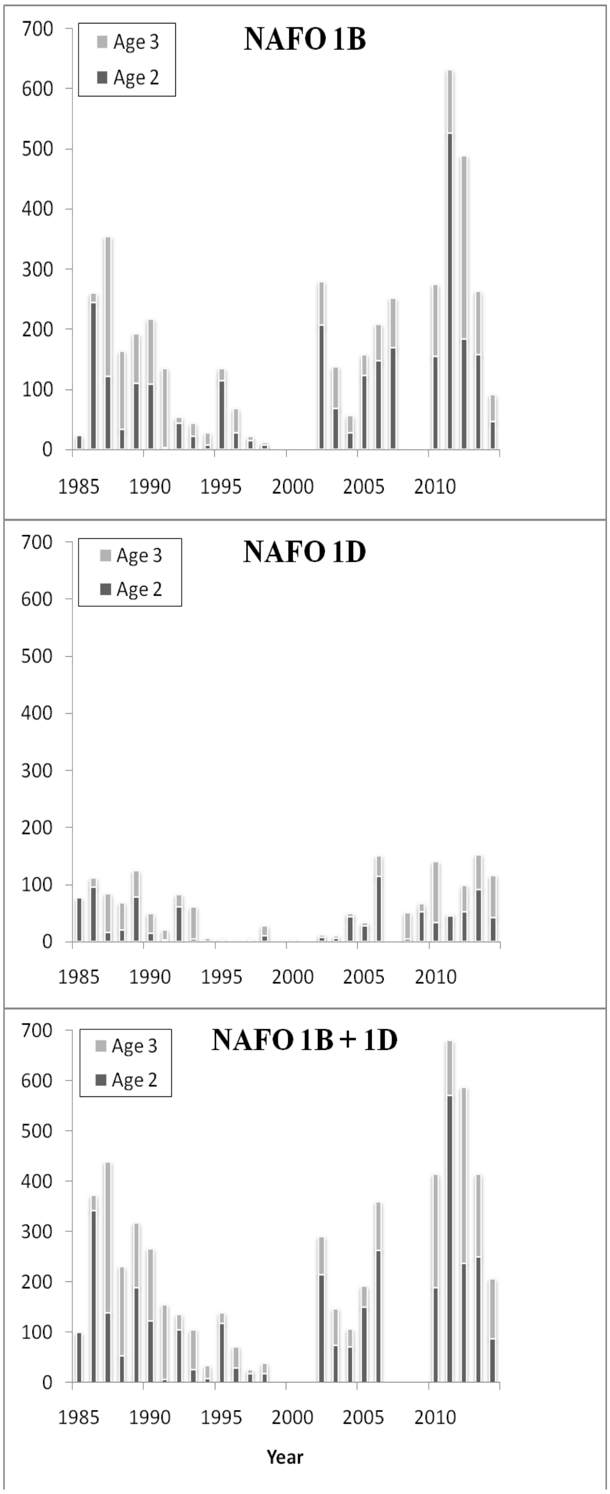


Figure 15.1.4.2. : Recruitment indices (numbers caught/100 hr.) for ages 2 and 3 in 1B (top), 1D (middle) and 1B and 1D combined (lower) in West Greenland. Simultaneous surveys were not carried out 1999-2001 and 2007-2009.

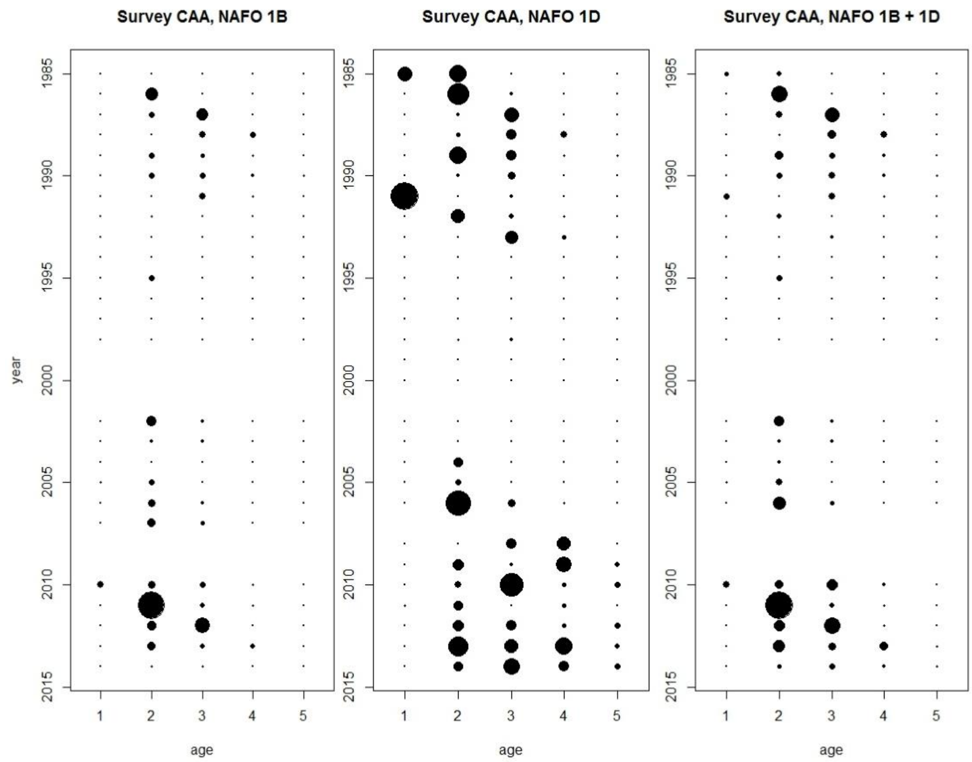


Figure 15.1.4.3 Recruitment indices (numbers caught/100 hr.) for ages 1-5 in 1B (left), 1D (middle) and 1B and 1D combined (right) in West Greenland from 1985-2014. Size of circles represents the size of the index values and the values are standardized within each area and are not comparable among each other.

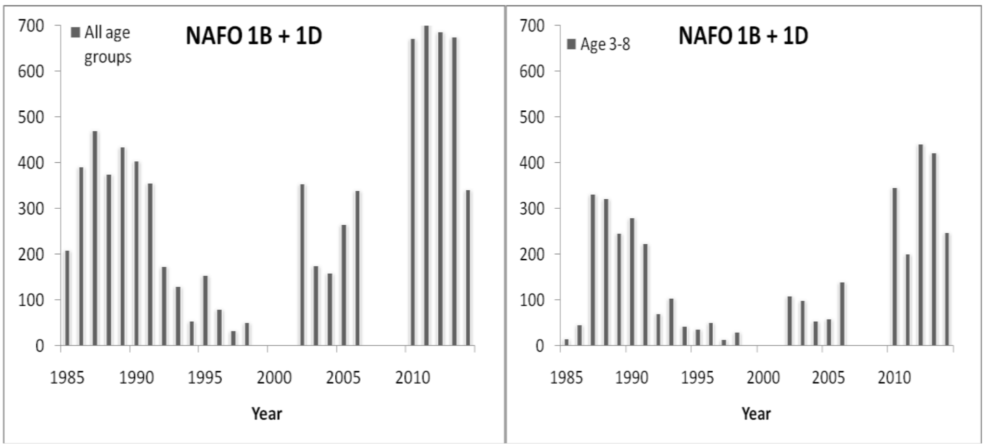


Figure 15.1.4.4 Recruitment indices (numbers caught/100 hr. netsetting) for all age groups (left) and ages 3-8 (right – used in the current catch advice) in 1B and 1D combined. Simultaneous surveys were not carried out 1999-2001 and 2007-2009.

16 Cod in offshore waters of ICES Subarea XIV and NAFO subarea 1

Executive summary

From 2014 the management for cod in Greenland offshore waters has been split in two stock components according to areas: NAFO subdivisions 1A-E in West Greenland and NAFO subdivision 1F in South Greenland combined with ICES subarea XIV in East Greenland. The ICES advice for 2016 has for the first time been given according to these two areas.

The offshore fishery in East and South Greenland in 2014 was conducted as an experimental fishery with a TAC of 10 000 tons. Total catches were 7 893 tons. The year-class dominating the catches was the 2007 YC, which it has done since 2012. The largest cod (mean length of 83 cm) were caught by trawlers on Dohrn Bank close to the Iceland EEZ.

Available survey biomass indices from the Greenland and German surveys show that the biomass has increased due to the growth of the 2009 YC and in part the 2007 YC. Abundance has however decreased as fewer young fish are observed.

The 2009 YC followed by the 2007 YC has dominated the survey since 2012. The 2009 YC is primarily distributed in South Greenland, whereas the 2007 YC is distributed more to the north in East Greenland. Spawning offshore cod are only found in East Greenland in local high densities.

The procedure suggested as basis for advice at the Benchmark in 2015 was not implemented by NWWG due to shortcomings. Instead, advice was based on an Fproxy multiplier generated from the relationship between the catches and survey index in a period with a considered sustainable fishery, multiplied by the latest year's smoothed survey index (Greenland Shrimp and Fish survey).

16.1 Stock definition

The cod found in Greenland is derived from four separate "stocks" that each is labelled by their spawning areas: I) offshore West Greenland waters; II) West Greenland fiords; III) offshore East Greenland and Icelandic waters and IV) inshore Icelandic waters (Therkildsen *et al*. 2013), (Fig. 16.1).

From 2012 the inshore component (West Greenland, NAFO Subarea 1) was assessed separately from all offshore components. From 2016 the offshore West Greenland (NAFO subdivisions 1A-E) and East Greenland (NAFO subdivision 1F and ICES subarea XIV) components was assessed separately. The Stock Annex provides more details on the stock identities including the references to primary works.

16.2 Fishery

16.2.1 The emergence and collapse of the Greenland offshore cod fisheries

The Greenland commercial cod fishery in East Greenland started in 1954, but started earlier in Southwest Greenland (NAFO subdiv. 1F, table 16.2.2.1). The fishery gradually developed culminating with catch levels above 40,000 tons annually in the 1960s. Due to overfishing and deteriorating environmental conditions the stock size declined and the fishery completely collapsed in the early 1990's (Fig 16.2.1). In the 2000s catches have gradually increased with maximum catches in 2008 of 14 500 tons. Between 2008 and 2010 offshore areal closures were implemented in order to protect the spawning stock in offshore areas. More details on the historical development in the fisheries are provided in the stock annex.

16.2.2 The offshore fishery in 2014

In 2014 a management plan was implemented for the offshore cod fishery in South and East Greenland. According to the management plan the TAC is 10 000 tons/year between 2014 and 2016, The TAC between 2014 and 2016 is to be taken in equal amounts in four areas: Survey area Q1+Q2, Survey area Q3+Q4, Survey area Q5+Q6 and NAFO subdivision 1F.

In 2014 the offshore TAC of 10 000 tons was divided with 6600 tons to Greenland, 2200 tons to EU and 1200 tons to Norway. Further 355 tons was allocated to the Faroe Islands as part of a mix quota (OTH). EU, Norway and the Faroe Islands fished their quota whereas Greenland fished 4300 tons.

Sampling of length frequencies and information on length, weight and age were collected by the crew on the ships who length measured 50 randomly selected cod each day and took individual measurements (length, weight, gutted weight and otoliths) from 20 randomly selected cod each day.

Offshore catches in South and East Greenland in 2014 amounted to a total of 7893 tons with 1833 tons caught in Southwest Greenland (NAFO 1F) and 6060 tons caught in East Greenland (table 16.2.2.1).

77% of the total catches were taken in East Greenland where the fishery peaked in June. Catches in Southwest Greenland peaked in March and November (table 16.2.2.2). The fishery where distributed from Julianehåb Bight in Southwest Greenland (60°N) to Dohrn Bank (66°N) in East Greenland (figure 16.2.2.1).

A dispensation was given to a Greenlandic longliner to fish within the 3nm from the baseline in East Greenland where vessels larger than 75BRT/120BT are not allowed. In total the vessel caught 230 tons, concentrated around the Tasiilaq area (65-66°N, figure 16.2.2.2).

67% of the total catch was taken by trawlers and 33% by longliners primarily in June (table 16.2.2.3). About half (48%) of the total trawl catches were taken in a small area between 65-66°N and 29-31°W on the edge of the continental shelf on Dohrn Bank (management area Q1Q2, figure 16.2.2.2). 50% of the total longline catches were taken along the continental shelf and on Kleine Bank (64°N) in management area Q3Q4 in East Greenland.

The offshore fishery peaked in summer and fall, and the majority of the catches where taken in management areas Q1Q2 and Q3Q4 in East Greenland. The trawlers conducted most of their fishing in a small area on the edge of Dohrn bank close to the Icelandic EEZ (management area Q1Q2), whereas the longliners conducted most of their fishing further to the south along the continental shelf and on Kleine Bank (management area Q3Q4). The reason for this separation is likely because the largest cod are found in the Dohrn Bank area and therefore attractive for the trawlers.

Larger and older fish (7+ yr old) are located furthest to the north on Dohrn Bank, whereas younger fish dominate in the South (5—7 yr old) which also corresponds to the composition of age classes in the different areas observed in the survey (Retzel & Post 2015).

The 2007 YC was the dominating YC in the catches at age 5 and 6 in 2012 and 2013. In 2014 the 2007 YC is still the dominating YC at age 7 and it is therefore believed that this

YC is primarily of Greenlandic origin and not Icelandic. The YC is now contributing to the spawning stock in East Greenland in considerable numbers, and it is still located in South Greenland indicating that spawning could also be going on here.

16.2.3 Length, weight and age distributions in the offshore fishery 2014

There is limited landing sample information from the 1990's where the cod fishery was very low in East Greenland. For that period length frequency information is generally lacking for the offshore fisheries where cod was only taken as a by-catch. Sampling intensities have increased considerably in the later years, and in 2014 the offshore fisheries was very well covered.

Catch-at-age and weight-at-age has been compiled for the offshore area since 2005 (table 16.2.3.1).

Length measurement amounted to 10 259 in Southwest Greenland and 3 657 in East Greenland.

The overall mean length in the catches was 74 cm, and the YC 2007 (7 yr old fish) dominated the catches (figure 16.2.3.1). The mean length differed between areas with the largest cod (mean length=83 cm) and oldest (7—10 yr old) being caught on Dohrn Bank furthest to the north in the fishing area in East Greenland (management area Q1Q2), and the smallest (mean length=66 cm) and youngest (5—7 yr old) being caught in Southwest Greenland (NAFO 1F, figure 16.2.3.2).

In 2012 and 2013 the 2007 YC dominated the total catches (Table 16.2.3.1). This YC was especially abundant in the catches in West Greenland and East Greenland south of Dohrn Bank in 2013. In 2014 this YC is abundant in all areas, especially in management area Q3Q4 in East Greenland. In Southwest Greenland (NAFO 1F) the 2008 and 2009 YC is more abundant than in the other management areas in East Greenland (figure 16.2.3.2).

16.2.4 CPUE index

Log books on a haul by haul basis from the cod fishery since 1975 where compiled in 2014. But due very low catches and few hauls in the 90'ies and closed areas in 2008-2010, the logbook data are not used in the assessment process. Nevertheless, CPUE results generated by a GLM model are presented here.

As EU and Greenland vessels have participated in the fisheries in the entire period, data from these were used in the GLM model. Hauls made in the closed area in the period of 2008-2010 were excluded from the analysis, as they were considered being by-catches.

The CPUE index was relatively stable in the first part of the time series (1975—1992, mean 0.675 tons/hr), except 1989 where it increased to 1.676 tons/hr (figure 16.2.4.1). This increase was likely caused by the large 1984 YC entering the fishery. The CPUE then declined from 1993—2005 (0.149 tons/hr), but sampling of the fishery was low in this period due to very low catches of about 200—300 tons, and catches where taken primarily as by-catch in the redfish fishery. In 2006—2008 the CPUE increased (mean 1.623 tons/hr) as catches started to increase. In 2009 the CPUE decreased to 0.436 tons/hr, which was most likely caused by the east ward migration of the 2003 year class out of the allowed fishing areas (table 16.2.4.1).

In 2010, where almost all of the offshore area was closed, except of a small area in South East Greenland, the index increased to 0.670 tons/hr, but catches were taken by very few vessels. In 2011 all closed areas where reopened and fishery started again, especially in East Greenland north of 63oN, resulting in an increase in CPUE to 1.164 tons/hr. This trend follows the development in survey index from 2008—2011 (Retzel & Post 2015), with several YC's being present and a steady increase in biomass since 2006. Since 2011 CPUE has declined (2012—2014, mean 0.937 tons/hr). In contrast the survey index has increased which is properly caused by a large 2009 YC observed in the survey, but not yet in the fishery as the 2009 YC is observed primarily in South Greenland in the survey and the majority of the fishery is concentrated further north in East Greenland.

Overall the CPUE index indicates a relatively stable biomass in recent years.

16.3 Surveys

At present, two offshore trawl surveys (Greenlandic and German) provide the core information relevant for stock assessment purposes. For details of survey design see stock annex.

The German survey targets mainly cod and has since 1982 covered the main cod grounds off both East and West Greenland at depths down to 400 m. The Greenland survey in West Greenland targets shrimp and cod down to 600 m. The Greenland survey is believed to provide a better coverage of the cod distribution in especially East Greenland as the survey has twice as many stations covering both shelf edge and top, whereas the stations in the German survey are usually concentrated at the shelf edge. The Greenland survey time series is however limited to the 2008-2014 period as the survey in East Greenland first started in 2008.

16.3.1 Results of the Greenland Shrimp and Fish survey in South and East-Greenland

A total number of 113 valid hauls were made in 2014 (**Error! Reference source not found.** 16.3.1.1).

For Atlantic cod the abundance index was estimated at 58 million individuals and the survey biomass at 184 500 tons. Survey abundance and biomass decreased with 44% and 11% respectively compared to 2013 (**Error! Reference source not found.** 16.3.1.2 and **Error! Reference source not found.** 16.3.1.3). SSB biomass increased with 10%.

The majority of the abundance and biomass was primarily located in Southwest Greenland (NAFO 1F) (figure 16.3.1.1 and figure 16.3.1.2). However, opposite to previous years a large amount was also found in mid-East Greenland (Q4). In this stratum (Q4, 1-200m) a high index for both abundance and biomass was calculated as a result of one single big trawl haul containing >4t Atlantic cod. This haul accounted for 30% and 44% of the total abundance and biomass index respectively which also resulted in large overall survey CV of 0.46.

The dominating cohort is the 2009 YC accounting for 38% in abundance and the second largest cohort was the 2007 YC (21%) (**Error! Reference source not found.**16.4.1.4,

Figure 16.3.1.3). The 2009 YC is dominating in South Greenland (NAFO 1F and Q6) where 90% of the total 2009 YC abundance is found (**Error! Reference source not found.**16.3.1.5, **Error! Reference source not found.**16.3.1.4). The 2007 YC is dominating in the northern part of the survey area in East Greenland (Dohrn Bank (Q1) – Skjoldungen Bank (Q4)) where 88% of the total 2007 YC abundance is found. However 63% of the total abundance of the 2007 YC is found in Q4 where the one large haul was taken. The size of fish caught in this one haul is comprised of the 2004-2008 YC (figure 16.3.1.5).

In general younger cod (3-6 yrs) are predominantly found in South Greenland (NAFO 1F + Q6), whereas older cod (> 7 yrs) are found in the northern survey area in East Greenland (**Error! Reference source not found.** 16.3.1.5, **Error! Reference source not found.**16.3.1.5). Estimated mean length has increased throughout the time series and now catches mainly comprises of fish from 45-100cm (**Error! Reference source not found.**16.3.1.6). SSB was estimated to 150 000 tons, which is by far the highest observed in the time series and 10% larger than the second highest, observed in 2013 (**Error! Reference source not found.**16.3.1.7).

Out of the 113 stations one contributed with 30% and 44% of the total abundance and biomass index estimates in East Greenland. This haul was located in Q4 with few stations and contained primarily older fish (>6 yrs), resulting in higher abundance index (**Error! Reference source not found.**16.3.1.4) and high spawning stock biomass compared to other areas in the survey (**Error! Reference source not found.**16.3.1.8). NAFO 1F show the same high abundance index, but this is not based on a single haul in this area, but on several hauls with above average catches. The fish caught in NAFO 1F where smaller than in Q4 and was mainly comprised of the 2009YC which is in agreement with the general perception of the migration pattern of the stock in this area.

The survey show a decline in both biomass and especially in abundance compared to 2013, but biomass is 62% above the average biomass for the period 2008-2014. Abundance is on the same level as the average abundance for the period 2008-2014. The decline in abundance is compensated by the growth of the existing cod stock, but indicates that the new cohorts entering the stock are smaller. West Greenland north of NAFO 1F is believed to be a nursing area for the East Greenland cod stock. The survey in this area (Retzel 2015a) indicates that new year classes (age 1—3 yrs) are present, but none are of the same size as the 2009 YC.

The last YC that gave rise to a substantial fishery (15 000 tons, (Retzel 2015,b)) was the 2003 YC in 2008. Comparing the size of the 2009 YC with 2003 YC at age 5 in all of Greenland offshore waters (West+East Greenland) indicates the 2009 YC is double the size of the 2003 YC. The distribution pattern of the two year classes seems different (**Error! Reference source not found.**16.3.1.5). The 2003 YC at age 5 was almost exclusively found in South Greenland, whereas the 2009 YC at age 5 is found more spread out in West Greenland from NAFO 1D – NAFO 1F. At younger ages (1—2 yrs) the 2009 YC was mainly distributed in Northwest Greenland in 2010 and 2011, but moved further south in 2012-2014.

The abundance of the 2003 YC at age 6 in 2009 declined by almost ¾ compared to the abundance at age 5 in 2008. Cod start to spawn at age 6 and the sharp decline of this YC in Greenlandic waters compared with an increase in the abundance of this YC in Icelandic waters (ICES 2014) indicate that this YC has originated from Iceland and has returned for spawning. The 2007 YC, that is dominating the fishery (Retzel 2015,b) and the survey in the northern part of East Greenland, has not declined in abundance from age 5 to age 6, and is therefore believed to be of East Greenlandic origin, and is now contributing substantially to the spawning stock in East Greenland

16.3.2 Results of the German groundfish survey off West and East Greenland

In 2014, 75 valid trawl stations were sampled during autumn in the German Greenland offshore groundfish survey (Table 16.3.2.1, Figure 16.3.2.1).

Abundance increased by 78% from 2013 to 2014 (table 16.3.2.2), and biomass doubled (94%, Table16.3.2.3). One haul located in NAFO 1F (Southwest Greenland, figure 16.3.2.2) accounted for 25% of the biomass index. In East Greenland several large hauls were taken from north to south, but none contributed with more than 10% to the biomass index. The large increase in biomass can therefore not be explained by one large haul. The main reason for the increase in abundance and biomass was increased numbers of the 2009 and 2010 YC in 2014 compared to 2013 (Table 16.3.2.4). The 2009 YC first appeared in considerable numbers in the survey in 2012, and has dominated the survey in 2013 and 2014. The 2010 YC first appeared in considerable numbers in the survey in 2014. The large increase in biomass is probably caused by a southward migration of especially the 2009 YC, which at a younger age was observed more in West Greenland than in South Greenland. In 2014 the 2009 YC and 2010 YC was dominating in South Greenland, whereas older year classes dominated in the northern areas in East Greenland (figure 16.3.2.3).

The survey time series (figure 16.3.2.4) shows three abundance peaks in 1987—1989 caused by the 1984 and 1985 YC, in 2005—2007 caused by the 2003 YC and in 2013—2014 caused by the 2009 YC. Biomass indices show the same peaks, although a large increase in biomass in 2014 compared to the previous periods (figure 16.3.2.5).

Overall findings where the same between the Greenland and the German survey: a 2009 YC dominating the catches in recent years in South Greenland. However the German survey observed increased numbers of the 2010 YC that was not observed in the Greenland survey. This YC was however observed in the Greenland survey in West Greenland north of NAFO subdivision 1F. The German survey is conducted in October, whereas the Greenland survey in West Greenland is conducted in June/July. The findings might results from a southward migration of the 2010 YC during summer/fall.

Both surveys show that older and larger cod are found furthest to the north in East Greenland, especially in the Dohrn Bank region.

16.3.3 Smoothed surveys

The East Greenland area is highly dynamic due to migrations to and from adjacent areas. Inflow of eggs and larvae from Iceland is a common and sometimes large event and some year classes found in East Greenland are primarily from this area (e.g. 2003 YC). West Greenland functions to a very large extent as nursing grounds for East Greenland juveniles and the return migration often produce very sudden and large biomass increases. Jointly, this dynamic can cause large between year variations in survey indices that may appear unrealistic. Furthermore, survey indices are associated with large uncertainties in this area, particularly because of single very large hauls. As the surveys form the basis for the advice, such uncertainty is unwanted and a random effects survey smoother was applied to the estimates of biomass. The underlying survey biomass is modelled with a random walk with process errors, and the observations of survey biomass estimates are estimated with observation errors:

$z_t = z_{t-1} + a_t$

$y_t = z_{t-1} + e_t$

where z_t is the natural log of true survey biomass at time t, y_t is the natural log of estimated survey biomass, and a_t and e_t are process and observation errors, respectively, modelled with normal distributions. For a more throughout description see ICES (2015). The smoothed biomass estimates are very close to the observed mean estimates in 2014 (**Error! Reference source not found.**16.3.1.3, Figure 16.3.3.116.3.3.1), but the CV was also very high. The observed CV was 0.45, while the smoothed CV estimate was 0.31. The process SD was 0.37.

16.3.4 Alternative basis for advice

This stock was benchmarked in 2015 and the benchmark concluded that catch advice for this stock should be based on the 3.2 DLS approach (ICES 2015). The NWWG however concluded that this approach had some major drawbacks for this stock. At NWWG the applicability of the DLS approach was explored and several shortcomings in relation to this stock were found:

- Using the DLS is a slow responding approach not suited to a species with a very dynamic stock development. Applying it for this stock would not allow managers to react to sudden increases or decreases in biomass due to the 20% cap/change limit from catches. To adjust for this, additional exploratory analyses looked at the consequence of having a cap 10%, 20%, 40% and without (Figure 16.3.4.1). The 40% and no cap however entailed that the advice rose very quickly in response to increasing survey values. On the other hand, the lower caps were not able to react in periods with low biomasses.
- The level of advised catch depends to a very large extent on the offset (Figure 16.3.4.2). For instance, if the approach is implemented at a time of low catches (<500 t) it will take a long time for the advice to adjust to increasing biomass. The other case with a starting point with high catches could also be chosen and that would result in an advice that starts high and stays at that level for a long time.

These issues raised above are particularly important for this stock were large year-to-year variations are a natural occurrence. Therefore, the NWWG concluded that the DLS category 3.2 method was not the best available options, and instead developed a new method to be used. As a period of relatively stable catches is co-occurring with rising survey indices (2009—2014), a derived F_{proxy} would be a better basis for advice and more precautionary. The fishing mortality in this period was explored by log catch ratios (Figure 16.3.4.3) and NWWG concluded that as F appeared to be very low in this period no precautionary buffer should be applied. Also, as the stock status is well described through two surveys no uncertainty cap should be applied. Hence, the catch advice should be based on an F_{proxy} multiplier on the Greenland survey (smoothed) which has the best coverage of the stock. The catch was divided by the survey from 2009—2014 and the average of this (0.051) was multiplied with the smoothed 2014 Greenland survey index (175 160) to give the 2016 catch advice.

16.4 Information on spawning

Adequate maturity information has been lacking for the offshore cod stock as the Greenland and German surveys are conducted well outside the spawning period. The offshore fishery has however shown dense concentrations of large spawning cod off East Greenland at least since 2004. The fishery showed that spawning is concentrated on banks north of 62°N in East Greenland. For further information on spawning see stock annex.

16.5 Tagging experiments

A total of 16 030 cod have been tagged in different regions of Greenland in the period of 2003—2014 (table 16.5.1). Cod in the offshore area in West Greenland have been tagged in 2007, 2012 and 2013 on Dana Bak (NAFO 1DE). Cod offshore in East Greenland have been tagged in 2007—2009, 2011, 2012 and 2014 from Julianhåbs Bight (NAFO 1F) in SouthWest Greenland to Dohrn Bank in East Greenland.

Inshore recaptures are almost exclusively recaptured in the same place as tagged (table 16.5.2). No tags from the inshore area have been recaptured offshore except 3 that were recaptured in Iceland. These three cod were tagged in the inshore area in South Greenland.

Offshore recaptures are found both in West-, East Greenland and Iceland (table 16.5.2). Most recaptured tags in both West and East Greenland are recaptured in the same place as they were tagged. Recaptured tags from Iceland are mostly tagged in East Greenland, but also in West Greenland typically in South Greenland. The majority of the recaptured tags in Iceland are caught in the northeast area close to Dohrn Bank (figure 16.5.1). More analysis needs to be performed on the tagging data in order to investigate the interaction between Iceland and East Greenland.

16.6 State of the stock

The offshore component has been severely depleted since 1990. However, the surveys indicate an improvement in recruitment with all year classes since 2002, and estimated at sizes above the very small year classes seen in the 1990s. These YC's has lead to a stock increase during the 00s and an increase in catches.

The overall trend in the two surveys is the same: the 2009 YC is distributed in South Greenland, whereas older yearclasses are distributed further north in East Greenland.

The German survey shows a doubling in biomass which cannot be explained by one large haul. The increase was caused by increasing numbers of especially the 2009 YC, but also the 2010 YC in South Greenland. The same increase was not observed in the Greenland survey in South and East Greenland, but instead in West Greenland. The Greenland survey takes place during summer whereas the German survey takes place a couple of month later in autumn. A southward migration of the 2009 YC and 2010 YC during fall might explain the difference between the two surveys.

The fishery confirmed the distribution found in the surveys with younger yearclasses (< 7 yrs) dominating the catches in South Greenland, and older yearclasses dominating the catches further north in East Greenland, especially in the Dohrn Bank area.

Indicators show that fishing pressure has been low the last 5—6 yrs and the stock is considered to be improving. The stock size is however still low in comparison to the 1950's and 1960', where catches exceeded 30 000 tons for a number of years.

16.7 Implemented management measures for 2015

The offshore quota for the total international fishery is set at 10 000 t according to a management plan that was implemented in 2014. The conditions of the fishery are as followed:

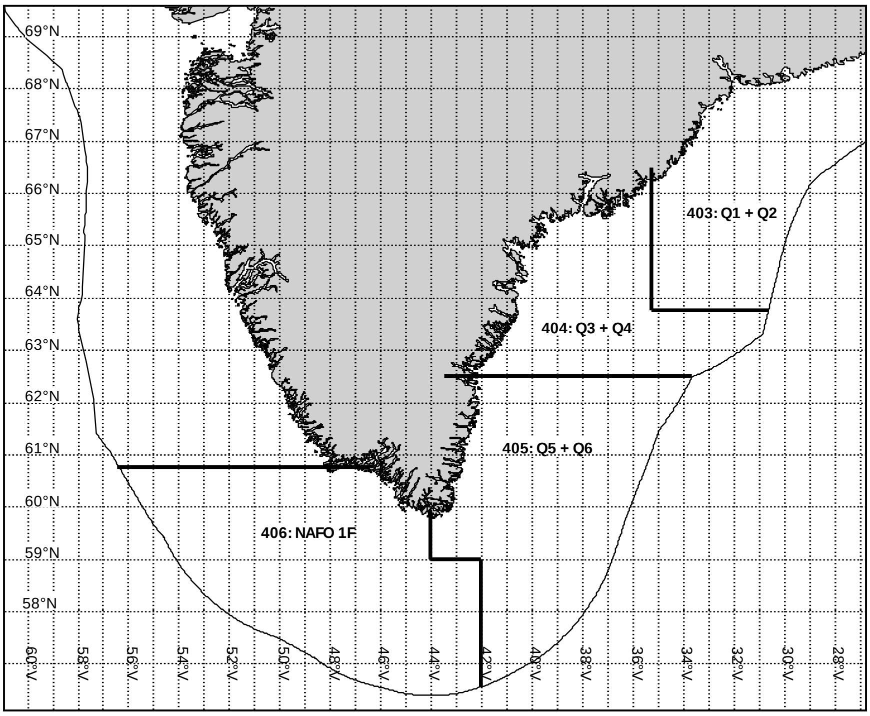
1) To spread the fishery so a maximum of 2.500 t are allowed to be taken in 4 management areas (see figure below).

To protect the spawning stock no fishing is allowed from April 1st to May 31st in all areas.

To obtain biological information of the cod stock, hence the vessels must register the catch composition as prescribed in the logbook regulation and conduct sampling of length (length measurements), weight and age (Otolith).

16.8 Management plan

In 2014 a management plan was implemented for the offshore cod fishery in Greenland (2014-2016) but it has not been evaluated by ICES. The management plan is built on the distinction between the inshore and two offshore stocks components.



Management area West covers NAFO Subarea 1A-E and management area Southeast covers ICES Subarea XIVb (survey area Q1-6) + NAFO 1F.

According to the management plan the TAC in management area Southeast is 10 000 t/year between 2014 and 2016 and no fishery should be done north of 1F in West Greenland.

The TAC in management area South and East Greenland is divided equally between four areas: Survey area Q1+Q2, Q3+Q4, Q5+Q6 and NAFO area 1F.

The management plan has not been evaluated by ICES.

16.9 Management considerations.

Larger and older fish (7+ yr old) are located furthest to the north on Dohrn Bank, whereas younger fish dominate in the South (5—7 yr old). This reflects the eastward migration behaviour towards the spawning grounds in East Greenland. Further, the genetic studies combined with tagging results suggest that the spawning stock component in East Greenland is associated with the offshore spawning population in Iceland, but the extent and exact dynamics of this association is unknown.

16.10 References

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Table 16.2.2.1. Offshore catches (t) divided into NAFO divisions in West Greenland and East Greenland (ICES XIVb). 1924-1995: Horsted 2000, 1995-2000: ICES Catch Statistics, 2001-present: Greenland Fisheries License Control.

Year	NAFO 1A	NAFO 1B	NAFO 1C	NAFO 1D	NAFO 1E	NAFO 1F	Unknown NAFO div.	ICES XIVb	NAFO 1F + ICES XIVb
1924							200		
1925							1871		
1926							4452		
1927							4427		
1928							5871		
1929							22304		
1930							94722		
1931							120858		
1932							87273		
1933							54351		
1934							88422		
1935							65796		
1936							125972		
1937							90296		
1938							90042		
1939							62807		
1940							43122		
1941							35000		
1942							40814		
1943							47400		
1944							51627		
1945							45800		
1946							44395		
1947							63458		
1948							109058		
1949							156015		
1950							179398		
1951							222340		
1952	0	261	2996	18188	707	37905	257488		
1953	4546	46546	10611	38915	932	25242	98225		
1954	2811	97306	18192	91555	727	15350	60179	4321	23759*
1955	773	50106	32829	87327	3753	4655	68488	5135	11567*
1956	15	56011	38428	128255	8721	4922	66265	12887	19189*
1957	0	58575	32594	62106	29093	16317	47357	10453	30659*
1958	168	55626	41074	73067	21624	26765	75795	10915	46972*
1959	986	74304	10954	30254	12560	11009	67598	19178	35500*
1960	35	58648	18493	35939	16396	9885	76431	23914	39219*
1961	503	78018	43351	70881	16031	14618	90224	19690	40212*
1962	1017	122388	75380	57972	25336	17289	125896	17315	41874*
1963	66	70236	73142	76579	46370	16440	122653	23057	46626*
1964	96	49049	49102	82936	33287	13844	99438	35577	55451*
1965	385	80931	66817	71036	15594	15002	92630	17497	38063*
1966	12	99495	43557	62594	19579	18769	95124	12870	38956*
1967	361	58612	78270	122518	34096	12187	95911	24732	40738*
1968	881	12333	89636	94820	61591	16362	97390	15701	37844*
1969	490	7652	31140	65115	41648	11507	35611	17771	31879*

Year	NAFO 1A	NAFO 1B	NAFO 1C	NAFO 1D	NAFO 1E	NAFO 1F	Unknown NAFO div.	ICES XIVb	NAFO 1F + ICES XIVb
1970	278	3719	13244	23496	23215	15519	18420	20907	40023*
1971	39	1621	28839	21188	9088	20515	26384	32616	59789*
1972	0	3033	42736	18699	7022	4396	20083	26629	32188*
1973	0	2341	17735	18587	10581	2908	1168	11752	14725*
1974	36	1430	12452	14747	8701	1374	656	6553	7950*
1975	0	49	18258	12494	6880	3124	549	5925	9091*
1976	0	442	5418	10704	8446	2873	229	13025	15922*
1977	127	301	4472	7943	8506	2175	35477 1	18000 2	23455*
1978	0	0	11856	2638	3715	549	34563 1	26000 2	27561*
1979	0	16	6561	4042	1115	537	51139 1	34000 2	36775*
1980	0	1800	2200	2117	1687	384	7241 1	12000 2	12724*
1981	0	0	4289	4701	4508	255	0	16000 2	16255
1982	0	133	6143	10977	11222	692	1174	27000 2	27720*
1983	0	0	717	6223	16518	4628	293	13378	18054*
1984	0	0	0	4921	5453	3083	0	8914	11997
1985	0	0	0	145	1961	1927	2402	2112	5187*
1986	0	0	0	2	72	24	1203	4755	5074*
1987	0	0	5	815	67	43	3041	6909	7093*
1988	0	0	919	17463	10913	6466	8101	9457	17388*
1989	0	0	0	11071	48092	14248	2	14669	28917
1990	0	0	2	563	21513	10580	7503	33508	46519*
1991	0	0	0	0	104	1942	0	21596	23538
1992	0	0	0	0	0	0	0	11349	11349
1993	0	0	0	0	0	0	0	1135	1135
1994	0	0	0	0	0	0	0	437	437
1995	0	0	0	0	0	0	0	284	284
1996	0	0	0	0	0	0	0	192	192
1997	0	0	0	0	0	0	0	355	355
1998	0	0	0	0	0	0	0	345	345
1999	0	0	0	0	0	0	0	116	116
2000	0	0	0	0	0	0	0	152	152
2001	0	0	0	0	0	0	0	125	125
2002	0	0	0	0	0	0	0	401	401
2003	0	0	0	0	0	0	0	485	485
2004	0	0	0	5	3	1	0	774	775
2005	0	0	1	0	0	71	0	819	890
2006	0	0	0	0	0	414	0	2042	2456
2007	0	0	0	31	435	20113	0	3194	5205
2008	0	0	0	23	526	113703	0	3258	14628
2009	0	0	0	0	6	33233	0	1642	4965
2010	0	0	0	0	2	281	0	2388	2669
2011	0	0	0	0	8	542	0	4571	5113
2012	0	0	1	95	236	1470	0	3941	5411
2013	0	0	0	209	270	1405	0	4104	5509
2014	0	0	30	68	18	1833	0	6060	7893

1) Estimates for assessment include estimates of unreported catches. The total estimated value for West Greenland (inshore + offshore) was 73000 t in 1977 and 1978, 1979: 99000 t, 1980: 54000 t. The value given in the table are these values minus the inshore catches minus known offshore NAFO division catches.

2) Estimates for assessment include estimates of unreported catches in East Greenland.

3) **Include catches taken with small vessels and landed to a factory in South Greenland (Qaqortoq), 2007:597 t, 2008: 2262 t, 2009: 136 t.**

***)** **Unknown NAFO division catches added accordingly to the proportion of known catch in NAFO division 1F to known total catch in all NAFO divisions.**

Table 16.2.2.2: 2014 cod catches (t) by area and month. East Greenland (XIVb) divided into three management areas.

ICES/NAFO	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	%
XIVb (Q1Q2)	1	0	30	55	37	40	626	635	92	482	602	5	2606	33%
XIVb (Q3Q4)	4	2	32	10	73	1030	329	412	197	198	193		2479	31%
XIVb (Q5Q6)		3		0.3	135	497	37	35	48	19	12	187	975	12%
1F		77	463	45	3	71	14	40	274	229	412	203	1833	23%
Total	4	83	525	110	248	1639	1007	1123	611	929	1220	395	7893	
%	0.1%	1%	7%	1%	3%	21%	13%	14%	8%	12%	15%	5%		

Table 16.2.2.3: 2014 cod catches (t) by gear, area and month. East Greenland (XIVb) divided into three management areas.

Gear	ICES/NAFO	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Longline	XIVb (Q1Q2)						0.3	4	28	4	6			42
	XIVb (Q3Q4)			32		3	1004	24	8	40	172	28		1310
	XIVb (Q5Q6)					4	453			0	16			472
	1F			242	42	0.2			4	68	131	171	115	773
	Total			274	42	7	1457	28	41	112	324	199	115	2598
Trawl	XIVb (Q1Q2)	1	0.2	30	55	37	40	622	607	88	477	602	5	2564
	XIVb (Q3Q4)	4	2		10	70	27	304	404	157	26	165		1168
	XIVb (Q5Q6)		3		0.3	132	44	37	35	48	4	12	187	503
	1F		77	222	3	3	71	14	36	206	99	242	87	1060
	Total	4	83	251	69	241	181	979	1082	499	605	1021	280	5295

Table 16.2.3.1. Cod in Greenland. Catch at age ('000) and Weight at age (kg) for offshore fleets in East Greenland (ICES XIVb + NAFO 1F). Yellow highlights dominating yearclasses in the catches.

Catch at age								
Year/age	3	4	5	6	7	8	9	10+
2005	5	33	57	103	94	57	16	7
2006	232	376	135	175	115	14	1	0
2007	49	1529	668	158	124	120	18	15
2008	77	586	6015	2417	592	44	26	12
2009	307	1287	1231	434	119	28	16	2
2010	10	87	331	193	334	58	8	5
2011	3	70	137	425	355	371	96	31
2012	13	109	471	281	258	253	148	59
2013	0	36	127	615	237	226	153	104
2014	1	4	279	434	658	335	173	131
Weight at age								
2005	0.354	0.717	1.073	1.963	2.737	3.699	5.271	7.366
2006	1.323	1.602	2.349	3.608	4.420	5.440	7.191	8.127
2007	0.387	0.917	1.597	3.294	6.092	8.524	11.114	14.435
2008	0.359	0.644	1.266	1.799	3.025	4.936	5.840	8.290
2009	0.489	0.776	1.396	2.797	4.634	6.453	7.804	9.993
2010	0.699	1.125	1.636	2.494	3.354	5.334	8.063	10.475
2011	0.553	1.026	1.541	2.297	3.377	4.685	6.285	10.022
2012	0.502	0.892	1.440	2.380	3.570	5.142	7.172	11.417
2013	0.480	0.998	1.698	2.272	3.408	4.745	6.827	9.024
2014	0.564	1.163	1.853	2.603	3.636	4.732	6.400	8.841

Table 16.2.4.1: Data used in the Atlantic cod CPUE. N are number of hauls from vessels from EU and Greenland used in the analysis.

year	N	ln CPUE (ton/hr)	SE
1975	82	-1.12595665	0.1602324
1976	5	-0.95595168	0.6044689
1977	304	0.06369107	0.1044638
1978	232	-0.24907508	0.1131963
1979	313	-0.21623841	0.1128258
1980	106	-0.8545272	0.1464227
1981	10	-1.46262129	0.431476
1982	15	-1.25247236	0.3515014
1983	52	-0.67873822	0.2232734
1984	211	-0.52057286	0.135287
1985	41	-0.33559598	0.2228306
1986	0	na	na
1987	0	na	na
1988	368	-0.03086541	0.0867818
1989	1637	0.51658905	0.0649446
1990	4374	-0.03188192	0.0427326
1991	3007	-0.65147626	0.0455893
1992	2392	-0.48332143	0.0492012
1993	244	-2.12548215	0.0978487
1994	124	-3.71358685	0.1276957
1995	6	-3.65761952	0.548426
1996	123	-2.17860376	0.1686357
1997	16	-0.73948754	0.3393005
1998	40	-2.35003708	0.2294059
1999	177	-2.42845091	0.1444615
2000	22	-2.08389238	0.288056
2001	94	-1.90463936	0.1449361
2002	140	-2.85274685	0.1629792
2003	144	-1.66609054	0.1322349
2004	89	-2.14857017	0.1856508
2005	55	-1.07553493	0.3548567
2006	261	0.49576899	0.1070256
2007	358	0.66449746	0.0819418
2008	1530	0.24979789	0.0578003
2009	710	-0.8291972	0.0717022
2010	255	-0.37128087	0.1019519
2011	500	0.427879	0.0818517
2012	493	0.15186911	0.0808314
2013	435	-0.32866291	0.1015757
2014	947	-0.07650472	0.0873358
Total	19912		

Table 16.3.1.1. Number of hauls in the Greenland Shrimp and Fish survey in ICES XIVb and NAFO 1F.

	ICES XIVb						NAFO	
Year/Strata	Q1	Q2	Q3	Q4	Q5	Q6	1F	Total
1992							15	
1993							13	
1994							9	
1995							11	
1996							11	
1997							19	
1998							14	
1999							17	
2000							29	
2001							26	
2002							27	
2003							22	
2004							34	
2005							23	
2006							31	
2007							39	
2008	8	6	12	7	7	11	47	98
2009	22	11	25	20	6	13	48	145
2010	19	14	24	9	6	10	40	122
2011	20	11	21	12	7	14	25	110
2012	20	16	28	13	7	15	26	125
2013	25	12	22	14	5	14	28	120
2014	22	14	12	9	8	16	32	113

Table 16.3.1.2 Cod abundance indices ('000) from the Greenland Shrimp and Fish survey by year and strata divisions in ICES XIVb and NAFO 1F. Q1 being the northern strata in East Greenland.

	ICES XIVb						NAFO		
Year	Q1	Q2	Q3	Q4	Q5	Q6	1F	Total	CV
1992							8		
1993							18		
1994							0		
1995							39		
1996							107		
1997							0		
1998							3		
1999							0		
2000							189		
2001							313		
2002							457		
2003							211		
2004							1610		
New survey Gear Introduced									
2005							86410		
2006							39475		
2007							32575		
2008	5456	1361	13043	1975	1635	7958	22887	54314	22
2009	14304	2191	28539	4374	548	4753	1776	56486	15
2010	5844	732	30042	3975	115	4633	6557	51897	45
2011	7843	1357	5178	7733	1470	19072	6330	48983	22
2012	5475	2164	3658	2453	352	8635	21238	43975	20
2013	11102	1420	5667	17360	537	27145	49874	113104	32
2014	4168	3445	2622	19267	493	5412	22702	58106	36

Table 16.3.1.3. Cod biomass indices (tons) from the Greenland Shrimp and Fish survey by year and strata divisions in ICES XIVb (Q1-Q6) and NAFO 1F. Smoothed index is a random effects survey smoother applied to the total index.

	ICES XIVb						NAFO			
Year	Q1	Q2	Q3	Q4	Q5	Q6	1F	Total	CV	Smoothed index
1992							2			
1993							5			
1994							0			
1995							4			
1996							49			
1997							0			
1998							3			
1999							0			
2000							46			
2001							100			
2002							150			
2003							46			
2004							305			
New survey Gear Introduced										
2005							56163			
2006							16828			
2007							23346			
2008	8692	2430	24101	1482	2173	8838	21232	68948	23	68370
2009	10844	8874	27251	7827	252	3094	502	58644	28	66876
2010	16014	3151	81064	6202	23	4203	3142	113798	51	82766
2011	27064	8128	5561	12486	5235	22665	3279	84417	19	85030
2012	24732	10058	9347	5802	160	14322	16212	80639	16	89797
2013	45018	9639	15017	48518	977	40319	47818	207306	22	168570
2014	17182	20637	15574	90795	734	8884	30751	184558	45	175160

Table 16.3.1.4: Abundance indices ('000) by age from the Greenland Shrimp and Fish survey by year in ICES XIVb + NAFO 1F.

East Greenland											
Year/age	0	1	2	3	4	5	6	7	8	9	10+
2008	4355	372	1113	7968	6582	23794	5412	2235	736	1006	739
2009	14970	7642	8019	4504	5378	5664	6610	2537	225	554	385
2010	150	2436	3959	5759	3253	12785	7969	11264	2958	450	914
2011	315	162	5682	8288	16346	5409	4707	2226	3382	1834	634
2012	0	258	1208	12748	7154	12041	4155	2428	1345	1849	790
2013	0	157	1432	1954	44843	25373	26654	5209	3440	1852	2190
2014	692	15	207	1849	1558	21863	8805	12411	2875	3790	4041

Table 16.3.1.5 The abundance indices ('000) by year class/age from the Greenland Shrimp and Fish survey subareas in ICES XIVb and NAFO 1F, 2014.

Year class	2014	2013	2012	2011	2010	2009	2008	2007	2006	2005	<2005
Age	0	1	2	3	4	5	6	7	8	9	10+
ICES Q1	454	0	0	0	76	644	591	1291	515	238	358
ICES Q2	0	0	4	0	0	107	519	1099	495	655	566
ICES Q3	98	0	0	309	0	154	451	752	309	0	549
ICES Q4	0	0	38	33	27	1190	3575	7759	1309	2799	2536
ICES Q5	97	15	0	0	8	186	160	25	1	0	0
ICES Q6	43	0	88	1142	86	2486	663	608	199	67	31
NAFO 1F	0	0	76	366	1361	17096	2846	877	47	32	0

Table 16.3.2.1 ***German survey*****. Numbers of valid hauls by stratum in South and East Greenland, stratum 9 furthest to the north.**

	NAFO 1 F		ICES XIVb						
year	Str 4.1	Str 4.2	Str 5.1	Str 5.2	Str 7.1	Str 7.2	Str 8.2	Str 9.2	Sum
1981	1	2	2	12	4	12	19	10	62
1982	13	2	.	12	1	9	15	15	67
1983	18	4	1	26	8	14	25	10	106
1984	20	4	4	5	1	5	7	2	48
1985	21	4	5	22	11	26	35	18	142
1986	20	3	2	27	11	14	31	34	142
1987	21	5	16	25	7	21	26	11	132
1988	18	2	20	19	10	13	36	9	127
1989	25	3	37	.	20	.	26	4	115
1990	21	6	15	24	4	6	15	12	103
1991	14	5	9	18	11	7	45	13	122
1992	7	5	.	.	.	.	4	2	18
1993	7	.	9	9	5	5	15	10	60
1994	7	5	.	.	.	.	.	6	18
1995	10	5	8	8	5	4	16	8	64
1996	10	5	7	9	5	3	13	6	58
1997	8	5	5	6	4	1	9	5	43
1998	10	5	5	9	6	2	12	6	55
1999	9	3	5	7	4	4	10	6	48
2000	9	5	6	7	8	4	12	9	60
2001	11	6	5	8	8	2	17	12	69
2002	8	4	6	7	5	2	10	7	49
2003	7	5	5	5	5	1	12	10	50
2004	9	5	7	7	8	3	13	11	63
2005	6	5	6	7	8	4	12	9	57
2006	8	5	3	1	5	4	11	7	44
2007	9	5	4	6	4	3	13	8	52
2008	7	6	6	8	4	3	10	8	52
2009	5	5	2	5	5	4	9	8	43
2010	10	6	1	3	8	3	14	8	53
2011	6	6	5	8	6	4	14	9	58
2012	10	6	6	7	8	3	12	9	61
2013	9	6	5	9	7	5	15	9	65
2014	10	6	5	7	10	6	20	11	75

Table 16.3.2.2 ***German survey*****. Cod abundance indices ('000) from the German survey in South and East Greenland by year and stratum.**

	NAFO 1F		ICES XIVb							
year	str4_1	str4_2	str5_1	str5_2	str7_1	str7_2	str8_2	str9_2	Sum	SD
1982	8540	1245	.	366	297	1493	664	385	12990	4973
1983	5267	2870	209	715	149	564	529	726	11029	3796
1984	3296	42	1268	413	138	750	173	333	6413	3845
1985	3492	1164	920	166	560	1554	401	310	8567	1978
1986	8967	492	3509	359	776	2641	1207	337	18288	5097
1987	23219	306	5655	4145	399	6298	1293	234	41549	14816
1988	28259	17	2590	2073	302	1175	738	601	35755	16719
1989	31810	31442	9979	.	880	.	2128	639	76878	42682
1990	7052	6306	2808	1155	861	4295	2799	468	25744	7720
1991	1367	233	790	937	122	368	652	510	4979	1548
1992	113	134	.	.	.	.	228	367	842	192
1993	0	.	613	62	127	317	114	148	1381	521
1994	44	12	.	.	.	.	.	234	290	135
1995	27	8	89	25	450	3082	77	91	3849	1314
1996	156	0	109	0	37	279	29	160	770	173
1997	49	0	25	17	200	54	145	1107	1597	479
1998	40	8	97	0	57	57	24	266	549	142
1999	155	0	198	8	165	1267	116	105	2014	582
2000	76	13	348	15	431	180	25	143	1231	251
2001	343	3	319	27	309	299	204	1071	2575	544
2002	1739	0	116	273	769	459	186	875	4417	1352
2003	840	8	199	183	1250	1399	1100	1438	6417	1004
2004	10902	107	1684	133	285	1817	1401	1073	17402	8499
2005	24438	1399	16577	3078	718	7157	1580	2070	57017	11411
2006	28894	486	14733	3686	6044	7378	2779	2700	66700	15653
2007	67049	772	2283	3256	758	5363	2080	2093	83654	56843
2008	18730	292	2036	4898	2203	9460	1285	2678	41582	10268
2009	1286	283	1017	567	3129	8755	1566	3275	19878	3581
2010	2372	141	532	1703	1101	8875	933	1748	17405	2958
2011	7547	162	3027	1326	868	1971	1243	2816	18960	3196
2012	23964	132	5689	167	901	2117	1114	3982	38066	22168
2013	41722	1947	2193	818	874	3121	1157	1342	53174	43105
2014	73612	111	8612	4013	228	1089	1436	5461	94562	77704

Table 16.3.2.3 ***German survey*****. Cod biomass indices (tons) from the German survey in South and East Greenland by year and stratum.**

	NAFO 1F		ICES XIVb							
year	str4_1	str4_2	str5_1	str5_2	str7_1	str7_2	str8_2	str9_2	Sum	SD
1982	14607	3690	.	1201	1036	3342	2576	1900	28352	8415
1983	9797	6219	653	2209	402	2294	2605	4442	28621	8201
1984	5326	82	3115	1444	346	1782	540	2553	15188	6650
1985	2942	1976	1812	803	1393	3875	1187	1605	15593	3099
1986	8005	943	1044	873	2537	3921	2301	709	20333	6054
1987	17186	276	2889	3735	504	10243	4558	1414	40805	16521
1988	26349	17	2812	4605	964	2297	3475	2012	42531	18651
1989	36912	35281	23605	.	2518	.	6889	2174	107379	61579
1990	9212	5897	5361	3215	2517	10386	6551	1620	44759	10905
1991	2088	200	1465	2759	196	1008	2610	2100	12426	4657
1992	79	50	.	.	.	.	171	734	1034	286
1993	0	.	431	73	247	532	254	547	2084	588
1994	2	7	.	.	.	.	.	779	788	514
1995	6	4	32	62	166	11744	250	123	12387	5550
1996	101	0	63	0	109	708	99	511	1591	333
1997	53	0	18	20	358	70	337	4017	4873	1800
1998	12	11	29	0	87	122	123	986	1370	554
1999	39	0	24	1	162	2229	492	201	3148	1184
2000	13	9	132	17	206	616	75	540	1608	366
2001	88	5	130	19	345	382	387	3005	4361	1593
2002	976	0	38	224	1547	531	541	2214	6071	1306
2003	361	17	121	266	3787	2440	1716	4169	12877	2817
2004	1945	177	359	55	957	2319	3264	3240	12316	3070
2005	9055	1870	8135	2537	3155	17882	3590	6806	53030	7772
2006	31616	681	8616	4130	3557	10291	6084	11567	76542	24680
2007	74671	1045	3749	5042	1363	14456	5374	8540	114240	58452
2008	18543	344	3630	9790	5075	26506	3772	11908	79568	12433
2009	583	277	1361	1726	10145	28613	6351	15520	64576	13358
2010	3629	273	741	5085	5244	31745	4282	10932	61931	11626
2011	12398	385	5839	4364	1658	8051	5735	17487	55917	10240
2012	33871	370	15679	579	2596	6245	5445	26885	91670	30054
2013	74193	6525	6672	2737	2577	9752	4853	7575	114884	75148
2014	132706	428	31885	15935	1060	4322	6480	29358	222174	132209

Table 16.3.2.4 ***German survey*****, South and East Greenland (NAFO 1F and ICES XIV). Age disaggregate abundance indices ('1000).**

Year	0	1	2	3	4	5	6	7	8	9	10	11+	TOTAL
1982		23	214	2500	1760	4451	1952	793	223	927	57	74	12974
1983													
1984	23	8	54	1134	507	2434	582	1242	229	125	17	49	6404
1985	279	2521	242	160	1658	947	1439	344	831	96	27	27	8571
1986		3367	9255	1128	273	1631	603	1300	165	473	31	58	18284
1987		4	10193	24656	2689	720	1368	296	966	80	487	49	41508
1988	6	18	335	9769	23391	876	200	559	83	337	31	146	35751
1989	12	2	111	732	23945	49864	1007	44	756	70	282	76	76901
1990	58	36	58	715	706	11679	12101	139	15	74		148	25729
1991		73	150	171	539	102	2128	1762	31	11	3	9	4979
1992	214	10	196	103	61	53	67	67	51			21	822
1993		4	15	869	152	95	97	31	83	34		2	1382
1994		71	5	16	84	39	22	38		8		0	283
1995		1	621	347	260	1399	372	120	403	32	192	102	3849
1996		0	0	353	130	131	110	23	25			0	772
1997		0	12	17	687	557	191	78	48			5	1595
1998	51	73	39	4	11	173	138	48	10			0	547
1999	105	426	389	346	118	257	174	156		29	16	0	2016
2000		202	243	323	208	40	72	20	46	61	15	0	1230
2001		166	568	493	631	362	190	60	50	18	10	2	2550
2002	40	1	395	2119	601	477	454	217	61	21	11	7	4404
2003	579	629	53	553	1761	1026	1015	541	220	37	.	4	6418
2004	386	10687	1770	448	617	1667	921	620	228	39	10	8	17401
2005	80	1603	39549	8091	1250	2819	2549	727	189	40		0	56897
2006	80	439	3375	48140	9269	1328	2404	1309	193	30	9	0	66576
2007	128	154	2007	5149	65974	8166	713	658	634	70		0	83653
2008	14	265	513	8213	4401	22939	4201	516	220	199	44	29	41554
2009	98	322	1057	391	1620	2863	11241	1964	111	134	64	17	19882
2010	22	700	1425	1388	845	2887	2518	5707	1362	236	163	139	17392
2011		120	1246	3475	4874	2402	2949	1179	2324	310	23	49	18951
2012	6	50	1624	10093	10233	9846	2827	1778	1166	379	35	5	38042
2013		17	35	4312	27014	11146	7455	1314	517	291	126	68	52295
2014		7	55	602	20847	58174	9275	3284	1316	494	441	52	94547

Table 16.5.1. Number of tagged cod in the period of 2003 to 2014 in different regions. Bank (West) = NAFO division 1D+1E. East Greenland = NAFO subdivision 1F + ICES subarea XIV.

Year	Fjord	Bank (West)	East Greenland
2003	599		
2004	658		
2005	565		
2006	41		
2007	1140	721	1387
2008	231		1296
2009	633		525
2010	88		
2011	28		403
2012	86	1563	2359
2013	183	2321	
2014			1203

Table 16.5.2: Number of recaptured cod in the period of 2003 to 2014 in different regions. Bank (West) = NAFO division 1D+1E. East Greenland = NAFO subdivision 1F + ICES subarea XIV.

	Fjord (West)	Bank (West)	East Greenland
Fjord (West)	436	8	3
Bank (West)		21	2
East Greenland		5	89
Fjord (East)			1
Iceland	3	13	98

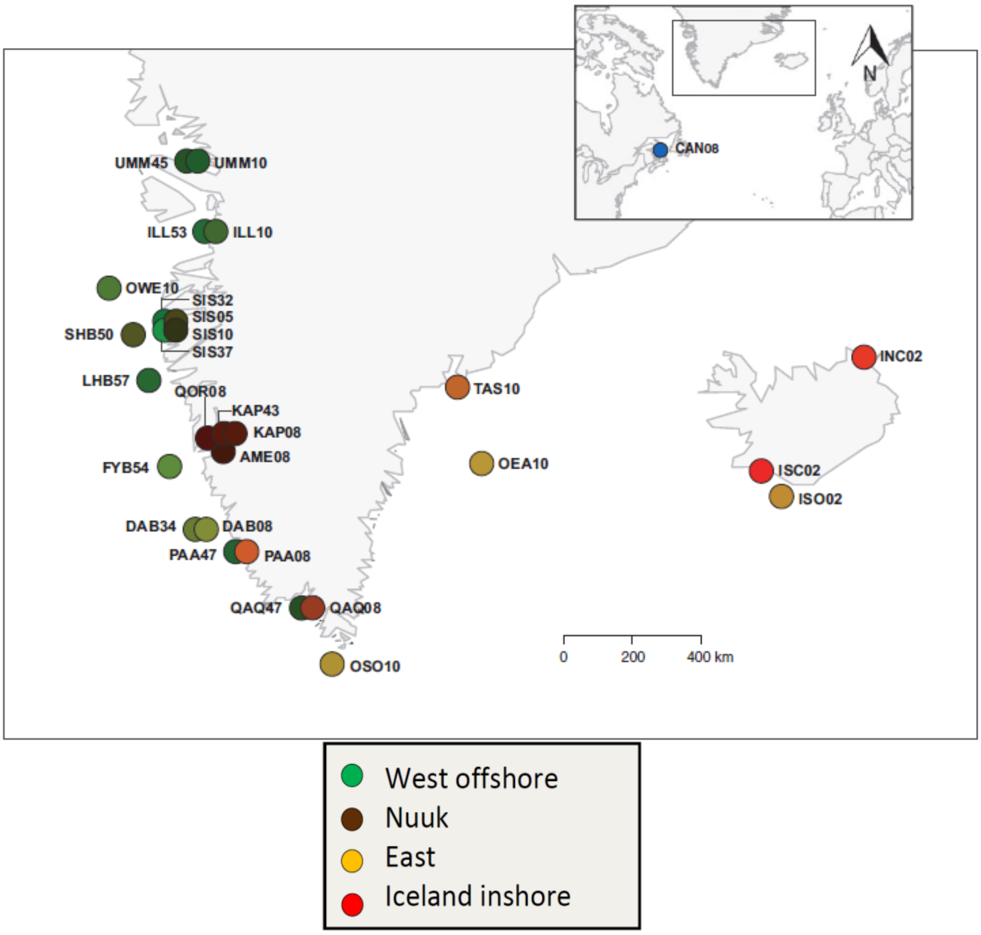


Figure. 16.1. Sampling location of spawning cod in Greenland and Iceland in the genetic project. The colours of the dots represent the blends of sample mean of the different spawning population: West offshore, Nuuk (inshore), East (Greenland and offshore Iceland) and Iceland inshore as signal intensities of green and red respectively. After Therkildsen et al. 2013.

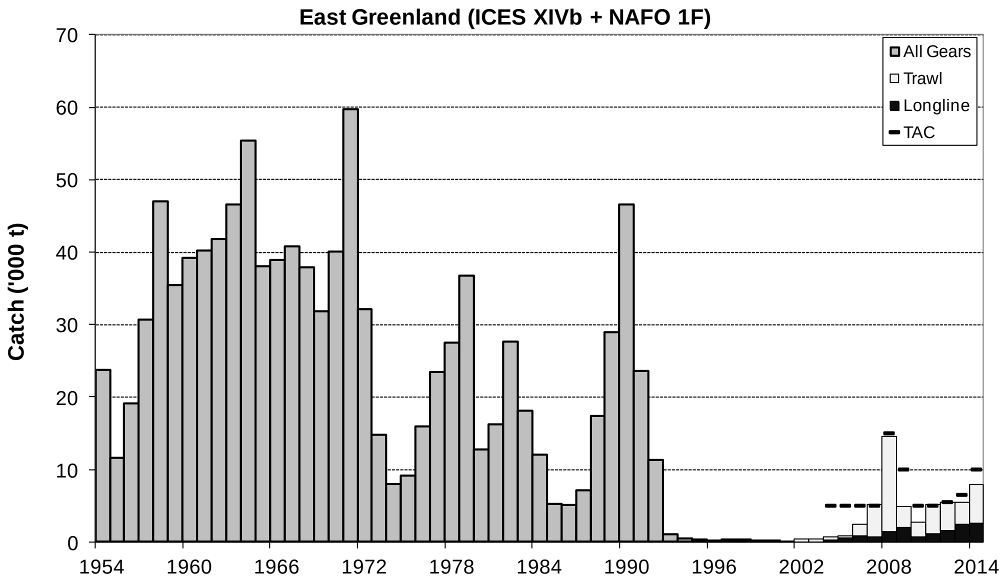


Figure 16.2.1. Annual total catch in South and East Greenland (NAFO subarea 1F and ICES subarea XIVb). From 2001 divided into gear. TAC until 2013 is for all the offshore area including West Greenland (NAFO subarea 1A-1E).

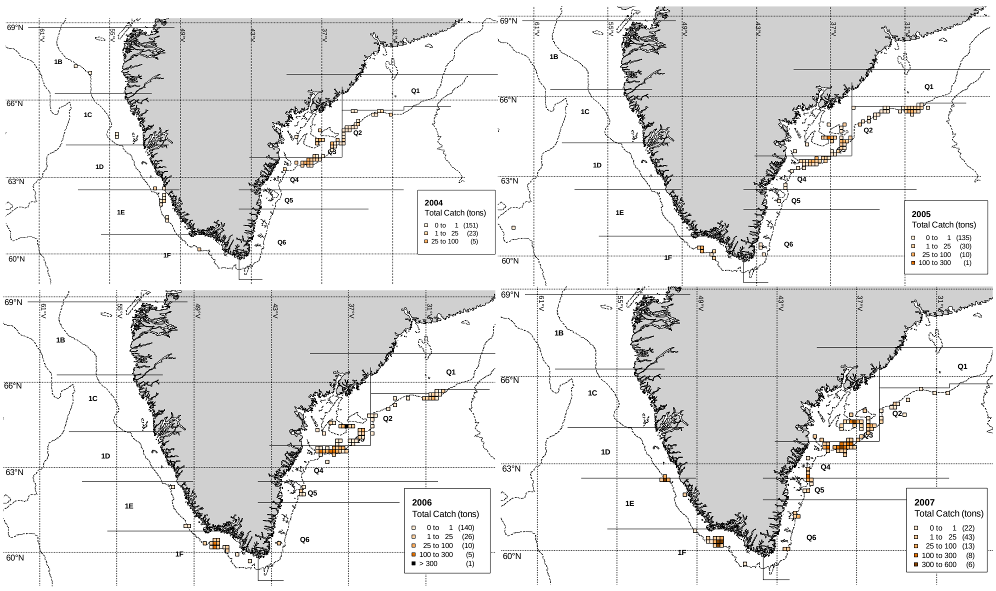


Figure 16.2.2.1: Annual distribution of total catches of Atlantic cod in West and East Greenland. Q1-Q6 illustrates survey areas (strata) in the East Greenland shrimp and fish survey.

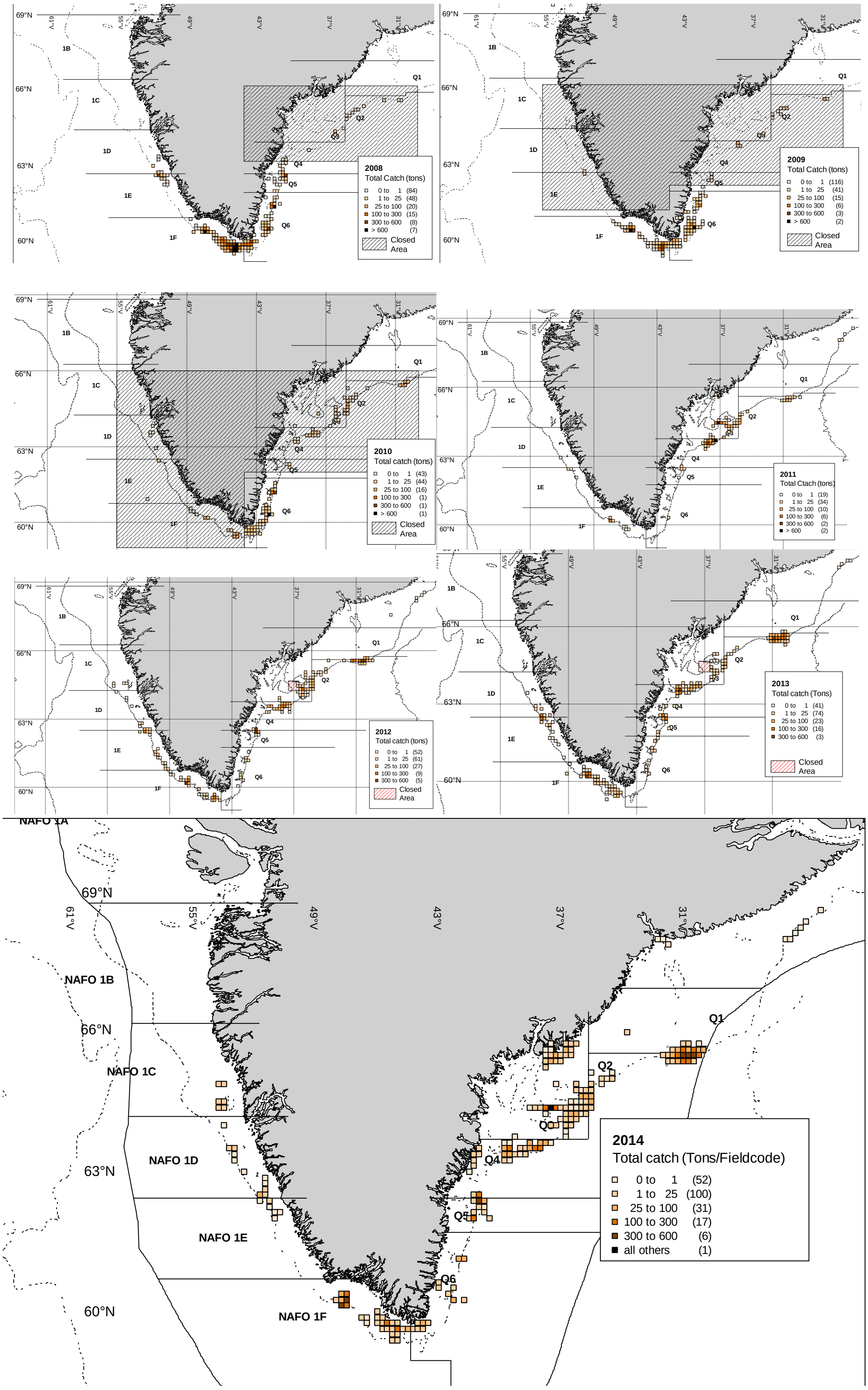


Figure 16.2.2.1: Continued. Annual distribution of total catches of Atlantic cod in West and East Greenland. Q1-Q6 illustrates survey areas (strata) in the East Greenland shrimp and fish survey.

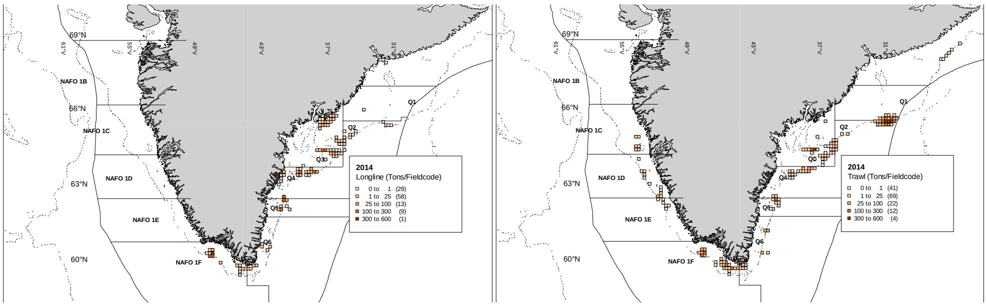


Figure 16.2.2.2: Distribution of Longline and Trawl catches of Atlantic cod in West and East Greenland 2014. Q1-Q6 illustrates survey areas (strata) in the East Greenland shrimp and fish survey.

i)

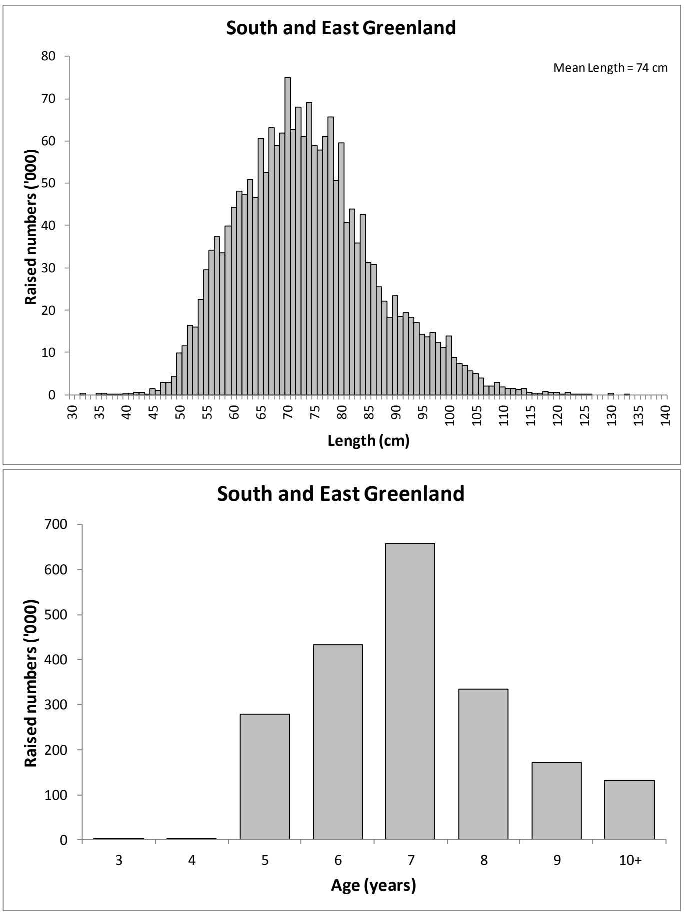


Figure 16.2.3.1: Combined length and age distributions of commercial cod catches in the South and East Greenland offshore fishery in 2014.

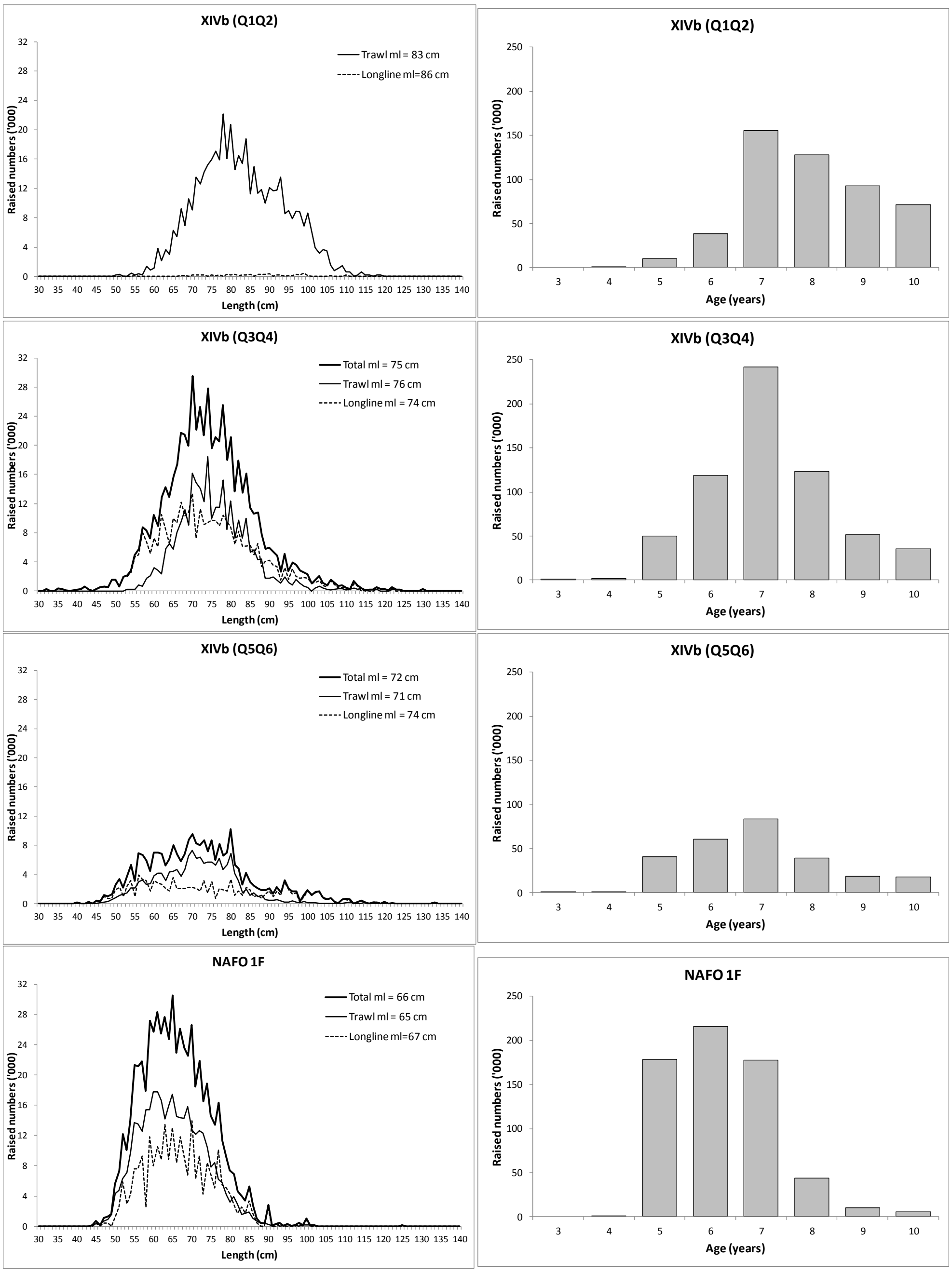


Figure 16.2.3.2: Length and age distributions of commercial cod catches in the four management areas of SouthWest (NAFO 1F) and East Greenland (Q1Q2 furthest north) in 2014.

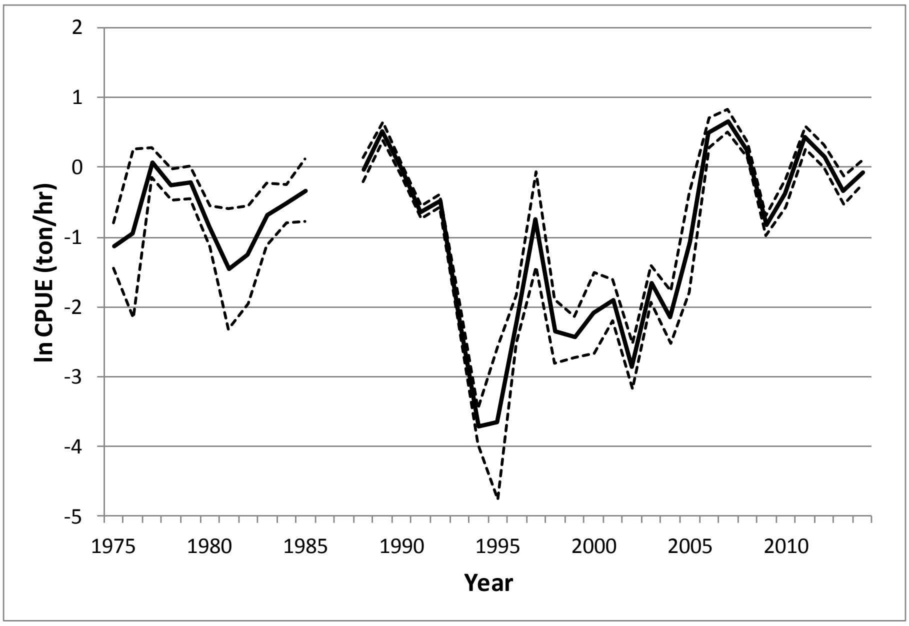


Figure 16.2.4.1: Ln CPUE (ton/hr) for Atlantic Cod caught in the fishery in East (ICES XIVb) and SouthWest (NAFO 1F) Greenland. Based on model: lncpue = year + management area (Q1Q2, Q3Q4, Q5Q6 and 1F) + ship. Dashed lines are 2*SE.

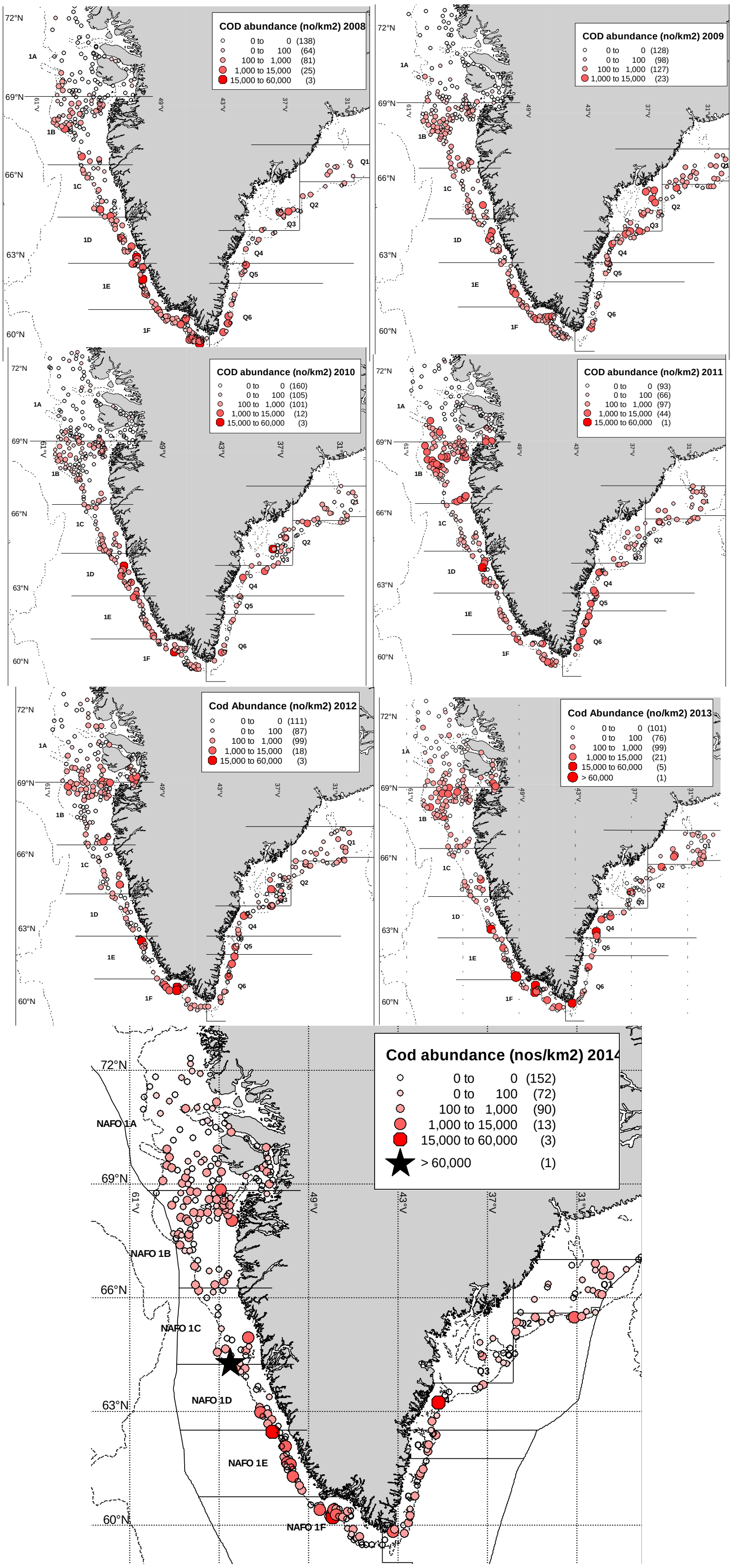


Figure16.3.1.1. Greenland shrimp and fish survey 2008-2014. Abundance per Km².

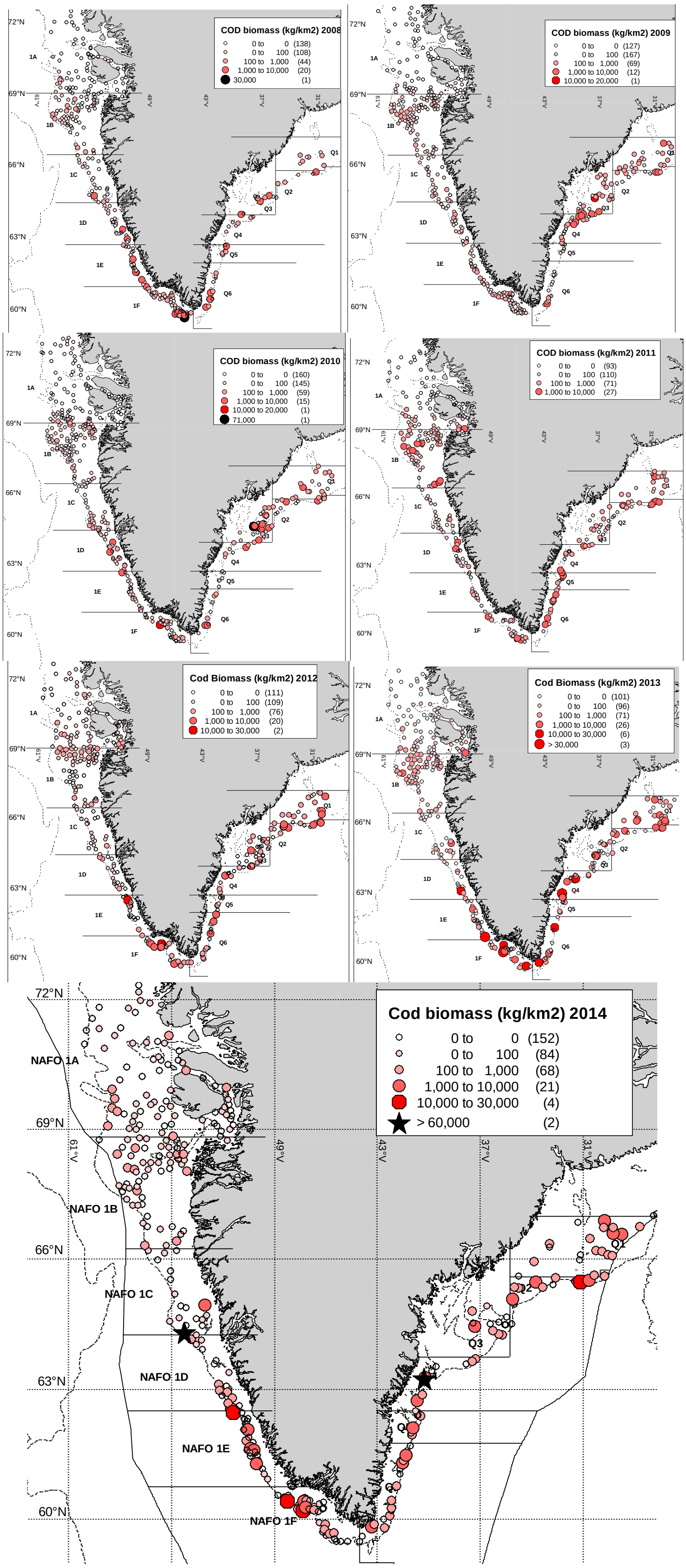


Figure 16.3.1.2. Greenland shrimp and fish survey 2008-2014. Catch weight kg per Km²

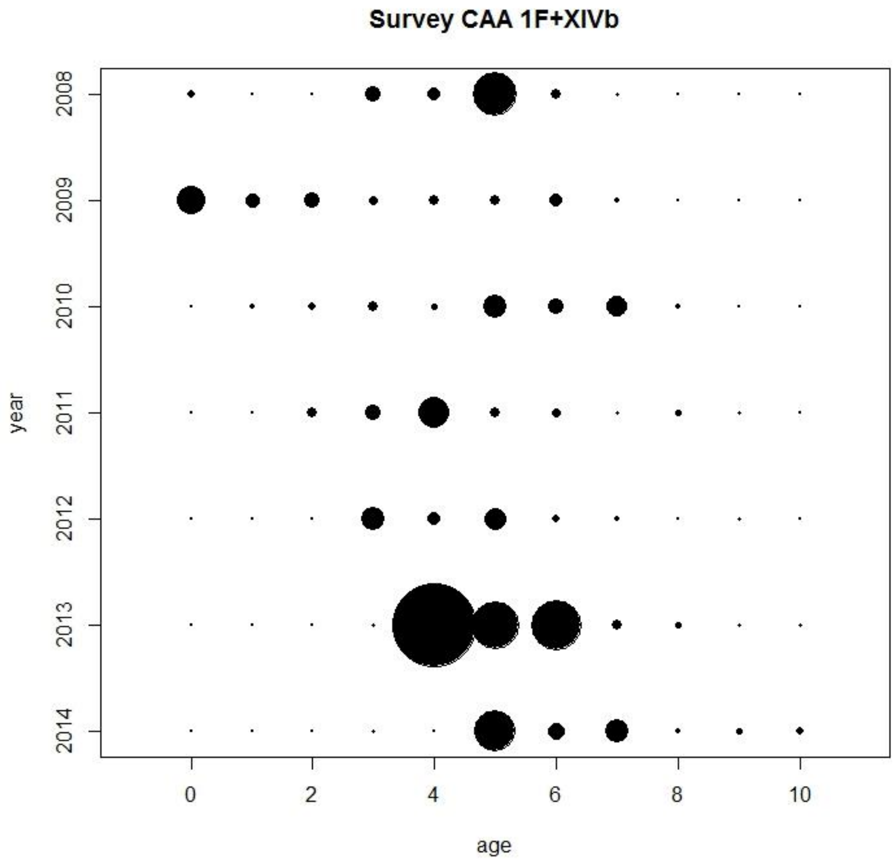


Figure 16.3.1.3: Abundance index pr. age in ICES XIVb and NAFO 1F combined. Size of circles represents size of index.

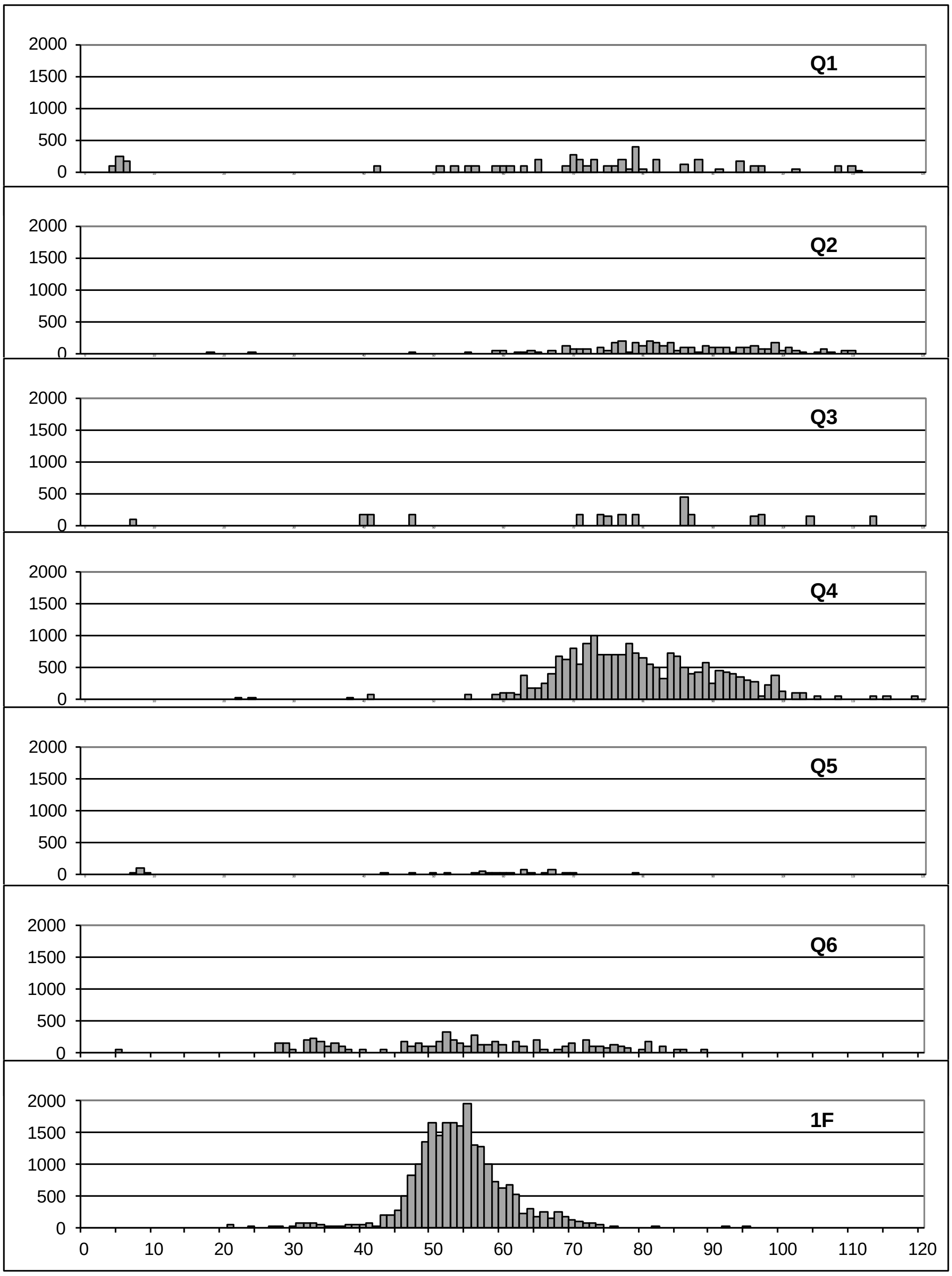


Figure 16.3.1.4: Abundance index by length (cm) and area in 2014. Areas from north (top) to south (bottom) is: Q1, Q2, Q3, Q4, Q5,Q6 (ICES XIVb) and NAFO 1F.

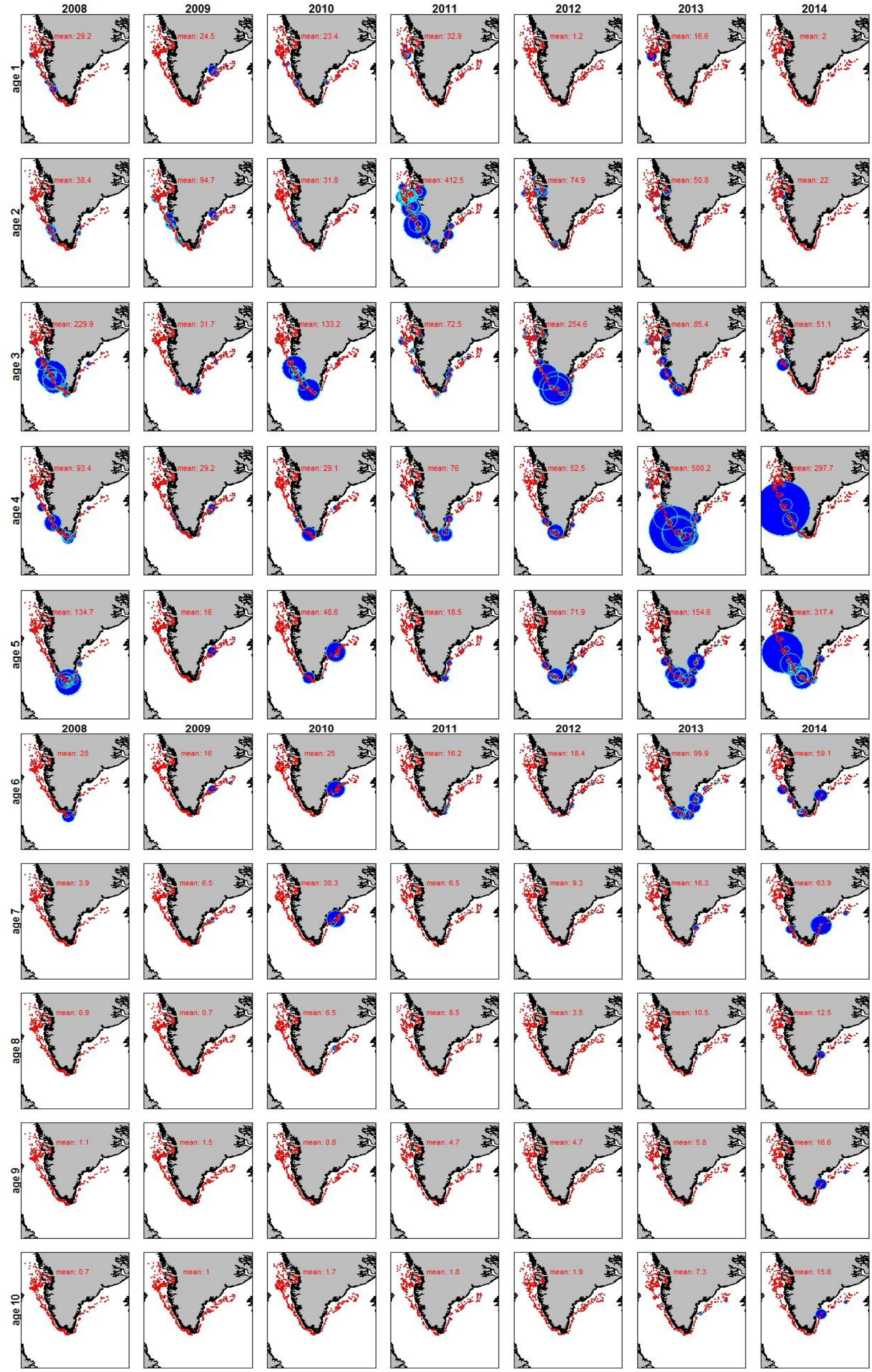


Figure 16.3.1.5. Abundace (no/km²) pr. station of ages 1-9 in the years 2008-2014.

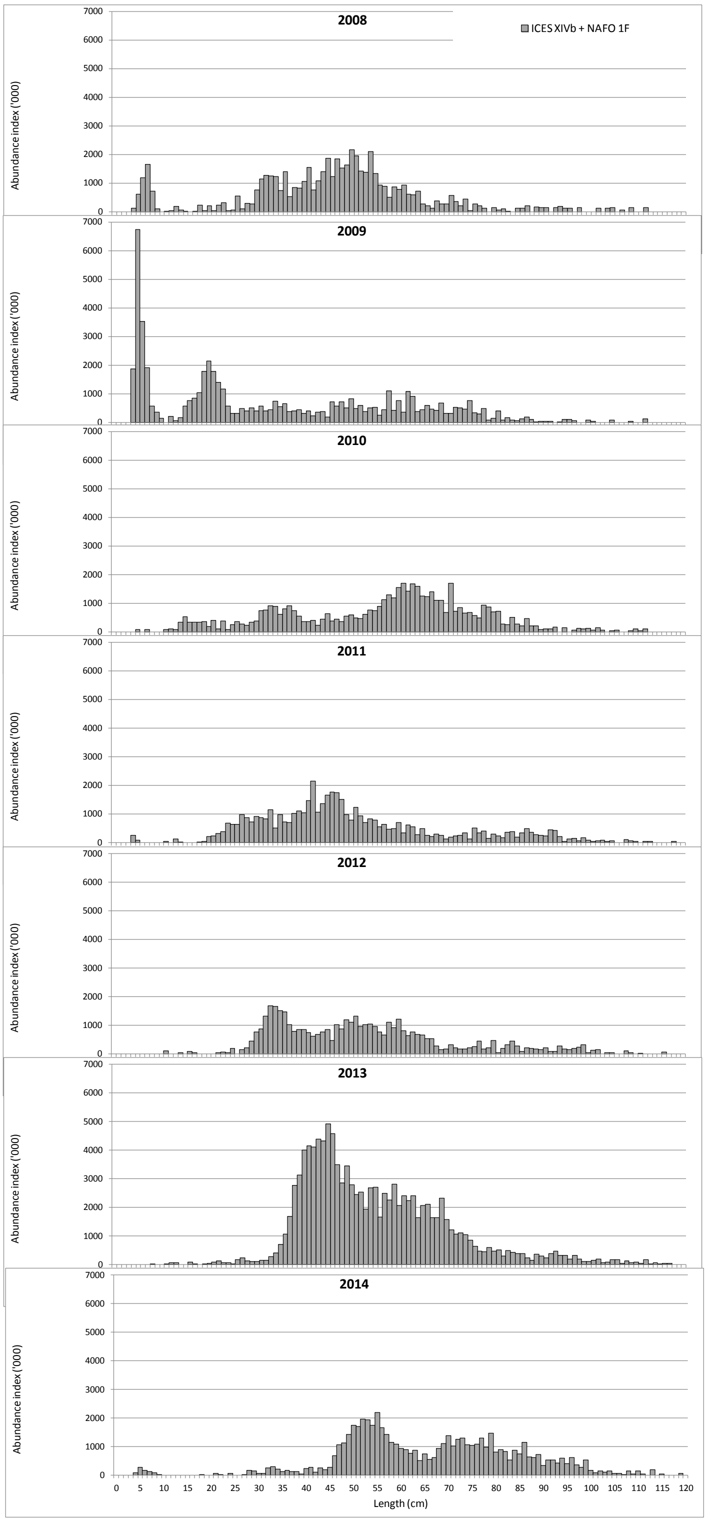


Figure 16.3.1.6: Total abundance indices by length in East Greenland (ICES XIVb + NAFO 1F) shrimp and fish survey.

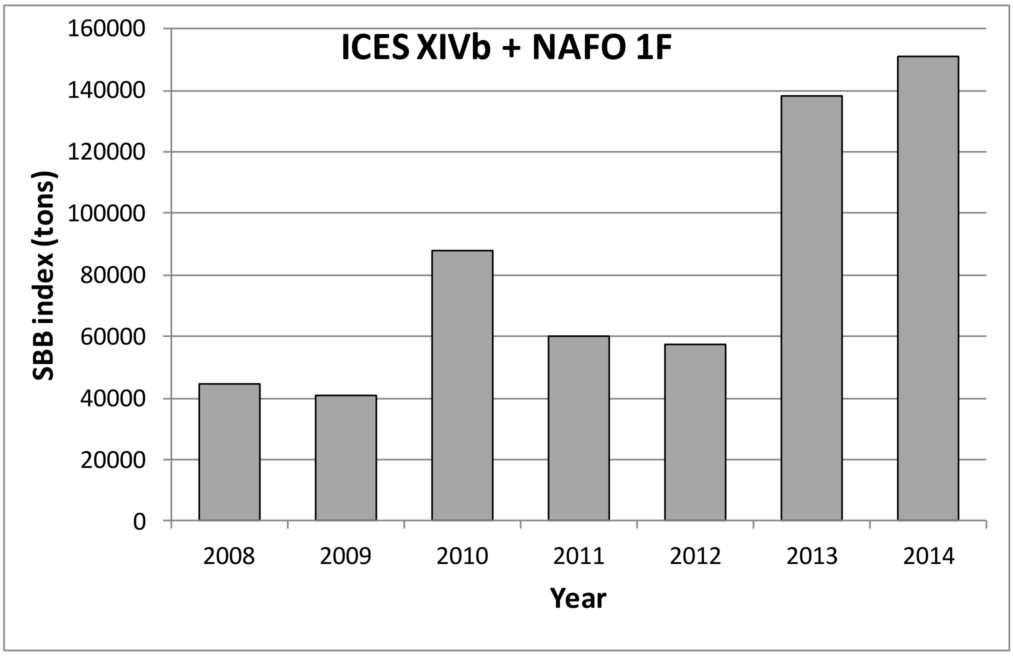


Figure 16.3.1.7: Estimated SSB (tons) by year from the East Greenland (ICES XIVb + NAFO 1F) Shrimp and Fish survey.

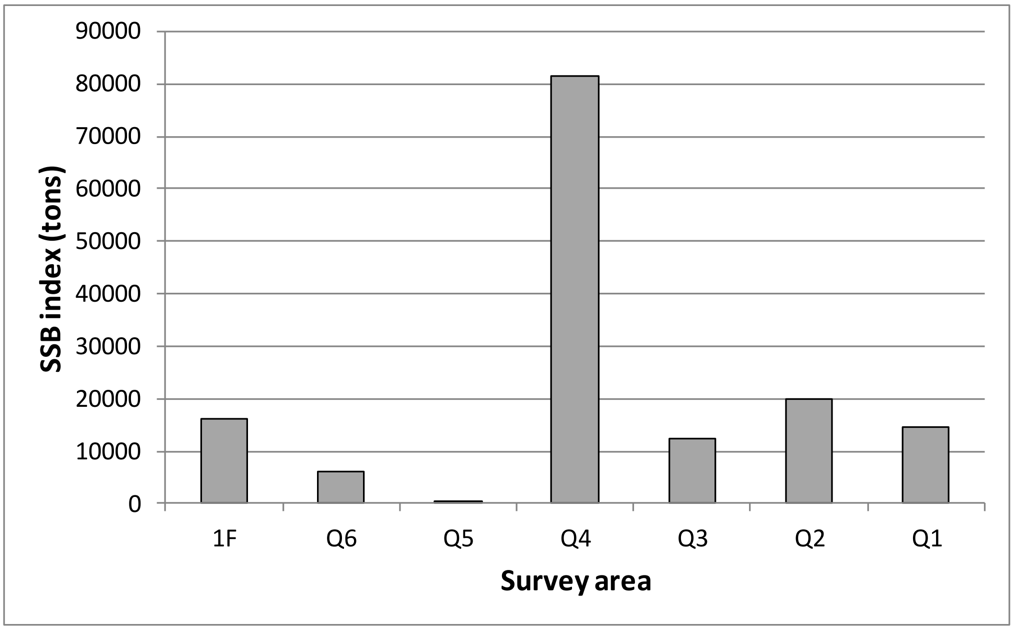


Figure 16.3.1.8: Estimated SSB (tons) by survey areas from the East Greenland (ICES XIVb + NAFO 1F) Shrimp and Fish survey, 2014. NAFO Div 1F (SouthWest Greenland) to the left, "Q" areas (East Greenland) to the right. Cape Farewell is between 1F and Q6.

Figure 16.3.2.1 German survey, 2014. Abundance (num per km2) pr haul.

Figure 16.3.2.2 German survey, 2014. Biomass (kg per km2) pr haul.

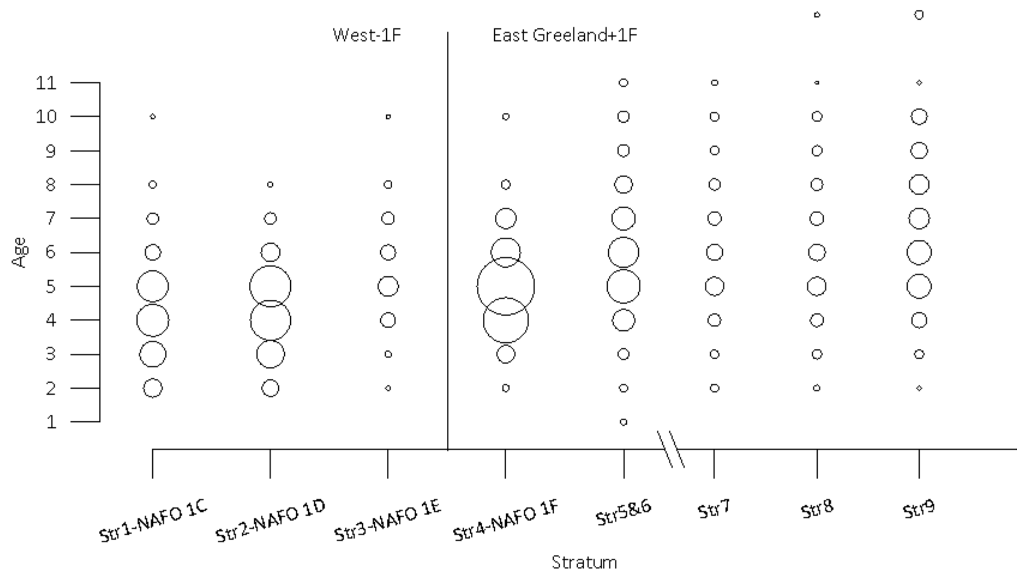


Figure 16.3.2.3 German survey, Cod off Greenland. Abundance per age group and stratum. Strata 1 –4 is West Greenland from north to south; strata 5-9 is East Greenland from south to north.

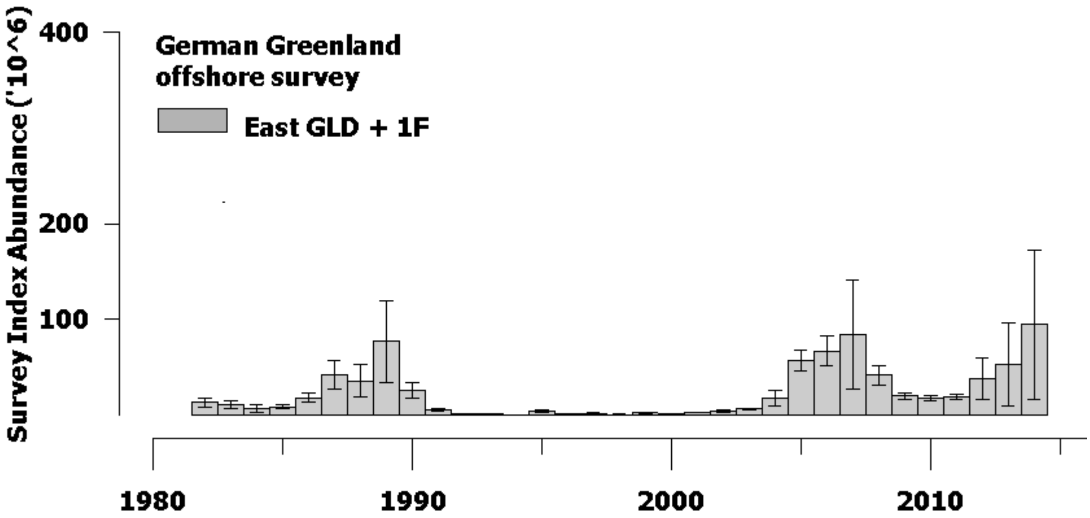


Figure 16.3.2.4 German survey, Cod off Greenland. Abundance indices for South and East Greenland.

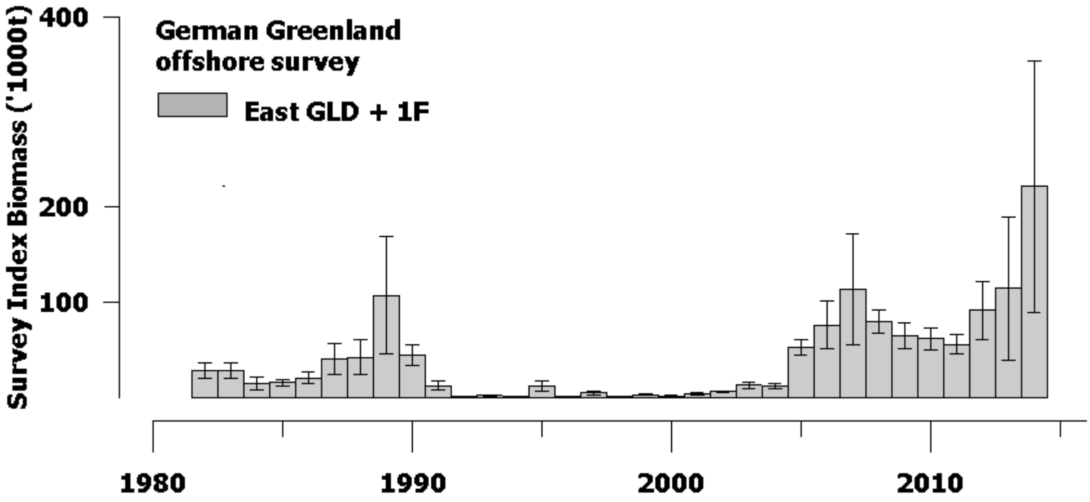


Figure 16.3.2.5 German survey, Cod off Greenland. Biomass indices for South and East Greenland.

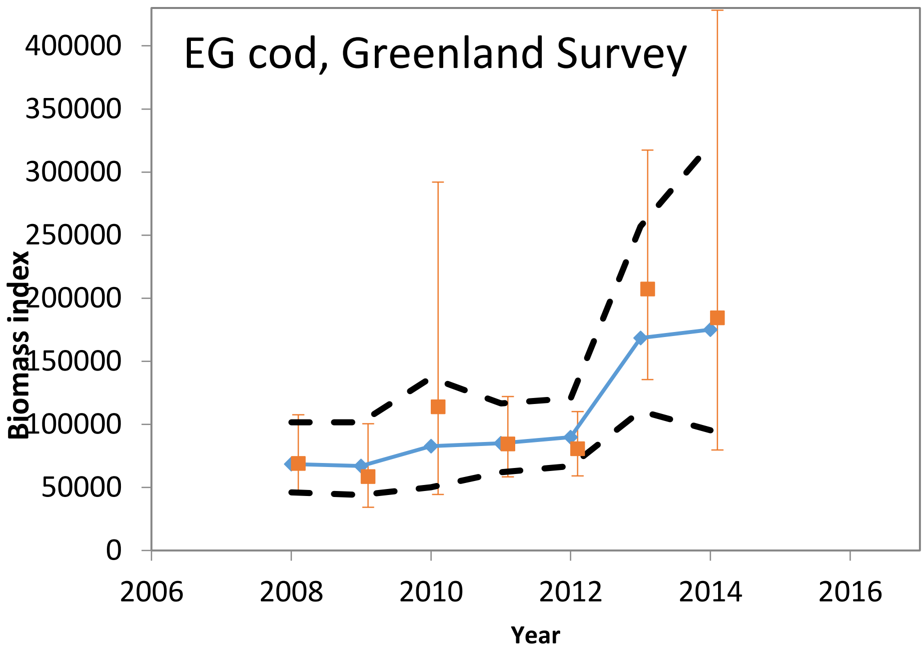


Figure 16.3.3.1: Biomass index for NAFO 1F and ICES Subarea XIVb. Red squares are the estimated mean value from the survey and the vertical connected lines are upper and lower 95% confidence intervals. The smoothed estimates are displayed as the blue line and the 95% confidence intervals of the smoothed values are shown as dashed lines.

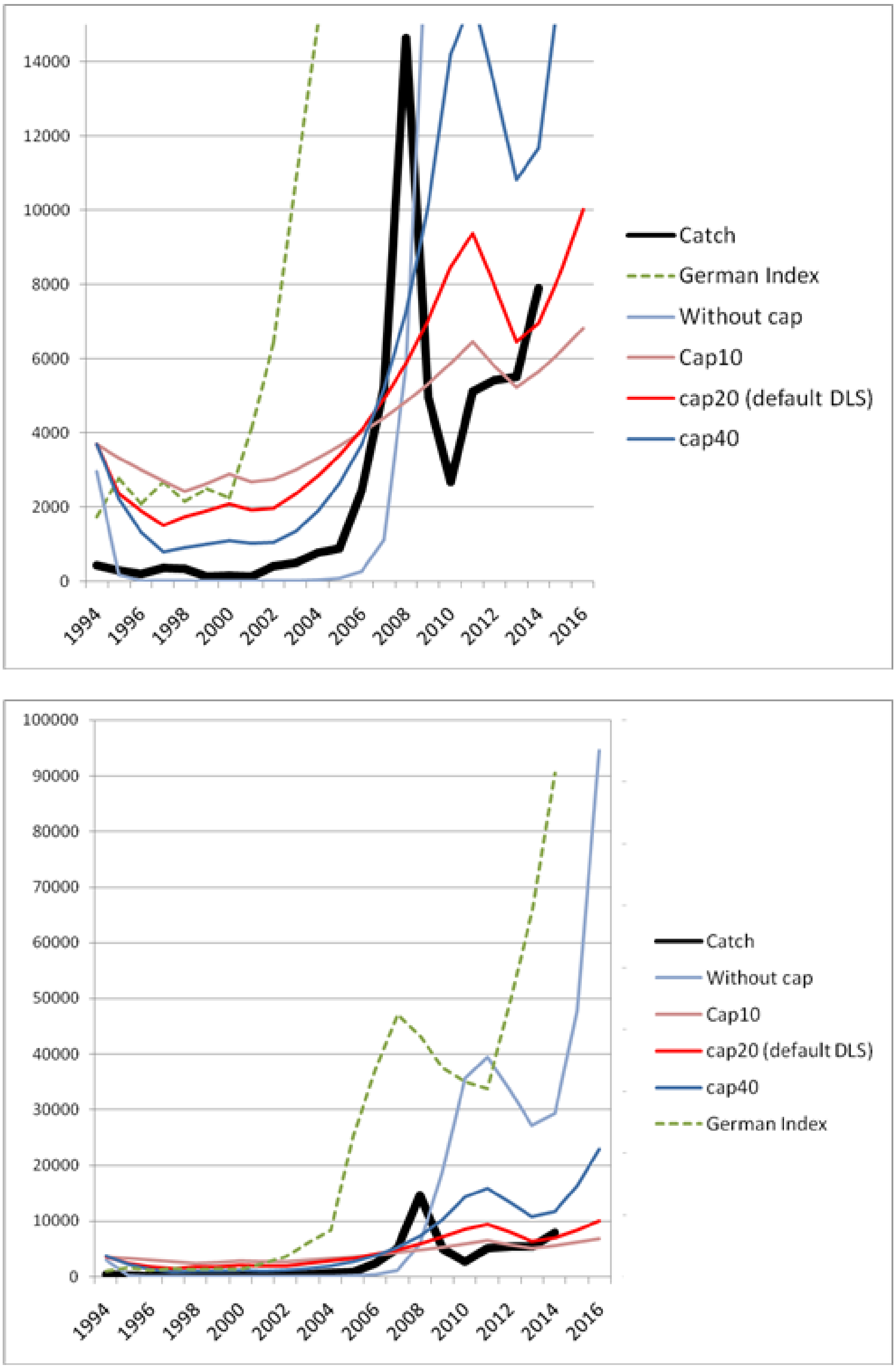


Figure 16.3.4.1: Catch, catch advice with different cap's on the 3.2 DLS approach and German survey index (without scale). The two figures show the same, but with two different scales on the Y-axis.

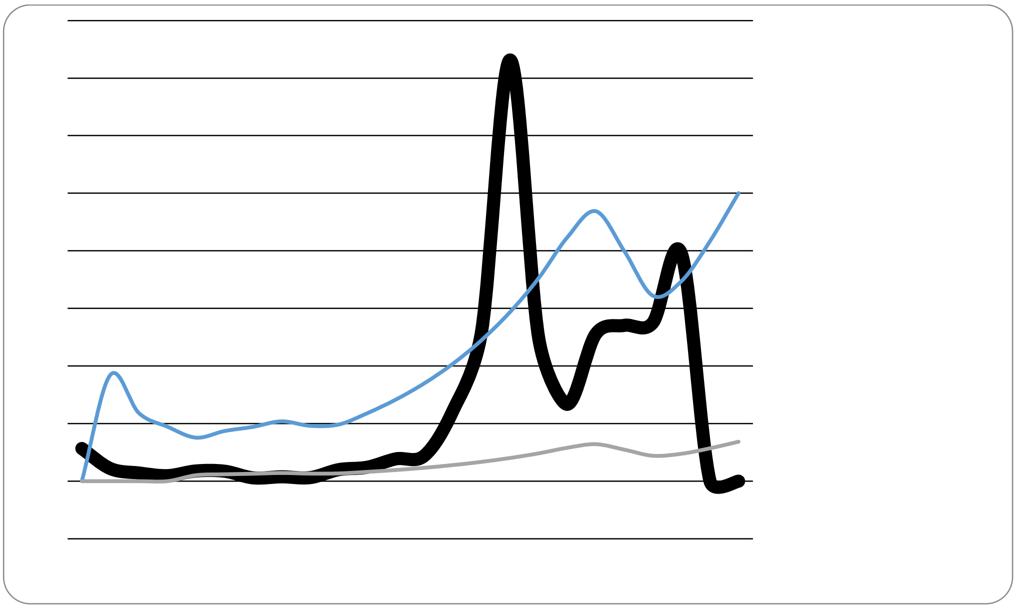


Figure 16.3.4.2: Catch (black), catch advice with setoff in year 1994 (blue), catch advice with setoff in year 1997 (green). Both 20%cap and 0.8 buffer were used for the two catch-advice calculations.

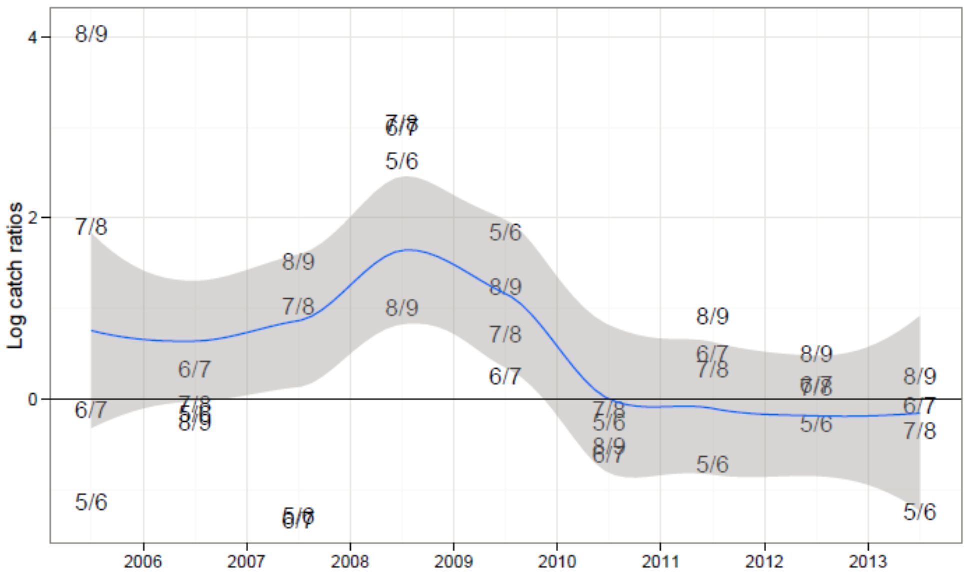


Figure 16.3.3.4: Log catch ratios in the period 2005-2014 using commercial data.

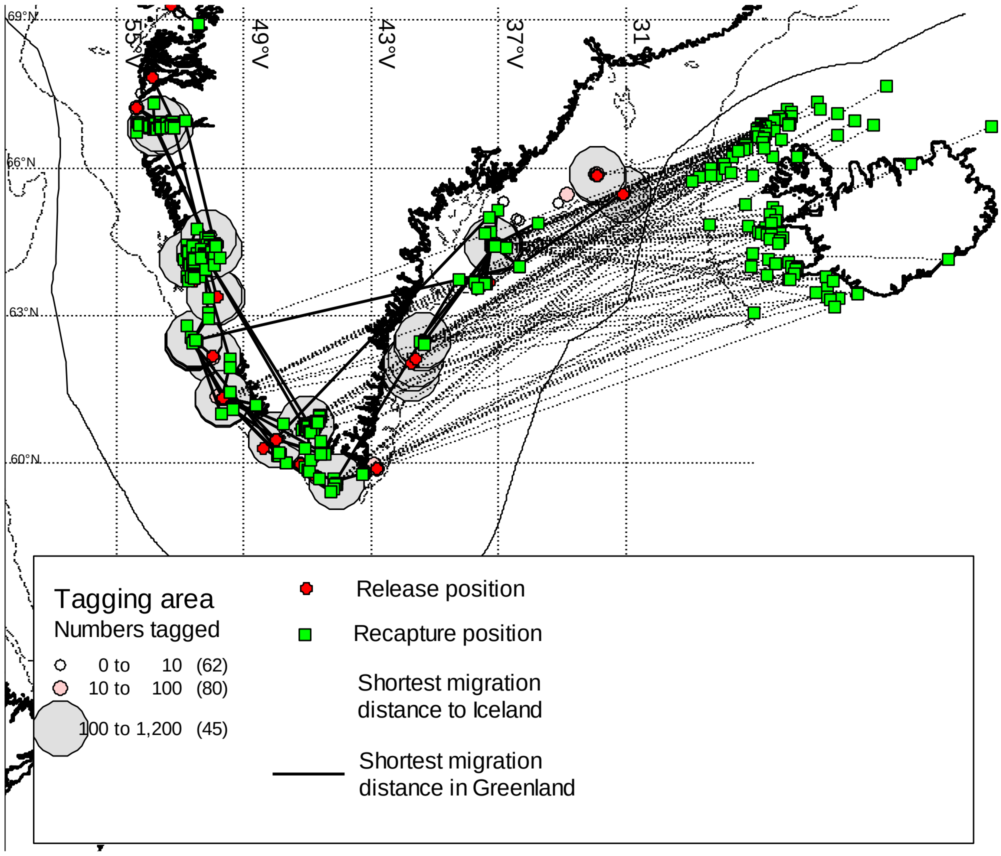


Figure 16.5.1: Tag and recapture of Greenlandic tagged cod in the period 2003-2014.

17 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.

The stock was benchmarked in November 2013 (ICES 2013, WKBUT) and changes for the stock assessment are provided in the Stock Annex. The NWWG suggested further changes from the benchmark, however, the advice drafting group referred to the benchmark decision in their minutes as follows:

"The ADG used the stock production model as a basis for the advice.

A number of issues were raised regarding the model. The early part of the CPUE series (pre-1995) may not be consistent with the later part. The model fitted with this series had a substantial process error component particularly in the early part of the series. This results in high autocorrelation in the error structure which increases the uncertainties in the predictions. The latter half of the assessment fits well to both CPUE and survey tuning series. It was considered that the main issue with the assessment was the relative magnitude of the stock and exploitation rate in the early part of the series. Although the error structure was a considerable concern the advantages of using the full catch time series to obtain plausible population growth parameters appear to out-weigh the problems that were apparent using a truncated series. The catch advice derived from this model was similar to the catch advice from DLS 3.3 analysis based on catch and the survey tuning series. The NWWG discussed this at length and although the majority considered the DLS approach was preferable it was not possible to reach consensus. The ADG commends the NWWG for their effort in providing a number of WGDOCs on this topic; however, the ADG would have been grateful for a synthesis of the issues. It is recognised that one of the reasons why this might not have been done was the lack of consensus in the NWWG. Given the outcome of the benchmark conducted in November 2013, and the considerations given above the ADG decided it was preferable to base the advice on the surplus production model, than to reject the benchmark and use the DLS approach. This should not be taken as an endorsement of the current model, but as interim solution for the advice this year. The NWWG should organise inter-sessional evaluation of CPUE series and modelling environment (stock production models, Gadget). If progress can be made and a report produced before the end of December 2014, ICES would put in place an inter-benchmark process to review any new proposed assessment."

17.1 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 which impede age based assessment.

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 assumed virgin status of the stock at the beginning of the fishery in 1961. Estimated stock biomass showed an overall decline along with the high catches in the late 1980s and early 1990s. Since 2004/2005 the stock has increased slowly and is now at 70%B_{msy} and fishing mortality has decreased to F_{msy}. Although the indices that are used for input to the assessment model (combined survey index at Greenland and Iceland) and logbook information from Iceland trawler fishery all show a slight decrease in 2014, the remaining available indices from East Greenland (logbook from trawl fishery) and from Faroese waters (logbooks from trawl fishery and a survey) all suggest high and stable biomass in recent years.

17.2 Catches, Fisheries, Fleet and Stock Perception

17.2.1 Catches

Total annual catches in Divisions Va, Vb, and Subareas VI, XII and XIV are presented for the years 1981–2014 in Tables 17.2.1—17.2.6 and since 1961 in Figure 17.2.1. Catches decreased in 2014 by 22% to 21.069 t mainly due to TAC restrictions.

Landings in Icelandic waters (usually allocated to Division Va) have historically predominated the total landings in areas V+XIV, but since the mid 1990s also fisheries in XIV and Vb have developed. Landings have since 1997 been between 20 and 31 kt.

17.2.2 Fisheries and fleets

In 2014 quotas in Greenland EEZ and Iceland EEZ were almost 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 also an insignificant gillnet and longline fishery takes place. Only minor catches in Va and XIVb are taken as by-catches in a redfish fishery (see section 21 on Greenland slope redfish). No or insignificant discarding has been observed in this fishery.

Spatial distribution of 2014 fishery and historic effort and catch in the trawl fishery in XIV and V is provided in Figures 17.2.2—5. Fishery in the entire area did in the past occur 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 2014 the distribution of the fishery covered all areas but was discontinuous in its distribution.

In 2001—2008 a directed and a by-catch fishery by Spain, France, Lithuania, UK and Norway developed in the Hatton Bank area of Division VIb. However, most of these fisheries ceased after 2008 and is presently insignificant. Landings in Divisions XII and VIb in Tables 17.2.5—17.2.6 derive from the Hatton Bank area.

17.2.3 By-catch and discard

The Greenland halibut trawl fishery is commonly a clean fishery with respect to by-catches. Eventual by-catches are mainly redfish and cod. Southeast of Iceland the cod fishery and a minor Greenland halibut fishery are coinciding spatially. In East Greenland where fishery is on the steep slope, fishing grounds for cod and redfish are close to the Greenland halibut fishing grounds, but nevertheless the catches from single hauls are clean.

The mandatory use of sorting grids in the shrimp fishery in Icelandic and Greenland waters since 2002 are observed to have reduced by-catches considerably. Based on sampling in 2006—2007, scientific staff observed by-catches of Greenland halibut to be less than 1% compared to about 50% by weight observed before the implementation of sorting grids (Sünksen 2007, WD # 18). No information has since been available but the fishery in XIVb report discard less than 1% by weight.

17.3 Trends in Effort and CPUE

17.3.1 Division Va

Indices of CPUE for the Icelandic trawl fleet directed at Greenland halibut for the period 1985—2014 is provided in Table 17.3.1 and Figures 17.3.1—3. At the benchmark (WKBUT 2013) the CPUE series from this fishery was questioned due to a marked change in season and area, and also because the regulations might have caused a changed behaviour in the fishing fleets. The important fishing grounds west of Iceland, where approximately 70—80% of the landings historically came from, are the areas where the season shift mainly has affected the CPUE. A simple standardization procedure was not considered sufficient to account for these changes (Figure 17.3.2.). Therefore a rough estimate on stock biomass distribution in Iceland in each of the fuor areas is that each area account equal. The overall CPUE index for the Icelandic fishery was therefore compiled as the average of the standardised indices from the four areas (Fig 17.3.1—2.).

Catch rates of Icelandic bottom trawlers decreased for all fishing grounds during 1990—1996 (Figure 17.3.1) but have since peaked in 2001 and have in recent years been stable and slowly increasing. The overall tendency is the same for all fishing grounds in Va (Figure 15.3.2) although the less important fishing grounds in north, east and southeast more variable in trend. Both observed and derived effort are about historic average in 2014 (Figure 17.3.3).

17.3.2 Division Vb

Information from logbooks from the Faroese otterboard trawl fleet (>1000 hp) was available for the years 1991—2014 (Table 17.3.1, Figure 17.3.4.). The bulk of the fishery has historically been on the south-east slope of the Faroe Plateau. CPUE decreased drastically in the early period by more than 50 % coinciding with a significant increase in effort. In 2011 CPUE increased sharply by more than 60% and remained at that level in 2012 and 2013.

17.3.3 Division XIVb

CPUE and effort from logbooks in XIV are provided in Table 17.3.1 and Figure 17.3.6—7. In 2005—2008 catch rates were high and above the average, but decreased by nearly 20% in 2009—2011 along with a massive increase in effort (85%). CPUE in 2012—14 has increased being at a 2009—2011 level. The CPUE series from Divisions Va, Vb and XIVb have different trends over the time series indicating that the populations/areas are affected by different dynamics.

17.3.4 Divisions VI and XIIb

Since 2001 a fishery developed in divisions VIb and XIIb in the Hatton Bank area, but in both divisions the recent catches are relatively small. Limited fleet information is available (ICES WGDEEP).

17.4 Catch composition

Length compositions of catches from the commercial trawl fishery in Div. Va are rather stable from year to year. In Figure 17.4.1 length distributions are shown since 1996 from the western area of Iceland, comprising the most important fishing grounds. Distributions are rather stable over the entire period and lack recruitment to the fishery in recent years is obvious. Little or no information is available of the catch composition in XIV and Vb.

17.5 Survey information

The total surveyed area in 2014 for Greenland halibut in Divisions Va and XIVb is provided in Figure 17.5.1. Most of the areas where commercial fishing takes place (Figure 15.2.2.) are covered by the annual surveys. The two surveys in Va and XIVb are compiled to one index and used as input in the assessment model.

17.5.1 Division Va

The fall survey for Greenland halibut was resumed in 2012 after no survey was conducted in 2011. Since 2008 the fishable biomass of Greenland halibut (fish of length equal to or greater than 50 cm) increased significantly in Icelandic waters (Figures 17.5.2) and the abundance of fish less 70 cm was historic high in 2013. (Figures 17.5.3. —17.5.4.). Abundance and to a lesser degree biomass decreased markedly in 2014.

17.5.2 Division Vb

The catch rates from the available time series of the Faroese survey (1995—2014) declines until 2007 but since then increase to record high levels the last three years (Figure 17.5.5).

17.5.3 Division XIVb

Total biomass in the Greenlandic survey (Figure 17.5.6) in 2014 was estimated at 9858 tons (S.E. 1394) which is a 33% increase from the lowest value in the time series in 2013. A GLM analysis performed on the survey catch rates, taking into account the scattered coverage of area and depth between years did support this development (Figure 17.5.7.). The text table below provides information on the coverage and numbers of stations in 2014 along with the Va survey.

Survey /Division	No. hauls in 2014 (planned hauls)	Depth range (m)	Coverage (km2)
Va	203 (219)	32 - 1309?	-130 000
XIVb	76 (70)	400-1500	29 000

The stock annex provides more extensive descriptions of the surveys.

17.6 Stock Assessment

17.6.1 Benchmark decisions for the stock assessment

The assessment model remains the stock production model using the new combined survey index and the Icelandic cpue index. Reference points as derived from this model are 30% B_{MSY} as B_{lim}, 1.7 x F_{MSY} as F_{lim} and an $MSYB_{trigger}$ defined as 50%B_{MSY}.B_{msy} and F_{msy} are inherited references in the model approach.

The combined Icelandic and Greenland survey index was the input index assuming to cover most of the distributional area for the stock.

17.6.2 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 V and XIV are considered to cover the adult stock distribution in the three divisions adequately. A detailed description of the survey/fishery design is provided in the stock annex.

The main fishing grounds are covered well by the available 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 in the entire area is likely influenced by a number of factors other than management restrictions, 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 caused improved 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 (since 1996) indicate a full recovery from a low level in 2004-2006 for all sizes of fish and in all surveyed areas. Icelandic trawl CPUE show signs of a recovery from a low in 2004 although recovery is slow.

Div. Vb: Both standardised survey/exploratory fishery and commercial cpues show a dramatic increase since 2011.

Div. XIVb: The Greenland survey in XIV have remained low since 2008 and reached record low in 2013. The survey index though increased in 2014 due to higher catch rates in the entire survey area. In contradiction to this trend CPUE's from the various trawl fleets in XIVb have been high since 2012.

Subarea VI and XII: No biomass indices are available for these areas. However, the areas are considered negligible with respect to stock size distribution.

17.6.3 A model based assessment

The assessment uses a stochastic version of the logistic production model and Bayesian inference according to the Stock Annex in which a more detailed formulation of the model and its performance is found.

17.6.3.1 Input data

The model synthesized information from input priors and two independent series of Greenland halibut biomass indices and one series of catches by the fishery (Table 17.6.1). The two series of biomass indices were: a revised and standardised series of annual commercial-vessel catch rates for 1985—2014, $CPUE_{t}$,; and a combined trawl-survey biomass index for 1996—2014, $Isur_{t}$.

Total reported catch or WGs best estimates in ICES Subareas V, VI, XII and XIV 1961-2014 was used as yield data (Table 17.6.1, Figure. 17.2.1). Since the fishery has no major discarding problems or misreporting, the reported catches were entered into the model as error-free.

Three additional biomass series were available. However, 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 Faroese indices of stock biomass (survey and logbooks from trawl fishery) were neither used in the assessment The omission of these indices from the analytical assessment only reflects that the model due to conflicting signals is not able to accommodate them but the indices are though considered to provide true populations trends and should therefore be treated as auxiliary information to the stock assessment.

17.6.3.2 Model performance

Inference was made from samples from the converged part of the MCMC samples as identified by appropriate statistics (Boje et al. 2015 WD 27). The model was able to produce a reasonable simulation of the observed data (Figure 17.6.2). 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 lay in the extreme tails of their posterior distributions (Table 17.6.4). Exceptions are observed for the survey in 1997 (p=0.96). The CPUE series was generally better estimated than the survey series (Figure. 17.6.2).

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 17.6.1). The prior for K was somewhat updated to slightly higher values. However, the posterior still had a wide distribution. The retrospective runs suggest high consistency (Figure. 17.6.3).

The priors for *MSY* was significantly updated (Figure. 17.6.1). As mentioned above *MSY* was relatively insensitive to changes in prior distributions. The posterior *K* had an inter-quartile range of 719-1059 ktons (Table 17.6.3).

17.6.3.3 Assessment results

The time series of estimated median biomass-ratios starts in 1960 as a virgin stock at K (Figure. 17.6.4—5). The fishery starts in 1961. Under continuously increasing fishing mortality the stock declined sharply in the mid 1990s to levels below the optimum, B_{msy}. Some rebuilding towards B_{msy} was then seen in the late 1990s. Since then the stock started to increase from its lowest level in 2004-5 of approx. 45% of B_{MSY}. In 2014 biomass was at 71% of B_{MSY}. The risk of the biomass being below B_{msy} in 2014 is 100% and 0 % of being below B_{LIM} (Table 17.6.5). The median fishing mortality ratio (F/F_{msy}) has exceeded F_{msy} since the 1990s and estimed at 1.3 F_{msy} in 2014. (Figure. 17.6.4 and 17.6.5). 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 26 ktons and 39 ktons (Table 17.6.3). 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 annex) and the low growth rate of the population. Risk associated with five optional catch levels for 2016 are given in Table 17.6.5.

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. 17.6.6.—7). The calculated risk is a result of the projected development of the stock and the increase in uncertainty as projections are carried forward. It must 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.

Catches around 20 ktons are likely to lead to an increase in stock size and annual catches of 15 kt or less will result in a 50% probability of reaching B_{MSY} within 10 years (Figure 17.6.6).

Scenarios of fixed levels of fishing mortality ratios within the range of 0.3 to 1.7 were conducted and are shown in Figure 17.6.8. Present biomass is above the MSY $B_{trigger}$ (50% of B_{MSY}) and a fishery at F_{MSY} is then advised according the ICES MSY approach. Fishing at Fmsy will result in catches of 22 kt in 2016 (Figure 15.6.8 panel D) and a stock size of 71% of B_{MSY} in 2016 (Table 17.6.5).

17.6.3.4 Conclusions

Stock status 2014–2015

- Stock size:
  - Stock biomass 0.70B_{msy} (median)
  - 100% probability of being below B_{msy}
  - 0% risk of being below B_{lim}
- Stock production:
  - MSY = 26—39 ktons (inter-quartile range)
  - Actual ≈ 0.9MSY (median)
- Exploitation:
  - 21 ktons
  - ~F_{msy} (median)
  - 10% risk of exceeding F_{lim}

Predictions

- Risk of exceeding MSY $B_{trigger}$
  - As the stock has improved since 2004—5 and is now further away from B_{LIM} the projected risk of exceeding this reference point is low (between 0 and 1%) at any catch at or below 30 kt.
- Catch option of 22 ktons/yr (*F_{MSY} level*)
  - Stock biomass is projected to be maintained or increase (0.71 of B_{MSY}).
- Moratorium
  - In the order of 5 years to rebuild to B_{MSY}

17.6.4 Reference points

Reference points were defined at the benchmark in 2013 (WKBUT): B_{LIM} as 30%B_{msy} corresponding to production is reduced to 50% of its maximum. This is equivalent to the SSB-level (spawning stock biomass) at 50% R_{max} (maximum recruitment). Greenland halibut is believed to be a slow growing species i.e. with relative low *r* (intrinsic rate of increase). This means that even without fishery it would take some 10 years to rebuild the stock from 30%B_{msy} to B_{msy} (calculated by setting r=0.21, the 75th percentile) – but likely longer.

MSY $B_{trigger}$, the biomass level that triggers a deviation from Fmsy advice, was defined as 50%B_{MSY}. F_{LIM} was defined as 1.7F_{MSY}.

17.7 Exploratory assessment: Gadget

An exploratory assessment on Greenland halibut using Gadget was presented at the meeting. This year only one run was presented based on growth data supplied by Norway. The resulting growth curves from Norway are identical to those estimated from mark-recapture data from Iceland that were presented at WKBUT-2013. The model setup was similar to the one presented at NWWG-2014.

17.7.1 Input data

The data used in the model were sex and length dis-aggregated indices from the Icelandic and Greenland surveys (combined in one index). Length distributions from the Icelandic and Greenland trawler fleet. Data on sex-ratio from the Icelandic trawler fleet and length at age data from Norway that was used to estimate growth inside the model. Catches from Iceland, Greenland and the Faroe Islands are included in the model.

17.7.2 Model settings

The model time was 1980 to 2015, with recruitment estimated annually. Two stocks are defined in the model, females and males that have different growth rates. Recruitment to the two stocks is equal that is 50:50.

In the model three fleets are defined, Icelandic, Greenland and Faroe Islands trawlers. The Icelanidc fleet has two selection patterns, one for females and another for males modeled as different L50 in the selection curves but with the same slope. The Greenland fleet has its own selection pattern but is not divided by sex. As there are no length distributions from the Faroe Islands it is assumed that the selection pattern in the same as in Iceland (for females).

In the model, natural mortality is set at 0.1 for all ages. The age range in the model is from age 3 to 25 with 25 being a plus-group.

17.7.3 Likelihood components

The likelihood components in the assessment are listed in table xxx. In all the model has 15 likelihood components but two of those are mainly for constraining the minimization routines (understocking and bounds).

Text Table: Components in Gadget model.

Component	Type	Weight	Notes
SexRatioIceTrawl.lik	stockdistribution	10	Sex ratio from Icelandic trawlers
FemaleSmhLD.lik	catchdistribution	12715	Female length distribution from the combined survey
MaleSmhLD.lik	catchdistribution	5847	Male length distribution from the combined survey
IceTrawlLD.lik	catchdistribution	1415	Length distributions from the Icelandic trawl fleet
GreTrawlLD.lik	catchdistribution	415	Length distributions from the Greenland trawl fleet
FemSmh2045.si	surveyindices	12	Female abundance survey index for length 20 to 45 cm
FemSmh4665.si	surveyindices	20	Female abundance survey index for length 46 to 65 cm
FemSmh4665.si	surveyindices	28	Female abundance survey index for length larget than 65 cm
MaleSmh2045.si	surveyindices	36	Male abundance survey index for length 20 to 45 cm
MaleSmh4665.si	surveyindices	28	Male abundance survey index for length 46 to 65 cm
MaleSmh4665.si	surveyindices	15	Male abundance survey index for length larget than 65 cm
FemSmhML.lik	catchstatistics	2	Mean length at age for females based on Norwegian data, allocated to the survey.
MaleSmhML.lik	catchstatistics	2	Mean length at age for males based on Norwegian data, allocated to the survey.
understocking	understocking	1	To constrain minimization so that the stock will always be larger than the catches
bounds	bounds	10	To constrain minimization to respect the bounds of the parameters.

17.7.4 Fit to data

In general the model captures the changes in the length distributions from both commercial catches and from the survey. However the model has problems with estimating the proportions of males and females from commercial catches. The fit to the survey indices is mostly reasonable, the model following the main trends in them. Due to time constraints the re-iterative weighing procedure was not used to assign weights to the likelihood components

17.7.5 Model estimates

The three estimated selection curves from commercial catches (Iceland females/males and Greenland) are virtually identical and might in future runs be merged to one selection curve. The estimated selection curve for the combined survey index has much lower L50 than the trawler fleets.

According to the model, recruitment is highly variable but that is most likely the result of very little information in the data on recruitment. Age-based data would help to stabilize this. SSB is estimated to have increased from 1980 to the early nineties when it started to decrease gradually and has been more or less stable since 2008-2010. Fishing mortality was relatively stable at around 0.12—0.15 from 1990.

When the model is run excluding the last years (analytical retrospective analysis) the runs ending in 2011 to 2013 show roughly the same pattern and even though there is some scaling issue the terminal estimates are quite consistent. However the run ending in 2015 is quite different from the other three where SSB is estimated considerably higher in the last years and the fishing mortality considerably lower.

17.7.6 Future work

The model will need more work to be usable as basis for assessment. Main issues to explore at present is the length aggregation of the survey indices, for example it may be more prudent to have only one index for males and one for females rather than the 6 currently used for tuning the model. The retrospective pattern also has to be addressed. This year the re-weighting of likelihood components procedure was not employed in assigning weights to the different data sets. Data from the Faroe Islands is missing and should be included. Work on aging is planned in Iceland based on the Norwegian method for age determination. When this gets started and a few years of ageing data become available it is expected that the model will be more stable as was the case for tusk and ling in Va (assessed in WGDEEP). Estimates of reference points were not presented based on the current model at the meeting due to computational difficulties.

17.8 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, 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. Recent information of tagging experiments in the Barents Sea suggests high mixing between the Barents Sea and Iceland. This connectivity is not accommodated for in the present assessment.

In 2012 the coastal states have initiated work on a common management plan for Greenland halibut. The plan is aimed to have two steps, a graduals lowering of the total catches until biological reference points have been defined by ICES, and thereafter implementation of a harvest control rule in accordance with ICES MSY approach. The plan will include continuous monitoring of the resource and requirements on information from the fishery. As a first step Greenland and Iceland decided on a TAC for 2013 at 26 000 t and further agreed to reduce catches in 2014 by 15% corresponding to catches of 22 100 t. The aim is to have a management plan to be implemented in 2015.

17.9 Data consideration and Assessment quality

The Icelandic CPUE series has for many years been used as a biomass indicator in the assessment of the stock. The CPUE of the Greenlandic trawlers and the biomass indices from the Faroese waters have not been used in the assessment, mainly because the stock production model is not able to accommodate contrasting indices (Icelandic CPUE and Greenlandic/Icelandic autumn surveys).

A number of issues on data and assessment quality were addressed in last year's report. The aim was that these issues should have been solved intersessionally and reviewed by an interbenchmark. However, no work has been done by the parties and it is realised that a meeting is necessary to be established to complete the work (see section 17.9).

17.10 Proposals and recommendations

Stock structure and connectivity between the main fishing areas remains partly unknown. Basic biological information on spawning and nursery grounds for the juveniles also remains poorly known. Biomass indices over the entire assessment area are not similar with respect to trend over time and may suggest different dynamics between areas. Further, recent tagging experiments in the Barents Sea suggest a high connectivity with Iceland waters. Therefore a compilation of present knowledge of stock identification for Greenland halibut in the East Greenland, Iceland, Faroese and Norwegian waters should be made in order to review whether present stock areas are appropriate for assessment purposes. Such a compilation should be evaluated outside NWWG, eg. by WGSIM.

A number of issues on the quality of the input biomass indices to the present assessment model were raised last year. The Icelandic CPUE series that is based on the principal trawler fleet is assumed to have undergone marked changes with respect to management regulations and spatial distribution. The possibility to estimate these effects by standardization of catch rates should be explored. Similar analyses should be conducted on the remaining CPUE series, in order to evaluate them as indicative of biomass development.

The present assessment model, a stock production model in Bayesian framework, is criticized for its behavior in relation to the biomass indices. The models use of process error and sensitivity to various priors should be further scrutinized. A generic review of the model's performance could potentially be by WGMG.

At the benchmark in 2013 (WKBUT) an alternative assessment model, Gadget, was presented. The group encouraged this model to be fully developed in order to replace the stock production model. Presently the Gadget model is not fully developed and several issues need further exploration (see section 17.7).

Ageing of Greenland halibut ceased for many of the marine institutes in Greenland, Iceland, Faroe Island and Norway around 2000 due to reading difficulties and lack of calibration. However, IMR in Norway have now developed a promising method to age Greenland halibut. With the aim to revert to an age based assessment, it is suggested that cooperation between institutes is initiated and an inter calibration protocol is established. This task is a major task since a number of sampled otoliths back in time have to be read, and the time horizon for this project is therefore expected to exceed the near future. NWWG recommends an ageing workshop to be conducted in collaboration with AFWG.

The above issues on input data and model approaches are suggested to be solved at a meeting in the autumn with a minimum attendance of experts from Greenland, Iceland and Faroe Islands. Such a meeting is expected to be coordinated by the relevant institutes. Eventual review of stock id and methods from WGSIM and WGMG should be evaluated externally by ICES along with any recommendations from the expert meeting in autumn prior to next year's NWWG.

Table 17.2.1 GREENLAND HALIBUT. Nominal landings (tonnes) by countries, in Sub-areas V, VI, XII and XIV 1981-2013, 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]	2010 [1]	2011 [1]	2012 [1]	2013 [1]	2014 [1]
Denmark	-	-	-	-	-	-	-
Estonia	-	-	-	-	-	-	429
Faroe Islands	-	270	1,408	1,705	2,811	2,788	3,393
France	114	-	-	9	67	133	-
Germany	4,846	427	5,287	5,782	4,620	3,814	3,701
Greenland	-	2,819	-	3,415	5,239	3,251	1,897
Iceland	-	-	13,293	13,192	13,749	14,859	9,861
Ireland	-	-	-	-	-	-	-
Lithuania	566		-	-	97	-	-
Norway	639	124	233	176	856	614	764
Poland	1,354	988	960	-	786	-	-
Portugal	-	-	-	-	-	-	-
Russia	799	762	1,070	1,095	1,168	1,369	587
Spain	-	-	-	-	-	-	67
United Kingdom	422	581	577	323	12	95	44
Total	9,744	5,974	22,901	25,618	29,405	26,923	20,743
Working Group estimate	24,481	28,197	25,995	26,347			21,069

1) Provisional data

Table 17.2.2 GREENLAND HALIBUT. Nominal landings (tonnes) by countries, in Division Va 1981-2011, 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 Scotland	3	5	12	16	5	2	27	1	
UK									1
Total	11,138	14,607	2,437	2,352	20,438	15,527	13,241	11,817	945
Working Group estimate		14,607	16,752	19,714	20,415	15,477	13,172	11,817	10,525

Country	2008 [1]	2009 [1]	2010 [1]	2011 [1]	2012 [1]	2013 [1]	2014 [1]
Faroe Islands			37	123	585	103	30
Germany	4	423	797	576	269	386	587
Greenland				157		92	
Iceland			13,293	13,192	6,459	14,859	9,859
Norway							
Russia	4						
Poland		270					
UK	179						
Total	187	693	14,128	14,048	7,313	15,440	10,476
Working Group estimate	11,859	15,782	14,128	14,048	7,313	15,440	10,476

1) Provisional data

2) Includes 223 t catch by Norway.

Table 17.2.3 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	4,750	3,660
France	...	...	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	3,825
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	1,116
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	1,060

Country	2008	2009	2010	2011	2012	2013	2014
Denmark							
Faroe Islands			1,037	1,476	2,149	2,560	2,953
France	36		35	1	13	20	
Germany							
Iceland							
Ireland							
Norway	1	1	5				3
UK (Engl. and Wales)							
UK (Scotland)							
United Kingdom	32	117	336	11		2	2
Total	69	118	1,413	1,489	2,162	2,582	2,958
Working Group estimate	1,759	1,739	1,413	1,489	2,162	2,582	2,958

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 17.2.4 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	5,940
Working Group estimate	736 [2]	875 [3]	1,176 [4]	2,249 [5]	3,125 [6]	5,077 [7]	7,283	8,558	

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	3,047	3,243	2,750	2,019	2,925	5,159	5,144	4,298	4,702
Greenland	200 [1,4]	1,740	1,553	1,887	1,459				
Iceland	93	30	14,280	16,947	6				
Ireland			7						
Norway	1,100	1,161	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	4,806	6,627	20,316	22,889	8,720	11,991	6,515	7,013	5,202
Working Group estimate	5376	6958	6,588 [6]	6,750 [6]	8,017	9,854	10,185	8,589	10,261

Country	2008 [1]	2009 [1]	2010 [1]	2011 [1]	2012 [1]	2013 [1]	2014 [1]
Estonia							429
Faroe Islands		270	333		77	125	409
Germany	4,842	4	4,490	5,206	4,351	3,428	3,114
Greenland		2,819		3,258	5,239	3,159	1,897
Iceland					7,290		3
Ireland							
Norway	637	29	226	164	853	613	761
Poland	1,354	718	960		786		
Portugal							
Russia	763		1,070	1,095	1,168	1,369	587
Spain							
United Kingdom	131	452	229	309	1	1	
Total	7,727	4,292	7,308	10,032	19,765	8,694	7,200
Working Group estimate	9,102	9,805	10,402	10,761			7,526

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 17.2.5 GREENLAND HALIBUT. Nominal landings (tonnes) by countries in Sub-area XII, as officially reported to the ICES and estimated by WG

Country	1996	1997	1998	1999	2000	2001	2002	2003 [1]	2004 [1]
Faroe Islands		47					40		
France					1			4	30
Ireland						49			
Lithuania								2	1
Poland						2		2	1
Spain [2]	2	42	67	137	751	1338	28	730	1145
UK					7	5			
Russia									
Norway	2				553	500	316	201	119
Estonia									
Total	4	89	67	137	1,312	1,894	384	939	1,296
WG estimate									

Country	2005 [1]	2006 [1]	2007 [1]	2008 [1]	2009 [1]	2010 [1]	2011 [1]	2012 [1]	2013 [1]	2014 [1]
Faroe Islands							106			
France										
Ireland										
Lithuania		2	3	566				97		
Poland										
Spain [2]	501									67
UK	3									
Russia		46	1		762					
Norway					94					
Estonia		2								
Total	504	50	4	566	856	0	106	97	0	67
WG estimate	504	50	4	566	856	0	106	97	0	67

[1] Provisional data

[2] Based on estimates by observers onboard vessels

Table 17.2.6 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]	2010 [1]	2011 [1]	2012 [1]	2013 [1]	2014 [1]
Estonia	5	1								
Faroe Islands						1			0	1
France		22	8	114		38	8	54	113	
Poland										
Spain [2]	3	33								
UK	217	74	15	80	12	11	3	11	93	42
Russia		1		32						
Norway		3		1	3	2	7	3	1	0
Lithuania				968				2		
Total	225	134	23	1195	15	52	18	70	207	43
WG estimate	225	134	23	1195	15	52	18	70	207	43

[1] Provisional data

[2] Based on estimates by observers onboard vessels

Table 17.3.1. CPUE indices of trawl fleets in Div Va, Vb and XIVb as derived from GLM multiplicative models.

area	year	cpue	% change in CPUE between years	landings	relative derived effort	% change in effort between years
Iceland Va	1985	1.00		29,197	100	
	1986	0.99	-1	31,027	108	8
	1987	0.96	-3	44,659	148	38
	1988	0.91	-5	49,379	117	-21
	1989	1.05	16	59,272	103	-12
	1990	0.75	-29	37,308	88	-15
	1991	0.73	-2	35,413	97	10
	1992	0.67	-9	31,978	100	2
	1993	0.54	-20	34,134	133	33
	1994	0.44	-18	28,608	102	-23
	1995	0.36	-19	27,391	118	15
	1996	0.30	-15	22,073	95	-20
	1997	0.32	5	16,792	72	-24
	1998	0.50	57	10,595	40	-44
	1999	0.54	9	11,138	97	140
	2000	0.58	7	14,607	122	27
	2001	0.59	2	16,752	113	-8
	2002	0.48	-19	19,714	146	29
	2003	0.35	-26	20,415	139	-4
	2004	0.30	-16	15,477	90	-36
	2005	0.27	-9	13,172	93	4
	2006	0.37	33	11,817	67	-28
	2007	0.46	25	10,525	71	6
	2008	0.39	-14	9,580	106	49
	2009	0.41	5	15,782	157	48
	2010	0.41	-1	13,565	87	-45
	2011	0.43	4	14,048	99	15
	2012	0.44	3	7,312	51	-49
	2013	0.45	2	15,439	207	310
	2014	0.41	-8	10,475	74	-64
Greenland, XIVb	1991	1.00		875	100	0
	1992	0.91	-9	1,176	148	48
	1993	2.48	172	2,249	70	-52
	1994	3.19	29	3,125	108	54
	1995	3.31	4	5,077	157	45
	1996	3.34	1	7,283	142	-9
	1997	3.45	3	8,558	114	-20
	1998	3.38	-2	5,940	71	-38
	1999	2.54	-25	5,376	120	70
	2000	2.15	-15	6,958	153	27

	2001	2.22	3	7,216	101	-34
	2002	2.40	8	6,621	85	-16
	2003	2.36	-2	8,017	123	45
	2004	2.30	-2	9,854	126	2
	2005	3.18	38	10,185	75	-41
	2006	3.27	3	8590	82	10
	2007	3.11	-5	10261	126	54
	2008	3.15	1	8,952	86	-32
	2009	2.60	-17	10,567	143	66
	2010	2.73	5	10,402	94	-35
	2011	2.68	-2	10,761	105	13
	2012	3.17	18	12,475	98	-7
	2013	2.95	-7	12,476	107	9
	2014	3.14	6	7,526	57	-47
Faroe Islands, Vb	1991	1.00		1,662	100	34
	1992	0.34	-21	2,269	397	297
	1993	0.24	-11	4,434	282	-29
	1994	0.23	-2	5,225	121	-57
	1995	0.16	-28	3,832	103	-15
	1996	0.17	4	6,469	160	55
	1997	0.19	12	4,870	67	-58
	1998	0.14	-34	3,825	112	67
	1999	0.16	12	4,265	96	-15
	2000	0.17	11	5,079	109	14
	2001	0.20	19	3,245	55	-50
	2002	0.16	-24	2,694	104	91
	2003	0.10	-29	2,426	141	35
	2004	0.08	-12	1,771	89	-37
	2005	0.09	4	892	48	-46
	2006	0.10	19	873	83	72
	2007	0.12	16	1,060	107	28
	2008	0.18	60	1735	100	-6
	2009	0.21	26	1760	107	7
	2010	0.17	-21	1,413	87	-19
	2011	0.31	65	1,489	98	13
	2012	0.30	-4	2163	59	-40
	2013				148	153
	2014			2,958		

Table 17.6.1. 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 (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	1.74	-
1987	46.622	1.69	-
1988	51.118	1.60	-
1989	61.396	1.86	-
1990	39.326	1.32	-
1991	37.950	1.29	-
1992	35.487	1.17	-
1993	41.247	0.94	-
1994	37.190	0.77	-
1995	36.288	0.63	-
1996	35.932	0.53	65.72
1997	30.309	0.56	90.24
1998	20.382	0.88	90.96
1999	20.371	0.96	89.75
2000	26.644	1.03	100.56
2001	27.291	1.04	109.96
2002	29.158	0.84	83.53
2003	30.891	0.62	52.10
2004	27.102	0.53	36.64
2005	24.249	0.48	55.92
2006	21.432	0.64	38.78
2007	20.957	0.81	49.76
2008	22.169	0.69	57.57
2009	27.349	0.73	79.77
2010	25.995	0.72	59.03
2011	26.424	0.75	70.97
2012	29.309	0.77	81.89
2013	27.045	0.79	84.29
2014	21.069	0.72	75.99
2015*	21.000		

*estimated

Table 17.6.2. 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 17.6.3. 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)	33.00	10.99	26.22	32.39	38.86
K (ktons)	896	250	719	885	1059
r	0.16	0.07	0.11	0.15	0.20
q_{cpue}	0.003	0.001	0.002	0.003	0.003
q_{Survey}	0.26	0.10	0.19	0.24	0.31
P_{1985}	1.56	0.12	1.48	1.56	1.65
P_{2014}	0.72	0.10	0.65	0.71	0.78
σ_{cpue}	0.09	0.02	0.08	0.09	0.11
σ_{Survey}	0.19	0.04	0.16	0.18	0.21
σ_P	0.16	0.03	0.14	0.16	0.17

Table 17.6.4. Model diagnostics: residuals (% of observed value), probability of getting a more extreme observation (p.extreame; see text for explanation).

	CPUE		Survey	
Year	resid (%)	Pr	resid (%)	Pr
1985	-2.02	0.56	-	-
1986	-0.93	0.53	-	-
1987	-0.60	0.52	-	-
1988	-1.37	0.54	-	-
1989	1.93	0.44	-	-
1990	-0.52	0.52	-	-
1991	-2.50	0.58	-	-
1992	-3.25	0.60	-	-
1993	0.20	0.49	-	-
1994	0.78	0.48	-	-
1995	3.85	0.38	-	-
1996	12.09	0.16	-14.44	0.76
1997	15.76	0.10	-36.21	0.96
1998	-3.56	0.62	-11.43	0.72
1999	-1.51	0.55	0.31	0.49
2000	-1.39	0.55	-3.90	0.58
2001	-3.17	0.61	-13.32	0.75
2002	-1.48	0.55	-6.12	0.62
2003	0.52	0.48	13.49	0.25
2004	-1.59	0.55	29.83	0.07
2005	7.84	0.25	-12.10	0.73
2006	-8.69	0.76	36.31	0.04
2007	-14.98	0.89	28.77	0.08
2008	-0.28	0.50	12.53	0.27
2009	0.48	0.48	-13.21	0.75
2010	-1.12	0.54	14.22	0.24
2011	-0.20	0.51	0.69	0.49
2012	1.67	0.45	-9.19	0.68
2013	0.22	0.50	-10.47	0.70
2014	4.00	0.37	-5.97	0.62

Table 17.6.5. Upper: stock status for 2014 and predicted to the end of 2015. Lower: predictions for 2016 with catch options from 0 to 30 ktons and the catch option corresponding to Fmsy.

Status	2014**	2015*
Risk of falling below Blim (0.3BMSY)	0%	0%
Risk of falling below BMSY	100%	95%
Risk of exceeding FMSY	47%	44%
Risk of exceeding Flim (1.7FMSY)	10%	11%
Stock size (B/Bmsy), median	0.71	0.70
Fishing mortality (F/Fmsy),	1.30	0.94
Productivity (% of MSY)	91%	91%

*Predicted catch = 21ktons

**Catches=21069 t

Catch option 2016(ktons)	0	5	10	15	20	22	30
Risk of falling below Blim (0.3BMSY)	0%	0%	0%	0%	0%	0%	0%
Risk of falling below BMSY	85%	86%	87%	88%	89%	90%	93%
Risk of exceeding FMSY	-	1%	6%	18%	38%	50%	79%
Risk of exceeding Flim (1.7FMSY)	-	0%	1%	4%	10%	15%	38%
Stock size (B/Bmsy), median	0.76	0.75	0.74	0.74	0.72	0.71	0.65
Fishing mortality (F/Fmsy),	0.00	0.21	0.42	0.64	0.87	1.00	1.46
Productivity (% of MSY)	94%	94%	93%	93%	92%	91%	88%

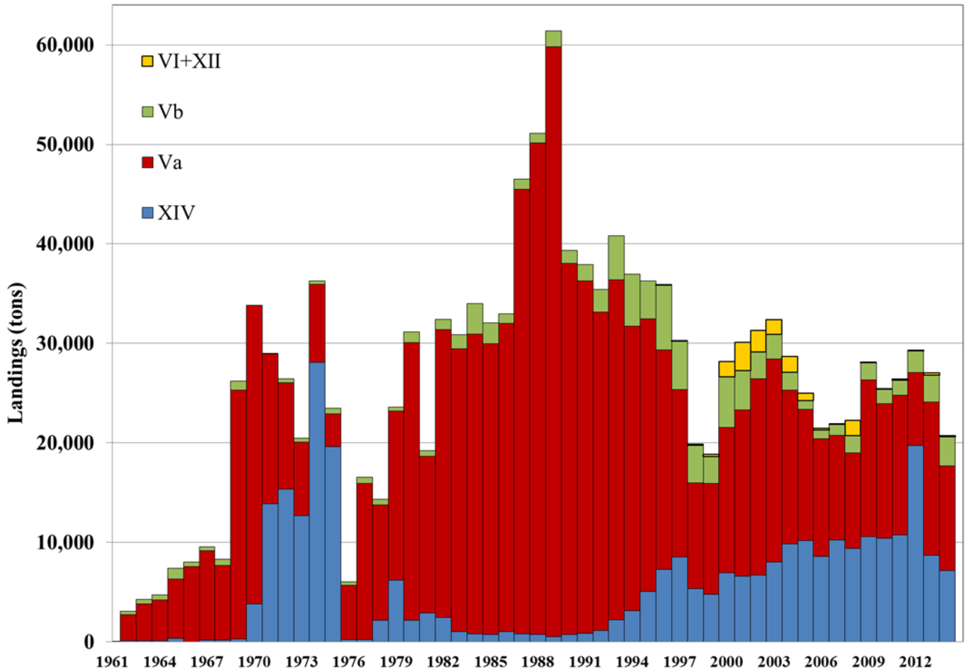


Figure 17.2.1. Landings of Greenland halibut in Divisions V, XI and XIV. As the landings within Icelandic waters, since 1976, have not officially been separated and reported according to the defined ICES statistical areas, they are set under area Va by the North Western Working Group. In 2012 Icelandic landings in XIV were recorded in XIV, while for remaining years all landings are recorded in Va.

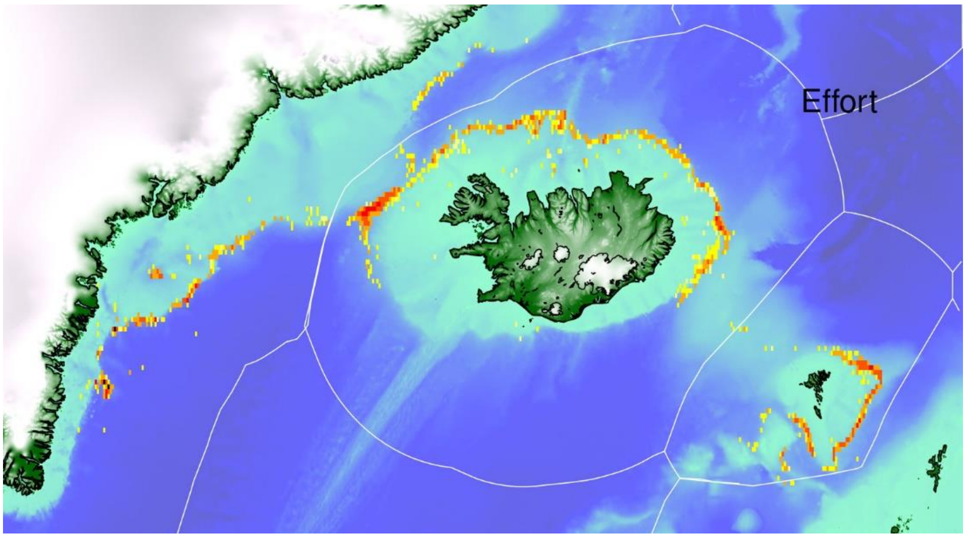


Figure 17.2.2 Greenland halibut V+XIV. Distribution of fishing effort in 2014. 500m and 1000 m depth contours are shown.

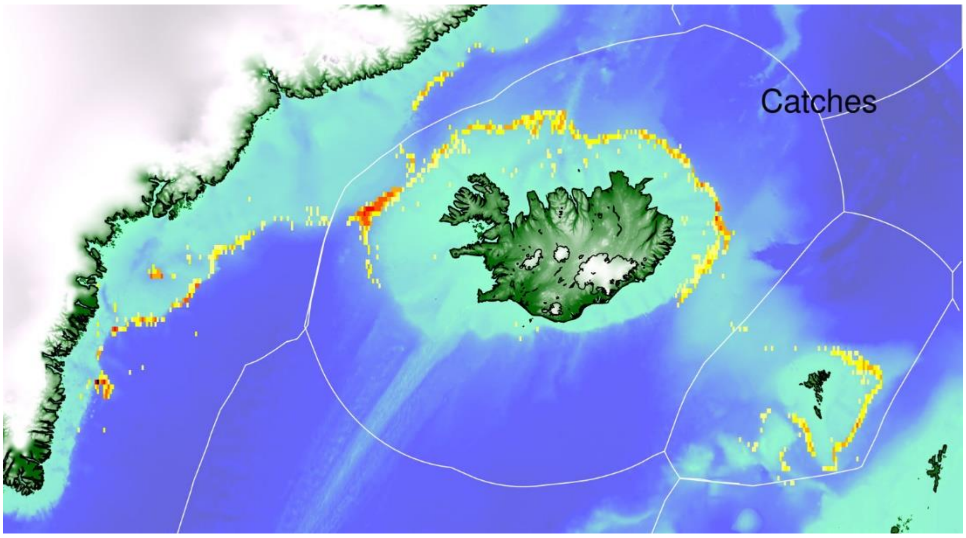


Figure 17.2.3. Greenland halibut V+XIV. Distribution of catches in the fishery in 2014. 500m and 1000 m depth contours are shown

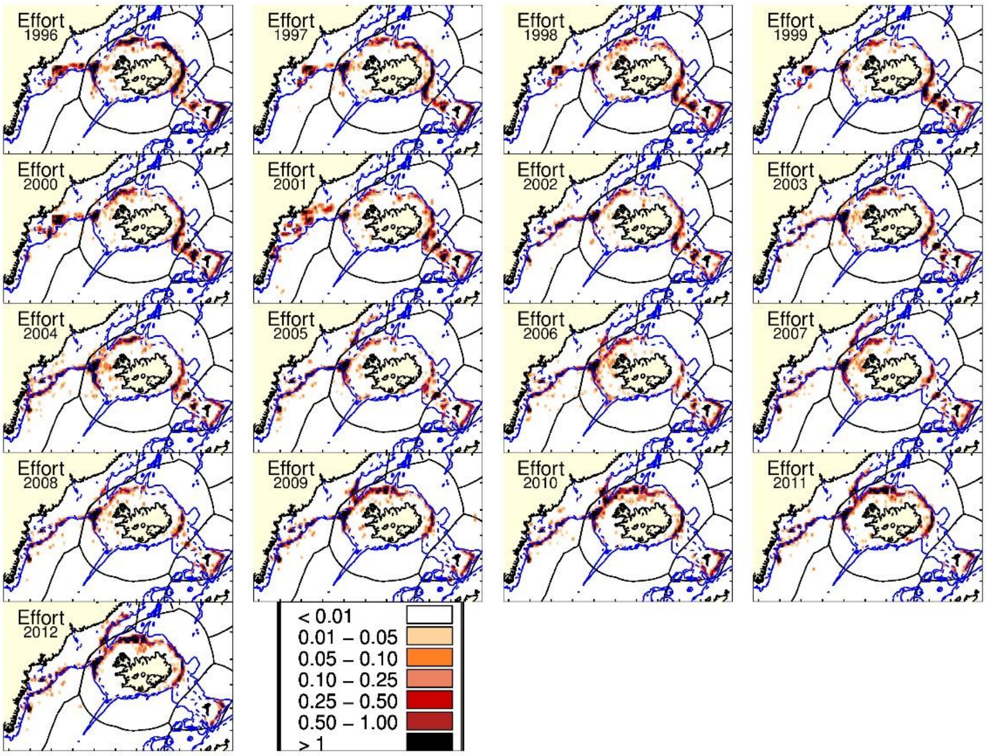


Figure 17.2.4. Greenland halibut V+XIV. Distribution of total fishing effort 1991-2012. The 500m and 1000 m depth contours are shown.

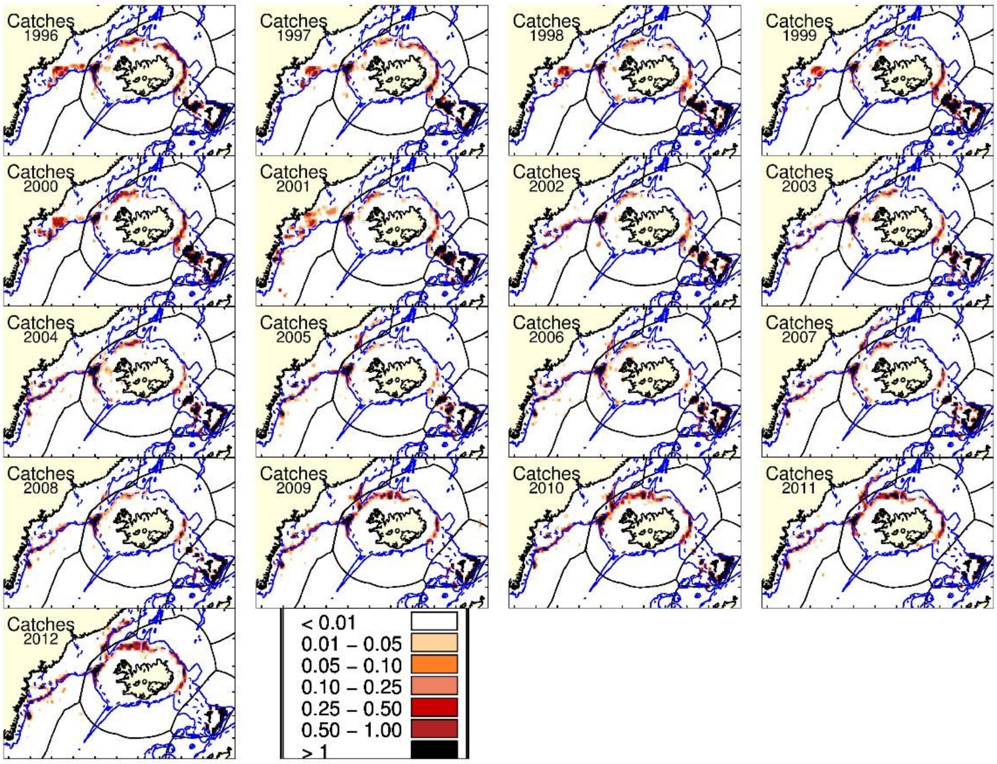


Figure 17.2.5. Greenland halibut V+XIV. Distribution of total catches in the fishery 1991-2012 500m and 1000 m depth contours are shown.

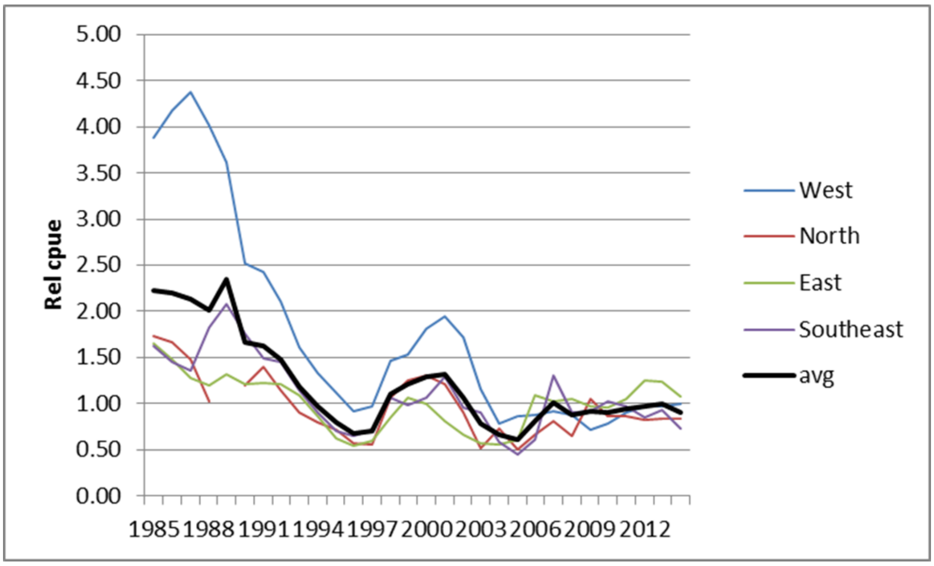


Figure 17.3.1. Standardised CPUEs from the Icelandic trawler fleet in Va. Area 1-4 are west, north, east and south-east. The average index of the four areas are used as biomass indicator input to the stock production model.

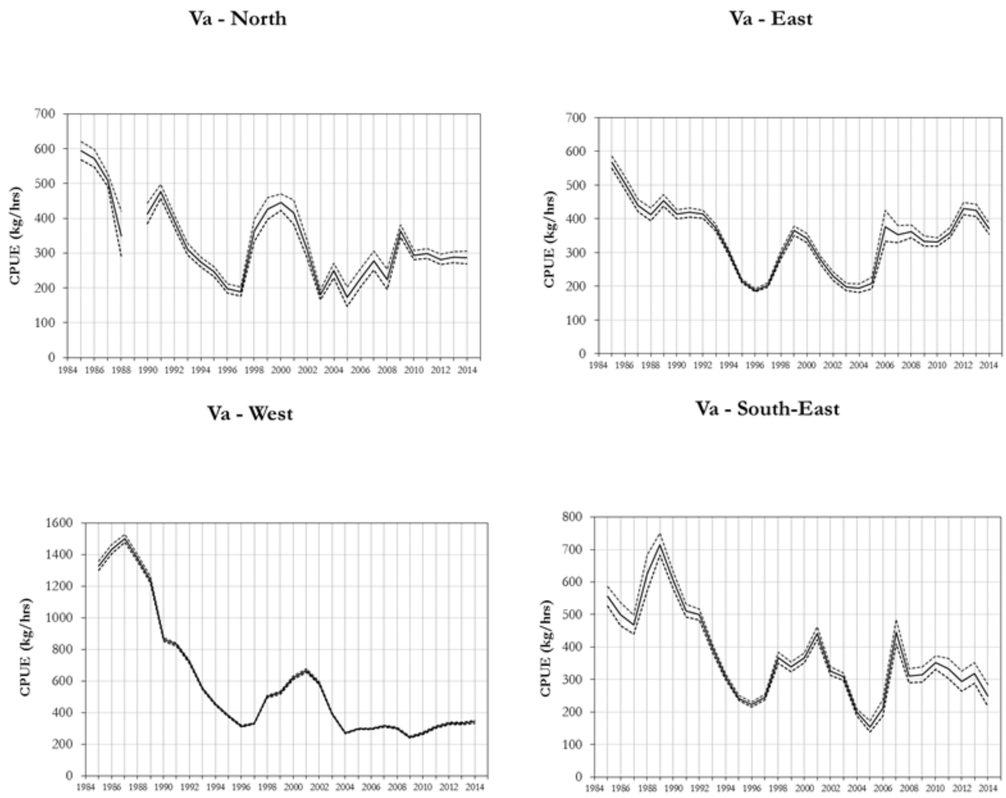


Figure 17.3.2 Standardised CPUE from the Icelandic trawler fleet in Va by four main fishing areas in Va. 95% CI indicated.

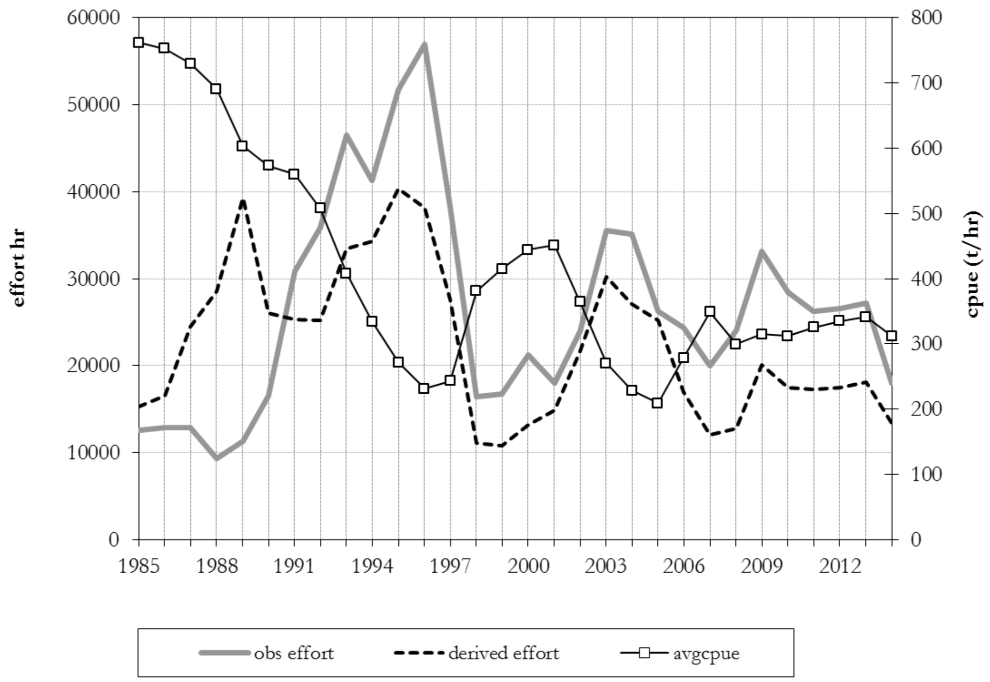


Figure 17.3.3. Standardised CPUE, observed and derived effort from Icelandic trawl fishery.

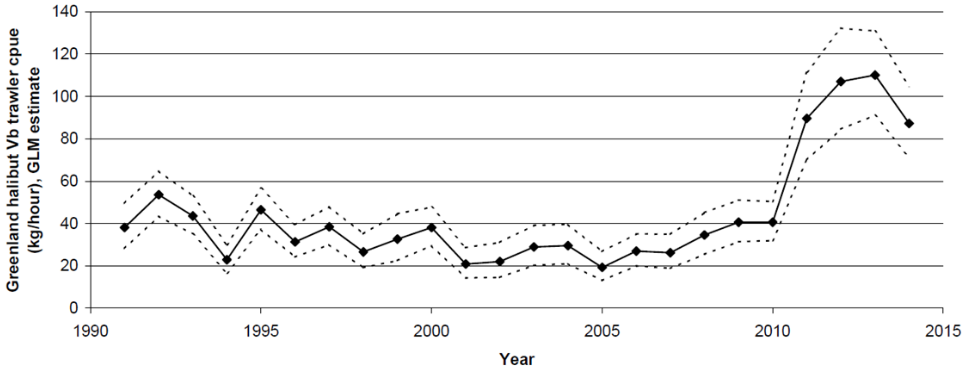


Figure 17. 3.4. Standardised CPUE from the Faroese trawler fleet. 95% CI indicated

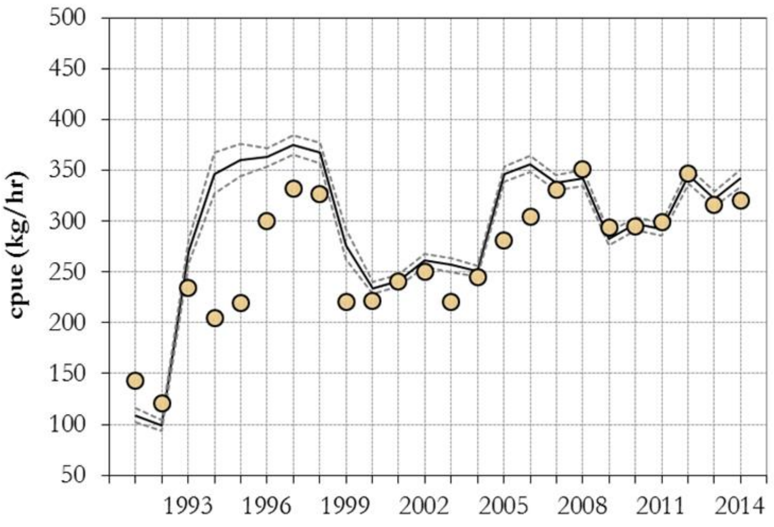


Figure 17.3.6. Standardised CPUE from trawler fleets in XIVb. 95% CI indicated. Points are raw observations.

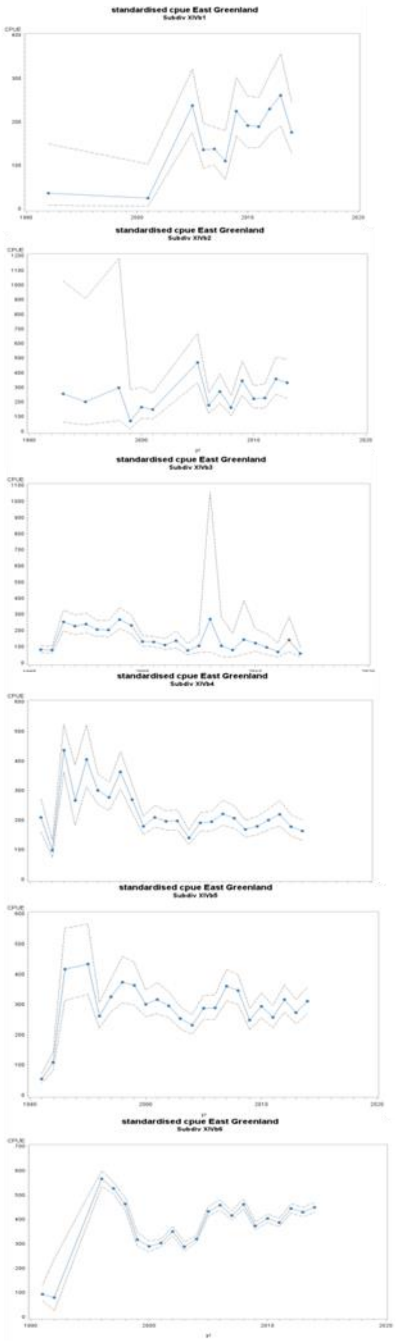


Figure 17.3.7. Standardised CPUE from trawler fleets in XIVb shown by subdivisions in XIVb in a north-south direction. 95% CI indicated.

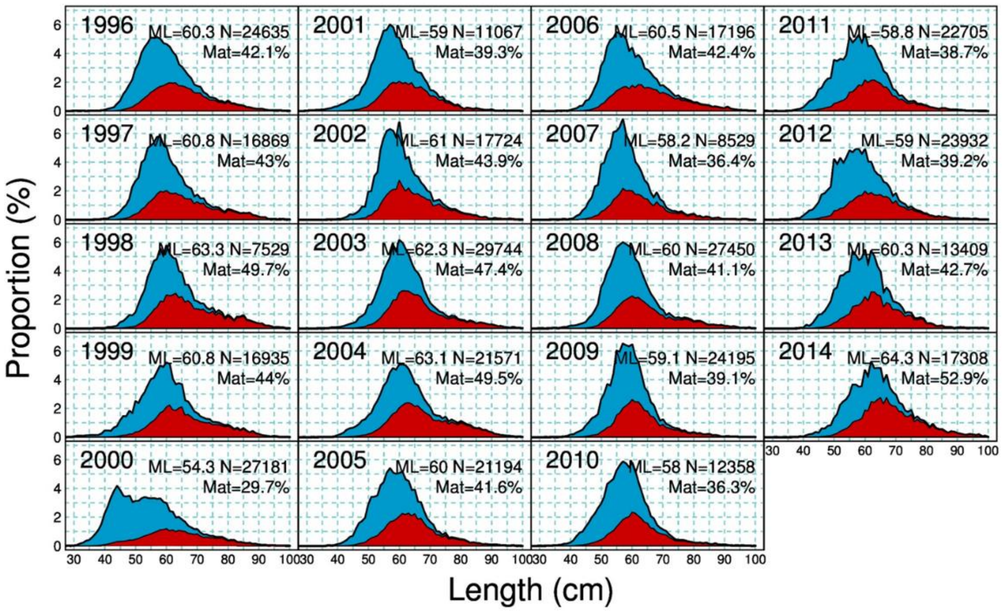


Figure 17.4.1. Length distributions from the commercial trawl fishery in the western fishing grounds of Iceland (Va) in the years 1996-2012. Blue indicate males and red indicates females.

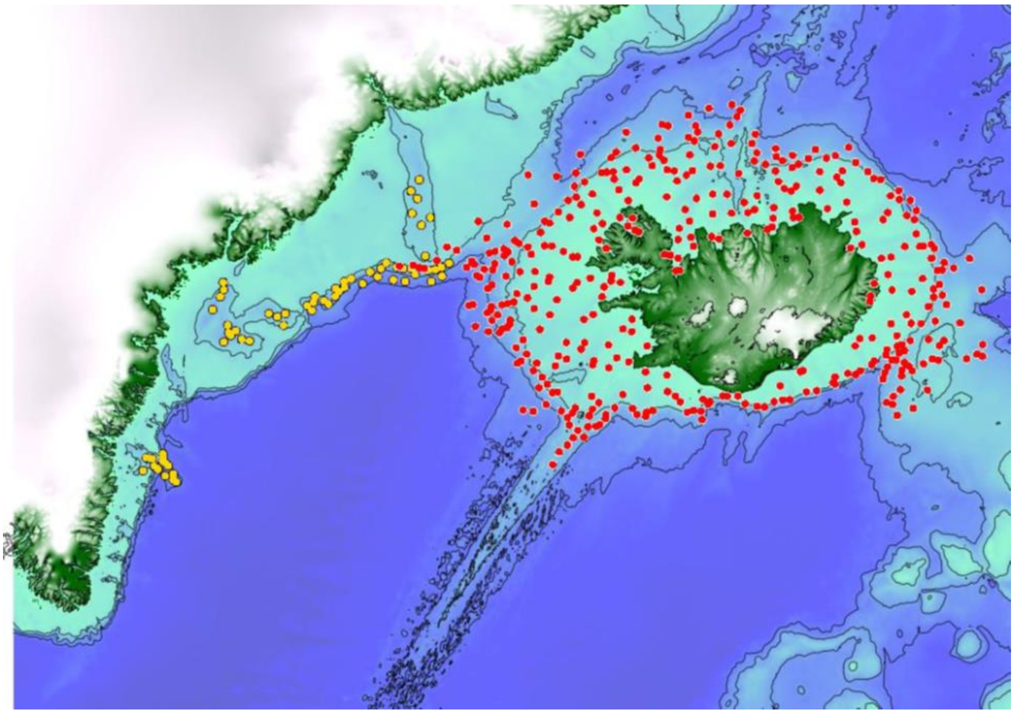


Figure 17.5.1. Stations covered by scientific surveys in XIV+V indicated as station positions in 2013 by the Greenland (n=76) and Iceland (n=203).

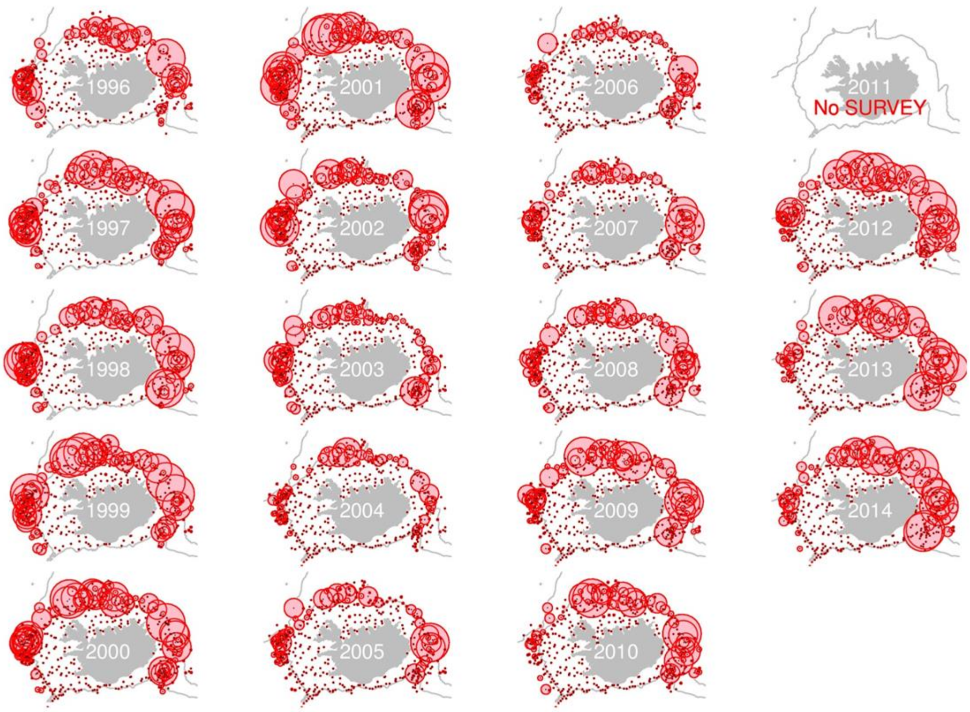


Figure 17.5.2. Distribution of Greenland halibut catches from the Icelandic fall survey since 1996. No survey was conducted in 2011.

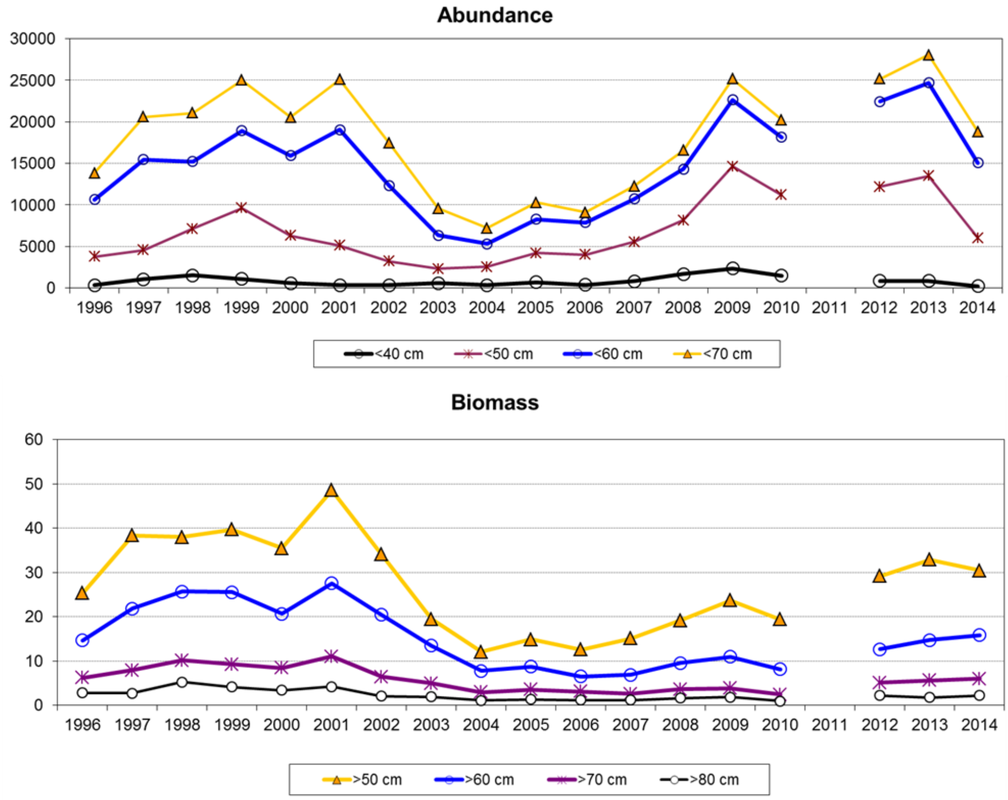


Figure 17.5.3. Greenland halibut in Icelandic fall groundfish survey. No survey was conducted in 2011.

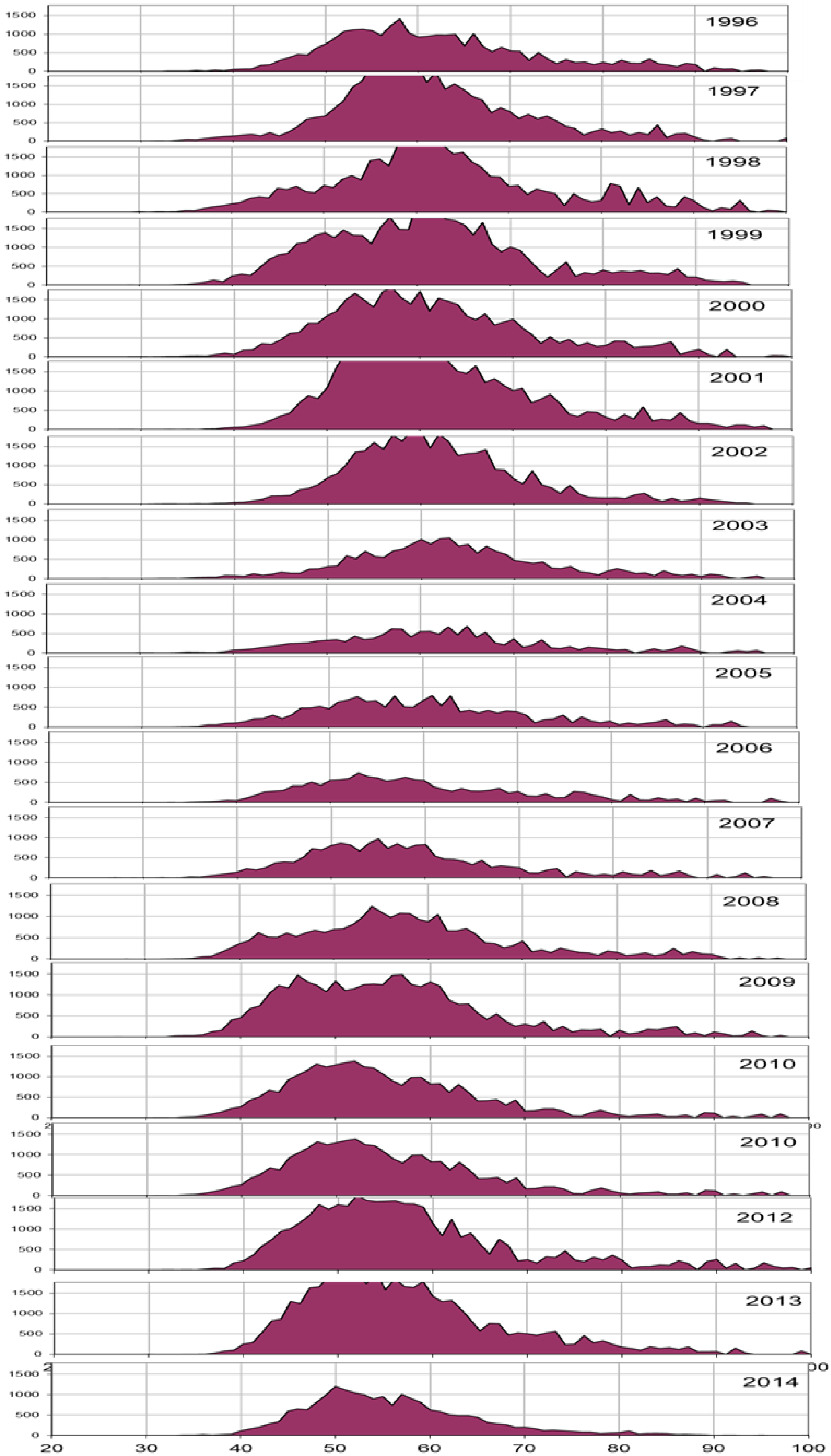


Figure 17.5.4. Abundance indices by length for the Icelandic fall survey 1996-2014. No survey was conducted in 2011.

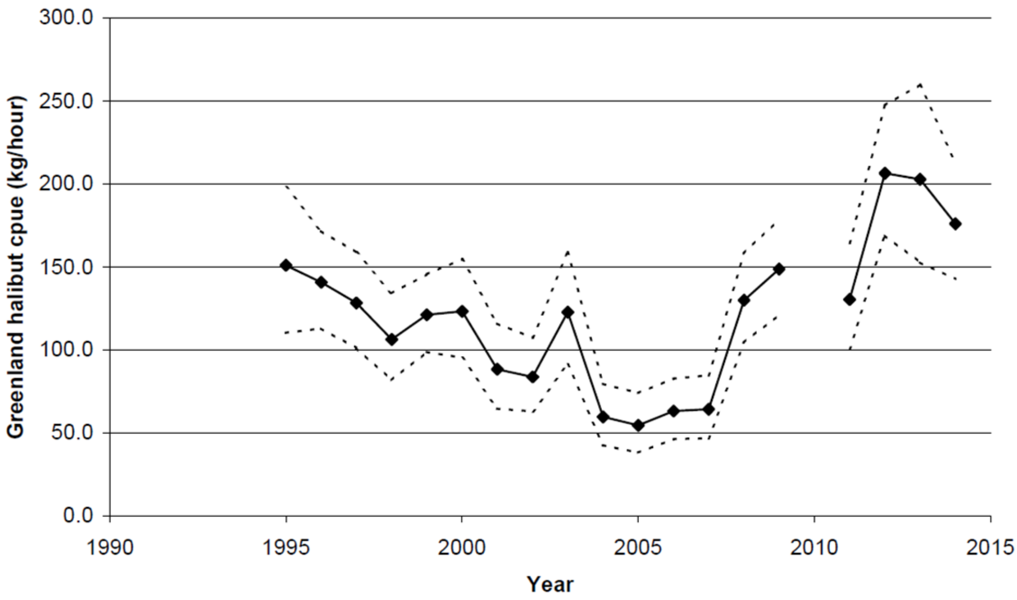


Figure 17.5.5. Catch rates from a combined survey/fisherman's survey in Vb. Estimates are from a GLM model.

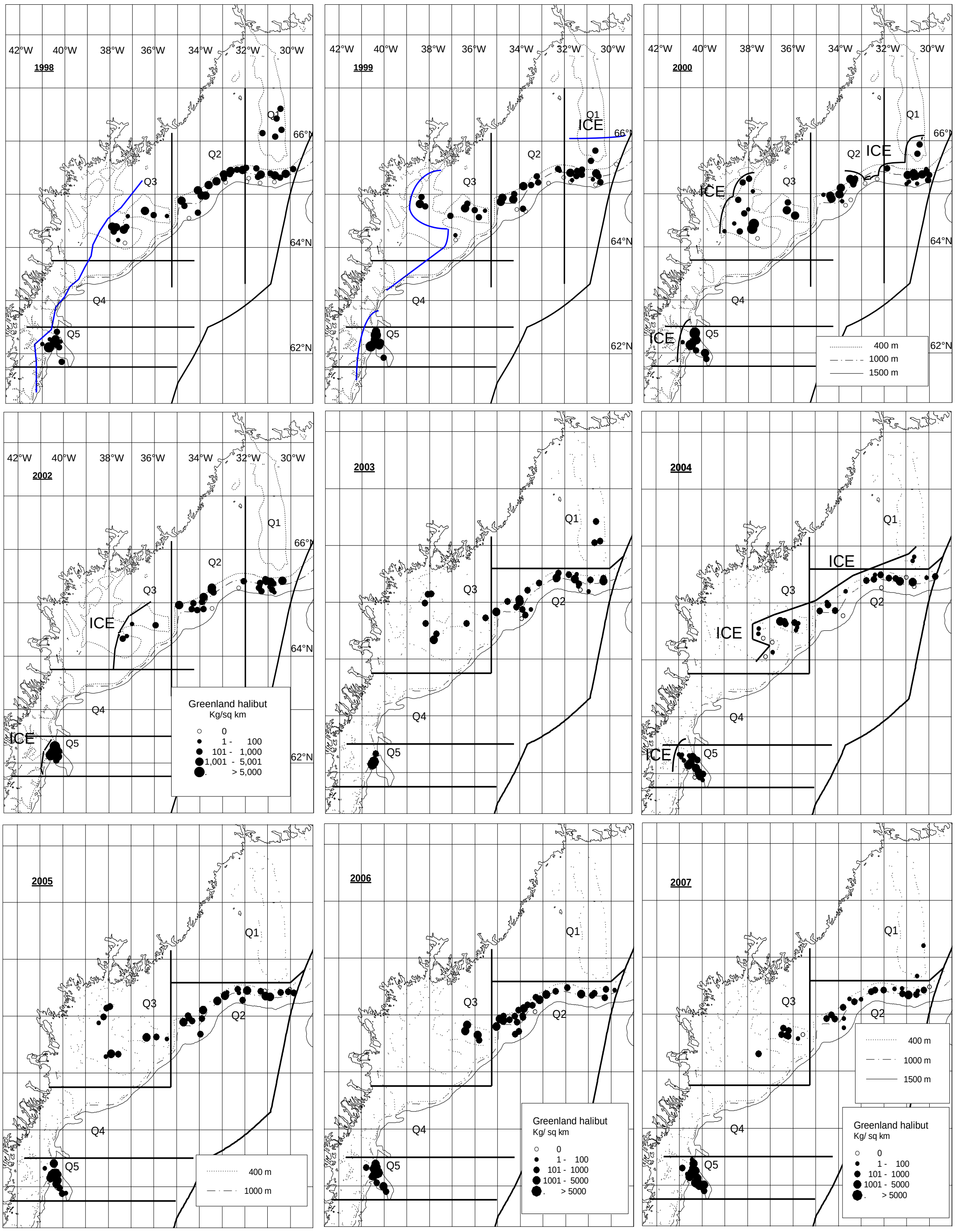


Figure 17.5.6. Distribution of catches of Greenland halibut at East Greenland in 1998 – 2014 in the Greenland deep-water survey.

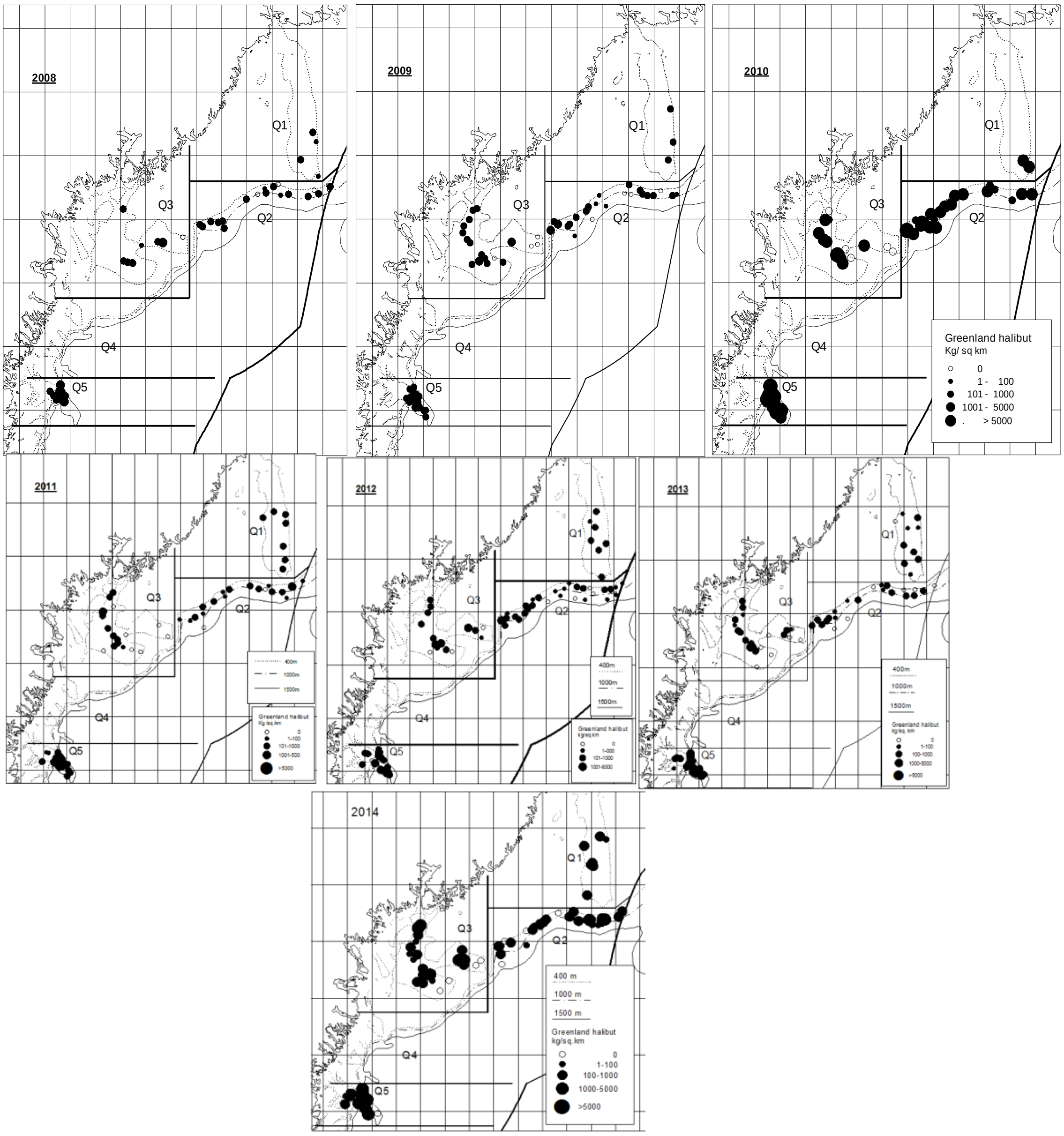


Figure 17.5.6 continued. Distribution of catches of Greenland halibut at East Greenland in 1998 – 2014 in the Greenland deep-water survey.

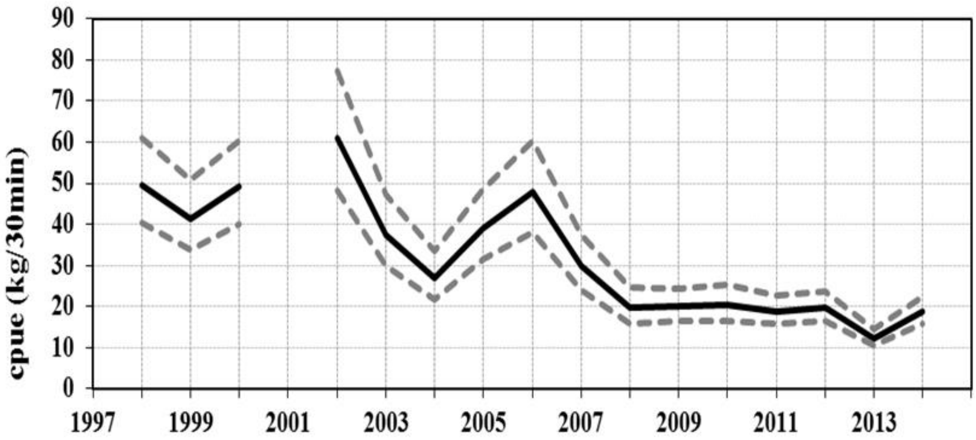


Figure 17.5.7. Standardised catch rates from the Greenland survey.(95% CI indicated.)

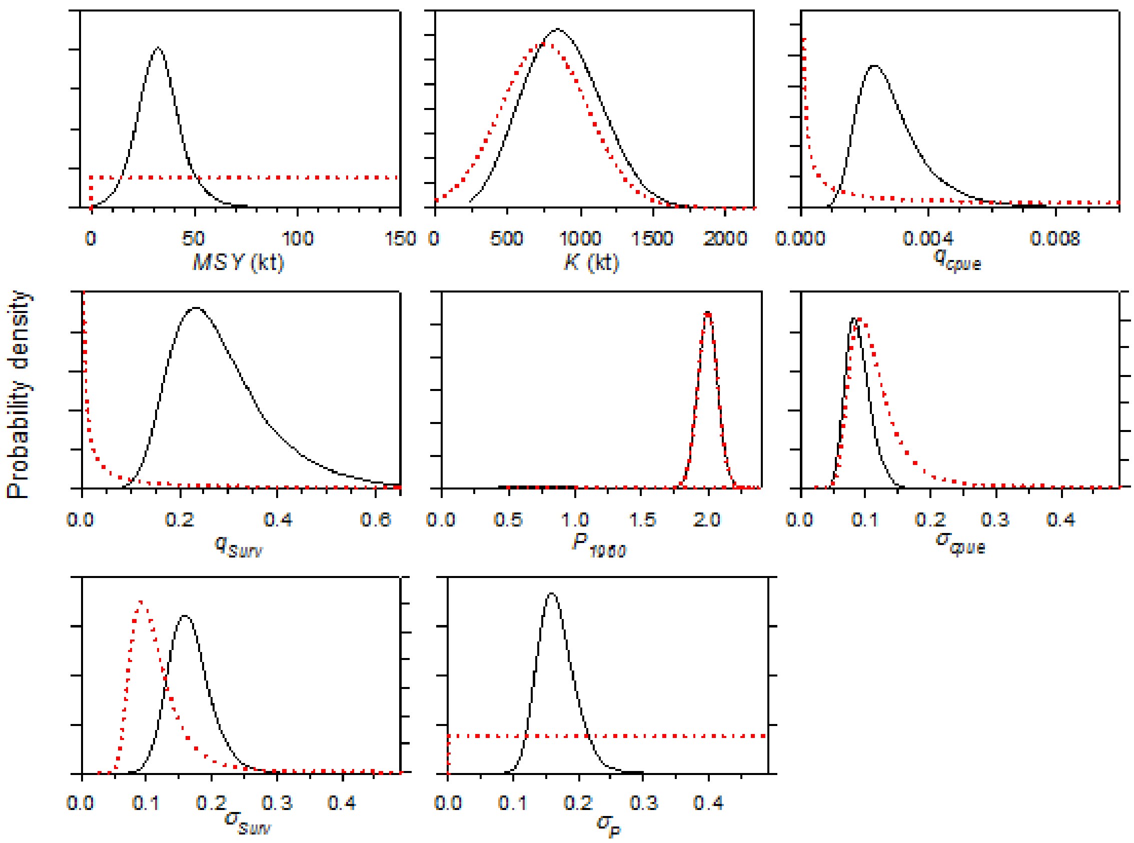


Figure 17.6.1. Probability density distributions of model parameters: estimated posterior (solid line) and prior (broken line) distributions.

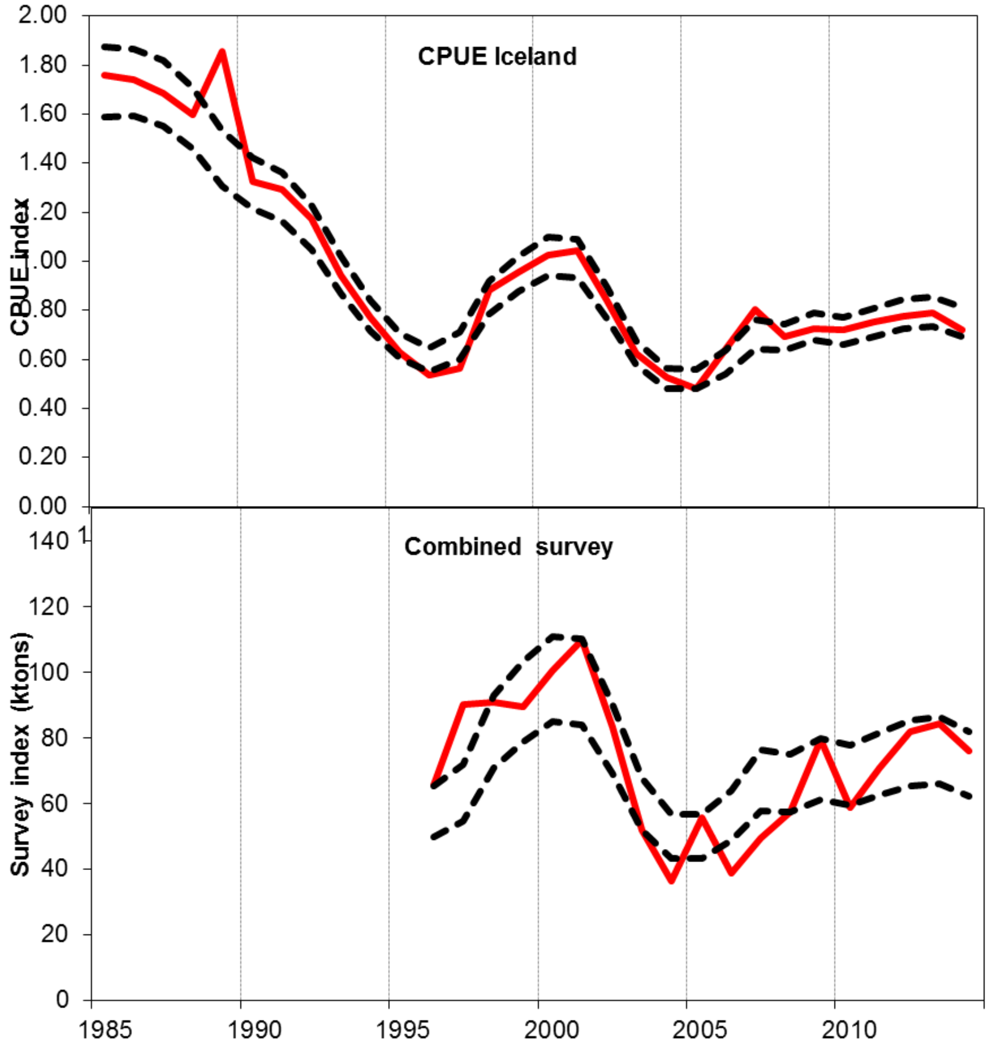


Figure 17.6.2. Observed (red curve) and predicted (dashed lines) series of the two biomass indices input to the model. Dashed lines are inter-quartile range of the posteriors.

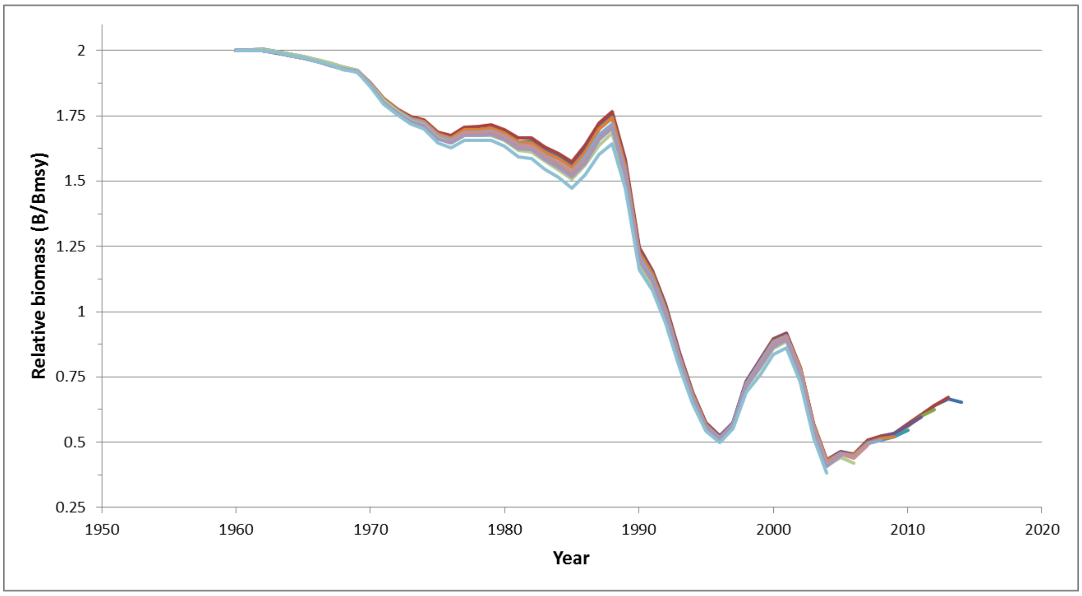


Figure 17.6.3. Retrospective plot of median relative biomass (*B/B$_{msy}$*). Relative biomass series are estimated by consecutively leaving out from 0 to 9 years of data.

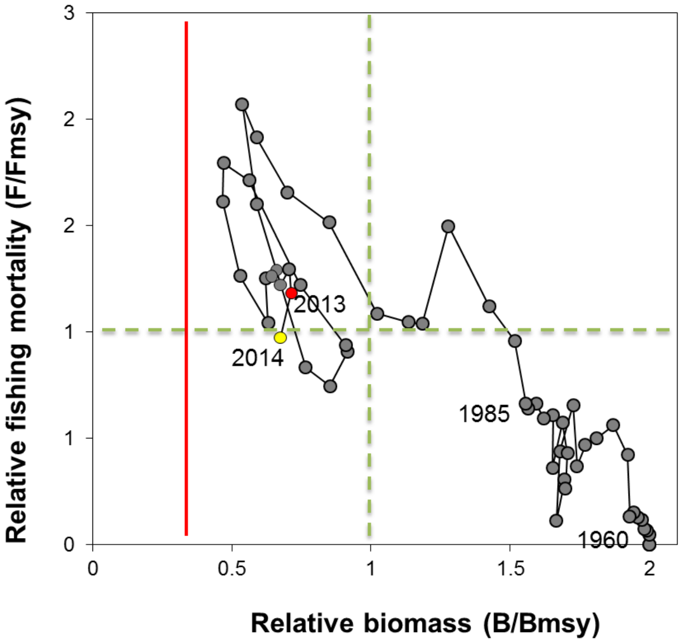


Figure 17.6.4. Stock trajectory. Estimated annual median biomass-ratio (B/BMSY) and fishing mortality-ratio (F/FMSY) 1985-2014. B$_{lim}$ indicated by red line.

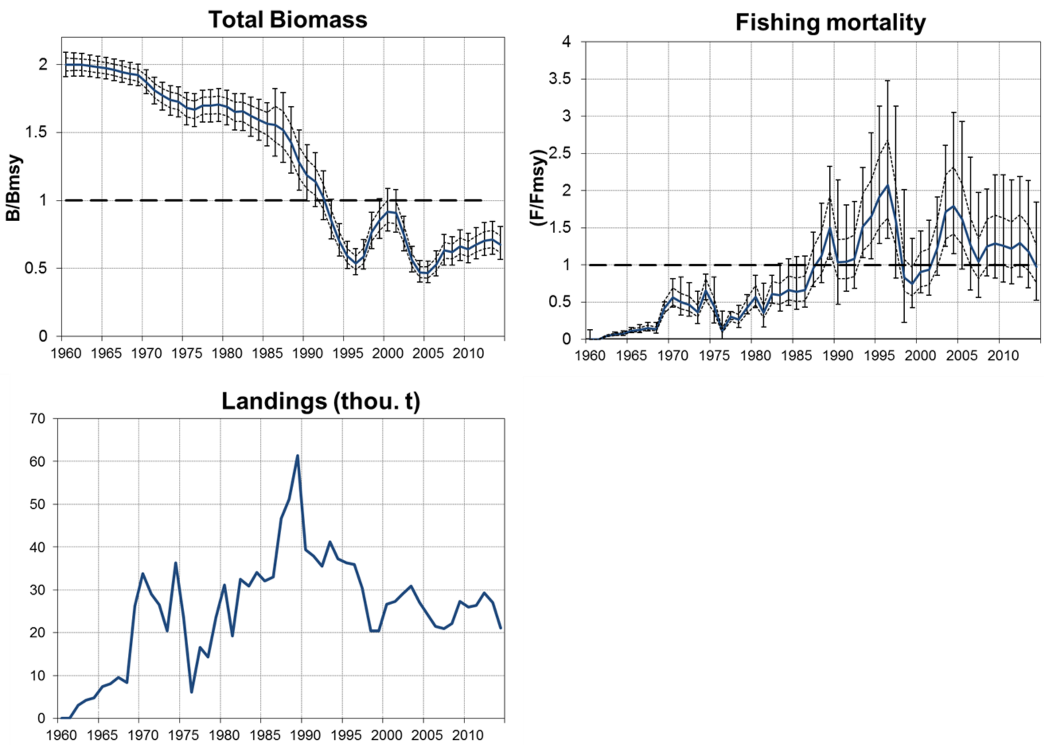


Figure 17.6.5. Stock summary, upper panel right: fishing mortality (F/Fmsy), left: total biomass (B/Bmsy) and lower panel is landings since start of the fishery.

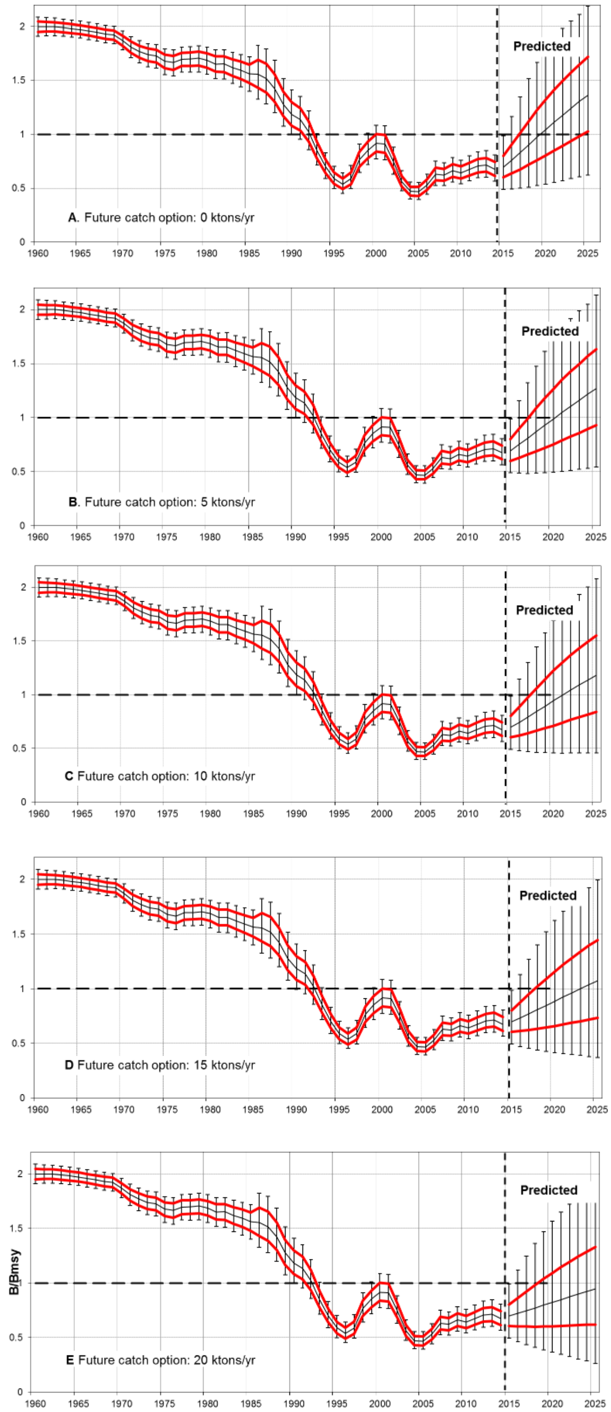


Figure 17.6.6 Estimated time series of relative biomass (B_t/B_{msy}) under different catch option scenarios: 0, 5, 10, 15 and 20 kt from upper to lower panel. Bold red lines are inter-quartile ranges and the solid black line is the median; the error bars extend to cover the central 90 per cent of the distribution.

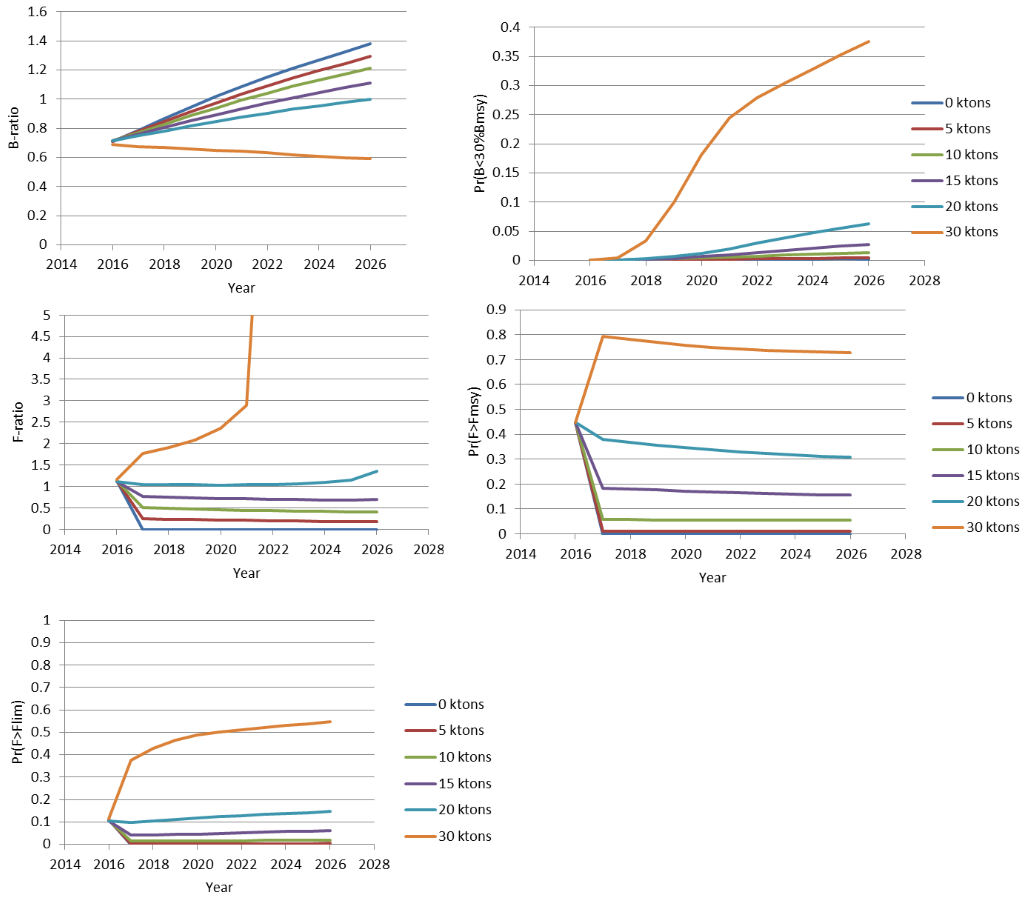


Figure 17.6.7. Projections: Medians of estimated posterior biomass- and fishing mortality ratios; estimated risk of exceeding F_{msy} or going below and $B_{MSYtrigger}$ given catches at 0, 5,10, 15, 20 and 30 ktons.

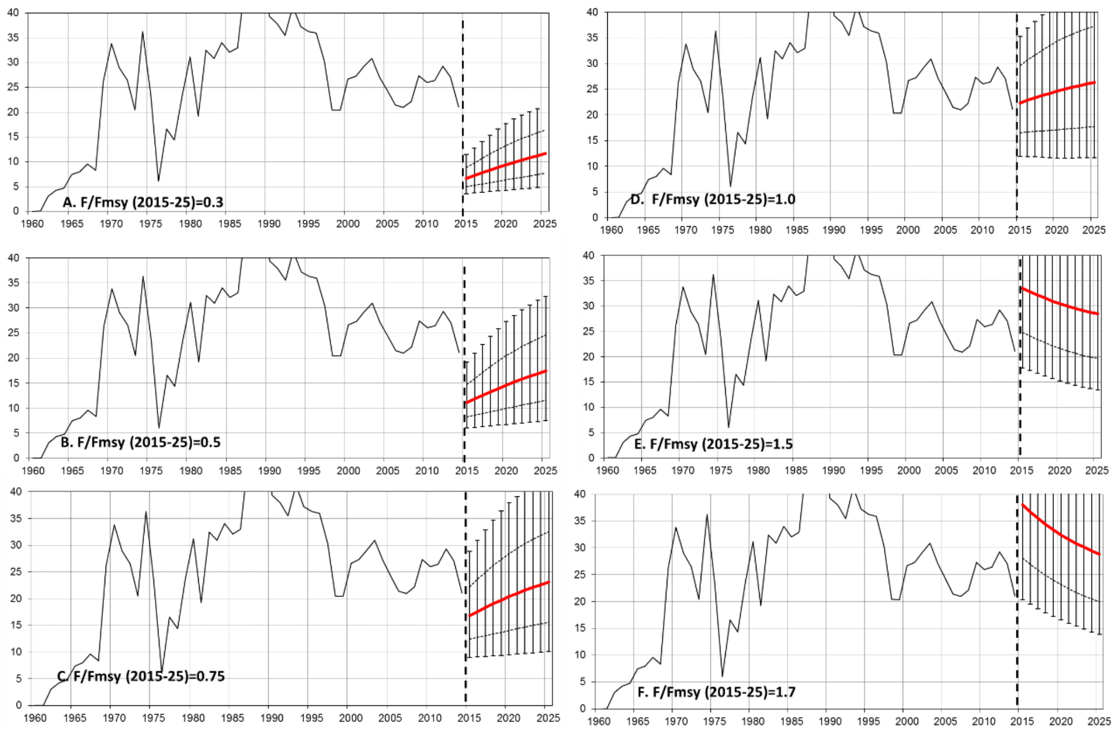
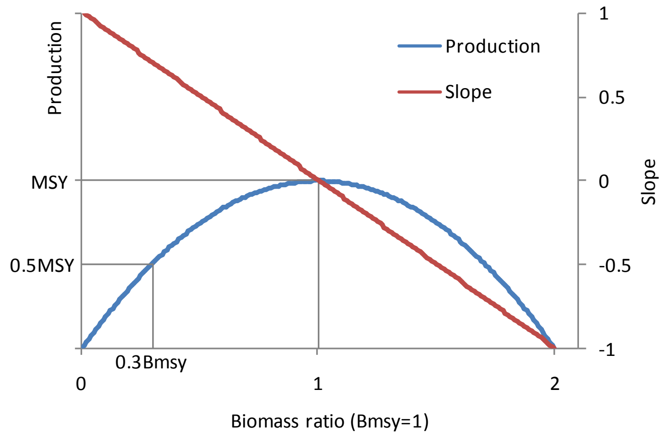


Figure 17.6.8. Historic landings and projected landings 2015-2025 under various F ratio options from 0.3-1.7 F/Fmsy Solid red line is median, quartiles and 90% conf limit indicated.



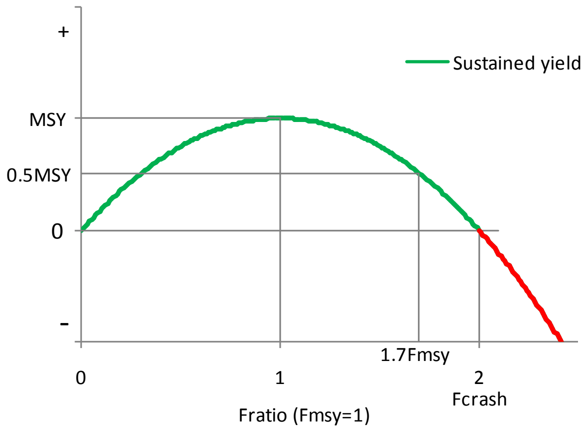


Figure 17.6.9. The logistic production curve in relation to stock biomass (B/Bmsy) (*upper*) and fishing mortality (F/Fmsy) (l*ower*). *Upper*: points of maximum sustainable yield (MSY) and corresponding stock size are shown as well as the slope (red line) of the production curve (blue line); *lower*: points of MSY and corresponding fishing mortality and Fcrash (F≥Fcrash do not have stable equilibriums and will drive the stock to zero).

18 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 18.4 and 18.7), and the abundance and distribution of juveniles (chapter 17.2.1), 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 Russian Federation maintains the point of view that there is only one stock of *S. mentella* in the pelagic waters of the Irminger Sea. Accordingly, the Russian Federation presented alternative approaches to stock assessment as well as environmental influence on stock dynamics. Briefly, it is claimed that the current survey based assessment does not adequately reflect stock status and that environmental factors – temperature causes major distributional changes of redfish – affect stock status more than fisheries and the use of the current management areas is rejected (see WD28, WD33 and Annex XX). The other NWWG members did not agree with the Russian Federation's view on stock structure and did not consider the presented assessment approach sufficiently documented.

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 18.1.1):

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. In the last decade the majority (more than 95%) of the catches have been taken in the northeast Irminger Sea. 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 18.1.2.

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 19),

the demersal *S. mentella* on the Icelandic slope (chapter 20),

the shallow and deep pelagic *S. mentella* units in the Irminger Sea and adjacent waters (chapters 21 and 22, respectively),

the Greenland shelf *S. mentella* (chapter 23).

18.1 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. Copulation occurs in autumn–early winter and larvae extrusion takes place in late winter–late spring/early summer. Little is known about the copulation areas.

The increase of water temperature in the Irminger Sea may have an effect on spatial and vertical distribution of *S. mentella* in the feeding area (Pedchenko, 2005). The abundance and distribution of pelagic *S. mentella* in relation to oceanographic conditions were analyzed in a special multistage workshop (ICES 2012). Based on 20 years of survey data, the results reveal the average relation of pelagic redfish to their physical habitat in shallow and intermediate waters: The most preferred latitude, longitude, depth, salinity and temperature for *S. mentella* are approximately 58ºN, 40ºW, 300 m, 34.89 and 4.4ºC, respectively. The spatial distribution of *S. mentella* in the Irminger Sea mainly in waters < 500 m (and thus mainly relating to the “shallow” stock) appears strongly influenced by the Irminger Current Water (ICW) temperature changes, linked to the Subpolar Gyre (SPG) circulation and the North Atlantic Oscillation (NAO). The fish avoid waters mainly associated with the ICW (>4.5ºC and >34.94) in the northeastern Irminger Sea, which may cause displacement of the fish towards the southwest, where fresher and colder water occurs.

Results based on international redfish survey data suggest that the interannual distribution of fish above 500 m will shift in a southwest/northeast direction depending on integrated oceanographic conditions (ICES 2012).

18.2 Environmental drivers of productivity

18.2.1 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 19), 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 18.2.1). Since 2008, the survey index has been very low and was in 2013the lowest value recorded since 1982. Juvenile redfish were only classified to the genus *Sebastes* spp., as identification of small specimens to species level is difficult due to very similar morphological features. The 1999—2013 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 and into the pelagic zone in the Irminger Sea and adjacent waters (Stransky 2000), with unknown shares.

18.3 Ecosystem considerations

Information on the ecosystems around the Faroe Islands, Iceland and Greenland is given in chapters 2, 7 and 13.

Analysis of the oceanographic situation in the Irminger Sea during the 2013 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 1994-2013. 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 2003 survey detected high temperature anomalies within the 0-200 m layer in the Irminger Sea and adjacent waters. At 200—500 m depth and deeper waters, positive anomalies were observed in most of the surveyed area. However, increasing temperature as compared to the survey in June-July 2001 was detected 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, 2003).

In June/July 2005 and 2007, water temperature in the shallower layer (0—500 m) of the Irminger Sea was higher than normal (ICES, 2005). As in the surveys 1999—2003, the redfish were aggregating in the southwestern part of the survey area, partly influenced by these hydrographic conditions. Favorable 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.

The hydrography in the survey of June/July 2013 shows that temperature in the survey area is above average but it was lower than in 2011 in most of the surveyed area, except for the Irminger Current (ICES, 2013).

18.4 Description of fisheries

There are three species of commercially exploited redfish in ICES Subarea V, VI, XII, and XIV: *S. norvegicus* (in publication both names *S. norvegicus* and *S. marinus* can be found, but according to Fernholm and Wheeler (1983) the first name is the correct name), *S. mentella* and *S. viviparus*. *S. viviparus* 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 18.4.1) due to decreased commercial interest in this species. The landings in 2009 amounted to 37 t, more than a twofold increase in comparison with 2008. After a directed fishery developed in 2010, with a total catch of 2 600 t, the MRI advised on a 1 500 t TAC for the 2012—2013 fishing year. Annual catches since 2012 are about 530 t.

The Group has in the past included the fraction of *S. mentella* that are caught with pelagic trawls above the western, south-western and southern continental slope of Iceland as part of the landing statistics of the demersal *S. mentella*. This practice has been in accordance with Icelandic legislation, where captains are obligated to report their *S. mentella* catch as either "pelagic redfish" or as "demersal redfish" depending in which fishing area they fish. According to this legislation, all catch outside the Icelandic EEZ and west of the ‘redfish line’ (red line shown in Figure 18.1.1, 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 19.3.2), and is on average 15%. With exception of 2007, no demersal *S. mentella* has been caught with pelagic trawls since 2004. 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 18.4.1). The pelagic catches of demersal *S. mentella* were taken in similar areas and depths as the bottom trawl catches (Figure 18.4.2). 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 18.4.3) 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 18.4.4. 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.

18.5 Russian pelagic *S. mentella* fishery

Russia's position regarding the structure of redfish stock in the Irminger Sea remains unchanged and it has been expressed in previous reports (ICES, 2009, Annex 4; ICES, 2013; Makhrov *et al*. 2011; Zelenina *et al*. 2011). The Russian Federation still maintains its point of view that there is only one stock of beaked redfish *S. mentella* in the pelagic waters of the Irminger Sea and that is why no split catches information about the fisheries is presented to the NWWG. Russia reiterates its standpoint that studies of the redfish stock structure should be continued (Artamonova *et. al* 2013) with the aim of developing agreed recommendations using all available scientific and fisheries data as a basis.

In 2014 the fishery was conducted from April to October in ICES Subareas XII and XIV and NAFO Divisions 1F (Tables 21.2.1, 21.2.2, 22.2.1 and 22.2.2) with average CPUE 26.4 t /day and 15.0 t/ day in ICES Subareas XII and XIV, respectively; and 18.8 t/day in NAFO.

18.6 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 2013:

Country	Area	No. of samples	No. of fish measured
Russia	XIV	250	37086
Russia	NAFO 1F	50	2822
Iceland	XIV (deep)		
Greenland	XIVb		
Spain	XIVb (deep)	51	4949

18.7 Demersal *S. mentella* in Vb and VI

18.7.1 Demersal *S. mentella* in Vb

18.7.1.1 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.

18.7.1.2 Fisheries

In Division Vb, landings gradually decreased from 15 000 t in 1986 to about 5 000 t in 2001 (Table 18.6.1). Between 2002 and 2011 annual landings varied between 1 100 and 4,000 t. In 2012 landings decreased drastically and in 2014 they remained below 400 t.

Length distributions from the landings in 2001-2014 indicate that the fish caught in Vb in 2014 are 42 cm (Figure 18.6.1).

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 2012 (Figure 18.6.2). In 2014, the CPUE increased slightly to about 200 kg /hour (Figure 18.6.2).

Fishing effort has decreased since the beginning of the time series and remains very low since 2008.

18.7.2 Demersal *S. mentella* in VI

18.7.2.1 Fisheries

In Subarea VI, the annual landings varied between 200 t and 1 100 t in 1978—2000 (Table 18.6.1). 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 since 2009.

18.8 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. norvegicus*, 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 17.4).

18.9 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. norvegicus* 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. norvegicus* and *S. mentella* (see stock annexes for Icelandic slope *S. mentella* and *S. norvegicus*). 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*.

18.10 References

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Table 17.4.1. Landings of *S. viviparus* in Division Va 1996-2014.

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
2010	2602
2011	1427
2012	535
2013	532
2014	550

Table 17.6.1. Nominal landings (tonnes) of demersal *S. mentella* 1978-2014 in ICES DivisionsVb and VI.

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	1 077	0
2010	1 202	0
2011	1 126	0
2012	263	0
2013	398	0
20141	370	0

[1)] Provisional

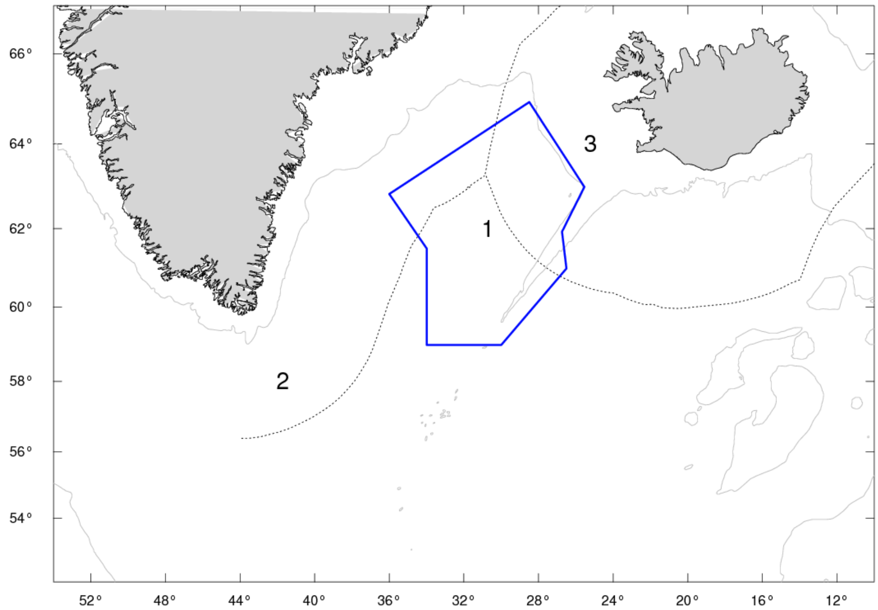

Figure 17.1.1Potential management unit boundaries. The polygon bounded by blue lines, i.e. 1, indicates the region for the 'deep pelagic' management unit in the northwest Irminger Sea, 2 is the "shallow pelagic" management unit in the southwest Irminger Sea, and 3 is the Icelandic slope management unit.

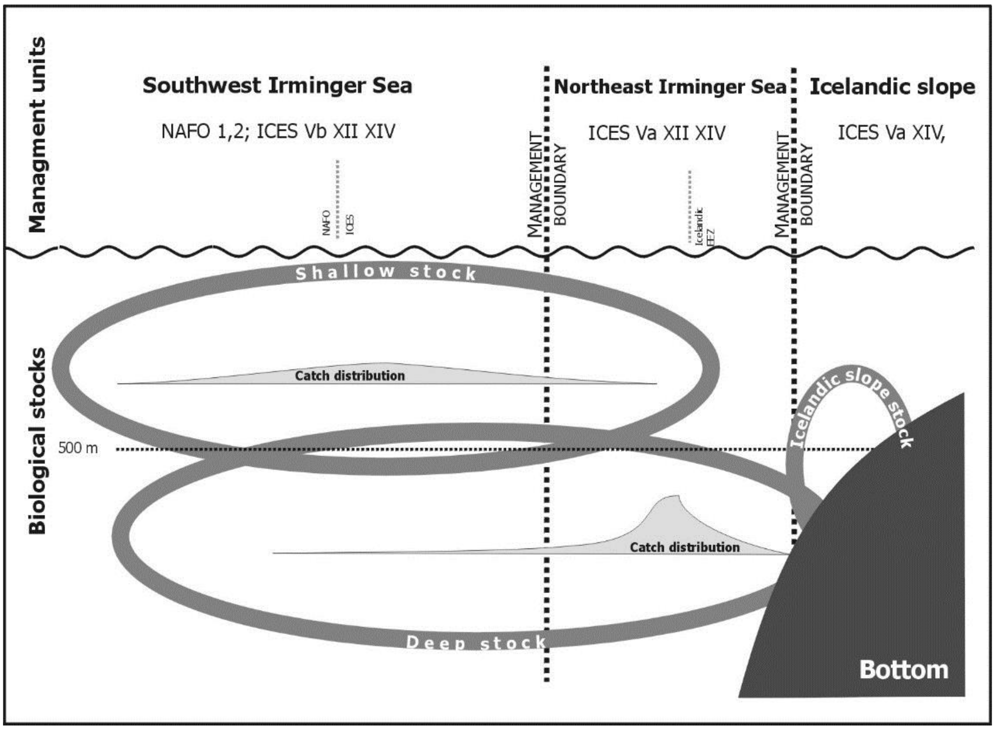

Figure 17.1.2 Schematic representation of biological stocks and potential management units of *S. mentella* in the Irminger Sea and adjacent waters. The management units are shown in Figure 17.1.1. Included is a schematic representation of the geographical catch distribution in recent years. Note that 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.

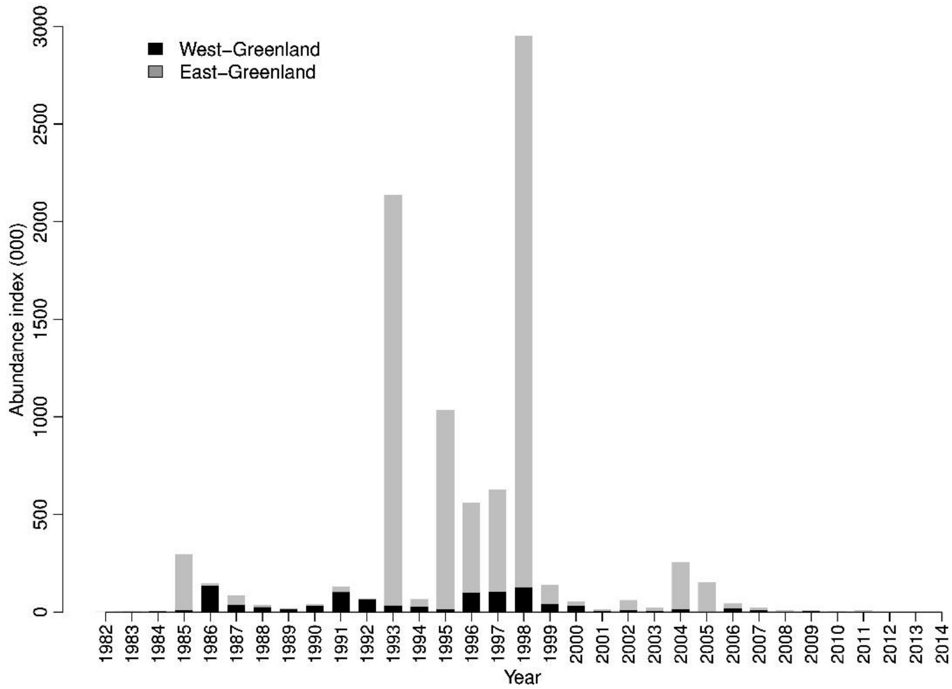

Figure 17.2.1 Survey abundance indices of *Sebastes spp.* (<17 cm) for East and West Greenland from the German groundfish survey 1982-2014.

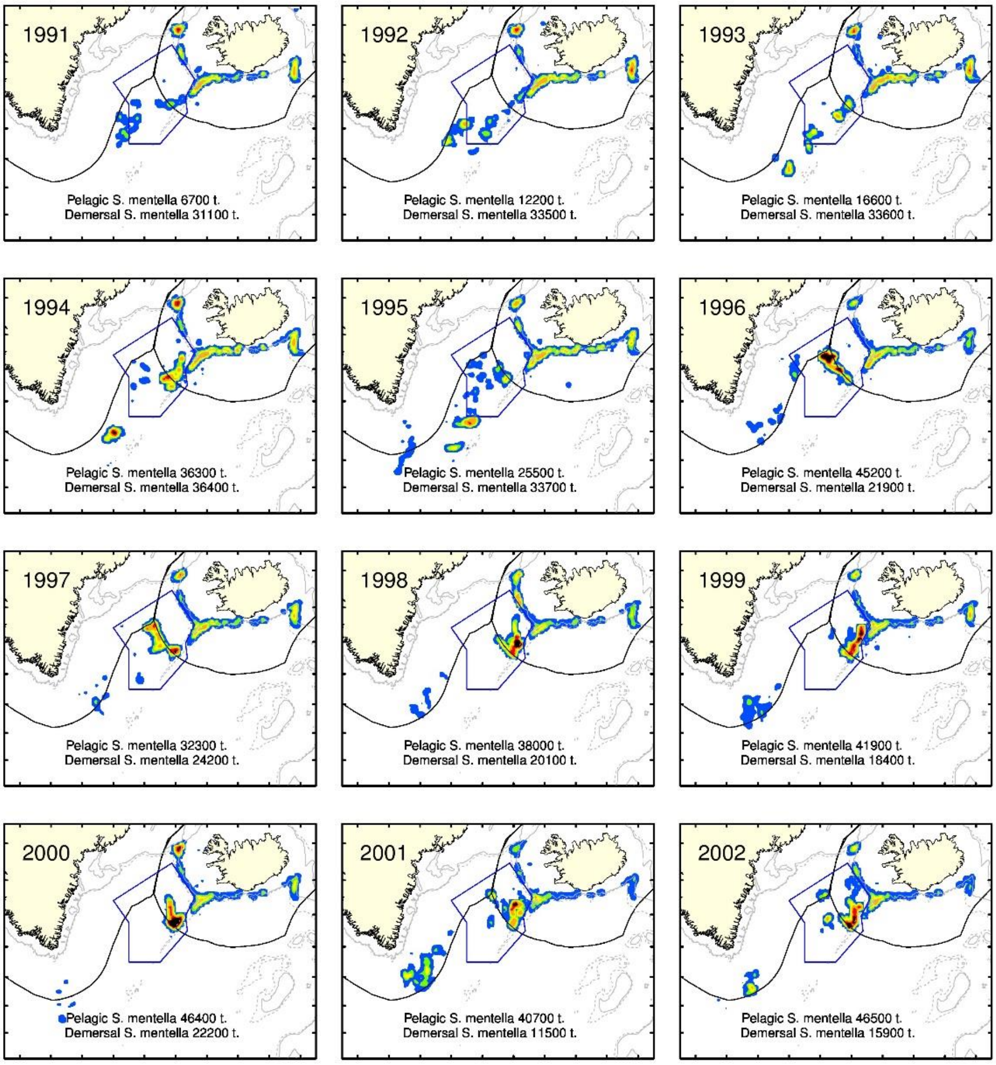

Figure 17.4.1Geographical distribution of the Icelandic catches of *S. mentella* 1991-2002. The color scale indicates catches (tonnes per NM²).

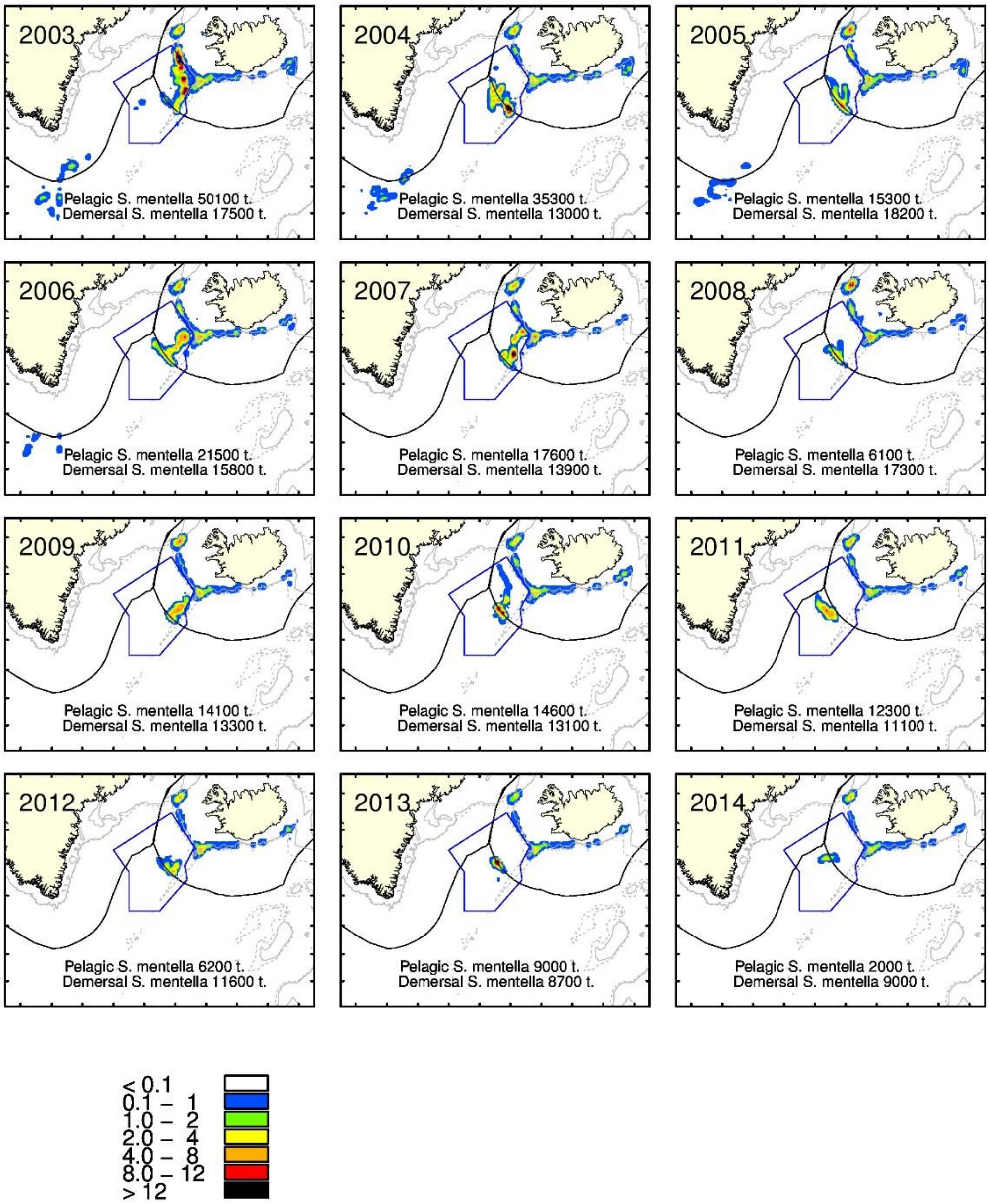

Figure 17.4.1 ***cont.*** **Geographical distribution of the Icelandic catches of** ***S. mentella*** **2003-2014. The color scale indicates catches (tonnes per NM²).**

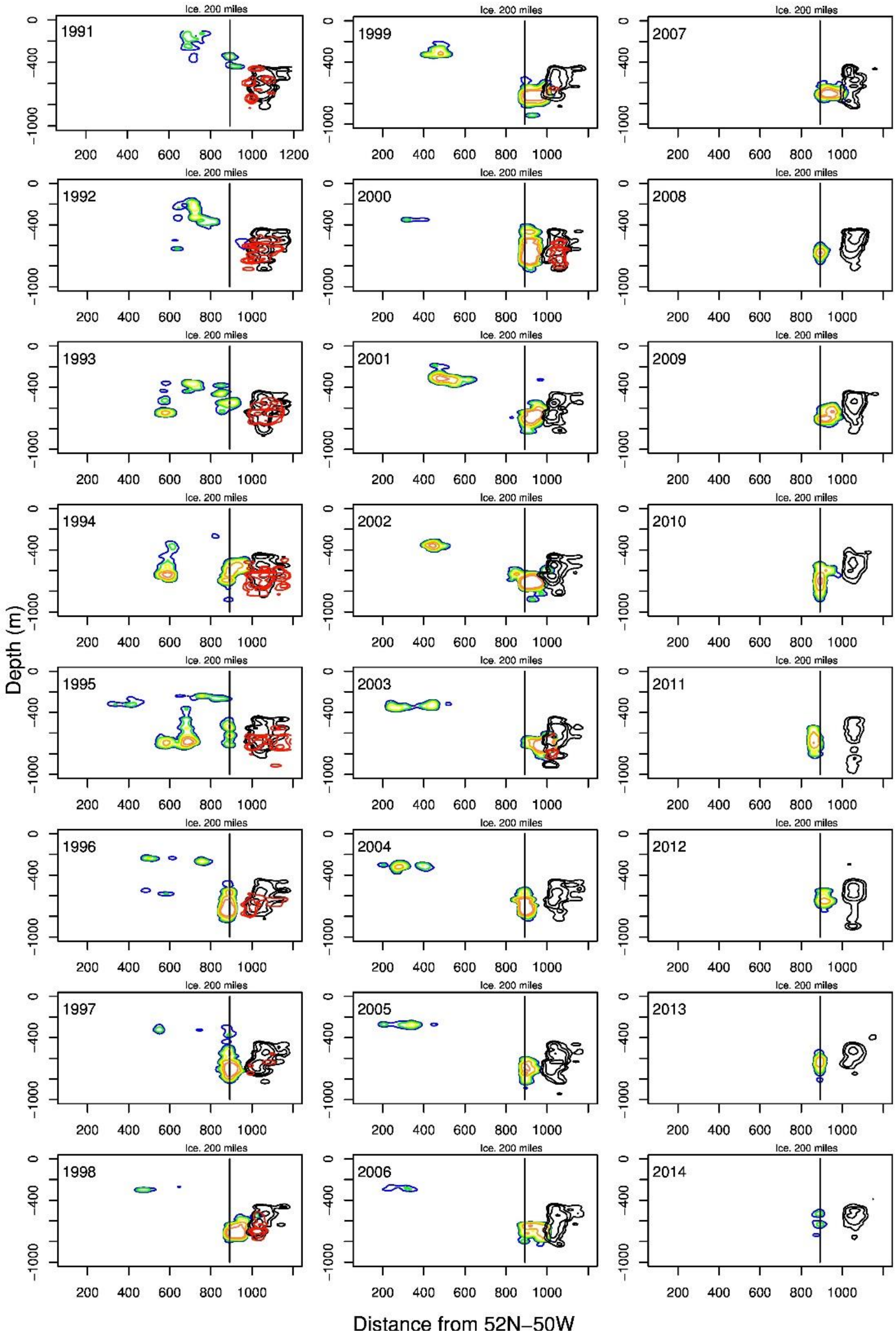

Figure 17.4.2Distance-depth plot for Icelandic *S. mentella* catches, where distance (in NM) from a fixed position (52°N 50°W) is given. The contour lines indicate catches in a given area and distance. The colored contours represent the fishery on pelagic *S. mentella*, the black contours indicate bottom trawl catches of demersal*S. mentella*, and the red contours represent catches of demersal *S. mentella* taken with pelagic trawls.

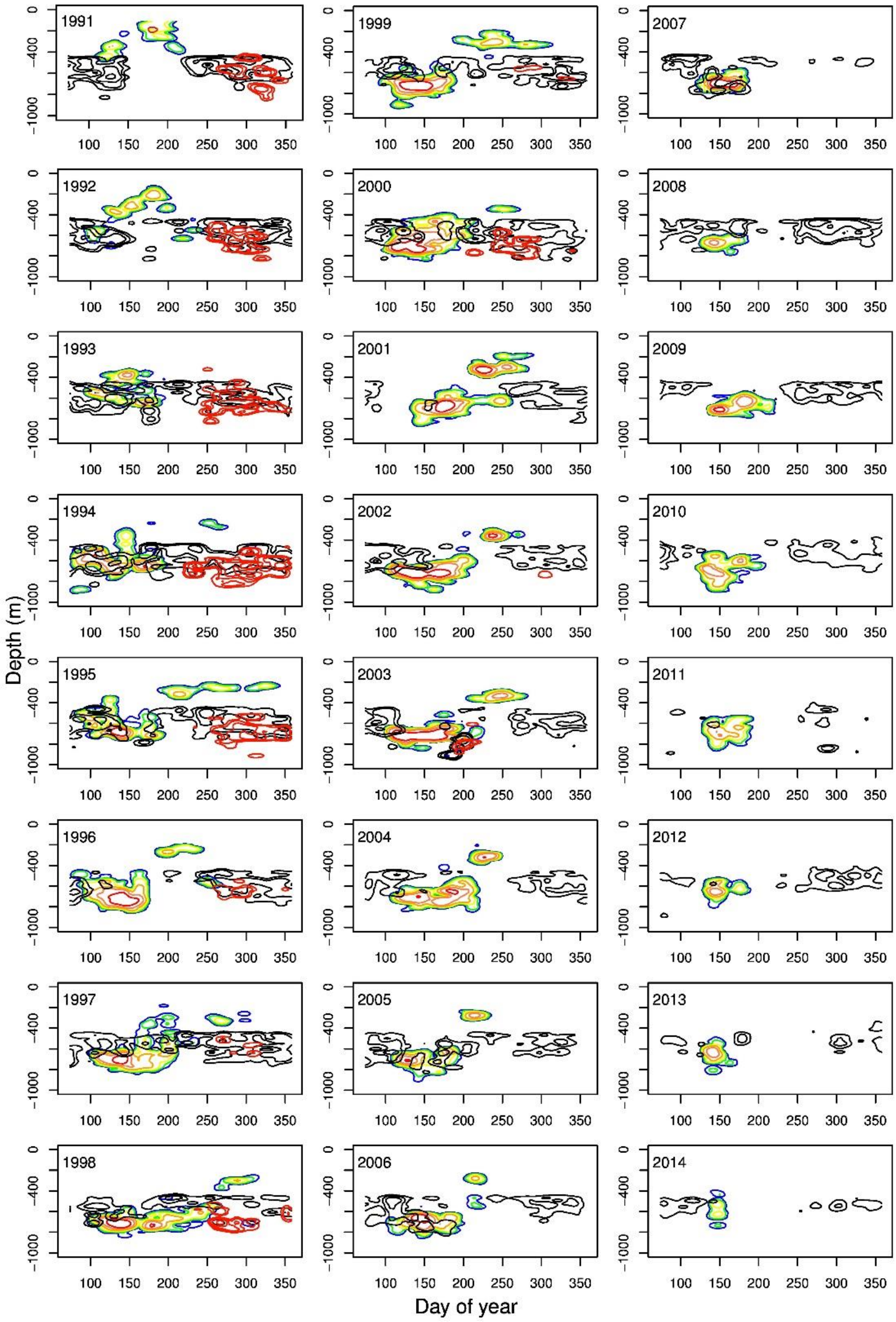

Figure 17.4.3 Depth-time plot for Icelandic *S. mentella* catches 1991-2014 where the y-axis is depth, the x-axis is day of the year and the color indicates the catches. The colored contours represent the fishery on pelagic *S. mentella*, the black contours indicate bottom trawl catches of demersal *S. mentella*, and the red contours represent catches of demersal *S. mentella* taken with pelagic trawls.

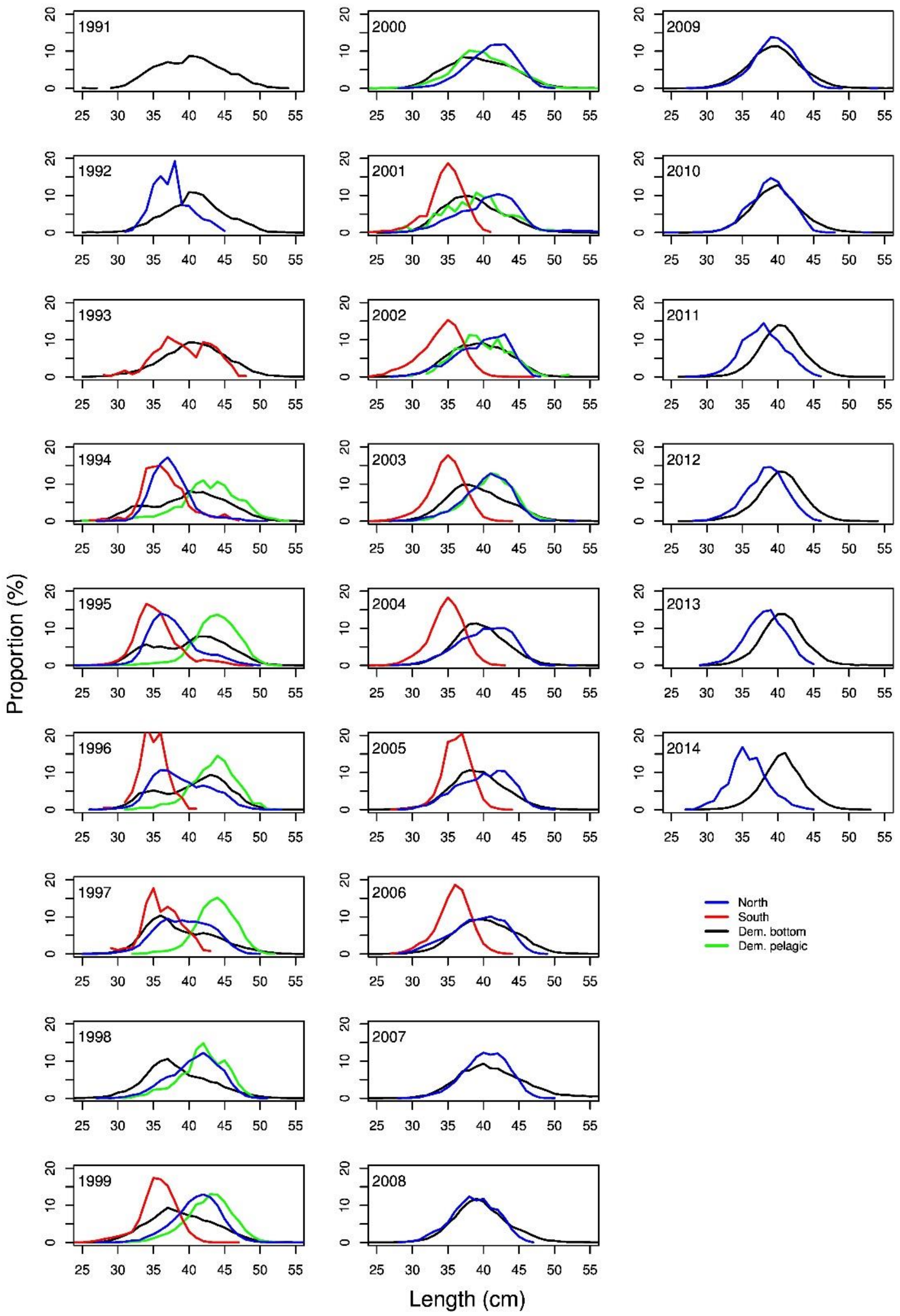

Figure 17.4.4 Length distributions from different Icelandic *S. mentella* fisheries, 1991-2014. The blue lines represent the fishery on pelagic *S. mentella* in the northeastern area, the red lines the pelagic fishery in the southwestern area, the black lines indicate bottom trawl catches of demersal *S. mentella*, and the green lines represent catches of demersal *S. mentella* taken with pelagic trawls.

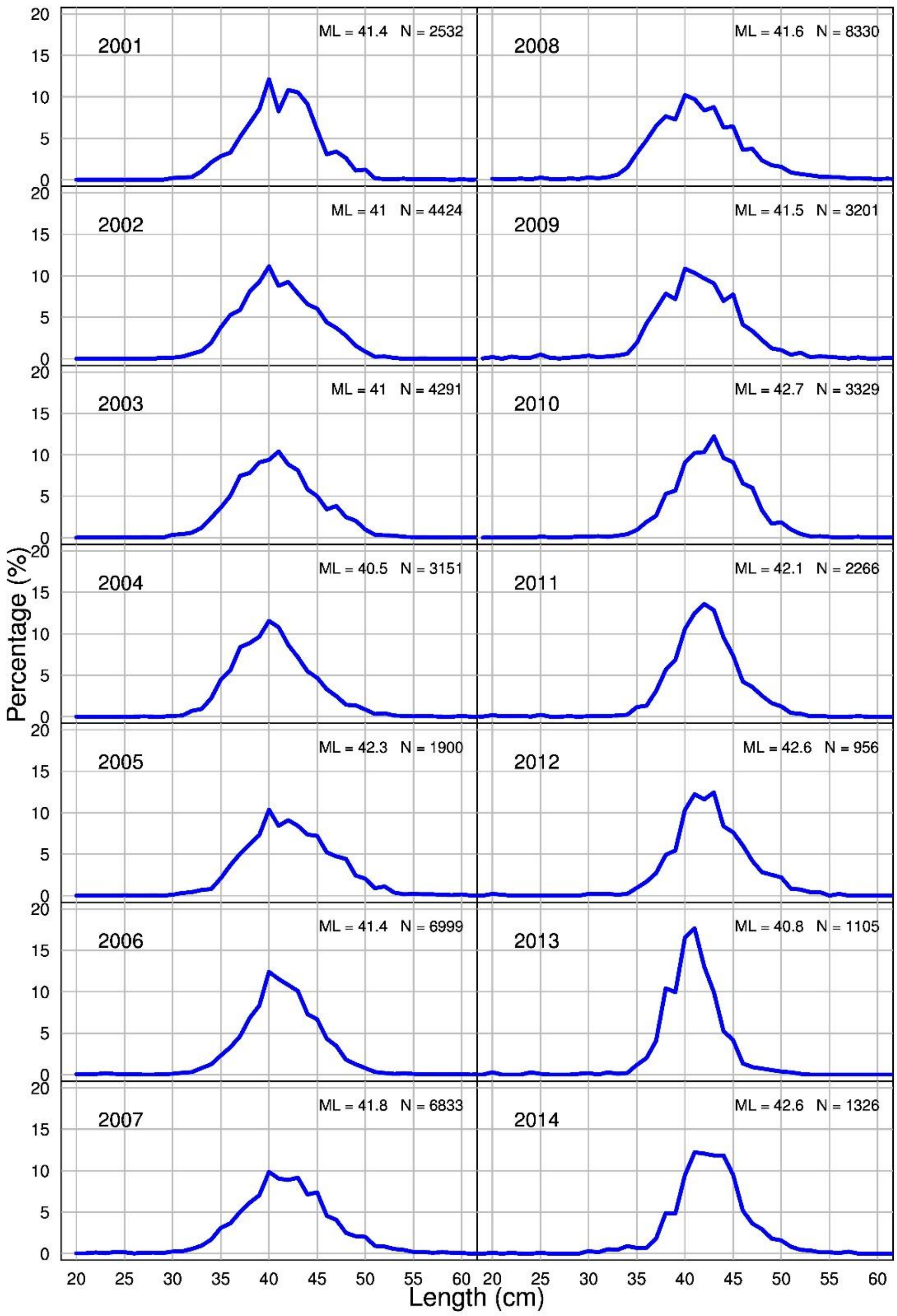

Figure 17.6.1 Length distribution of demersal *S. mentella* from landings of the Faeroese fleet in Division Vb 2001-2014.

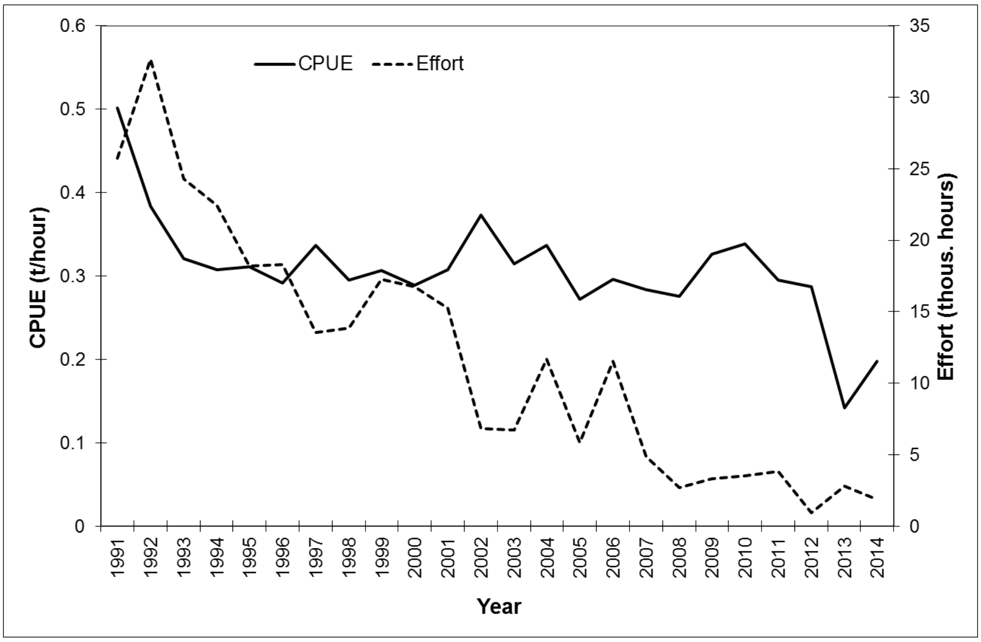

Figure 17.6.2 Demersal *S. mentella*, CPUE (t/hour) and fishing effort (in thousands hours) from the Faeroese CUBA fleet 1991-2014 and where 70% of the total catch was demersal *S. mentella*.

19 Golden redfish (*Sebastes norvegicus*) in Subareas V, VI and XIV

Executive summary

Total landings in 2014 were about 50 800 t, which is about 2 500 t less than in 2013. About 94% of the catches were taken in Division Va. A substantial increase in landings from XIVb since 2010, the highest since early 1990s, and is in relation to re-established redfish fishery in 2010. Very little redfish is now taken in Vb.

Catch-at-age data from Va show that the catch was dominated by two strong year classes from 1985 and 1990. From 2008—2011 year-classes 1996—1999 were the most important in the fisheries. Their share has reduced relatively fast and the 2000-2005 year classes are now most important contributing about 60% of the total catch.

Recruitment seems to be low in all areas, both according to the Icelandic groundfish surveys, and the German survey and the Greenland shrimp and fish survey in East-Greenland. Recruitment is likely to be underestimated as the surveys do not adequately cover nursery areas of the stock.

The stock was benchmarked in 2014 and a management plan evaluated and adopted. The Gadget model was used as basis for advice but the main difference in settings from earlier years was inclusion data from the German survey in East-Greenland and changes in growth rate.

The management plan was based on $F_{9\text{-}19}$=0.097 reducing linearly if the spawning stock is estimated below 220 000 t ($B_{trigger}$). B_{lim} was proposed as 160 000 t, lowest SSB in the 2012 run.

According to the management plan the TAC for 2016 will be 51 000 t.

19.1 Stock description and management units

Golden redfish (*Sebastes norvegicus*) 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.

19.2 Scientific data

This chapter describes results from various surveys conducted annually on the continental shelves and slopes of Subareas V and XIV.

19.2.1 Division Va

Two bottom trawl surveys are conducted in Icelandic waters: the Spring Survey in March 1985-2015 and the Autumn Survey in October 1996—2014. The autumn survey was not conducted in 2011. Two survey indices are calculated from these surveys and used in the assessment of golden redfish in ICES Va. Length disaggregated indices from the Spring Survey are used in the Gadget model. Age disaggregated indices from the autumn survey are used in TSA model but the age data as age-length keys in 2 cm length groups in the Gadget model.

The survey stratification and subsequent survey indices for golden redfish were recalculated for the Autumn Survey in 2008 and for the Spring Survey in 2011. The method is described in the Stock Annex for the species. Further changes were made in the calculation of the survey indices in 2012 by taking into account length dependent diurnal vertical migration of the species. Golden redfish is known for its diurnal vertical migration showing semi-pelagic behaviour. Usually the species is in the pelagic area during the night time and close to the bottom during the day time. However, there is also a size or age difference in this pelagic behaviour where smaller fish shows opposite vertical migration pattern compared to larger fish. The method is described in more details in the Stock Annex.

This scaled diurnal variation by length was used for calculating Cochran index for redfish. The sum of those abundance indices multiplied by mean weight at length or age are the total indices shown in Figure 19.2.1 and Table 19.2.1.

Figure 19.2.1*a* shows the total biomass index from the Icelandic spring and autumn groundfish surveys with ±1 standard deviation in the estimate (68% confidence interval). The total biomass of golden redfish as observed in the spring survey decreased from 1988 to a record low in 1995. Between 1996 and 2002 the stock showed signs of improvement but was low compared to the beginning of the series. In 2003 the biomass increased significantly and has since then been high. The 2012 and 2013 estimates were the highest in the time series, but decreased again in 2014 but remained high. The total biomass index in 2015 was similar as in 2014. The index is 25% higher than in the beginning of the time series. The CV of the measurement error has been considerably higher since 2003 than before that.

The total biomass index from the autumn survey gradually increased from 2000 to 2014 and was in 2014 the highest in the time series (Figure 19.2.1*a*).

Length distribution from the spring survey shows that the peaks, which can be seen first in 1987 and then in 1991—1992, reached the fishable stock approximately 10 years later (Figure 19.2.2). The increase in the survey index between 1995 and 2005 reflects the recruitment of a relatively strong year classes (1985-year class and then the 1990-year class). Abundance of small redfish has since then been much smaller, highest in 1998-2000, but in recent six years very little has been observed of small redfish (Figure 19.2.1*d*). This has been confirmed by age readings (Figure 19.2.4). In recent years the modes of the length distribution in both surveys has shifted to the right and is narrower. Much less is now observed of golden redfish less than 30 cm compared to other years (Figures 19.2.2 and 19.2.3).

Age disaggregated abundance indices from the autumn survey is shown in Figure 19.2.4 and Table 19.2.2. The sharp increase in the survey indices since 2005 reflects the recruitment of the year-classes from 1996—2005. The year-classes 1996—1999 are gradually disappearing from the stock. The 2000—2005 year-classes are now similar to the indices of the large 1990 year-class at same age and the 2004 year-class the biggest recorded as a 10 year old fish. In 2013 and 2014, the abundance of fish 7 years' old and younger was at the lowest level in the time series for all age groups although slightly improving in 2014 (Table 19.2.2).

19.2.2 Division Vb

In Division Vb, CPUE of *S. norvegicus* were available from the Faeroes spring groundfish survey from 1994—2015 and the summer survey 1996—2014. Both surveys show similar trends in the indices from 1998 onwards with sharp declines between 1998 and 1999 (Figure 19.2.5). After an increase in the mid-1990s, CPUE decreased drastically. CPUE in the spring survey was between 2000 and 2008 stable at low level. In the period 2009-2015 it has been at the lowest level since the beginning of the series. The CPUE index in the summer survey has gradually decreased and is also at the lowest level recorded.

19.2.3 Subarea XIV

Relative abundance and biomass indices from the German groundfish survey from 1982 to 2014 for *S. norvegicus* (fish >17 cm) are illustrated in Figure 19.2.6. In 2013, the survey was re-stratified, with 4 strata in West Greenland resembling NAFO sub-area structure, and 5 strata in East Greenland. Depth zones considered are 0—200 m and 200—400 m. The time series was recalculated accordingly. In general, the survey indices are much lower with the new stratification scheme but show similar trend (WD 30 of the 2013 NWWG report).

After a severe depletion of the *S. norvegicus* stock on the traditional fishing grounds around East Greenland in the early 1990's, the survey estimates showed a significant increase in both abundance and biomass with the highest value observed in 2007 (Figure 17.2.7). The survey indices were high although fluctuating until 2013. The survey index increased in 2014 to the highest level in the time series and was almost two times higher than in 2013 (Figure 19.2.6*a* and Figure 19.2.6*b*). 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 considerably (Figures 19.2.7*c* and 19.2.8). In 2010—2014 the biomass of 17-30 cm fish has decreased compared to previous five years whereas the fishable biomass has remained high since 2007.

Abundance indices of redfish smaller than 18 cm from the German annual groundfish survey show that juveniles were abundant in 1993 and 1995—1998 (Figure 18.2.1). Since 2008, the survey index has been very low and was in 2014 the lowest value 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—2014 survey results indicate low abundance and are similar to those observed in the late 1980s. The Greenland shrimp and fish shallow water survey also shows no juvenile redfish (<18 cm, not classified to species) were present.

19.3 Information from the fishing industry

19.3.1 Landings

Total landings gradually decreased by more than 70% from about 130 000 t in 1982 to about 43,000 t in 1994 (Table 19.3.1 and Figure 19.3.1). Since then, the total annual landings have varied between 33,500 and 54,000 t. The total landings in 2014 were 50 700 t, which is about 2 500 t less than in 2013. The majority of the golden redfish catch is taken in ICES Division Va that contributes to about 94—98% of the total landings.

Landings of golden redfish in Division Va declined from about 98 000 t in 1982 to 39 000 t in 1994 (Table 19.3.1). Since then, landings have varied between 32 000 and 51 000 t, highest in 2013. The landings in 2014 were about 47 800 t, about 3500 t less than in 2013. 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, long-line, and lobster fishery. In 2014, as in previous years, most of the catches were taken along the shelf southwest, west and northwest of Iceland (Figure 19.3.2). A notable change is that higher proportion of the catches is now taken along the shelf northwest of Iceland and less south and southwest.

In Division Vb, landings dropped gradually from 1985 to 1999 from 9000 t to 1500 t and varied between 1500 and 2500 t from 1999—2005 (Table 19.3.1). In 2006—2014 annual landings were less than 1000 t which has not been observed before in the time series. The landings in 2014 were 201 t which is 170 less than in 2013 and the lowest landings in the time series. 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 19.3.1). 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 4200 t, but from 1995 to 2009 there was little or no direct fishery for golden redfish and landings were 200 t or less mainly taken as by-catch in the shrimp fishery. In 2010, landings of golden redfish increased considerable and were 1650 t, similar to it was in early 1990s. This increase is mainly due to increased *S. mentella* fishery in the area. Annual landings 2010—2014 have been between 1000 t and 2700 t, highest in 2014.

Annual landings from Subarea VI increased from 1978 to 1987 followed by a gradual decrease to 1992 (Table 19.3.1). From 1995 to 2004, annual landings have ranged between 400 and 800 t, but decreased to 137 t in 2005. Little or no landings of golden redfish were reported from Subarea VI in 2006—2014 and were 60 t in 2014.

19.3.2 Discard

Comparison of sea and port samples from the Icelandic discard sampling program does not indicate significant discarding due to high grading in recent years (Palsson *et al* 2010), possibly due to area closures of important nursery grounds west off Iceland. Substantial discard of small redfish took place in the deep-water shrimp fishery from 1986 to 1992 when sorting grids became mandatory. Since then the discard has been insignificant both due to the sorting grid and much less abundance of small redfish in the region.

Discard of redfish species in the shrimp fishery in Subarea XIVb is currently considered insignificant (see Chapter 18).

19.3.3 Biological data from the commercial fishery

The table below shows the fishery related sampling by gear type and ICES Divisions in 2014. No sampling of the commercial catch from subdivision VI was carried out.

Area	Nation	Gear	Landings (t)	Samples	No. length measured	No. Age read
Va	Iceland	Bottom trawl	4 ,769	229	40 818	1 492
Vb	Faroe Islands	Bottom trawl	201	10	444	
XIV	Greenland	Bottom trawl	2 706			

19.3.4 Landings by length and age

The length distributions from the Icelandic commercial trawler fleet in 1975—2014 show that the majority of the fish caught is between 30 and 45 cm (Figure 19.3.3). The modes of the length distributions range between 35 and 37 cm. The length distributions in 2012-2014 are narrower than previously, with less than average of both small and large fish caught.

Catch-at-age data from the Icelandic fishery in Division Va show that the 1985-year class dominated the catches from 1995—2002 (Figure 19.3.4 and Table 19.3.2) 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 6% of the total catch in weight in 2013 and the 1985-year class about 1.5%, but their share has gradually been decreasing in recent years. In 2007—2010 the 1996—1999 year classes dominated in the catches, but are now gradually decreasing. The 2000—2004 year classes contributed in total about 60% of the total catch in 2014.

The average total mortality (Z), estimated from the 16-year series of catch-at-age data (Figure 19.3.5) is about 0.20 for age groups 15 and older.

Length distribution from the Faroese commercial catches for 2001—2014 indicates that the fish caught are on average larger than 40 cm with modes between 45 cm and 50 cm (Figure 19.3.6).

No length data from the catches have been available for several years in Subareas XIV and VI.

19.3.5 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 19.3.3 and Figure 19.3.7 and the model residuals in Figure 19.3.8. CPUE derived from logbooks is not considered indicative of stock trends however the information contained in the logbooks on effort, spatial and temporal distribution the fishery is of value.

The CPUE index derived from the GLM model increased considerably in 2001 after being at low level 1993—1999 and was until 2006 high but stable (Figure 19.3.7). In 2006, the CPUE index decreased by 12% compared to the previous year but has since then increased rapidly. Both the un-standardized CPUE index and the one derived from the GLM model was in 2014 the highest in the time series with sharp increase in recent 8 years. Effort towards golden redfish has since 1986 gradually decreased and is at the lowest level recorded (Figure 19.3.7).

Un-standardized CPUE of the Faroese otter-board (OB) trawlers has been presented in previous reports. They are however considered unreliable and un-representative about the stock in Division Vb. This is because no separation of S. *norvegicus*/*S. mentella* is made in the catches.

19.4 Methods

19.4.1 Changes to the assessment model in January 2014.

The stock was benchmarked in January 2014 and a management plan evaluated and adopted (WKREDMP, ICES 2014). The benchmark group agreed to base the advice for next five years on the Gadget model. The settings are described in the Stock Annex. The following changes were done to the model compared to previous runs:

Abundance indices from the German survey in East Greenland were included in the tuning. The indices were added to the Icelandic spring survey.

Tuning data were limited to 19—54 cm instead of 25—54 cm as larger part of the stock area is included. 19 cm is around the length at which redfish in the German survey is classified to species. Earlier, smaller fish had gradually been removed from the tuning fleet as the nursery area for year classes 1996—2003 seemed to be outside Icelandic waters.

Length at recruitment was estimated separately for year classes 1996—2000 and 2001 and onwards. The reason was higher mean weight at age in landings and autumn survey.

Of the changes mentioned above, the first one has the largest effect on the estimated stock size but the third one does also have considerable effect as when growth increases fishes recruit to the fisheries at younger age if selection is size dependent.

The German survey did get half weight compared to the results in Figure 19.2.6. This was done to avoid extrapolation to areas not surveyed, and hence reduce noise, but the indices are calculated as numbers per square km^2 multiplied by an area drawn around the stations (Figure 19.4.1). By using the stratification used to calculate indices shown in Figure 19.2.6, each station in the German survey would get 2.5 times more weight compared to the Icelandic survey. Several things are not comparable between the two surveys, for example different gears are used and the German survey is not conducted during night while the Icelandic survey is conducted both day and night. Therefore the "correct" weight of each survey in the total is difficult to estimate and part of the benchmark work 2014 was to look at the sensitivity to the weight.

The German survey has in recent decade provided increased proportion of the total biomass, but is still only 10% of the total biomass (Figure 19.4.2). The contribution for each length group (Figure 19.4.3) does though show that large redfish is abundant in East Greenland and large part of the largest redfish (45+ cm) is found there. This affects the model results as the relatively large abundance of middle size redfish in the Icelandic spring survey (Figure 19.2.1a) has not lead to subsequent increase in large fish (Figure 19.2.1c). Including the large fish from East Greenland does therefore affect model results and estimated SSB is 20% higher when the German survey is included, even though the German survey does only account for 10% of the total biomass as it is weighted. The recruitment signal from the German survey (Figure 19.4.3) is on the other hand not explaining much of the "missing recruitment" from Icelandic waters in recent years.

The weighing of individual data sets in the GADGET model is done using an iterative re-weighing algorithm. The process essentially assigns weights to each input data set on the basis of the inverse variance of the fitted residuals. This is done to reduce the effect of low quality input data. It can also help to identify data discrepancy as shown in Figure 19.4.4 (taken from the WKREDMP report; ICES 2014) which shows that information from the commercial catches indicate *status quo* state of the stock while the increase is caused by the survey data. In this year assessment the weights were the same as in the benchmark runs in January 2014 and the assessment in May 2014.

19.4.2 Gadget model

19.4.2.1 Data and model settings

Below is a brief description of the data used in the model and model settings is given. A more detailed description is given in the Stock annex.

Data used in the GADGET model are:

Length disaggregated survey indices 19—54 cm in 2 cm length increments from the Icelandic groundfish survey in March 1985—2015 and the German survey in East

Greenland 1984-2014. Indices are added together and the German survey gets half the weight compared to what is presented in Figure 19.2.6.

Length distributions from the Icelandic, Faroe Islands and East Greenland commercial catches since 1970.

Landings by 6 month period from Iceland, Faroe Islands and East Greenland.

Age-length keys and mean length at age from the Icelandic groundfish survey in October 1996—2014.

Age-length keys and mean length at age from the Icelandic commercial catch 1995—2014.

The simulation period is from 1970 to 2019 using data until the first half of 2015 for estimation. Two time steps are used each year. The ages used were 5 to 30 years, where the oldest age is treated as a plus group (fish 30 years and older). Recruitment was set at age 5.

Estimated parameters are:

Number of fishes when the simulation starts (8 parameters).

Recruitment at age 5 each year (43 parameters).

Length at recruitment (3 parameters).

Parameters in the growth equation; (2 parameters).

Parameter β of the beta-binomial distribution controlling the spread of the length distribution.

Selection pattern of the three commercial fleets assuming logistic selection (S-shape) (3x2 parameters).

Selection pattern of the survey fleet assuming an Andersen selection curve (bell-shape) (3 parameters).

It needs to be mentioned that the length disaggregated indices are from the spring survey but the age data are from the autumn survey conducted six months later. The surveys could have different catchability but the age data are used as proportions within each 2 cm length group so it should not matter. Growth in between March and October is taken care of by the model.

Projections were run using the Gadget model based fishing mortality of equal to 0.097 for ages 9 to 19 according to agreed management plan.

Assumptions done in the predictions:

Recruitment at age 5 in 2013 and onwards was set as the average of the recruitment in 1970—2012.

Catches in the first time step in 2015 (first 6 months) were set at the same as in the first time step of 2014 for all the fleets. In step 2 in 2015 and onwards the model was run at fixed effort corresponding to $F_{9\text{-}19}$=0.097

The estimated selection pattern from the Icelandic fleet was used for projections.

19.4.2.2 Results of the assessment model and predictions

Summary of the assessment is shown in Figure 19.4.5 and Table 19.4.1. The spawning stock has increased in recent years and fishing mortality decreased but annual landings have been relatively stable. The last year class estimated is the 2007 year class but the following year-classes are assumed to be the average. Compared to last year's assessment the 2006 year-class is estimated smaller than assumed last year but the 2004 and 2005 year-classes are estimated larger. Later year-classes are likely to be smaller than assumed here based on information from the surveys in East-Greenland and Iceland that all indicate low abundance of small redfish. Assumptions about those year-classes will not have much effect on the advice this year but later advice will be affected as well as the development of the spawning stock in short term. The surveys do not seem to cover the nursery areas of the stock.

The results of the assessment presented here are similar to what was presented at WKREDMP (ICES 2014) (Figure 19.4.6). This similarity is expected as only one year of data has been added and the model is a is a low pass filter that does usually not respond rapidly to new data except they are very far from predicted values.

Estimated selection patterns of different fleets are shown in Figure 19.4.7. The Greenlandic and Faeroese fleet catch much larger fish than the Icelandic fleet. This is in line with the results from the German survey in East-Greenland that show most of the large fish in East-Greenland (Figure 19.4.3)

19.4.2.3 Fit to data

An aggregated fit to the survey index (converted to biomass) is presented in Figure 19.4.8. It shows a greater level of agreement than most runs based only on the Icelandic data but does mostly show negative residuals for the last 13 years. Residuals by length group show positive residuals in size groups 33—38 cm in recent years but negative for most other size groups, indicating narrower length distributions in the survey than predicted (Figure 19.5.9).

This lack of fit between observed and predicted survey biomass was one of the main critics of WKRED 2012 (ICES 2012). As can be seen in Figure 19.4.8 the fit is still not good. That lack of fit is caused by too narrow length distribution, with both small and large fish missing but they weight much more in the tuning data than in the total biomass. When looking at the number of years with observed > predicted biomass it must be noted that the assessment converges very slowly and 10 years are in some sense comparable to less than 5 years in other species. Discussions about the problem in WKRED 2014 are still valid.

The correlation between observed and predicted survey indices is good for 33-50 cm fish (Figures 19.4.10 and 19.4.11). As the model converges slowly, predicted indices could change a number of years back when more data are added. However, it is not the magnitude of the residuals but rather the temporal pattern that is worrying (Figure 19.4.9).

Length distributions from the Icelandic commercial catch does usually show good fit except in the most recent period when the large fish is missing and the length distribution narrower than ever (Figure 19.4.11). One explanation could be that selection in recent years is dome shaped as the large fish is in East-Greenland where the fisheries are less.

The discrepancy between predicted and observed age distributions is not as apparent as for the length distributions (Figures 19.4.12 and 19.4.13). The model uses the data as age-length keys in 2 cm intervals for tuning. Presenting the residuals on that scale is difficult so here the age distributions are shown as aggregates over all length groups. This is not a problem for the catches where the otolith sampling is random, which is not the case for the survey as there is a maximum limit on the number of otoliths sampled in each tow and therefore lower proportion sampled in hauls with many fish.

19.5 Information from catch curves.

The discrepancy in different data sources can be seen by looking at catch curves from age disaggregated catch in numbers and survey indices. The 1995—1999 year-classes have disappeared more rapidly from the fisheries than predicted (Figure 19.4.14) with average Z being 0.24 (F=0.19) for ages 12—20. Comparable number for year-classes 1985—1990 is Z=0.15.

The analyses indicate that fishing mortality was higher than predicted by the assessment models. One explanation is that we are overestimating the stock but there can be a number of alternative explanations.

1. The cohorts grow faster and mature earlier than earlier cohorts. Natural mortality, *M*, might have increased
2. The selection of the fisheries is more dome shaped than before. The fisheries concentrate on the dense schools west of Iceland where the length distribution is narrow.
3. Compared to cohorts 1985—1990 the later cohorts seem to come from other nursery areas.
4. Most of the biomass in the Icelandic surveys in the last decade comes from very dense schools west of Iceland. Catchability in those schools might be different from less dense aggregations.

19.6 Alternative assessment

Time Series Analysis (TSA) was run this year as in recent year (ICES 2014). This year, only the age based TSA model was presented. Two model runs were predicted.

1. Catch in numbers by age 1995—2014, ages 9—19.
2. Catch in numbers by age 1995—2014, ages 9—19 and age disaggregated indices from the Icelandic autumn survey 1995-2014, ages 7—19.

Figure 19.4.15 shows the biomass of age 9—19 based on the TSA and Gadget model and Figure 19.4.16 the average fishing mortality. The model tuned with the autumn survey shows similar biomass as the results from the Gadget model. The difference is that data from Greenland is not included in the TSA model. The TSA model based on catch in numbers only has to rely on how the cohorts disappear from the fisheries as it does not have any information on incoming cohorts other than proportions in catch in numbers. Also, the lack of information for older than 19 years old fish is a problem in that model. The difference between the two TSA models does indicate some of the discrepancies seen in the data but the TSA model tuned with the autumn survey does, as the Gadget model, depends on data from the catches and the surveys.

19.7 Reference points

Harvest control rule (HCR) was evaluated in January 2014 based on stochastic simulations using the Gadget model. Taking into account conflicting information by different data continuing for many consequent years (sections 19.4—19.6) the simulations were conducted using large assessment error with very high autocorrelation. (CV=0.25, rho=0.9). It can therefore be argued that the problems described in sections 19.4—19.6 were taken into account by relatively conservative HCR.

Yield-per-recruit analysis show that when average size at age 5 was allowed to change after year class 1996 $F_{9–19,MAX}$ changed from 0.097 to 0.114. F_{MAX} of fully recruited fish or size based F_{MAX} does not change. This is a known phenomenon, for example taken into account in the management of Icelandic haddock and George bank haddock. The proposed fishing mortality of 0.097 is therefore around 85% of F_{MAX} with current settings. Stochastic simulations indicate that it leads to very low probability of spawning stock going below $B_{trigger}$ and B_{lim}, even with relatively large auto-correlated assessment error

Yield-per-recruit reference points from the Gadget model (length-based) are not comparable to age based reference points. The proposed harvest ratio, 0.097, is well above $F_{0.1}$ and F_{SSB35} estimate from the Gadget model. These reference points have previously been proposed for this stock, but these points are also lower than from age based models.

The recruitment pattern observed from year classes 1975—2003 (Figure 19.4.6) does not show long periods of poor recruitment. From a management perspective this is beneficial since overly cautious rules (i.e. low harvest rates) may not be needed to see the stock through long periods of very low recruitment. A spawning stock generated by poor recruitment and low fishing mortality has much broader, and hence more resilient, age distribution than the same size spawning stock generated under higher fishing mortality and a few large recruitment events. Therefore, if poor recruitment lead to the stock declining towards B_{loss} after adoption of the HCR, 19+ biomass (or another measure of old fish) would still be relatively high, potentially benefitting the stock due the disproportionate reproductive output of older fish.

$B_{trigger}$ was defined as 220 kt by adding a precautionary buffer to the proposed B_{lim} of 160 kt: 160*exp(0.2*1.645). The probability of current SSB <$B_{trigger}$ is estimated 2.7%. For simplicity, the action of $B_{trigger}$ is not included in the simulations since Gadget is not keeping track of "perceived spawning stock". Analysis of the stochastic prediction in R shows that if SSB is below $B_{trigger}$ it will only be noted in <15% of the cases. The reason is that the spawning stock is only likely to go below $B_{trigger}$ in periods of severe overestimation of the stock that occur due to the assumed high autocorrelation in assessment error. This situation differs from that of the stock going below $B_{trigger}$ due to poor recruitment (worse than observed in recent decades). In this case the spawning stock should still have a resilient age structure (as discussed above) and this could reduce the need to take further action below $B_{trigger}$.

Data on recruitment are still poor and data from other surveys at East-Greenland than the German survey need to be investigated. The Icelandic surveys indicate that recruitment has been very poor for at least the last five years (Figure 19.2.1). The applicability of the Icelandic surveys as measure of recruitment of redfish has been questioned but this is at least a negative signal and in long periods of poor recruitment a low harvest ratio is preferable.

Finally, it must be noted that the F_{target} suggested implies a substantial reduction in fishing mortality compared to the last three decades. The stock is not at present considered to be in a very unhealthy state despite this three decade period of relatively high fishing pressure in relation to that proposed for the HCR. Still, the adoption of the HCR should not lead to major changes in the advice from recent years, which has partly been based on similar considerations.

The deliberations above offer some justification that the proposed harvest rate ($F_{9\text{–}19}$ = 0.097) is a sensible target for this stock. This of course depends also on the assumption that assessment is based on natural mortality M=0.05.

19.8 State of the stock

The results from GADGET indicate that fishing mortality has reduced in recent years and is now close to F_{MSY} (Figure 19.4.5). Spawning stock and fishable stock have been increasing in recent years and are now the highest since 1986.

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 been relatively high since 2007. No information is available on exploitation rates in Divisions Vb and XIV.

Results from surveys in Iceland and East Greenland indicate that most recent year classes are poor. The reliability of the surveys as an indicator of recruitment is not known.

19.9 Short term forecast

The Gadget model is length based where growth is modelled based on estimated parameters. The only parameters needed for short term forecast are assumptions about size of those cohorts that have not been seen in the surveys. These year classes were assumed to be the average of year classes 1975—2003 (Figure 19.4.5).

The results from the short term simulations based on $F_{9\text{-}19}$ is shown in Figure 19.4.5 and from short term prognosis with varying fishing mortality in 2015 in Table 19.4.2.

19.10 Medium term forecast

No medium term forecast was carried out.

19.11 Uncertainties in assessment and forecast

Various factors regarding the uncertainty and modelling challenges are listed in the WKRED-2012 and WKREDMP-2014 reports. The main things relate to the lack of explanation of the GADGET model (or any model for that matter) to account for the increase of abundance in intermediate length groups in the Icelandic March survey. These factors were discussed in sections 19.4—19.7 but a short list is repeated below.

Immigration of intermediate sized redfish in to Va, most likely from Greenland.

Increased aggregation of redfish in areas closed to fishing. These areas on the western part of the Icelandic shelf make up most but not all of the increase in intermediate sized golden redfish in the Icelandic surveys. However eliminating the hauls from these areas in calculation of indices does to some extend reduce this increase.

There are indications that growth of golden redfish has changed over time. This can be seen for example in the 2001 year class which is on average larger than fish of the same age in the earlier year classes (for example, the 1985—1990 year classes). Size at maturity has also decreased that could lead to growth ceasing earlier than before explaining lack of large fish in recent years

19.12 Comparison with previous assessment and forecast

The current assessment gives similar state of the stock compared to last year's assessment and the assessment presented at the benchmark 2014. Management plans and evaluation

See chapter 19.7

19.13 Basis for advice

Harvest control rule accepted at WKREDMP 2014 (ICES 2014).

19.14 Management consideration

In 2009 a fishery targeting redfish was initiated in ICES XIV with annual catches of more than 8300 tonnes in 2010—2013 and 7300 in 2014. The fishery does not distinguish between species, but based on survey information, golden redfish is estimated to be between 1000 and 2700, highest in 2014..

Redfish and cod in XIV 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 recommend measures that will keep effort on cod low in the redfish fishery.

Greenland opened an offshore cod fishery 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. norvegicus* 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.

19.15 Ecosystem consideration

Not evaluated for this stock.

19.16 Regulation and their effects

The separation of golden redfish and Icelandic slope *S. mentella* quota was implemented in the 2010/2011 fishing season.

In the late 1980's, Iceland introduced a sorting grid with a bar spacing of 22 mm in the shrimp fishery to reduce the by-catch of juveniles in the shrimp fishery north of Iceland. This was partly done to avoid redfish juveniles as a by-catch in the fishery, but also juveniles of other species. Since the large year classes of golden redfish disappeared out of the shrimp fishing area, there in the early 1990's, observers report small redfish as being negligible in the Icelandic shrimp fishery. If the sorting grids work where the abundance of redfish is high is a question but not a relevant problem at the moment in Vb as abundance of small redfish is low and shrimp fisheries limited.

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.

19.17 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.

19.18 Changes in the environment

No information available.

19.19 References

ICES 2012. Report of the Benchmark Workshop on Redfish (WKRED 2012). ICES CM 2012/ACOM:48, 291 pp.

ICES 2014. Report of the Workshop on Redfish Management Plan Evaluation (WKREDMP). ICES CM 2014/ACOM:52, 269 pp.

Pálsson, Ó., Björnsson, H., Björnsson, E., Jóhannesson, G. and Ottesen Þ. 2010. Discards in demersal Icelandic fisheries 2009. Marine Research in Iceland 154.

Table 19.2.1 Survey indices and CV from the spring survey 1985-2015 and the autumn survey 1996-2014.

	Spring Survey		Autumn Survey	
Year	Biomass	CV	Biomass	CV
1985	308,145	0.095		
1986	328,081	0.120		
1987	322,175	0.122		
1988	251,597	0.095		
1989	281,241	0.122		
1990	242,496	0.223		
1991	199,179	0.114		
1992	160,561	0.088		
1993	179,369	0.130		
1994	171,167	0.097		
1995	146,124	0.102		
1996	195,661	0.164	197,168	0.248
1997	212,249	0.216	117,771	0.284
1998	206,544	0.136	186,466	0.348
1999	297,008	0.143	262,029	0.310
2000	221,273	0.176	137,959	0.200
2001	192,739	0.176	171,417	0.158
2002	249,371	0.173	187,889	0.147
2003	334,004	0.161	196,233	0.156
2004	327,174	0.236	214,472	0.239
2005	310,706	0.129	224,245	0.237
2006	257,208	0.157	272,377	0.332
2007	339,967	0.224	215,214	0.249
2008	248,119	0.154	280,348	0.242
2009	302,498	0.253	285,841	0.281
2010	383,771	0.245	223,862	0.172
2011	401,870	0.235		
2012	462,078	0.204	333,915	0.224
2013	457,736	0.177	302,568	0.156
2014	403,083	0.174	416,901	0.233
2015	407,050	0.280		

Table 19.2.2 Golden redfish in Va. Age disaggregated indices (in numbers) from the autumn groundfish survey 1996-2014. The survey was not conducted in 2011.

Year/ Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
1	0.3	1.0	3.7	3.3	0.8	0.4	0.1	0.0	0.0	0.1	0.2	0.1	0.0	0.1	0.0		0.0	0.0	0.0
2	2.4	0.3	1.5	3.3	1.7	1.0	1.0	0.6	0.2	0.1	0.6	1.3	0.3	0.3	0.0		0.0	0.0	0.3
3	0.7	2.2	0.9	3.3	1.4	2.0	1.5	1.1	1.0	0.2	0.7	1.2	2.5	0.4	1.7		0.1	0.0	0.3
4	1.6	1.6	2.3	1.5	1.6	2.4	6.1	1.1	1.9	1.0	0.5	1.1	2.7	4.6	0.3		1.1	0.2	0.1
5	8.4	2.2	0.9	4.7	1.2	5.2	5.8	12.2	3.2	4.2	5.0	2.1	4.1	12.2	4.3		3.9	1.1	0.8
6	40.4	6.9	3.5	2.8	7.8	2.2	11.7	17.4	28.1	4.8	6.8	10.2	7.7	11.6	14.3		3.1	4.0	1.7
7	11.4	22.4	16.7	10.5	6.6	10.6	3.2	37.5	35.9	39.0	15.2	25.6	38.3	13.7	15.0		23.1	3.0	12.6
8	19.0	14.2	58.5	47.2	6.1	10.7	25.5	9.6	63.8	43.9	79.8	35.0	73.1	72.4	23.0		68.6	40.8	23.8
9	14.7	12.8	22.4	100.0	25.5	6.8	10.9	47.4	20.3	61.2	79.1	74.8	65.7	94.0	53.4		58.9	82.3	93.8
10	28.6	10.8	26.0	43.4	92.8	16.6	15.9	12.2	44.2	24.1	83.2	36.3	103.3	56.9	67.8		61.0	54.0	146.8
11	103.4	17.3	18.7	20.3	11.0	109.3	30.8	16.5	18.6	43.1	25.4	35.2	61.2	98.2	31.8		100.9	39.3	87.7
12	15.7	67.4	19.0	16.5	13.8	23.0	114.6	39.0	12.9	19.0	36.4	18.5	53.5	44.6	56.6		71.8	65.2	67.3
13	9.7	5.9	105.4	20.6	7.6	22.7	19.5	109.6	25.9	15.0	17.5	23.2	13.1	41.7	28.2		42.1	45.2	65.3
14	16.6	5.1	10.0	148.1	7.8	7.6	11.0	12.1	101.5	26.3	14.6	7.9	17.7	9.8	19.3		38.1	25.1	48.8
15	34.0	7.0	7.6	5.8	50.6	8.7	9.5	10.6	13.3	80.8	17.9	6.6	8.8	17.7	8.9		19.1	30.1	26.1
16	15.9	9.8	7.7	9.6	5.1	57.4	10.3	6.0	9.4	9.3	74.0	16.6	7.6	6.7	10.8		16.2	17.8	25.7
17	1.7	6.8	14.2	10.8	2.5	4.1	45.1	7.5	5.8	6.5	8.5	48.8	12.8	6.2	4.6		5.9	12.2	16.5
18	1.6	3.9	7.6	11.1	2.5	4.9	4.5	32.5	5.9	3.7	4.2	10.2	36.0	7.1	3.0		5.8	6.8	11.9
19	4.2	2.0	0.5	8.4	4.5	3.5	2.7	4.5	21.2	5.0	2.7	4.4	6.0	27.7	6.6		3.8	4.9	5.8
20	6.5	1.4	3.2	3.9	6.5	4.1	3.2	1.6	3.0	21.8	3.1	1.5	5.6	4.6	22.0		3.8	4.3	5.7
21	1.0	0.8	2.4	2.8	1.0	3.6	3.9	1.1	1.8	2.5	17.6	3.9	2.0	2.1	3.1		3.4	4.6	4.7
22	4.9	1.5	0.8	1.0	1.6	2.2	3.1	2.7	1.7	2.0	1.9	13.6	2.3	1.3	1.2		17.9	2.3	3.5
23	3.9	2.4	2.2	2.0	0.4	0.3	0.8	1.0	2.4	2.3	1.7	1.3	10.8	1.9	1.6		2.8	17.3	3.3
24	4.5	0.8	0.4	0.5	1.0	0.5	0.4	0.3	0.0	0.9	1.0	1.2	1.4	10.0	0.7		2.0	2.4	12.3
25	3.8	2.7	1.4	2.8	0.7	0.2	0.5	0.3	1.2	1.2	1.7	0.2	0.8	0.7	5.7		1.2	1.2	1.4
26	0.8	1.1	0.2	1.1	0.6	0.5	0.5	0.2	0.4	0.3	0.9	0.6	0.8	0.9	0.6		1.6	1.1	0.9
27	0.8	0.2	0.9	2.9	0.5	0.7	0.3	0.3	0.0	0.1	0.9	0.3	1.2	1.3	0.4		7.4	0.8	0.8
28	0.8	0.4	0.5	1.5	0.6	0.5	0.2	0.0	0.2	0.2	0.2	0.0	0.5	0.2	0.7		0.4	8.3	0.4
29	0.1	0.0	0.4	1.2	0.5	0.2	0.7	0.1	0.2	0.0	0.4	0.4	0.8	1.5	0.4		0.4	0.4	3.2
30+	0.8	1.3	3.1	1.1	1.3	2.1	1.4	1.5	1.5	2.1	1.0	0.9	1.4	1.6	2.0		2.0	3.3	2.5
Total	358.0	211.8	342.3	492.0	265.5	313.9	344.4	386.4	425.4	420.5	502.6	382.9	542.3	551.9	387.9		566.4	477.9	674.0

Table 19.3.1 Official landings (in tonnes) of golden redfish, by area, 1978-2013 as officially reported to ICES. Landings statistics for 2014 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	45 538	569	64	80	46 251
2009	38 442	462	50	224	39 177
2010	36 155	620	220	1 653	38 648
2011	43 773	493	83	1 005	45 354
2012	43 089	491	41	2 017	45 635
2013	51 330	372	92	1 499	53 263
20141)	47 769	201	60	2 706	50 736

1) Provisional

Table 19.3.2 Golden redfish in Va. Observed catch in weight (tonnes) by age and years in 1995-2014. 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	2010	2011	2012	2013	2014
7	62	0	33	24	7	40	122	129	201	226	235	187	136	464	109	60	143	71	56	151
8	374	360	230	284	350	65	138	900	211	845	779	1063	453	1279	979	356	559	585	625	467
9	1596	825	481	595	1623	849	394	759	1366	497	1917	2217	1760	2244	1756	2204	1561	1603	2395	1747
10	9436	3701	1039	1208	1259	4290	1620	833	1120	2098	1519	3721	2480	5173	3153	2710	4519	3271	3991	5620
11	2719	9127	2701	1129	1855	1888	7746	3155	1194	789	3120	2143	3356	4053	5069	2770	5453	6532	6015	6014
12	1319	2102	11572	3245	2523	2268	1802	10939	3945	975	1908	2837	1923	4721	4503	4893	4869	7322	9500	5786
13	3518	1317	2822	12501	2441	1686	1977	3046	9749	2020	1371	1640	3070	2285	3426	3873	6248	4034	6876	5863
14	5671	1477	1365	2077	15504	2346	1246	2580	2349	8594	3007	1300	1048	2758	1827	2727	3811	4948	4003	4925
15	5971	4347	3108	2026	1238	14677	835	1820	1958	2131	11771	2827	953	1491	1974	1371	2462	2896	4424	3195
16	1730	5456	3599	2392	1246	1744	11486	2938	1204	1675	2056	10097	2150	1056	1229	1192	1381	1310	3010	2744
17	852	934	2981	3376	1791	1167	512	11695	2223	804	1433	2063	9261	1800	664	814	915	781	1711	2012
18	368	379	877	2025	2606	1574	766	2038	6330	1366	1231	1154	1308	8032	1482	643	639	696	1190	1347
19	1134	259	620	1002	2183	2359	1021	1119	748	5129	1229	666	733	1464	6023	1081	802	389	757	501
20	1128	340	910	714	1236	2099	1683	626	402	1104	6331	946	713	876	938	4972	845	899	474	1247
21	503	1157	444	512	452	528	914	1360	593	331	386	5433	861	516	635	897	5156	709	516	531
22	644	988	511	389	210	435	400	983	773	482	457	597	4708	802	561	757	1162	3557	705	456
23	1427	791	651	416	325	266	400	703	737	605	765	221	718	4062	330	569	754	499	3171	517
24	647	0	564	652	214	62	156	357	375	556	598	365	111	363	2495	661	220	368	204	3261
25	745	0	711	510	821	384	119	281	292	250	410	452	595	241	96	2147	66	257	197	200
26	365	0	267	391	264	330	109	176	73	102	97	71	323	407	96	264	1589	217	170	214
27	350	0	134	420	597	192	264	79	80	178	264	248	341	329	189	383	86	1408	99	139
28	725	0	192	352	226	508	182	288	26	136	162	194	195	163	91	131	177	208	803	69
29	0	0	136	52	104	357	142	479	102	134	28	161	35	163	381	176	47	83	36	721
30+	232	0	394	480	747	1076	1033	1287	524	660	1520	916	1131	795	438	506	309	447	406	40
Total	41516	33560	36342	36772	39822	41190	35067	48570	36575	31687	42594	41519	38362	45537	38444	36157	43773	43090	51334	47767

Table 19.3.3 Results of the GLM model to calculate standardized CPUE for Icelandic golden redfish fishery in Va. Note that the residuals are shown in Fig. 19.3.9.

```
Call:
glm(formula = lafli ~ ltogtimi + factor(ar) + as.factor(veman) +
    factor(skipnr) + factor(reitur), family = gaussian(), data = tmp)

Deviance Residuals:
    Min       1Q   Median       3Q      Max
-6.4139  -0.4713   0.0315   0.5031   7.8381

Coefficients:
                   Estimate Std. Error t value Pr(>|t|)
(Intercept)        4.917333   0.876835   5.608 2.05e-08 ***
ltogtimi           1.123516   0.003586 313.334  < 2e-16 ***
factor(ar)1979     0.041680   0.047178   0.883 0.376997
factor(ar)1980     0.143095   0.044494   3.216 0.001300 **
factor(ar)1981     0.194387   0.043819   4.436 9.17e-06 ***
factor(ar)1982     0.139999   0.043563   3.214 0.001311 **
factor(ar)1983     0.003101   0.042357   0.073 0.941638
factor(ar)1984    -0.003777   0.043701  -0.086 0.931123
factor(ar)1985     0.048689   0.044108   1.104 0.269653
factor(ar)1986     0.012195   0.043864   0.278 0.781005
factor(ar)1987     0.098549   0.044939   2.193 0.028314 *
factor(ar)1988     0.047076   0.045351   1.038 0.299258
factor(ar)1989     0.069109   0.045381   1.523 0.127803
factor(ar)1990     0.060588   0.045236   1.339 0.180459
factor(ar)1991     0.057138   0.040117   1.424 0.154374
factor(ar)1992    -0.136530   0.040346  -3.384 0.000715 ***
factor(ar)1993    -0.254184   0.040047  -6.347 2.21e-10 ***
factor(ar)1994    -0.265108   0.040882  -6.485 8.95e-11 ***
factor(ar)1995    -0.234088   0.041133  -5.691 1.27e-08 ***
factor(ar)1996    -0.225875   0.041519  -5.440 5.34e-08 ***
factor(ar)1997    -0.224488   0.041658  -5.389 7.12e-08 ***
factor(ar)1998    -0.150249   0.041890  -3.587 0.000335 ***
factor(ar)1999    -0.195277   0.041412  -4.715 2.42e-06 ***
factor(ar)2000    -0.049658   0.041488  -1.197 0.231349
factor(ar)2001     0.100519   0.042527   2.364 0.018100 *
factor(ar)2002     0.126804   0.042064   3.015 0.002574 **
factor(ar)2003     0.129320   0.043185   2.995 0.002750 **
factor(ar)2004     0.178750   0.043846   4.077 4.57e-05 ***
factor(ar)2005     0.113224   0.042494   2.664 0.007713 **
factor(ar)2006    -0.032306   0.041827  -0.772 0.439907
factor(ar)2007     0.016620   0.042755   0.389 0.697474
factor(ar)2008     0.013847   0.042118   0.329 0.742324
factor(ar)2009     0.046115   0.042368   1.088 0.276408
factor(ar)2010     0.077359   0.042528   1.819 0.068917 .
factor(ar)2011     0.308057   0.042833   7.192 6.45e-13 ***
factor(ar)2012     0.469463   0.043423  10.811  < 2e-16 ***
factor(ar)2013     0.556898   0.043335  12.851  < 2e-16 ***
factor(ar)2014     0.523193   0.043729  11.965  < 2e-16 ***
as.factor(veman)2  0.144551   0.017712   8.161 3.38e-16 ***
as.factor(veman)3  0.345441   0.016988  20.335  < 2e-16 ***
as.factor(veman)4  0.327880   0.017528  18.706  < 2e-16 ***
as.factor(veman)5  0.165737   0.019984   8.294  < 2e-16 ***
as.factor(veman)6  0.362572   0.018323  19.787  < 2e-16 ***
as.factor(veman)7  0.327200   0.017674  18.513  < 2e-16 ***
```

as.factor(veman)8 0.245485 0.017707 13.864 < 2e-16 ***
as.factor(veman)9 0.161327 0.017198 9.381 < 2e-16 ***
as.factor(veman)10 0.101764 0.017231 5.906 3.52e-09 ***
as.factor(veman)11 0.037417 0.018019 2.077 0.037844 *
as.factor(veman)12 -0.075603 0.019886 -3.802 0.000144 ***

(Dispersion parameter for gaussian family taken to be 0.7377318)
Null deviance: 159817 on 62727 degrees of freedom
Residual deviance: 45975 on 62319 degrees of freedom
AIC: 159344
Number of Fisher Scoring iterations: 2

Analysis of Deviance Table
Model: gaussian, link: identity
Response: lafli
Terms added sequentially (first to last)

	Df	Deviance	Resid. Df	Resid. Dev	F	Pr(>F)	
NULL			62727	159817			
ltogtimi	1	96166	62726	63651	130353.525	< 2.2e-16	***
factor(ar)	36	4115	62690	59536	154.955	< 2.2e-16	***
as.factor(veman)	11	1175	62679	58361	144.740	< 2.2e-16	***
factor(skipnr)	206	9174	62473	49187	60.367	< 2.2e-16	***
factor(reitur)	154	3212	62319	45975	28.275	< 2.2e-16	***

Table 19.4.1 Results from the Gadget model of total biomass, spawning stock biomass, recruitment at age 5, catch and fishing mortality, projections are in italic.

Year	Biomass	SSB	R(age5)	Catches	F9-19
1971	605.4	369.8	202.9	67.9	0.100
1972	607.7	365.2	184.8	50.9	0.077
1973	650.3	374.2	443.3	43.7	0.066
1974	683.4	388.4	210.5	50.6	0.073
1975	701.9	398.4	124.1	61.9	0.088
1976	707.0	396.1	207.8	94.4	0.134
1977	716.7	400.1	196.6	53.8	0.079
1978	743.8	423.7	129.2	48.7	0.066
1979	761.2	440.5	161.7	77.2	0.099
1980	751.2	441.8	105.4	89.1	0.114
1981	721.6	431.8	75.3	102.0	0.135
1982	664.4	402.6	63.4	130.3	0.184
1983	598.9	366.0	67.6	106.0	0.162
1984	546.3	337.0	73.4	95.3	0.154
1985	509.2	313.8	131.7	78.5	0.132
1986	479.2	294.1	122.1	76.9	0.140
1987	443.3	271.8	64.7	76.6	0.152
1988	395.7	241.3	41.4	89.8	0.205
1989	355.1	215.1	44.9	56.6	0.145
1990	355.3	199.3	352.7	66.3	0.192
1991	334.2	182.4	59.0	56.0	0.179
1992	315.4	168.9	40.1	55.8	0.196
1993	299.1	157.7	54.8	50.2	0.194
1994	288.9	151.9	64.8	42.5	0.172
1995	308.1	151.6	334.8	44.3	0.182
1996	313.9	154.1	89.9	35.6	0.144
1997	313.7	156.1	41.3	39.0	0.153
1998	315.5	161.0	41.7	39.7	0.153
1999	313.4	162.2	86.9	42.5	0.162
2000	308.6	164.1	50.9	42.6	0.158
2001	315.4	168.3	115.5	36.7	0.131
2002	319.0	169.4	125.7	50.7	0.178
2003	335.4	173.4	193.6	38.2	0.134
2004	353.3	184.7	112.6	32.8	0.111
2005	375.4	193.7	183.9	46.6	0.154
2006	402.1	204.3	197.0	42.1	0.140
2007	418.2	216.3	107.1	39.2	0.125
2008	443.3	233.9	134.5	46.2	0.139
2009	476.2	251.3	218.4	39.3	0.110
2010	510.0	276.5	142.7	38.5	0.098
2011	525.5	298.7	42.4	45.1	0.106
2012	531.8	312.4	79.9	45.2	0.100
2013	544.7	327.8	120.0	53.1	0.111
2014	547.8	335.4	120.0	50.6	0.102
2015	557.2	346.7	120.0	49.1	0.096
2016	562.8	354.2	120.0	51.0	0.098
2017	567.0	359.8	120.0	51.6	0.098
2018	570.2	363.9	120.0	51.9	0.098
2019	572.9	366.9	120.0	52.1	0.098

Table 19.4.2 Output from short term prognosis. Multiplier is based on reference to the adopted HCR $F_{9\text{-}19}$=0.097. Biomasses are in the beginning of the year to apply to ICES standard in short term prognosis in other places in the report they are in the middle of the year. NOT UPDATED

F(2014)=0.101 C(2014)=47.300 tons.

2015				
Bio 5+	SSB	Fmult	F9-19	Landings
507	342	1.043	0.101	48.5

		2015		2016		
Fmult	F9-19	Bio 5+	SSB	Landings	Bio 5+	SSB
0.0	0	516	352	0	574	404
0.1	0.01	516	352	4.9	569	399
0.2	0.019	516	352	9.7	564	395
0.3	0.029	516	352	14.5	559	391
0.4	0.038	516	352	19.3	554	387
0.5	0.048	516	352	24	549	382
0.6	0.058	516	352	28.7	544	378
0.7	0.067	516	352	33.4	539	374
0.8	0.077	516	352	38	535	370
0.9	0.087	516	352	42.7	530	366
1.0	0.097	516	352	47.3	525	362
1.1	0.107	516	352	51.8	520	358
1.2	0.117	516	352	56.4	516	354
1.3	0.127	516	352	60.9	511	350
1.4	0.137	516	352	65.4	506	346
1.5	0.147	516	352	69.8	502	342
1.6	0.158	516	352	74.3	497	338
1.7	0.168	516	352	78.7	493	334
1.8	0.178	516	352	83	488	330
1.9	0.189	516	352	87.4	484	326
2.0	0.199	516	352	91.7	479	322

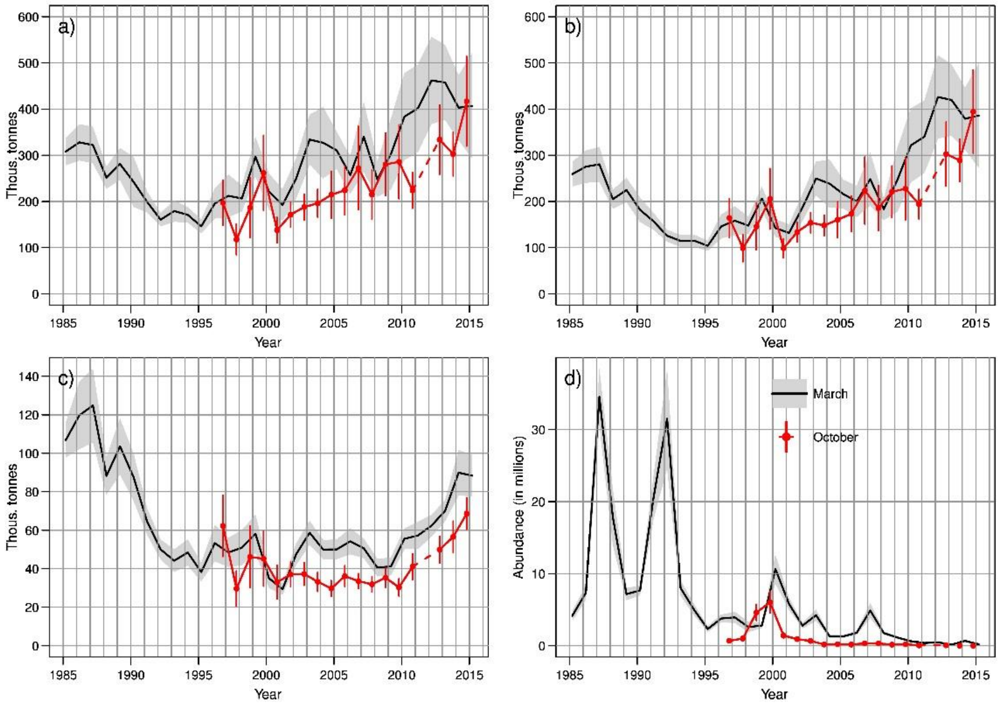

Figure 19.2.1 Indices of golden redfish from the groundfish surveys in March 1985-2015 (line, shaded area) and October 1996-2014 (red and vertical lines). a) Total biomass; b) biomass of fish larger than 32 cm; c) biomass of fish larger than 40 cm; d) indices of juvenile golden redfish (4-11) cm in millions. The shaded area and the vertical bar show ±1 standard error of the estimate.

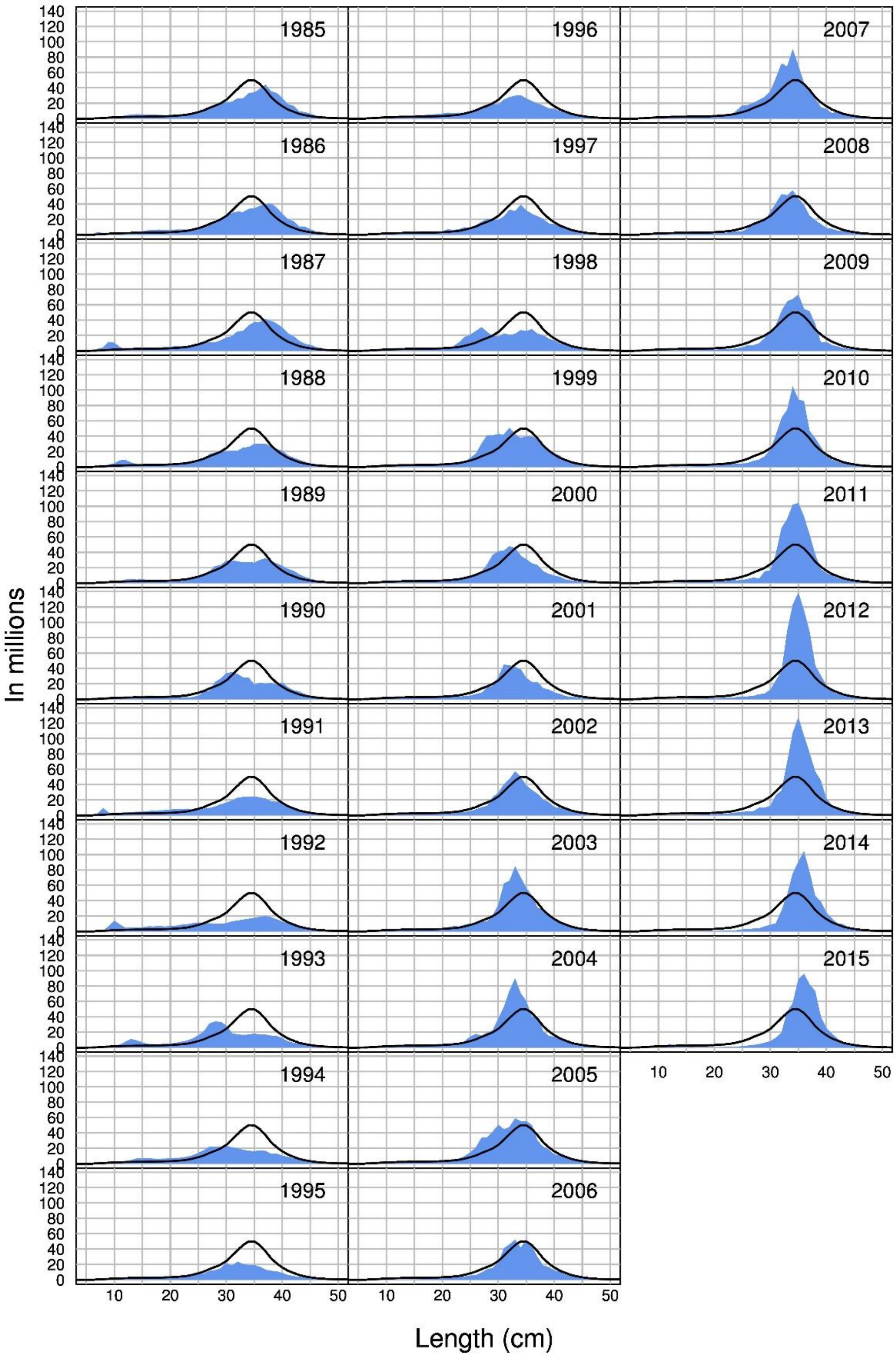

Figure 19.2.2. Length disaggregated abundance indices of golden redfish from the bottom trawl survey in March 1985-2015 conducted in Icelandic waters. The black line is the mean of total indices 1985-2015.

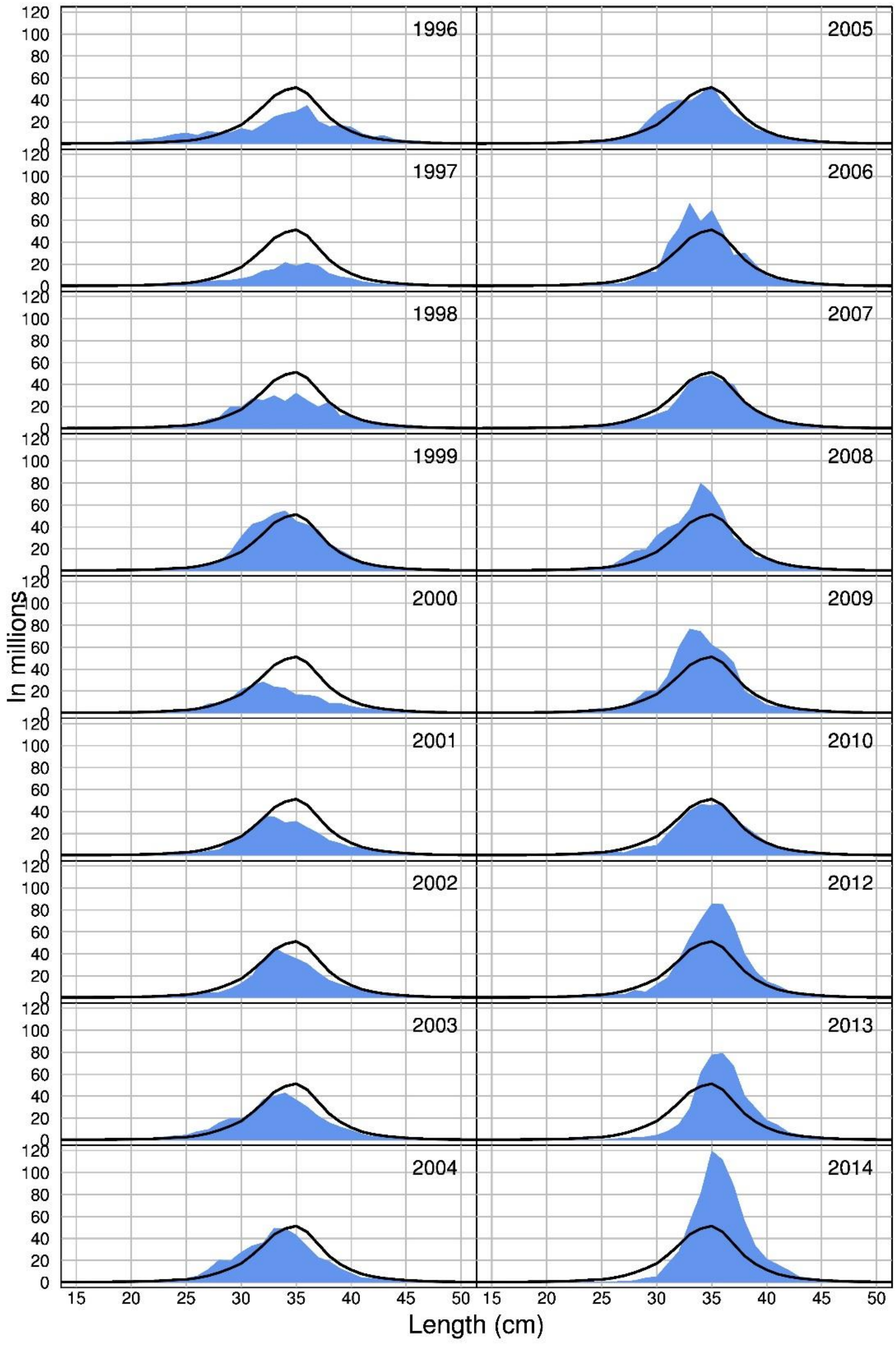

Figure 19.2.3. Length disaggregated abundance indices of golden redfish from the bottom trawl survey in October 1996-2014 conducted in Icelandic waters. The black line is the mean of total indices 1996-2014. The survey was not conducted in 2011.

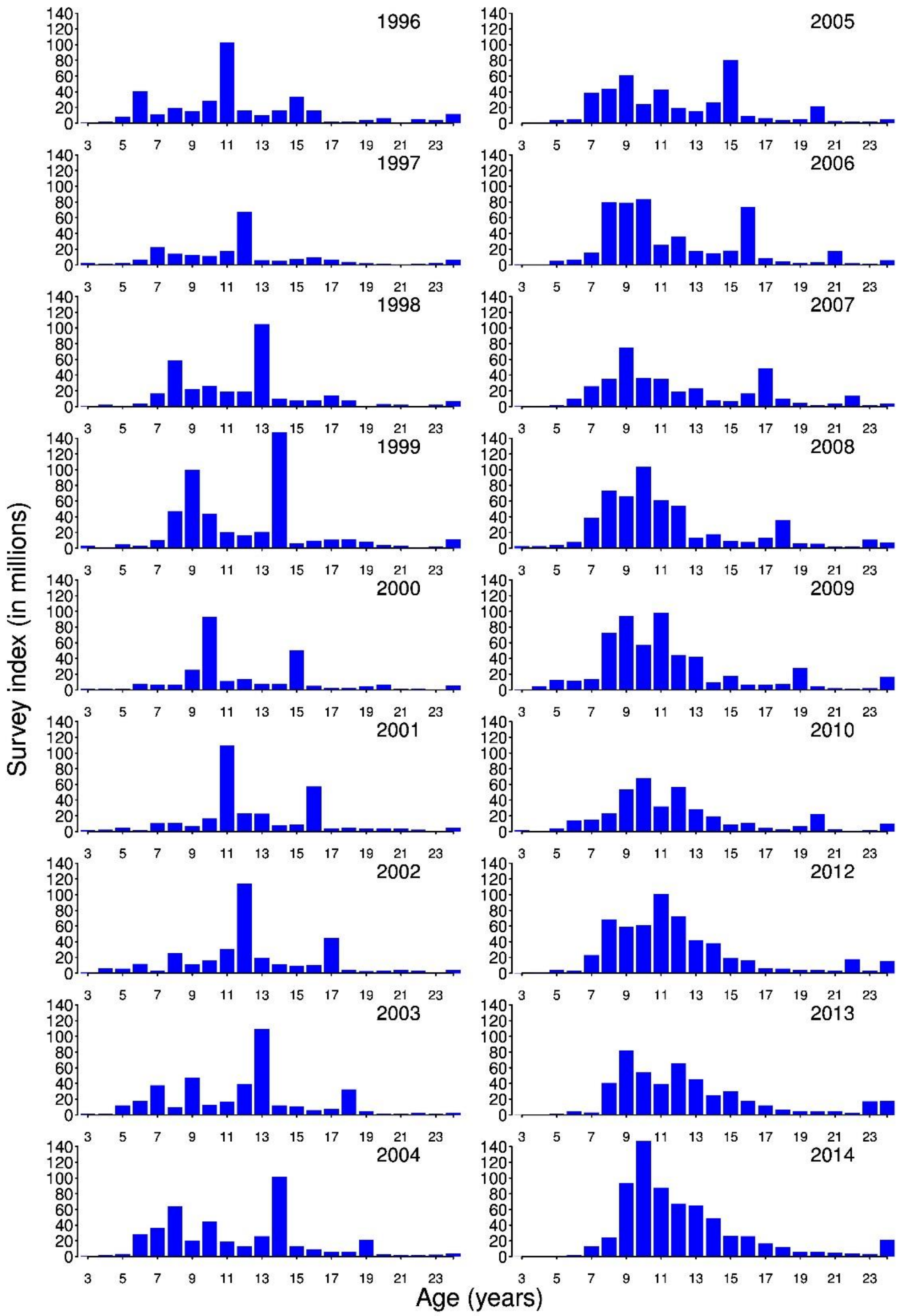

Figure 19.2.4 Age disaggregated abundance indices of golden redfish in the bottom trawl survey in October conducted in Icelandic waters 1996-2014. The survey was not conducted in 2011.

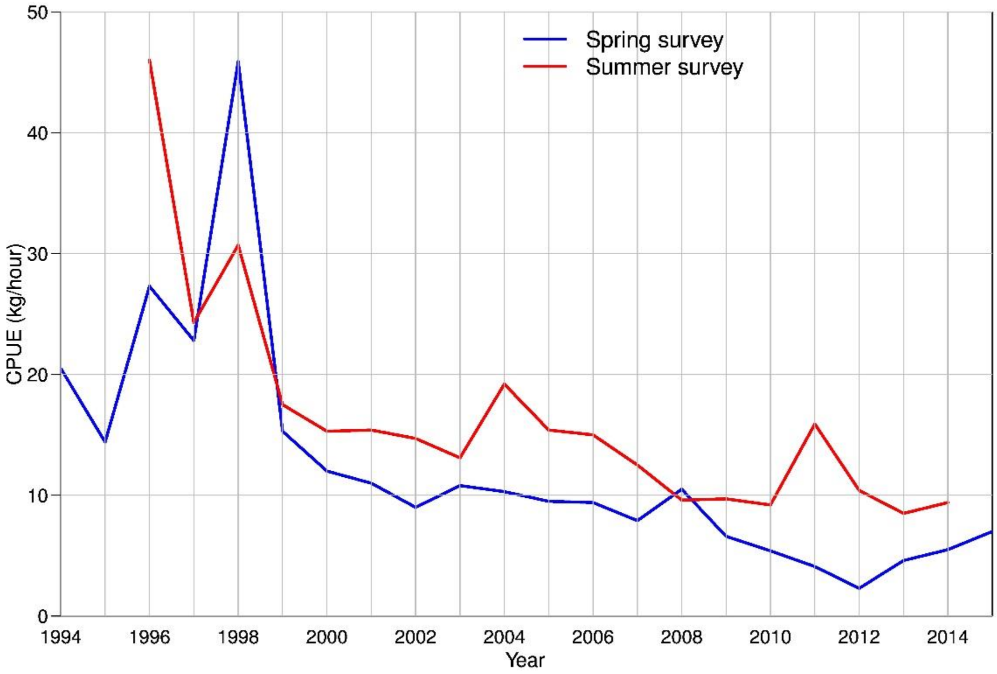

Figure 19.2.5 CPUE of golden redfish in the Faeroes spring groundfish survey 1994-2015 and the summer groundfish survey 1996-2014 in ICES Division Vb.

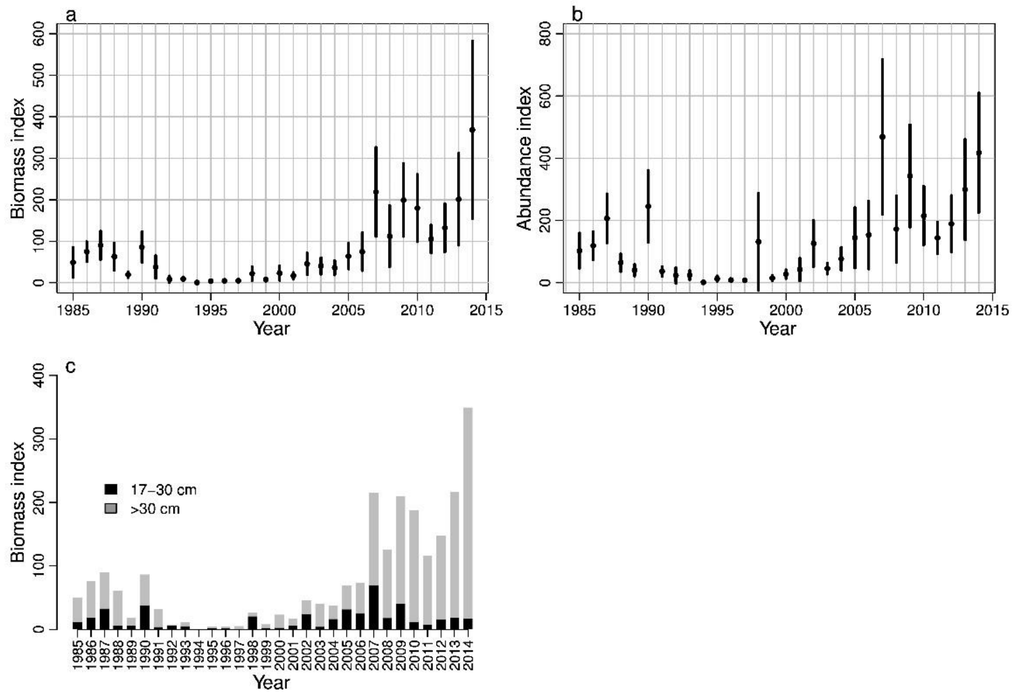

Figure 19.2.6 Golden redfish (>17 cm). Survey abundance indices for East and West Greenland from the German groundfish survey 1985-2013. a) Total biomass index, b) total abundance index, c) biomass index divided by size classes (17-30 cm and > 30 cm).

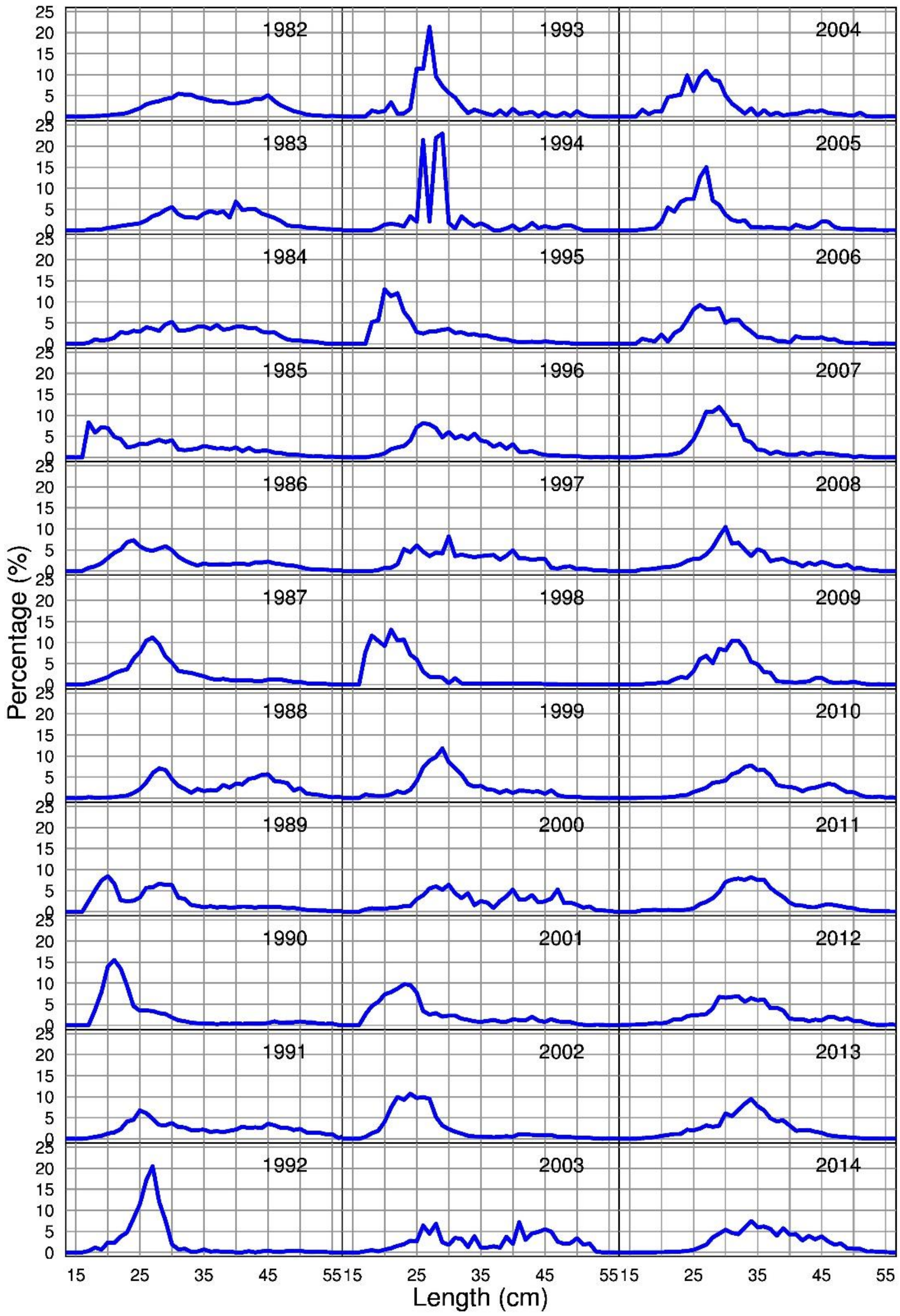

Figure 19.2.7 Golden redfish (>17 cm). Length frequencies for East and West Greenland 1982-2014.

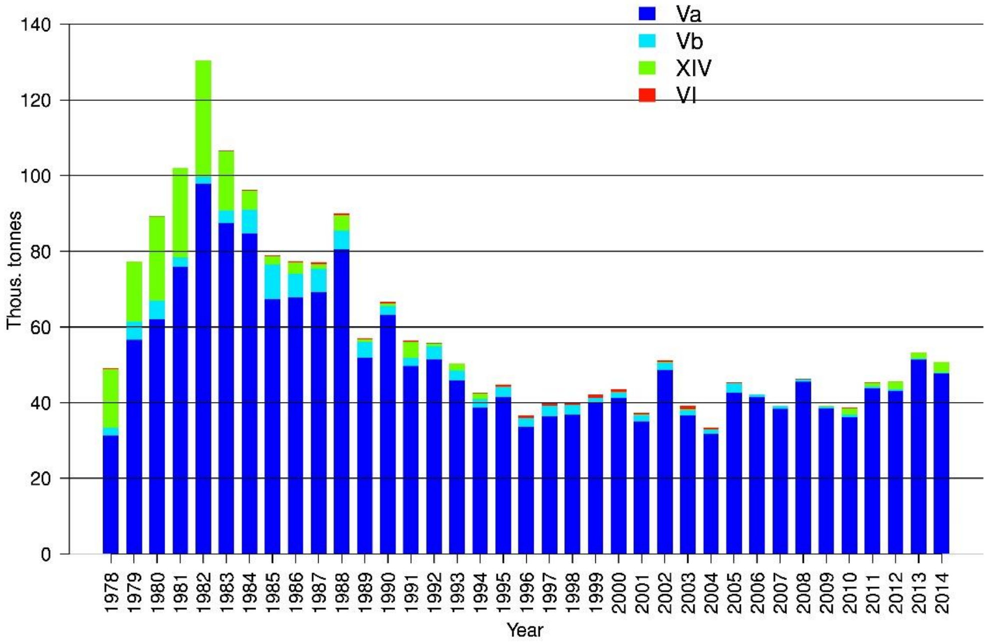

Figure 19.3.1 Nominal landings of golden redfish in tonnes by ICES Divisions 1978-2014. Landings statistics for 2014 are provisional.

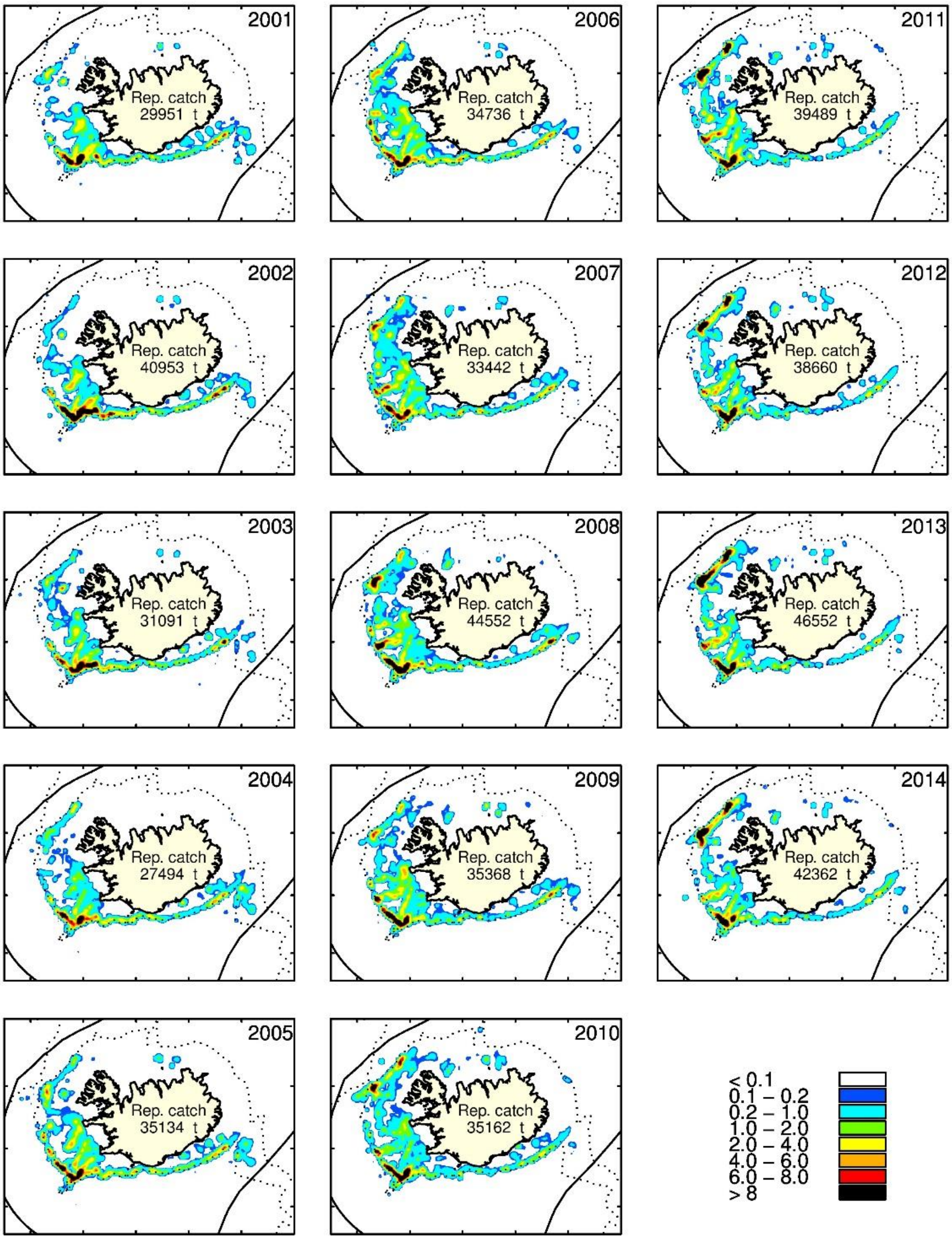

Figure 19.3.2 Geographical distribution of golden redfish bottom trawl catches in Division Va 2001-2014.

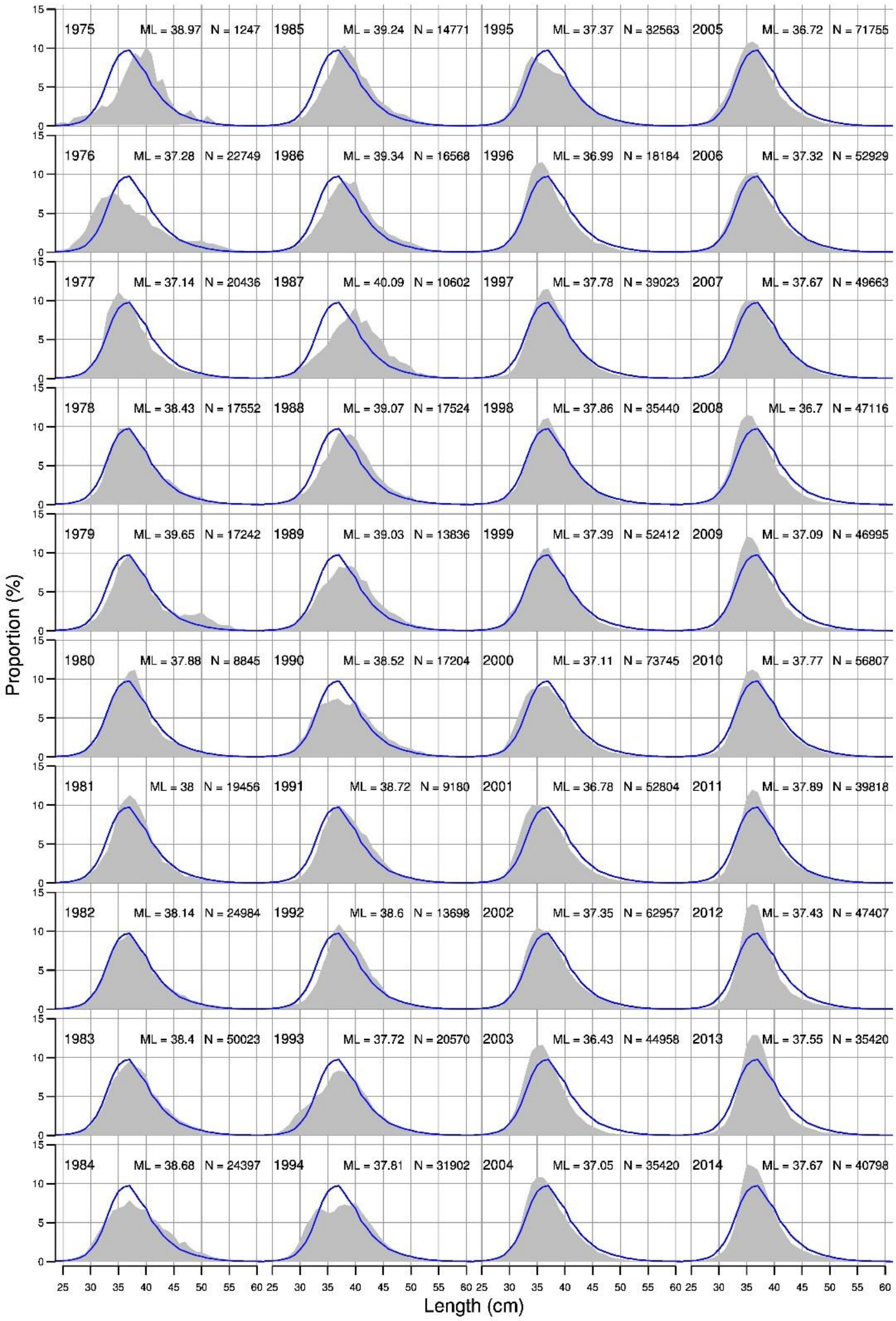

Figure 19.3.3 Length distribution (gray shaded area) of golden redfish in the commercial landings of the Icelandic bottom trawl fleet 1975-2014. The blue line is the mean of the years 1975-2014.

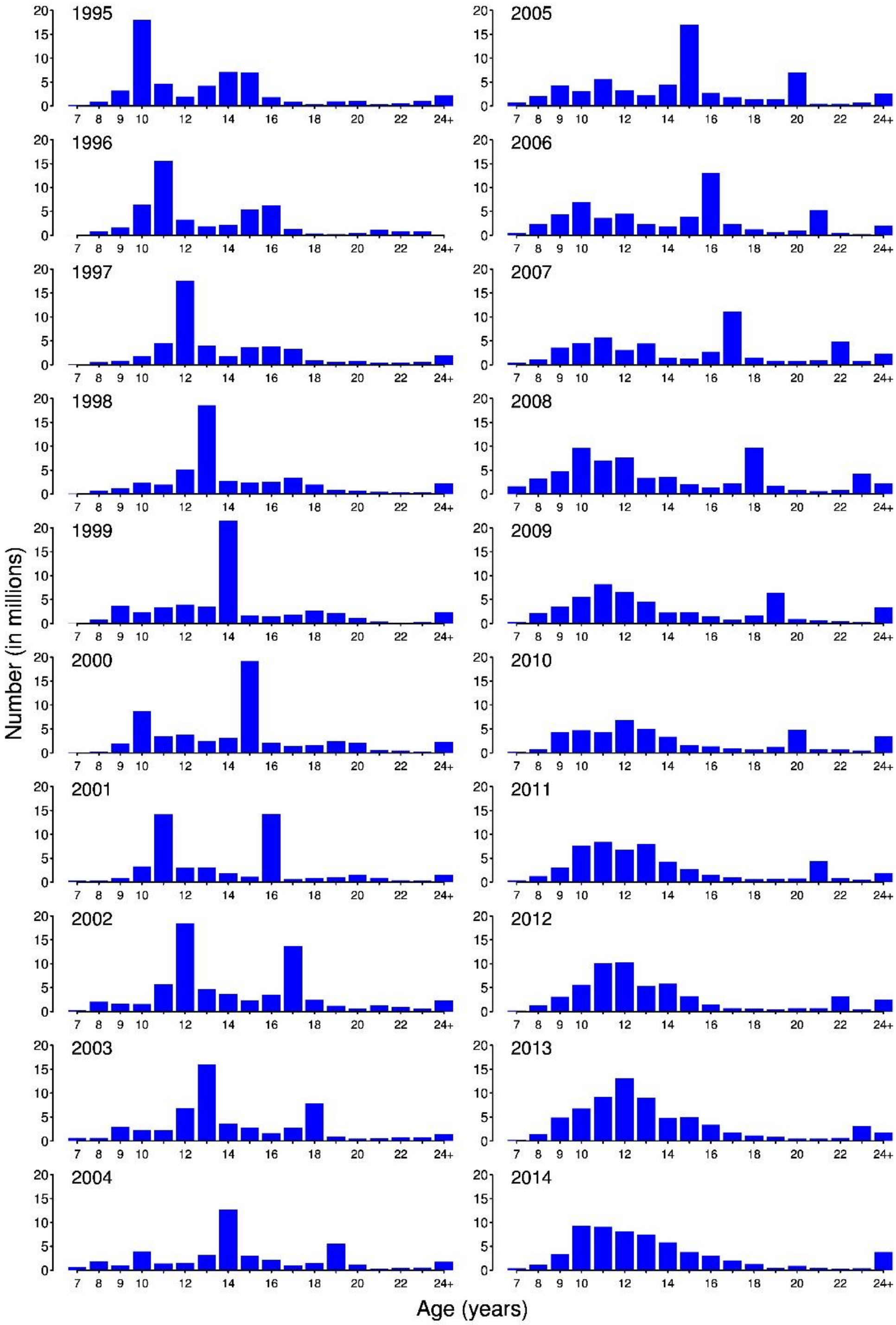

Figure 19.3.4 Catch-at-age of golden redfish in numbers in ICES Subdivision Va 1995-2014.

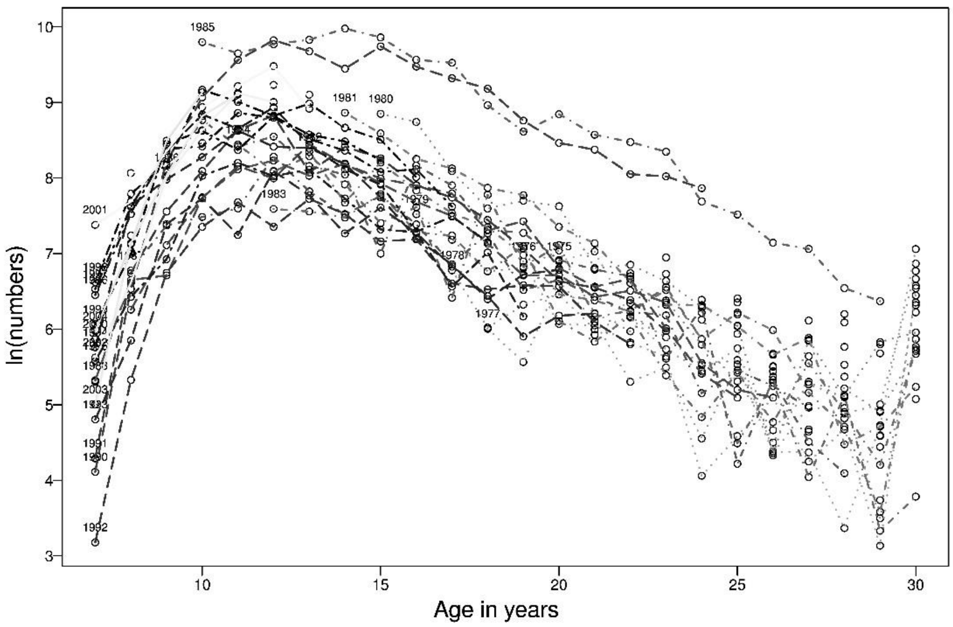

Figure 19.3.5 Catch curve of golden redfish based on the catch-at-age data in ICES Division Va 1995-2014.

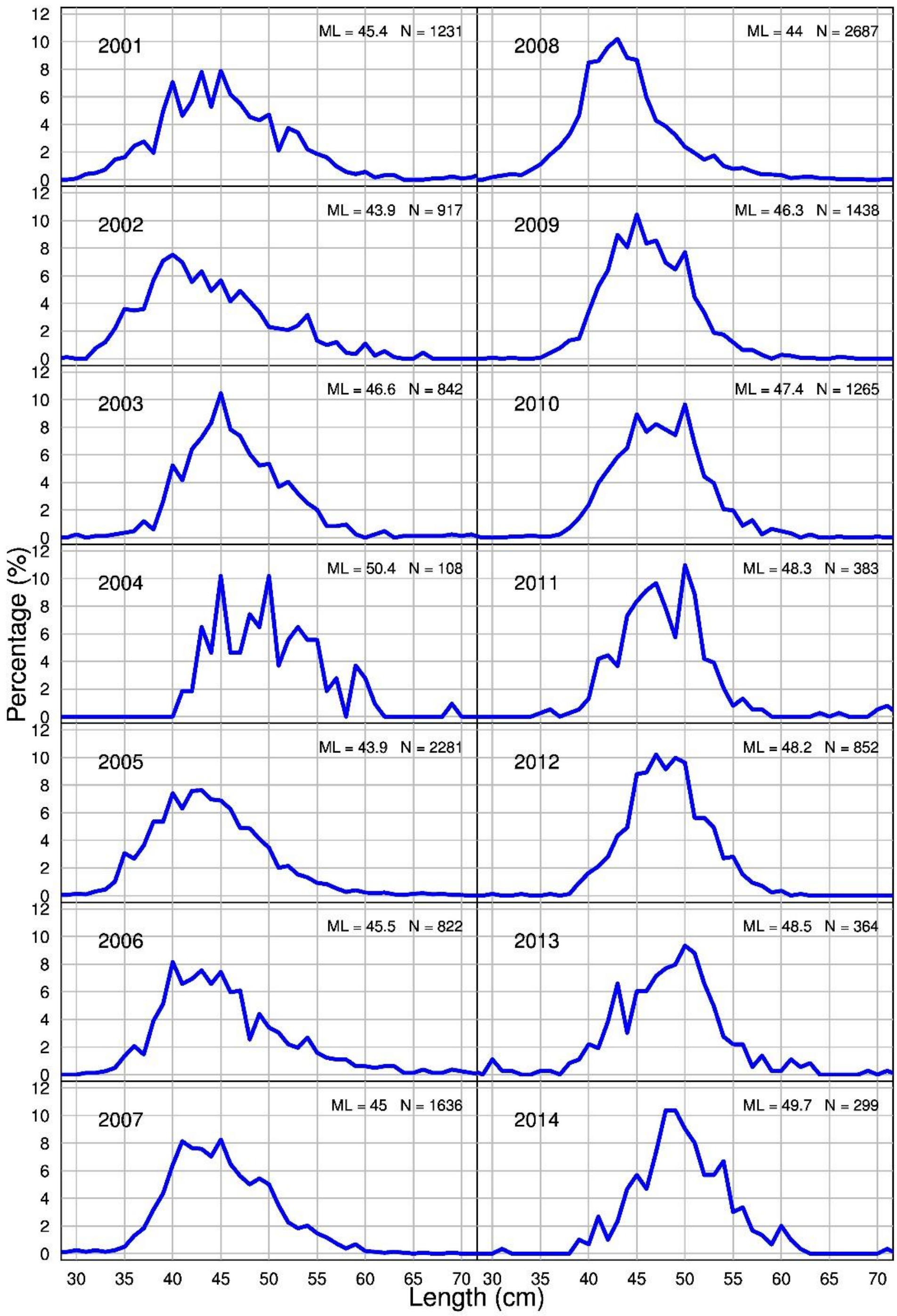

Figure 19.3.6 Length distribution of golden redfish from Faroese catches in 2001-2014.

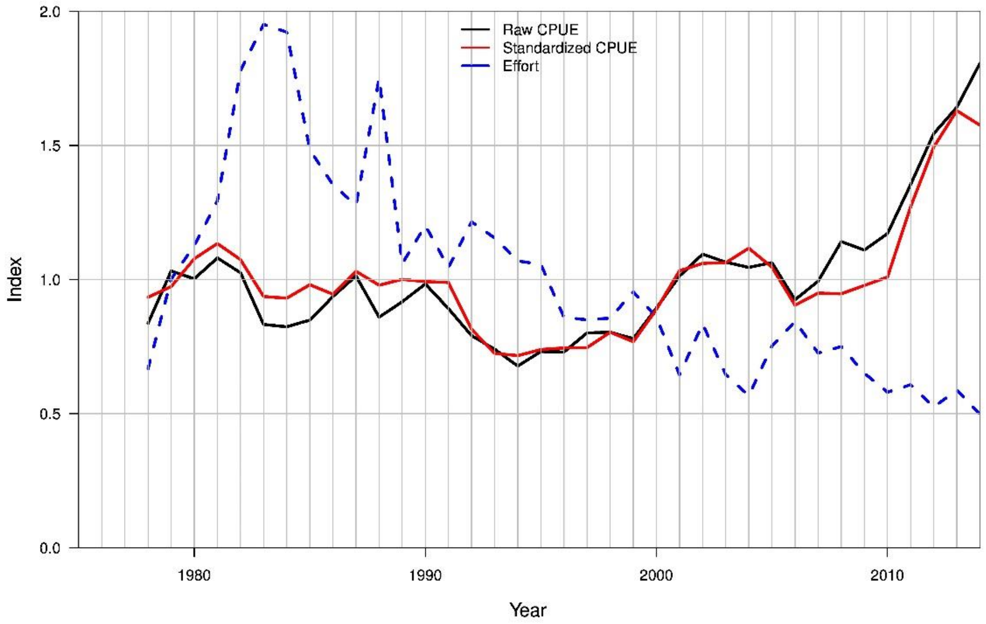

Figure 19.3.7 CPUE of golden redfish from Icelandic trawlers based on results from the GLM model 1978-2014 where golden redfish catch composed at least 50% of the total catch in each haul. The figure shows the raw CPUE index (sum(yield)/sum(effort)), standardized CPUE index estimated using a generalized linear model, and effort (blue dotted line).

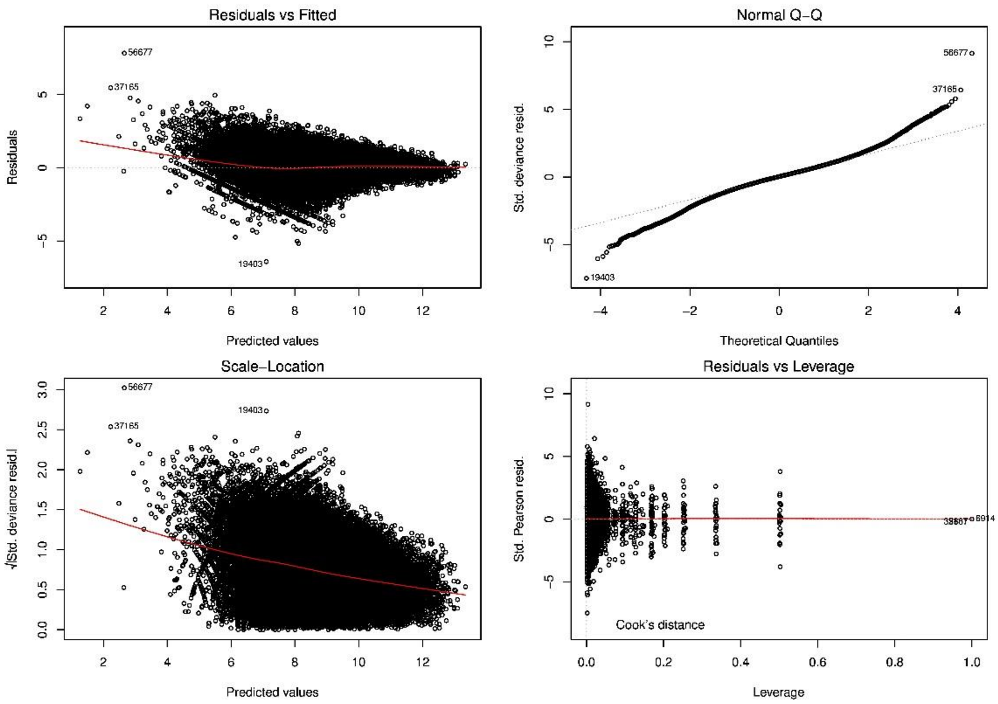

Figure 19.3.8 Results from the GLM modle (section 8.2.1) for the CPUE series of golden redfish in Va. From left to right, top to bottom: Residuals against fitted values; square root of the absolute value of residuals against predicted values; response against fitted values; normal QQplot of standardized residuals.

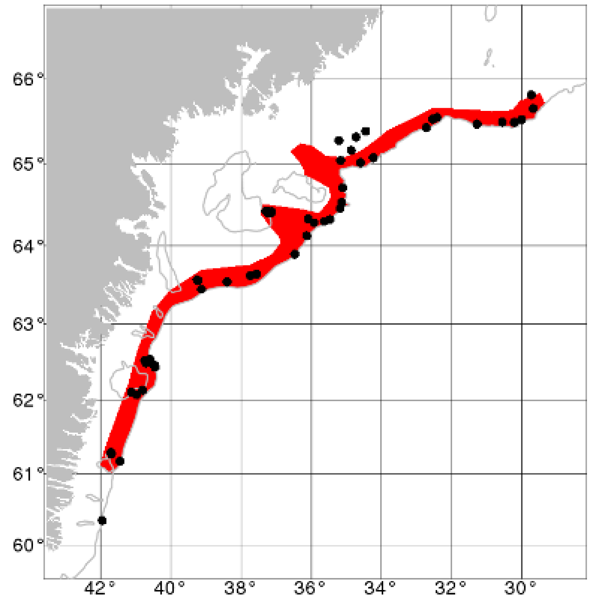

Figure 19.4.1 Stations in the German survey in East Greenland with an area used to compile the indices for Gadget shown. This area corresponds to giving a weight of 0.5 to the results in Figure 19.2.7.

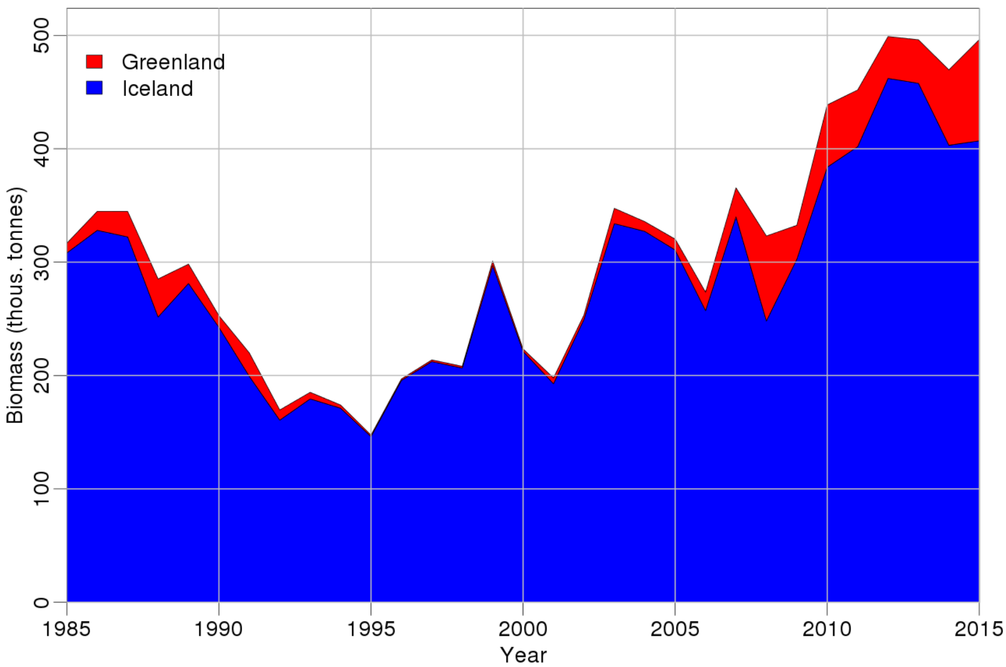

Figure 19.4.2 Biomass index from Iceland (blue) and Greenland black, based on weighting the German survey data in Figure 19.2.7 by 0.5.

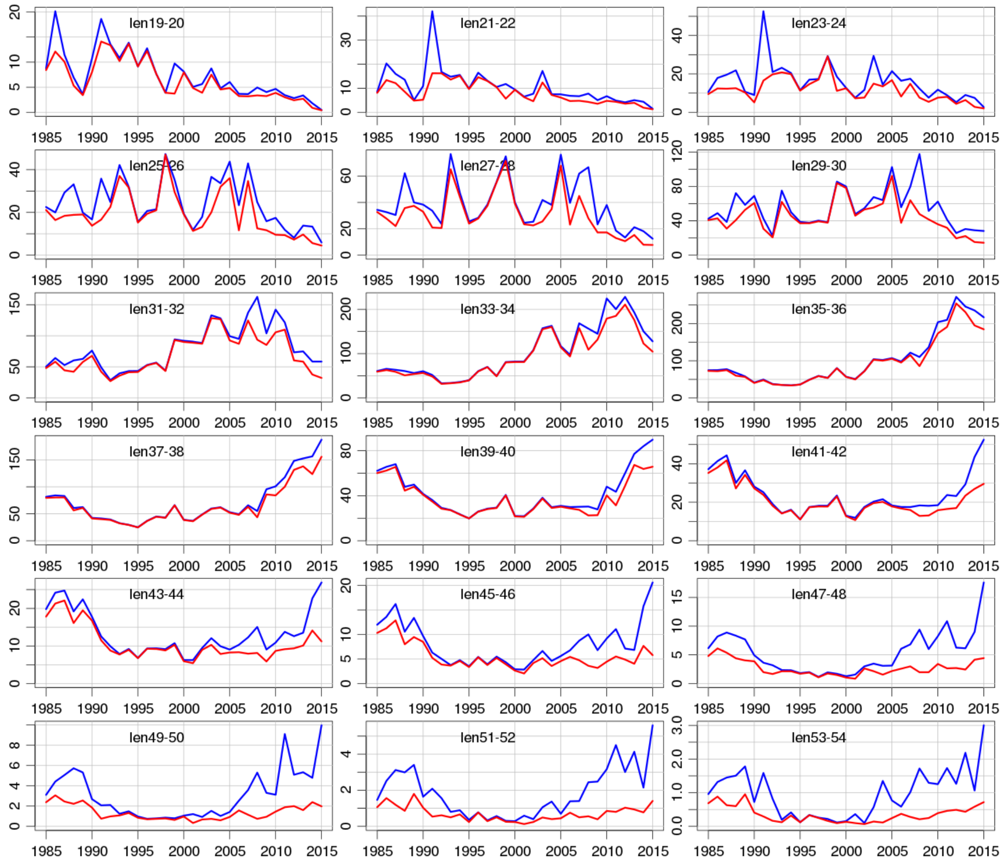

Figure 19.4.3. Indices from the Icelandic March survey (red) and Icelandic March survey plus German survey in Greenland (blue) by length group.

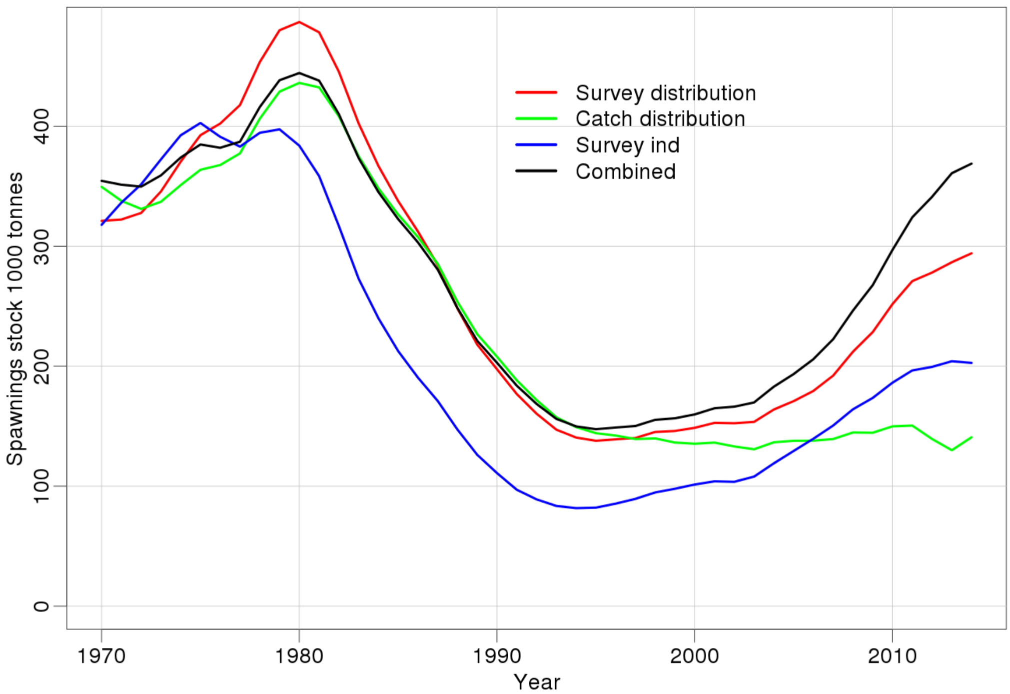

Figure 19.4.4. Development of SSB from run where certain components of the likelihood function weighted much more than the other components.

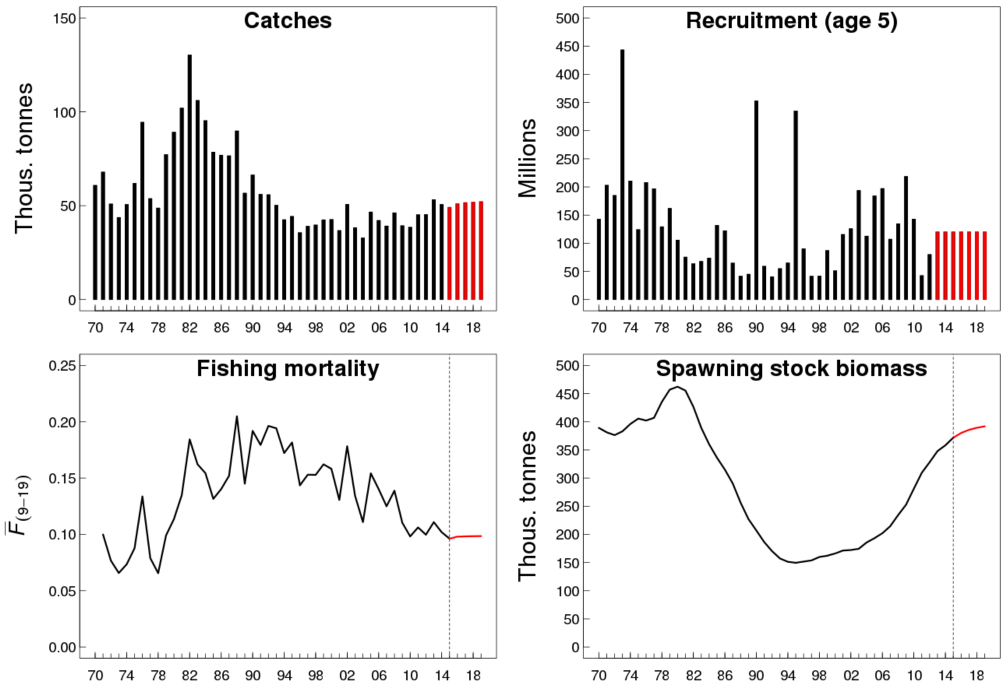

Figure 19.4.5. Summary from the assessment. Red values are predictions. Spawning stock is compiled using a fixed maturity ogive with L50=33cm.

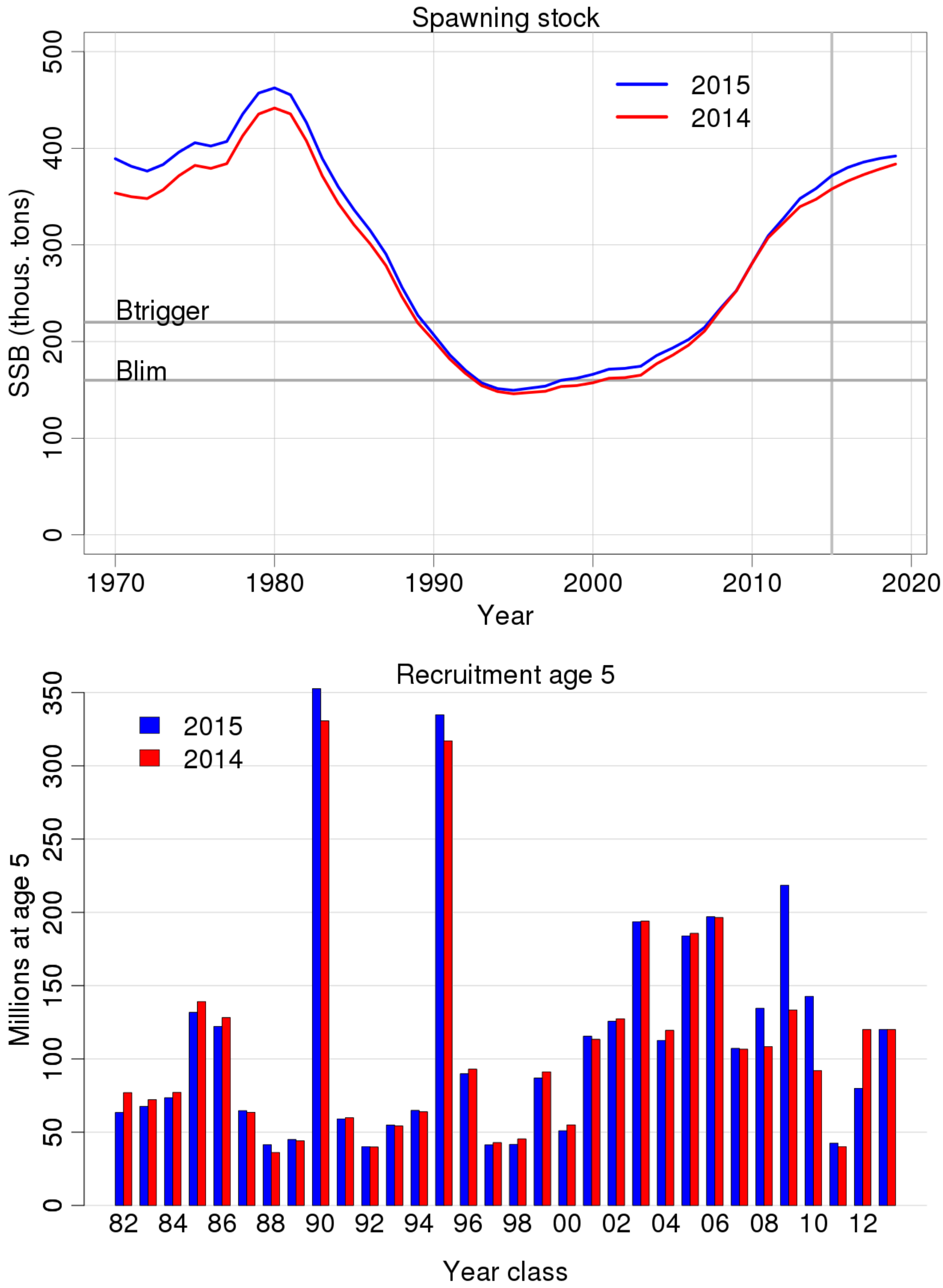

Figure 19.4.6. Comparison of the current assessment and the same assessment done in 2014.

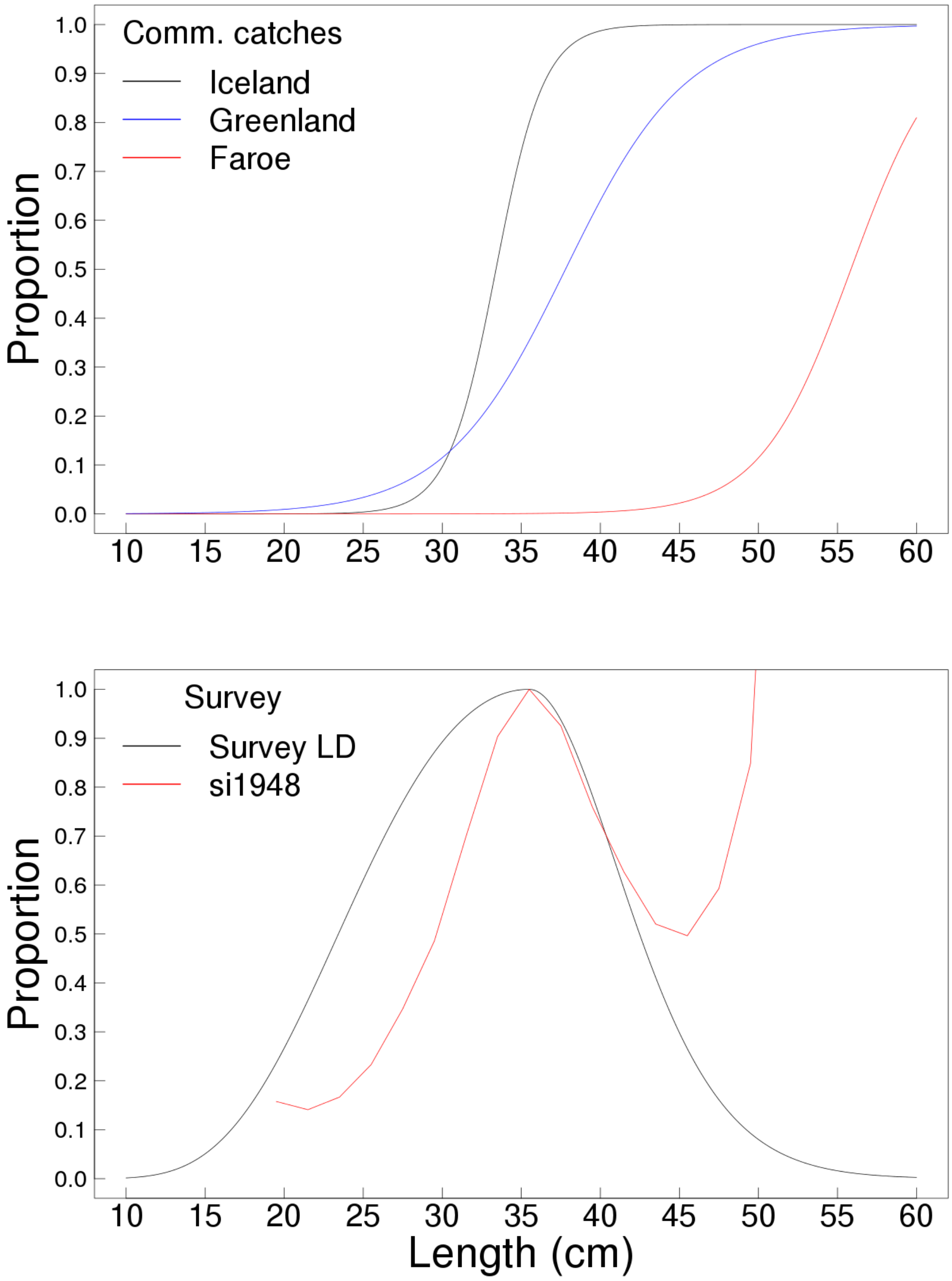

Figure 19.4.7. Estimates of selection curves from commercial catches (upper panel) and from the Icelandic March survey. The black line is the estimated selection curve fitted to the length distributional data (Figure 19.4.14) and the red line is the estimated q from the disaggregated tuning indices, scaled to one.

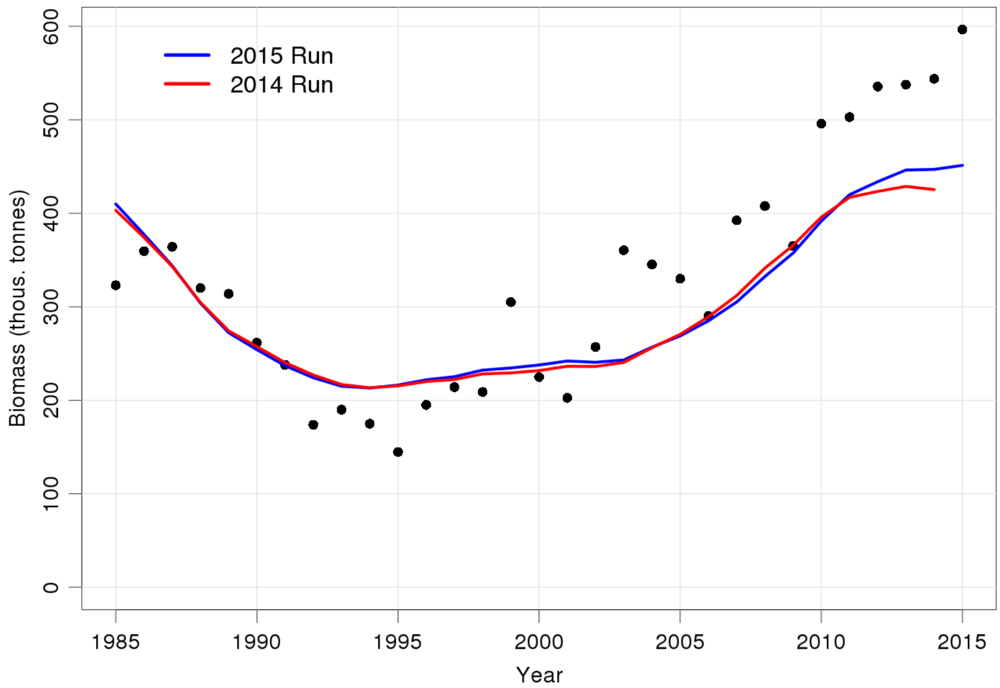

Figure 19.4.8. Comparison of observed and predicted survey biomass from the 2014 (red line) and 2015 (blue) runs.

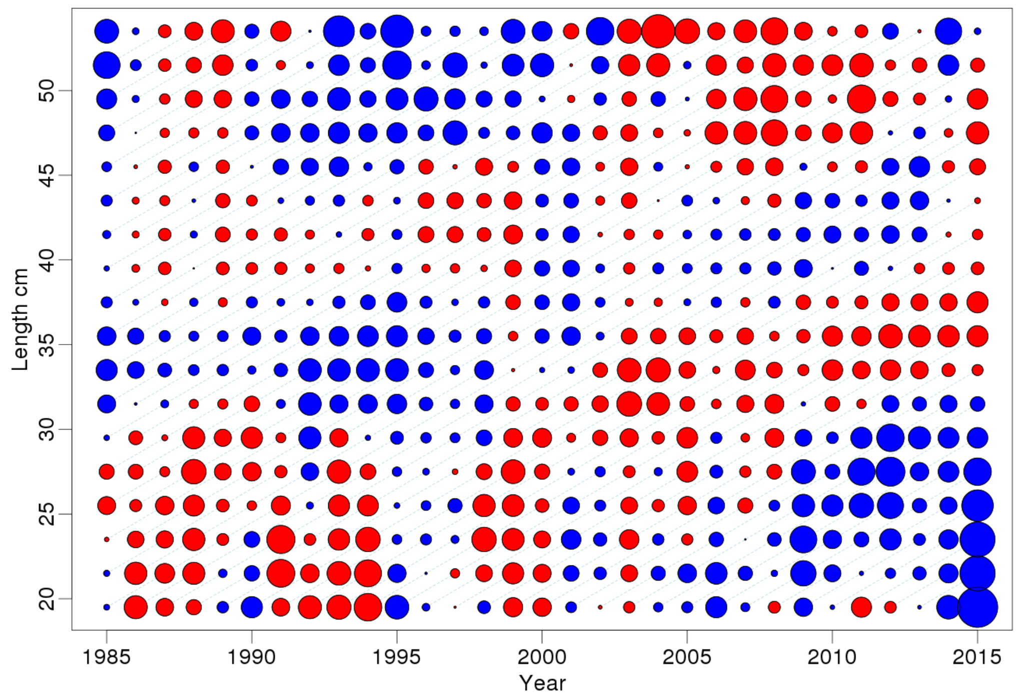

Figure 19.4.9. Residuals from the fit between model and survey indices. The red circles indicate positive residuals (survey results exceed model prediction). Largest residuals correspond to log(obs/mod) = 1

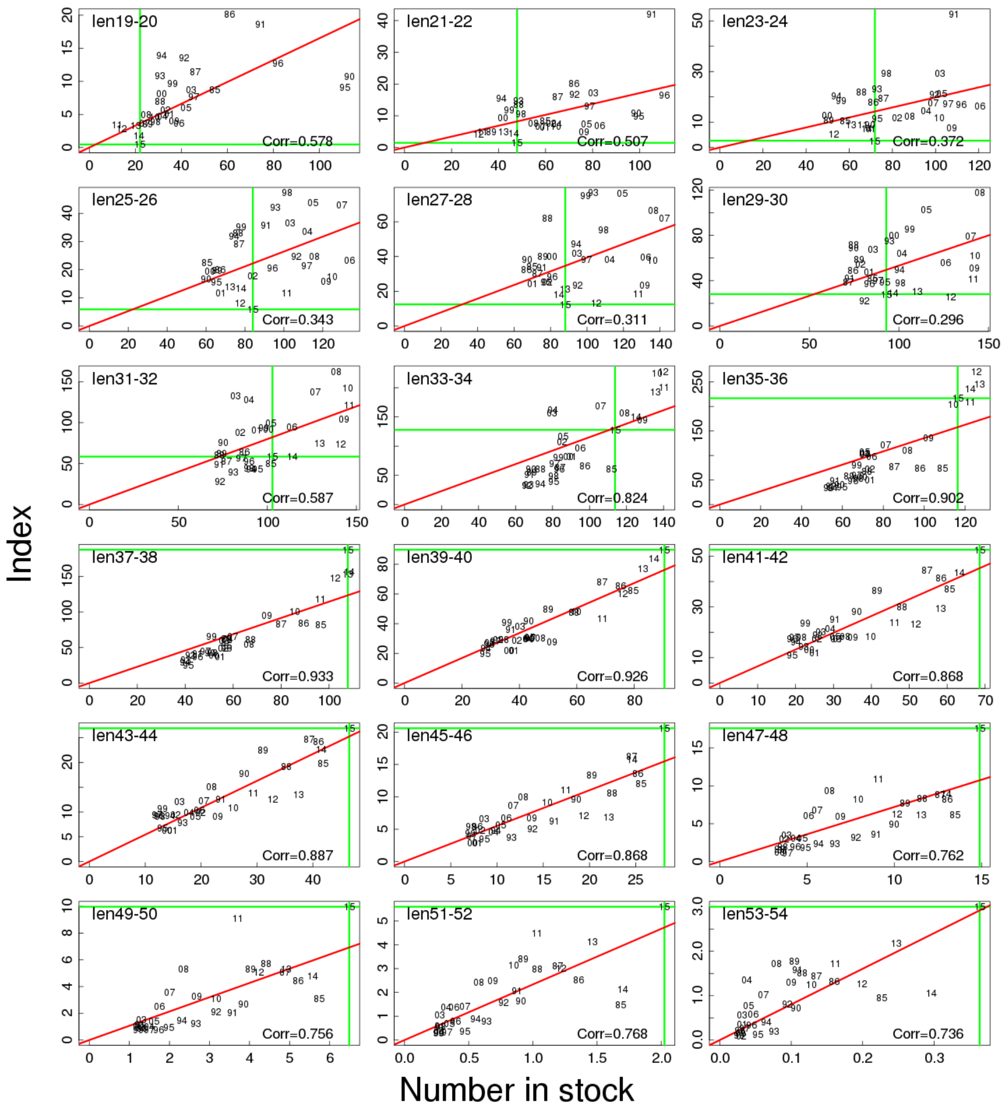

Figure 19.4.10. Fit to length disaggregated survey indices from Gadget run as XY-scatter. The red line is fitted going through the 0-point, the green cross goes over the terminal year.

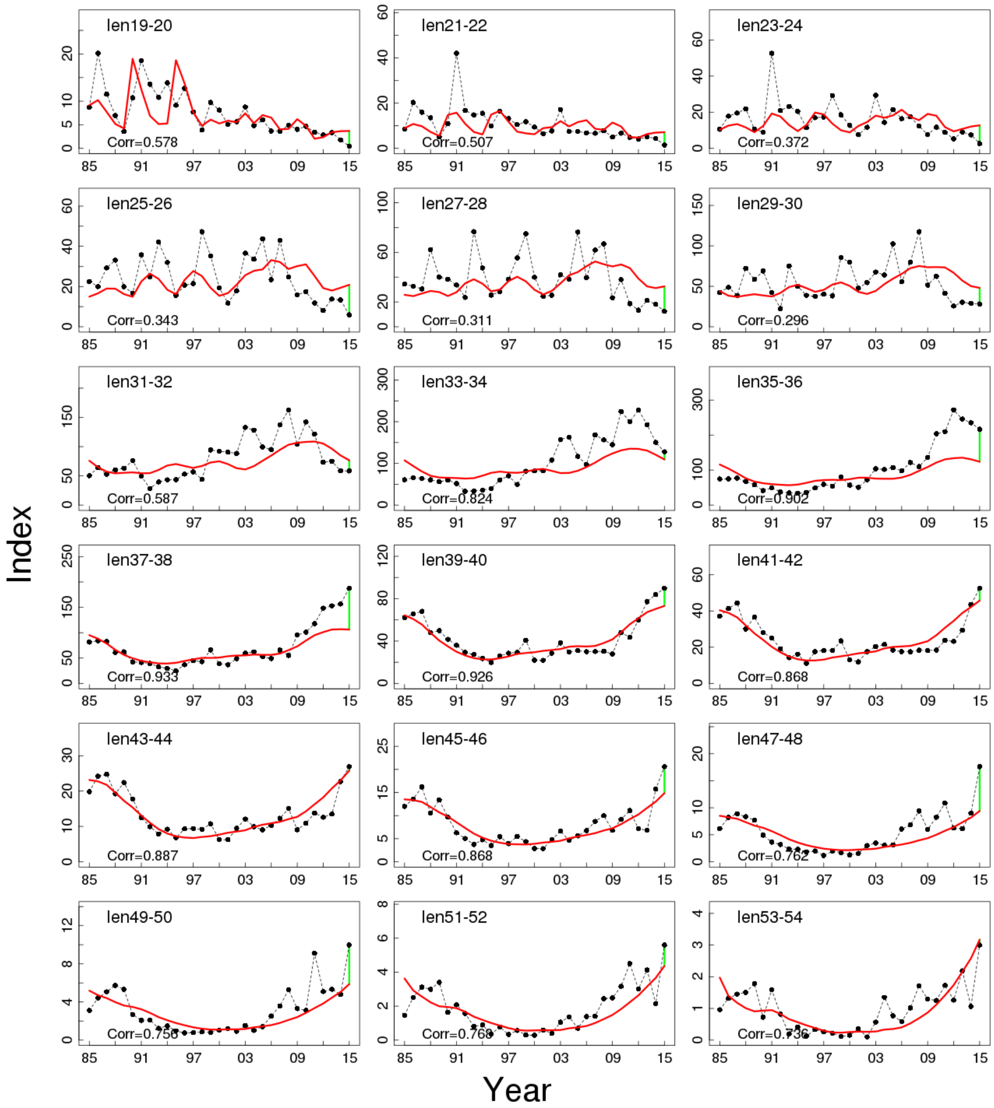

Figure 19.4.11. Fit (red lines) to length disaggregated survey indices (broken lines and points) from Gadget run as time series.

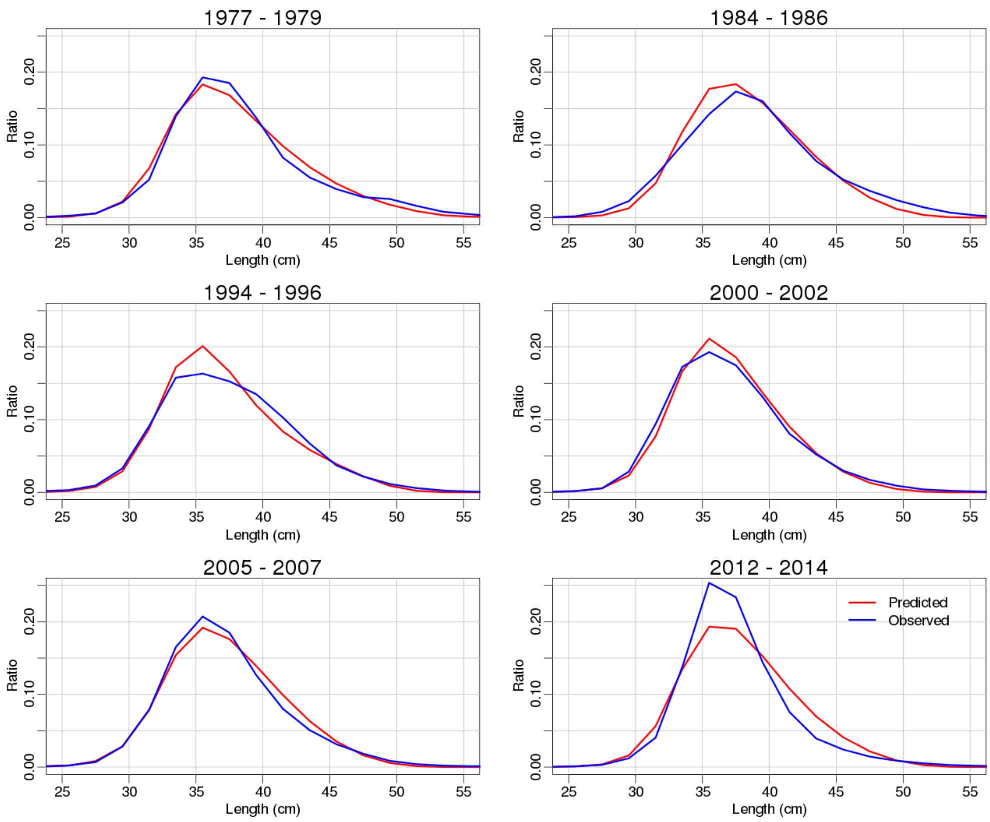

Figure 19.4.12. Fit (red line) to Icelandic commercial length distributions aggregated by 3 years.

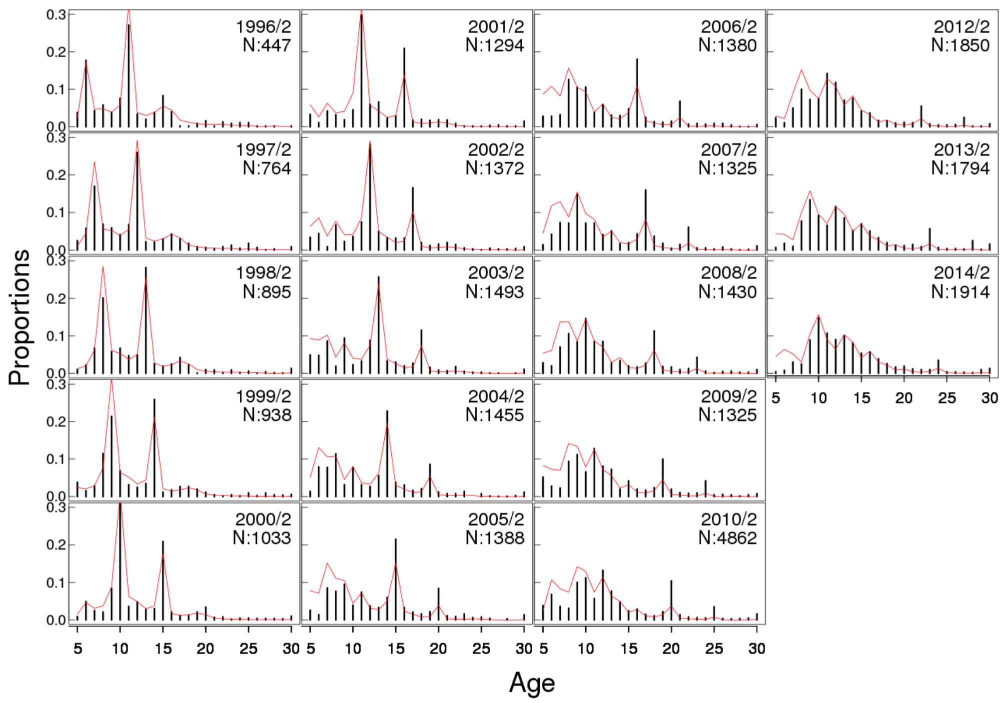

Figure 19.4.12. Fit to survey age data (run 1). Bars represent the data and red lines the fit. The likelihood data are used in the model as proportions in each 2cm length group but presented here as total for each age group something that should only be comparable if catchability was independent of size (age).

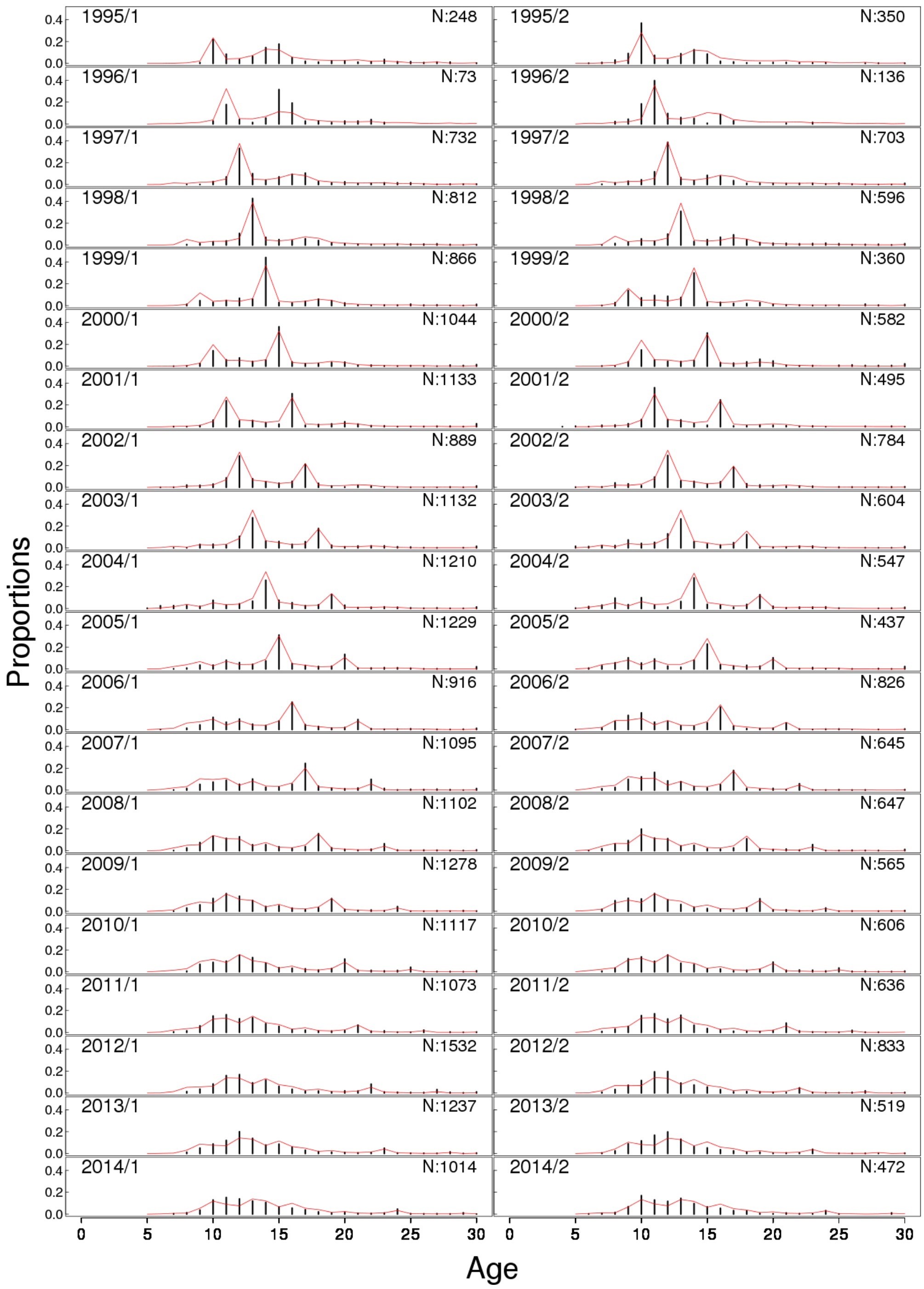

Figure 19.4.13. Predicted (red) and observed (blue) age distributions from Icelandic commercial fishery.

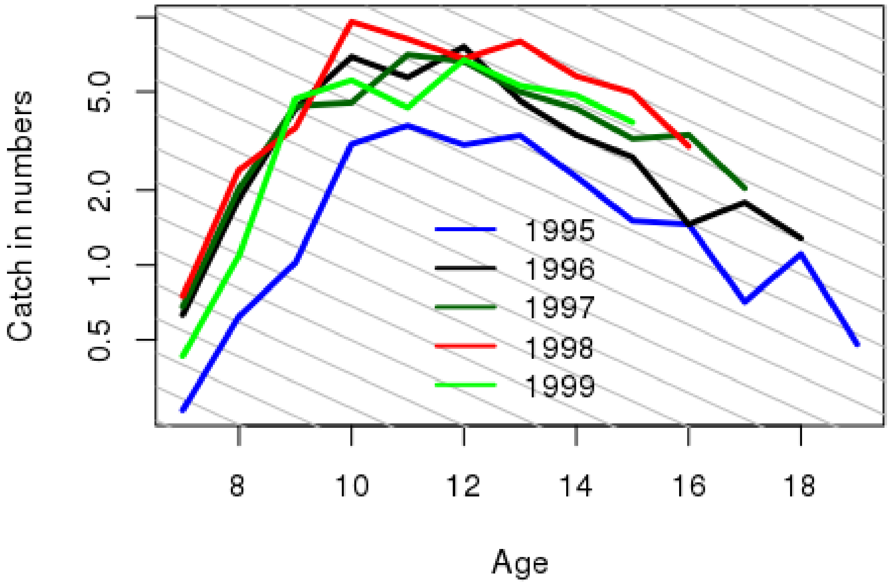

Figure 19.4.14 Catch in numbers by age for year-classes 1995-1999 plotted on log scale. The grey lines correspond to Z=0.24 that is the calculated average Z for age 12+ for these year-classes.

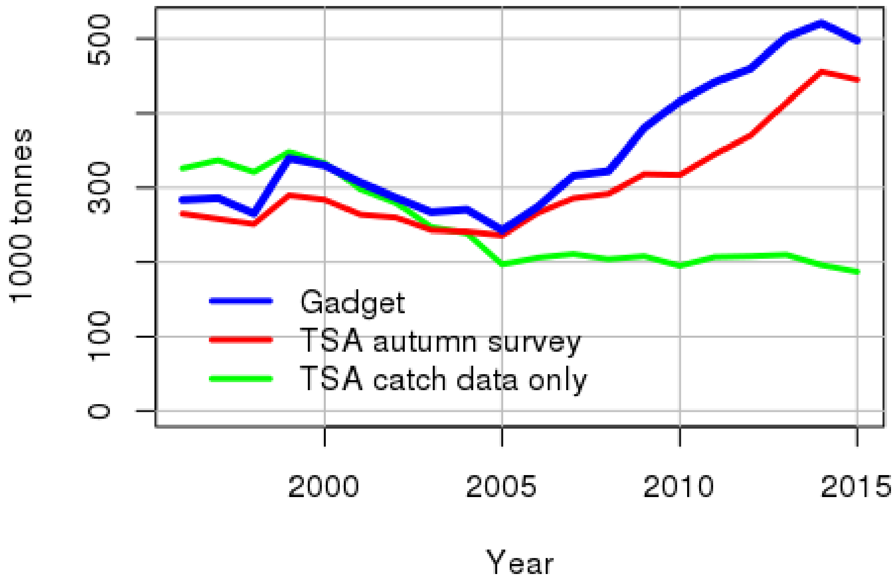

Figure 19.4.15 Estimated. Biomass of ages 9 – 19 from the Gadget and TSA assessments. All biomasses compiled based on the calculated mean weight at age in the catches.

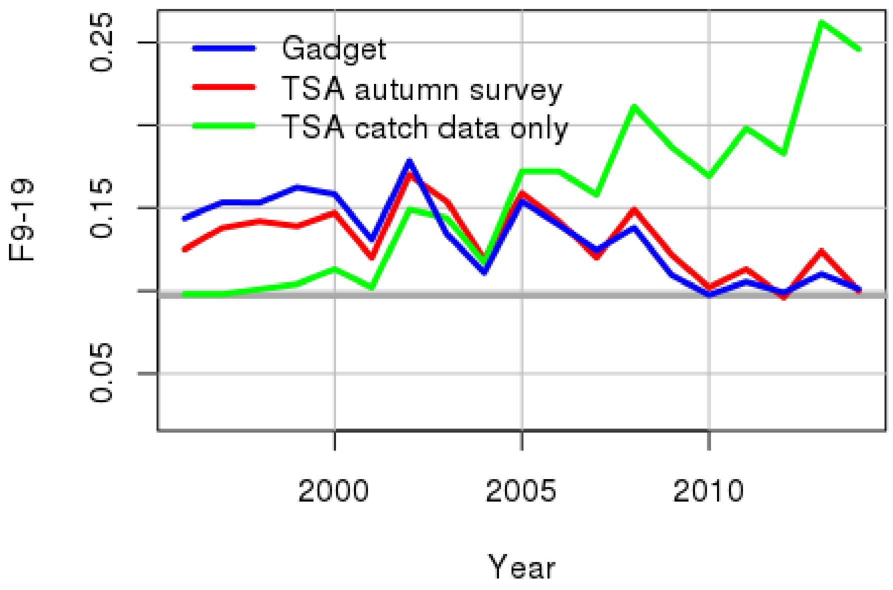

Figure 19.4.15 Estimated average fishing mortality of age 9 – 19 from the Gadget and TSA assessments.

20 Icelandic slope *Sebastes mentella* in Va and XIV

Executive summary

ICES concluded in February 2009 that *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 a separate biological stock and management unit.

Total landings of demersal *S. mentella* in Icelandic waters in 2014 were about 9 500 t, 750 t more than in 2013.

No analytical assessment was conducted and there are no biological reference points for the species. Survey indices from the annual autumn survey since 2000 are used as basis for advice.

Available survey biomass indices show that in Division Va the biomass has gradually decreased from 2006 to 2013, but increased in 2014.

The East-Greenland shelf is most likely a nursery area for the stock. No new recruits (>18 cm) are seen in the survey catches of the German survey and the Greenland shrimp and fish shallow water survey conducted in the area and no juveniles are present (<18 cm) recent years.

Icelandic slope *S. mentella* is considered a data limited stock (DLS) and follows the ICES framework for such (Category 3.2). When the precautionary approach is applied, catches in 2016 should be no more than 9954 t. All catch are assumed to be landed.

20.1 Stock description and management units

The stock structure of *S. mentella* in the Irminger Sea and adjacent water is described in Chapter 18 and Stock Annex. 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 Stock Annex, including the Icelandic slope one.

20.2 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 1500 m, does, therefore, not cover the whole distribution of the stock. Data for Icelandic slope *S. mentella* from the Autumn Survey is available from 2000-2014. No survey was conducted in 2011. A description of the autumn survey is given in Stock Annex for the species.

The total biomass index and the abundance indices from the autumn survey were highest in 2001. After a decrease in 2003 the index increased again in 2006 but gradually decreased until 2013 and to similar level as in 2003 when it was lowest in the time series (Table 20.2.1 and Figure 20.2.1*a* and *b*). The biomass index increased again in 2014 to similar level as in 2004 (Table 20.2.1 and Figure 20.2.1*a* and *b*). The biomass index of fish larger than 45 cm was at lowest level in 2007 but increased again in 2009 were it was at similar level until 2013 (Figure 19.2.1*c*). Sharp increase in biomass index of 45 cm and larger fish in 2014 and was at the highest in the time series.

The abundance index of fish smaller than 30 cm has in 2007—2014 been at lowest level (Figure 20.2.2*d*). 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—43 cm in 2012—2014 (Figure 20.2.2). Very little Icelandic slope *S. mentella* smaller than 35 cm was observed in the 2014 survey.

Otoliths have been sampled since 2000 and otoliths from the 2000, 2009 and 2010 surveys have been age read. Figure 20.2.3 shows that the 1985 and the 1990 year classes are the most abundant ones in this samples.

20.3 Information from the fishing industry

20.3.1 Landings

Total annual landings of Icelandic slope *S. mentella* from ICES Division Va 1978—2014 are presented in Table 20.3.1 and from 1950—2014 in Figure 20.3.1. Annual landings gradually decreased from a record high of 57 000 t in 1994 to 17 000 t in 2001. Landings in 2001-2010 fluctuated between 17 000 t and 20 500 except in 2003 and 2008 when annual landings were 28 500 t and 24 000 respectively. The landings in 2014 were about 9 500 t, 700 t more than 2013. The decrease is related to lower TAC for the species.

20.3.2 Fisheries and fleets

Most of the fishery for Icelandic slope *S. mentella* in Va is a directed bottom 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 20.3.2). The proportion of Icelandic slope *S. mentella* catches taken by pelagic trawls 1991-2000 varied between 10 and 44% of the total landings (Table 20.3.2). In 2001-2014, no pelagic fishery occurred or it was negligible except in 2003 and 2007 (see Stock Annex). In general, the pelagic fishery was mainly in the same areas as the bottom trawl fishery (Figure 20.3.3), but usually in later months of the year (Figure 19.3.4). The bottom trawl catches in the third and fourth quarter of the year decreased considerable in 2001-2007 compared with earlier years but increased again in 2008—2012 (Figure 20.3.4).

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 20.3.2). This area has historically been an important fishing area for Icelandic slope *S. mentella*.

20.3.3 Sampling from the commercial fishery

The table below shows the 2014 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. Otoliths from the commercial catch have been collected, but no systematic age reading is done.

Year	Nation	Gear	Landings (t)	No. samples	No. length measured
Va	Iceland	Bottom trawl	9 500	84	14 490

20.3.4 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 20.3.5). 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—2014 peaked around 39—42 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 20.3.5).

20.3.5 Catch per unit effort

Trends in both standardized (glm) and raw CPUE and effort are shown in Figure 20.3.6. CPUE gradually decreased from 1978 to a record low in 1994, but has since then slightly increased annually to 2000. The CPUE estimate in 2014 was at similar level as in late 1980s and about 40% higher than it was in 1994. The CPUE has been stable since 2010. From 1991 to 1994, when CPUE decreased, the fishing effort increased drastically. Since then, effort decreased and is now at similar level as in the early 1980s. Output of the model is given in Table 20.3.3 and the model residuals in Figure 20.3.7.

20.3.6 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.

20.4 Methods

No analytical assessment was conducted on this stock.

20.5 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.

Icelandic slope beaked redfish in ICES Division Va has previously been assessed based on trends in survey biomass indices from the Icelandic Autumn survey or in ICES "trends based assessment". Supplementary data used in the assessment includes information from the fishery and length distributions from the commercial catch and the Autumn Survey. ICES advised in 2013, based on DLS approach (Method 3.2), that catches are set no higher than 9 875 t in 2014. Same advice was applied for the 2015 fishing year. The TAC set by the Icelandic government was 10 000 t in 2014 and 2015.

20.6 State of the stock

The Group concludes that the state of the stock is on a low level. With the information at hand, current exploitation rates cannot be evaluated for the Icelandic slope *S. mentella* in Division Va.

The fishable biomass index of Icelandic slope *S. mentella* from the Icelandic autumn survey shows that the biomass index for 2004—2013 has decreased to similar level as in 2003 when it was at lowest level, but increased again in 2014. The survey was not conducted in 2011. 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.

In 2000-2008, good recruitment was been observed in the German survey 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. The German survey and the Greenland shrimp and fish shallow water survey both show no new recruits (>18 cm) and no juveniles are present (<18 cm). This suggests that the fishery in coming years will be based on the same cohorts.

20.7 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 slightly increased annually since a record low in 1994, especially in recent 3-4 years and is now 40% higher than in 1994. 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 2008-2012 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 advice for 2014 and 2015 were 9875 t based on the DLS approach (Category 3.2).

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* but the species is within the TAC system described in Chapter 7.5. Icelandic authorities gave until the 2010/2011 a joint quota for golden redfish and Icelandic slope *S. mentella* in Icelandic waters, but now give separate quotas for the species.

20.8 Basis for advice

Icelandic slope *S. mentella* is considered a data limited stock (DLS) and should follow the ICES framework for such (Category 3.2). Below is the description of the formulation of the advice for the 2016 fishing year.

Based on the North Western Working Group recommendation, the stock is treated as a stock with survey data, but no proxies for MSY $B_{trigger}$ or F values, are known. This means that the catch advice for 2015 is based on the survey adjusted status quo catch equation:

$$C_{y+1} = C_{y-1}\left(\frac{\sum_{i=y-x}^{y-1} I_i/x}{\sum_{i=y-z}^{y-x-1} I_i/(z-x)}\right)$$

Where I is the survey index, x is the number of years in the survey average, z=5 and C_{y-1} is the advice last year. The biomass is estimated to have increased by 0.8% between 2009-2012 (average of the three years, no survey conducted in 2011) and 2013 and 2014 (average of the two years). This implies an increase of catches of at most 0.8% in relation to the last year advise (9875 t), corresponding to catch of no more than 9,954 t. A precautionary buffer of 20% consistent with the ICES approach is not applied as it was applied the first time DLS was used in 2013.

20.9 Regulation and their effects

There are no explicit management for Icelandic slope *S. mentella*. The species is managed under the ITQ system (see Chapter 7.5.1). Icelandic authorities gave until the 2010/2011 fishing year a joint quota for golden redfish (*S. marinus*) and Icelandic slope *S. mentella*. The separation of quotas was implemented in the fishing year that started September 1, 2010.

A general description of management and regulation of fish populations in Icelandic waters is given in Chapter 7.5 and in Stock Annex A.2 with emphasis on Icelandic slope *S. mentella* where applicable.

Table 20.2.1 Total biomass index ofIcelandic slope *S. mentella* in the Icelandic Autumn Groundfish survey 2000-2014. No survey was conducted in 2011.

Year	Iceland	cv
2000	138 924	0.145
2001	164 030	0.172
2002	96 923	0.137
2003	64 621	0.127
2004	98 373	0.164
2005	114 953	0.249
2006	124 509	0.172
2007	85 469	0.183
2008	82 703	0.139
2009	99 767	0.183
2010	81 963	0.149
2011		
2012	78 016	0.144
2013	70 250	0.139
2014	104 307	0.185

Table 20.3.1 Nominal landings (in tonnes) of Icelandic slope *S. mentella* 1978-2014 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	17 091	282	17 373
2008	24 123	0	24 123
2009	19 430	0	19 430
2010	17 642	0	17 642
2011	11 738	0	11 738
2012	11 965	0	11 965
2013	8 761	0	8 761
20141)	9 500	0	9 500

1) Provisional

Table 20.3.2 Proportion of the landings of Icelandic slope *S. mentella* taken in ICES Division Va by pelagic and bottom trawls 1991-2014.

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%
2010	0%	100%
2011	0%	100%
2012	0%	100%
2013	0%	100%
2014	0%	100%

Table 20.3.3 Results of the GLM model to calculate standardized CPUE for Icelandic slope redfish fishery in Va. Note that the residuals are shown in Figure 18.3.8.

```
Call:glm(formula = lafli ~ ltogtimi + factor(ar) + as.factor(veman) +
factor(skipnr) + factor(reitur), family = gaussian(), data = tmp)
DevianceResiduals:
Min       1Q   Median       3Q      Max
-5.0420  -0.3340   0.0145   0.3499   4.7053

Coefficients:
EstimateStd. Error t valuePr(>|t|)
(Intercept)         7.815942   0.635480  12.299  < 2e-16 ***
ltogtimi            1.128215   0.003627 311.058  < 2e-16 ***
factor(ar)1979      0.048608   0.075981   0.640 0.522341
factor(ar)1980      0.162845   0.070851   2.298 0.021543 *
factor(ar)1981      0.055250   0.071480   0.773 0.439557
factor(ar)1982      0.117208   0.067764   1.730 0.083703 .
factor(ar)1983     -0.016378   0.065831  -0.249 0.803531
factor(ar)1984      0.002665   0.066417   0.040 0.967989
factor(ar)1985     -0.036672   0.066483  -0.552 0.581230
factor(ar)1986     -0.009475   0.066984  -0.141 0.887520
factor(ar)1987      0.068589   0.067871   1.011 0.312222
factor(ar)1988     -0.005756   0.067071  -0.086 0.931613
factor(ar)1989     -0.052207   0.066528  -0.785 0.432612
factor(ar)1990     -0.103960   0.064947  -1.601 0.109455
factor(ar)1991     -0.071487   0.062601  -1.142 0.253487
factor(ar)1992     -0.325045   0.062333  -5.215 1.85e-07 ***
factor(ar)1993     -0.416666   0.062303  -6.688 2.30e-11 ***
factor(ar)1994     -0.532328   0.062345  -8.538  < 2e-16 ***
factor(ar)1995     -0.497444   0.062501  -7.959 1.79e-15 ***
factor(ar)1996     -0.480674   0.062892  -7.643 2.18e-14 ***
factor(ar)1997     -0.419092   0.062762  -6.677 2.47e-11 ***
factor(ar)1998     -0.423970   0.063917  -6.633 3.34e-11 ***
factor(ar)1999     -0.370873   0.063400  -5.850 4.97e-09 ***
factor(ar)2000     -0.316698   0.063806  -4.963 6.96e-07 ***
factor(ar)2001     -0.315265   0.064868  -4.860 1.18e-06 ***
factor(ar)2002     -0.353717   0.064062  -5.521 3.39e-08 ***
factor(ar)2003     -0.278988   0.064086  -4.353 1.34e-05 ***
factor(ar)2004     -0.350058   0.064470  -5.430 5.68e-08 ***
factor(ar)2005     -0.353155   0.063799  -5.535 3.13e-08 ***
factor(ar)2006     -0.360114   0.064295  -5.601 2.15e-08 ***
factor(ar)2007     -0.355708   0.065965  -5.392 7.00e-08 ***
factor(ar)2008     -0.280466   0.064961  -4.317 1.58e-05 ***
factor(ar)2009     -0.324753   0.065550  -4.954 7.30e-07 ***
factor(ar)2010     -0.297453   0.065913  -4.513 6.42e-06 ***
factor(ar)2011     -0.188108   0.066109  -2.845 0.004438 **
factor(ar)2012     -0.292790   0.066402  -4.409 1.04e-05 ***
factor(ar)2013     -0.264235   0.067864  -3.894 9.90e-05 ***
factor(ar)2014     -0.271598   0.067844  -4.003 6.26e-05 ***
as.factor(veman)2   0.119721   0.014585   8.208 2.32e-16 ***
as.factor(veman)3   0.134197   0.015365   8.734  < 2e-16 ***
as.factor(veman)4   0.114174   0.015363   7.432 1.10e-13 ***
as.factor(veman)5   0.024324   0.016765   1.451 0.146817
as.factor(veman)6  -0.007176   0.019157  -0.375 0.707973
as.factor(veman)7  -0.107690   0.019793  -5.441 5.34e-08 ***
as.factor(veman)8  -0.098225   0.019047  -5.157 2.52e-07 ***
as.factor(veman)9  -0.050757   0.016390  -3.097 0.001957 **
as.factor(veman)10 -0.040110   0.015276  -2.626 0.008650 **
as.factor(veman)11 -0.078574   0.015573  -5.046 4.55e-07 ***
as.factor(veman)12 -0.128913   0.016345  -7.887 3.18e-15 ***
```

```
Analysis of DevianceTable
Model: gaussian, link: identity
Response: lafli
Termsaddedsequentially (first to last)


DfDevianceResid. DfResid. Dev          F    Pr(>F)
NULL                           33222      60961
ltogtimi          1    43574     33221      17387 111790.442 < 2.2e-16 ***
factor(ar)       36     1392     33185      15995     99.231 < 2.2e-16 ***
as.factor(veman)  11      270     33174      15725     62.956 < 2.2e-16 ***
factor(skipnr)   157     1898     33017      13826     31.022 < 2.2e-16 ***
factor(reitur)   133     1009     32884      12818     19.459 < 2.2e-16 ***
```

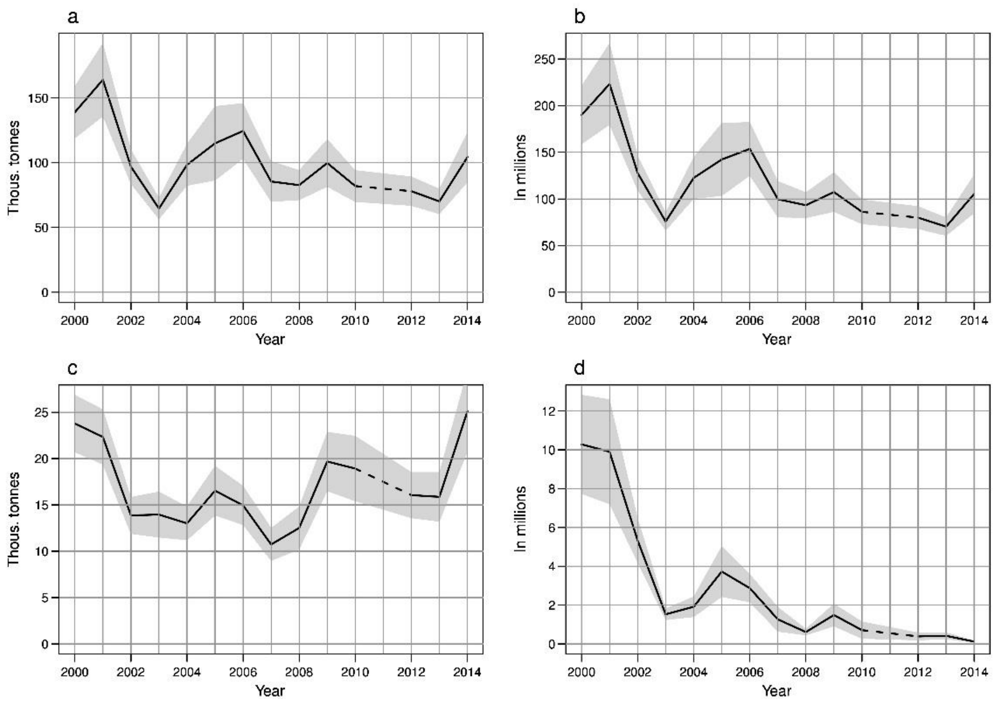

Figure 20.2.1 Survey indices of the Icelandic slope *S. mentella* in the autumn survey in ICES Division Va 2000-2014. No survey was conducted in 2011. a) Total biomass index. b) Total abundance index in millions of fish. c) Biomass index of fish larger than 45 cm. d) Abundance index of fish smaller than 30 cm.

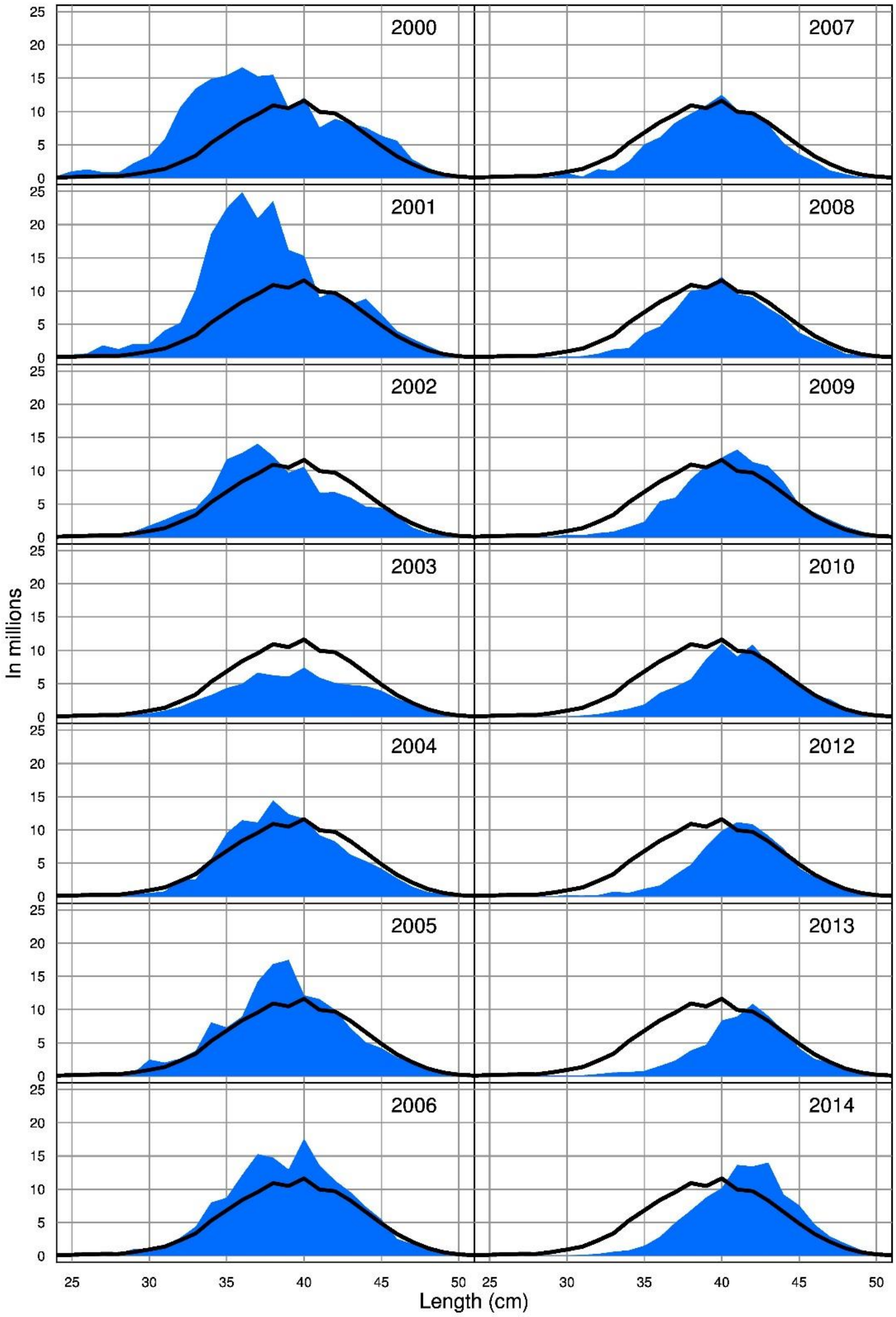

Figure 20.2.2 Length distribution of Icelandic slope *S. mentella* in the Autumn Groundfish Survey in October 2000-2014 in ICES Division Va. No survey was conducted in 2011. The black line is the mean of 2000-2014.

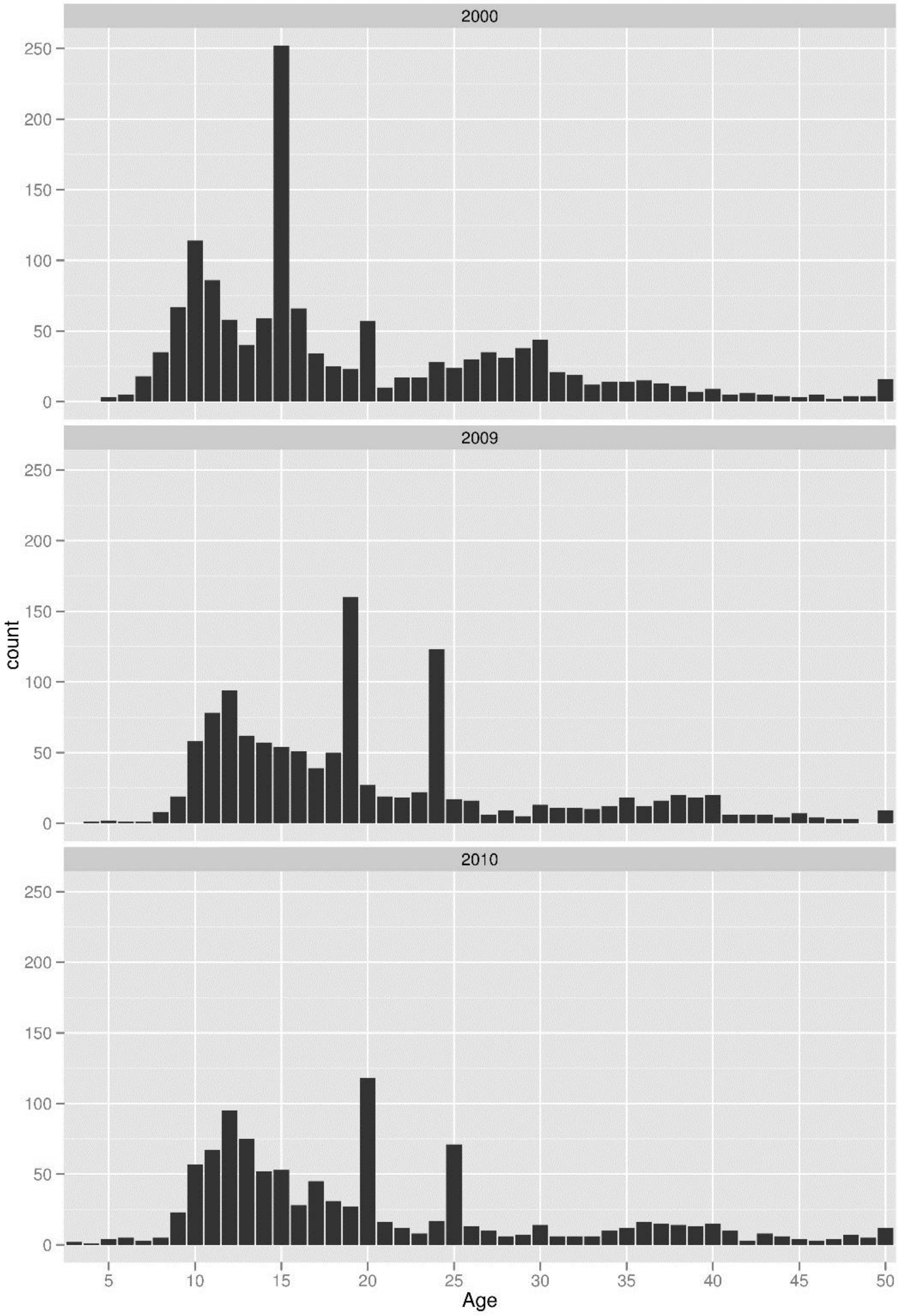

Figure 20.2.3 Age distribution of Icelandic slope *S. mentella* from the Autumn Survey in 2000 (n = 1 405), 2009 (n = 1 101), and 2010 (n = 1 206). The age class 50 are the combined age-classes of 50 years and older.

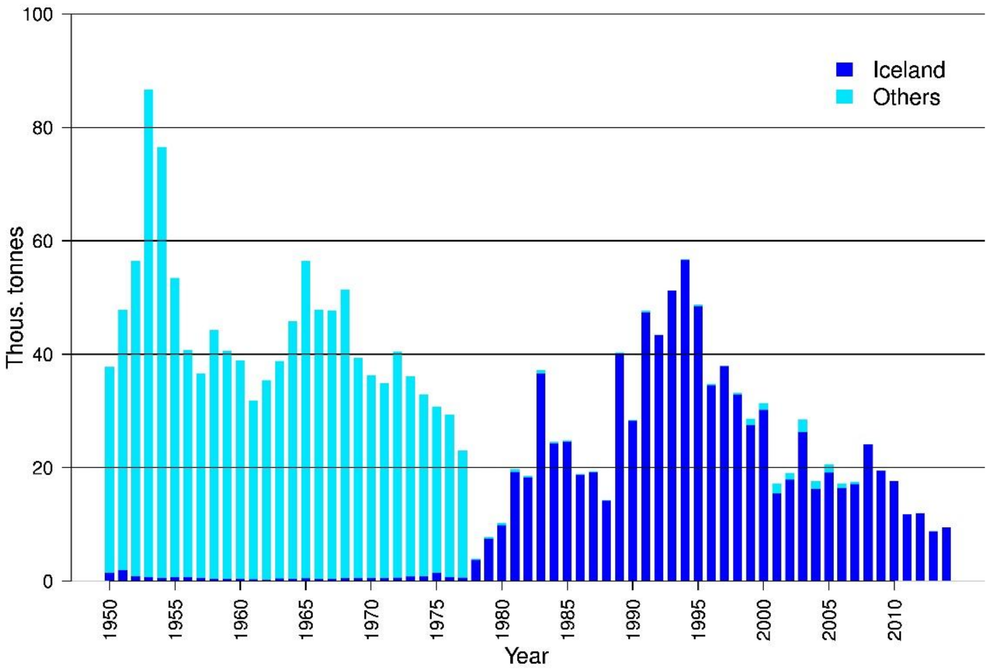

Figure 20.3.1 Nominal landings (in tonnes) of Icelandic slope *S. mentella* from ICES Divisions Va 1950-2014.

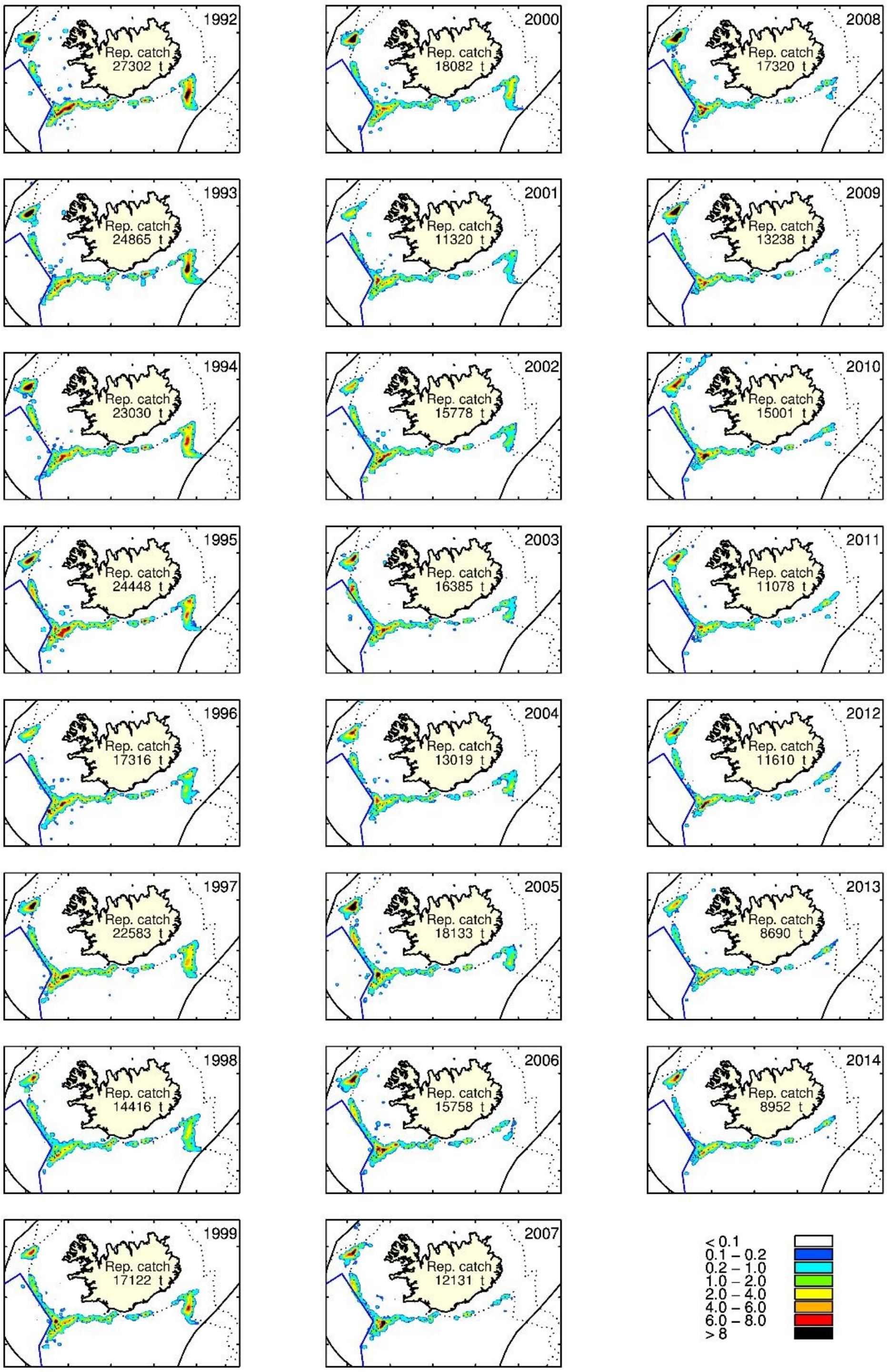

Figure 20.3.2 Geographical location of the Icelandic slope *S. mentella* catches in Icelandic waters (ICES Division Va and XIV) 1992-2014 as reported in log-books of the Icelandic fleet using bottom trawl. The blue line indicates part of the management unit for the deep-pelagic redfish stock. The dotted line represents the 500 m isobaths.

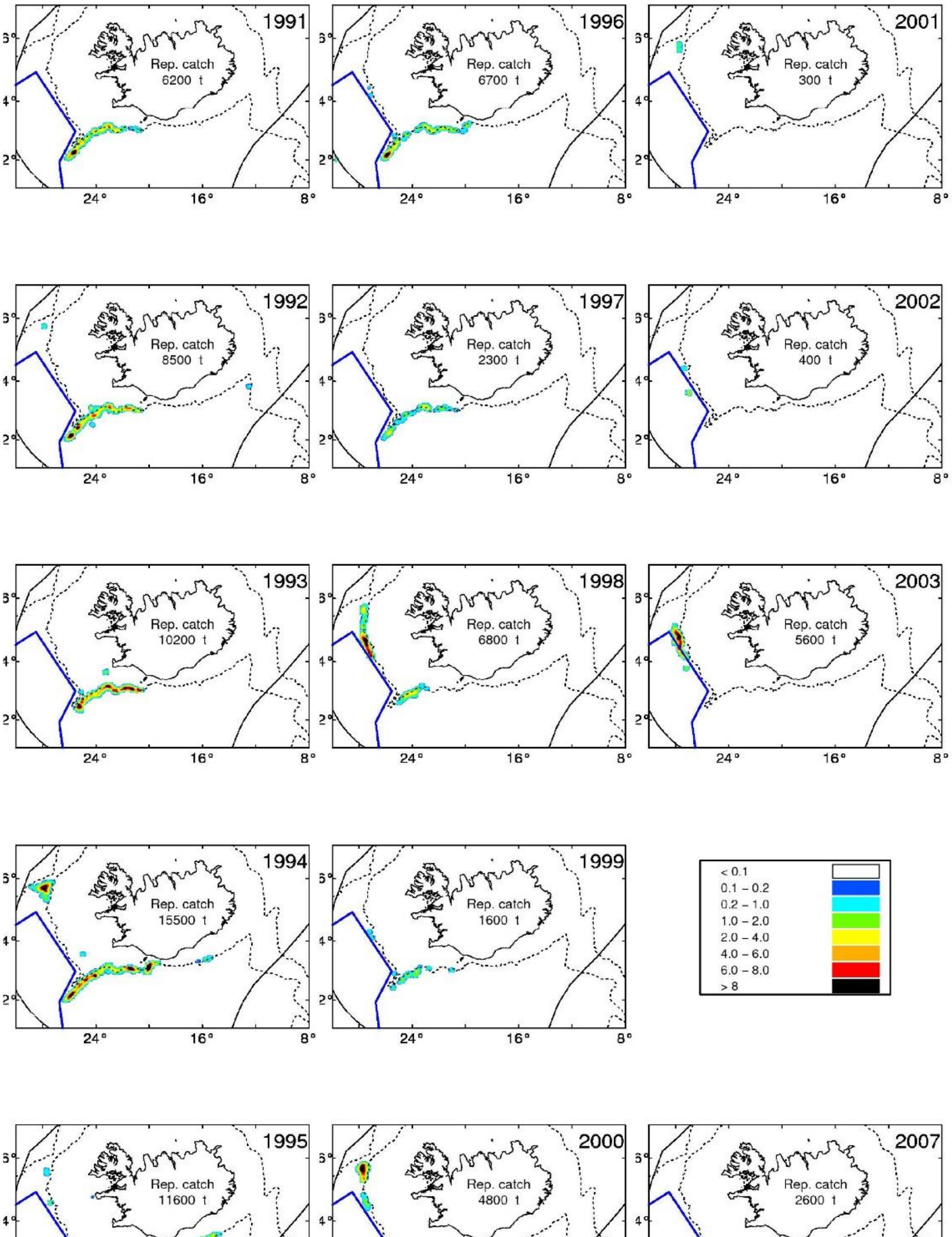

Figure 20.3.3 Geographical location of the Icelandic slope *S. mentella* catches in Icelandic waters (ICES Division Va and XIV) 1991-2003 and 2007 as reported in log-books of the Icelandic fleet using pelagic trawl. The blue line indicates part of the proposed management unit for the deep-pelagic redfish stock. The dotted line represents the 500 m isobaths.

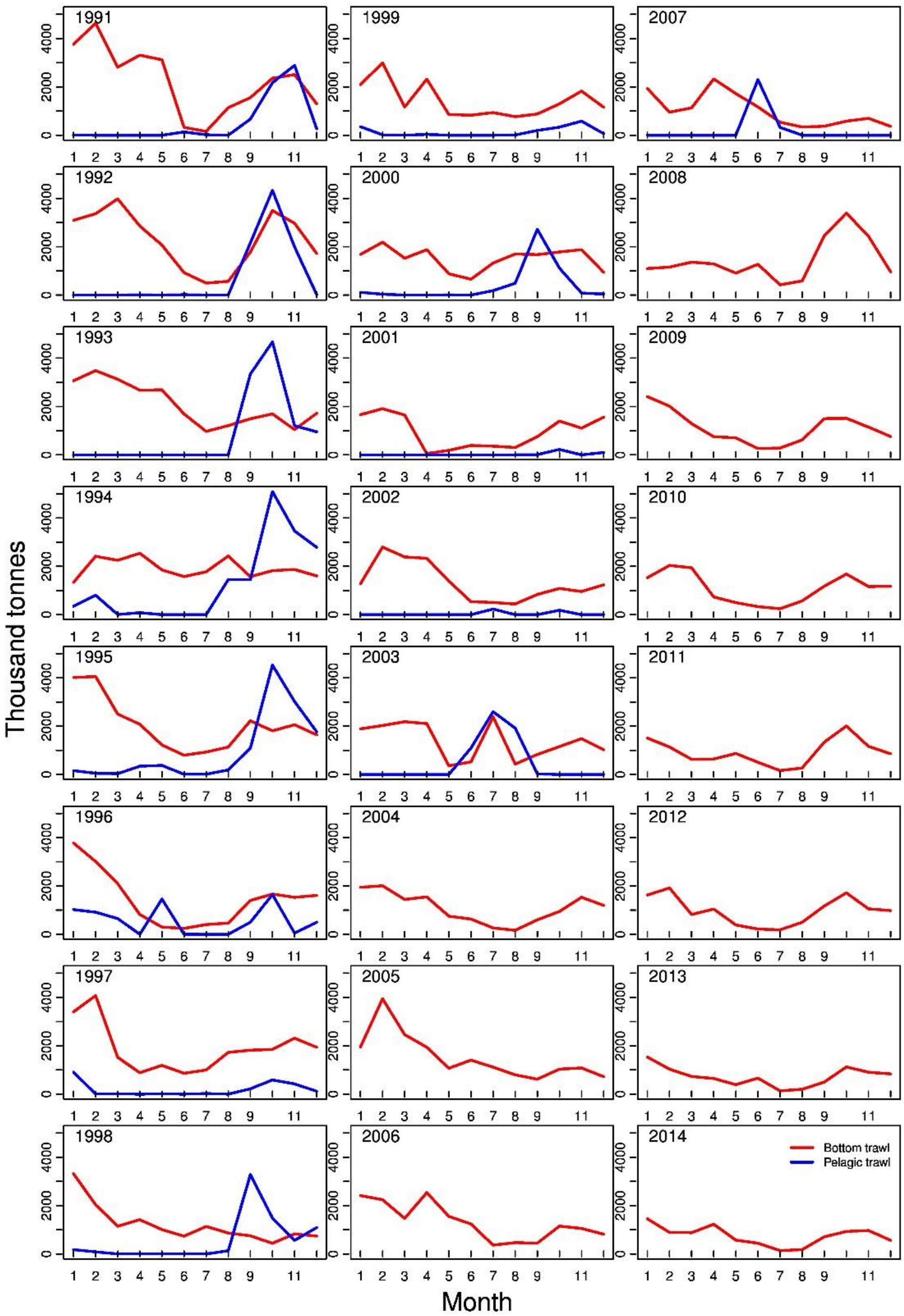

Figure 20.3.4 Nominal landings (in tonnes) of Icelandic slope *S. mentella* in Icelandic waters (ICES Division Va and XIV) of the Icelandic fleet using either bottom trawl (red line) or pelagic trawl (blue line) 1991-2014 divided by month.

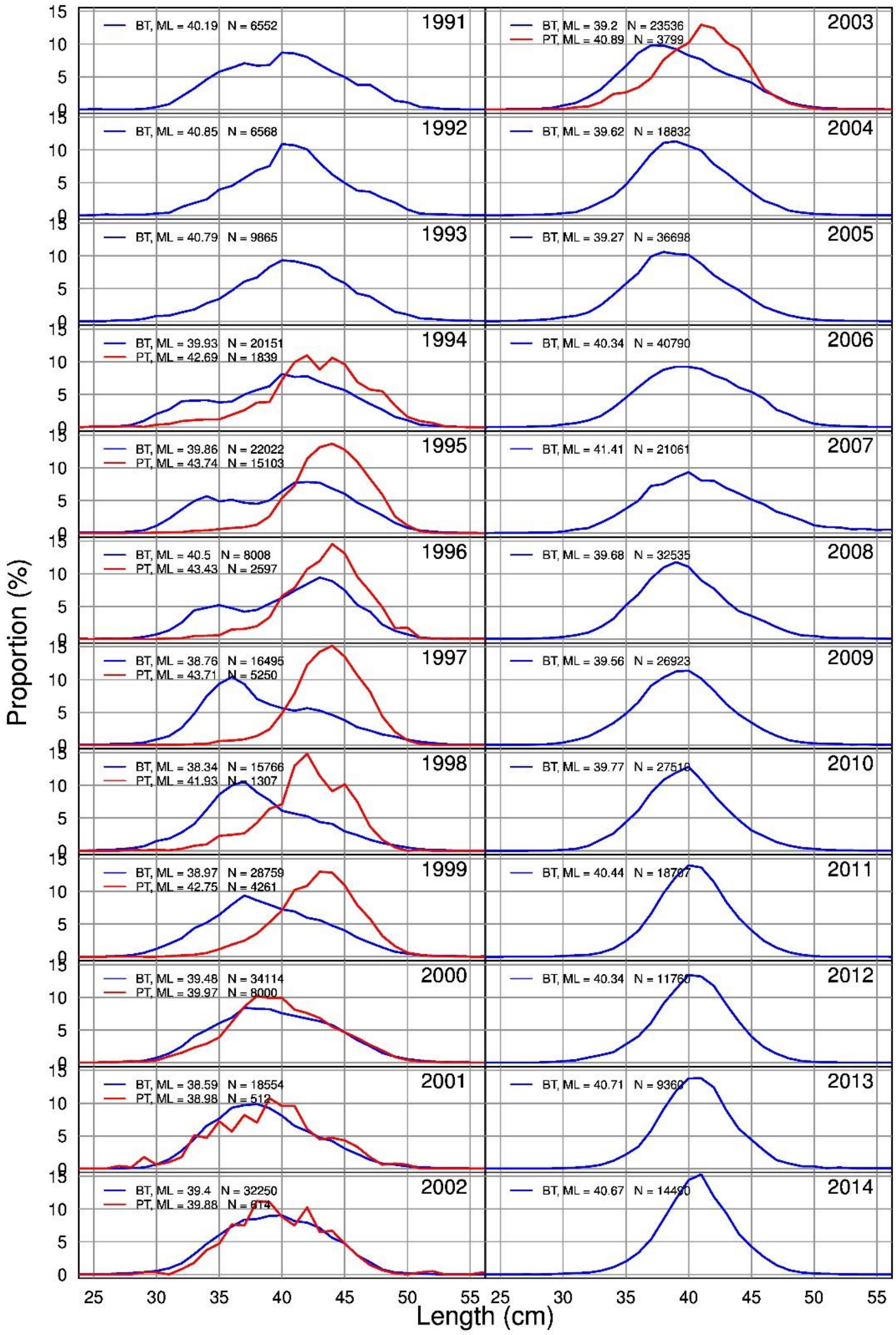

Figure 20.3.5 Length distributions of Icelandic slope *S. mentella* from the Icelandic landings taken with bottom trawl (blue line) and pelagic trawl (red line) in ICES Division Va 1991-2014.

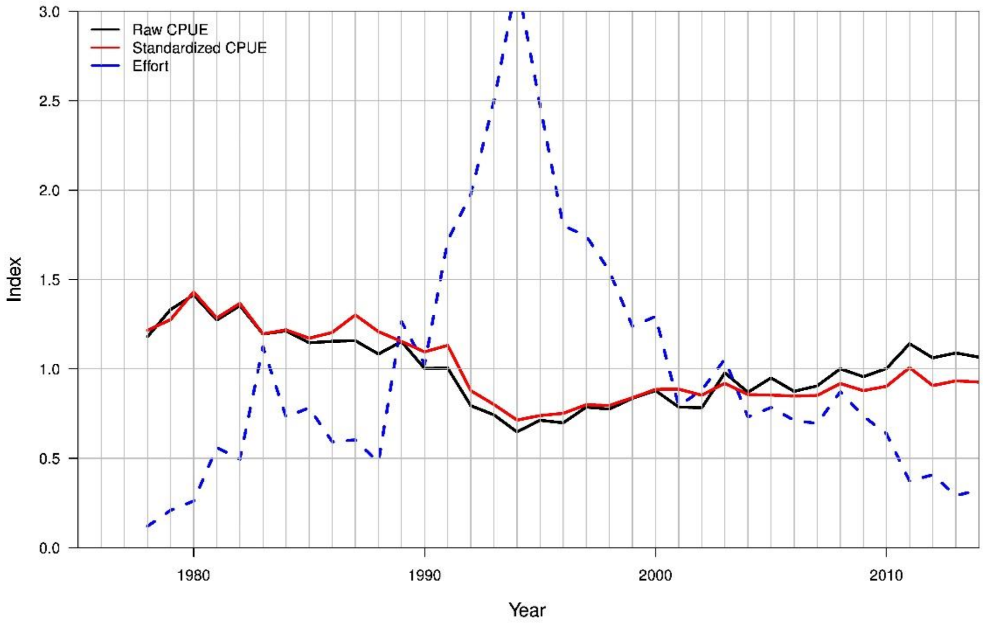

Figure 20.3.6 CPUE relative to 1978 of Icelandic slope *S. mentella* from the Icelandic bottom trawl fishery in Division Va. CPUE based on a GLM model based on data from log-books and where at least 50% of the total catch in each tow was Icelandic slope *S. mentella*. Also shown is fishing effort (hours fished in thousands).

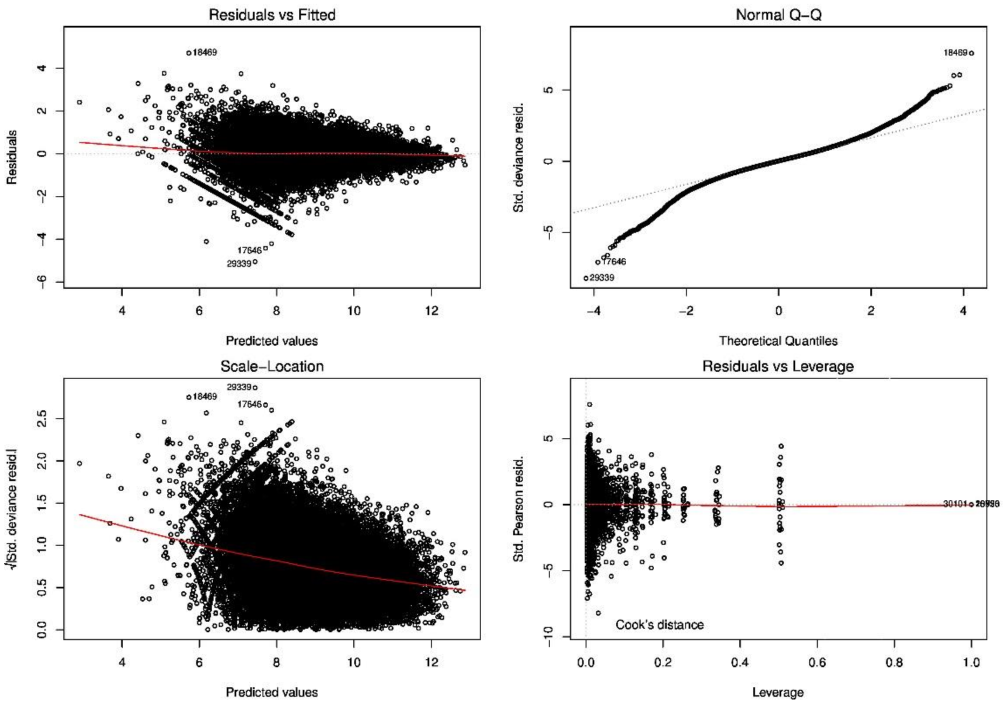

Figure 20.3.7 Residual of the GLM model (section 18.3.5) for the CPUE series of Icelandic slope *S. mentella*.

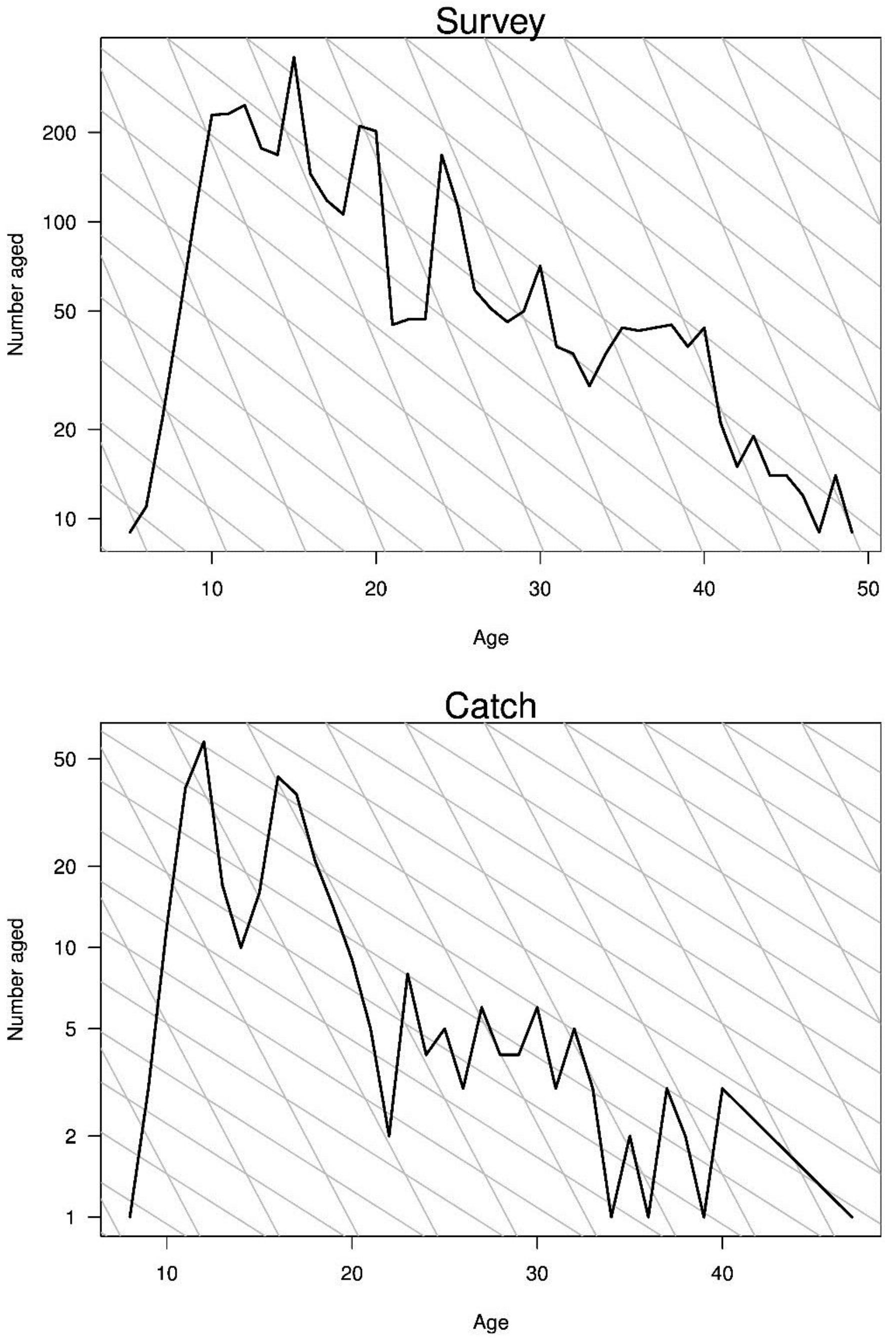

Figure 20.5.1. Icelandic slope *S. mentella*. Number aged plotted on log-scale. Grey lines correspond to *Z*=0.1 and *Z*=0.3.

21 Shallow Pelagic *Sebastes mentella*

Executive summary

ICES concluded in February 2009 that *S. mentella* is to be divided into three biological stocks and that the shallow pelagic *S. mentella* in the Irminger Sea and adjacent areas should be treated as separate biological stock and management unit.

Total landings of shallow pelagic *S. mentella* in 2014 were 6423 t, a significant increase compared to 1527 t in 2013. The catches were almost entirely taken in ICES XII.

No analytical assessment was conducted and there are no biological reference points for the species. Survey indices from the biennial international acoustic redfish survey conducted in the Irminger Sea and adjacent waters since 1991 are used as basis for advice.

The last survey was conducted in June/July 2013. Since 1994, the results of the acoustic survey show a drastic decreasing trend within the deep scattering layer (DSL) from 2.2 million t to 91 000 t in 2013. With the trawl method within the DSL (350—500 m) the biomass was estimated 200 000 t, significantly below the 361 000 t of 2011. The next international acoustic redfish survey was scheduled to be conducted in June/July 2015.

No signs of recruitment have been observed in the latest German survey on the East-Greenland shelf.

21.1 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 summarizes the available information from fishing fleets in the Irminger Sea and adjacent waters fishing for the shallow pelagic redfish in 2014. Only Russia conducted directed fishery on the stock. It should be noted that they also fished the deep pelagic stock:

Russia	17 factory trawlers

21.2 Summary of the development of the fishery

The historic development of the fishery can be found in the Stock Annex. The clear changes in the spatial pattern of the fishery can be seen in Figure 20.2.1, based on logbook data from the Faroe Islands, Greenland, Iceland and Norway. 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 Figure 20.2.2. The estimated catch for 2014 is 6423 t, a significant incecrease from the 1527 t caught in 2013. The catches were almost entirely produced by Russia with 5780 t fromICES XII and NAFO 1F (Tables 20.2.1 and 20.2.2).

There are no new CPUE data for 2014. The standardized CPUE index trend for the period 1994—2006 is shown in Figure 20.2.3. This standardized CPUE series includes data from Faroe Islands, Iceland, Germany, Greenland, and Norway, and it is estimated with a GLM model including the factors year, ship, month and towing time. The model output is shown in Table 20.2.3 and the residuals are in Figure 20.2.4.

21.3 Biological information

There are no new data. The length distributions for the period 1989—2006 of biological stocks based on Icelandic data are shown in Figure 20.3.1. The length of the largest proportion of caught fish oscillates around 35 cm for the whole period.

21.4 Discards

Redfish form aggregations composed of individuals with a narrow size range, which results in very clean catches. Thus, discards are negligible according to available data from various institutes.

21.5 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.

21.6 Surveys

The last international trawl-acoustic survey was carried out in 2013 and it is described in detail in ICES WGRS Report 2013 (ICES, 2013). The next survey was scheduled to be carried out in June/July 2015 (ICES, 2013) but it may have to be cancelled after Russia withdrew its participation, unless other countries take part in it .

21.6.1 Survey acoustic data

Since 1994, the results of the acoustic survey show a drastic decreasing trend from 2.2 kt to 0.6 kt in 1999 and have fluctuated between 0.7 kt - 0.09 kt in 2001—2013 (Table 20.6.1). 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, Germany and Russia in June/July 2013. Approximately 341 000 NM^2 were covered. Figures 20.6.1 and 20.6.2 show the biomass estimates for depth shallower than the DSL (Depth Scattering Layer). A total biomass of 91 000 t was estimated acoustically in the layer shallower than the DSL (Table 20.6.1 and Figure 20.6.4). The results showed a substantial biomass decline in subarea B compared to 2011 but in other areas the biomass was similar as in 2011 (Table 20.6.2 and Figure 20.6.5 for area definition). Biological samples from the acoustic estimate within the DSL and shallower than 500 m showed a mean length of 36.0 cm (Figure 20.6.6).

21.6.2 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 at 200 000 t, a 45% decrease respect the estimation of 360,000 for 2011 (Table 20.6.1 and Figure 20.6.4). Figure 20.6.3 shows the distribution of the redfish catches within the DSL and shallower than 500 m. It should be noted that the estimate for 2013 was recalculated due to technical error made in 2013 (ICES 2014).

The obtained correlation was used to convert the trawl data at greater depths to acoustic values and from there to abundance. For that purpose, standardized trawl hauls were carried out at depth 350—500 m, evenly distributed over the survey area (Figure 20.6.3). 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 within the DSL. 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 35.5 cm. Figure 20.6.3 shows the spatial distribution of samples used in the survey and Figure 20.6.6 shows the corresponding length distribution.

21.6.3 Methods

The assessment of pelagic redfish in the Irminger Sea and adjacent waters is based on survey indices, catches, CPUE and biological data. See Stock Annex and Section 20.6 for details.

21.6.4 Reference points

For pelagic redfish in the Irminger Sea and adjacent waters, no analytical assessment is carried out due to data uncertainties and the lack of reliable age data. Thus, no reference points can be derived.

21.7 State of the stock

21.7.1 Short term forecast

For pelagic redfish in the Irminger Sea and adjacent waters, no analytical assessment is carried out due to data uncertainties and the lack of reliable age data. Thus, no short-term forecasts can be derived.

21.7.2 Uncertainties in assessment and forecast

21.7.2.1 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 20.3.3 in the 2008 NWWG report, ICES, 2008). No new data in IUU have been available since 2008.

As in previous years, detailed descriptions on the horizontal, vertical and seasonal distribution of the fisheries were given.

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. With this need in mind, ICES sent a data call to all EU countries participating in the redfish fishery, encouraging stockholders to deliver detailed catch data before the WG would meet, but the response was very limited.

21.7.2.2 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 across depth and areas, the uncertainty of these estimates is very high.

The reduction in biomass observed in the surveys within the hydroacoustic layer (about 2 million t in the last decade) cannot be explained by the reported removal by the fisheries (about 500,000 t in the entire depth range in 1995—2011) 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 indices are likely to reflect a decreasing stock. The new data available to the NWWG were insufficient to estimate the CPUE for 2013.

NEAFC set for 2013 a 0 TAC for Shallow Pelagic *S. mentella*. However, the Russian Federation decided on an unilateral quota of 27 300 t. This quota was taken from both Shallow and Deep pelagic stocks, since the Russian Federation does not agree on the division of the *S. mentella* management units.

21.7.3 Comparison with previous assessment and forecast

The data available for evaluating the stock status are similar to last year.

21.7.4 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 are not enough scientific bases available to propose an appropriate split of the total TAC among the two fisheries/areas.

21.7.5 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.

21.7.6 Changes in the environment

The hydrography in the June/July 2013 survey show that temperature in the survey area is above average but it was lower than in 2011 in most of the surveyed area, except for the Irminger Current (ICES, 2013).

The increase of water temperature in the Irminger Sea may have an effect on spatial and vertical distribution of S. mentella in the feeding area (Pedchenko, 2005). The abundance and distribution of *S. mentella* in relation to oceanographic conditions were analysed in a special multistage workshop (WKREDOCE1-3). Based on 20 years of survey data, the results reveal the average relation of redfish to their physical habitat in shallow and intermediate waters: The most preferred latitude, longitude, depth, salinity and temperature for *S. mentella* are approximately 58ºN, 40ºW, 300 m, 34.89 and 4.4ºC, respectively. The spatial distribution of S. mentella in the Irminger Sea mainly in waters < 500 m (and thus mainly relating to the "shallow" stock) appears strongly influenced by the Irminger Current Water (ICW) temperature changes, linked to the Subpolar Gyre (SPG) circulation and the North Atlantic Oscillation (NAO). The fish avoid waters mainly associated with the ICW (>4.5ºC and >34.94) in the north-eastern Irminger Sea, which may cause displacing towards the southwest, where fresher and colder water occurs (ICES 2012).

Results based on international redfish survey data suggest that the interannual distribution of fish above 500 m will shift in a southwest/northeast direction depending on integrated oceanographic conditions (ICES 2012).

21.8 References

ICES. 2009a. Report of the Workshop on Redfish Stock Structure (WKREDS). ICES CM 2009/ACOM:37.

ICES. 2009b. Report of the Planning Group on Redfish Surveys (PGRS). ICES CM 2009/RMC:01.

ICES. 2012a. Report of the Benchmark Workshop on Redfish (WKRED 2012), 1–8 February 2012, Copenhagen, Denmark. ICES CM 2012/ACOM:48. 291 pp.

ICES. 2012b. Report of the Third Workshop on Redfish and Oceanographic Conditions (WKREDOCE3), 16-17 August 2012, Johann Heinrich von Thunen Institute, Hamburg, Germany. ICES CM 2012/ACOM:25. 70 pp.

ICES. 2013. Report of the Working Group on Redfish Surveys (WGRS), 6-8 August 2013, Hamburg, Germany. ICES CM 2013/SSGESST:14. 56 pp.

ICES. 2014. Report of the Workshop on Redfish Management Plan Evaluation (WKREDMP) ICES CM 2014/ACOM: 52.

NAFO 2005. Scientific Council Reports 2004, 306 ppPedchenko, A. P. 2000. Specification of oceanographic conditions of the Irminger Sea and their influence on the distribution of feeding redfish in 1999. ICES North-Western Working Group 2000, Working Document 22, 13 pp.

Pedchenko, A. P. 2005. The role of interannual environmental variations in the geographic range of spawning and feeding concentrations of redfish *Sebastes mentella* in the Irminger Sea. ICES Journal of Marine Science 62: 1501-1510.

Table 21.2.1 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	0	39 783	20 798	0	0	0	60 581
1983	0	60 079	155	0	0	0	60 234
1984	0	60 643	4 189	0	0	0	64 832
1985	0	17 300	54 371	0	0	0	71 671
1986	0	24 131	80 976	0	0	0	105 107
1987	0	2 948	88 221	0	0	0	91 169
1988	0	9 772	81 647	0	0	0	91 419
1989	0	17 233	21 551	0	0	0	38 784
1990	0	7 039	24 477	385	0	0	31 901
1991	0	9 689	17 048	458	0	0	27 195
1992	106	22 976	38 709	0	0	0	62 564
1993	0	66 458	32 500	0	0	0	100 771
1994	665	77 174	18 679	0	0	0	96 869
1995	77	78 895	17 895	0	0	0	100 136
1996	16	22 474	18 566	0	0	0	41 770
1997	321	18 212	8 245	0	0	0	27 746
1998	284	21 976	1 598	0	0	0	24 150
1999	165	23 659	827	534	0	0	25 512
2000	3 375	17 491	687	11 052	0	0	33 216
2001	228	32 164	1 151	5 290	8	1 751	41 825
2002	10	24 004	222	15 702	0	3 143	43 216
2003	49	24 211	134	26 594	325	5 377	56 688
2004	10	7 669	1 051	20 336	0	4 778	33 951
2005	0	6 784	281	16 260	5	4 899	28 229
2006	0	2 094	94	12 692	260	593	15 734
2007	71	378	98	2 843	175	2 561	6 126
2008	32	25	422	1 580	0	0	2 059
2009	0	210	2 170	0	0	0	2 380
2010	15	686	423	1 074	0	0	2 198
2011	0	0	234	0	0	0	234
2012	28	0	0	3 113	32	0	3 173
2013	32	13	40	1 443	1	0	1 529
2014	153	5 068	489	713	0	0	6 423

1982-1991 All pelagic catches assumed to be of the shallow pelagic stock

1992-1996 Guesstimates based on different sources (see text)

1997-2014 Catches from calculations based on jointed catch database and total landings

Table 21.2.2 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				719		5 354	657	5 229		1 841	12 052		1 094	428	878	13 958	1 005			43 216

Year	Bulgaria	Canada	Estonia	Faroes	France	Germany	Greenland	Iceland	Japan	Latvia	Lithuania	Netherlands	Norway	Poland	Portugal	Russia*	Spain	UK	Ukraine	Total
2003				1 955		3 579	1 047	4 274		1 269	21 629		3 214	917	1 926	15 418	1 461			56 688
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		3 086		919	1 169		624	1 170	2 780	15 562	1 557			28 229
2006				334		994		1 293		1 803	466		280	663	1 372	4 953	3 576			15 734
2007			209	98		0		71		186	467			189	529	4 037	339			6 126
2008				319				63			8					1 597	73			2 059
2009				87				5			138					649	1 438			2 380
2010				653				22			551		12		377	567	16			2 198
2011				162				72												234
2012								28								3 145				3 173
2013								72								1 457				1 529
2014								355			287					5 781				6 423

Table 21.2.3 Output from the GLM model used to standardize CPUE

Call:
glm(formula = lafli ~ ltogtimi + factor(land) + factor(yy) + factor(mm) + factor(skip), family = gaussian(), data = south)

Deviance Residuals:

Min	1Q	Median	3Q	Max
-2.67560	-0.27475	0.01545	0.28216	1.70226

Coefficients:

	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	7.288330600	0.62153190	11.72639829	4.487183e-27
ltogtimi	1.031189089	0.02865434	35.98719217	1.185172e-120
factor(land)46	0.307108007	0.19677419	1.56071282	1.194800e-01
factor(land)58	-0.609222384	0.59427534	-1.02515171	3.059877e-01
factor(yy)1995	-0.014544145	0.17246972	-0.08432869	9.328425e-01
factor(yy)1996	-0.539967092	0.20301506	-2.65973905	8.173648e-03
factor(yy)1997	-0.781097375	0.19187694	-4.07082472	5.775636e-05
factor(yy)1998	-0.598205682	0.20022972	-2.98759682	3.006814e-03
factor(yy)1999	-1.032123656	0.19849297	-5.19979958	3.371986e-07
factor(yy)2000	-0.449067015	0.18062595	-2.48617105	1.337053e-02
factor(yy)2001	-0.294095749	0.18731402	-1.57006796	1.172876e-01
factor(yy)2002	-0.553422698	0.20779476	-2.66331403	8.089018e-03
factor(yy)2003	-0.448530462	0.20695582	-2.16727635	3.087629e-02
factor(yy)2004	-0.940467562	0.19921557	-4.72085375	3.382253e-06
factor(yy)2005	-0.874228087	0.21534893	-4.05958874	6.047701e-05
factor(yy)2006	-0.792513622	0.23511568	-3.37073907	8.318962e-04
factor(mm)3	0.403539915	0.62653390	0.64408313	5.199363e-01
factor(mm)4	0.080886336	0.59965529	0.13488805	8.927766e-01
factor(mm)5	0.697289482	0.59729418	1.16741383	2.438246e-01
factor(mm)6	0.106581504	0.59582112	0.17888172	8.581323e-01
factor(mm)7	0.156006539	0.59913389	0.26038677	7.947160e-01
factor(mm)8	0.288687902	0.60200469	0.47954427	6.318459e-01
factor(mm)9	0.147372745	0.60350755	0.24419370	8.072215e-01
factor(mm)10	-0.073137396	0.61289180	-0.11933166	9.050799e-01
factor(mm)11	-0.111429636	0.62872288	-0.17723172	8.594272e-01
factor(mm)12	-0.687207654	0.84232729	-0.81584399	4.151349e-01
factor(skip)118	-0.309179778	0.22143007	-1.39628629	1.634983e-01
factor(skip)1270	0.037603149	0.44828091	0.08388300	9.331966e-01
factor(skip)1273	-0.628141253	0.22041607	-2.84979787	4.629299e-03
factor(skip)1279	-1.173362444	0.44513557	-2.63596647	8.756942e-03
factor(skip)1308	-0.266919265	0.22303502	-1.19675943	2.321967e-01
factor(skip)1328	-0.271654251	0.21750992	-1.24892811	2.125120e-01
factor(skip)1345	-0.389432255	0.27300563	-1.42646238	1.546113e-01
factor(skip)1351	-0.210922567	0.30230014	-0.69772567	4.858042e-01
factor(skip)1360	-0.160337035	0.37131520	-0.43180843	6.661421e-01
factor(skip)1365	-0.037778373	0.28528994	-0.13242098	8.947261e-01
factor(skip)1369	0.008221878	0.23222821	0.03540430	9.717772e-01
factor(skip)1376	-0.079339629	0.21104413	-0.37593857	7.071865e-01
factor(skip)1408	-0.360954071	0.46295849	-0.77966833	4.361041e-01
factor(skip)1412	-0.186735060	0.60272438	-0.30981833	7.568804e-01
factor(skip)1459	-0.659207386	0.22905256	-2.87797434	4.243932e-03
factor(skip)1471	-0.067779436	0.39810737	-0.17025416	8.649070e-01
factor(skip)1472	-0.243213212	0.33706786	-0.72155563	4.710413e-01
factor(skip)1473	-0.831933012	0.45025953	-1.84767443	6.547885e-02
factor(skip)1552	-1.308585894	0.61116338	-2.14113925	3.294138e-02
factor(skip)1578	-1.486687432	0.38045634	-3.90764269	1.115534e-04
factor(skip)1579	-0.474709749	0.30501933	-1.55632678	1.205189e-01
factor(skip)1585	-0.553949127	0.61783175	-0.89660191	3.705373e-01
factor(skip)1628	0.048861984	0.45291686	0.10788290	9.141494e-01
factor(skip)180	-0.532613734	0.18564922	-2.86892530	4.364387e-03
factor(skip)1833	-0.296067754	0.22785023	-1.29939633	1.946488e-01

```
factor(skip)1868 -0.104954736 0.22921245 -0.45789282  6.473088e-01
factor(skip)1880  0.004153055 0.25826361  0.01608068  9.871790e-01
factor(skip)1902  0.204043987 0.28417282  0.71802782  4.732111e-01
factor(skip)1976 -0.380940434 0.61538320 -0.61902963  5.362928e-01
factor(skip)1977 -0.774106835 0.33815309 -2.28922009  2.265145e-02
factor(skip)2165  0.105047590 0.20580896  0.51041311  6.100784e-01
factor(skip)2170 -0.122213348 0.20408250 -0.59884286  5.496585e-01
factor(skip)2182 -0.454140930 0.23283220 -1.95050737  5.190006e-02
factor(skip)2184 -0.295249414 0.25222782 -1.17056639  2.425561e-01
factor(skip)2203 -0.136558045 0.20059787 -0.68075523  4.964689e-01
factor(skip)2212  0.183302143 0.30496276  0.60106402  5.481798e-01
factor(skip)2236 -0.581565095 0.26502996 -2.19433717  2.885678e-02
factor(skip)2265  0.239718865 0.43951519  0.54541657  5.858086e-01
factor(skip)2592 -0.282434578 0.59801605 -0.47228595  6.370121e-01
factor(skip)3033 -0.283499142 0.72458991 -0.39125461  6.958431e-01
factor(skip)3135 -0.016478186 0.66105345 -0.02492716  9.801270e-01
factor(skip)3156 -0.260805362 0.61679034 -0.42284281  6.726652e-01
factor(skip)3382 -0.423424919 0.62159313 -0.68119305  4.961922e-01
factor(skip)3523 -0.395258535 0.72563919 -0.54470396  5.862982e-01
factor(skip)3542  0.018355745 0.61994189  0.02960882  9.763956e-01
factor(skip)3709 -0.609676578 0.64465767 -0.94573695  3.449242e-01
factor(skip)934  -1.054646713 0.17107235 -6.16491621  1.912436e-09---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for gaussian family taken to be 0.3450127)

    Null deviance: 989.53  on 458  degrees of freedom
Residual deviance: 131.45  on 381  degrees of freedom
AIC: 886.64

----------------------

Number of Fisher Scoring iterations: 2
Analysis of Deviance Table
Model: gaussian, link: identity
Response: lafli
Terms added sequentially (first to last)


Df Deviance Resid. DfResid. Dev       F    Pr(>F)
NULL                        428     934.30
ltogtimi      1   682.16       427     252.14 2126.3228 < 2.2e-16 ***
factor(land)  2    38.99       425     213.15  60.7682 < 2.2e-16 ***
factor(yy)   12    43.18       413     169.96  11.2167 < 2.2e-16 ***
factor(mm)   10    17.04       403     152.92   5.3122 2.600e-07 ***
factor(skip) 47    38.71       356     114.21   2.5673 5.376e-07 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Table 21.6.1 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 NM2)	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	392
2007	349	372	283
2009	360	108	331
2011	343	123	361
2013	340	91	200

*** 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.**

Table 21.6.2. Results (biomass in ´000 t) for the international surveys conducted since 1994, for redfish shallower than the DSL for each subarea (see Figure 21.6.5 for area definition) and total.

	Sub-area						
Year	A	B	C	D	E	F	Total
1994	673	1228	-	63	226		2190
1996	639	749	-	33	155		1576
1999	72	317	16	42	167		614
2001	88	220	30	267	103	7	716
2003	32	46	1	2	10	0	89
2005	121	123	0	87	204	17	551
2007	80	95	0	53	142	3	372
2009	39	48	4	1	15	1	108
2011	5	74	0	3	40	1	123
2013	9	33	2	5	42	0	91

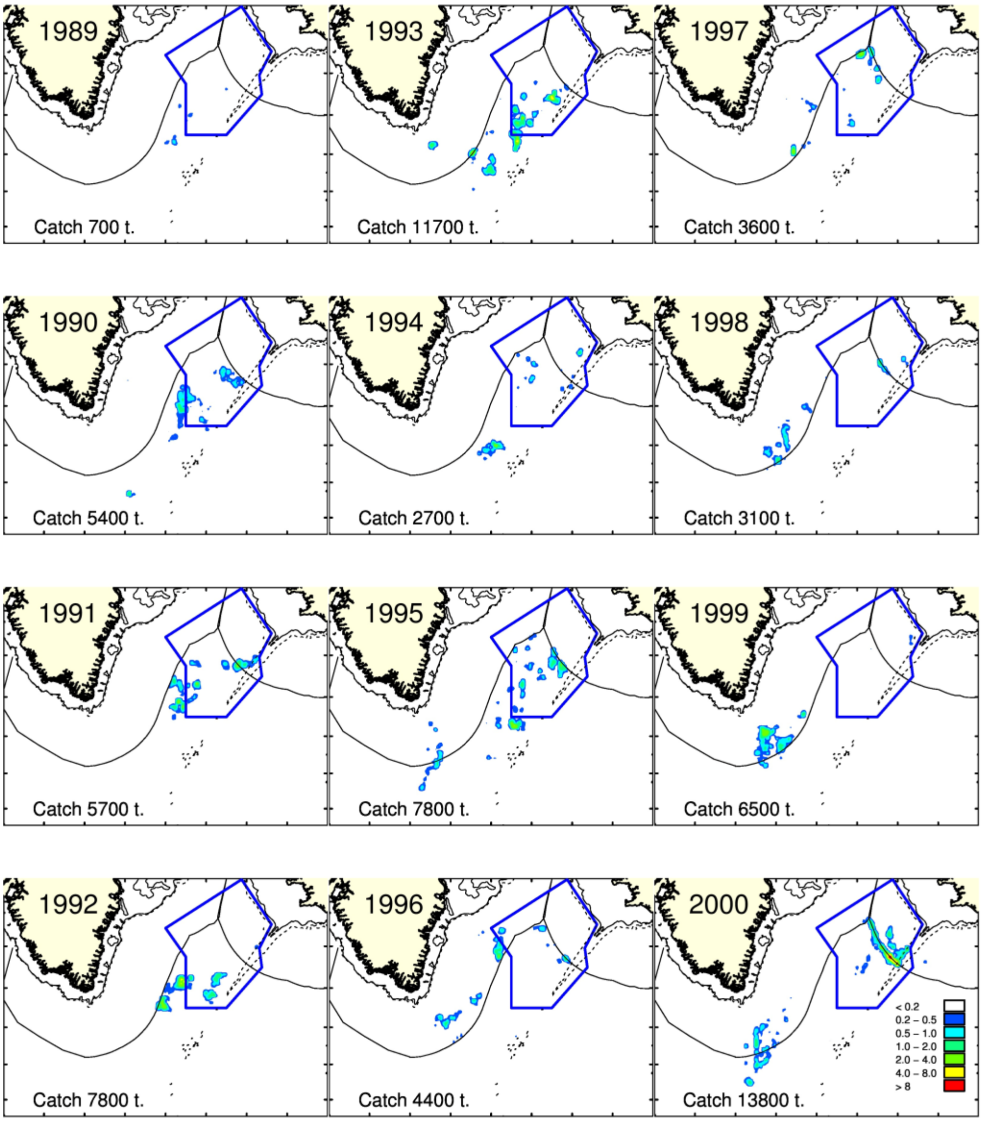

Figure 21.2.1 Fishing areas and total catch of pelagic redfish (*S. mentella*) in the Irminger Sea and adjacent waters 1989-2012. Data are from the Faroe Islands (1995-2012), Iceland (1989-2012) and Norway (1992-2003). The catches in the legend are given as tonnes per square nautical mile. The blue box represents the management unit for the northern fishing area.

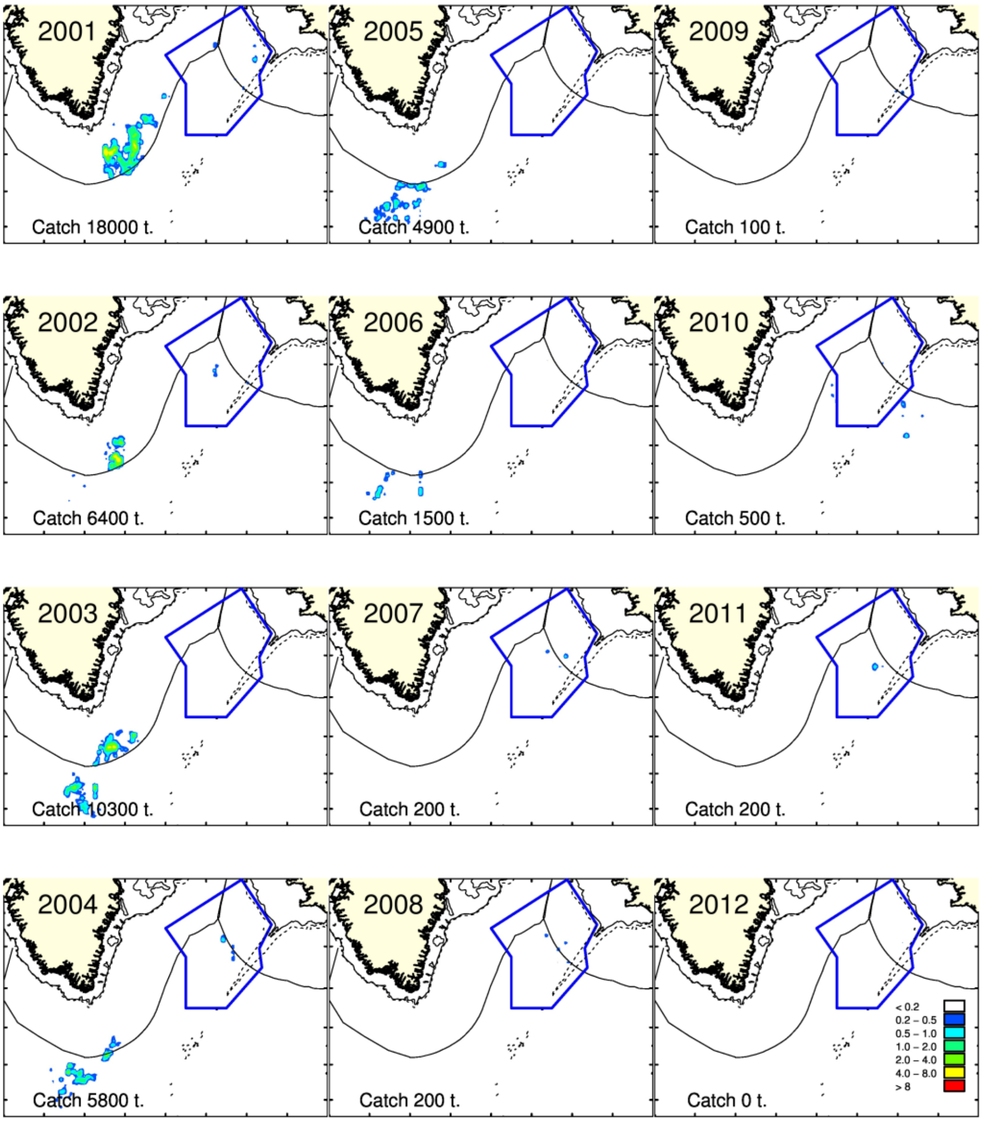

Figure 21.2.1 (Cont.) Fishing areas and total catch of pelagic redfish (*S. mentella*) in the Irminger Sea and adjacent waters 1989-2012. Data are from the Faroe Islands (1995-2012), Iceland (1989-2012) and Norway (1992-2003). The catches in the legend are given as tonnes per square nautical mile. The blue box represents the management unit for the northern fishing area.

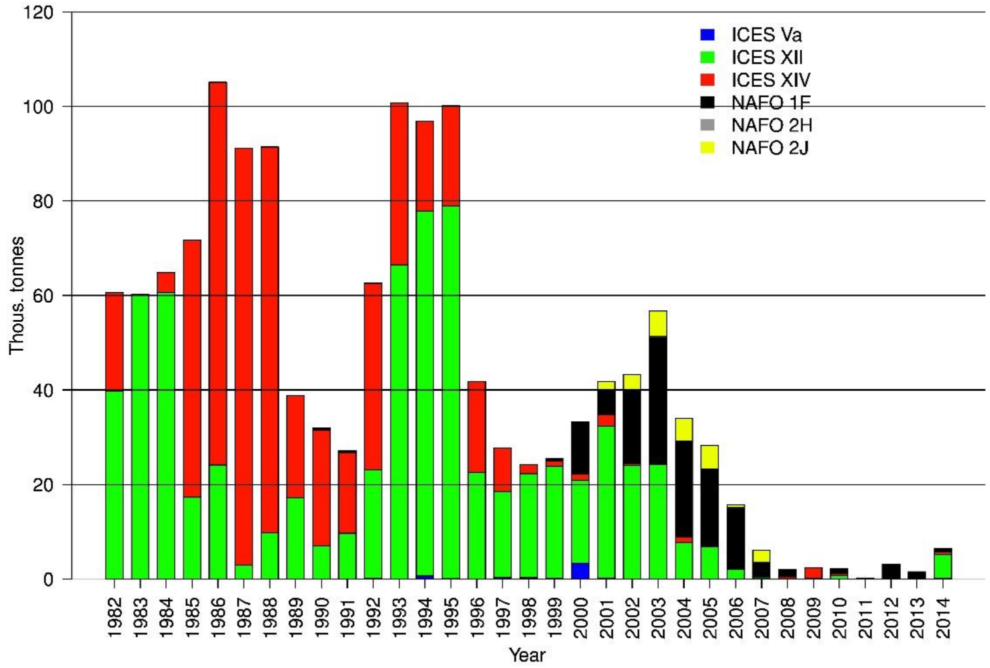

Figure 21.2.2 Landings of shallow pelagic *S. mentella* (Working Group estimates, see Table 21.2.1).

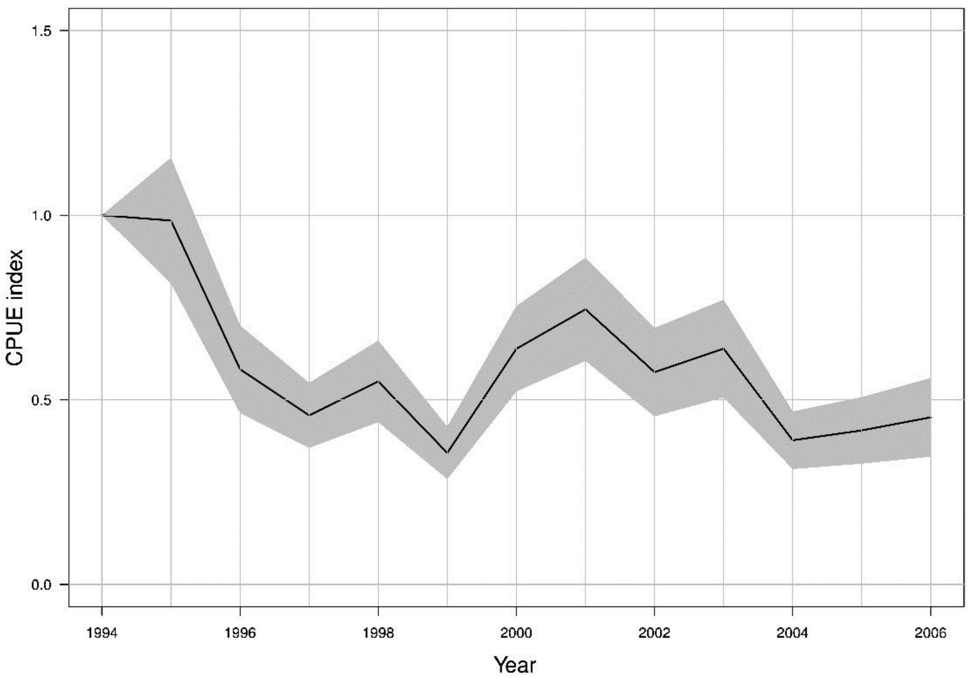

Figure 21.2.3 Trends in standardised CPUE of the shallow pelagic *S. mentella* fishery in the Irminger Sea and adjacent waters, based on log-book data from Faroes, Iceland, Norway, and Greenland.

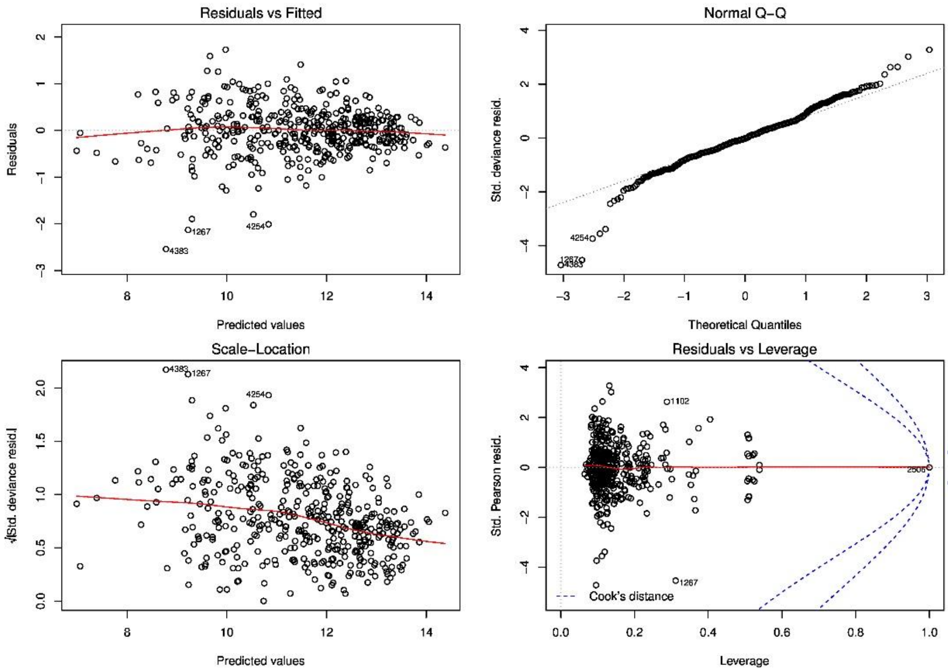

Figure 21.2.4 Residuals from the GLM model used to standardize CPUE, based on log-book data from Faroe Islands, Iceland, Greenland and Norway.

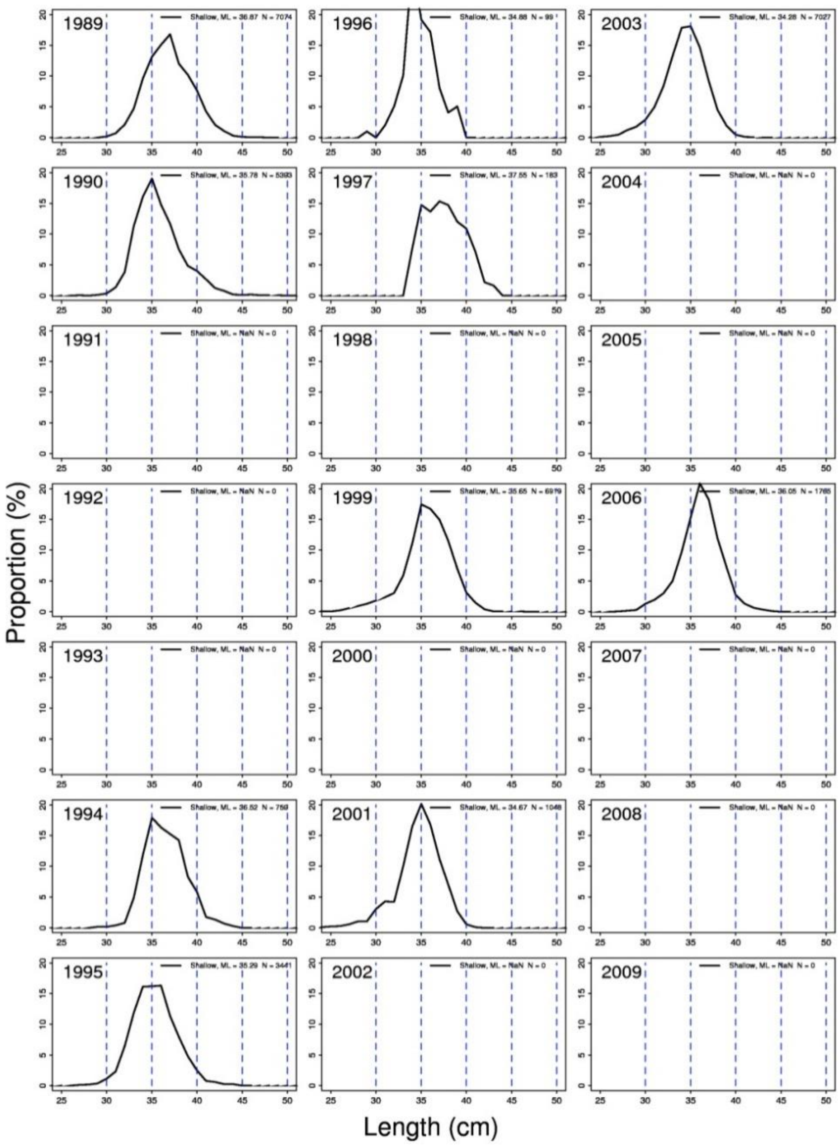

Figure 21.3.1 Length distribution from Icelandic landings of shallow pelagic *S. mentella*.

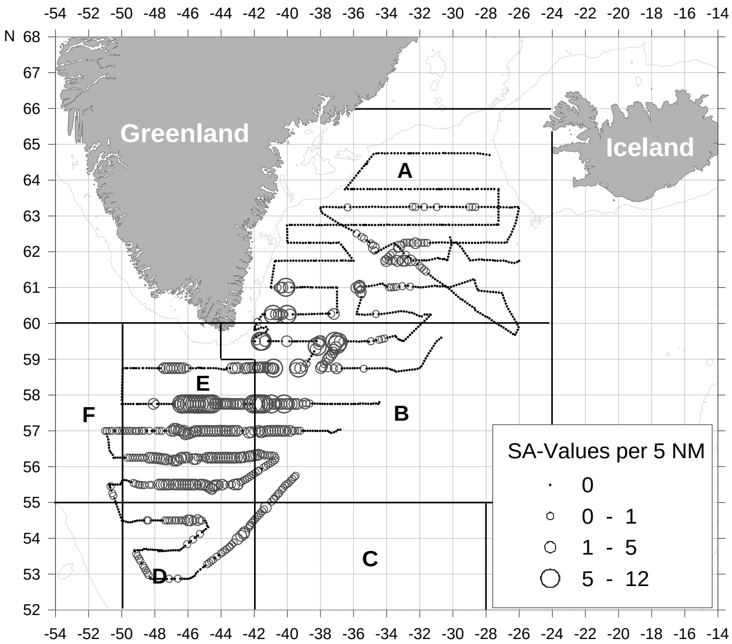

Figure 21.6.1 Pelagic *S. mentella*. Acoustic estimates (average sA values by 5 NM sailed) shallower than the deep-scattering layer (DSL) from the joint trawl-acoustic survey in June/July 2013.

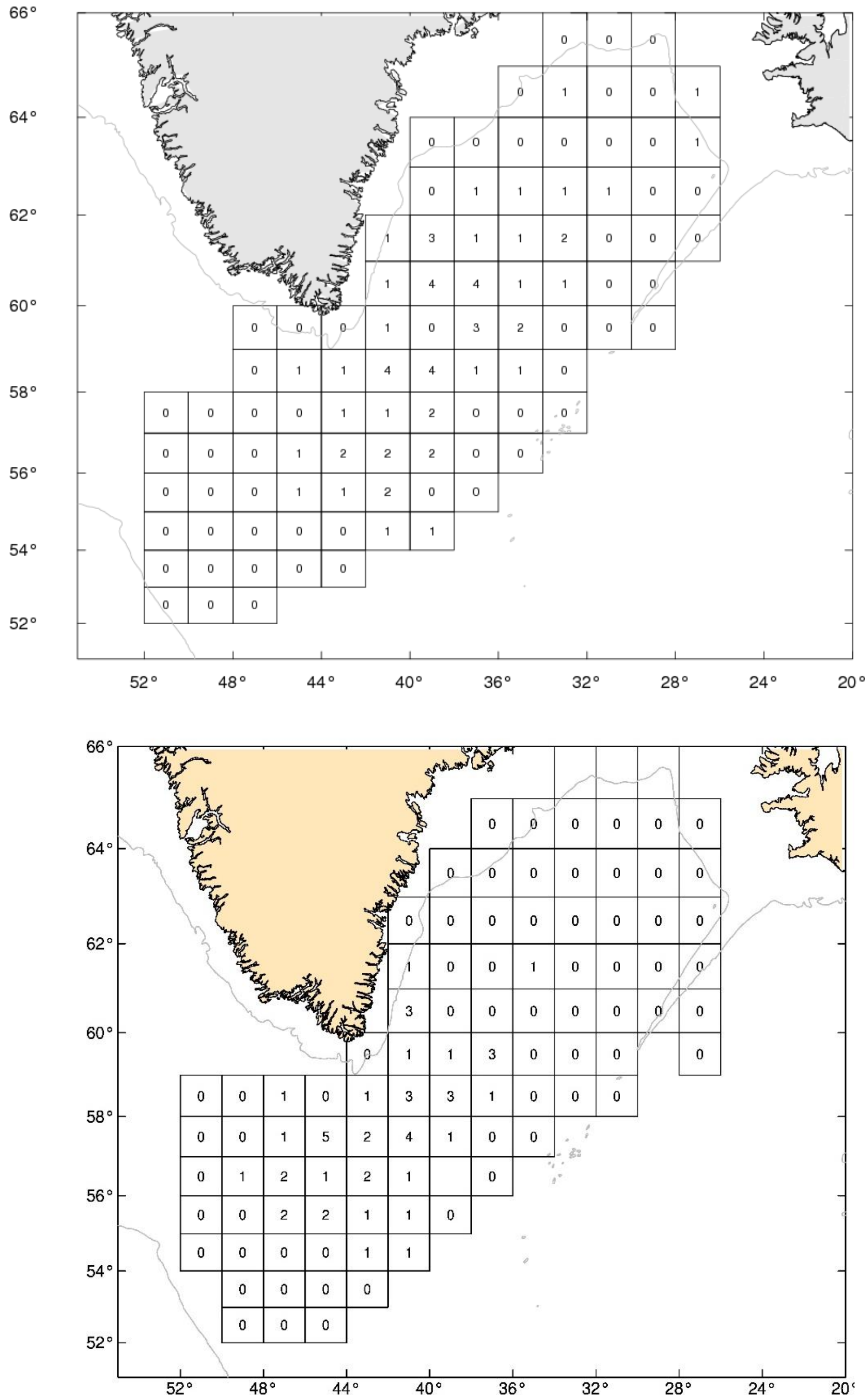

Figure 21.6.2. Redfish acoustic estimates shallower than the DSL. Average sA values within statistical rectangles during the joint international redfish survey in June/July 2013.

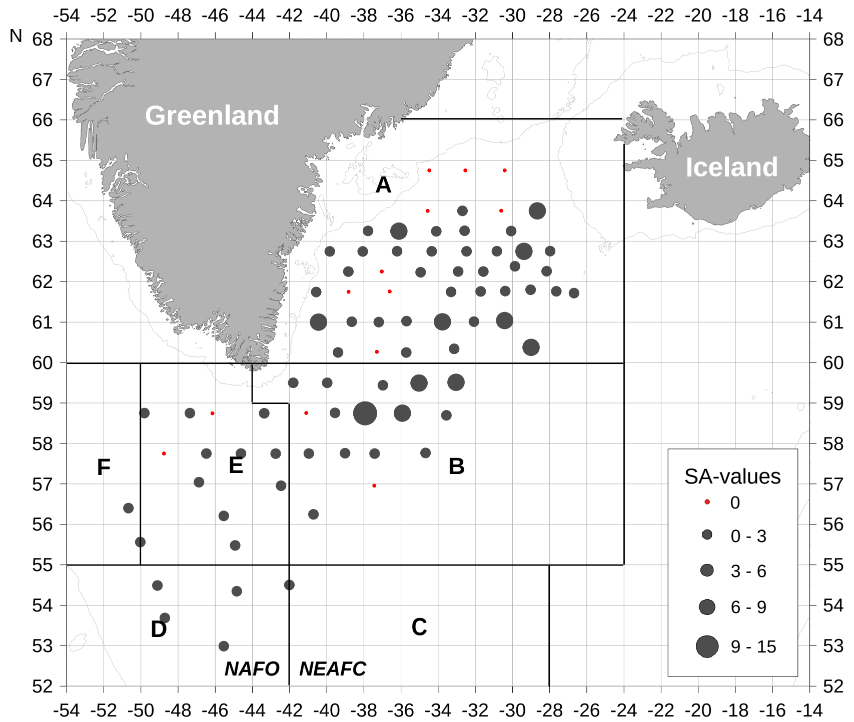

Figure 21.6.3 Redfish trawl estimates within the DSL shallower than 500 m (type 2 trawls). sA values calculated by the trawl method (chapter 2.2.3) during the joint international redfish survey in June/July 2013.

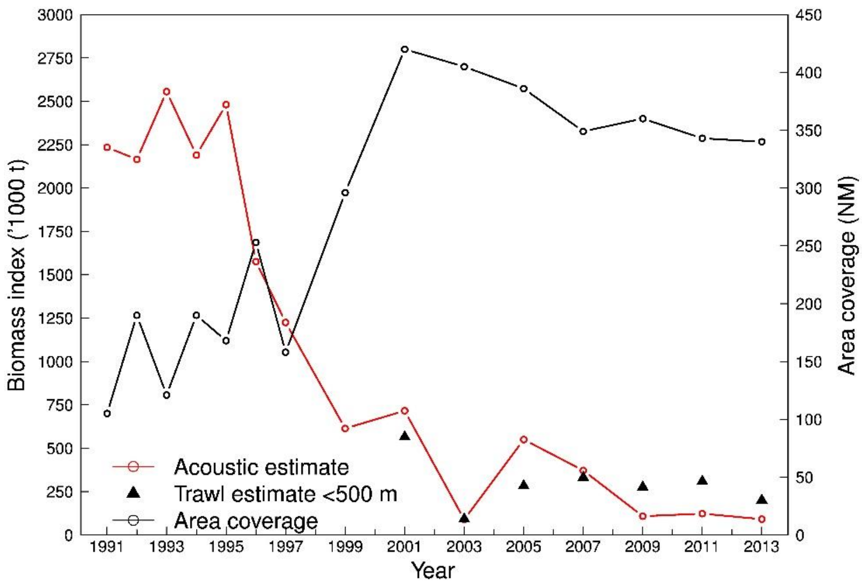

Figure 21.6.4. Overview of acoustic survey indices (thousand tonnes) from above the scattering layer (red filled circle), trawl estimates within the scattering layer and shallower than 500 m (black triangle), and aerial coverage (NM2) of the survey (black open circle) in the Irminger Sea and adjacent waters.

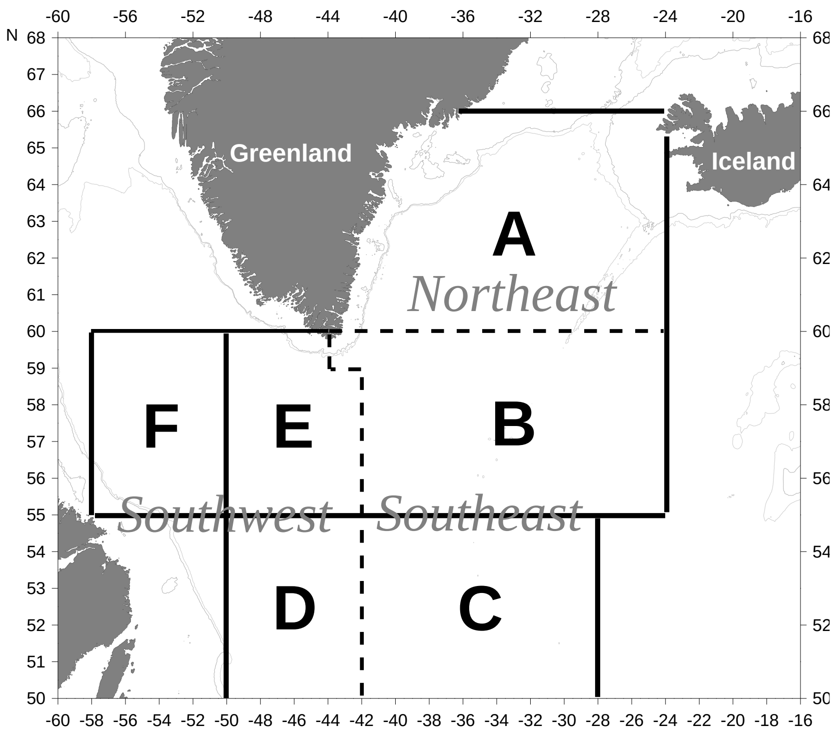

Figure 21.6.5 Sub-areas A-F used on international surveys for redfish in the Irminger Sea and adjacent waters, and divisions for biological data (Northeast, Southwest and Southeast; boundaries marked by broken lines).

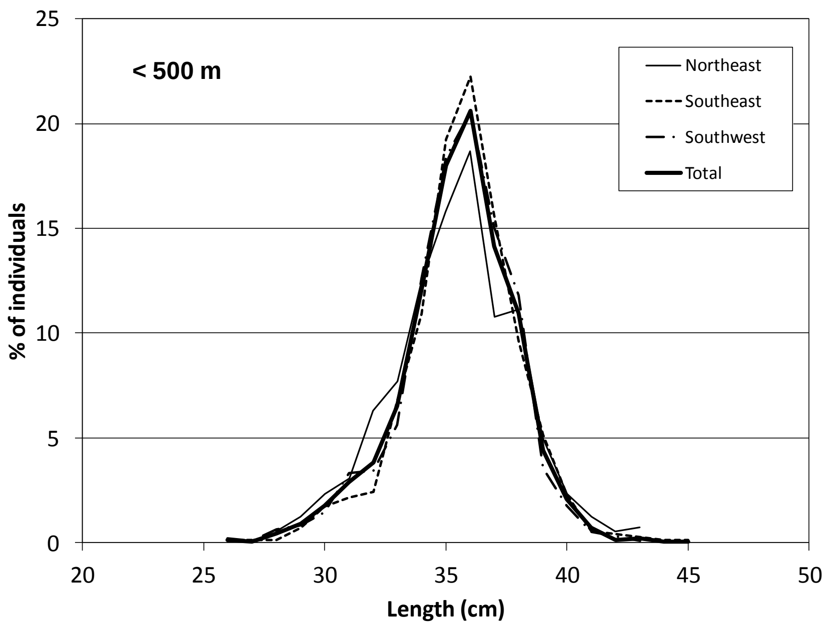

Figure 21.6.6 Length distribution of redfish in the trawls, by geographical areas and total, from fish caught shallower than 500 m (in 2013).

22 Deep Pelagic *Sebastes mentella*

Executive summary

ICES concluded in February 2009 that *S. mentella* is to be divided to three biological stocks and that the deep pelagic *S. mentella* in the Irminger Sea and adjacent areas should be treated as separate biological stock and management unit.

Total landings of deep pelagic *S. mentella* s in 2014 were 23 755 t, half of the 2013 total catch.

No analytical assessment was conducted and there are no biological reference points for the species. Survey indices from the biennial international trawl-acoustic redfish survey conducted in the Irminger Sea and adjacent waters since 1999 are used as basis for advice.

The survey was conducted in June/July 2013. A total biomass of 280 900 t was estimated, a 41% less than in 2011 (474 000 t).Trawl survey estimates in 2011 and 2013 are lower than the average for 1999—2009 and the estimate for 2013 is the lowest observed. The next international trawl-acoustic redfish survey in the Irminger Sea will be conducted in June/July 2015.

No recruitment has been observed on the East-Greenland shelf during 2013 and 2014, which is a concern because it is assumed to contribute to the three *S. mentella* stocks at unknown shares.

22.1 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 > 500 m, 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 summarizes the available information from fishing fleets in the Irminger Sea and adjacent waters in 2014. It should be noted that some these fleets are also fishing the Shallow Pelagic stock:

Country	Number of trawlers
Faroes	2 factory trawlers
Iceland	10 factory trawlers
Germany	1 factory trawlers
Latvia	1 factory trawlers
Lithuania	1 factory trawlers
Norway	5 factory trawlers
Russia	17 factory trawlers
Spain	3 factory trawlers

22.2 The fishery

The historic development of the fishery can be found in the Stock Annex. Tables 22.2.1 and 22.2.2 show annual catches, as estimated by the Working Group, disaggregated by ICES and NAFO regulatory areas and by country, respectively.

The changes in the spatial pattern of the fishery for the period 1992—2014 are shown in Figure 22.2.1, and annual catches are presented in Figure 22.2.2. Catches decreased by nearly 50% from 45 594 t in 2013 to 23 755 t (Table 22.2.2).

Standardized CPUE series for Faroe Islands, Iceland, Greenland, and Norway 1994—2014 are estimated with a GLM model including the factors year, ship, month and towing time. The results from the model show that the CPUE oscillates without trend since 1995 (Figure 22.2.3). The model output is shown in Table 21.2.3 and the residuals are in Figure 22.2.4. The CPUE index increased from about 0.3 in 2012 to >1.0 in 2013

22.3 Biological information

The length distribution from Icelandic landings for the period 1991—2014 is shown in Figure 22.3.1. 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. Mean length has decreased further over the past years, but an increase was observed with 38.3 cm in 2012 compared with 37.8 cm in 2011. The length distribution in 2014 decreased to 35.8 cm (Figure 22.3.1).

22.4 Discards

Discards are not considered to be significant for the time being, according to available data from various institutes.

22.5 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.

22.6 Surveys

The last international trawl-acoustic survey took place in 2013 and it is described in detail in ICES CM WGRS REPORT 2013 (ICES, 2013). The next survey was scheduled to be carried out in June/July 2015 but after the withdrawal of Russia it may be cancelled unless other countries take part. It should be noted that the 2013 estimate was recalculated during the WKREDMP meeting in January 2014 (ICES 2014) as it was wrong because of technical error. The 1999 estimate was also recalculated.

22.6.1 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 . The deep identification hauls covered the depth layers (headline) 550 m, 700 m, and 850 m.

The most recent trawl-acoustic survey on pelagic redfish (*S. mentella*) in the Irminger Sea and adjacent waters was carried out by Iceland, Germany and Russia in June/ July 2013. Approximately 341 000 NM^2 were covered. A total biomass of 280 000 t was estimated, significantly below the 474 000 t of 2011 (Table 22.6.2). The results showed large biomass declines in subareas A, B and E (see Figure 22.6.1 for area definition) (Table 21.6.2). Biological samples from the trawls taken at depth >500 m showed a mean length of 38.5 cm, which is 0.5 cm larger than the mean length in 2011. Figure 22.6.2 shows the spatial distribution of samples used in the survey and Figure 22.6.3 shows the corresponding length distribution.

22.7 Methods

The assessment of pelagic redfish in the Irminger Sea and adjacent waters is based on survey indices, catches, CPUE and biological data.

22.8 Reference points

For pelagic redfish in the Irminger Sea and adjacent waters, no analytical assessment is carried out due to data uncertainties and the lack of reliable age data. Thus, no reference points can be derived.

22.9 State of the stock

22.9.1 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.

22.9.2 Uncertainties in assessment and forecast

22.9.2.1 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.

As in previous years, detailed descriptions on the horizontal, vertical and seasonal distribution of the fisheries are given.

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. With this need in mind, ICES sent a data call to all EU countries participating in the redfish fishery, encouraging stockholders to deliver detailed catch data before the WG would meet, but the response was very limited.

22.9.2.2 Assessment quality

The results of the international trawl-acoustic survey are given in section 21.6. 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 across depth and areas, the uncertainty of these estimates is very high.

It is not known to what extent CPUE reflect changes in the stock status of pelagic *S. mentella*, 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.

22.9.3 Comparison with previous assessment and forecast

The data available for evaluating the stock status are similar to last year.

22.9.4 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.

The 20 000 t TAC set by NEAFC for 2014 was overshot by a much smaller percentage than usual, 20% vs 80% in 2013. This excess is due to the unilateral decision of the Russian Federation to self-allocate an annual TAC, which was 23 700 t for 2014. It was taken from both Shallow and Deep pelagic (15 475 t) stocks, since the Russian Federation does not agree on the division of the *S. mentella* management units.

22.9.5 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.

22.9.6 Changes in the environment

The hydrography in the survey of June/July 2013 show that temperature in the survey area is above average but it was lower than in 2011 in most of the surveyed area, except for the Irminger Current (ICES, 2013).

The increase of water temperature in the Irminger Sea may have an effect on spatial and vertical distribution of *S. mentella* in the feeding area (Pedchenko, 2005). The abundance and distribution of *S. mentella* in relation to oceanographic conditions were analysed in a special multistage workshop (WKREDOCE1-3, see ICES 2012b). Based on 20 years of survey data, the results reveal the average relation of redfish to their physical habitat in shallow and intermediate waters: The most preferred latitude, longitude, depth, salinity and temperature for *S. mentella* are approximately 58ºN, 40ºW, 300 m, 34.89 and 4.4ºC, respectively. The spatial distribution of *S. mentella* in the Irminger Sea mainly in waters < 500 m (and thus mainly relating to the "shallow" stock) appears strongly influenced by the Irminger Current Water (ICW) temperature changes, linked to the Subpolar Gyre (SPG) circulation and the North Atlantic Oscillation (NAO). The fish avoid waters mainly associated with the ICW (>4.5ºC and salinity >34.94) in the north-eastern Irminger Sea, which may cause displacing towards the southwest, where fresher and colder water occurs (ICES 2012b).

Results based on international redfish survey data suggest that the inter-annual distribution of fish above 500 m will shift in a southwest/northeast direction depending on integrated oceanographic conditions (ICES 2012). Whether the results of the study mentioned are applicable to the conditions for the deep pelagic stock needs further investigation.

22.10 WKREDMP 2014

At WKREMP 2014 ICES was requested by Faroe Islands, Iceland and Greenland to evaluate proposed harvest control rules for deep pelagic redfish in the Irminger Sea and adjacent waters (ICES 2014). ICES reanalysed the survey time-series, which is the main source of information for the assessment. This changed the perception of stock status and productivity: The stock appears to be at a historical low. ICES also evaluated the proposed harvest control rules, and none of them are expected to lead to an increase in stock size by 2025. Therefore, ICES considers none of these options as being in accordance with the precautionary approach. It is suggested that managers discuss other options with ICES that might be more suitable, including a starting phase to reverse the decline of the stock.

22.11 References

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NAFO 2005. Scientific Council Reports 2004, 306 pp

Pedchenko, A. P. 2000. Specification of oceanographic conditions of the Irminger Sea and their influence on the distribution of feeding redfish in 1999. ICES North-Western Working Group 2000, Working Document 22, 13 pp.

Pedchenko, A. P. 2005. The role of interannual environmental variations in the geographic range of spawning and feeding concentrations of redfish *Sebastes mentella* in the Irminger Sea. ICES Journal of Marine Science 62: 1501-1510.

Table 22.2.1 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	Total
1991	0	7	52	0	59
1992	1 862	280	1 257	0	3 398
1993	2 603	6 068	6 393	0	15 064
1994	14 807	16 977	20 036	0	51 820
1995	1 466	53 141	21 100	0	75 707
1996	4 728	20 060	113 765	0	138 552
1997	14 980	1 615	78 485	0	95 079
1998	40 328	444	52 046	0	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	86 993
2002	37 269	2	65 858	0	103 128
2003	46 627	21	57 648	0	104 296
2004	14 446	0	77 508	0	91 954
2005	11 726	0	33 759	0	45 485
2006	16 452	51	50 531	254	67 288
2007	17 769	0	40 748	0	58 516
2008	4 602	0	25 443	0	30 045
2009	16 828	4 658	32 920	0	54 406
2010	8 552	0	50 736	0	59 288
2011	0	7	47 326	0	47 333
2012	5 530	608	26 668	0	32 806
2013	5 274	0	40 778	0	46052
2014	603	0	23 152	0	23 755

Table 22.2.2 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
1991								59												59
1992								3 398												3 398
1993				310		1 135		12 741					878							15 064
1994						2 019		47 435					523		377	1 465				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		3 307	33 237	6 895			95 079
1998			76	4 484		8 368	302	46 537	1		34		438		4 073	25 748	2 758			92 818
1999			53	3 466		8 218	3 271	40 261					3 337		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			9 771		4 197		2 208	25 309	7 402			103 128
2003				3 938		7 028	3 403	44 620			0		5 185		2 109	28 638	9 374			104 296
2004				4 670		2 251	2 419	31 098			0		6 277	1 889	2 286	31 067	9 996			91 954
2005				1 800		1 836	1 431	12 919			1 027		3 950	1 240	1 088	16 323	3 871			45 485
2006				3 498		1 830	744	20 942			1 294		5 968	1 356	1 313	23 670	6 673			67 288
2007				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				3 206			1 519	15 125		1 355	2 613			178	1 596	25 309	2 907			54 006
2010				3 195			1 932	14 772		1 963	2 228		2 388	3	2 203	22 803	7 801			59 288
2011				2 028		1 787		11 994		845	1 348		1 066		1 540	22 364	4 361			47 333
2012				1 438		1 523		5 912		724	558		3 362		250	18 377	632			32 806
2013				1 882		1 176		8 545		1 200	1 163		2 979			26 463	2 644			46 052
20141)				721		890		2 081		867	1 024		1 965			15 475	732			23 755

Provisional. Official Spanish catch data were lower than the data provided by NEAFC and the WG decided to use the highest catch data as a precautionary measure.

Table 22.2.3 Output from the GLM model used to standardize CPUE – NOT UPDATED

```
Call:
glm(formula = lafli ~ ltogtimi + factor(land) + factor(yy) +
factor(mm) + factor(skip), family = gaussian(), data = north)

Deviance Residuals:
   Min      1Q   Median      3Q     Max
-3.5126  -0.2410   0.0168   0.2924   1.4568

Coefficients: (3 not defined because of singularities)
              Estimate Std. Error t value Pr(>|t|)
(Intercept)       7.871595279 0.39094194  20.134946938 2.522077e-78
ltogtimi          1.051438993 0.01695572  62.010886787 0.000000e+00
factor(land)6    -0.198774546 0.35054379  -0.567046256 5.707845e-01
factor(land)46    0.356416371 0.13062029   2.728644788 6.448602e-03
factor(land)58    0.385905663 0.35297372   1.093298568 2.744732e-01
factor(land)69    0.131427216 0.21480114   0.611855295 5.407447e-01
factor(yy)1995   -0.544478224 0.09104861  -5.980082924 2.906186e-09
factor(yy)1996   -0.591350758 0.08559433  -6.908761003 7.764598e-12
factor(yy)1997   -1.074579737 0.08522551 -12.608663463 2.120951e-34
factor(yy)1998   -0.695638042 0.08486144  -8.197339811 6.028342e-16
factor(yy)1999   -0.797915967 0.08474619  -9.415361145 2.186144e-20
factor(yy)2000   -0.431790078 0.08594177  -5.024216475 5.788362e-07
factor(yy)2001   -0.955769159 0.08486379 -11.262391106 4.296930e-28
factor(yy)2002   -0.575545027 0.08596398  -6.695188372 3.244414e-11
factor(yy)2003   -0.316293204 0.08682628  -3.642828098 2.806914e-04
factor(yy)2004   -1.016098316 0.08870892 -11.454296393 5.867807e-29
factor(yy)2005   -1.325075546 0.09344673 -14.180009215 1.955001e-42
factor(yy)2006   -0.919905830 0.09688906  -9.494424199 1.079864e-20
factor(yy)2007   -0.681404991 0.10068657  -6.767585940 2.007085e-11
factor(yy)2008   -1.039292973 0.11665575  -8.909059427 1.776186e-18
factor(yy)2009   -0.575811515 0.10378067  -5.548350380 3.516366e-08
factor(yy)2010   -0.337330572 0.10886481  -3.098618992 1.987589e-03
factor(yy)2011   -0.715714357 0.10794155  -6.630573586 4.961323e-11
factor(yy)2012   -1.309676579 0.11568546 -11.321012872 2.345629e-28
factor(yy)2013    0.008868325 0.15200923   0.058340700 9.534866e-01
factor(mm)3      -0.812659803 0.39174110  -2.074481862 3.823868e-02
factor(mm)4      -0.378550109 0.37671843  -1.004862201 3.151575e-01
factor(mm)5      -0.180482597 0.37822841  -0.477178853 6.333181e-01
factor(mm)6      -0.333063915 0.37796344  -0.881206692 3.783752e-01
factor(mm)7      -0.503871648 0.37798537  -1.333045363 1.827596e-01
factor(mm)8      -0.608838137 0.38197175  -1.593934978 1.112032e-01
factor(mm)9      -0.459326697 0.39365610  -1.166822263 2.435045e-01
factor(mm)10     -0.758170930 0.43452708  -1.744818582 8.126201e-02
factor(mm)11     -0.746833434 0.50556889  -1.477213994 1.398700e-01
factor(skip)118  -0.267350277 0.14387130  -1.858260004 6.336686e-02
factor(skip)1265 -0.305357861 0.22335074  -1.367167461 1.718184e-01
factor(skip)1268 -0.266852354 0.48481836  -0.550417180 5.821315e-01
factor(skip)1270 -0.152220760 0.13168835  -1.155916653 2.479360e-01
factor(skip)1273 -0.419400828 0.13225616  -3.171125008 1.555377e-03
factor(skip)1279 -0.447449821 0.22139223  -2.021072797 4.348488e-02
factor(skip)1308 -0.038459005 0.12407714  -0.309960450 7.566427e-01
factor(skip)1328 -0.144677028 0.13096482  -1.104701450 2.695014e-01
factor(skip)1345 -0.458372216 0.12962963  -3.536014115 4.210561e-04
factor(skip)1351 -0.357088024 0.13798946  -2.587792070 9.771199e-03
factor(skip)1360 -0.115260878 0.13128164  -0.877966489 3.801305e-01
factor(skip)1365 -0.295965760 0.14818615  -1.997256610 4.601360e-02
factor(skip)1369 -0.011320574 0.14158965  -0.079953400 9.362871e-01
factor(skip)1376 -0.169473795 0.12691871  -1.335294073 1.820230e-01
factor(skip)1395 -0.409995924 0.26206284  -1.564494724 1.179543e-01
factor(skip)1408 -1.101773815 0.48734615  -2.260762308 2.394521e-02
factor(skip)1412 -0.111357948 0.29537612  -0.377003899 7.062346e-01
```

```
factor(skip)1459 -0.583761981 0.13242885  -4.408117879 1.132118e-05
factor(skip)1471 -0.613726934 0.17679359  -3.471432056 5.353333e-04
factor(skip)1472 -0.511423665 0.16493944  -3.100675325 1.973945e-03
factor(skip)1473 -0.952361655 0.21265005  -4.478539431 8.201613e-06
factor(skip)1484 -1.433135836 0.48533948  -2.952852375 3.207303e-03
factor(skip)1497 -1.418776803 0.35333866  -4.015345477 6.288939e-05
factor(skip)1530 -0.740040738 0.48506624  -1.525648831 1.273501e-01
factor(skip)1536 -1.814090714 0.48651089  -3.728777180 2.010160e-04
factor(skip)1552 -1.430344940 0.29607192  -4.831072584 1.525962e-06
factor(skip)1553 -0.003402939 0.35390074  -0.009615518 9.923296e-01
factor(skip)1578 -0.354319033 0.15025452  -2.358125591 1.852067e-02
factor(skip)1579 -0.071762545 0.12696644  -0.565208749 5.720331e-01
factor(skip)1585 -0.417372263 0.17163124  -2.431796521 1.516373e-02
factor(skip)1628 -1.097387934 0.29532540  -3.715860332 2.114507e-04
factor(skip)180  -0.522664061 0.11197449  -4.667706574 3.373762e-06
factor(skip)1833 -0.025339243 0.12377825  -0.204714826 8.378282e-01
factor(skip)1868 -0.141108499 0.12362729  -1.141402470 2.539209e-01
factor(skip)1880 -0.300538211 0.13797726  -2.178172089 2.957946e-02
factor(skip)1902 -0.122037774 0.13376781  -0.912310478 3.617811e-01
factor(skip)1903 -0.503244254 0.29824691  -1.687341029 9.178708e-02
factor(skip)1976 -0.628200177 0.20114205  -3.123166888 1.830228e-03
factor(skip)1977 -0.169902957 0.14830443  -1.145636427 2.521647e-01
factor(skip)2107 -0.796278905 0.35043313  -2.272270619 2.323928e-02
factor(skip)2165  0.072495588 0.13389141   0.541450638 5.882934e-01
factor(skip)2170 -0.090472494 0.12251178  -0.738479960 4.603614e-01
factor(skip)2182 -0.227474427 0.12989539  -1.751212416 8.015439e-02
factor(skip)2184 -0.083675892 0.12979356  -0.644684474 5.192499e-01
factor(skip)2203 -0.195064716 0.12387778  -1.574654639 1.155890e-01
factor(skip)2212  0.043365160 0.16082696   0.269638625 7.874828e-01
factor(skip)2220  0.170552846 0.48621844   0.350774122 7.258169e-01
factor(skip)2236 -0.240310005 0.20254007  -1.186481294 2.356576e-01
factor(skip)2248 -0.468803577 0.35307606  -1.327769382 1.844965e-01
factor(skip)2265 -0.081118608 0.13404819  -0.605145127 5.451923e-01
factor(skip)2410 -0.192166371 0.21987506  -0.873979834 3.822970e-01
factor(skip)2549 -0.144974322 0.14686104  -0.987153031 3.237585e-01
factor(skip)2550  0.027568334 0.48384311   0.056977837 9.545719e-01
factor(skip)2592  0.229114661 0.35461605   0.646092198 5.183381e-01
factor(skip)3033 -1.789786537 0.44139343  -4.054855382 5.326475e-05
factor(skip)3135 -0.358279004 0.40653274  -0.881304184 3.783225e-01
factor(skip)3156 -1.276943431 0.36406219  -3.507487084 4.683906e-04
factor(skip)3382 -1.174260049 0.37396205  -3.140051352 1.728735e-03
factor(skip)3523 -1.415480845 0.45907228  -3.083350696 2.091640e-03
factor(skip)3542 -0.818668375 0.38925897  -2.103145841 3.565233e-02
factor(skip)3709 -1.212729719 0.37572436  -3.227711221 1.280216e-03
factor(skip)934  -0.560484938 0.10397540  -5.390553316 8.388350e-08
factor(skip)A     0.478887900 0.44197157   1.083526488 2.787836e-01
factor(skip)B     0.747484733 0.39901053   1.873345878 6.125365e-02
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for gaussian family taken to be 0.2216236)

    Null deviance: 1901.61  on 1335  degrees of freedom
Residual deviance:  274.59  on 1239  degrees of freedom
AIC: 1873.7

Number of Fisher Scoring iterations: 2

Analysis of Deviance Table

Model: gaussian, link: identity

Response: lafli
```

Terms added sequentially (first to last)

```
Df Deviance Resid. DfResid. Dev F Pr(>F)
ltogtimi 1 1353.66 1347 559.66 6153.6477 < 2.2e-16 ***
factor(land) 4 68.12 1343 491.55 77.4139 < 2.2e-16 ***
factor(yy) 19 132.78 1324 358.76 31.7700 < 2.2e-16 ***
factor(mm) 9 17.82 1315 340.94 9.0021 2.899e-13 ***
factor(skip) 64 65.75 1251 275.19 4.6701 < 2.2e-16 ***
---
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Table 22.6.1 Deep pelagic *S. mentella*. Survey estimates for depth >500 m from trawl samples taken in 2013.

	A	B	C	D	E	F	Total
Area (NM2)	123 531	83 385	4 181	51 185	62 730	15 683	340 695
Mean length	(cm)	38.8	37.5	36.1	36.3	38.2	37.7
Mean weight	(g)	717	653	615	595	482	654
Biomass (t)	193 000	75 000	0	2 000	10 000	0	280 000

Table 22.6.2. Results (biomass in ´000 t) for the international redfish surveys conducted since 1999 for deep pelagic *S. mentella* for each subarea (see Figure 22.6.2) and total.

	Sub-area						
Year	A	B	C	D	E	F	Total
1999	277	568	12	27	52	0	935
2001	497	316	28	79	64	18	1001
2003	476	142	20	13	27	0	678
2005	221	95	0	8	65	3	392
2007	276	166	1	5	62	11	522
2009	291	121	0	8	37	1	458
2011	342	112	0	1	18	0	474
2013	193	75	0	2	10	0	280

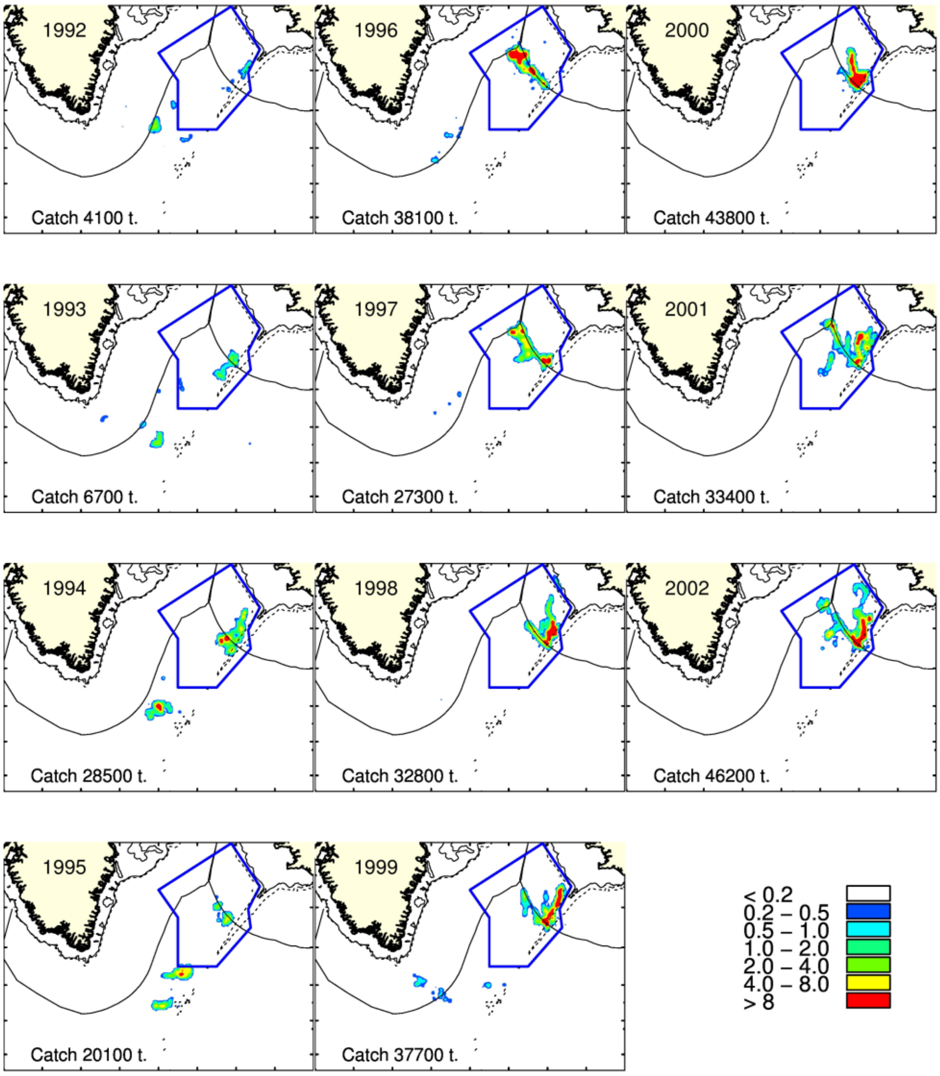

Figure 22.2.1 Fishing areas and total catch of deep pelagic redfish (*S. mentella*) in the Irminger Sea and adjacent waters 1992-2014. Data are from the Faroe Islands (1995-2013), Germany (2011-2014) Greenland (1999-2003 and 2009-2010), Iceland (1995-2014), and Norway (1995-2003 and 2010-2014). The catches in the legend are given as tones per square nautical mile. The blue box represents the proposed management unit.

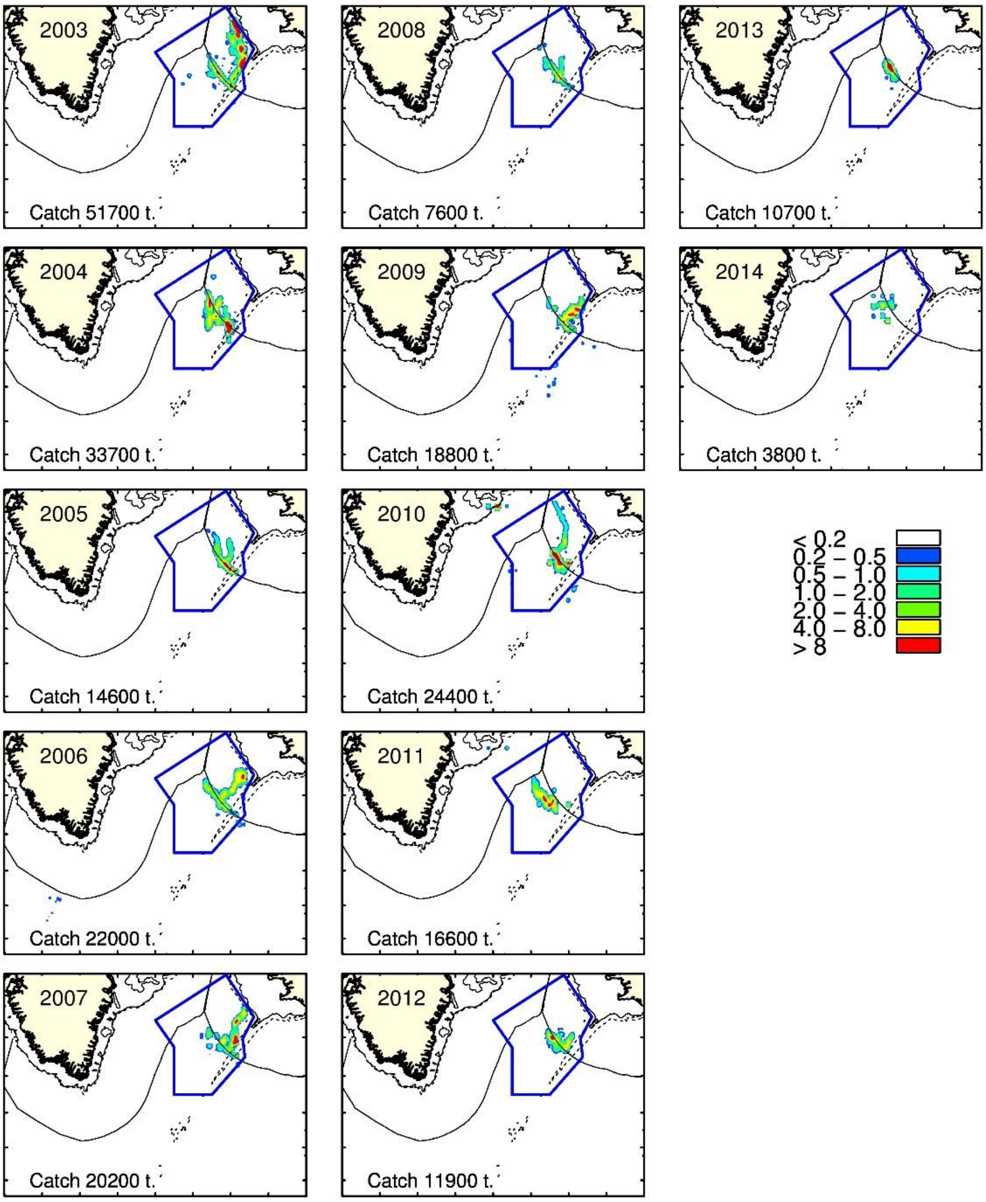

Figure 22.2.1 (Cont.) Fishing areas and total catch of deep pelagic redfish (*S. mentella*) in the Irminger Sea and adjacent waters 1992-2014. Data are from the Faroe Islands (1995-2013), Germany (2011-2014) Greenland (1999-2003 and 2009-2010), Iceland (1995-2014), and Norway (1995-2003 and 2010-2014). The catches in the legend are given as tones per square nautical mile. The blue box represents the proposed management unit.

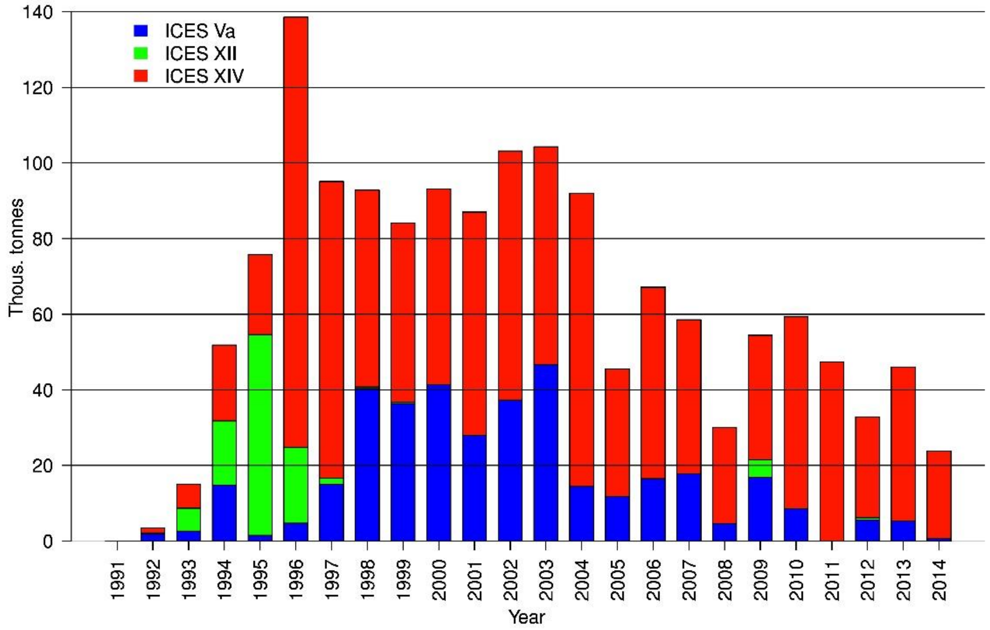

Figure 22.2.2 Landings of deep pelagic *S. mentella* (Working Group estimates, see Table 21.2.1).

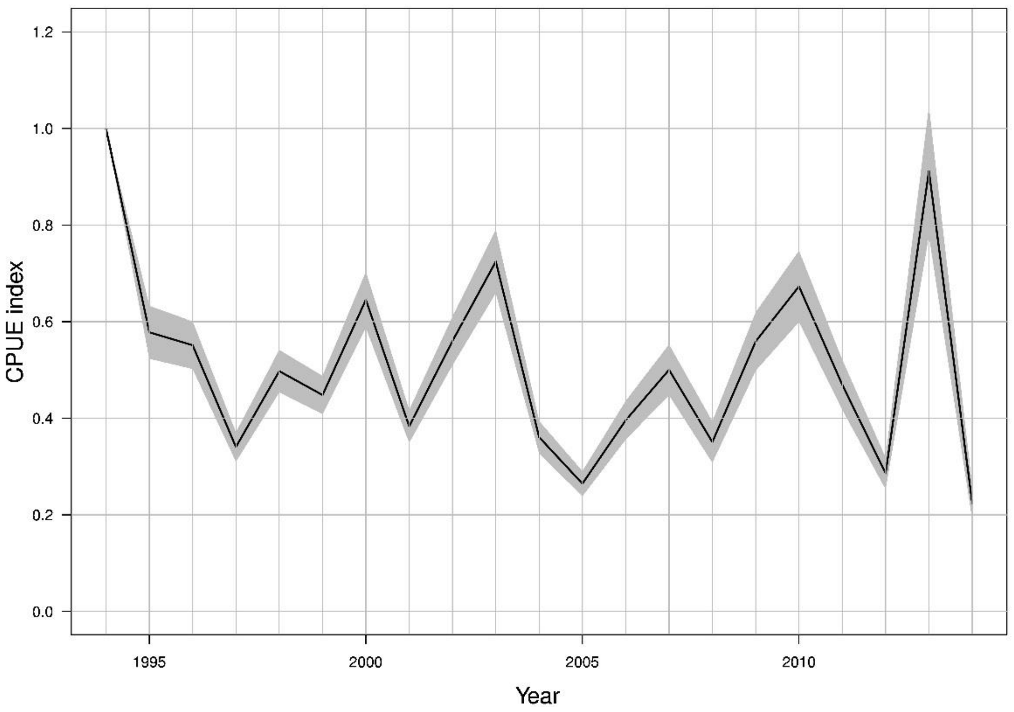

Figure 22.2.3 Trends in standardised CPUE of the deep pelagic *S. mentella* fishery in the Irminger Sea and adjacent waters, based on log-book data from Faroe Islands, Iceland, Germany, Greenland and Norway.

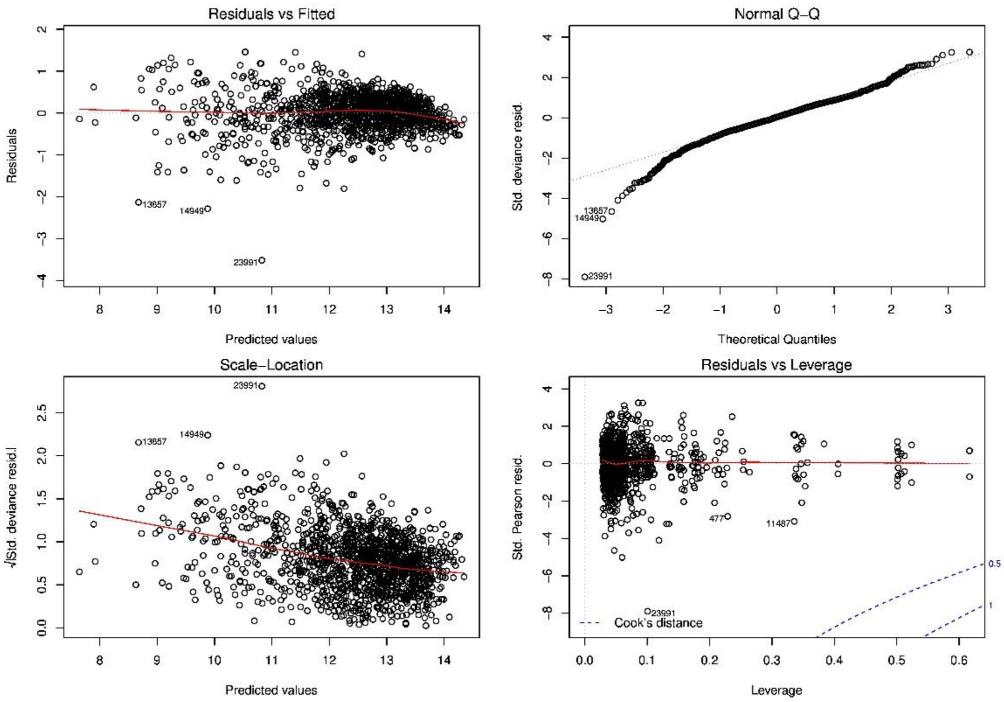

Figure 22.2.4 Residuals from the GLM model used to standardize CPUE, based on log-book data from Faroe Islands, Iceland, Greenland and Norway.

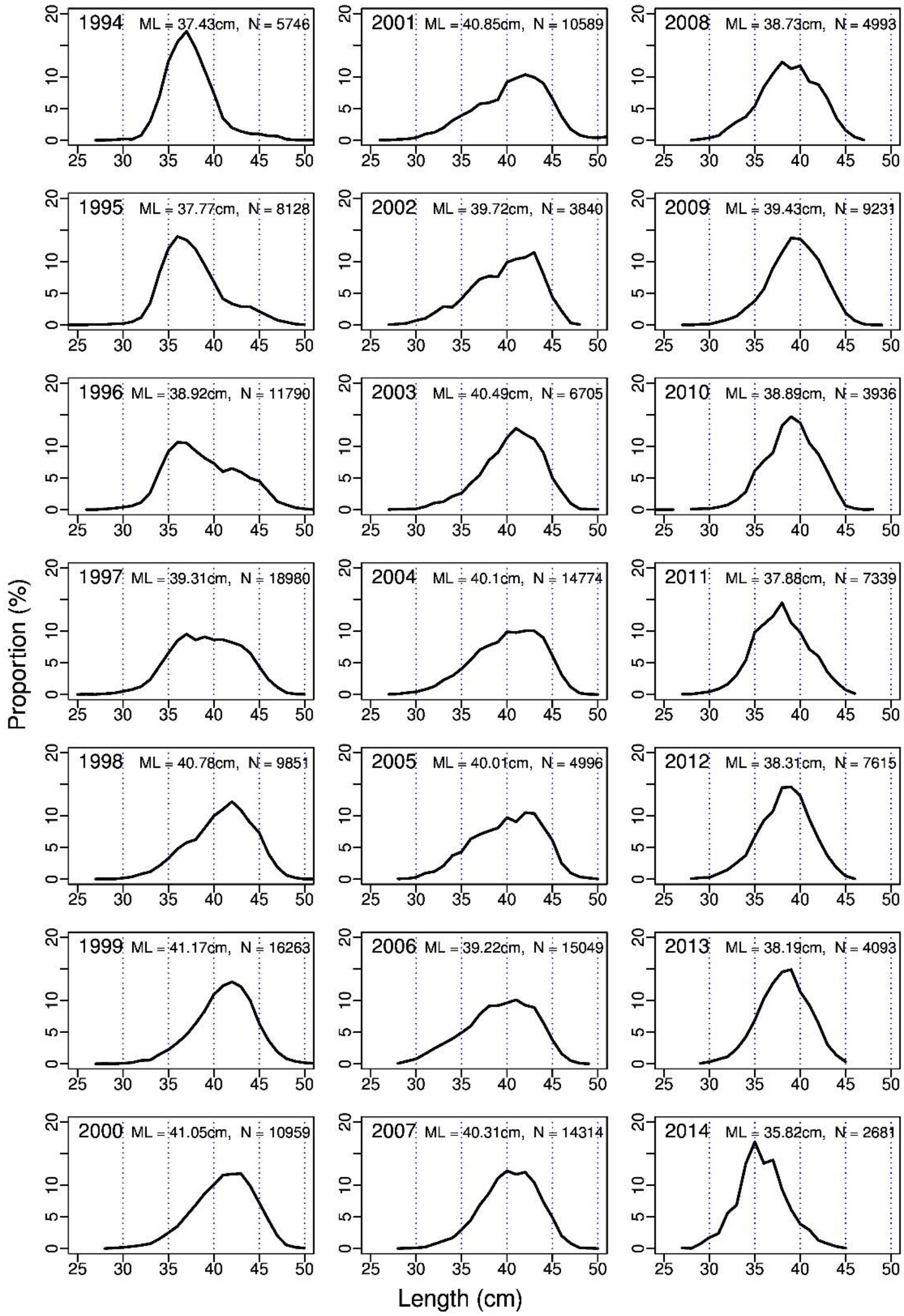

Figure 22.3.1 Length distribution from Icelandic landings of deep pelagic *S. mentella*.

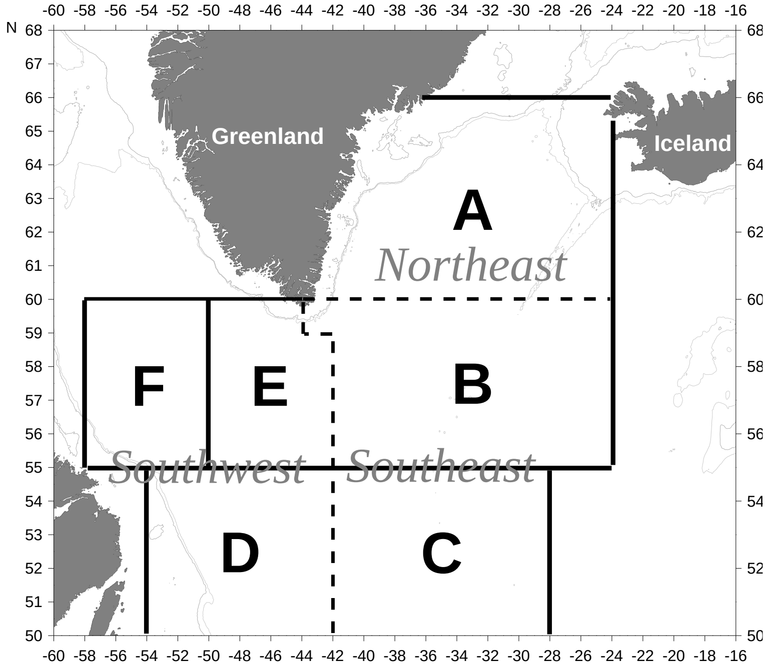

Figure 22.6.1 Sub-areas A-F used on international surveys for redfish in the Irminger Sea and adjacent waters, and divisions for biological data (Northeast, Southwest and Southeast; boundaries marked by broken lines).

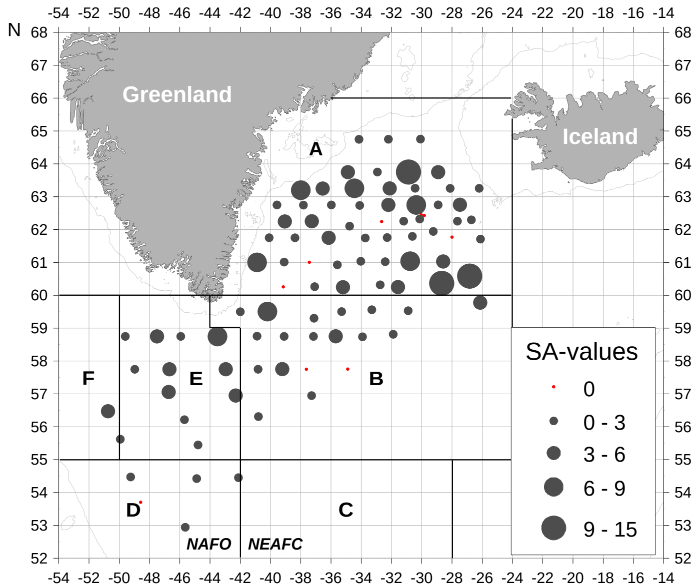

Figure 22.6.2. Redfish trawl estimates deeper than 500 m (type 3 trawls). sA values calculated by the trawl method (see WGRS Report, 2013) during the joint international redfish survey in June/July 2013.

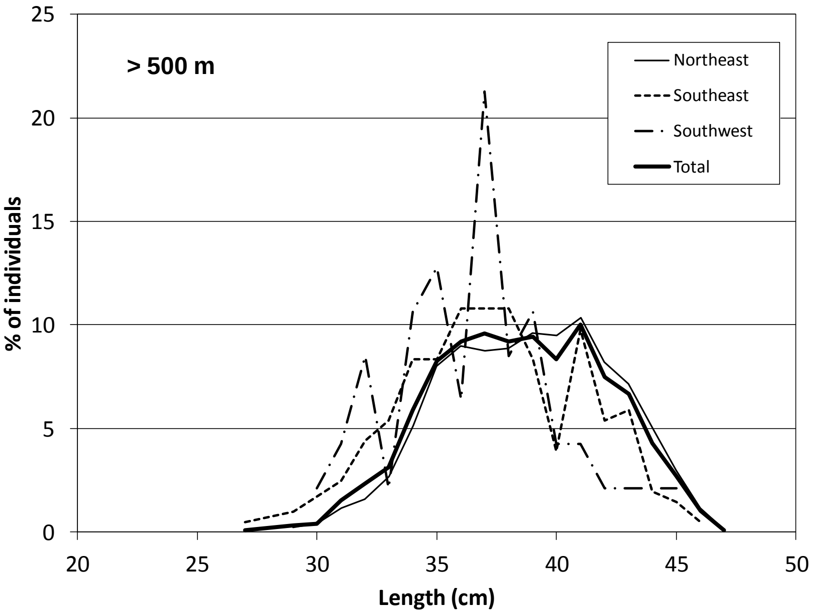

Figure 22.6.3 Length distribution of redfish in the trawls, by geographical areas (see Fig. 22.6.1) and total, from fish caught deeper than 500 m.

23 Greenlandic slope *Sebastes mentella* in XIVb

Summary

ICES concluded in February 2009 that demersal *S. mentella* is to be divided into three biological stocks and that the *S. mentella* on the continental shelf and slope should be treated as a 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 stock 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 2014 were about 4600 tons, which is less than 2010-2012 landings. The lower catches are partly due to a lower presence of mentella in the mixed stock fishery and partly due to a lower total landing of demersal redfish.

In the decade before 2009 *S. mentella* was mainly a valuable by-catch in the fishery for Greenland halibut. However, since 2009 a fishery directed towards demersal redfish has taken place.

Available survey biomass indices show that in Division XIVb the biomass decreased further in 2014. No new recruits (>18 cm) are seen in the surveys since 2012, and no juveniles are present (<18 cm) in both 2013 and 2014 surveys

The advice is based on the DLS approach (3.2) using the Greenland shallow water survey as basis for advice. The ratio is applied to the 2014 advice as catches are well above the current advice. The advice for 2016 is 2240 t.

23.1 Stock description and management units

See chapter 18 for description of the stock structure of *S. mentella* in the Irminger Sea and adjacent waters. ICES has advised separately for *S. mentella* found demersal in ICES XIVb since 2011, and will do so until all available information on stock origin in this area is analysed and a new procedure is agreed upon.

23.2 Scientific data

Indices were available from three surveys in XIVb. A German survey directed towards cod in Greenlandic waters (0—400 meters, Fock *et al.* 2015), the Greenland deep water survey (400—1500 meters) targeting Greenland halibut (Hedeholm *et al.* 2015a) and the Greenland shrimp and fish survey in shallow water (0—600 meters) which has been conducted since 2008 (Hedeholm *et al.* 2015b). The German survey on the slope in XIVb has since 1982 been covering the slopes in East Greenland waters. Cod is the target species in this survey and it operates at depths of 400 meters and shallower. The survey was re-stratified in 2009 (see Stock Annex). From 1993—1998 a large number of *Sebastes* sp. smaller than 17 cm. was found in the survey (Figure 23.2.1). This coincided with a large increase in the amount of 17-30 cm large *S. mentella* from 1995—1998. From 1998 to 2003 the total biomass increased as a result of many small fish (<17 cm) in the survey, followed by a few years of high biomass estimates for *S. mentella* from 2003—2009. This increase occurred in one particular stratum only, i.e. stratum 8.2. From 2009 onward, a declining trend was observed, with the low biomass estimates resembling the conditions before (Figure 23.2.1). In the same period, the amount of small fish (17—30 cm) has steadily declined causing an increase in the amount of larger fish (Figure 23.2.1c) until the overall biomass declines in 2010 and 2011. The depletion of the small size group has led to a progressive decline in the juvenile biomass index to a current low level, and no new recruits have been seen in the survey since 2012. This pattern is also reflected in the abundance estimates (Figure 23.2.1). The modal size of the adult fish has increased from 25 cm in 2001 to around 37 cm in 2010, but declined slightly in 2011 and the distribution has becomes flat with clearly defined mode in 2013 (Figure 23.2.2).

The Greenland 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 targeting Greenland halibut. The biomass indices in the Greenland deep water survey peaked in 2012, but has decreased since then (Figure 23.2.3). The overall length distribution from the entire area in 2013 and 2014 shows a mode around 31 cm which is a 1—2 cm increase compared to 2011 and 2012 values (Figure 23.2.4).

The Greenland shrimp and fish survey in shallow water in East Greenland started in 2007, and surveys the East Greenland shelf and shelf edge at depths between 0—600 m. However, 2007 was mostly exploratory and is not reported. In general, survey estimates of schooling fish are associated with large uncertainties due to their patchy distribution. This, in conjunction with the relatively short time series, makes overall conclusions regarding stock trends based solely on this survey tentative although it is probably the survey with the best coverage of redfish distribution. The 2014 biomass estimate was the lowest observed in the time series (Figure. 23.2.5). The German survey shows very similar trends both with regards to adult fish and juveniles. The juveniles are at the lowest level in the 30 year time series, and the adult biomass index has declined for the past five years and is at the lowest level since 2005. Both survey length distributions showed no clear mode, but a rather flat distribution (Figure 23.2.6). The German survey and the Greenland shrimp and fish shallow water survey both show overall declines in the *S. mentella* biomass since 2010 (Figure 23.2.7). Fproxy values based on surveys indicate an increasing fishing mortality in recent years (Figure 23.2.8).

23.3 Information from the fishing industry

23.3.1 Landings

From the Greenland and German surveys we know that the demersal redfish found on the Greenland slope is a mixture of *S. marinus* and *S. mentella*. Based on the surveys and fourteen samples from the commercial fishery the 7314 tonnes of demersal redfish caught in ICES XIVb, was estimated to be 63 % *S. mentella* (4608) and 37% S. norvegicus (2706), which is the lowest proportion of *S.mentella* observed. Prior to 1974 all catches were reported as *S. marinus* and the split was determined by working groups on a yearly bases.

Total annual landings of demersal *S. mentella* from Divisions XIVb since 1974 are presented in Table 23.3.1.1. From 1976 to 1994 annual landings were at a relatively high level with landings ranging between 2000 tons to 20 000 tons with a very high peak at nearly 60 000 t in 1976. However, this fishery was ended abruptly in 1995 due to large amounts of very small redfish in the catches. From 1998 to 2002 the landings ranged from 1000 to 2000 tons and from 2003 to 2008 landings remained at lower levels (<500 tons). In 2009 an exploratory fishery landed 895 tons of *S. mentella*. This was a large increase compared to 2008 and for the first time in ten years the fishery was limited by a TAC. In 2010, a quota on 5,000 tons demersal redfish was initially given and of these, 400 t were allocated to the Norwegian fleet. After this amount was fished, an extraordinary research quota of 1000 tons was given to a Greenlandic vessel. Since 2010 the catches have been around 8300 t (*S. mentella* and *S. marinus* combined) and 2013 catches were 8246 t (Figure 23.3.1.1). The TAC for 2014 is 8500. In 2010 there was no jurisdiction that clearly delimited the pelagic stocks from the redfish found on the shelf. A few vessels benefitted from this by fishing their pelagic quota on the shelf (2179 tons) making catches on the shelf exceed the TAC. This led to the introduction of a "redfish line" that separates the demersal slope stock from the pelagic stocks (see stock annex).

23.3.2 CPUE and by-catch CPUE

A redfish by-catch CPUE was introduced at the redfish 2012 benchmark (WKRED). This is based on catches from the Greenland halibut directed fishery (Hedeholm and Boje 2014a) which covers redfish distribution better than data from the redfish directed fishery and covers a longer period (1999—2014). The CPUE has very low values in the initial two years of the time series, but following an increase in 2001, values have remained at the same level until 2006 after which a decline followed. From 2010 to 2012 the CPUE increased, followed by a small decline in 2013—2014 (Figure 23.3.2.1).

The index does not show the decline in biomass index seen in the shallow water surveys (German and Greenland). This could be associated with the nature of the decline, which appears to be confined to the commercial area. The Greenland halibut fishery is not as spatially restricted as the redfish fishery, so it will not be as sensitive to local changes. Based on the CPUE there does not appear to be any large decline in stock size.

The CPUE from the redfish directed fishery showed a drastic decline from 2010 (3.7 t/h) to 2014 (1.3 t/h, Figure 23.3.2.2). This fishery takes place in a geographically limited area between 63.5°N and 65°N, where approximately 90% of the catches are taken. Accordingly, the CPUE series can only be used as an index on local stock development. Both the Greenland shallow water survey (0—600m) and German survey (0-400m) show that the main fishing area coincides with the area of highest overall abundance. Hence, the CPUE decline indicates a severe local stock depletion that is also reflected in the overall stock trend.

23.3.3 Fisheries and fleets

The fishery for *S. mentella* on the slopes in XIVb is mainly conducted with bottom trawl. From 1998—2012 only 1% were caught with longlines. The area where *S. mentella* is caught is closely related to the area where fishery for Greenland halibut and cod takes place. The majority of the catches are taken at depths from 300 m to 400 m. (Figure 23.3.3.1)

The directed fishery was stopped in 1995, but in 1998 Germany restarted a directed fishery for redfish with annual landings of approximately 1000 t in 1998—2001 increasing to 2100 t in 2002 (Bernreuther *et al.* 2013). 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 in 2003—2004 (less than 500 t). This continued in 2005—2008 and most *S. mentella* were caught as by-catch in the Greenland halibut fishery.

After the German fleet stopped fishing in 2002 the majority of the catches have been taken by the British, Faroese, Norwegian and Greenland fleet. The British fishery took place from 2001 to 2005 and since 2006 only Greenland, Faroese Islands, Norway and Germany have had any significant catches (Table 23.3.3.2).

In 2009 three Greenland vessels started a fishery targeting demersal redfish. Each was given an explorative quota of 250 t. This fishery was very successful and led to an increased fishery in 2010 (seven boats), 2011 (15 boats) and 2012 (21 boats). However, in 2012 95% of the catch was taken by six vessels and 97% by five vessels in 2013.

On the steep slopes very little horizontal distance separates the distribution of cod, redfish and Greenland halibut (Figure 23.3.3.2). The part of the fleet with both quotas for redfish and Greenland halibut takes advantage of this by shifting between very short hauls targeting redfish and long hauls directed to Greenland halibut. Thereby avoiding time where the vessel is not fishing due to processing of the catch.

23.3.4 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). However, the 22 mm spacing between the bars in the separator 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). Coincident with the introduction of these separator grids the amount of juvenile redfish caught by the shrimp fishery dropped from annual 100-200 tons to a lower 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 negligible (Table 23.3.4.1). Since 1999 the fishery has started in April-May due to poor winter conditions such as ice and wind that prevents fishing. Only in 2000 and 2002 the fishery started already in February (Table 23.3.4.2). Since 2010, the fishery has been starting already in January. The depth distribution of cod and redfish overlaps (Figure 23.3.3.2) and therefore the fishery for redfish led to a by-catch of cod on 96 tons in 2013. The vessels are allowed a 10% by-catch of cod.

23.3.5 Sampling from the commercial fishery

In 2013 the catch length distribution was estimated from 14 samples (N=1 019, Figure 23.3.6.1). Length distribution of 752 redfish analysed by the Greenland Institute of Natural Resources separated into *S.mentella* (N=548) and *S.norvegicus* (N=204). It showed a clear mode around 34 cm. which is a decrease of 4 cm compared to the last three years. All samples were analyzed by the Greenland Institute of Natural Resources, and it was found that *S. mentella* constituted 76% of the total sample weight (Figure 23.3.6.2). In both species a mode was seen between 34-36cm. and for *S. marinus* an additional increase in frequency was seen at 45-50cm.

23.4 Methods

No analytical assessment was conducted.

23.5 Reference points (Benchmark, WKRED)

There are no biological reference points defined for this stock. However, part of the benchmark in 2012 (WKRED) was to evaluate the possible use of a stock production model in generating a quantitative advice for this stock. Under certain assumptions and for various intrinsic growth rates (r), current sustainable yields (and MSY) were calculated using the German survey and landings as input data. Across the range of r's, results seemed robust (CV range: 0.03-0.17), and the current sustainable yield was estimated at approximately 3.5 Kt. However, this procedure was criticized at the benchmark due to lack of coverage of redfish distribution in the survey and questionable landings, and it is stated in the benchmark report that: "*The panel does not suggest that the Schaefer model approach used here is to be final; to the contrary it is offered as a first step (from which interim management advice might be formulated)*". As there are doubts on stock structure, species determination (and hence catch data accuracy), migration and the quality of the surveys used as basis for the model approach, the applicability of the proposed reference points from WKRED is questionable. Indeed, the use of a stock production model on an aggregation of fish that is not clearly defined as a stock is questionable.

23.6 State of the stock

The German survey and the Greenland shrimp and fish shallow water survey both show overall declines in the *S. mentella* biomass since 2010 (Figure 23.2.7 , and both show a complete absence of small fish since 2013 (<18 cm). The adult stock decline is caused by a large decline in a small area which coincides with the main fishing area. The directed fishery CPUE for this area has declined from 3.7 t/h (2010) to 1.3 t/h suggesting a large local decline. Changes in length distributions in both surveys also suggests that no new cohorts are present on the slope and that the adult biomass decline is caused by the gradual decline of a single/few cohorts. Especially the complete absence of juveniles is cause for concern.

The biomass estimate declines and the concentrated fishery could point to a fishery induced decline. However, the declines are of a magnitude that seems beyond what a limited number of years catches can cause. Hence, surveys may either overestimate the biomass in especially Q3, not survey the entire area of distribution or *S. mentella* is disappearing due to migration. Survey overestimation may result from the large aggregations of redfish in Q3, which may cause two different survey scenarios, a low-density and high-density situation. If large redfish aggregations changes the catchability, the assumptions of linearity between catch and abundance are rendered invalid – high fish concentration may simply reduce the trawl escape potential. Such a situation would produce disproportionally high catches and subsequently biomass estimates in high density areas such as Q3. Hence, the decline may be a synergetic effect of a reduced biomass caused by the local fishery, and the reduced catchability inferred from the less dense fish aggregations following some years of intense fishing. This is further complicated by the lack of knowledge on the stocks connection to the pelagic (deep and shallow) and Icelandic slope stocks and the degree of migration. Based on this, care must be taken when evaluating stock status, but nevertheless, the consistency in both the German and shallow Greenlandic surveys suggests that the biomass has decreased, especially in area Q3, but the magnitude of the decline is probably not attributable to the fishery alone. Also, the apparent lack of juveniles in all the East Greenland area means that no new fish will grow into the fishable part of the stock for at least 6-8 years, and there is reason for concern. Fproxy values based on surveys indicate an increasing fishing mortality in recent years.

The advice is based on the Data Limited Stock approach (DLS) including biomass indices from the Greenland shallow water survey in the most recent 5 years combined with the recent advice, applying a cap and a precautionary buffer. The ratio is applied to the 2014 advice as catches are well above current advice. The advice for 2016 is 2 240 t.

23.7 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 fact that the fishery is targeting a localized aggregation of fish is cause for concern as is the absence of juveniles in the area. Given the biology of the species and the uncertainty in the biomass trend, any advice should consider this a hotspot fishery as it is potentially detrimental to this local and potentially important aggregation of larger fish. The fishery should still be at a low level involving few vessels. This should be maintained until the effect of the fishery can be clarified, especially with the recent declines in biomass estimates (Figures 23.2.1 and 23.2.6) and the fishery should preferably cover a larger area.

23.8 References

Bernreuther, M., Stransky, C. & Fock, H. 2013. German commercial catches of demersal redfish (*Sebastes mentella* and *Sebastes marinus*) on the East Greenland shelf (ICES Division XIVb) up to 2012.ICES NWWG WD#11, 10 pp.

Fock, H., C. Stransky and M. Bernreuther. 2013. Abundance and length composition for Sebastes marinus L., deep sea S. mentella and juvenile redfish (Sebastes spp.) off Greenland based on groundfish surveys 1985-2012. ICES NWWG WD#30.

Hedeholm R. and Boje J. 2014a. Survey for Greenland halibut in ICES Division 14B, August – September 2013. ICES NWWG WD#04.

Hedeholm R. and Boje J. 2014b. Greenland Shrimp and Fish Survey Results for Redfish in East Greenland Offshore Waters in 2012. ICES NWWG WD#02

G.H. 2001. Hjemmestyrets bekendtgørelse nr. 39 af 6. december 2001 om regulering af fiskeri ved tekniske bevaringsforanstaltninger. Http://www.nanoq.gl/gh.gllove/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. 07/88

Hedeholm, R. and Boje J. 2012. Exploratory analysis on survey and commercial catch data from the Greenland slope Sebastes mentella and Sebastes marinus stocks. ICES WKRED WD#17

Table 23.3.1.1 Nominal landings (tonnes) of demersal *S. mentella* 1974-2013 ICES division XIVb.

Demersal S.mentella	
1974	0
1975	4 400
1976	59 700
1977	0
1978	5 403
1979	5 131
1980	10 406
1981	19 391
1982	12 140
1983	15 207
1984	9 126
1985	9 376
1986	12 138
1987	6 407
1988	6 065
1989	2 284
1990	6 097
1991	7 057
1992	7 022
1993	14 828
1994	19 305
1995	819
1996	730
1997	199
1998	1 376
1999	853
2000	982
2001	901
2002	2109
2003	446
2004	482
2005	267
2006	202
2007	226
2008	92
2009	895
2010	6 613
2011	6 705
2012	6 572
2013	6 597
2014	4 608

Table 23.3.3.2 Landings (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
2010	10		12	381		5672		2190		1		8266
2011	1262		26	2		6757		334		1		8381
2012	1810		5	32		5964	1	403		1		8216
2013	1957			32	30	5863		356		8		8246
2014	1973		0.2	13		4611	98	613		5		7314
Sum	10400	3	162	969	534	30552	128	4442	3	52	856	47248

Table 23.3.4.1 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
2010	1	2	2	1	1	0	1	0	0	0	0	2	10
2011	0	0	0	0	1	0	0	0	0	0	0	0	3
2012	0	0	1	1	1	0	0	0	0	0	0	0	4
2013	0	1	1	0	0	0	0	0	0	0	0	0	2
2014	0	0	0	0	0	0	0	0	0	0	0	0	0
Sum	60	81	131	75	48	49	71	196	84	75	106	81	1056

Table 23.3.4.2 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
2010	799	786	708	1058	2149	2100	108	134	88	301	36		8266
2011	419	1396	1661	1017	268	250	236	598	255	583	1223	475	8381
2012	899	2197	628	852	577	699	966	143	44	23	474	712	8215
2013			709	1290	925	1423	1218	1086	723	227	119	527	8246
2014	10	421	206	1210	1187	1709	231	401	376	448	632	479	7314
Sum	2155	5250	4670	6268	5763	6791	3953	3037	1811	1999	3760	2633	48100

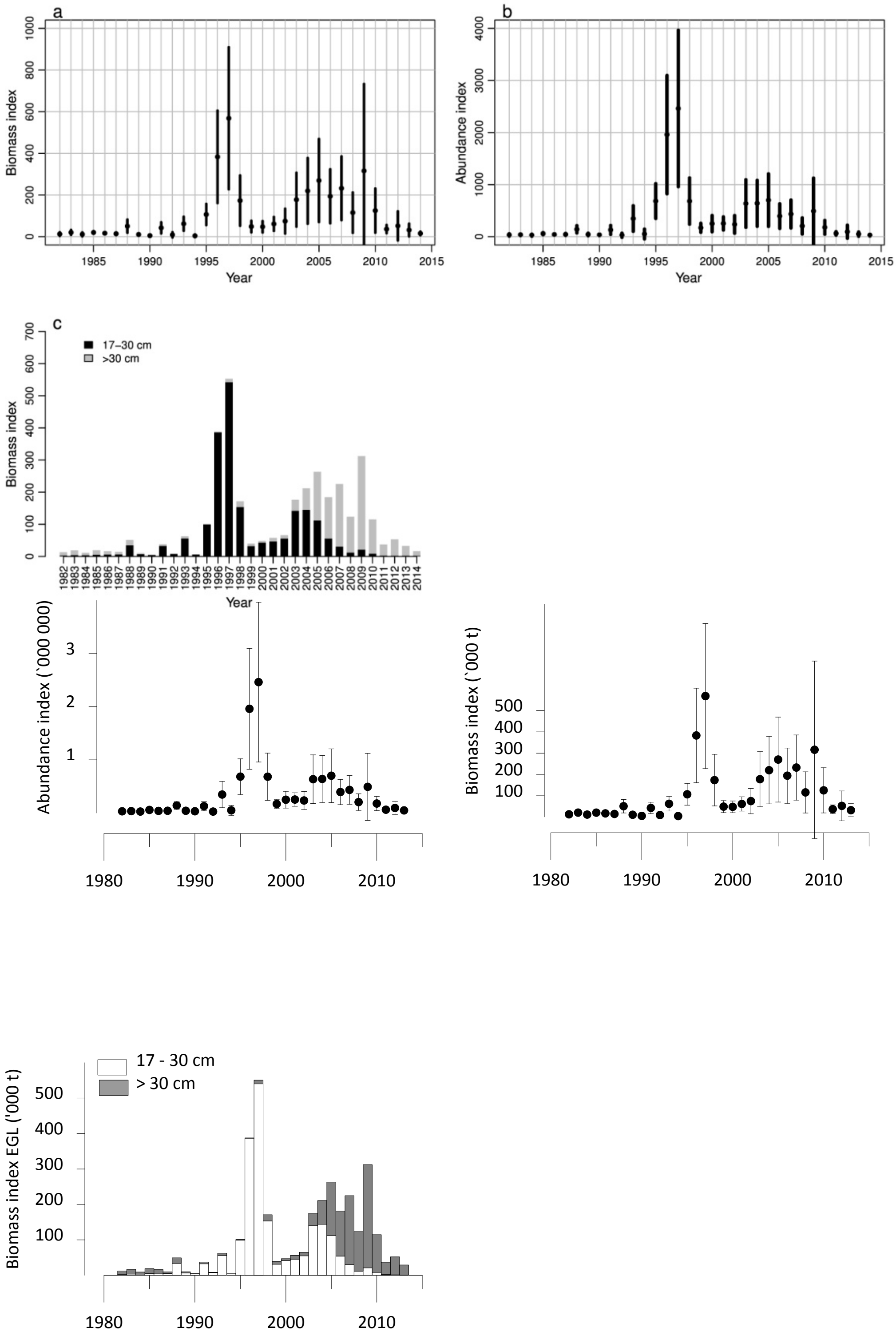

Figure 23.2.1. Indices from the German East Greenland survey of *S. mentella* larger than 17 cm. Abundance (a), biomass (b), and biomass split on length (c). On figure (c) the grey bars represent the biomass of *S. mentella* larger than 30 cm and the light bars biomass in fish from 17-30 cm.

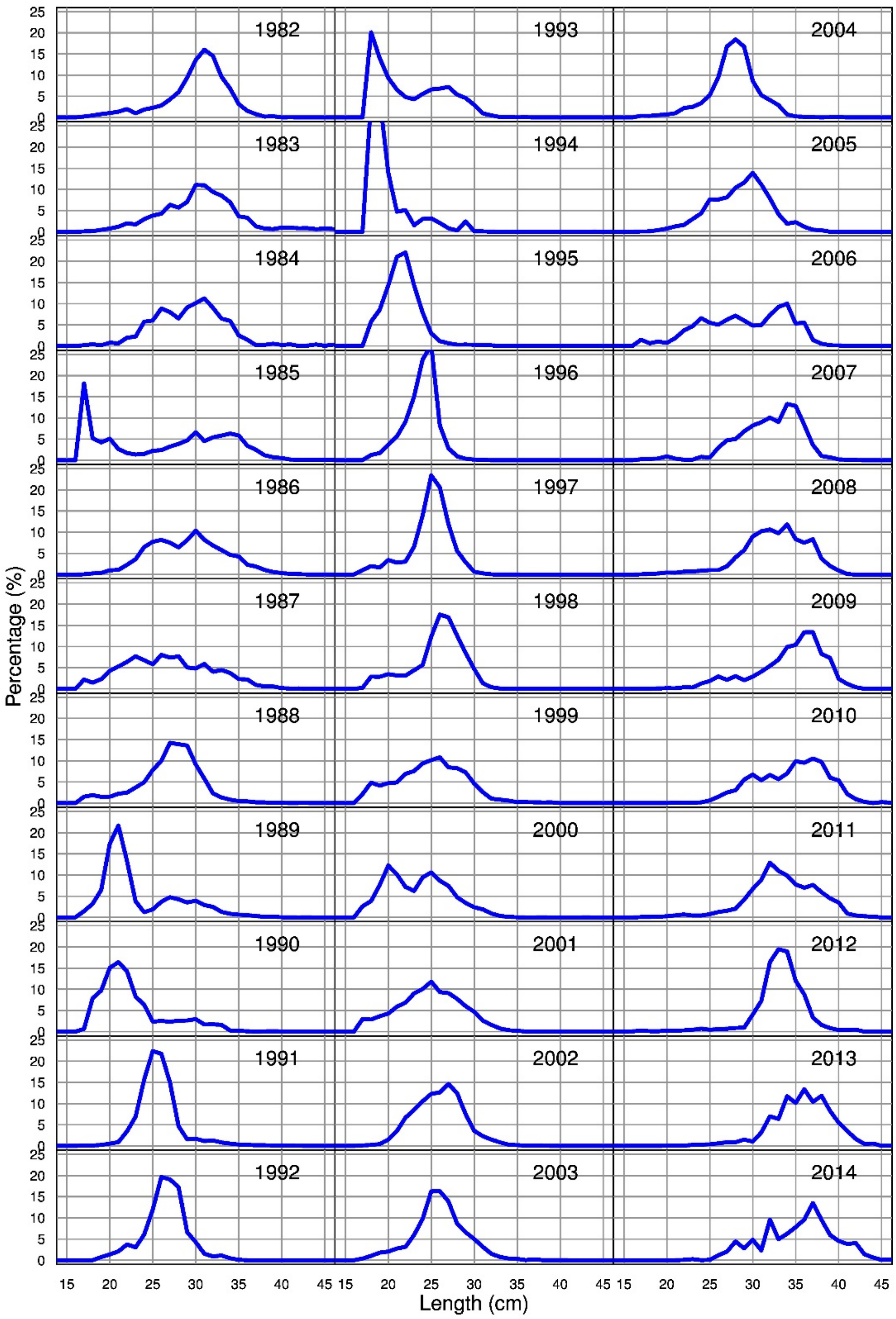

Figure 23.2.2. Length distributions from the German East Greenland survey 1985-2014.

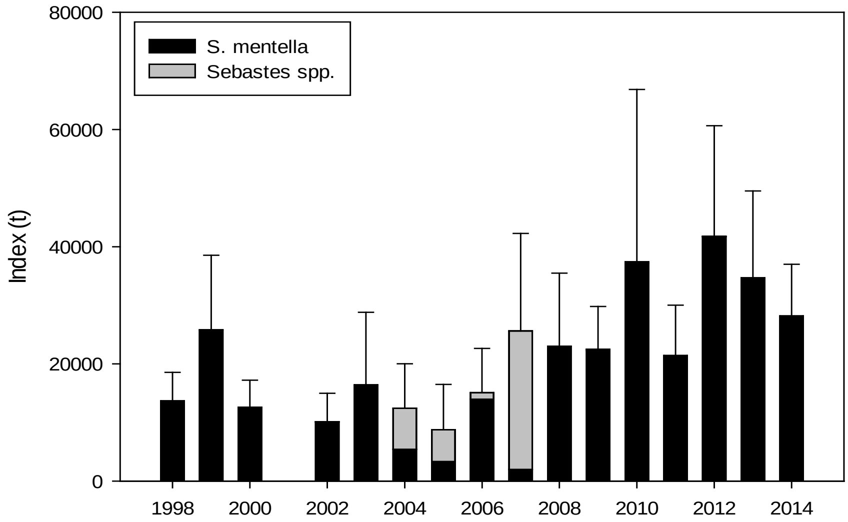

Figure 23.2.3. Biomass of *S .mentella* and *Sebastes* sp derived from the deep Greenland survey. Bars indicate 2SE of the biomass of *S. mentella* including *Sebastes* sp.. No survey in 2001. In 2004, 2005 and 2007 a large proportion of the redfish were not determined to species and only reported as "*Sebastes* sp". It is most likely that the majority of these fish were *S. mentella.*

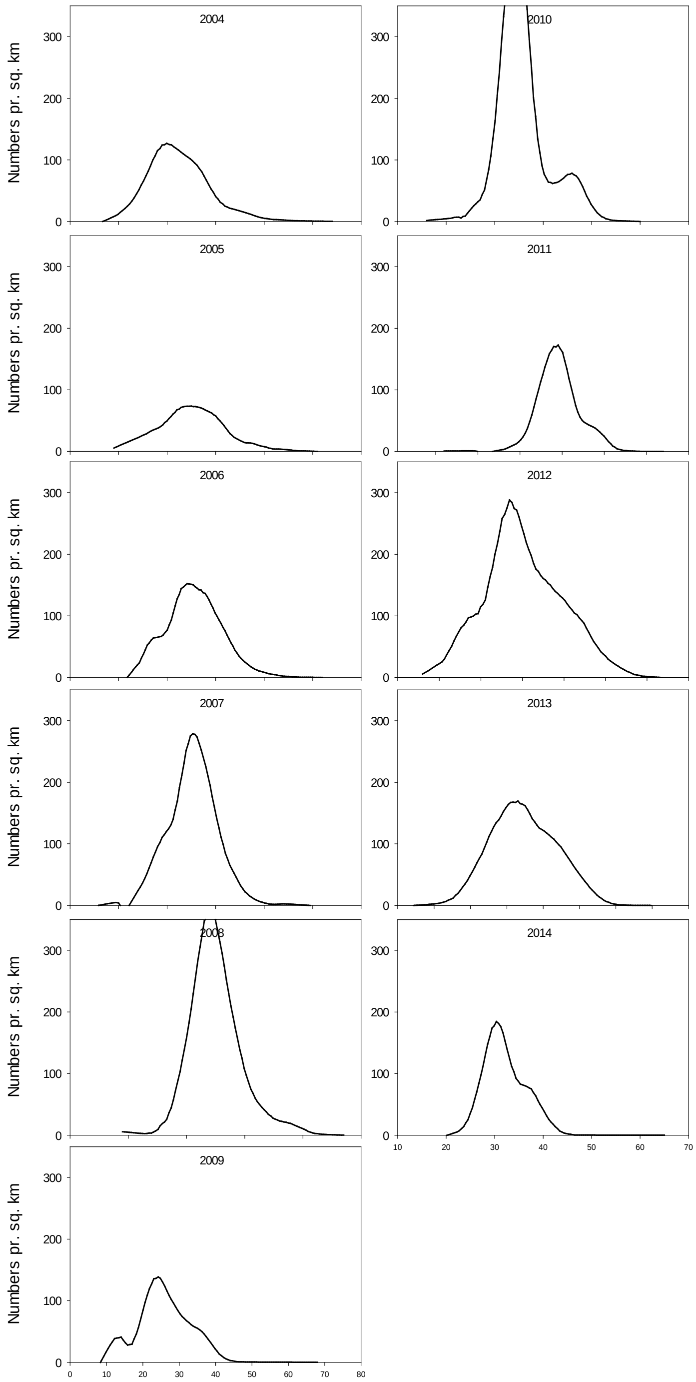

Figure 23.2.4. Overall length distribution of *Sebastes mentella* (number per km²) from the deep Greenland survey.

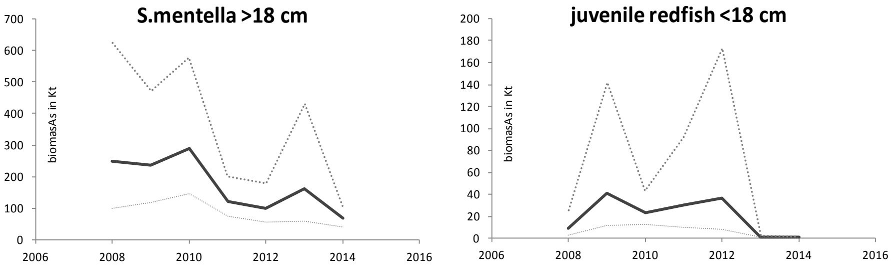

Figure 23.2.5: Biomass (Kt) indices for *S. mentella* (left) and *Sebastes* sp. (<18cm) off East Greenland in 2008-2014 from the Greenlandic shallow water survey. All surveyed areas (Q1-Q6) are combined.

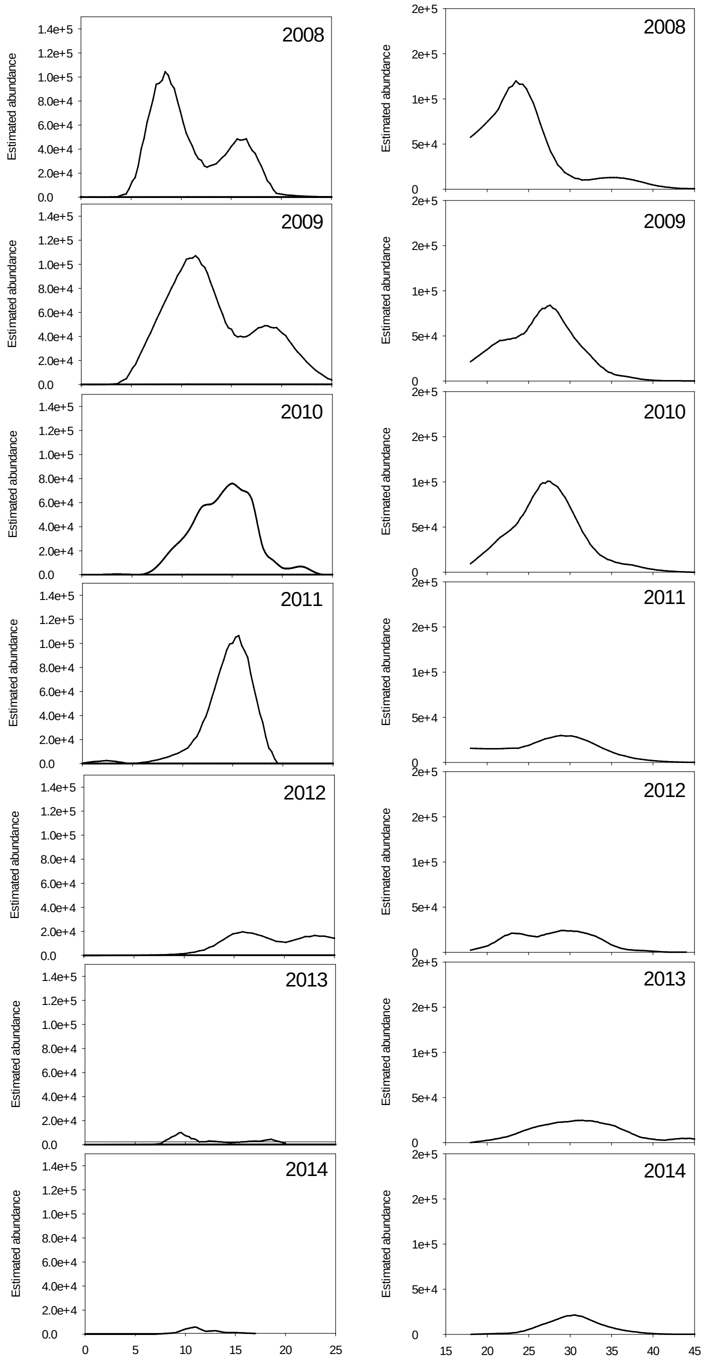

Figure 23.2.6. Overall length distributions for juvenile redfish S.mentella and S.norvegicus <17 cm combined (left) and *S. mentella* > 17 cm from the Greenlandic shallow water survey. All surveyed areas combined (Q1-Q6).

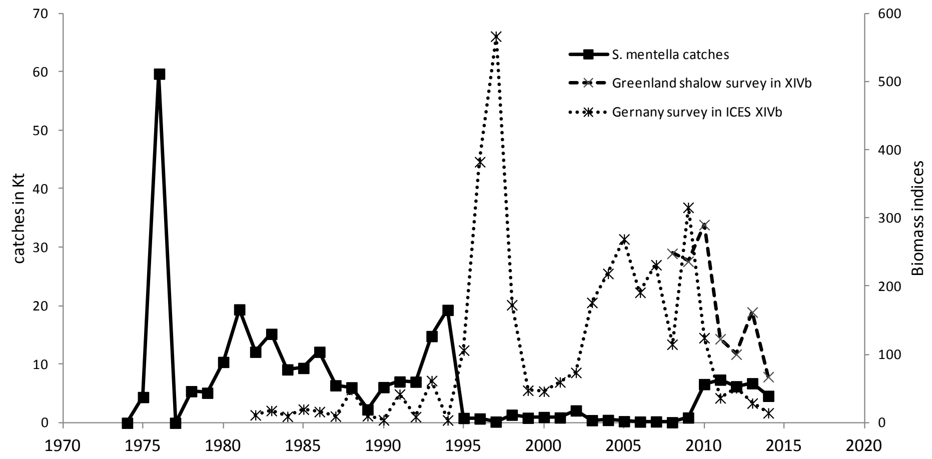

Figure 23.2.7: Biomass indices from the German survey in ICES XIVb and the Greenland shallow water survey combined with historical catches.

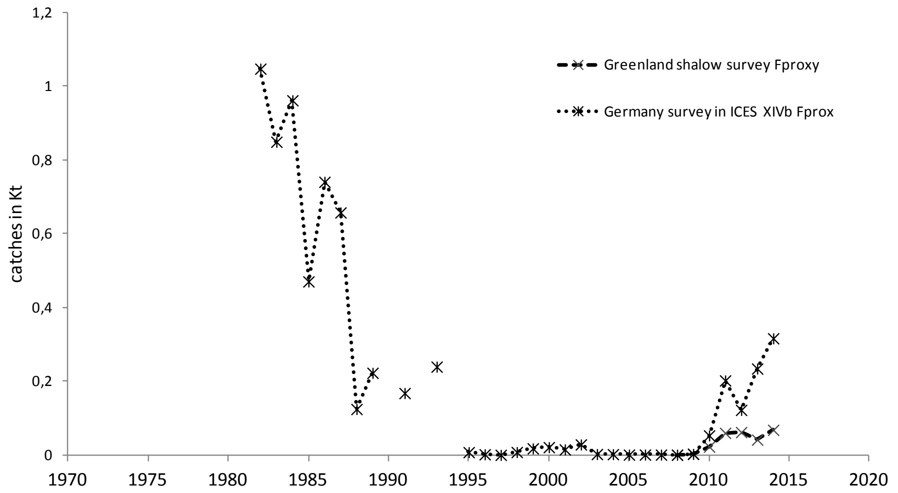

Figure 23.2.8: Fproxy developed for the German survey excluding years with poor coverage (1990, 1992 and 1994) and the Greenland shallow survey.

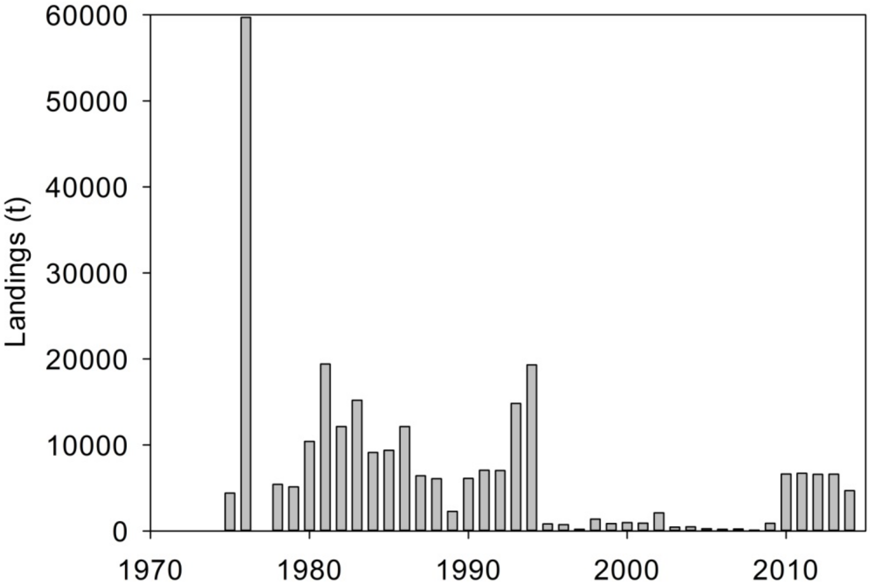

Figure 23.3.1.1 Landings of *S. mentella* in subarea XIVb. Landings of "redfish" have been split based on estimates from survey and commercial catches

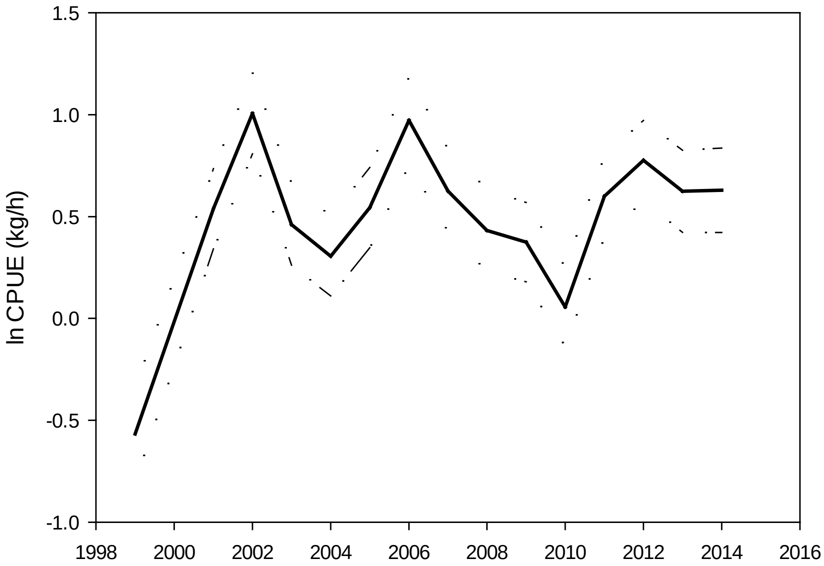

Figure 23.3.2.1 Standardized redfish by-catch CPUE in the directed fishery for Greenland halibut in ICES XIVb as a function of year. CPUE was estimated from the GLM model: lnCPUE=year+ICES subdivision+depth. Bars represent standard error. Only hauls made below 1000m were used in the analyses.

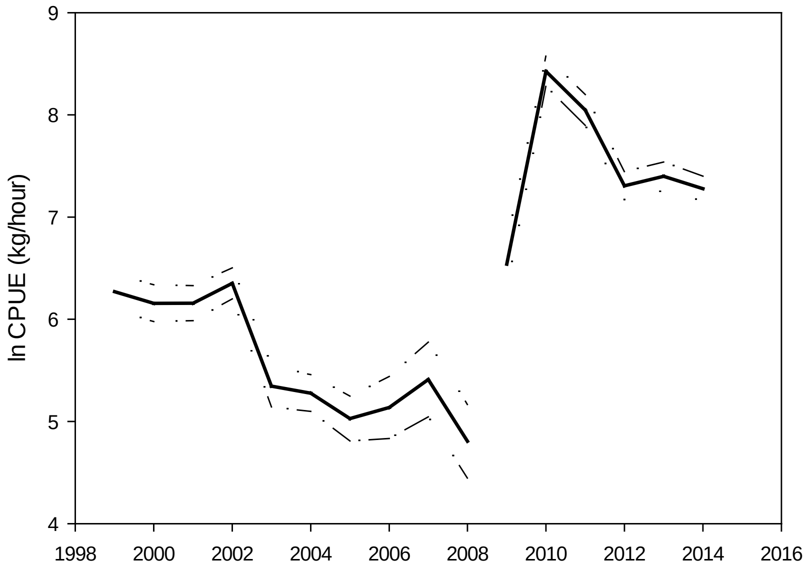

Figure 23.3.2.2 Standardized redfish CPUE in the redfish directed fishery ICES XIVb as a function of year. CPUE was estimated from the GLM model: lnCPUE=year+ICES subdivision+depth. Dashed lines represent standard error.

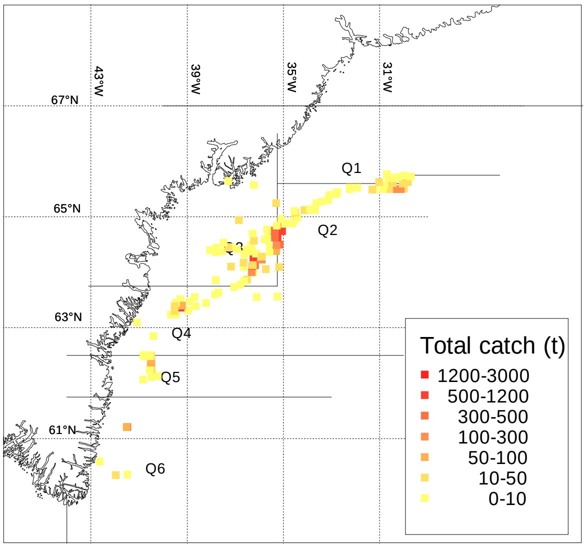

Figure 23.3.3.1 Distribution of catches of demersal redfish in 2014.

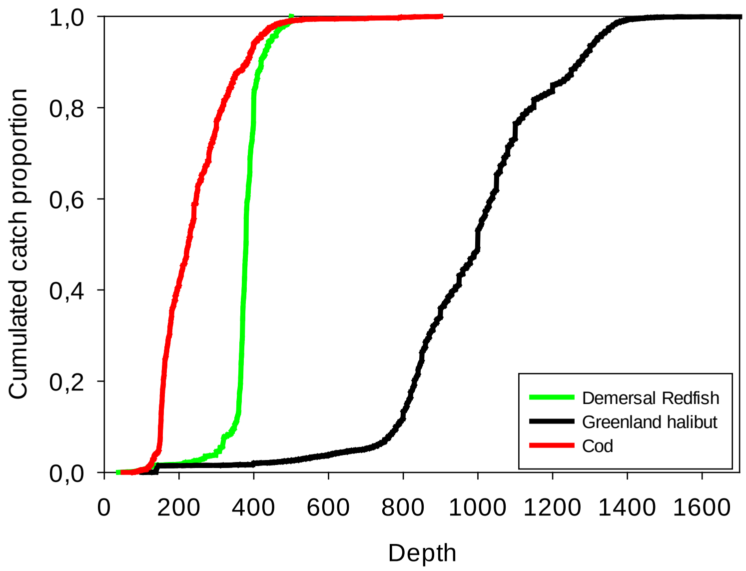

Figure 23.3.3.2. Lines represent the share of the total commercial catch caught at a given depth from 1999-2011 in *G. morhua*, demersal redfish (mixed *S. mentella* and *S. marinus)* and *R. hippoglossoides*.

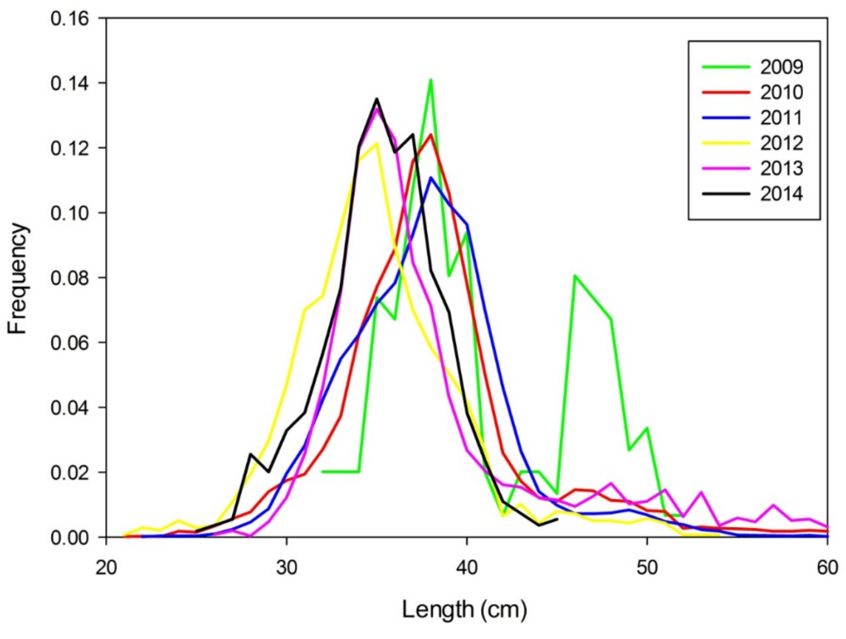

Figure 23.3.6.1: Length distribution of *Sebastes* sp. in the commercial catches from 2009-2014. In 2009-2011 the measurements were conducted onboard the trawlers by inspectors that were unable to separate *S. mentella* from *S. marinus*.

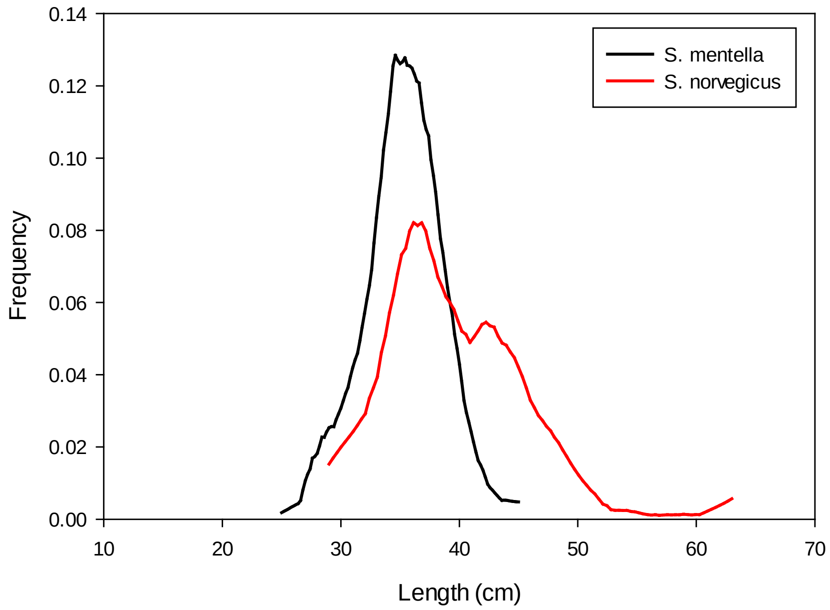

Figure 23.3.6.2: Length distribution of 752 redfish analysed by the Greenland Institute of Natural Resources separated into S.mentella (N=548) and S.norvegicus (N=204).

Annex 1: List of Participants

North-Western Working Group

28 April – 05 May 2015

Name	Address	Phone/Fax	Email
Rasmus Hedeholm (Chair)	Greenland Institute for Natural Resources P.O. Box 570 GL-3900 Nuuk Greenland	Phone +299 361200 Fax +299 361212	rahe@natur.gl
Petur Steingrund	Faroe Marine Research Institute P.O. Box 3051 FO-110 Tórshavn Faroe Islands	Phone +298 35 3900 Fax +298 353901	peturs@hav.fo
Sergey Melinkov	Russian Federal Research Institute of Fisheries & Oceanography (VNIRO) 17 Verkhne Krasnoselskaya 107140 Moscow Russian Federation	Phone +7 (495) 2644583 Fax +7 (499) 264 31 87	melnikov@vniro.ru
Alexander Bobyrev	Russian Federal Research Institute of Fisheries & Oceanography (VNIRO) 17 Verkhne Krasnoselskaya 107140 Moscow Russian Federation		abobyrev@mail.ru
Søren Post	Greenland Institute for Natural Resources P.O. Box 570 GL-3900 Nuuk Greenland	Phone +299 361200 Fax +299 361212	sopo@natur.gl
Rasmus Nygaard	Greenland Institute for Natural Resources P.O. Box 570 GL-3900 Nuuk Greenland	Phone +299 361200 Fax +299 361212	rany@natur.gl
Höskuldur Björnsson	Marine Research Institute PO Box 1390 121 Reykjavík Iceland	Phone +354 575 2000 Fax +354 575 2001	hoski@hafro.is

Jesper Boje	The National Institute of Aquatic Resources Section for Fisheries Advice Charlottenlund Slot, Jægersborg Alle 1 DK-2920 Charlottenlund Denmark	Phone +45 339 634 64 Fax +45 339 63333	jbo@aqua.dtu.dk
Luis Ridao Cruz	Faroe Marine Research Institute P.O. Box 3051 FO-110 Tórshavn Faroe Islands	Phone +298 35 3900 Fax +298 353901	Luisr@hav.fo
Heino Fock	Johann Heinrich von Thünen-Institute, Institute for Sea Fisheries Palmaille 9 D-22767 Hamburg Germany	Phone +49 40 38905 169 Fax +49 40 389 05 263	heino.fock@vti.bund.de
Einar Hjörleifsson	Marine Research Institute Skúlagata 4 IS-121 Reykjavík Iceland	Phone +354 552 0240 Fax +354 562 3790	einarhj@hafro.is
Kristjan Kristinsson	Marine Research Institute Skúlagata 4 IS-121 Reykjavík Iceland	Phone +354 575 2000 Fax +354 575 2091	krik@hafro.is
Arni Magnusson	Marine Research Institute PO Box 1390 IS-121 Reykjavík Iceland	Phone +354 575 2000 Fax +354 575 2001	arnima@hafro.is
Gudmundur J. Oskarsson	Marine Research Institute Skúlagata 4 IS-121 Reykjavík Iceland	Phone +354 575 2000 Fax +354 575 2001	gjos@hafro.is
Jákup Reinert	Faroe Marine Research Institute P.O. Box 3051 FO-110 Tórshavn Faroe Islands	Phone +298 35 3900 Fax +298 353901	jakupr@hav.fo
Anja Retzel	Greenland Institute for Natural Resources P.O. Box 570 GL-3900 Nuuk Greenland	Phone +299 361200 Fax +299 361212	AnRe@natur.gl
Alexey Rolskiy	Knipovich Polar Research Institute of	Phone +7 8152 45 05 68	rolskiy@pinro.ru

	Marine Fisheries and Oceanography 6 Knipovitch Street RU-183763 Murmansk Russian Federation	Fax +7 8152 47 33 31	
Gudmundur Thordarson	Marine Research Institute PO Box 1390 121 Reykjavík Iceland	Phone +354 5752000 Fax +354 5752001	gudthor@hafro.is
Elena Guijarro Garcia	Instituto Español de Oceanografía Centro Oceanográfico de Vigo P.O. Box 1552 E-36200 Vigo Spain	Phone +34 986 462 201 Fax +34 986 498626	elena.guijarro@vi.ieo.es
Agnes Gundersen	Møreforsking Marin, PO Box 5075, 6021 Ålesund, Norway	+47 70 11 16 21 (00) / +47 926 11 524	agnes@mfaa.no
Asta Gudmundsdóttir	Marine Research Institute PO Box 1390 IS-121 Reykjavík Iceland	Phone +354-5752000 Fax +354-5752001	asta@hafro.is
Birkir Bardarson	Marine Research Institute PO Box 1390 IS-121 Reykjavík Iceland	Phone +354-5752000 Fax +354-5752001	birkir@hafro.is

Annex 2: Recommendations

1) For the attention of WGMG, the NWWG recommends that: The present model used to assess the Greenland halibut in V,VI,XII and XIV, a stock production model in Bayesian framework, should be reviewed with respect to performance. A number of issues was identified in the NWWG 2014 report, a.o. process error handling and autocorrelation.
2) For the attention of WKARGH and WGBIOP, the NWWG recommends that: Ageing of Greenland halibut has been resumed since 2000 for assessment of the Greenland halibut stock in V,VI,XII and XIV. WKARGH in 2011 made progress that could timely be followed up by a new workshop in 2016 or 2017.

Annex 3: ToRs for the Next Meeting

NWWG – North-Western Working Group

The **North-Western Working Group** (NWWG), chaired by Rasmus Hedeholm, Greenland, will meet at ICES Headquarters, 26 April – 3 May, 2016 to:

a) Address generic ToRs for Regional and Species Working Groups.

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.

For capelin in Iceland-East Greenland-Jan Mayen area,. NWWG will agree any changes to the WG type report and the Advice sheet no later than X May. An ADG will work by correspondence XX May. The WEBEX will be XX May, and the Advice Release date XX May.

Other 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 XX May 2015 for the attention of ACOM.

Annex 4: List of Stock Annexes

A list of the stock annexes (including direct hyperlinks) will be placed here as soon as the work on the annexes is finished.

Annex 5: Audit reports

Audit of Cod in Division Va (Icelandic cod; cod-iceg)

Date 4st of May 2015

Reviewer: Anja Retzel

General

The stock has been assessed in close agreement with the stock annex.

For single stock summary sheet advice:

1) **Assessment type: update**
2) **Assessment**: analytical
3) **Forecast**: presented
4) **Assessment model**: statistical catch-at-age (ADCAM) tuned with two (spring and fall) surveys.
5) **Data issues:** All data is available as described in the Stock Annex.
6) **Consistency**: SPALY assessment was consistent with last year's assessment.
7) **Stock status**: Blim is 125 kt, MSY Btrigger is 220 kt and SSB in 2015 is estimated at 547 kt. Reference biomass, (B4+) is estimated at 1302 kt in 2015. PA and MSY reference points have not been set for this stock.
8) **Man. Plan.**: Because SSB> Btrigger, the $TAC_{2015/2016}$ is set as ($TAC_{2014/2015}$ + 0.2*$B_{B4+,2015}$)/2. In accordance with this plan, the proposed TAC for 2015/2016 is 239 kt. According to the advice sheet, ICES has evaluated the plan and concludes that it is in accordance with the precautionary approach and the ICES MSY framework.

General comments

This was a well documented, well ordered and considered section. It was easy to follow and interpret.

Technical comments

None

Conclusions

The assessment has been performed in as close proximity to the Stock annex and the results can be used as basis for advice.

Audit of Golden redfish (*Sebastes norvegicus*) in Subareas V, VI and XIV.docx

Date 5 of May 2015

Reviewer: Alexey Rolskiy

General

A comprehensive review of scientific, fishery and assessment data. Some corrections are needed.

For single stock summary sheet advice:

1) **Assessment type: update**
2) **Assessment**: analytical
3) **Forecast**: presented
4) **Assessment model**: the stock was benchmarked in January 2014. Gadget model. Alternative assessment: Time Series Analysis (TSA)
5) **Data issues:** All data is available as described in the Stock Annex. The assessment indicates conflicting stock trends from different data sources, the catch-at-age data showing less increase in stock size than the survey data.
6) **Consistency**: Consistent with last year.
7) **Stock status**: B_{lim} is 160 kt, MSY $B_{trigger}$ is 220 kt and SSB in 2015 is estimated at 347 kt. Biomass (B_{5+}) is estimated at 557 kt in 2015. PA reference points have not been set for this stock.
8) **Man. Plan.**: Management plan evaluated and adopted in 2014 (WKREDMP, ICES 2014). According to management plan catches in 2016 should be no more than 51 000 tonnes ($F_{9–19}$ = 0.097).

General comments

The results from GADGET indicate that fishing mortality has reduced in recent years and is now close to F_{MSY} Spawning stock and fishable stock have been increasing in recent years and are now the highest since 1986. Results from surveys in Iceland and East Greenland indicate that most recent year classes are poor.

Technical comments

None

Conclusions

The assessment has been performed in as close proximity to the Stock annex and the results can be used as basis for advice. Further work should be invested into the data sources used for the assessment.

Audit of Faroe Bank Cod (cod-farb)

Date 5 May 2015

Auditor: Guðmundur J. Óskarsson

For single stock summary sheet advice:

1) **Assessment type: Update**
2) **Assessment**: trends
3) **Forecast**: not presented
4) **Assessment model**: None
5) **Data issues:** None, in relation to Stock Annex
6) **Consistency**: Same advice as in last year, the area closed for fishery, which has been followed
7) **Stock status**: Poor status of the stock, the biomass indices below average and no signs of improvements
8) **Man. Plan.**: There is no management plan for this stock

General comments

The message in the text is clearly put forward and the graphs illustrative. However, the structure and subheadings of the Assessment report is a bit different from other stocks, and should be improved and made more along the lines with others at some point (e.g. during benchmark assessment). For example, the section "Status of the stock" is normally few sentences but fills 1.5 pages out of total 3 pages for this stock. Most of the text there should be under different sections (e.g. "Landings","Information from Surveys", "Exploratory assessment" etc).

Technical comments

I did not see any errors in the report and the assessment was done according to the Stock Annex.

Conclusions

The assessment has been performed correctly

Checklist for review process

General aspects

- Has the EG answered those TORs relevant to providing advice? *-Yes*
- Is the assessment according to the stock annex description? *-Yes*
- Is general ecosystem information provided and is it used in the individual stock sections. *–Not provided in the stock report, and therefore not used*
- If a management plan has been agreed, has the plan been evaluated? *–Not relevant*

For update assessments

- Have the data been used as specified in the stock annex? *-Yes*
- Has the assessment, recruitment and forecast model been applied as specified in the stock annex? *–Not relevant, it is surveys trends based assessment*
- Is there any **major** reason to deviate from the standard procedure for this stock? *-No*
- Does the update assessment give a valid basis for advice? If not, suggested what other basis should be sought for the advice? *-Yes, the update assessment gives a valid basis for advice.*

Annex 7: List of Working Documents. (NWWG 2015)

Guðmundur J.Ó. and Páll R.. 2015. Results of acoustic measurements of Icelandic summer-spawning herring in the winter 2014/2015. ICES NWWG 2015 Working Document no. 01.

Guðmundur J.Ó. and Jónbjörn P. 2015. Estimation on number-at-age of the catch of Icelandic summer-spawning herring in 2014/2015 fishing season and the development of I*chthyophonus* hoferi infection in the stock. ICES NWWG 2015 Working Document no. 02.

Hedeholm R. and Boje J. 2015. Survey for Greenland halibut in ICES Division 14B, August – September 2014. ICES NWWG 2015 Working Document no. 03.

Steingrund P. 2015. Greenland halibut CPUE for the research vessel operating on the slope on the Faroe Plateau in May-June 1995-2014. ICES NWWG 2015 Working Document no. 04.

Steingrund P. 2015. Greenland halibut CPUE for commercial trawlers operating on the slope on the Faroe Plateau 1991-2014. ICES NWWG 2015 Working Document no. 05.

Steingrund P. 2015. Survey biomass indices of Greenland halibut on the slopes of the Faroe Plateau 1983-2014. ICES NWWG 2015 Working Document no. 06.

Steingrund P. 2015. A combined biomass index of Greenland halibut on the slopes of the Faroe Plateau 1983-2014. ICES NWWG 2015 Working Document no. 07.

Steingrund P. 2015. Greenland halibut in the Faroese September deepwater survey 2014. ICES NWWG 2015 Working Document no. 08.

Steingrund P. 2015. Maturity status of Greenland halibut in Faroese waters as observed in the Greenland halibut May-June survey 1995-2014. ICES NWWG 2015 Working Document no. 09.

Kristinsson K. 2015. Fishery of Golden Redfish (*Sebastes norvegicus*) in ICES Divisions Va in 2014. ICES NWWG 2015 Working Document no. 10.

Kristinsson K. 2015.Golden Redfish (*Sebastes norvegicus*) in ICES Division Va as observed in groundfish surveys. ICES NWWG 2015 Working Document no. 11.

Kristinsson K. 2015. The Fishery of Icelandic Slope Deep-Water Redfish (*Sebastes mentella*) in ICES Division Va. ICES NWWG 2015 Working Document no. 12.

Kristinsson K. 2015. Icelandic Slope Beaked Redfish (*Sebastes mentella*) in ICES Division Va as Observed in the Icelandic Autumn Survey 2000-2014. ICES NWWG 2015 Working Document no. 13.

Kristinsson K. 2015. The fishery for shallow and deep pelagic deep-water redfish (*Sebastes mentella*) in the Irminger Sea and adjacent waters. ICES NWWG 2015 Working Document no. 14.

Kristinsson K. 2015. Golden redfish and slope beaked redfish catch statistics in ICES Divisions Va, Vb and XIV 1906–2014. ICES NWWG 2015 Working Document no. 15.

Post S. L., Retzel A. and Hedeholm R. 2015 West Greenland inshore gillnet survey results for juvenile Atlantic cod in 2014. ICES NWWG 2015 Working Document no. 16.

Boje J. and Hedeholm R. 2015. The fishery for Greenland halibut in ICES Div. XIVb in 2014. ICES NWWG 2015 Working Document no. 17.

Retzel A. 2015. Greenland commercial data for Atlantic cod in Greenland inshore waters for 2014. ICES NWWG 2015 Working Document no. 18.

Retzel A. 2015. Greenland Shrimp and Fish survey results for Atlantic cod in NAFO subareas 1A-1E (West Greenland) in 2014. ICES NWWG 2015 Working Document no. 19.

Retzel A. 2015. Greenland commercial data for Atlantic cod in West Greenland offshore waters for 2014. ICES NWWG 2015 Working Document no. 20.

Retzel A. and Post S. 2015. Greenland Shrimp and Fish survey results for Atlantic cod in ICES subarea XIVb (East Greenland) and NAFO subarea 1F (SouthWest Greenland) in 2014. ICES NWWG 2015 Working Document no. 21.

Retzel A. 2015. Greenland commercial data for Atlantic cod in East Greenland offshore waters for 2014. ICES NWWG 2015 Working Document no. 22.

Popov V. and Rolskiy A. 2015. Preliminary information on the results of Russian fishery and biological samples of pelagic redfish from the ICES subarea XII, XIV and NAFO Div. 1F in 2014. ICES NWWG 2015 Working Document no. 23.

Hedeholm R., Nygaard R. and Boje J. 2015. The fishery for demersal Redfish (*S.mentella*) in ICES Div. XIVb in 2014. ICES NWWG 2015 Working Document no. 24.

Hedeholm R., Nygaard R. and Boje J. 2015. Greenland Shrimp and Fish Survey Results for Redfish in East Greenland Offshore Waters in 2014. ICES NWWG 2015 Working Document no. 25.

Bobyrev . and Vasilyev. 2015. The assessment of stock status of redfish, *Sebastes mentella*, in the Irminger Sea. ICES NWWG 2015 Working Document no. 26.

Boje J., Hvingel C. and Hedeholm R. 2015. An assessment of Greenland halibut (*Reinhardtius hippoglossoides*) off East Greenland, Iceland and the Faroe Islands. ICES NWWG 2015 Working Document no. 27.

Kristinsson K. 2015. Methodology of biomass estimation of deep pelagic beaked redfish (*Sebastes mentella*) from the international redfish survey in the Irminger Sea and adjacent waters. ICES NWWG 2015 Working Document no. 28.

Fock H. 2015. Update of Groundfish Survey Results for the Atlantic Cod Greenland offshore component After re-stratification of the survey 1982-2014. ICES NWWG 2015 Working Document no. 29.

Fock H. 2015. An age4plus index for the Atlantic Cod Greenland offshore component Based on recommendations from WKICE 2015 1989-2014. ICES NWWG 2015 Working Document no. 30.

Fock H., Stransky C. and Bernreuther. 2015. Abundance for *Sebastes norvegicus* L., deep sea *S. mentella* and juvenile redfish (Sebastes spp.) off Greenland based on groundfish surveys 1985-2014. ICES NWWG 2015 Working Document no. 31.

Steingrund P. 2015 A simple reconstruction of the stock size of Faroe Plateau cod back to 1906. ICES NWWG 2015 Working Document no. 32.

Annex 7: Russian statement

Russian statements regarding the stock assessment, influence in environmental conditions on pelagic redfish distribution and estimates biomass during the surveys in the Irminger Sea

Statement regarding Russian assessment of beaked redfish, *Sebastes mentella*, stock status

According to the opinion of Russian experts, survey-based assessment of redfish stock biomass is not efficient enough due to the limited data involved into the analysis and some methodological problems related with surveys design and data processing.

Russian fisheries scientists do not agree with the stock subdivision into different management units and assess stock status using consolidated data. Assessment is based on Russian fisheries statistics and biological data, which appear to be sufficient for applying analytical methods of stock assessment such as surplus-production models and cohort models.

The results of stock assessment using a surplus-production model were presented at NWWG meetings in 2013 (WD 24) and 2014 (WD 28). The conclusion was made that redfish stock is in rather safe condition and relatively stable. The management strategy, based on the MSY concept and the precautionary approach, was implemented through a nonlinear (sigmoid) harvest control rule. With this HCR, the relevant advised TAC for 2015 was estimated as 100 thou. tones (with MSY = 185 thou. tones and B_{MSY} about 1700 thou. tones).

At the NWWG meeting in 2015 (WD 26), the results of the cohort model TISVPA application for redfish stock assessment have been presented. In the analysis, the data on total annual redfish catches by all countries were used with the division by age-groups following from Russian data on age composition over the period 1990-2013. In the calculations, the age interval starting from 8-years class was used; the natural mortality coefficient was assumed to be equal to 0.1 $year^{-1}$ for all age classes. The data on standardized catch per unit of effort (cpue) were involved as an index of stock biomass. In Figure 1, the reconstructed dynamics of stock biomass (left panel) and fishing mortality (right panel) are shown.

The estimates obtained suggest that current level of redfish stock biomass exceeds 1000 thou. tones, with fishing mortality being at the minimum level. It should be noted that the lack of reliable data on redfish maturation rate impedes estimation of spawning stock biomass (SSB). Due to the same reason, it is not possible, as yet, to optimize the HCR using the results from the TISVPA model. To this end, the estimation of fisheries perspectives is still based on the data from the surplus-production model, and recommended TAC remains at the last year level, i.e., 100 thou. tones.

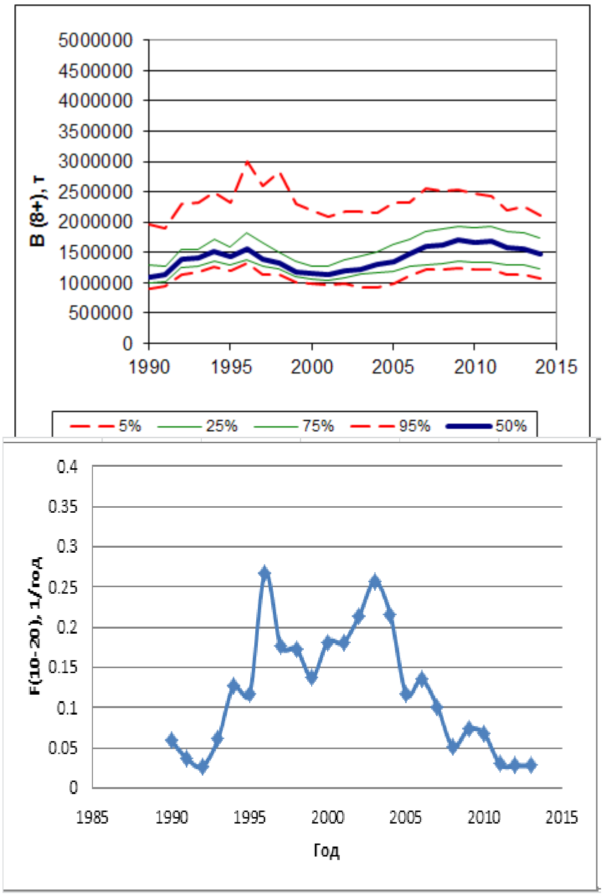

Figure 1. Estimates of redfish stock biomass (left) and average fishing mortality (right) resulting from the TISVPA model

Statement regarding the impact of variations in environmental conditions on estimates *S. mentella* biomass during the surveys in the Irminger Sea by results of analysis of SST satellite monitoring data

According opinion of the Russian experts, survey-based assessment of redfish alone does not reflect actual state of the stock due to some methodical difficulties associated with surveys i.e. limited number of trawl stations, changes in survey methodology e.t.c.

In this connection for the first time used the satellite data from meteorological satellites during the studies of environmental long-term fluctuations' influence on distribution and evaluation of redfish biomass.

There have been analytical calculations of the average values of sea surface temperature (SST) for the reference zone, integral acoustic values (SA) for the reference zone, and the average values of the SA only for those places of the reference zone where the aggregations of redfish were found in the layer 0-500 m.

Obtained results demonstrates strong correlation between SST and average values of redfish density in upper layer of the Irminger Sea. (Figure 1, 2). Revealed: the lower the value of SST is in on the lower integral and average values on density of redfish. In other words, the cooling of the sea surface temperature leads to a decrease in the density of redfish aggregations above 500 m, and accordingly, to a decrease in the biomass estimated during international survey in 2001-2013.

Revealed strong correlation between SST and average values of redfish density in upper layer of the Irminger Sea. The cooling of the sea surface temperature leads to a decrease in the density of redfish aggregations above 500 m. In contrast, analysis of oceanographic observations within the different depth layers suggests reduction of redfish density in upper layer with increasing of water temperature in the intermediate layers above 500 m depth. Both cases (variations in SST or changes in water temperature on the depth of redfish distribution) provide the evidence of the influence of oceanographic conditions on vertical (Melnikov et al., 2009) and spatial distribution of redfish aggregations (Riboni et al., 2013). It could be the one of the main reason of stock underestimation during the surveys.

The obtained results once again confirm the decisive role of fluctuations in environmental conditions on estimates of redfish biomass during the survey, rather than the impact of fishing on the stock.

References

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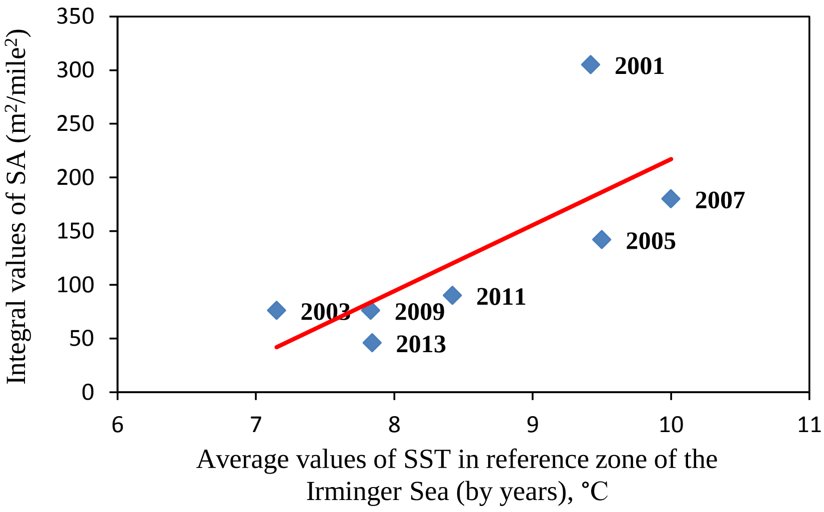
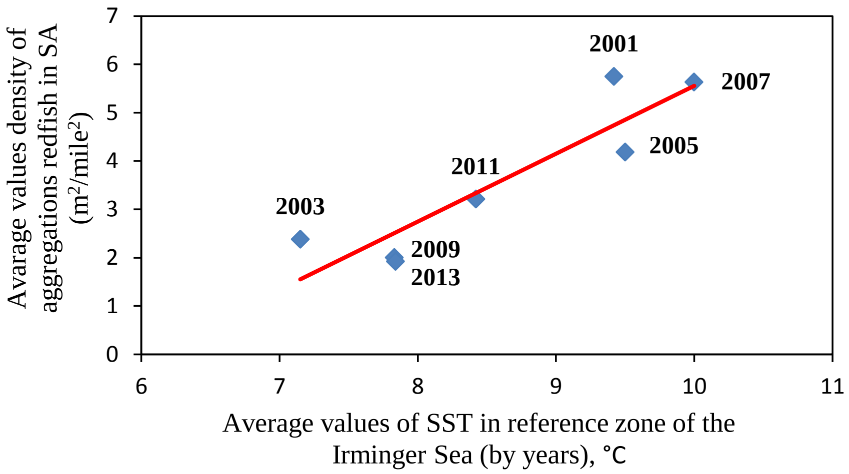


Y = 61,54X - 398,18 R^2 = 0,54 R = 0,73

Figure 1. Comparison quasi-synchronous average values of SST and integral values of SA depended on the distribution and abundance of redfish in reference zone of the Irminger Sea



Y = 1,40X - 8,49 R^2 = 0,83 R = 0,91

Figure 2. Comparison quasi-synchronous average values of SST and average density of aggregations redfish (in SA m²/mile²) in reference zone of the Irminger Sea for 1°x1° (only for places its discovery)

Statement about influence of the oceanographic condition on pelagic redfish distribution in the Irminger Sea

According to the international survey results, in 1999-2007 strong positive anomalies of water temperature in the upper 0-200 m layer of the Irminger Sea and adjacent waters were observed. This led to redistribution of part redfish aggregation (above 500 m) to southwestern part of the survey area (ICES, 2007). Surveys observations are also consistent with fishery development, which considerably spread since 1999 in the southwestern direction, covering Divisions 1F, 2GHJ of the NAFO area (Figure 1).

Later influence of oceanographic condition on abundance and distribution of pelagic redfish was studied during ICES Workshop on Redfish and Oceanographic Conditions (WKREDOCE) with the primary objective to compile and evaluate available hydrographical, hydroacoustic, and trawl data from the Irminger Sea and adjacent waters. A study examining changes in the distribution of redfish over 20 years revealed that at the interannual time scale, the spatial distribution of *S. mentella* in the Irminger Sea mainly in waters < 500 m appears strongly influenced by the Irminger Current Water (ICW) temperature changes, linked to the Subpolar Gyre (SPG) circulation and the North Atlantic Oscillation (NAO). Acceleration of the SPG due to increase of the NAO index leads to displacement of part redfish aggreagitons in the southwest. An SPG weakening has the opposite effect. A decrease in the NAO index strength since 2008 and the present deceleration of the SPG suggest a subsequent northeast displacement of part of the redfish aggreagitons in upper layer northward in the coming years (ICES, 2012, Riboni et. al, 2013).

In our opinion, these year-to-year northeast/southwest displacement of the redfish (above 500 m depth) influenced by the interannual hydrographic changes in the Irminger Sea - the one of the reason of periodic transformation of the fishery pattern. These fluctuations make impractical using of current management unit boundaries, which are based on spatial patterns of the fishery only (ICES, 2009).

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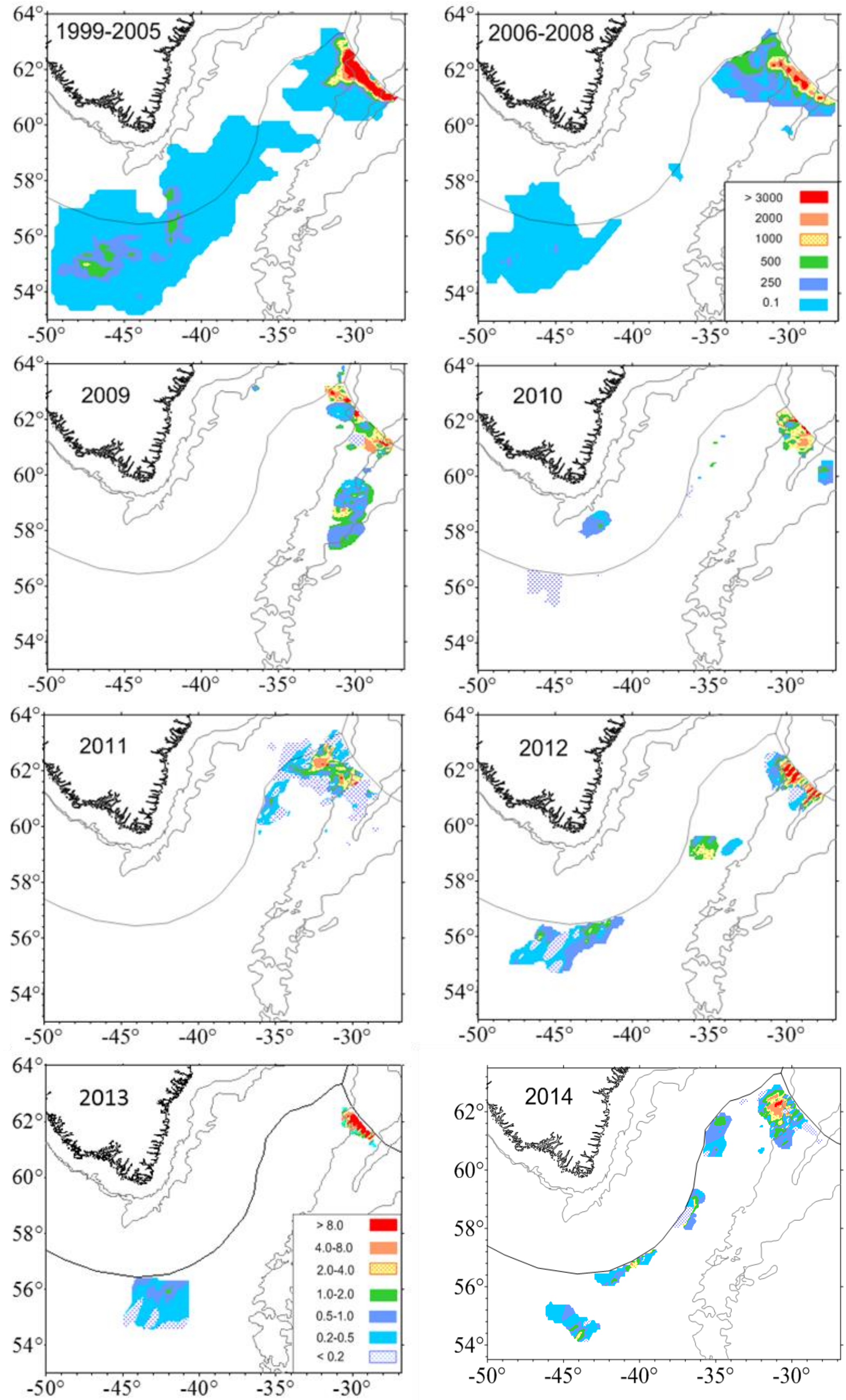

Figure 1. Fishing areas and total catch of pelagic redfish (*S. mentella*) in 1999-2014, derived from catch statistics provided by Russia. The colour scale indicates catches (tonnes per NM²)