NORTH WESTERN WORKING GROUP (NWWG)

Please note: Sections 4–7 and Annex 7 were added to this report in November 2020

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i Executive summary

Icelandic stocks

The Ministry of Industries and Innovation in Iceland decided considering the Covid-19 outbreak that Iceland would be without ICES advice for the 2020/2021 fishing year for stocks that are considered local to Iceland. For NWWG these stocks are cod (cod.27.5a), haddock (had.27.5a), saithe (pok.27.5a), Icelandic summer spawning herring (her.27.5a) and Icelandic slope beaked redfish (reb.27.5a14). The assessments for these stocks were therefore not discussed at the NWWG 2020 meeting in April. Only tables (landings, survey indices and results of the assessment) were updated.

Capelin in the Iceland-East Greenland-Jan Mayen area

In October 2019, the Icelandic Marine & Freshwater Research Institute (MFRI) advised an intermediate TAC of 0 tonnes based on an acoustic survey in September and based on surveys in January–February 2020 this advice was not changed. All advice was based on the HCR from ICES WKICE (2015).

There were no capelin fisheries or landings in the fishing season 2019/2020.

In October 2020, MFRI advised an intermediate TAC of 0 tonnes based on an acoustic survey in September. Final advice for 2020/2021 will be based on surveys in January-February 2021.

In November 2020, ICES advised an initial quota of 400 000 tonnes for the fishing season 2021/2022.

The stock is proposed to go through a benchmark in 2022.

Offshore West Greenland Cod

The West Greenland offshore stock component is 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 14 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. An annual TAC of 5000 tonnes was set in 2015-2018 and the average catches have been 3000–4000 tonnes per year. TAC in 2019 was set at 2000 tons, 900 tons was fished. Cod ages 6-8 years dominates the catches.

Both the German Groundfish survey and Greenland Shrimp and Fish survey indices show that the biomass and abundance increased in the period 2010–2015 due primarily to the 2009 YC and in part the 2010 YC. In the period 2016-2018, the German survey did not cover the area, and in 2019 only covered the southern part (NAFO 1E). The Greenland survey showed a reduction in biomass in 2016, due to a decrease in the 2009 and 2010 yearclasses at age 6 and 7 yrs which where historically high at age 5 and 6 yrs in 2015. The decrease has been attributed as an effect of fishing and migration inshore and eastward. The abundance of older cod (age >7 yrs), however, increased since 2017 compared to previous years where older cod where almost absent indicating that not all cod has migrated out of the area and/or they returned from the inshore area. The Greenland survey show a massive increase in biomass and abundance in 2019, but is caused by two very large hauls. The dominating yearclass is the 2015 YC, which was also dominating the German survey in 2019 in NAFO 1E.

No analytical assessment is available and there are no biological reference points for the stock. Information from two survey indices are used as basis for advice. Several yearclasses of spawning cod has been documented in NAFO 1C and 1D in 2018 and 2019. Further investigations on the extent of spawning and genetic composition will be conducted during 2020 and 2021.

The advice is biennial and the one given in 2019 is valid for 2020 and 2021.

The stock is proposed to go through a benchmark in 2022.

Inshore Greenland cod

The stock has increased between 2006 and to historic high levels in 2016 and is currently above reference points. Recent decreasing recruitment has now started to affect the spawning stock biomass, which has decreased in the past four years. Fishing mortality has never been below F_{MSY} (0.27) and remains above although it has generally been decreasing since 2005.

The mixing of cod from different stocks in the West Greenland inshore area adds uncertainty to the assessment. This is most pronounced in the poor model fit to catches, which is substantial in years with large catches (> 15 000 t). Managers should take this into account when relating the ICES advice to the TAC setting.

The stock is proposed to go through a benchmark in 2022.

Cod in East Greenland, South Greenland

Fishing mortality (F_{5-10}) has been below F_{MSY} (0.46) during since 1993 but is above to F_{MSY} in 2019 (0.54). SSB has been declining since 2014 but is still above MSY $B_{trigger}$ (14 803 tonnes).

A part of cod larvae and eggs from the Icelandic spawning grounds drift to the Greenland area resulting in mixing between cod stocks in Greenland and Iceland. The cod in East Greenland are genetically similar to the Icelandic cod. Tagging shows substantial spawning emigration to Iceland and is accounted for in the assessment. The level is however not exactly known and therefore adds uncertainty to the assessment.

The stock is proposed to go through a benchmark in 2022.

Greenland Halibut in Subareas 5, 6, 12, and 14

Catches of Greenland halibut in subareas 5, 6, 12 and 14 have ranged between 20 and 30 kt in the last two decades and amounts to 23 kt in 2019 which is a 8% decrease in total catches compared to 2018. The biomass indices used as input to the assessment (combined survey index at Greenland and Iceland) and logbook information from Iceland trawler fishery showed slight different trends; survey decreased while cpue increased from 2018 to 2019. The decrease in survey biomass is due to recent low abundance of young fish.

A logistic production model in a Bayesian framework are used to assess stock status and for catch forecast scenarios. 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 increased slowly and is in recent years at about 70% of B_{MSY}. Fishing mortality has since 2013 been close but above F_{MSY} and is in 2019 at 4% above F_{MSY}. The remaining available tuning indices are currently not used in the analytical assessment due to conflicting signals (logbook information from East Greenland trawl fishery, from Faroese trawl fishery and biomass index from a Faroese survey). The Greenland fishery in 14.b suggest high biomass while the Faroese indices suggest a significant lower and declining biomass in the eastern areas of the stock distribution. Survey estimates of the abundance of fish smaller than 40 cm show a reduced recruitment since 2014. This is likely the cause of the decline in recent survey biomass. Stock structure and connectivity between the main fishing areas within the stock distribution area remains partly unknown and this will be an important issue in a forthcoming benchmark.

Golden redfish (*Sebastes norvegicus*) in Subareas 5, 6 and 14

Total landings in 2019 were 48 464 tonnes, which is 4964 tonnes less than in 2018. About 90% of the catches were taken in Division 5.a. Landings decreased in all areas in 2019 compared to 2018.

This year assessment is an update. The assessment results of 2020 show that the spawning stock increased from 1995 to 2015 but has since then decreased. Annual landings have increased gradually since 2003–2010 period when they were at low level. Fishing mortality has been low since 2010, but since the HCR was adopted in 2014, the fishing mortality has been above the target of 0.097 due to TAC exceeding advised catches. Recruitment after 2013 is record low for the time series.

Results from surveys in Iceland and East Greenland indicate that most recent year classes are poor. The accuracy of the surveys as an indicator of recruitment is not known but recruitment is expected to be poor.

The management plan is based on $F_{9–19}$ = 0.097 that is reduced linearly if the spawning stock is estimated below 220 000 t ($B_{trigger}$). B_{lim} is set at 160 000 t, lowest SSB in the 2012 run. The 2020 SSB was estimated at 297 105 t.

Greenlandic slope *Sebastes mentella* in 14.b

In the decade before 2009, *S. mentella* was mainly a valuable bycatch in the fishery for Greenland halibut. However, since 2009 a fishery directed towards demersal redfish has taken place. Total landings of demersal *S. mentella* in East Greenland waters in 2019 were 3998 tonnes,. The proportion of *S. mentella* in the redfish mixed-stock fishery has been declining the last six to seven years. In 2016, the proportion of *S. norvegicus* exceeds the proportion of *S. mentella* for the first time. Catch depth has at the same time been reduced and have since 2017 primarily in the range of 300–400 m compared to 350–400 m in 2011–2012.

The advice has until 2019 been based on the Data Limited Stock approach (DLS) for category 3 stocks including biomass indices from the Greenland Shallow Water survey (GRL-GFS). The advice for 2020 was based on a more conservative category 5 approach due to the lack of a survey estimate from the Greenland Shallow Water survey (GRL-GFS) in 2017-2019. *Sebastes mentella* is a slow growing, late maturing species and is therefore considered vulnerable to overexploitation. Biomass and abundance index for both adult and juvenile redfish have been declining. The trend was confirmed in the German Survey (GER(GRL)-GFS-Q4) conducted in 2019. In the whole periode the CPUE from the fishery has remained relatively stable. Applying the category 5 approach corresponds to 914 tonnes of catches in 2021.

Faroe Plateau cod

The stock was historically low in the period from 2006 to 2017. The spawning stock biomass increased above MSY Btrigger in 2018 and 2019 and was expected to increase even further in the near future. However, the current assessment shows that the recruitment is markedly revised downwards, probably due to low food availability in 2019 that also was reflected in high catchabilities with longlines and a high fishing mortality of 0.76. It is expected that the spawning stock biomass will stay slightly above MSY Btrigger in 2021 and 2022.

Faroe Haddock

The spawning-stock biomass (SSB) decreased significantly from 2003 and is estimated to have been below B_{lim} in the period 2009–2017, but has been improving since 2018. The fishing mortality (F) has decreased in recent years, however is again in 2019 above F_{MSY}. Recruitment (age 1) from

2004 onwards has been well below the long-term average. However, the 2016 and 2017 year classes are estimated to be above average.

The short-term prediction, using status quo fishing mortality, showed an increase of the spawning stock biomass to 55 000, 90 000 and 95 000 tonnes in 2020–2022, respectively.

Faroe saithe

This stock was benchmarked in 2017. SAM was adopted as basis for the advice. In 2020, the stock was inter-benchmarked

Nominal landings in 2019 are estimated at 21 303 tonnes. Estimated fishing mortality in 2019 is F_{bar} = 0.36, which is above F_{MSY} = 0.30. SSB has been above MSY $B_{trigger}$ = 41 400 tonnes since 2017. Recruitment has fluctuated without trend declined since 2015. According to the MSY approach, catches in 2021 should be no more than 27 368 t. The current assessment is a downward revision of last year's assessment due to lower and higher estimates of SSB and F respectively.

i Expert group information

Expert group name	North Western Working Group (NWWG)
Expert group cycle	Annual
Year cycle started	2020
Reporting year in cycle	1/1
Chair	Kristján Kristinsson, Iceland
Meeting venue and dates	23–28 April 2020, Online meeting. (16 participants)
	2–6 November 2020, Online meeting (11 participants)

1 Introduction

1.1 Terms of Reference (ToR)

1.1.1 Specific ToR

2019/2/FRSG05 **The North-Western Working Group** (NWWG), chaired by Kristján Kristinsson, Iceland, will meet: Online (WebEx) 23–28 April 2020 to:

a) Address generic ToRs for Regional and Species Working Groups for all stocks, except stocks mentioned in ToR b).

and during November 2020 by correspondence to:

b) Address generic ToRs for Regional and Species Working Groups for Capelin (*Mallotus villosus*) in subareas 5 and 14 and Division 2.a west of 5°W, Cod (*Gadus morhua*) in Subdivision 5.b.1 (Faroe Plateau), Cod in Subdivision 5.b.2 (Faroe Bank,) Haddock (*Melanogrammus aeglefinus*) in Division 5.b (Faroes grounds) and Saithe (*Pollachius virens*) in Division 5.b (Faroes grounds).

The assessments will be carried out on the basis of the stock annex. The assessments must be available for audit on the first day of the meeting.

Material and data relevant for the meeting must be available to the group on the dates specified in the 2020 ICES data call.

NWWG will report by 13 May and 7 November 2020 for the attention of ACOM.

1.1.2 Adaptions to expert groups' generic terms of reference for spring 2020.

In light of the disruptions caused by COVID 19 in 2020, the generic terms of reference for the FRSG stock assessment groups have been re-prioritised. This applies to expert groups that feed into the spring advice season process. ACOM is encouraging expert groups to use virtual meetings (e.g. webex) and subgroups to deliver the high priority terms of reference.

High Priority for spring 2020 advice season

c) Conduct an assessment on the stock(s) to be addressed in 2020 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. **Check the list of the stocks to be done in detail and those to roll over**.

  i) Input data and examination of data quality;

  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 (i.e., all stocks with catches in the NEAFC Regulatory Area) estimate the percentage of the total catch that has been taken in the NEAFC Regulatory Area in 2019.

  v) 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;

vi) The state of the stocks against relevant reference points;

vii) Catch scenarios for next year(s) for the stocks for which ICES has been requested to provide advice on fishing opportunities;

viii) Historical and analytical performance of the assessment and catch options with a succinct description of quality issues with these. For the analytical performance of category 1 and 2 age-structured assessment, report the mean Mohn's rho (assessment retrospective (bias) analysis) values for R, SSB and F. The WG report should include a plot of this retrospective analysis. The values should be calculated in accordance with the "Guidance for completing ToR viii) of the Generic ToRs for Regional and Species Working Groups - Retrospective bias in assessment" and reported using the ICES application for this purpose.

d) Produce a first draft of the advice on the stocks under considerations according to ACOM guidelines. Check list to confirm whether the stock requires a concise advice sheet or a traditional advice sheet.

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

j) Audit all data and methods used to produce stock assessments and projections.

Medium Priority for spring 2020 advice season

a) Consider and comment on Ecosystem and Fisheries overviews where available;

b) For the aim of providing input for the Fisheries Overviews, consider and comment for the fisheries relevant to the working group on:

i) descriptions of ecosystem impacts of fisheries
ii) descriptions of developments and recent changes to the fisheries
iii) mixed fisheries considerations, and
iv) emerging issues of relevance for the management of the fisheries;
e) Review progress on benchmark processes of relevance to the Expert Group; High for application.

Low Priority for spring 2020 advice season

c iv) Estimate MSY proxy reference points for the category 3 and 4 stocks

g) Identify research needs of relevance for the work of the Expert Group.

h) Review and update information regarding operational issues and research priorities and the Fisheries Resources Steering Group SharePoint site.

i) Take 15 minutes, and fill a line in the audit spread sheet 'Monitor and alert for changes in ecosystem/fisheries productivity'; for stocks with less information that do not fit into this approach (e.g. higher categories >3) briefly note in the report where and how productivity, species interactions, habitat and distributional changes, including those related to climate-change, have been considered in the advice. ACOM would encourage expert groups to carry out this term of reference later in the year through a webex.

1.2 NWWG 2020 work in relation to the generic ToR

Because of the disruptions caused by COVID 19 in 2020 the physical meeting in Tórshavn, the Faroe Islands, was cancelled and the meeting was held remotely.

To reduce the workload the Ministry of Industries and Innovation in Iceland decided that Iceland would be without ICES advice for the 2020/2021 fishing year for stocks considered local (see letter in Figure 1). For NWWG, these stocks are cod (cod.27.5a), haddock (had.27.5a), saithe (pok.27.5a), herring (her.27.5a) and Icelandic slope beaked redfish (reb.27.5a14). In this report only tables (landings, survey indices and results of the assessment) were updated. Furthermore, the advice sheets for these stocks were not updated.

This year the meeting focused therefore only on five stocks: West Greenland inshore cod, East Greenland cod, Greenland halibut, golden redfish, and Greenland slope beaked redfish. For all stocks discussed during the meeting, the NWWG adopted the assessment which formed the basis for stock status and the premise for the forecasts. Based on the assessments the group produced a draft advice (abbreviated form) for all stocks.

There is no advice in 2020 for West Greenland offshore cod, shallow pelagic beaked redfish, and deep pelagic beaked redfish. Only catch tables for these stocks were updated.

The fisheries overview for the Icelandic Ecoregion was published in December 2019. Ecosystem overview for Greenland and Fisheries Overview for the Greenland and Faroese ecoregion are scheduled to be published in December 2020.

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Reykjavík March 12, 2020
Reference: ANR20030188/15.09.00

Subject: ICES advice to Iceland

The Ministry of industries and innovation is aware of the actions taken by ICES in reaction to the COVID19 outbreak which means a considerable reduction in the output of the organization. After consultation with the Marine and Freshwater Research Institute the Ministry has decided that Iceland can in light of the unprecedented circumstances be without ICES advice for the 2020/2021 fishing year on stocks considered local to Iceland as listed below. Therefore Iceland will not need updated advice sheets nor updates of expert group reports on the stocks listed. This is expected to reduce considerably travelling of Icelandic experts and the workload of both MFRI and ICES.

Cod in 5a
Haddock in 5a
Saithe in 5a
Herring in 5a
Beaked redfish in Subarea 14 and Division 5.a, Icelandic slope stock.
Ling in 5a
Tusk in 5a14
Greater silver smelt in 5a14
Blue ling in 5a14

On behalf of the Minister of Fisheries and Agriculture

Jóhann Guðmundsson

Þorsteinn Sigurðsson

Figure 1. Letter from the Ministry of Fisheries and Agriculture stating that Iceland will not seek advice for the 2020/2021 fishing year for stocks that are considered local in Icelandic waters.

1.3 Mohn's Rho

Generic Term of Reference c)-viii).

Mean Mohn's Rho for category 1 stocks for F_{BAR}, spawning-stock biomass (SSB) and Recruitment for the four stocks discussed during the April meeting, and the three demersal Faroese stocks. The plots are shown in relevant chapters.

Stock	Code	Term. year	Retro years	F_{bar}	SSB	Recr
Faroese saithe	pok.27.5b	2019	5	-0.04	0.32	0.52
Faroe Plateau cod	cod.27.5b	2019	5	-0.14	0.07	1.78
Faroese haddock	had.25.5b	2019	5	-0.18	0.14	0.49
Inshore West Greenland cod	cod.21.1	2019	5	0.058	-0.222	-0.406
East Greenland, South Greenland cod	cod.2127.1f14	2019	5	0.024	0.010	-0.123
Greenland halibut	ghl.27.561214	2019	5	0.030		
Golden redfish	reg.27.561214	2019	5	0.0252	-0.0186	-0.2194

1.4 NWWG 2020 work in relation to the specific ToR

There are no specific ToR's for NWWG 2020. The group will meet remotely 2-6 November 2020 to discuss the assessment and produce a draft of advice for capelin, Faroese cod, Faroes haddock and Faroes saithe.

1.5 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*	Advice
Faroe Bank cod	Qualitative evaluation	Survey	No advice in 2020
Faroe Plateau cod	SAM	Survey	November 2020
Faroe haddock	SAM	Survey	November 2020
Faroe saithe	SAM	CPUE	November 2020
Iceland saithe	ADCAM (statistical catch-at-age)	Survey	No advice in 2020
Iceland cod	ADCAM (statistical catch-at-age)	Survey	No advice in 2020
Iceland haddock	Adapt type model	Survey	No advice in 2020
Iceland herring	NFT-Adapt	Survey	No advice in 2020
Capelin	Linear regression	Survey	November 2020
Inshore West Greenland cod	SAM	Survey	June 2020
East and South Greenland cod	SAM	Survey	June 2020
Offshore West Greenland cod	Descriptive	Survey	No advice in 2020
Greenland halibut	Stock production model (Bayesian)	Survey + CPUE	June 2020
Golden redfish	GADGET (age-length based cohort model)	Survey	June 2020
Iceland slope *S. mentella*	DLS category 3.2	Survey	No advice
Deep pelagic *S. mentella*	Gadget	Survey	No advice in 2020
Shallow pelagic *S. mentella*	Qualitative evaluation	Survey	No advice in 2020
Greenland Slope *S. mentella*	DLS category 3.2	Survey	June 2020

*** Landings or landings by age are input to all assessments**

1.6 Audits

All audits were completed. The auditors found the work of the assessment and advice satisfactory.

1.7 Recommendations

There are five recommendations addressed to the group.

Recommendation from ADGANW (ID 96): *In general, to have four assessments for the different cod stocks in Greenlandic waters and around Iceland is questionable. There is often not enough stock specific information supporting these assessments. To combine assessments should be considered in future benchmarks*. The group has proposed a benchmark for the three Greenland cod stocks in 2022 where the issue will (partly) be discussed.

Recommendation from ADGANW (ID 98): *pok.27.5a to get the Harvest Rates (and not F) in historical plots during NWWG 2020*. There is no advice required for this stock from ICES this year. The recommendation was therefore not discussed during the WG meeting.

Recommendation from ADGANW (ID 99): *Reb.27.5a14. It may be a good idea to have a 2 year advice. WG to think of another year range that may reflect more redfish dynamics. Check for other rules for category 3 stocks that may be better?* There is no advice required for this stock from ICES this year. The recommendation was therefore not discussed during the WG meeting. Other assessment methods are currently being explored (Gadget) and will be presented to the group next year. It should also be noted that there is an ongoing genetic study exploring the relationship of beaked redfish along the east Greenland slope with the Icelandic slope. All samples have been collected and sent for analysis. Results from this study is expected later this year.

Recommendation from ADGPOUTRED (ID 158): *The stock reb.2127.dp needs to be benchmarked*. The group will address this recommendation in November 2020. There is currently no new data available or proposed assessment method proposed to recommend a benchmark meeting.

Recommendation from ADGPOUTRED (ID 160): *Any new data or genetic studies concerning reb.2127.dp should be encouraged given the lack of information on this stock. This should be presented at NWWG in preparation for future benchmark initiatives*. No new genetic data are available to address stock structure. Regarding the survey index and recalculation WGIDEEPS will discuss this matter at a meeting scheduled 25-27 August 2020. It is recommended that ICES Secretariat get this work on the indices reviewed before NWWG-II so it can be discussed when the WG meets in November.

1.8 Benchmarks and workshops

The assessments of Icelandic cod and plaice in Icelandic waters are proposed to go through a benchmark in 2021 (dates to be decided).

Benchmark of golden redfish, which was scheduled to be benchmarked in 2020, has been postponed to 2022. Issue list for golden redfish has already been prepared.

The group further recommends that East Greenland, inshore and offshore West Greenland cod stocks to be benchmarked in 2022. Condensed issue lists were prepared and are listed in the relevant report sections.

The group further recommends that capelin should be benchmarked in 2022.

1.9 Chair

This is the third and final year for Chair, Kristján Kristinsson, Iceland. Teunis Jansen, Greenland/Denmark, was nominated for the position of chair for 2021–2023. The group supported this nomination at the meeting in November.

2 Demersal stocks in the Faroe area (Division 5.b and Subdivision 2.a4)

This section was updated in November 2020.

2.1 Overview

2.1.1 Fisheries

The main fisheries in Faroese waters are mixed-species, demersal fisheries and single species pelagic fisheries. The demersal fisheries are mainly conducted by Faroese 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 2.1.2.

2.1.2 Fisheries and management measures

The fishery around the Faroe Islands has for centuries been an almost free international fishery involving several countries. Apart from a local fishery with small wooden boats, the Faroese offshore fishery started in the late 19th century. The Faroese fleet had to compete with other fleets, especially from the UK with the result that a large part of the Faroese fishing fleet became specialized 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 multifleet and multispecies 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 portions of the catches. Reorganization 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 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, was maintained.

The individual transferable effort quotas applied to 1) the longliners less than 110 GRT, the jiggers, and the single trawlers less than 400 HP (Groups 4,5), 2) the pairtrawlers (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 were not allowed to fish within the 12 nautical mile limit and the areas closed to them, as well as to the pairtrawlers, had increased in area and time. Their catch of cod and haddock was before 2011 limited by maximum bycatch allocation. This fleet started to pair-trawl, and since the fiscal year 2011/12, merged with the pairtrawlers group. The single trawlers less than 400 HP were given special licenses to target flatfish inside 12 nautical miles with a bycatch allocation of 30% cod and 10% haddock. In addition, they were obliged to use sorting devices in their trawls in order to minimize their bycatches. One fishing day by longliners less than 110 GRT was 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 2.1 it can been seen that since 1996/1997, the number of days allocated has been reduced considerable and is now around half 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 could fish for 3 days for each day allocated inside the line. Trawlers were 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 were 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 summertime.

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 were 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 was also an assumption that the day system was self-regulatory, because the fishery was expected to move between stocks according to the relative availability of each of them and no stock would be overexploited. In retrospect these target fishing mortalities were substantially higher than the F_{MSY} reference points that were defined for cod, haddock and saithe in spring 2017. Also, the fishing mortality on cod was higher than for haddock and saithe, probably because the fleets targeted cod more than haddock and saithe.

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 was introduced (See the 2013 NWWG report, Figure 2.3) in July 2011, but was terminated in August 2013.

2.1.3 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 Seawater, 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 and has since been stable. 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 of primary production in the ecosystem (Gaard *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 and 2017 when it was above average (Figure 2.3). The primary production index could therefore be a candidate ecosystem and stock indicator. Another potential indicator candidate is the Subpolar Gyre Index (Hátún *et al.*, 2005, Hátún and Chafik, 2018 (Figure 2.3). The subpolar gyre index presented here is merged from these references using simple linear regression for the 1993–2003 period.

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. If all three species are combined, the positive correlation becomes stronger (Figure 2.4). However, the period of high productivity (2008–2010) did not lead to any marked increase in the stock size of cod/haddock, but only in saithe. The catchability of cod with longlines also increased by a factor of 2–3 in the same period. The productive period in 2016-2017 also seems not to have led to any marked recovery of cod, but probably more so for haddock.

2.1.4 Summary of the 2020 assessment of Faroe Plateau cod, haddock and saithe

A summary of selected parameters from the assessment of Faroe Plateau cod, Faroe haddock and Faroe saithe is shown in Figure 2.6. 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 and haddock, the exploitation ratio and fishing mortality have remained relatively stable over time, although they have been more fluctuating since the 1980s (Figure 2.6). For saithe, the exploitation rate was low in the 1930s and 1950s and increased until the 1970s, it decreased from the early 1990s–2004 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. Moreover, while the sum of cod, haddock and saithe biomasses has been rather constant over time (varied between 300–500 thousand tonnes most years), the proportion of saithe has increased during the period from 1924 up to today whereas the proportion of cod has decreased (Figure 2.6).

2.1.5 Reference points for Faroese stocks

A benchmark assessment was held in February 2017 where the assessment model was changed from the XSA to SAM. Since the assessment model was changed, the reference points were recalculated/revised at the NWWG 2017 (ICES, 2017) meeting, according to the ICES guidelines (ICES fisheries management reference points for category 1 and 2 stocks, January 2017, http://ices.dk/sites/pub/Publication%20Reports/Advice/2017/2017/12.04.03.01_Reference_points_for_category_1_and_2.pdf).

These reference points are all estimated based on single-species models. Multispecies models may give 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). For example, adding the recruitment of cod and haddock and relating them to zooplankton concentration shows a strong negative correlation (Figure 2.5). Sandeels are abundant at times with strong cod and haddock recruitment (age 1) and sandeels probably graze down the zooplankton biomass during summer when they are numerous.

Faroe saithe stock dynamics is puzzling. If the biomass estimates prior to 1961 are approximately correct (see ICES, 2016) then there has been an increase in biomass from 1925 up to now as well as in catch and exploitation rate. There might be an interaction with cod, since the cod biomass has decreased over the same period. It might be speculated that trawling activity in the deep areas (> 150 m) from the 1950s has had a negative effect on cod and a positive effect on saithe. Hence, it might not be possible to maximize cod and saithe catches at the same time.

2.1.6 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 and the Faroese University, of 1 representative from the industry (trawlers) and 1 from the Ministry of Fisheries. The results of this work was delivered to the Minister of Fisheries in spring 2012 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.

In 2015, the Faroese minister of fisheries established a new group of experts to formulate a new fisheries management system. The reason was that all fishing licences would be withdrawn on 31 December 2017 – 10 years after the Faroese Parliament decided to do this. The group delivered its recommendations on 3 October 2016. The group recommended that the effort management system was replaced by a quota system in the new fisheries management system. The following treatment in the political system resulted in a law that was adopted by the Faroese Parliament in December 2017. In the law it was stated that the large trawlers (Group 2) and the large longliners

(Group 3) should be regulated by catch quotas whereas the rest of the fleets will be regulated in the same way as before, i.e., by fishing days and licences. This was supposed to be implemented on 1 January 2019, but that was in November 2018 postponed to 1 January 2020. The fiscal year starting on 1 September 2017 and ending 31 August 2018 was extended to 31 December 2018. From 2019 the fishing year will be equal to the calendar year. As already mentioned, the fishery in 2019 will be regulated by fishing days and licences.

Although the new law was formulated in correspondence with the MSY principle there were no detailed management plans for demersal fish in Faroese waters. At least preliminary management plans are supposed to be constructed before 1 January 2019 for a number of fish species listed in the law, e.g. cod, haddock, saithe, ling and monkfish.

A committee was in September 2018 set by the Ministry of Fisheries to work on management plans for cod, haddock and saithe in Faroese waters. The committee was composed of representatives from the Ministry of Fisheries, the fishing industry, Faroe Marine Research Institute and Faroe Coastal Guard. The committee delivered its report in May 2019. There were two main outcomes in the report. Firstly, the continuation to use fishing days as the main measure of fishing effort for all fleets (i.e., abandoning the quotas for Group 2 and Group 3), and secondly, the formulation of a harvest control rule. Importantly, the whole group was content with the harvest control rule. The harvest control rule aimed to keep fishing mortalities within sustainable limits and a recovery plan was used in cases when spawning stocks were below certain limits. A buffer was applied so that the number of fishing days could only be changed by either -5%, 0% or 5% from one year to the next. The management plan is not implemented yet.

The partial F per fishing day for the fleets is not constant but varies between years. In the case of longliners this is probably a result of the varying amounts of sandeels (Figure 2.7) – cod and probably haddock prey preferably on sandeels and, if they are scarce, on other prey items like longline baits. Also, the recruitment of cod and haddock is strongly positively correlated with sandeel abundance (Figure 2.8). When sandeels are abundant, recruitment of cod and haddock is high while the partial F per fishing day is low – this may lead to a rapid increase in the stock. Conversely, when sandeels are scarce, the opposite happens, recruitment is low while the partial F per fishing day is high and the stocks may decrease rapidly. This implies that the cod and haddock stocks may be overfished during periods with low sandeel abundance. The proposed management plan, especially the limits of fishing mortalities, needs to be scrutinised in the future to ensure that the management plan is sustainable.

2.1.7 Other issues

In order to put assessments into a wider context, the biomass of Faroe saithe, cod and haddock on the Faroe Plateu has been estimated over centuries (ICES, 2016). The biomass of Faroe Plateu cod was in the years 2006–2017, the lowest compared to the last 300 years. The biomass of Faroe haddock in the same time period was the lowest for a century. Saithe on the other hand, shows an opposite trend, its biomass in the same time period is well above average and it had a lower biomass prior to 1960, when there was little fishery for saithe. The stock dynamics of saithe is therefore a bit contradictory since an increase in fishing mortality is associated with increased biomass.

2.1.8 References

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Table 2.1. Number of allocated days since the fiscal year 1996/97. The fiscal year 2017/2018 was extended to 31 December 2018 (2017/2018 end).

	Number of allocated days								
	Fleet group								
Fishing year	2 outer	2 inner	3	4 A	4 B	4 T	5	Total days	Total 2-4
1996/1997		8225	3040	4700	3080		22000	49585	20275
1997/1998		7199	2660	4696	4632		23625	43389	19187
1998/1999		6839	2527	4461	4400		22444	41219	18227
1999/2000		6839	2527	4461	4400		22444	41219	18227
2000/2001		6839	2527	4461	4400		22444	41219	18227
2001/2002		6839	2527	4461	4400		22444	40671	18227
2002/2003		6771	2502	4416	4356		22220	40265	18045
2003/2004		6636	2452	4328	4269		21776	39461	17685
2004/2005		6536	2415	4263	4205		21449	38868	17419
2005/2006		5752	3578	1770	2067	1766	21235	36168	14933
2006/2007		5752	3471	1717	2005	1713	20598	35256	14658
2007/2008		5637	3402	1683	1965	1679	20186	34552	14366
2008/2009		4406	2940	1323	1756	1540	17259	30762	12595
2009/2010		4406	2940	1323	1756	1540	17259	29224	11965
2010/2011	1700	5174	2852	1323	1756	1540	13259	27604	11745
2011/2012	1530	4657	2657	1058	1405	1386	10607	23210	12603
2012/2013	1530	4626	2567	1011	1533	1386	10607	23260	12653
2013/2014	1530	4441	2387	1011	1533	1386	9865	22153	12288
2014/2015	1530	4455	2887	1029	1530	1386	9865	22182	12317
2015/2016	1530	4455	2387	1029	1530	1386	9865	22182	12317
2016/2017	1530	4386	2029	859	1323	1178	8879	20660	11781
2017/2018	1530	4386	2029	859	1323	1178	8879	20660	11781
2017/2018 end	2040	5848	2705	1145	1764	1571	11839	26912	15073
2018 cal year	1530	4386	2029	859	1323	1178	8879	20184	11305
2019 cal year	1530	4386	2029	791	1436	1178	11029	22379	11350
2020 cal year	1582	4291	2571	902	1851	1581	11029	23807	12778

Table 2.2. Number of used days since the fiscal year 1997/1998. The values for 2020 were based on the January 1 to November 16 period and scaled up by 12/10.5

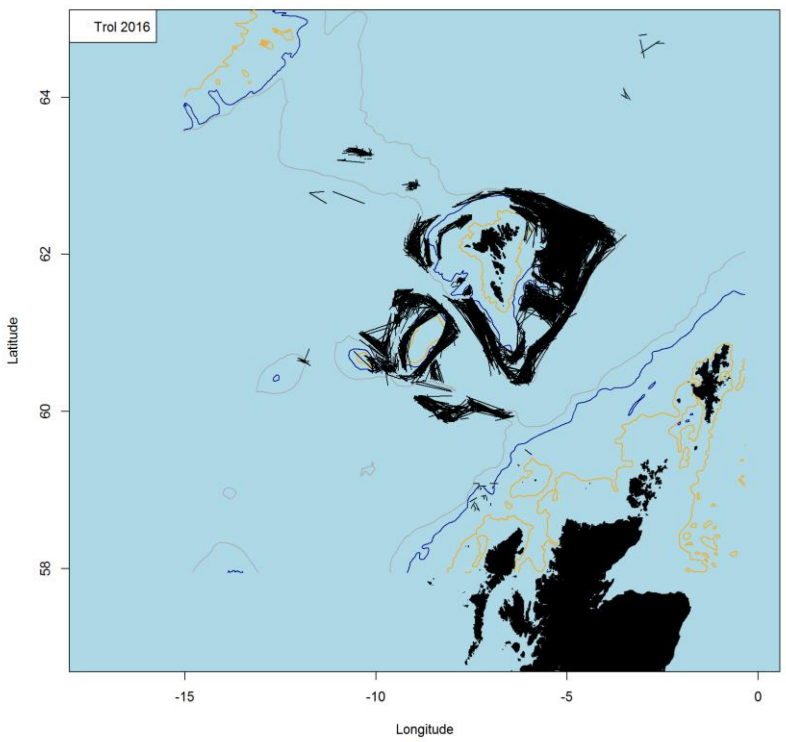
	Number of used days									
	2 outer	2 inner	3	4 A	4 B	4 T	5 A	5 B	Total days	Total 2-4
1996/1997										
1997/1998		6211	2469	2619	3983					15282
1998/1999		5907	2309	2147	3715					14078
1999/2000		6497	2207	2255	3995					14954
2000/2001		6065	2469	2733	4435					15702
2001/2002		5643	2494	2454	4450					15041
2002/2003		4688	2432	2303	4554					13977
2003/2004		5018	2186	2184	5108					14496
2004/2005		5070	2468	1647	4613					13798
2005/2006		4381	3141	1200	1717	2443				12883
2006/2007		4186	2820	961	1113	2208				11288
2007/2008		4524	2447	582	1036	1923				10512
2008/2009		4065	2273	415	1016	1434				9201
2009/2010		4585	2078	426	1158	1382				9629
2010/2011		3883	2071	405	1016	1412	2856	4525	17506	8787
2011/2012	895	4758	1986	260	657	1313	1834	3160	14862	9869
2012/2013	879	3953	1205	271	688	1166	1410	2845	12415	8162
2013/2014	797	3916	1120	272	519	895	1136	3337	11992	7519
2014/2015	1125	4308	1235	254	565	717	1297	3709	13210	8204
2015/2016	1312	3784	1452	315	699	919	810	4421	13711	8481
2016/2017	1225	3882	1075	280	556	1111	646	3440	12215	8129
2017/2018 est.	1202	4472	963	289	812	990	634	2904	12267	8729
2017/2018 end	1390	5562	1568	461	895	1518	887	5486	17719	11394
2018 cal year	1043	4077	1201	391	718	1239	785	5053	14507	8669
2019 cal year	864	3940	1665	420	818	1390	3801	5539	18320	9097
2020 cal year, estim.	915	3254	1721	288	471	1241	4271	1911	14072	7890

Table 2.2. Continued. Number of used days since the fiscal year 1997/1998 (%).

	Percentage of used days								
	2 outer	2 inner	3	4 A	4 B	4 T	5	Total days	Total 2-4
1997/1998		86	93	56	86				
1998/1999		86	91	48	84				77
1999/2000		95	87	51	91				82
2000/2001		89	98	61	101				86
2001/2002		83	99	55	101				83
2002/2003		69	97	52	105				77
2003/2004		76	89	50	120				82
2004/2005		78	102	39	110				79
2005/2006		76	88	68	83	138			86
2006/2007		73	81	56	55	129			77
2007/2008		80	72	35	53	115			73
2008/2009		92	77	31	58	93			73
2009/2010		104	71	32	66	90			80
2010/2011		75	73	31	58	92	56	63	75
2011/2012	58	102	75	25	47	95	47	64	78
2012/2013	57	85	47	27	45	84	40	53	65
2013/2014	52	88	47	27	34	65	45	54	61
2014/2015	74	97	43	25	37	52	51	60	67
2015/2016	86	85	61	31	46	66	53	62	69
2016/2017	80	89	53	33	42	94	46	59	69
2017/2018 est.	79	102	47	34	61	84	40	59	74
2017/2018 end	68	95	58	40	51	97	54	66	76
2018 cal year	68	93	59	46	54	105	66	72	77
2019 cal year	56	90	82	53	57	118	85	82	80
2020 cal year	58	76	67	32	25	78	56	59	62

Table 2.3. Main regulatory measures by fleet in the Faroese fisheries in 5.b. 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	Subgroups		Main regulation tools
1	Single trawlers > 400 HP	none		Fishing days, have from 2011/12 been merged with the pairtrawlers, area closures
2	Pairtrawlers > 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



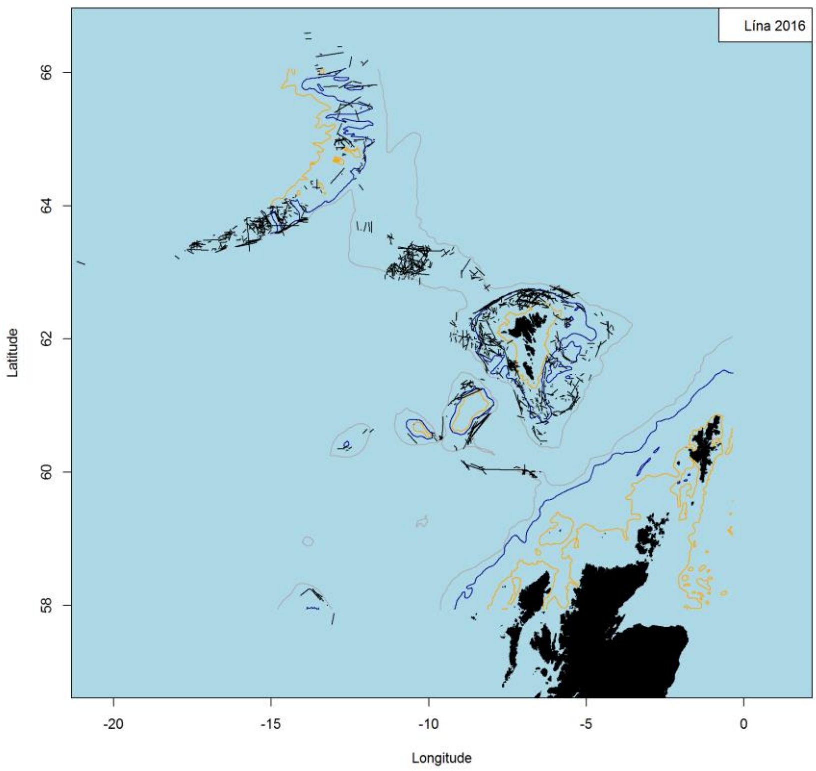


Figure 2.1. The 2016 distribution of fishing activities by some major fleets. From top: 1010HP, trap and trawl > Gillnet, longline. The longline fleet below 110 GRT is not shown here since they are not obliged to keep logbooks.

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

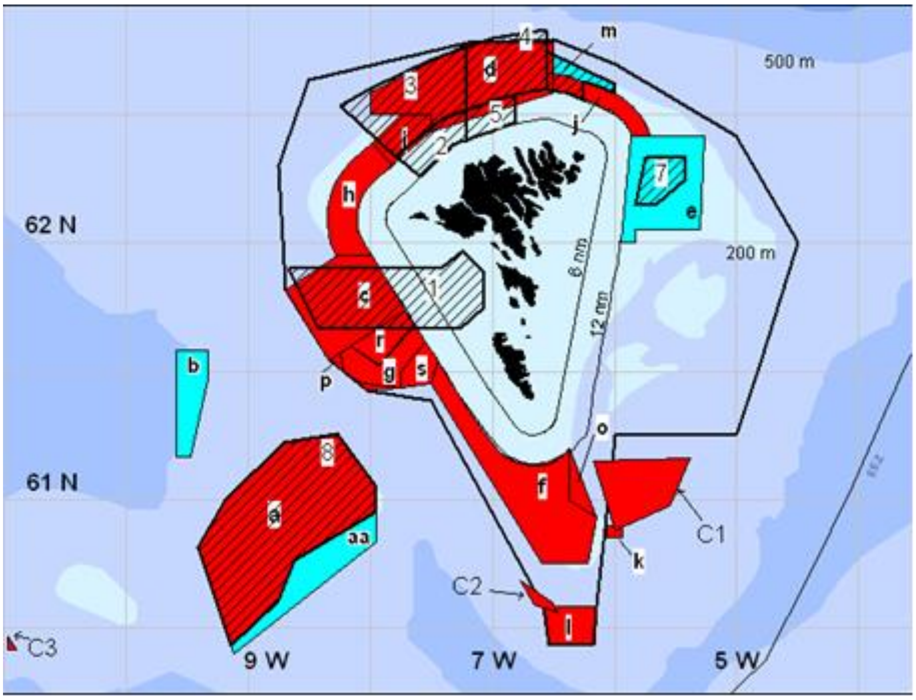


Figure 2.2. Fishing area regulations in Division 5.b. Allocation of fishing days applies to the area inside the outer thick line on the Faroe Plateau. Holders of effort quotas who fish outside this line can triple their numbers of days. Longliners larger than 110 GRT are not allowed to fish inside the 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.

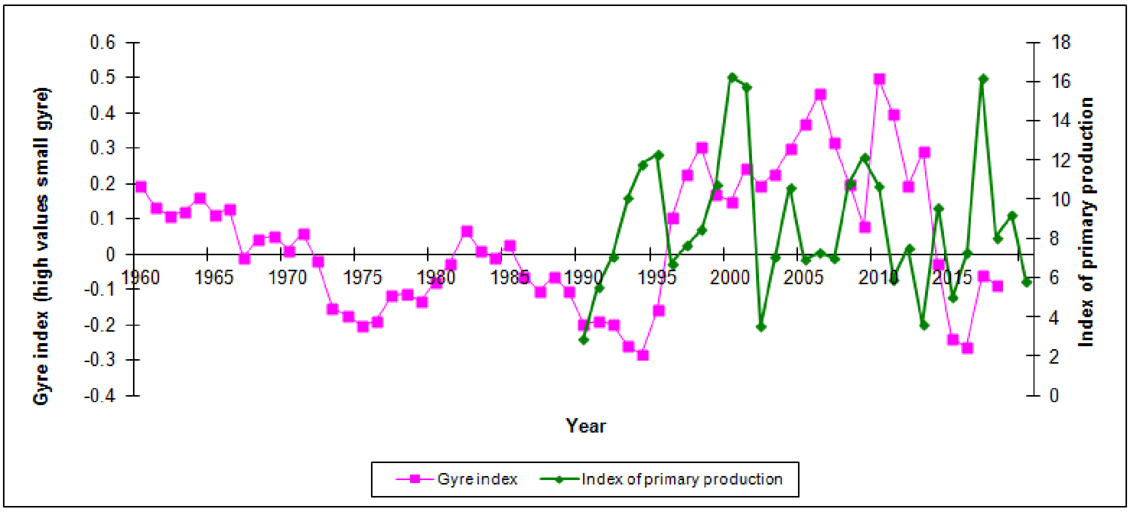


Figure 2.3. Temporal development of the phytoplankton index over the Faroe Shelf area (< 130 m) and the Subpolar Gyre index which may indicate productivity in deeper waters.

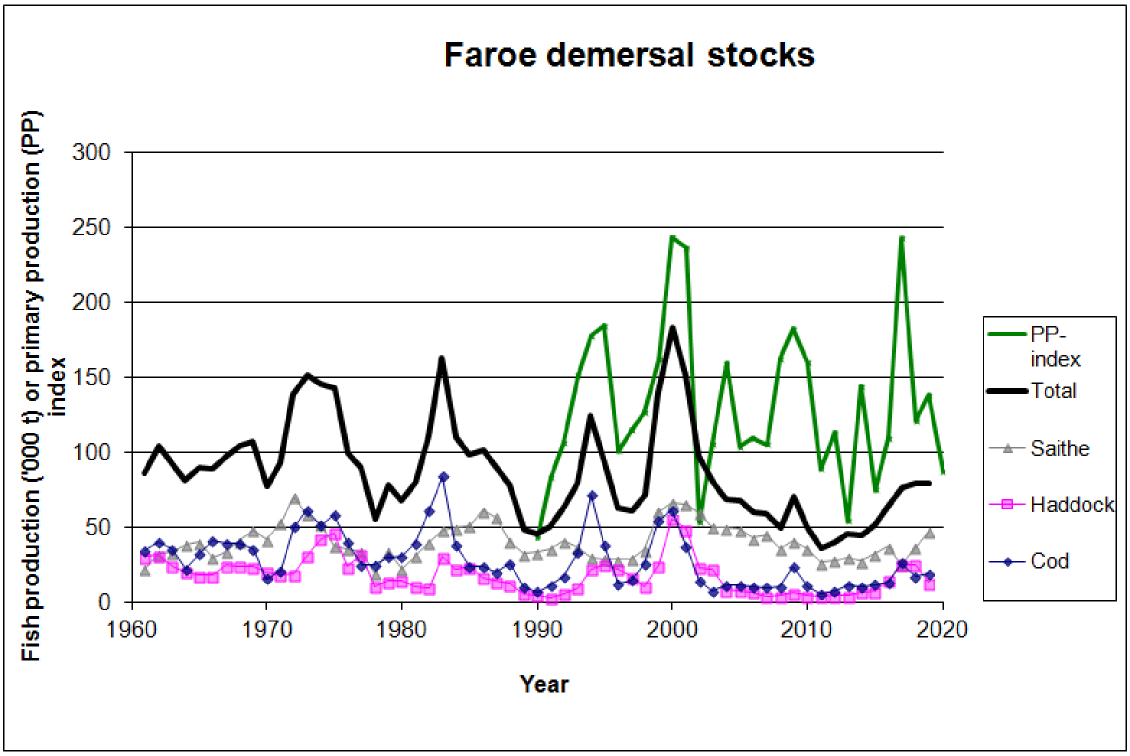


Figure 2.4. Temporal development of primary production and production of cod, haddock and saithe.

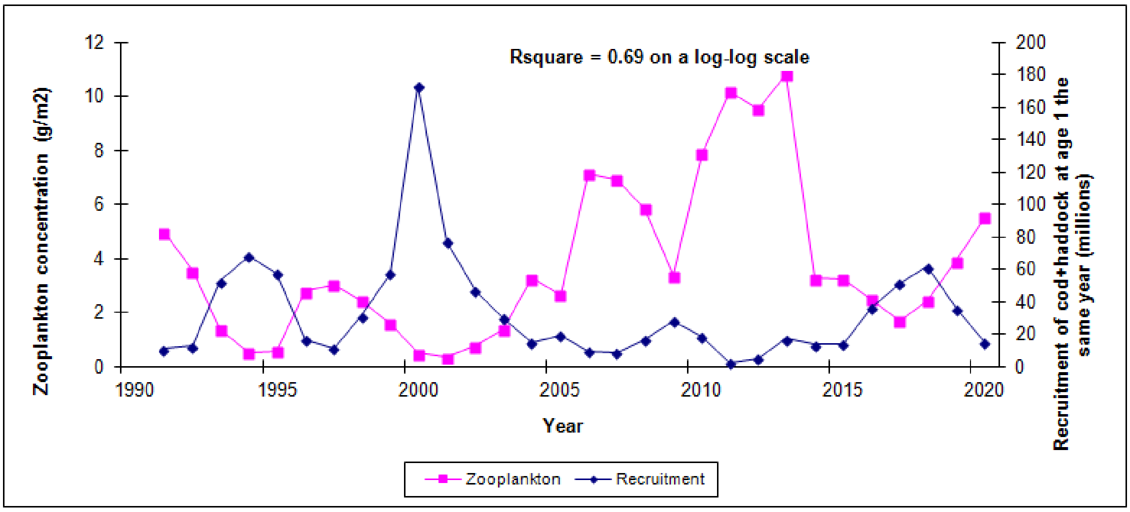


Figure 2.5. Relationship between zooplankton concentration in June/July and recruitment of cod and haddock on the Faroe Plateau.

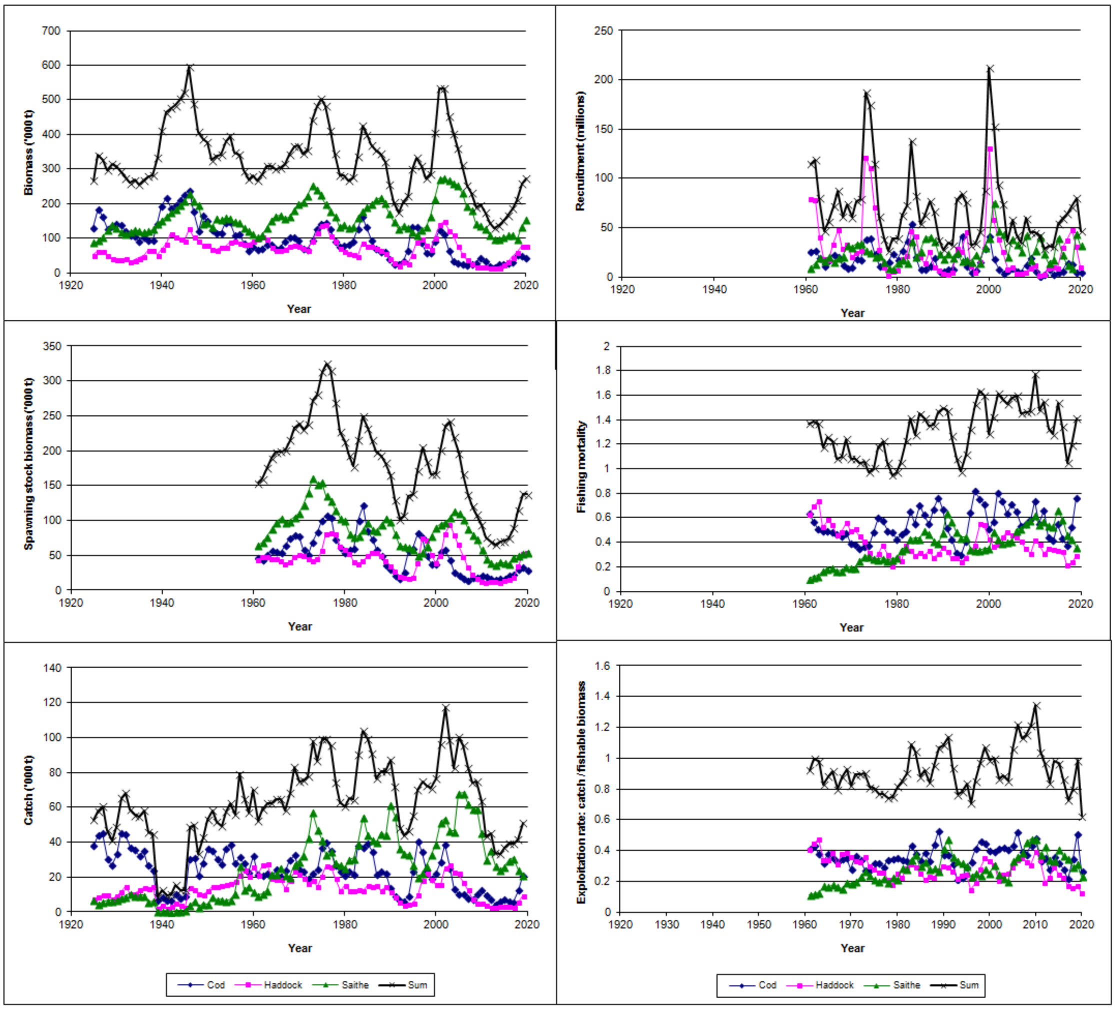


Figure 2.6. Summary of the stock dynamics for Faroe Plateau cod, Faroe haddock and Faroe saithe. Fishable biomass is age 3+ for cod and haddock and age 4+ biomass for saithe.

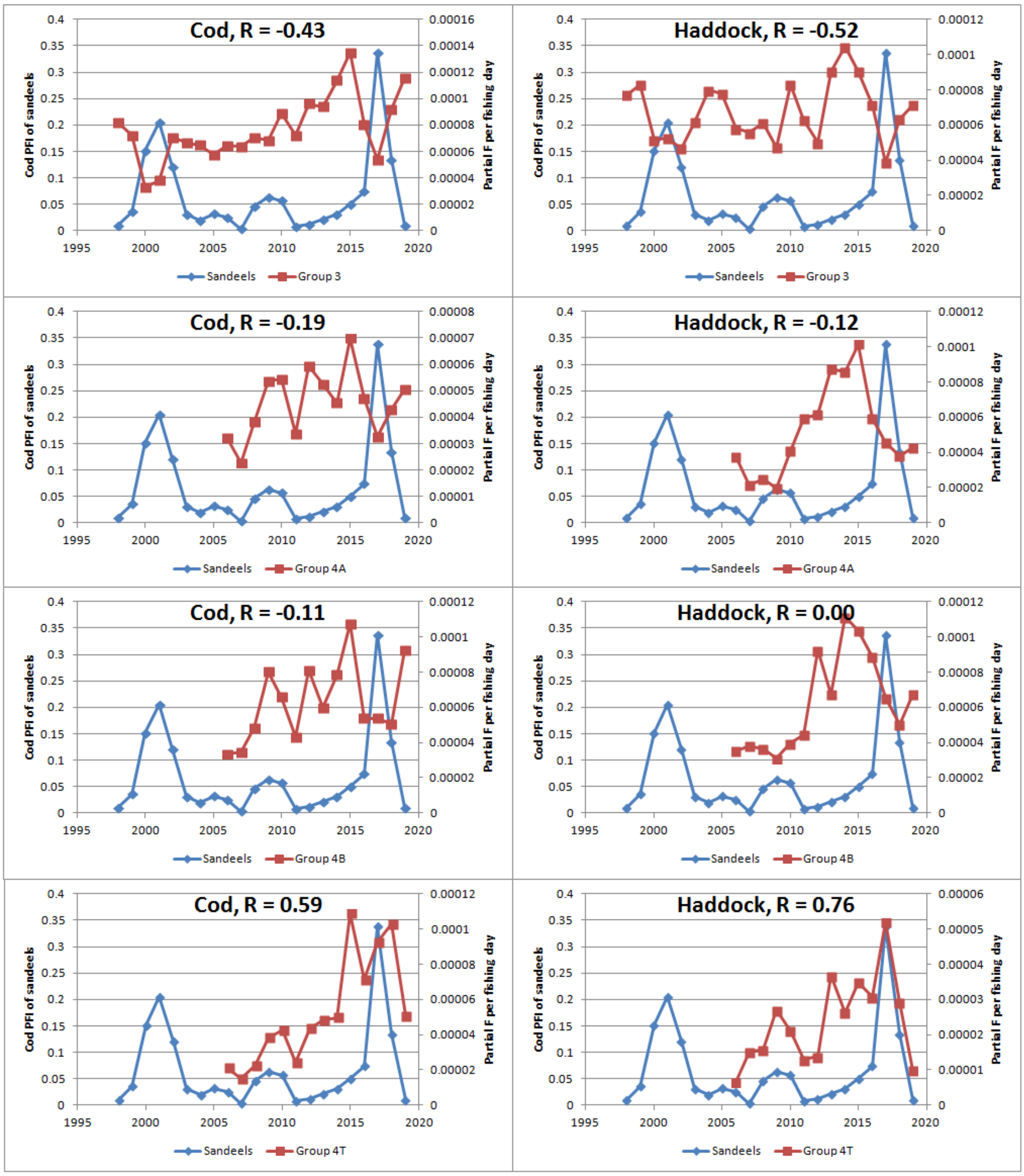


Figure 2.7. Partial F per fishing day of cod and haddock for large longliners (Group 3), medium-sized longliners (Group 4A) and small longliners (Group 4B) as well as small single trawlers (Group 4T). A comparison with sandeel abundance is made.

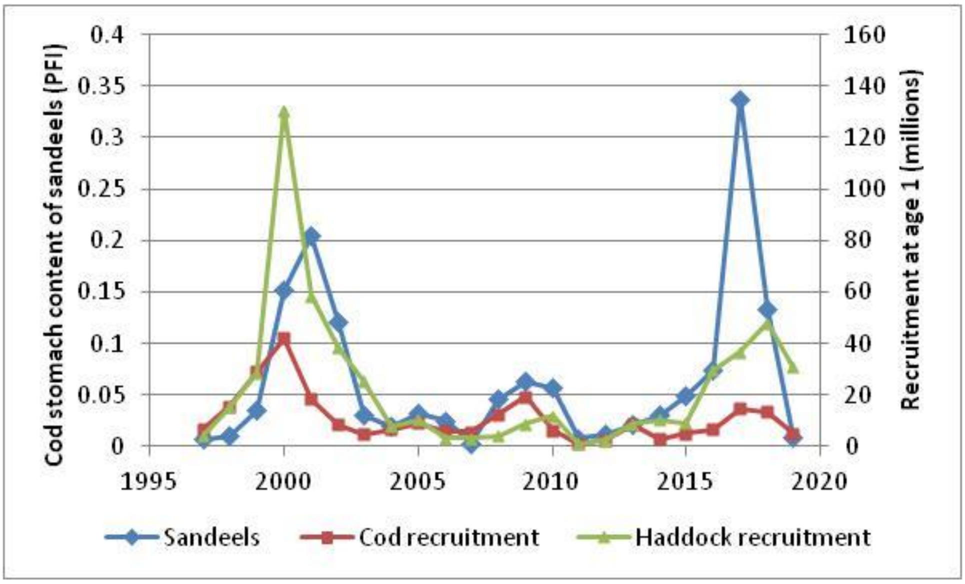


Figure 2.8. Sandeel abundance, as measured by cod stomach partial fullness index of sandeels, compared with the recruitment of cod and haddock.

3 Faroe Bank cod

3.1 State of the stock

Total nominal catches of the Faroe Bank cod from 2002 to 2018 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 5000t in 1973 and 2003. The trend of landings has been smoother since 1987, declining from about 3500 t in 1987 to only 330 t in 1992 before increasing to 3600 t in 1997. Landings have declined sharply from a peak of almost 6000 t. in 2004 to 31 in 2018. (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). Since 2005–2007 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.

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.

Spring survey was initiated in 1983 and discontinued in 1996, 2004 and 2005. Summer survey has been carried out since 1996. The CPUE of spring survey was low during 1988–1995 varying between 73 and 95 kg per tow. Although noisy, the survey suggests higher, possibly increasing biomass during 1995–2003 and in 2013 and 2014 but it decreased rapidly in 2015 and 2016. Survey stock estimates since 2016 do not indicate a substantial change in the perception of the stock status. The summer index was high from 1996 to 2003 but declined substantially in 2004 and it has remained at low levels since then. There are conflicting signals between both indices from 2013 to 2014. The agreement between summer and spring index is good during 1996 to 2001, but they diverged in the 2002–2003 and 2013—2014 periods. Both indices 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 summer survey from 2000–2002 (lengths 26–45 cm), corresponding to good recruitment of 2 years old in spring surveys from 2001 to 2003 (40–60 cm). The spring index shows poor recruitment from 2006–2019 reflecting the weak year classes observed in summer survey since 2004. Length composition shows relatively high numbers of individuals in the 80–100 cm range. 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 spring index, recruitment was estimated as total number of fish below 60 cm (2-year old) and in 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). Spring recruitment index in 2015 was the highest since 2005. Correlation between spring and summer survey recruitment indices is fairly good ($r = 0.86$). Correlation between numbers of 1-year and 2-years old cod in the age-disaggregated summer and spring surveys respectively is estimated at $r = 0.79$.

Surplus production models have been run from 2014 to 2016. 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 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 3.8). The exploitation ratio has decreased since 2006 but increased in 2011 and 2016 due to the increase in catches.

3.2 Comparison with previous assessment and forecast

The status of the stock remains almost unchanged with respect to last year's assessment. Both spring and summer indices suggest the stock is well below average while there are no indications of incoming recruitment. The spring index suggested an increasing stock biomass from 2013–2014 which it was however not confirmed by the summer index.

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 in 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 2016 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 1050 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–1 May) has been enforced since 2005. In 2009, fishing was restricted to all fishing gears from 1 January–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. Since 2009 the number of fishing days allocated to the Bank has been negligible.

Table 3.1. Faroe Bank (subdivision Vb2) cod. Nominal catches (tonnes) by countries 2002–2018 as officially reported to ICES. From 1992 the catches by Faroe Islands and Norway are used in the assessment.

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Faroe Islands	1840	5957	3607	1270	1005	471	231	81	111	393	115	40	40	26	19	14	33 *
Norway	25	72	18	37	10	7	1	4	1		0		1	0	1	1	
France															3		
Greenland	-	-	-	-	-	-	-	-	5		1						
UK (E/W/NI)	42 [3]	15 [3]	15 [3]	24 [3]	1 [3]												
UK (Scotland)	218 [3]	254 [3]	244 [3]	1129 [3]	278 [3]	53	32	38	54				45 [4]	16 [4]	60 [4]	404 [3,4]	
Total	2125	6298	3884	2460	1294	531	264	123	171	393	116	40	86	42	83	419	33
Correction of Faroese catches in Vb2	-109	-353	-214	-75	-60	-28	-14	-5	-7	-23	-7	-2	-2	-2	-1	-1	-2
Used in assessment	1756	5676	3411	1232	955	450	218	80	105	370	108	38	39	24	19	14	31

* Preliminary
[2] Included in Vb1.
[3] Reported as Vb.
[4] Reported as GB

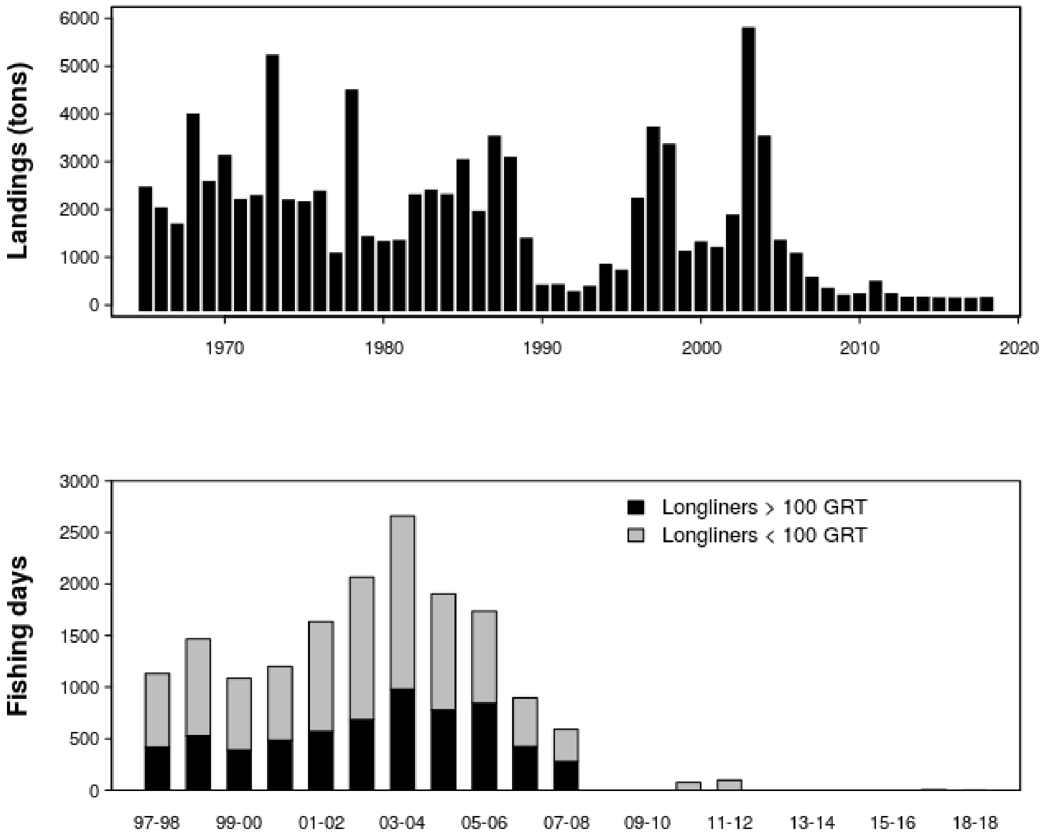


Figure 3.1. Faroe Bank (subdivision Vb2) cod. Reported landings 1965–2018. Since 1992 only catches from Faroese and Norwegian vessels are considered to be taken on Faroe Bank. Lower plot: fishing days (fishing year) 1997–2018 for long-line gear type in the Faroe Bank.

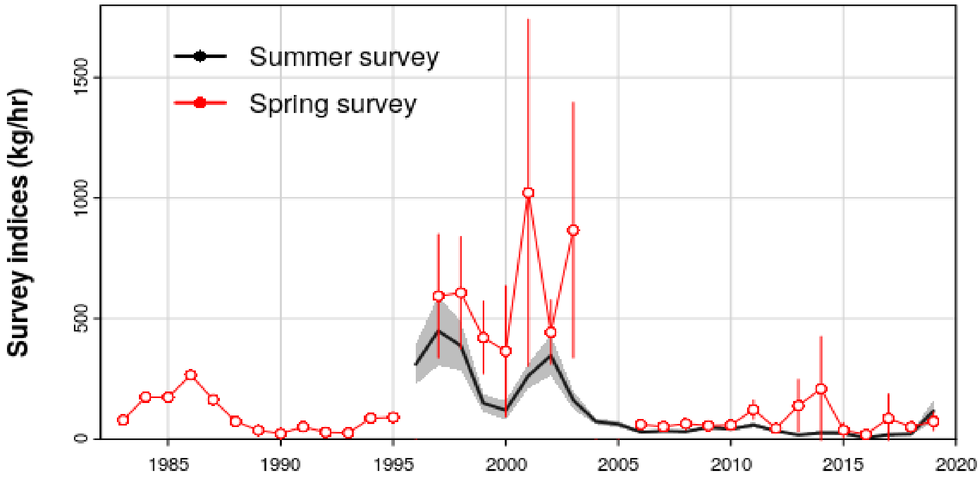


Figure 3.2. Faroe Bank (subdivision Vb2) cod. Catch per unit of effort in spring groundfish survey (1983–2019)(red line) and summer survey (1996–2019)(black line). Vertical bars and shaded areas show the standard error in the estimation of indices.

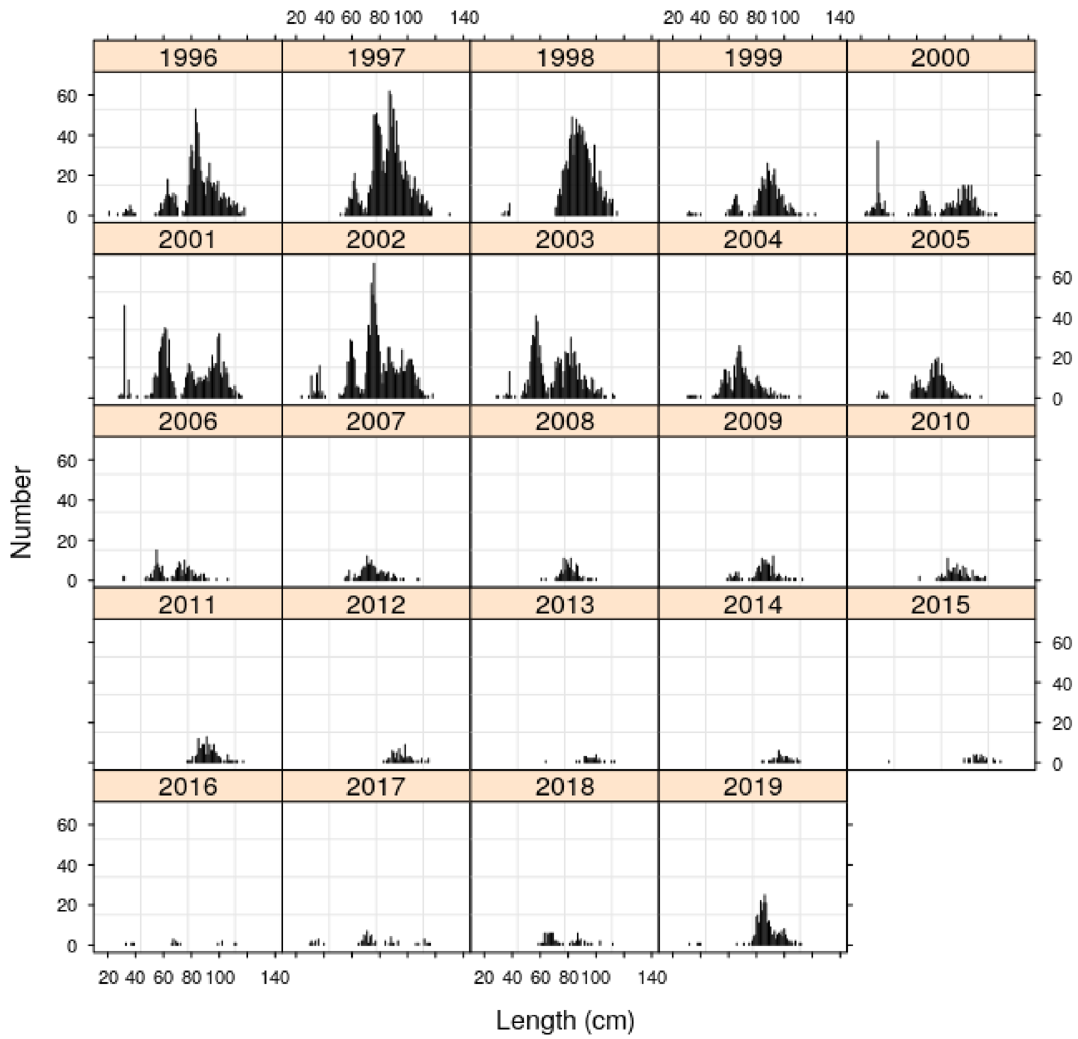


Figure 3.3. Faroe Bank (subdivision Vb2) cod. Length distributions in summer survey (1996–2019)

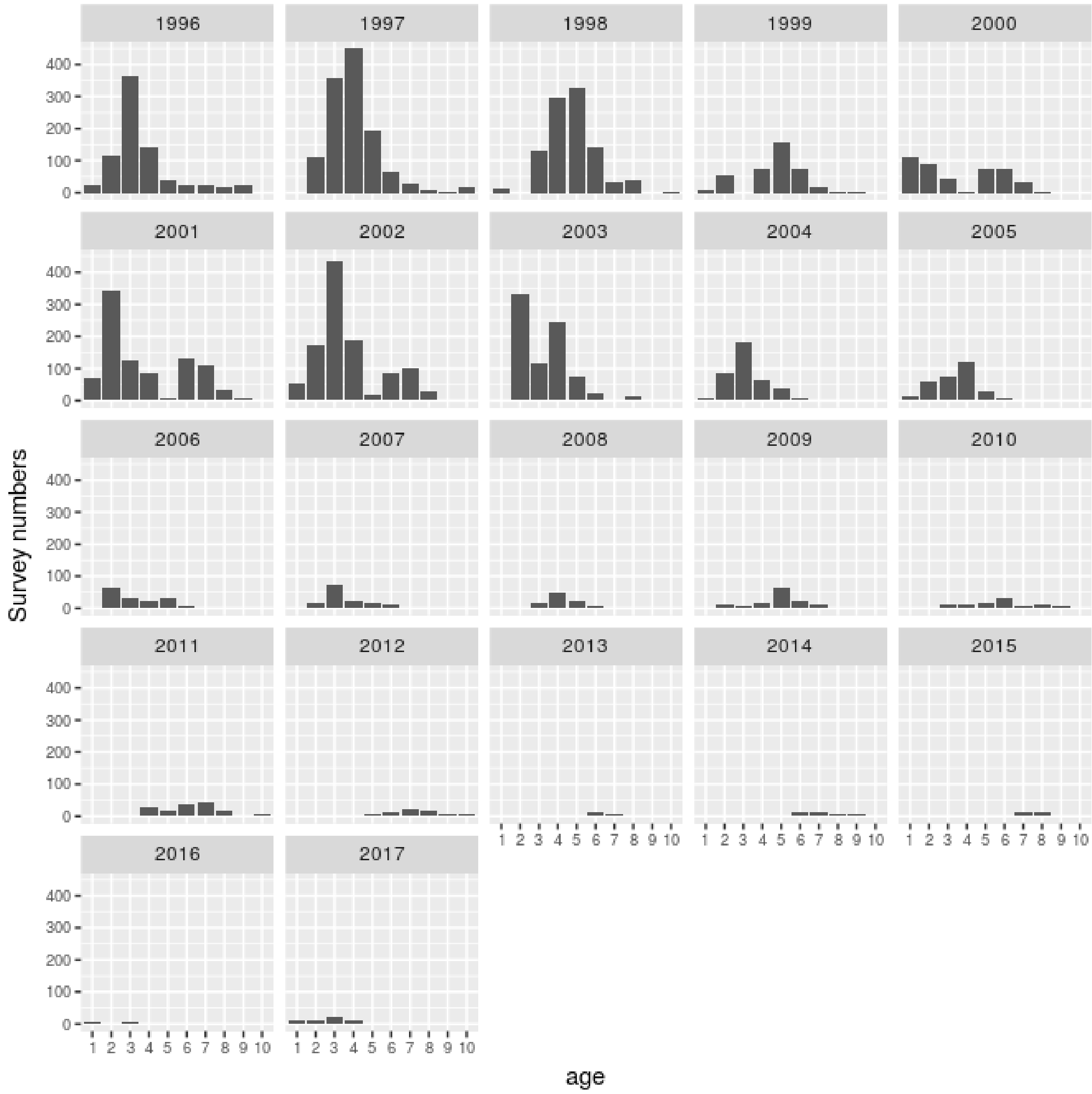


Figure 3.4. Faroe Bank (subdivision Vb2) cod. Age-disaggregated indices in summer survey (ages 1–10)(1996–2017)

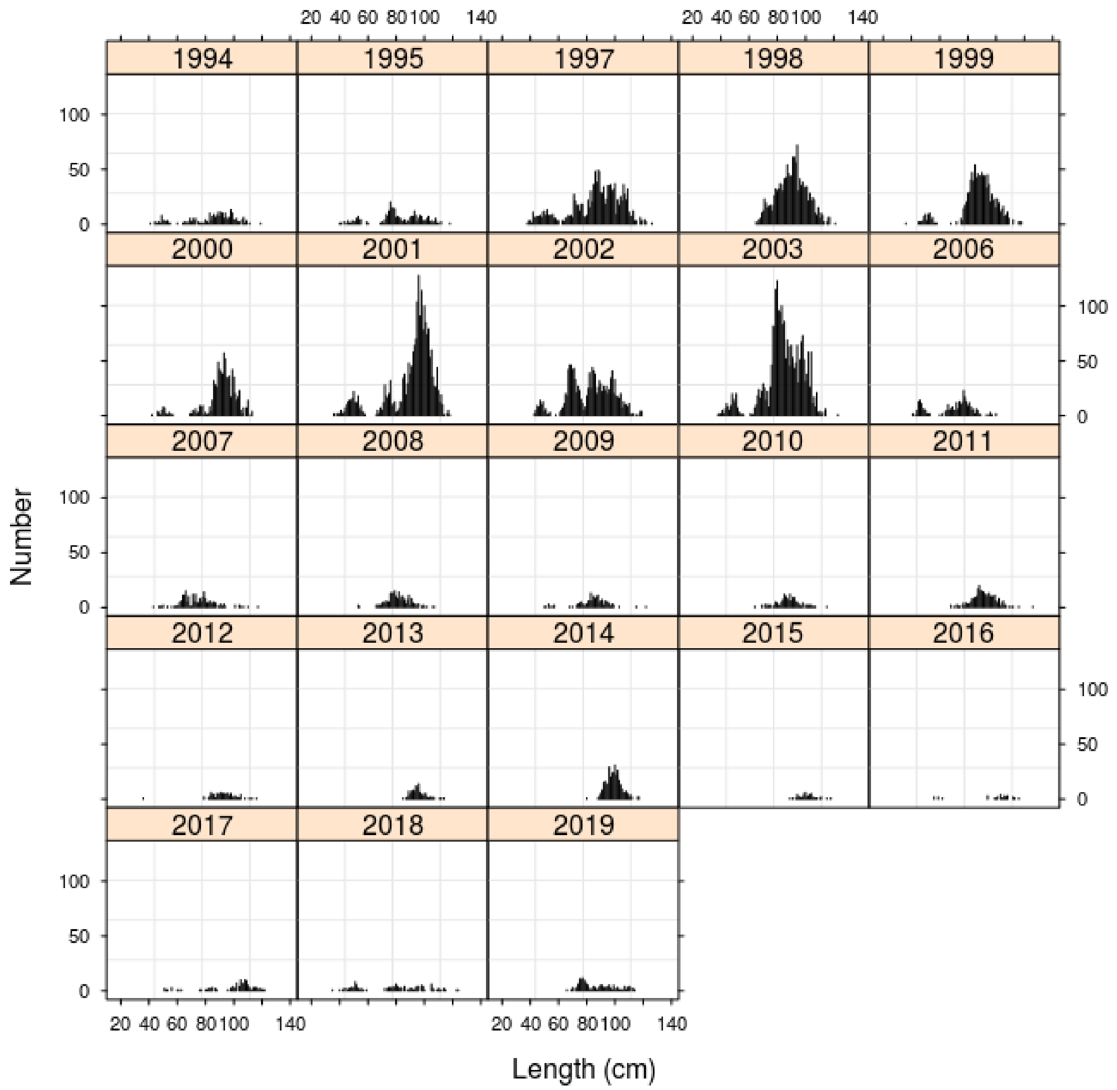


Figure 3.5. Faroe Bank (subdivision Vb2) cod. Length distributions in spring survey (1994–2018). No surveys were conducted in 1996, 2004 and 2005.

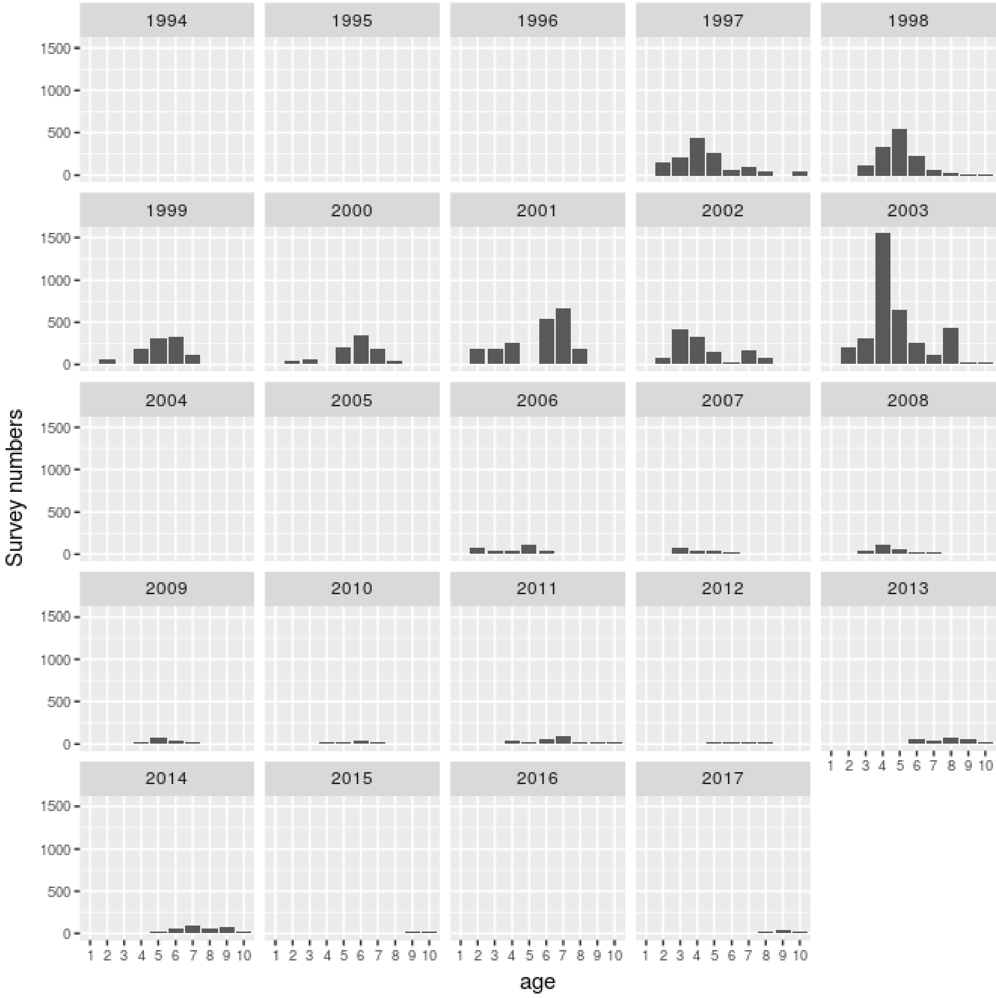


Figure 3.6. Faroe Bank (subdivision Vb2) cod. Age-disaggregated indices in spring survey (ages 1–10) (1994–2015). No surveys were conducted in 1996, 2004 and 2005.

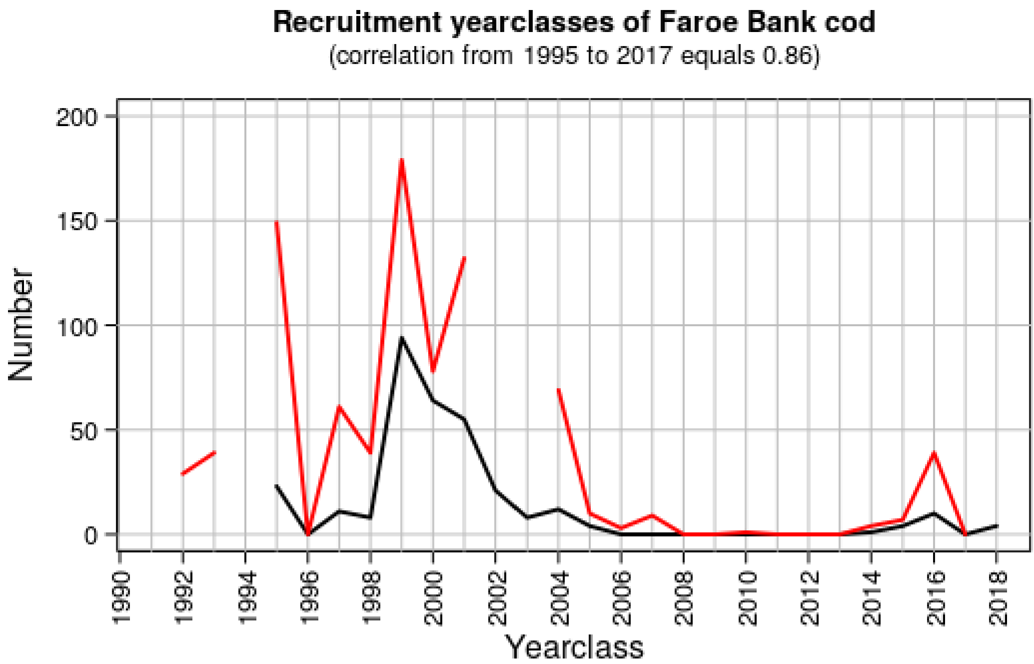


Figure 3.7. Faroe Bank (subdivision Vb2) cod. Correlation between recruitment year classes in both survey indices.

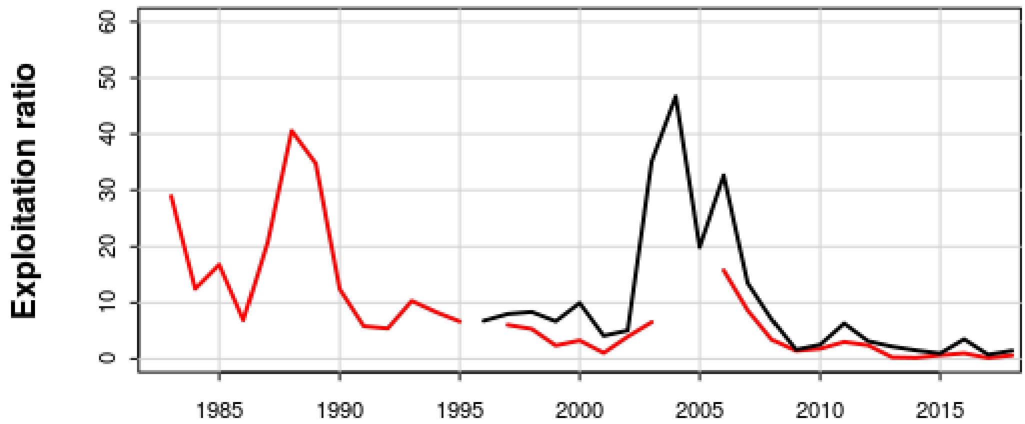


Figure 3.8. Faroe Bank (subdivision Vb2) cod. Exploitation ratios, ratio of spring index to landings (red line) and ratio of summer index to landings (black line).

4 Faroe Plateau cod

This section was updated in November 2020.

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 5.b.2), on the Faroe Plateau (Division 5.b.1) 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 stock 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 single trawlers and the large longliners were not included in the catch-at-age calculations (Table 4.2.3).

4.2.2 Catch-at-age

Landings-at-age for 2019 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 Figure 4.2.1.

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 2019 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. Maturities were slightly revised during the benchmark in February 2017. The maturities prior to 1983 were set to the average for 1983 to 1996.

4.2.5 Catch, effort and research vessel data

Fisheries independent CPUE series

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 decreased in the recent years.

The other tuning series used is the Summer Groundfish Survey. The stratified mean catch of cod per unit effort has also decreased 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 the 2016 and 2017 year classes initially seemed to be of average strength but were less abundant in 2020 than expected. Catch per tow in the spring and summer survey shows that there were occasional large hauls in both surveys (Figure 4.2.7 and Figure 4.2.8).

Commercial CPUE series

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. The incoming year classes observed in the surveys are only seen in the small longliners, probably because the large longliners and pairtrawlers operate in deeper waters where the juveniles are infrequent. Note that the small boats (0–25 GRT) operating with longlines and jigging reels close to land have had an extremely high CPUE in recent years relative to the fishable biomass (Figure 4.2.10, Figure 4.2.11), a feature also observed for the larger longliners (Figure 4.2.9). When that happens, the recruitment of cod tends to be low (Steingrund *et al*., 2010). However, the catchability for the large longliners came down to the average level in 2017 but increased thereafter (Figure 4.2.11).

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

The benchmark in February 2017 decided to change the traditional assessment tool from XSA to SAM although it was recognised that the results of the assessment were mainly data-driven. The SAM model had some beneficial characteristics, e.g. that it provided uncertainty estimates for the catch in numbers, surveys and the output from the assessment (biomasses and fishing mortalities).

4.5 Reference points

Since the assessment model was replaced at the benchmark in February 2017, it was necessary to recalculate reference points at the NWWG meeting in 2017 (this was not finally conducted during the benchmark).

The B_{lim} was kept unchanged at 21 thousand tonnes, since this previously defined B_{loss} was the lowest spawning biomass from which the stock had made a recovery. It was noted that the biomass had been lower afterwards but the stock had not recovered by the time when the reference point was defined.

The $B_{pa} = B_{trigger} = 29\,226$ tonnes (changed from 40 000 tonnes). The uncertainty in the SAM assessment on the final year of SSB was found to be $\sigma = 0.20$ and the B_{pa} was found by using the formula $B_{pa} = B_{lim} \times \exp(\sigma \times 1.645)$. The $B_{trigger}$ was, according to ICES guidelines, set equal to B_{pa} since the stock had not been fished at F_{MSY} for five or more years.

F_{lim} = 0.90 (changed from 0.68). F_{lim} was derived from B_{lim}. A stock was simulated with a segmented regression on the spawning stock – recruitment function having the point of inflection at B_{lim}. F_{lim} was set to the F that, in equilibrium, gave a 50% probability that SSB > B_{lim}. This simulation was based on a fixed F, i.e., without inclusion of a $B_{trigger}$ and without inclusion of assessment/advice errors.

F_{pa} = 0.69 (changed from 0.35). F_{pa} was derived from F_{lim} in the reverse of the way B_{pa} was derived from B_{lim}, i.e., $F_{pa} = F_{lim} \times \exp(-\sigma \times 1.645)$, where $\sigma = 0.16$.

The calculations were conducted using EQSIM following ICES guidelines. Decisions made involved the spawning stock – recruitment relationship, the weights at age, the selection pattern and the level of advice error. The full time series (1959–2015) was used as basis for the spawning stock – recruitment relationship where the S-R function was based on the segmented regression (weight 0.61), Ricker (weight 0.36) and Beverton and Holt (weight 0.03). The Ricker curve was included because recruitment at very large stock sizes was low according to extension of stock biomass back to 1710 (ICES, 2016). The autocorrelation between SSB-R data points was approximately 0.55. The weights at age were based on the last 10 years (2007–2016). The selection pattern was also based on the last 10 years. The selection pattern has been very stable over time, so the use of the last 20 years would not make any big difference for the F_{MSY}. The advice error was estimated from advice sheets back to 1999: cvF = 0.44, phiF = 0.47, cvSSB = 0.38, phiSSB = 0.24. In total, 2000 iterations were performed that projected the stock 200 years into the future, of which, the last 50 years were kept to calculate 'equilibrium' values.

The result of the analyses was that F_{MSY} = 0.23 (changed from 0.32). The fishing mortality that is associated with a risk of 5% to fall below B_{lim}, Fp0.5, was estimated to be 0.41, greater than F_{MSY}.

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

As previous years, the two surveys were used for tuning. The commercial series showed a similar overall tendency as the surveys (Figure 4.2.9) but were not used in the tuning. At the benchmark in February 2017, the traditional XSA was replaced by a SAM assessment model. The SAM model settings and the model parameters are shown in Table 4.6.1, e.g. the fishing mortality is assumed equal for ages 7+. The variation in the catchability coefficients for the survey at age was set equal for ages 2+, although different for each survey, and age 1 was set different from the other ages, but different for the two surveys. An AR covariance structure was applied for the summer survey, eliminating year effects, but not for the spring survey. The observation residuals looked quite random (Figure 4.6.1) as well as the joint residuals (Figure 4.6.2).

The results from the SAM-run shows that fishing mortality (F3–7) has decreased in recent years albeit increasing steeply the last two years (Table 4.6.2, 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, but temporarily increased around 2017 and decreased again (Table 4.6.3, Table 4.6.4, Figure 4.6.4, Figure 4.6.5). The poor state of the stock since 2004 was due to poor recruitment (not poor individual growth). Prior to that time, extremely weak year classes (< 5 million individuals at age 2) were only observed three times, whereas it has happened eight times since 2004. In the past there has been a poor relationship between the size of the spawning stock and subsequent recruitment (Figure 4.6.6), 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 above $B_{trigger}$ and the fishing mortality above F_{pa} (Table 4.6.4). The spawning stock biomass in the assessment year was below $B_{trigger}$.

The decade of low biomass of Faroe Plateau cod since 2004 has been unprecedented over the last 300 years (Figure 4.6.4); for data and figures for the years before 1959, see ICES (2016), although there were short periods of low biomass between 1700 and 1750 and around 1813.

4.7 Short term forecast

4.7.1 Input data

The short term prediction was performed in the SAM model. The SAM model provides predictions that carry the signals from the assessment into the short term forecast. The forecast procedure starts from the last year's (assessment year) estimate of the state (log(N) and log(F) at age. One thousand replicates of the last state are simulated from its estimated joint distribution. Each of these replicates are then simulated forward according to the assumptions and parameter estimates found by the assessment model. In the forward simulations a 5 year average (years up to the assessment year) is used for catch mean weight, stock mean weight, proportion mature, and natural mortality. Recruitment is re-sampled from the last 10 years (up to the year before the assessment year). In each forward simulation step the fishing mortality is scaled, such that the median of the distribution is matching the requirement in the scenario (e.g. hitting a specific mean F value or a specific catch).

4.7.2 Results

The landings in 2020 were originally expected to be 17 thousand tonnes (Table 4.6.4) with an extremely high projected fishing mortality of 0.87. However, the landings in 2020 were estimated to be only 10600 tonnes, based on the January-September landings 2020 and comparing with 2019. Therefore, (deviating from the stock annex) a catch constraint was set on the landings in 2020 of 10600 tonnes and forecasts based on this assumption (Table 4.6.4). The landings from the Faroe-Iceland Ridge should be added to this figure in order to get the total Faroese landings within the 5.b.1 area. The spawning stock biomass is expected to be 33 thousand tonnes in 2021 and 37 thousand tonnes in 2022 if the Fmsy is applied. This is markedly lower than expected in the last years' forecast.

4.8 Long term forecast

The yield per recruitment calculations were performed in the SAM model and were based on the last 20 years (up to the year before the assessment year). The F_{max} was estimated at 0.27 (Figure 4.8.1).

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.

The retrospective pattern indicates uncertainties in the assessment, especially in recruitment (Figure 4.9.1). The Mohn's rho was -178%, -14% and -7% for recruitment, F, and the spawning stock biomass, respectively. The massive downscaling of the recruitment is commented on later in this report (4.10).

Steingrund *et al.* (2010) found that the recruitment of Faroe Plateau cod (age 2) could be rather precisely estimated as there is a significant 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 and that the 2016 and 2017 year classes were slightly stronger (Figure 4.9.2).

A preliminary catch-at-age for 2020 was calculated, based on the data already available (catch figures January-September scaled up to the whole year, 10604 tonnes, based on the landings in 2019; age and length samples from the catch January-September). The catch-at-age figures for 2020 were (age 2 to 10+ in thousands): 24, 808, 1340, 528, 344, 129, 56, 12, and 4. The fishing mortality in 2020 was much more reasonable (0.57 vs. 0.87) and the recruitment was even more downscaled leading to a more pessimistic forcast of future biomass. Question is whether an additional recruitment index should be used in future assessments that reflects the food availability in the ecosystem – much food, large recruitment, and *vice versa* (WD 23), see 4.10.

4.10 Comparison with previous assessment and forecast

The assessment settings were according to the Stock Annex. The assessment this year showed substantial downscaling of the recruitment, a lower total stock biomass and spawning stock biomass and higher fishing mortality compared with last year's assessment (Figure 4.10.1). Reason for this downscaling of recruitment is likely either food shortage or cannibalism or both. This is indicated by a high catchability with longlines and a high abundance of age 3+ cod close to land (in the nursery areas of recruiting cod) that are easily caught by small longliners. This was observed in summer-autumn 2018 and especially in 2019 (Figure 4.2.10, Figure 4.2.11 and Figure 4.9.2). In hinsight, this has happened before (in 1997, 2002-2003) and was not surprising given the low abundance of sandeels and below-average abundance of Norway pout. For some reason, though, the weights-at-age in 2019 and 2020 were above average and this should be investigated further in the future.

4.11 Management plans and evaluations

A management plan based on the fishing day system is agreed on by the fishing industry, Faroe Marine Research Institute and Faroe Coastal Guard but is not implemented yet.

4.12 Management considerations

The productivity of the Faroe Plateau cod stock seems to be less now than for decades ago. Future management plans should preferably keep the fishing mortality close to F_{MSY} in order to obtain maximum catch and avoiding low stock levels in the future.

4.13 Ecosystem considerations

Regarding the ecosystem effects on fishing, this issue is partly addressed in the overview section for Faroese stocks. Although the fishery has changed substantially during the last century the total biomass of cod+haddock+saithe has fluctuated around the same level. However, the proportion of saithe has increased steadily over the time period, whereas cod has decreased. This could indicate some effect of fishing on the ecosystem, although other factors cannot be ruled out.

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).

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. They also have fished in other areas, e.g. in Greenland and on the Flemish Cap. 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 was low for a number of years, albeit high in 2008 to 2010 and in 2017, but it is not believed that this has any relationship with a change in the environment. Since 2002, the temperature has been about 1 °C higher than in the 1990s, which may have had a negative effect on cod recruitment.

Table 4.2.1. Faroe Plateau cod (Subdivision 5.b.1). Nominal catch (t) by countries, as officially reported to ICES.

	Denmark	Faroe Islands	France	Germany	Iceland	Netherlands	Norway	Greenland	Portugal	UK	UK Scotland	Total
1986	8	34492	4	8			83	-		0	0	34595
1987	30	21303	17	12			21	-		8	0	21391
1988	10	22272	17	5			163	-		0	0	22467
1989	-	20535	-	7			285	-		0	0	20827
1990	-	12232	-	24			124	-		0	0	12380
1991	-	8203	-**	16			89	-		1	0	8309
1992	-	5938	3***	12			39	-		74	0	6066
1993	-	5744	1***	+			57	-		186	0	5988
1994	-	8724	-	2***			36	-		56	0	8818
1995	-	19079	2***	2			38	-		43	0	19164
1996	-	39406	1***	+			507	-		126	0	40040
1997	-	33556	-	+			410	-		61***	0	34027
1998	-	23308	-*	-			405	-		27***	0	23740
1999	-	19156	-*	39	-		450	-		51	0	19696
2000		0	1	2	-		374	-		18	0	395
2001		29762	9***	9	-		531	-		50	0	30361
2002		40602	20	6	5		573			42	0	41248
2003		30259	14	7	-		447	-		15	0	30742
2004		17540	2	3***			414		1	15	0	17975
2005		13556	-				201			24	0	13781
2006		11629	7	1***			49	5		0	0	11691
2007		9905	1***				71	7		0	360	10344
2008		9394	1				40			0	383	9818
2009		10736	1				14	7		0	300	11058

	Denmark	Faroe Islands	France	Germany	Iceland	Netherlands	Norway	Greenland	Portugal	UK	UK Scotland	Total
2010		13878	1				10			0	312	14206
2011		11348	-				0			0	0	11348
2012		8437	0		28		0			0	0	8466
2013		5331	0		20		0	2		0	0	5333
2014		6655					2			0	226	6883
2015		7812					33	14		0	367	8174
2016		6736					31	5		0	456	7232
2017		6215	2			0	16			0	388	6625
2018		13297	2			0	69			0	504	13872
2019		22342*	1			0	219			0	238	22800

*** Preliminary, ** Included in 5.b.2, *** Reported as 5.b.**

Table 4.2.2. Faroe Plateau cod (Subdivision 5.b.1). Nominal catch (t) used in the assessment.

		Faroese catches				Reported as 5.b.2			Foreign catches				
	Officially reported	in 5.b.1	Adjustment in 5.b.1	On Faroe-Iceland ridge	in 2.a within Faroe area jurisdiction	UK (E/W/NI)	UK (Scotl.)	UK	French ***	Greenland ***	Russia ***	UK ***	Used in the 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****				-	551						23045
1996	40040					-	382						40422
1997	34027					-	277						34304
1998	23740					-	265						24005
1999	19696			-661		-	210						19245
2000	395	21793*		-600		-	245						21833
2001	30361		-1766	-306		-	288						28577
2002	41248		-2409	-223		-	218	-				-	38834
2003	30742		-1795	-4034		-	254	-				-	25167
2004	17975		-1041	-4338		-	244	-				-	12840
2005	13781		-804	-3987			1129	-				-	10119
2006	11691		-690	-1435			278						9844

	Officially reported	Faroese catches				Reported as 5.b.2			Foreign catches				Used in the assessment
		in 5.b.1	Adjustment in 5.b.1	On Faroe-Iceland ridge	in 2.a within Faroe area jurisdiction	UK (E/W/NI)	UK (Scotl.)	UK	French ***	Greenland ***	Russia ***	UK ***	
2007	10344		-588	-2304			53			6			7511
2008	9818		-557	-1978			32						7315
2009	11058		-637	-510			38			26	4		9979
2010	14206		-823	-680			54			5			12762
2011	11348		-673	-986						3			9692
2012	8466		-500	-766						5			7205
2013	5333		-316	-544							0		4473
2014	6883		-395	-777									5711
2015	8174		-460	-384									7329
2016	7232		-399	-958									5876
2017	6625		-369	-896									5360
2018	13872		-789	-869									12214
2019	22800*		-1326	-804									20670

*** Preliminary, ** In order to be consistent with procedures used previous years, *** Reported to Faroese Coastal Guard, **** expected misreporting/discard.**

Table 4.2.3. Faroe Plateau cod (Subdivision 5.b.1). The landings of Faroese fleets (in percentage) of total catch (t). Note that the catches on the Faroe-Iceland ridge (mainly belonging to single trawlers and longliners) are included in this table, but excluded in the catch in numbers.

Year	Openboats	Longliners <100 GRT	Singtrawl <400 HP	Gill-nets	Jiggers	Sing trawl 400–1000 HP	Sing trawl >1000 HP	Pair trawl <1000 HP	Pair trawl >1000 HP	Long liners >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

Year	Openboats	Longliners <100 GRT	Singtrawl <400 HP	Gill-nets	Jiggers	Sing trawl 400–1000 HP	Sing trawl >1000 HP	Pair trawl <1000 HP	Pair trawl >1000 HP	Long liners >100 GRT	Industrial trawlers	Others	Faroe catch Round.weight
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
2015	9.0	26.0	9.6	0.1	9.1	2.1	4.2	2.2	10.9	26.9	0.0	0.0	5,890
2016	9.7	21.0	10.9	0.7	9.4	2.4	2.0	3.7	12.9	27.2	0.0	0.0	5,562
2017	5.6	13.8	14.8	0.5	9.3	9.3	6.7	2.6	19.5	17.9	0.0	0.0	5,279
2018	8.0	15.2	14.3	0.3	11.3	6.8	9.1	3.0	14.9	17.1	0.0	0.0	10379
2019	14.2	21.8	6.0	0.2	15.3	2.9	3.2	2.6	14.5	19.4	0.0	0.0	16176
Avg	5.5	25.2	6.5	0.7	9.2	4.1	7.3	6.9	12.7	21.5	0.3	0.1	

Table 4.2.4. Faroe Plateau cod (Subdivision 5.b.1). Catch in numbers at age per fleet in terminal year. Numbers are in thousands and the catch is in tonnes, gutted weight.

Age\Fleet	Longliners < 100 GRT	Single trwl 400-700 HP	Trawlers > 700 HP	Longliners > 100 GRT	Sum CAA	Final CAA
2	298	66	71	141	576	576
3	994	187	416	573	2170	2170
4	585	186	276	361	1408	1407
5	545	150	188	358	1241	1242
6	501	103	78	247	929	928
7	118	30	23	68	239	239
8	14	3	7	12	36	37
9	10	0	4	8	22	23
10+	4	0	3	2	9	9
Numbers	3069	725	1066	1770	6630	6631
Tonnes	9014	2294	3679	5683	20670	20670

Open boats are included in longliners < 100 GRT.
Jiggers and gillnetters have negligible catch.

Table 4.2.5. Faroe Plateau cod (Subdivision 5.b.1). Number of samples, lengths, otoliths, and indi-vidual weights in terminal year.

Drift	Samples		Only lengths		Lengths and Weights		Otoliths	
	Q1-2	Q3-4	Q1-2	Q3-4	Q1-2	Q3-4	Q1-2	Q3-4
Open boats	2	0	0	0	445	0	104	0
Longliners < 100 GRT	3	2	0	0	610	311	179	120
Jiggers	0	1	0	0	0	116	0	60
Single trawlers < 400 HP	4	3	0	0	771	646	239	178
Single trawlers > 400 HP	0	0	0	0	0	0	0	0
Pair trawlers < 1000 HP	13	10	153	0	2405	1783	711	665
Pair trawlers > 1000 HP	9	11	326	0	1434	2183	420	646
Longliners > 100 GRT	16	17	0	0	2972	3393	898	1006
Sum	47	44	479	0	8637	8432	2551	2675

Table 4.2.6. Faroe Plateau cod (Subdivision 5.b.1). Catch in numbers at age.

Year\age	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	247	2892	1504	865	410	298	295	51	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

Year\age	1	2	3	4	5	6	7	8	9	10+
1998	0	455	745	1558	5140	1529	159	118	28	25
1999	0	1246	1044	840	1164	2339	461	62	18	8
2000	0	2170	2737	811	443	700	840	108	8	1
2001	0	3967	3812	2130	373	372	728	443	36	6
2002	0	2099	7354	3405	1688	474	538	417	293	7
2003	0	697	2186	4696	1979	657	182	94	118	21
2004	0	98	673	1230	2051	717	234	63	41	36
2005	0	504	604	896	1146	841	208	41	19	31
2006	0	1110	1097	469	663	801	333	76	10	3
2007	0	506	1226	723	315	289	255	85	20	3
2008	0	287	761	783	430	187	157	156	57	19
2009	0	873	2262	861	618	296	85	55	43	17
2010	0	2114	2034	861	468	481	178	58	33	38
2011	0	328	2344	1234	365	188	126	50	19	2
2012	0	49	517	1347	555	200	99	69	25	22
2013	0	55	173	333	587	175	39	25	15	5
2014	0	387	517	286	499	350	86	14	9	1
2015	0	154	1026	517	208	280	219	46	23	7
2016	0	175	374	702	214	146	143	67	18	2
2017	0	112	280	333	438	151	75	41	24	8
2018	0	929	1026	717	541	476	94	60	36	4
2019	0	576	2170	1407	1242	928	239	37	23	9

Table 4.2.7. Faroe Plateau cod (Subdivision 5.b.1). Mean weight at age (kg) in the catches. Stock weights are set equal to catch weights.

Year\age	2	3	4	5	6	7	8	9	10+
1959	0.850	1.730	3.230	4.400	5.800	6.370	7.340	7.880	10.270
1960	1.000	2.030	3.370	4.420	6.020	6.650	8.120	11.000	10.270
1961	1.080	2.220	3.450	4.690	5.520	7.090	9.910	8.030	10.270
1962	1.000	2.270	3.350	4.580	4.930	9.080	6.590	6.660	10.270
1963	1.040	1.940	3.510	4.600	5.500	6.780	8.710	11.720	10.820
1964	0.970	1.830	3.150	4.330	6.080	7.000	6.250	6.190	14.390
1965	0.920	1.450	2.570	3.780	5.690	7.310	7.930	8.090	11.110
1966	0.980	1.770	2.750	3.510	4.800	6.320	7.510	10.340	11.650
1967	0.960	1.930	3.130	4.040	4.780	6.250	7.000	11.010	10.690
1968	0.880	1.720	3.070	4.120	4.650	5.500	7.670	10.950	9.280
1969	1.090	1.800	2.850	3.670	4.890	5.050	7.410	8.660	14.390
1970	0.960	2.230	2.690	3.940	5.140	6.460	10.310	7.390	9.340
1971	0.810	1.800	2.980	3.580	3.940	4.870	6.480	6.370	10.220
1972	0.660	1.610	2.580	3.260	4.290	4.950	6.480	6.900	11.550
1973	1.110	2.000	3.410	3.890	5.100	5.100	6.120	8.660	7.570
1974	1.080	2.220	3.440	4.800	5.180	5.880	6.140	8.630	7.620
1975	0.790	1.790	2.980	4.260	5.460	6.250	7.510	7.390	8.170
1976	0.940	1.720	2.840	3.700	5.260	6.430	6.390	8.550	13.620
1977	0.870	1.790	2.530	3.680	4.650	5.340	6.230	8.380	10.720
1978	1.112	1.385	2.140	3.125	4.363	5.927	6.348	8.715	12.229
1979	0.897	1.682	2.211	3.052	3.642	4.719	7.272	8.368	13.042
1980	0.927	1.432	2.220	3.105	3.539	4.392	6.100	7.603	9.668
1981	1.080	1.470	2.180	3.210	3.700	4.240	4.430	6.690	10.000
1982	1.230	1.413	2.138	3.107	4.012	5.442	5.563	5.216	6.707
1983	1.338	1.950	2.403	3.107	4.110	5.020	5.601	8.013	8.031
1984	1.195	1.888	2.980	3.679	4.470	5.488	6.466	6.628	10.981
1985	0.905	1.658	2.626	3.400	3.752	4.220	4.739	6.511	10.981
1986	1.099	1.459	2.046	2.936	3.786	4.699	5.893	9.700	8.815
1987	1.093	1.517	2.160	2.766	3.908	5.461	6.341	8.509	9.811
1988	1.061	1.749	2.300	2.914	3.109	3.976	4.896	7.087	8.287
1989	1.010	1.597	2.200	2.934	3.468	3.750	4.682	6.140	9.156
1990	0.945	1.300	1.959	2.531	3.273	4.652	4.758	6.704	8.689
1991	0.779	1.271	1.570	2.524	3.185	4.086	5.656	5.973	8.147
1992	0.989	1.364	1.779	2.312	3.477	4.545	6.275	7.619	9.725
1993	1.155	1.704	2.421	3.132	3.723	4.971	6.159	7.614	9.587
1994	1.194	1.843	2.613	3.654	4.584	4.976	7.146	8.564	8.796
1995	1.218	1.986	2.622	3.925	5.180	6.079	6.241	7.782	8.627
1996	1.016	1.737	2.745	3.800	4.455	4.978	5.270	5.593	7.482
1997	0.901	1.341	1.958	3.012	4.158	4.491	5.312	6.172	7.056

Year\age	2	3	4	5	6	7	8	9	10+
1998	1.004	1.417	1.802	2.280	3.478	5.433	5.851	7.970	8.802
1999	1.050	1.586	2.350	2.774	3.214	5.496	8.276	9.129	10.652
2000	1.416	2.170	3.187	3.795	4.048	4.577	8.182	11.895	13.009
2001	1.164	2.076	3.053	3.976	4.394	4.871	5.563	7.277	12.394
2002	1.017	1.768	2.805	3.529	4.095	4.475	4.650	6.244	7.457
2003	0.820	1.362	2.127	3.329	4.092	4.670	6.000	6.727	6.810
2004	1.037	1.154	1.693	2.363	3.830	5.191	6.326	7.656	9.573
2005	0.986	1.373	1.760	2.293	3.138	5.287	8.285	8.703	9.517
2006	0.839	1.304	1.988	2.386	3.330	4.691	7.635	9.524	11.990
2007	0.937	1.324	1.970	3.076	3.529	4.710	6.464	9.461	9.509
2008	1.209	1.478	2.104	2.714	3.804	4.669	5.915	7.233	9.559
2009	0.805	1.431	2.287	2.723	3.435	5.081	6.281	8.312	9.959
2010	1.049	1.642	2.400	3.212	3.678	4.774	5.973	7.094	9.800
2011	0.815	1.367	2.413	3.493	4.525	5.076	6.631	6.863	10.089
2012	1.007	1.315	1.893	3.102	4.279	5.573	5.871	7.482	9.206
2013	1.011	1.527	2.528	3.180	4.672	6.776	6.966	9.028	10.324
2014	1.099	1.653	2.466	3.000	4.148	6.489	9.394	9.236	12.120
2015	1.198	1.733	2.769	3.650	4.403	5.768	8.035	10.334	11.127
2016	1.358	1.993	2.752	3.937	4.419	5.399	7.059	10.227	10.975
2017	1.281	2.162	3.051	4.042	4.985	5.650	7.407	9.172	10.882
2018	1.278	2.095	3.392	4.249	4.919	5.553	6.987	8.530	10.099
2019	1.328	2.123	3.408	4.292	4.956	5.663	7.009	8.817	10.393
2020	1.169	2.016	3.304	4.547	5.243	6.006	7.655	8.034	9,613

Table 4.2.8. Faroe Plateau cod (Subdivision 5.b.1). Proportion mature at age. The average for 1983 to 1996 is used prior to 1983.

Year	Age									
	1	2	3	4	5	6	7	8	9	10+
1959	0.00	0.18	0.64	0.87	0.95	0.99	0.99	0.99	1.00	1.00
1960	0.00	0.18	0.64	0.87	0.95	0.99	0.99	0.99	1.00	1.00
1961	0.00	0.18	0.64	0.87	0.95	0.99	0.99	0.99	1.00	1.00
1962	0.00	0.18	0.64	0.87	0.95	0.99	0.99	0.99	1.00	1.00
1963	0.00	0.18	0.64	0.87	0.95	0.99	0.99	0.99	1.00	1.00
1964	0.00	0.18	0.64	0.87	0.95	0.99	0.99	0.99	1.00	1.00
1965	0.00	0.18	0.64	0.87	0.95	0.99	0.99	0.99	1.00	1.00
1966	0.00	0.18	0.64	0.87	0.95	0.99	0.99	0.99	1.00	1.00
1967	0.00	0.18	0.64	0.87	0.95	0.99	0.99	0.99	1.00	1.00
1968	0.00	0.18	0.64	0.87	0.95	0.99	0.99	0.99	1.00	1.00
1969	0.00	0.18	0.64	0.87	0.95	0.99	0.99	0.99	1.00	1.00
1970	0.00	0.18	0.64	0.87	0.95	0.99	0.99	0.99	1.00	1.00
1971	0.00	0.18	0.64	0.87	0.95	0.99	0.99	0.99	1.00	1.00
1972	0.00	0.18	0.64	0.87	0.95	0.99	0.99	0.99	1.00	1.00
1973	0.00	0.18	0.64	0.87	0.95	0.99	0.99	0.99	1.00	1.00
1974	0.00	0.18	0.64	0.87	0.95	0.99	0.99	0.99	1.00	1.00
1975	0.00	0.18	0.64	0.87	0.95	0.99	0.99	0.99	1.00	1.00
1976	0.00	0.18	0.64	0.87	0.95	0.99	0.99	0.99	1.00	1.00
1977	0.00	0.18	0.64	0.87	0.95	0.99	0.99	0.99	1.00	1.00
1978	0.00	0.18	0.64	0.87	0.95	0.99	0.99	0.99	1.00	1.00
1979	0.00	0.18	0.64	0.87	0.95	0.99	0.99	0.99	1.00	1.00
1980	0.00	0.18	0.64	0.87	0.95	0.99	0.99	0.99	1.00	1.00
1981	0.00	0.18	0.64	0.87	0.95	0.99	0.99	0.99	1.00	1.00
1982	0.00	0.18	0.64	0.87	0.95	0.99	0.99	0.99	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

Year	Age									
	1	2	3	4	5	6	7	8	9	10+
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
2015	0.00	0.28	0.48	0.70	0.95	0.97	1.00	1.00	1.00	1.00
2016	0.00	0.21	0.89	0.91	0.97	1.00	1.00	1.00	1.00	1.00
2017	0.00	0.10	0.73	0.98	0.98	0.97	1.00	1.00	1.00	1.00
2018	0.00	0.14	0.64	0.78	0.94	0.95	0.91	0.92	1.00	1.00
2019	0.00	0.07	0.55	0.83	0.98	0.97	1.00	1.00	1.00	1.00
2020	0.00	0.07	0.45	0.74	0.93	1.00	1.00	1.00	1.00	1.00

Table 4.2.9. Faroe Plateau cod (Subdivision 5.b.1). 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 assessment model. Zero values were replaced by 0.1.

Year	Effort	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9
1996	200	39.0	724.2	6568.0	3719.9	1298.6	700.2	232.4	48.4	75.5
1997	200	55.0	514.5	1476.6	6647.4	1445.9	177.0	138.1	30.6	1.4
1998	200	411.5	529.2	507.9	981.8	3677.1	901.0	49.6	36.5	17.8
1999	200	121.7	374.3	1257.2	752.3	676.4	1419.0	236.8	40.0	10.0
2000	200	461.6	1374.3	1151.0	672.7	310.5	436.6	601.2	36.5	7.6
2001	200	212.2	3442.3	2446.6	1534.3	417.2	237.4	282.9	242.7	30.9
2002	200	737.1	2368.2	5574.6	1812.6	811.5	149.2	84.3	69.9	49.9
2003	200	68.3	357.4	1038.0	2211.5	566.0	123.7	17.7	12.0	18.4
2004	200	204.1	451.8	839.2	1081.3	1547.3	344.3	80.1	25.6	21.6
2005	200	218.8	616.3	736.6	871.7	1167.8	754.8	142.4	44.7	12.7
2006	200	133.5	980.1	689.3	348.3	311.5	256.3	122.8	28.0	15.5
2007	200	85.6	233.2	449.5	314.0	179.7	134.8	75.8	30.8	12.7
2008	200	181.6	70.3	370.6	328.0	400.6	159.8	52.5	27.8	33.3
2009	200	612.4	435.5	1975.0	821.1	552.9	392.3	131.5	47.2	37.6
2010	200	269.1	1247.8	1551.3	1008.4	363.2	244.2	148.9	41.8	34.2
2011	200	7.1	302.8	1374.7	1083.8	380.7	160.7	105.0	37.4	14.1
2012	200	40.9	22.2	231.1	1080.5	512.6	88.3	35.7	19.2	4.7
2013	200	394.5	105.1	205.3	209.3	888.9	541.5	104.3	44.3	30.9
2014	200	14.4	644.0	866.2	357.9	357.6	400.8	124.0	36.8	22.2
2015	200	205.8	233.0	2236.9	1694.9	412.5	361.1	241.6	66.8	15.8
2016	200	205.6	590.4	838.8	1849.4	693.1	146.5	142.7	73.2	14.6
2017	200	708.3	831.3	997.4	1591.2	1636.3	361.0	129.7	65.0	17.8
2018	200	980.3	982.0	779.4	781.5	502.9	409.8	105.8	27.7	19.8
2019	200	234.0	743.9	922.9	801.5	437.6	276.2	123.4	36.3	16.6
2020	200	83.6	164.6	857.0	685.5	212.3	86.0	48.6	29.6	4.5

Year	Effort (hours)	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9
1994	100	7.8	611.1	336.9	915.0	509.3	130.1	187.3	29.0	0.0
1995	100	4.4	628.7	848.3	1524.9	1518.4	1200.4	282.5	348.3	49.5
1996	100	0.0	216.6	4042.0	3986.7	1889.7	1374.3	421.6	83.2	169.2
1997	100	2.1	74.9	841.6	5395.5	2362.7	332.6	225.4	57.4	4.9
1998	100	1.2	69.5	422.0	1568.5	4928.3	1136.3	82.0	40.6	35.0
1999	100	10.7	708.4	676.9	991.9	1227.7	2085.0	253.4	25.0	13.6
2000	100	2.0	321.5	1433.1	747.1	442.1	507.8	838.6	64.5	1.6
2001	100	1.4	945.3	2381.3	1992.4	456.6	323.9	576.9	125.2	5.3
2002	100	0.2	397.1	4559.4	2896.1	1578.3	330.5	230.8	177.9	130.7
2003	100	0.0	91.4	723.4	3915.6	1263.7	531.3	68.5	52.3	39.8
2004	100	0.5	629.8	581.8	846.8	1178.8	295.0	66.5	22.4	12.0

Year	Effort (hours)	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9
2005	100	0.0	382.1	440.3	1151.8	1442.4	839.5	140.1	14.0	3.8
2006	100	1.1	167.7	156.5	177.0	360.1	292.6	94.7	15.4	4.0
2007	100	0.0	41.7	271.8	286.2	154.8	170.4	105.1	38.6	14.8
2008	100	5.6	174.0	464.9	832.6	469.8	149.4	83.2	39.4	13.5
2009	100	73.7	309.3	470.5	980.0	1162.5	427.1	73.4	31.8	24.8
2010	100	36.9	699.5	1316.9	747.7	539.3	381.2	99.1	41.4	17.4
2011	100	0.0	149.5	1318.6	1241.6	562.7	300.4	237.4	84.8	21.8
2012	100	0.0	1.4	273.2	1301.5	327.5	73.7	27.1	23.9	6.2
2013	100	3.5	65.2	379.6	1694.7	2055.9	297.3	32.6	22.6	17.5
2014	100	1.0	143.6	126.2	160.3	421.2	333.2	74.8	21.9	13.4
2015	100	0.0	22.5	532.4	226.5	193.9	304.9	138.9	32.6	8.0
2016	100	6.2	82.7	279.3	697.0	152.2	73.7	77.4	27.2	7.7
2017	100	26.6	109.4	529.0	695.0	1085.1	136.0	56.3	31.7	10.3
2018	100	22.7	592.3	923.6	1002.7	730.6	714.4	155.0	50.8	35.3
2019	100	39.0	352.1	1080.5	760.0	555.5	350.7	187.4	20.2	14.2
2020	100	0.2	11.2	676.7	728.7	306.2	147.2	76.2	36.1	4.1

Table 4.2.10. Faroe Plateau cod (Subdivision 5.b.1). Pair trawler abundance index (number of individuals per 1000 fishing hours). This series was not used in the tuning in the assessment model. The season is June–December. The otoliths are selected from deep (> 150 m) locations.

Year	Age							
	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
2015	43	967	1943	1019	1190	1086	320	96
2016	130	485	2227	1521	905	691	362	177
2017	158	392	855	1477	561	276	216	142
2018	620	1205	1929	1927	1466	629	176	74
2019	2170	5140	2243	1207	339	86	8	6

Table 4.2.11. Faroe Plateau cod (Subdivision 5.b.1). Longliner abundance index (number of individuals per 100 000 hooks). This series was not used in the tuning in the assessment model. 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.

Year	Age							
	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
2015	0	1260	10417	8202	3167	3342	2428	414
2016	157	1790	3118	5109	1985	873	1370	1548
2017	584	1624	1700	1255	1073	743	462	553
2018	0	3690	8057	7624	6613	7832	1836	1899
2019	0	5430	15027	7622	6057	2776	698	73

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 assessment model. The age composition was obtained from all long-liners.

Year	Age							
	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
2015	0.9	25.4	148.6	65.3	23.0	17.9	10.7	0.7
2016	3.2	30.5	40.6	36.9	7.8	4.9	5.6	0.0
2017	14.6	41.2	36.0	18.8	11.6	2.1	0.1	0.0
2018	1.2	126.1	86.6	40.4	25.1	27.8	6.5	9.3
2019	0.0	60.5	148.2	83.0	63.4	46.5	7.8	1.0

Table 4.6.1. Faroe Plateau cod (Subdivision 5.b.1). Configuration in the SAM-run and the model parameters.

```
> conf
$minAge
[1] 1

$maxAge
[1] 10

$maxAgePlusGroup
[1] 1

$keyLogFsta
     [,1] [,2] [,3] [,4] [,5] [,6] [,7] [,8] [,9] [,10]
[1,]   -1    0    1    2    3    4    5    5    5     5
[2,]   -1   -1   -1   -1   -1   -1   -1   -1   -1    -1
[3,]   -1   -1   -1   -1   -1   -1   -1   -1   -1    -1

$corFlag
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     [,1] [,2] [,3] [,4] [,5] [,6] [,7] [,8] [,9] [,10]
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[2,]    0    1    2    3    4    5    6    7    7    -1
[3,]    8    9   10   11   12   13   14   15   15    -1

$keyQpow
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[2,]   -1   -1   -1   -1   -1   -1   -1   -1   -1    -1
[3,]   -1   -1   -1   -1   -1   -1   -1   -1   -1    -1

$keyVarF
     [,1] [,2] [,3] [,4] [,5] [,6] [,7] [,8] [,9] [,10]
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[2,]   -1   -1   -1   -1   -1   -1   -1   -1   -1    -1
[3,]   -1   -1   -1   -1   -1   -1   -1   -1   -1    -1

$keyVarLogN
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$keyVarObs
     [,1] [,2] [,3] [,4] [,5] [,6] [,7] [,8] [,9] [,10]
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[3,]    3    4    4    4    4    4    4    4    4    -1

$obsCorStruct
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Levels: ID AR US

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$stockRecruitmentModelCode
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$noScaledYears
[1] 0

$keyScaledYears
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$keyParScaledYA
<0 x 0 matrix>

$fbarRange
[1] 3 7

$keyBiomassTreat
[1] -1 -1 -1

$obsLikelihoodFlag
[1] LN LN LN
Levels: LN ALN

$fixVarToWeight
[1] 0
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Table of model parameters:

Parameter name	par	sd(par)	exp(par)	Low	High
logFpar_0	-9.068	0.223	0.000	0.000	0.000
logFpar_1	-7.763	0.135	0.000	0.000	0.001
logFpar_2	-6.657	0.129	0.001	0.001	0.002
logFpar_3	-6.154	0.126	0.002	0.002	0.003
logFpar_4	-5.923	0.124	0.003	0.002	0.003
logFpar_5	-5.823	0.122	0.003	0.002	0.004
logFpar_6	-5.700	0.118	0.003	0.003	0.004
logFpar_7	-5.613	0.121	0.004	0.003	0.005
logFpar_8	-13.242	0.375	0.000	0.000	0.000
logFpar_9	-8.404	0.147	0.000	0.000	0.000
logFpar_10	-6.682	0.140	0.001	0.001	0.002
logFpar_11	-5.767	0.136	0.003	0.002	0.004
logFpar_12	-5.436	0.134	0.004	0.003	0.006
logFpar_13	-5.386	0.133	0.005	0.004	0.006
logFpar_14	-5.447	0.133	0.004	0.003	0.006
logFpar_15	-5.631	0.103	0.004	0.003	0.004
logSdLogFsta_0	-1.393	0.119	0.248	0.196	0.315
logSdLogN_0	-0.298	0.126	0.742	0.577	0.955
logSdLogN_1	-1.257	0.115	0.285	0.226	0.358
logSdLogObs_0	-1.334	0.103	0.263	0.215	0.323
logSdLogObs_1	-0.019	0.163	0.981	0.708	1.358
logSdLogObs_2	-0.639	0.086	0.528	0.445	0.627
logSdLogObs_3	0.628	0.140	1.875	1.415	2.483
logSdLogObs_4	-0.444	0.054	0.642	0.576	0.715
transfIRARdist_0	-0.612	0.226	0.542	0.345	0.853
itrans_rho_0	1.683	0.212	5.383	3.521	8.230

Model	log(L)	#par	AIC
Current	-886.04	26	1824.08
base	-886.04	26	1824.08

Table 4.6.2. Faroe Plateau cod (Subdivision 5.b.1). Fishing mortality at age from the SAM model.

Year Age	1	2	3	4	5	6	7	8	9	10
1959		0.226	0.466	0.495	0.538	0.525	0.577	0.577	0.577	0.577
1960		0.293	0.608	0.654	0.722	0.725	0.804	0.804	0.804	0.804
1961		0.252	0.527	0.581	0.656	0.672	0.750	0.750	0.750	0.750
1962		0.216	0.458	0.519	0.593	0.608	0.666	0.666	0.666	0.666
1963		0.178	0.388	0.455	0.526	0.551	0.605	0.605	0.605	0.605
1964		0.146	0.336	0.418	0.504	0.553	0.627	0.627	0.627	0.627
1965		0.129	0.310	0.403	0.500	0.568	0.658	0.658	0.658	0.658
1966		0.110	0.278	0.376	0.484	0.579	0.705	0.705	0.705	0.705
1967		0.099	0.262	0.360	0.462	0.556	0.674	0.674	0.674	0.674
1968		0.094	0.258	0.360	0.452	0.533	0.630	0.630	0.630	0.630
1969		0.093	0.267	0.381	0.479	0.576	0.689	0.689	0.689	0.689
1970		0.071	0.212	0.308	0.388	0.475	0.571	0.571	0.571	0.571
1971		0.063	0.195	0.292	0.375	0.471	0.575	0.575	0.575	0.575
1972		0.059	0.186	0.276	0.345	0.424	0.510	0.510	0.510	0.510
1973		0.062	0.202	0.297	0.364	0.437	0.537	0.537	0.537	0.537
1974		0.061	0.200	0.299	0.371	0.449	0.567	0.567	0.567	0.567
1975		0.072	0.248	0.381	0.473	0.566	0.728	0.728	0.728	0.728
1976		0.077	0.280	0.453	0.586	0.721	0.972	0.972	0.972	0.972
1977		0.071	0.274	0.451	0.575	0.685	0.889	0.889	0.889	0.889
1978		0.061	0.243	0.398	0.494	0.581	0.746	0.746	0.746	0.746
1979		0.060	0.247	0.402	0.486	0.560	0.701	0.701	0.701	0.701
1980		0.056	0.233	0.369	0.433	0.487	0.592	0.592	0.592	0.592
1981		0.060	0.255	0.406	0.476	0.541	0.663	0.663	0.663	0.663
1982		0.061	0.267	0.426	0.498	0.569	0.705	0.705	0.705	0.705
1983		0.079	0.357	0.576	0.666	0.750	0.901	0.901	0.901	0.901
1984		0.069	0.313	0.505	0.573	0.632	0.742	0.742	0.742	0.742
1985		0.073	0.348	0.598	0.711	0.836	1.022	1.022	1.022	1.022
1986		0.061	0.301	0.532	0.633	0.745	0.902	0.902	0.902	0.902
1987		0.054	0.266	0.472	0.553	0.649	0.790	0.790	0.790	0.790
1988		0.069	0.330	0.587	0.680	0.791	0.949	0.949	0.949	0.949
1989		0.082	0.383	0.685	0.788	0.897	1.047	1.047	1.047	1.047
1990		0.067	0.314	0.581	0.690	0.799	0.950	0.950	0.950	0.950
1991		0.050	0.229	0.435	0.529	0.623	0.755	0.755	0.755	0.755
1992		0.039	0.178	0.343	0.428	0.516	0.647	0.647	0.647	0.647
1993		0.031	0.136	0.257	0.319	0.384	0.496	0.496	0.496	0.496
1994		0.032	0.134	0.244	0.296	0.352	0.456	0.456	0.456	0.456
1995		0.044	0.178	0.321	0.395	0.481	0.640	0.640	0.640	0.640
1996		0.057	0.235	0.444	0.600	0.801	1.144	1.144	1.144	1.144
1997		0.068	0.274	0.511	0.721	1.024	1.550	1.550	1.550	1.550
1998		0.075	0.281	0.486	0.658	0.925	1.420	1.420	1.420	1.420

Year Age	1	2	3	4	5	6	7	8	9	10
1999		0.085	0.298	0.480	0.620	0.853	1.318	1.318	1.318	1.318
2000		0.077	0.257	0.379	0.453	0.586	0.855	0.855	0.855	0.855
2001		0.089	0.294	0.428	0.511	0.661	0.958	0.958	0.958	0.958
2002		0.117	0.396	0.593	0.736	0.960	1.335	1.335	1.335	1.335
2003		0.101	0.349	0.532	0.685	0.901	1.204	1.204	1.204	1.204
2004		0.075	0.269	0.425	0.579	0.807	1.108	1.108	1.108	1.108
2005		0.094	0.327	0.493	0.647	0.884	1.186	1.186	1.186	1.186
2006		0.104	0.350	0.495	0.614	0.794	0.998	0.998	0.998	0.998
2007		0.094	0.312	0.426	0.507	0.638	0.793	0.793	0.793	0.793
2008		0.092	0.312	0.431	0.515	0.660	0.850	0.850	0.850	0.850
2009		0.103	0.354	0.476	0.555	0.682	0.836	0.836	0.836	0.836
2010		0.117	0.415	0.577	0.701	0.890	1.093	1.093	1.093	1.093
2011		0.082	0.301	0.428	0.530	0.675	0.814	0.814	0.814	0.814
2012		0.080	0.308	0.467	0.622	0.849	1.076	1.076	1.076	1.076
2013		0.051	0.201	0.308	0.414	0.561	0.706	0.706	0.706	0.706
2014		0.052	0.204	0.308	0.406	0.527	0.620	0.620	0.620	0.620
2015		0.060	0.241	0.373	0.516	0.716	0.883	0.883	0.883	0.883
2016		0.045	0.181	0.282	0.400	0.577	0.714	0.714	0.714	0.714
2017		0.037	0.149	0.234	0.343	0.505	0.623	0.623	0.623	0.623
2018		0.057	0.233	0.359	0.513	0.720	0.818	0.818	0.818	0.818
2019		0.079	0.340	0.536	0.775	1.051	1.109	1.109	1.109	1.109

Table 4.6.3. Faroe Plateau cod (Subdivision 5.b.1). Stock number at age from the SAM model.

Year Age	1	2	3	4	5	6	7	8	9	10
1959	20144	11861	12081	2389	4244	602	505	158	25	0
1960	18570	16691	8562	5985	1183	1871	334	227	95	12
1961	26287	14274	8138	3664	2520	515	692	139	70	39
1962	26960	22567	7896	3637	1819	1112	235	221	51	42
1963	19898	23167	13813	3806	1778	760	494	123	81	39
1964	11375	16915	13484	7311	1824	868	345	221	74	54
1965	17954	8021	12845	7972	3714	878	395	134	119	56
1966	22719	15184	5158	7960	4105	1623	378	185	64	74
1967	20903	19493	12485	3447	5128	2120	715	124	67	56
1968	12570	18218	15825	8535	2383	3085	991	300	35	51
1969	8875	10052	13944	10772	4574	1221	1629	399	166	38
1970	10062	6777	6661	8530	6053	2263	570	773	134	85
1971	19117	7636	5096	3895	4707	3592	1176	245	425	104
1972	18178	17329	7286	3727	2334	2554	1622	503	88	280
1973	38547	13228	15291	5845	2541	1392	1000	700	282	218
1974	39512	35120	9101	9196	3525	1587	910	441	353	237
1975	24230	34888	25690	6659	6185	2130	837	402	227	295
1976	11303	20652	23888	13852	3560	3347	1103	473	151	202
1977	12961	8108	14960	17698	7626	1636	1589	391	207	40
1978	15615	10534	6641	8838	9234	2951	637	450	131	98
1979	24067	12330	8291	4952	4620	4742	1326	273	161	80
1980	17895	21933	10676	5134	2762	2250	2216	682	114	66
1981	26714	13225	18015	6811	2779	1476	1072	1109	311	105
1982	36377	22169	10007	10626	3855	1377	683	418	478	212
1983	55032	29326	18226	6770	5877	2165	739	271	183	229
1984	20556	55343	20454	9410	3294	2419	804	217	82	147
1985	8069	16708	37735	10718	4086	1422	1198	384	99	113
1986	8694	5695	13559	20968	5038	1687	450	315	96	65
1987	11377	6918	5838	7691	8960	2052	592	140	112	51
1988	19735	8936	7016	4372	3728	4321	925	276	51	47
1989	6053	20845	6986	4452	2137	1704	1634	331	101	21
1990	5859	4186	12580	3721	1810	810	557	467	95	41
1991	7970	4563	2709	6497	1622	694	303	184	129	47
1992	8595	6751	3552	1697	2875	727	276	124	71	74
1993	23753	6128	6432	2882	909	1286	298	96	57	66
1994	42283	20747	6279	5090	2125	510	699	140	41	60
1995	11946	45294	16946	6018	3696	1527	340	525	92	80
1996	5204	9025	31754	12861	3483	2501	933	186	379	75
1997	6929	4554	6517	21682	6941	1116	921	269	40	142
1998	15637	6621	3453	4521	11663	2806	283	147	48	32

Year Age	1	2	3	4	5	6	7	8	9	10
1999	28812	13201	5571	2530	2730	4939	758	83	24	12
2000	42070	25604	10502	3005	1368	1690	1944	158	19	4
2001	18371	44107	16074	6587	1401	920	1178	735	53	9
2002	8553	16938	26784	8527	3452	790	609	526	291	14
2003	4550	6562	8661	12782	3733	1181	262	153	153	46
2004	6722	3350	3874	4306	4978	1275	334	83	55	55
2005	9254	6161	2614	2559	2721	1839	384	80	23	33
2006	6123	9426	3753	1433	1377	1262	560	106	21	8
2007	5558	5125	4804	2138	828	640	462	174	44	7
2008	12508	4011	3903	2477	1338	478	278	189	90	27
2009	19343	8417	5802	2327	1506	744	219	104	78	36
2010	6279	16262	6801	2630	1080	786	335	96	44	41
2011	1094	4711	9293	3615	1001	436	280	98	38	9
2012	2575	729	2449	4644	1535	363	169	102	31	24
2013	8390	1819	1100	1395	2144	592	109	52	27	11
2014	3019	7788	2427	926	1108	972	228	46	24	6
2015	5150	2508	5462	1789	574	631	418	98	26	12
2016	6695	4363	2420	3186	872	312	278	130	34	7
2017	14667	5186	2904	2065	1901	454	180	112	41	16
2018	13455	13207	4808	2683	1596	1098	231	95	58	13
2019	4999	9804	7713	3343	1802	1085	417	75	37	19
2020	4749	2896	6922	4141	1364	602	282	124	19	15

Table 4.6.4. Faroe Plateau cod (Subdivision 5.b.1). Summary table from the SAM model (catch is also provided) and forecast with Fmsy fishing mortality.

Year	R(age 1)	Low	High	SSB	Low	High	Fbar(3-7)	Low	High	Catch	TSB	Low	High
1959	20144	10178	39870	47632	37738	60120	0.52	0.402	0.673	22415	65439	52119	82163
1960	18570	9786	35237	52981	43200	64978	0.703	0.556	0.887	32255	75962	61698	93522
1961	26287	13855	49877	46563	37959	57118	0.637	0.5	0.812	21598	68034	54973	84198
1962	26960	14158	51337	43803	35503	54043	0.569	0.443	0.73	20967	70852	56016	89616
1963	19898	10448	37896	50770	40537	63587	0.505	0.392	0.651	22215	82406	64331	105558
1964	11375	5930	21819	56504	44688	71445	0.487	0.378	0.629	21078	82321	64767	104633
1965	17954	9370	34399	54851	43627	68963	0.488	0.378	0.63	24212	71063	56528	89334
1966	22719	11828	43637	54237	43117	68225	0.484	0.373	0.629	20418	73408	58331	92381
1967	20903	10878	40169	64503	51600	80632	0.463	0.355	0.602	23562	91115	72298	114831
1968	12570	6525	24217	75163	60053	94076	0.447	0.345	0.578	29930	102227	81202	128695
1969	8875	4581	17193	79658	63476	99965	0.478	0.369	0.619	32371	102680	81585	129230
1970	10062	5169	19585	78124	62265	98024	0.391	0.301	0.508	24183	93216	74436	116733
1971	19117	9856	37081	58112	46565	72521	0.382	0.295	0.495	23010	69052	55516	85888
1972	18178	9412	35110	51023	41420	62854	0.348	0.268	0.452	18727	66478	53609	82436
1973	38547	19977	74382	69347	55517	86623	0.368	0.287	0.47	22228	95646	75514	121146
1974	39512	20551	75969	84323	67665	105082	0.377	0.298	0.478	24581	127820	100398	162731
1975	24230	12626	46498	100446	81246	124183	0.479	0.385	0.597	36775	143697	114393	180507
1976	11303	5858	21810	108018	87577	133231	0.603	0.487	0.746	39799	144779	116397	180081
1977	12961	6739	24926	104531	83577	130739	0.575	0.46	0.718	34927	127365	101892	159206
1978	15615	8117	30042	73510	59021	91557	0.492	0.391	0.621	26585	90524	73065	112155
1979	24067	12502	46329	61493	50198	75331	0.479	0.379	0.607	23112	77967	63578	95611
1980	17895	9322	34355	54657	45003	66381	0.423	0.333	0.536	20513	78962	63513	98169
1981	26714	13979	51051	58812	47966	72110	0.468	0.373	0.589	22963	82582	66215	102995
1982	36377	19047	69476	60465	49351	74082	0.493	0.395	0.615	21489	91583	73043	114829

Year	R(age 1)	Low	High	SSB	Low	High	Fbar(3-7)	Low	High	Catch	TSB	Low	High
1983	55032	28495	106286	99677	80395	123583	0.65	0.525	0.804	38133	126736	100310	160125
1984	20556	10756	39287	121553	96788	152653	0.553	0.446	0.686	36979	163703	125811	213006
1985	8069	4171	15610	85733	68523	107266	0.703	0.572	0.864	39484	133817	104897	170710
1986	8694	4527	16695	73679	57464	94469	0.623	0.502	0.771	34595	95600	75747	120657
1987	11377	5969	21683	59253	47359	74135	0.546	0.44	0.678	21391	71409	57763	88279
1988	19735	10187	38232	50210	41546	60681	0.667	0.545	0.817	23182	61888	51193	74817
1989	6053	3127	11719	36997	30868	44343	0.76	0.622	0.929	22068	62675	49903	78716
1990	5859	3022	11357	30697	24839	37937	0.667	0.537	0.828	13692	40640	32463	50876
1991	7970	4080	15566	21924	17359	27690	0.514	0.406	0.651	8750	26934	21486	33762
1992	8595	4405	16773	16624	13267	20831	0.423	0.328	0.544	6396	27003	21246	34319
1993	23753	12496	45151	25681	20166	32705	0.318	0.245	0.413	6107	35788	27668	46293
1994	42283	22308	80147	56479	44468	71734	0.296	0.232	0.378	9046	65101	50600	83759
1995	11946	6527	21861	60395	49712	73375	0.403	0.327	0.496	23045	133764	104486	171247
1996	5204	2861	9464	82440	68176	99689	0.645	0.535	0.777	40422	132320	107611	162702
1997	6929	3828	12541	75959	61519	93788	0.816	0.684	0.973	34304	87656	71358	107677
1998	15637	8853	27621	49422	40039	61004	0.754	0.631	0.901	24005	59107	48703	71735
1999	28812	16197	51253	37804	31330	45615	0.713	0.591	0.861	19245	57289	47942	68458
2000	42070	23622	74926	38225	32234	45330	0.506	0.412	0.622	21833	91110	73314	113225
2001	18371	10365	32560	56177	46900	67291	0.57	0.47	0.691	28577	124760	99423	156553
2002	8553	4805	15224	58224	48371	70082	0.804	0.669	0.966	38834	111008	90295	136472
2003	4550	2550	8117	44056	35821	54185	0.734	0.609	0.886	25167	65111	53442	79327
2004	6722	3803	11881	26113	21560	31627	0.638	0.526	0.773	12840	35084	29272	42051
2005	9254	5235	16358	21235	17864	25242	0.707	0.585	0.855	10119	29392	24821	34804
2006	6123	3465	10818	16631	14108	19605	0.651	0.533	0.793	9844	26874	22442	32181
2007	5558	3135	9853	14547	12305	17199	0.535	0.436	0.658	7511	23965	20001	28713
2008	12508	7005	22334	18049	15157	21493	0.554	0.454	0.676	7315	24606	20500	29534

Year	R(age 1)	Low	High	SSB	Low	High	Fbar(3-7)	Low	High	Catch	TSB	Low	High
2009	19343	10670	35066	19056	16014	22676	0.58	0.477	0.706	9979	29833	24708	36021
2010	6279	3494	11283	21990	18443	26220	0.735	0.603	0.897	12762	43787	35189	54485
2011	1094	599	2000	19899	16356	24210	0.55	0.443	0.682	9692	33164	26926	40847
2012	2575	1444	4589	17444	14273	21319	0.664	0.539	0.819	7205	21058	17249	25707
2013	8390	4629	15205	16074	13100	19723	0.438	0.348	0.552	4473	18087	14826	22065
2014	3019	1655	5509	16776	14019	20075	0.413	0.331	0.516	5711	24410	19884	29967
2015	5150	2878	9217	17138	14384	20419	0.546	0.44	0.677	7329	25898	21286	31510
2016	6695	3718	12055	21070	17170	25855	0.431	0.345	0.538	5876	27173	22050	33485
2017	14667	8040	26759	23539	19120	28979	0.371	0.295	0.466	5360	31560	25515	39038
2018	13455	7066	25622	31071	25629	37669	0.528	0.424	0.659	12214	52800	42190	66078
2019	4999	2284	10942	33134	26507	41417	0.762	0.589	0.987	20670	50936	40051	64780
2020	4888	1365	17761	29040	20594	40991	0.476	0.289	0.724	10600	44310	30992	62275
2021	6279	1094	14667	33111	20744	55003	0.23	0.124	0.449	6247	42630	26257	72406
2022	5150	1094	14667	37415	20383	71425	0.23	0.106	0.516	7653	47954	27090	90414
2023	6279	1094	14667	39780	19518	81010	0.23	0.091	0.566	8129	50852	25709	100666

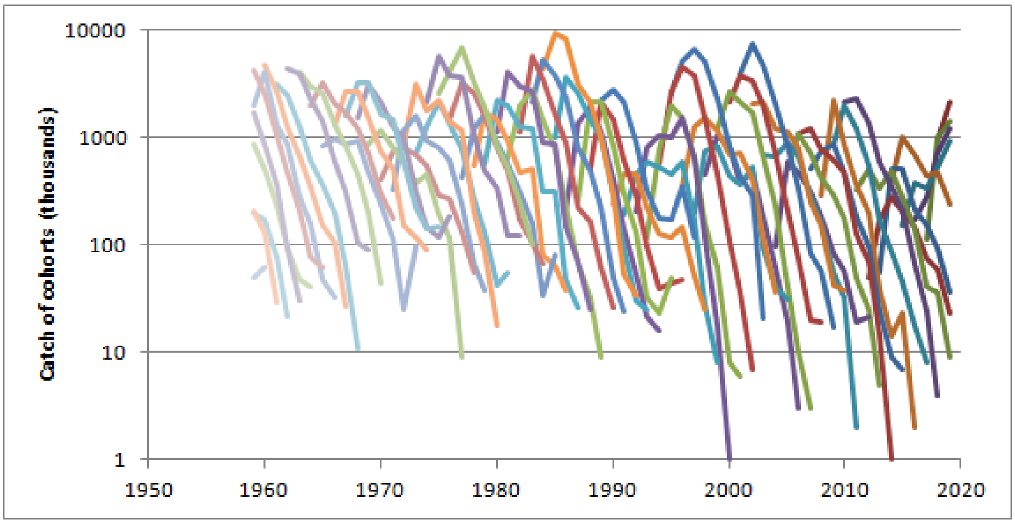


Figure 4.2.1. Faroe Plateau cod (Subdivision 5.b.1). Catch in numbers at age shown as catch curves.

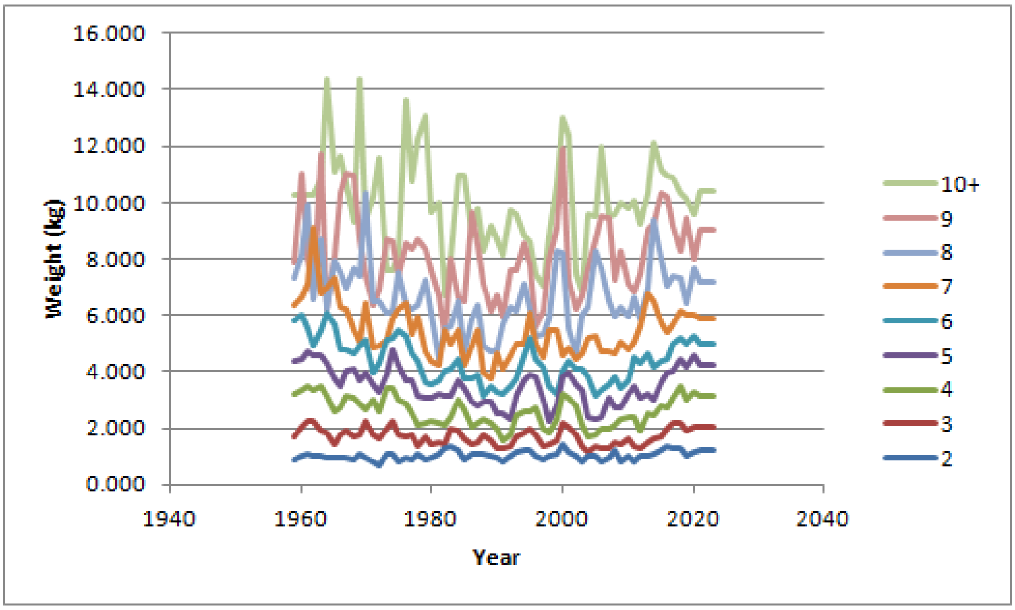


Figure 4.2.2. Faroe Plateau cod (Subdivision 5.b.1). Mean weight at age in the catches. The last three years are based on a previous 5 year average.

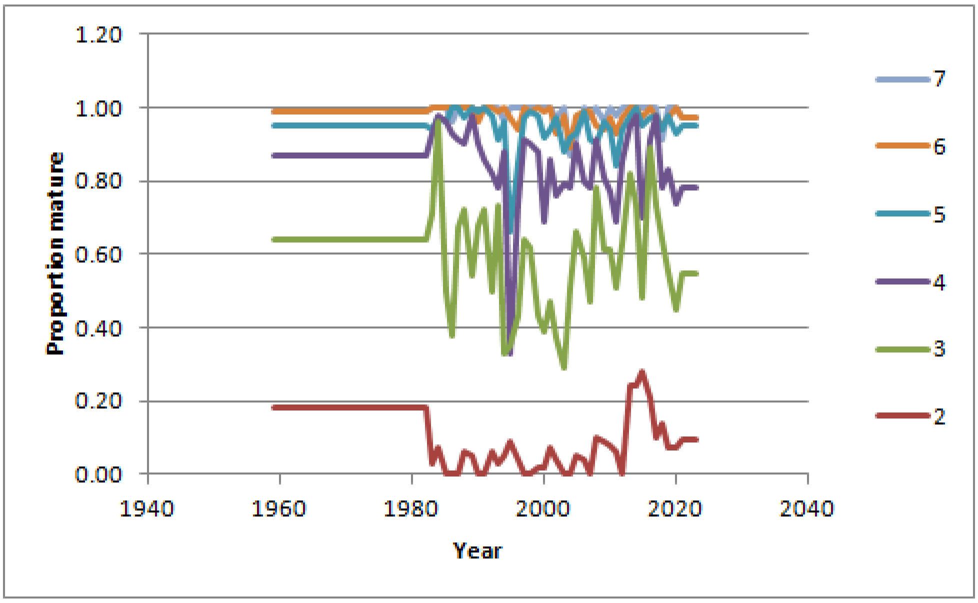


Figure 4.2.3. Faroe Plateau cod (Subdivision 5.b.1). Proportion mature at age as observed in the spring groundfish survey. The last three years are based on a previous 5 year average.

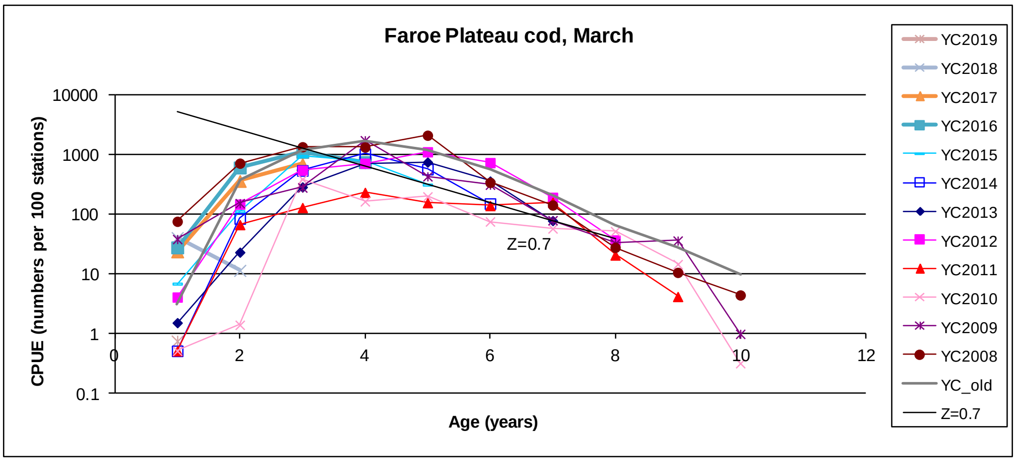


Figure 4.2.4. Faroe Plateau cod (Subdivision 5.b.1). Catch curves from the spring groundfish survey.

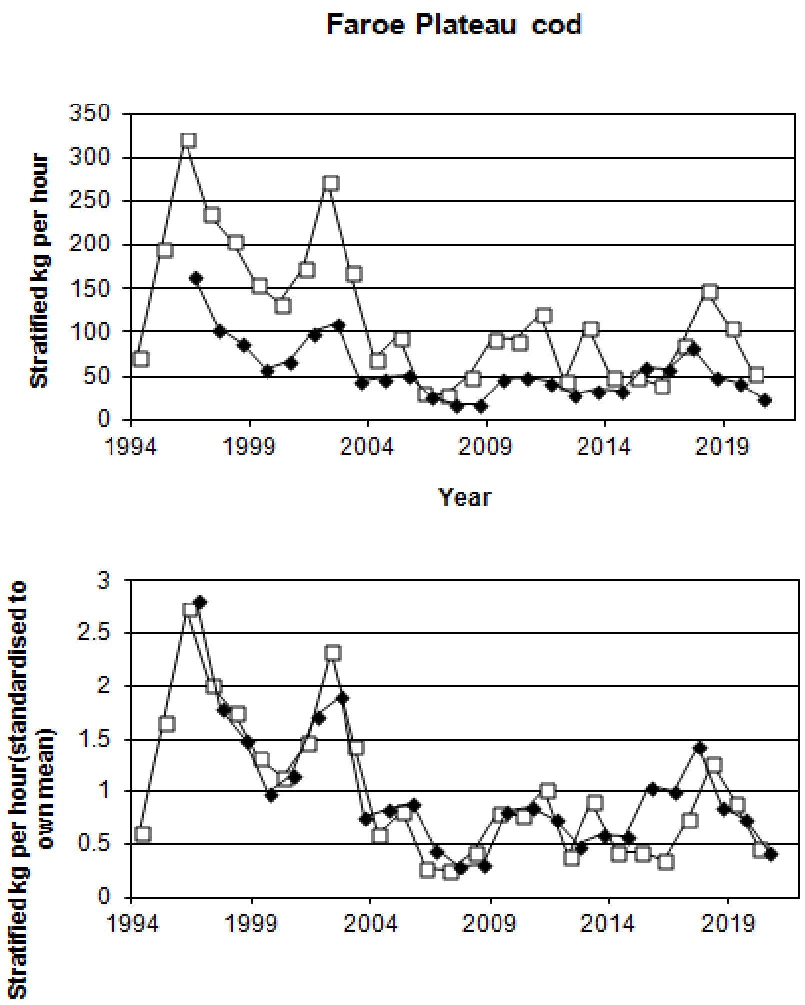


Figure 4.2.5. Faroe Plateau cod (Subdivision 5.b.1). Stratified kg/hour in the spring and summer surveys.

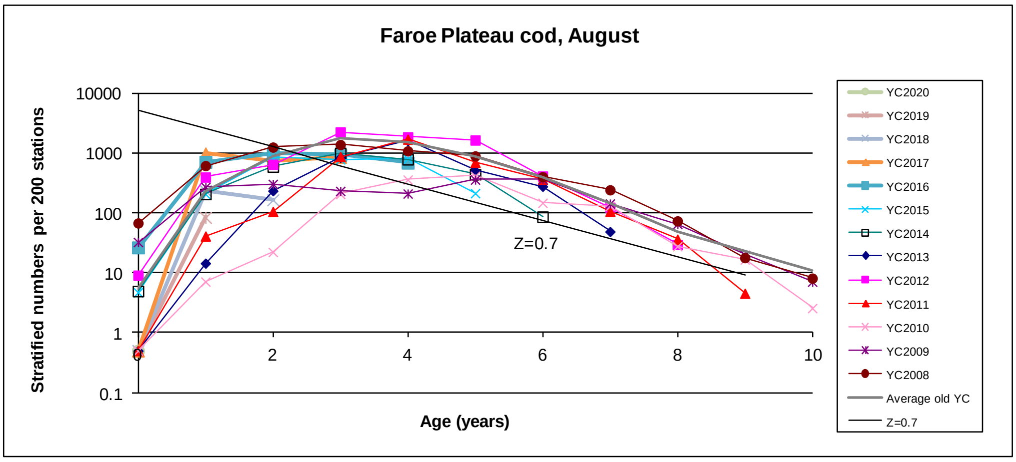


Figure 4.2.6. Faroe Plateau cod (Subdivision 5.b.1). Catch curves from the summer groundfish survey.

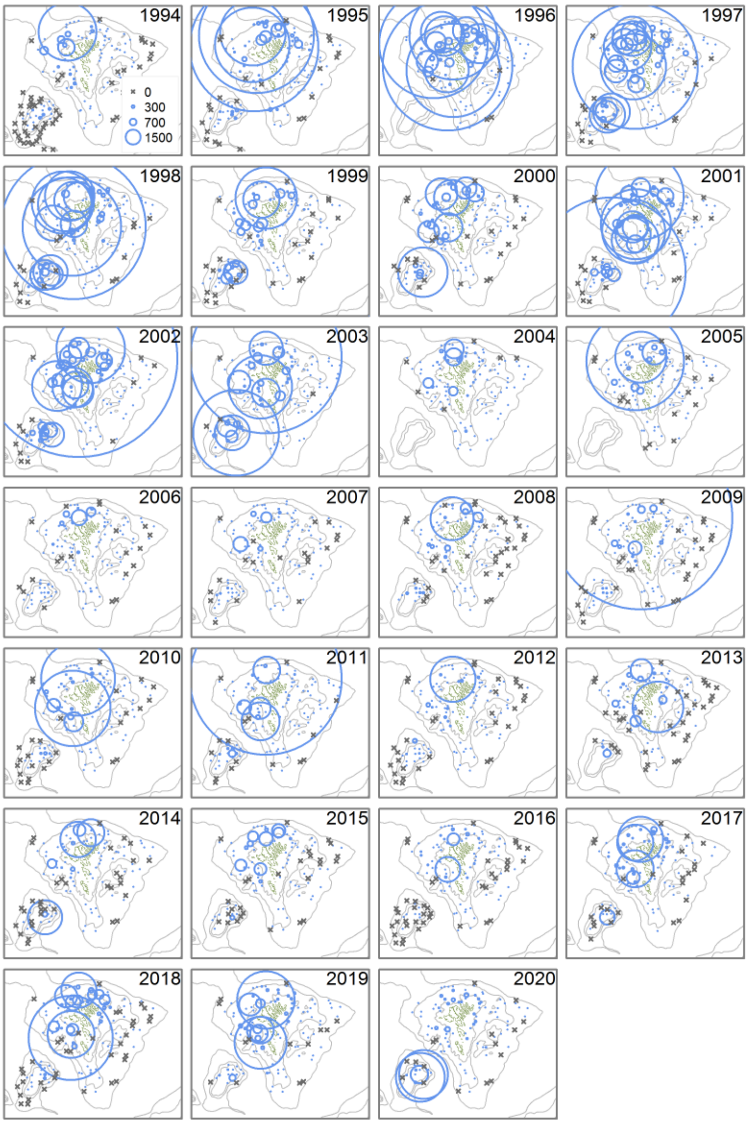


Figure 4.2.7. Faroe Plateau cod (Subdivision 5.b.1). Catch per tow in the spring groundfish survey.

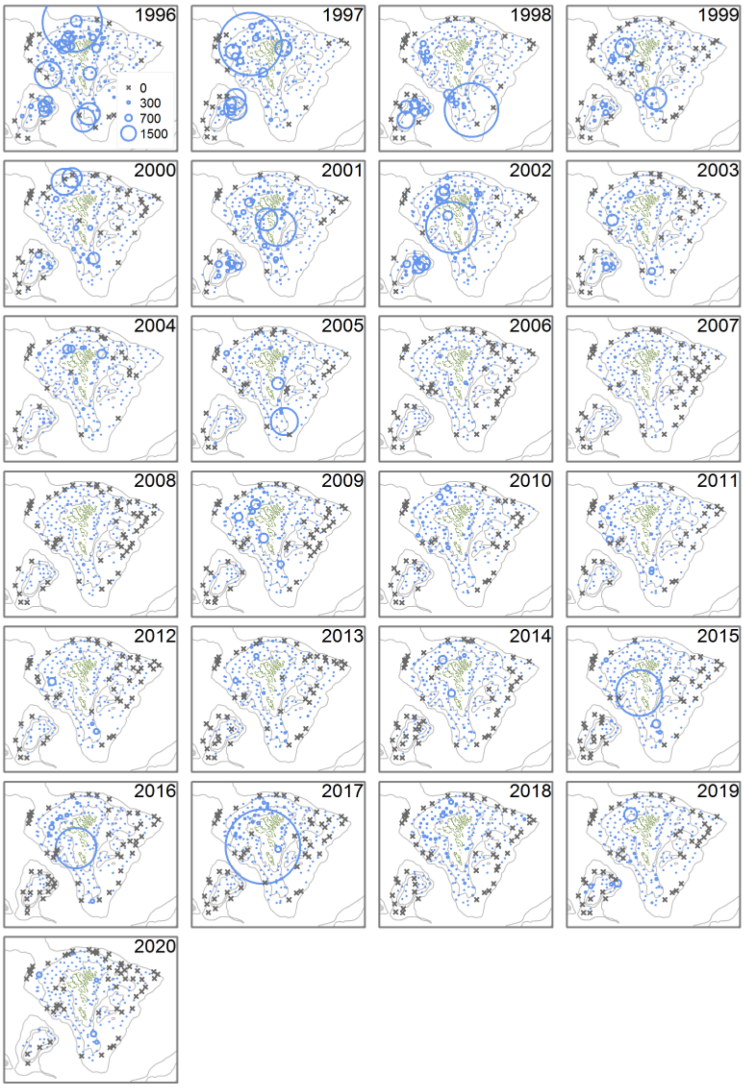


Figure 4.2.8. Faroe Plateau cod (Subdivision 5.b.1). Catch per tow in the summer groundfish survey.

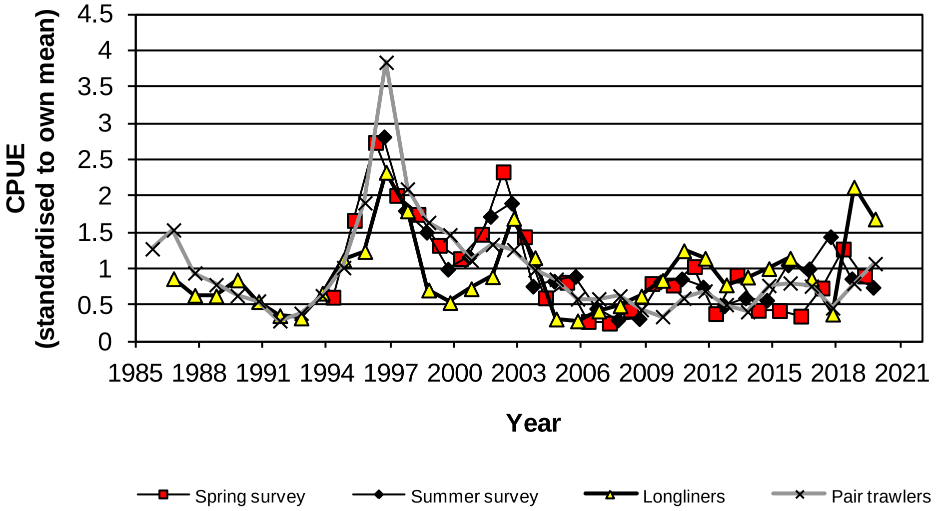


Figure 4.2.9. Faroe Plateau cod (Subdivision 5.b.1). Standardised catch per unit effort for pair trawlers and longliners. The two surveys are shown as well.

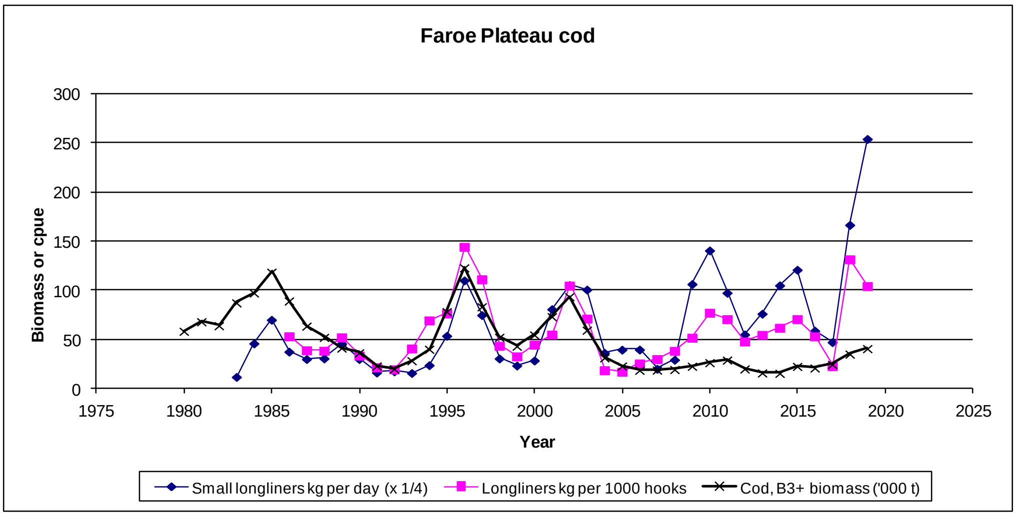


Figure 4.2.10. Faroe Plateau cod (Subdivision 5.b.1). Catch per unit effort for small and large longliners compared with the fishable (age 3+) biomass.

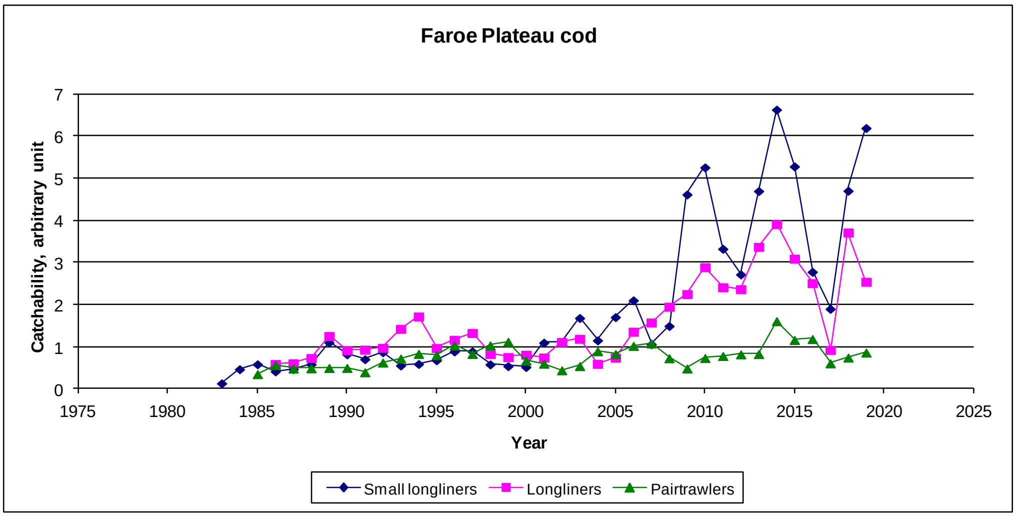


Figure 4.2.11. Faroe Plateau cod (Subdivision 5.b.1). Catchability (cpue divided by age 3+ biomass) for small and large longliners and pair trawlers.

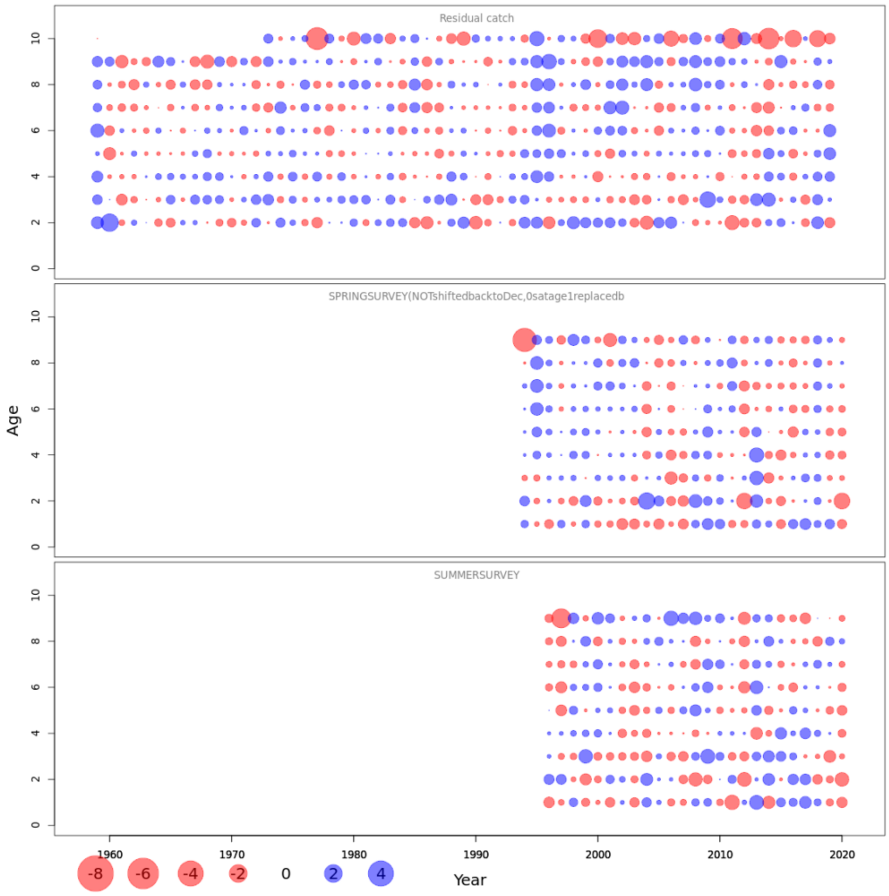


Figure 4.6.1. Faroe Plateau cod (Subdivision 5.b.1). Observation residuals for the catch, spring survey and the summer survey as estimated by the SAM model.

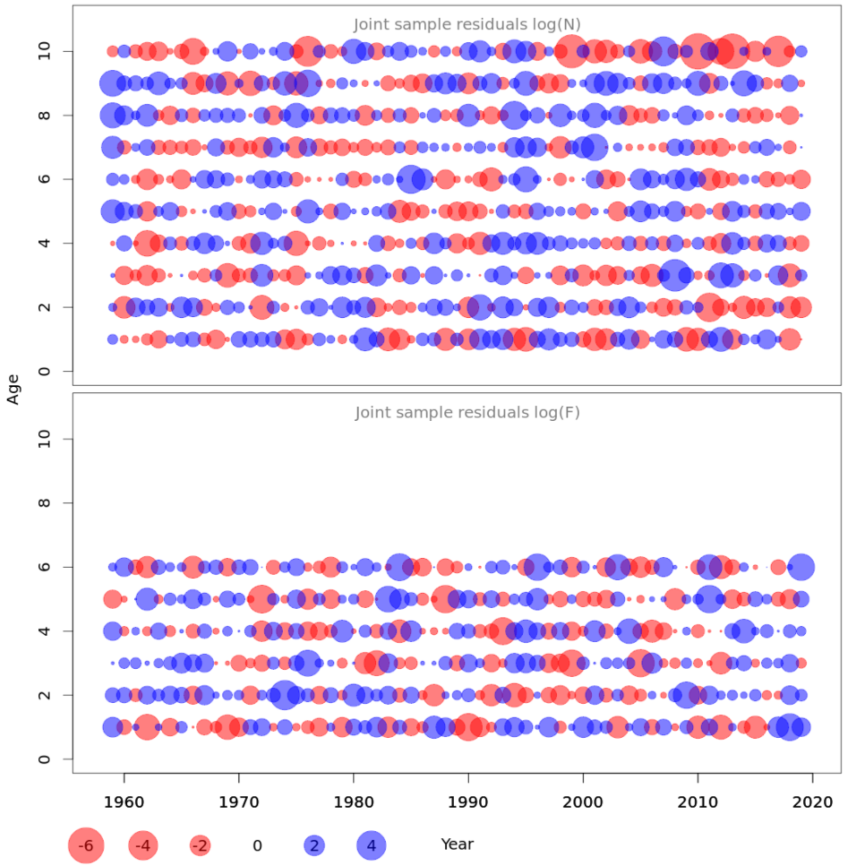


Figure 4.6.2. Faroe Plateau cod (Subdivision 5.b.1). Joint sample residuals for the population numbers and fishing mortality as estimated by the SAM model.

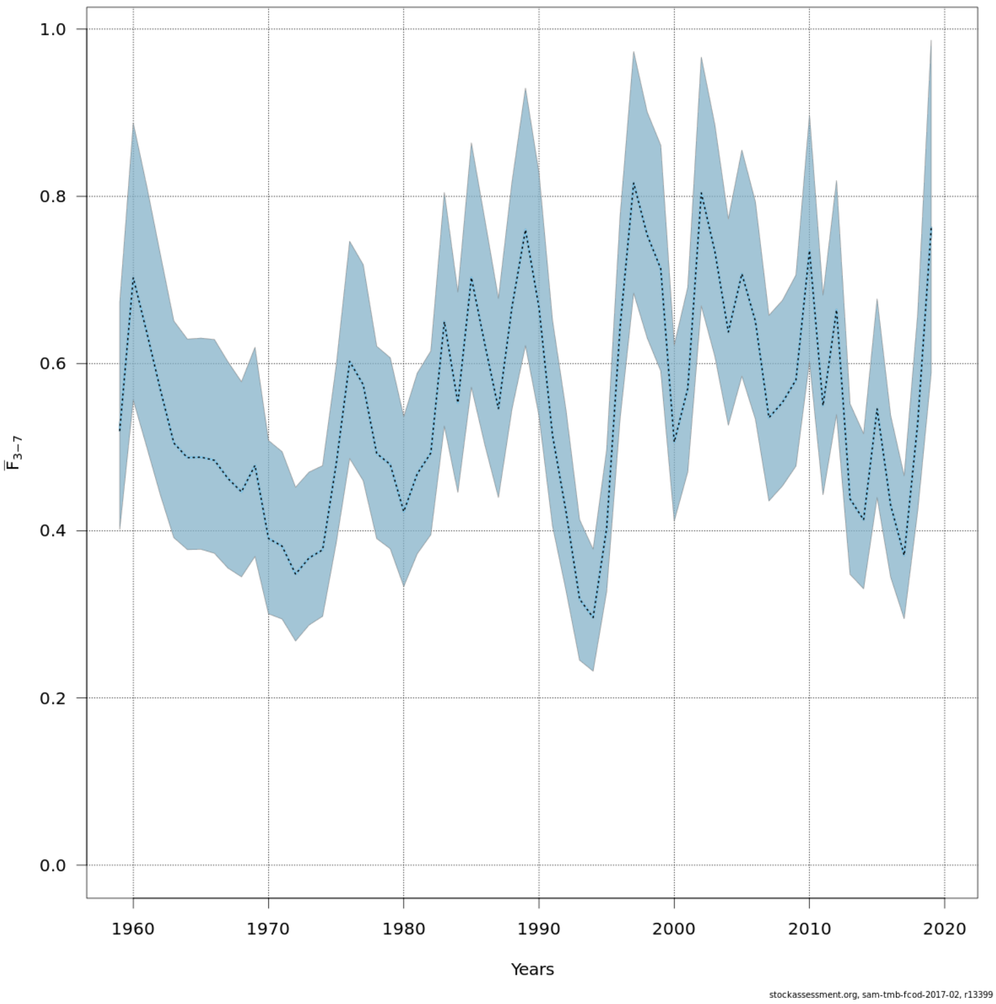


Figure 4.6.3. Faroe Plateau cod (Subdivision 5.b.1). Development of fishing mortality over time.

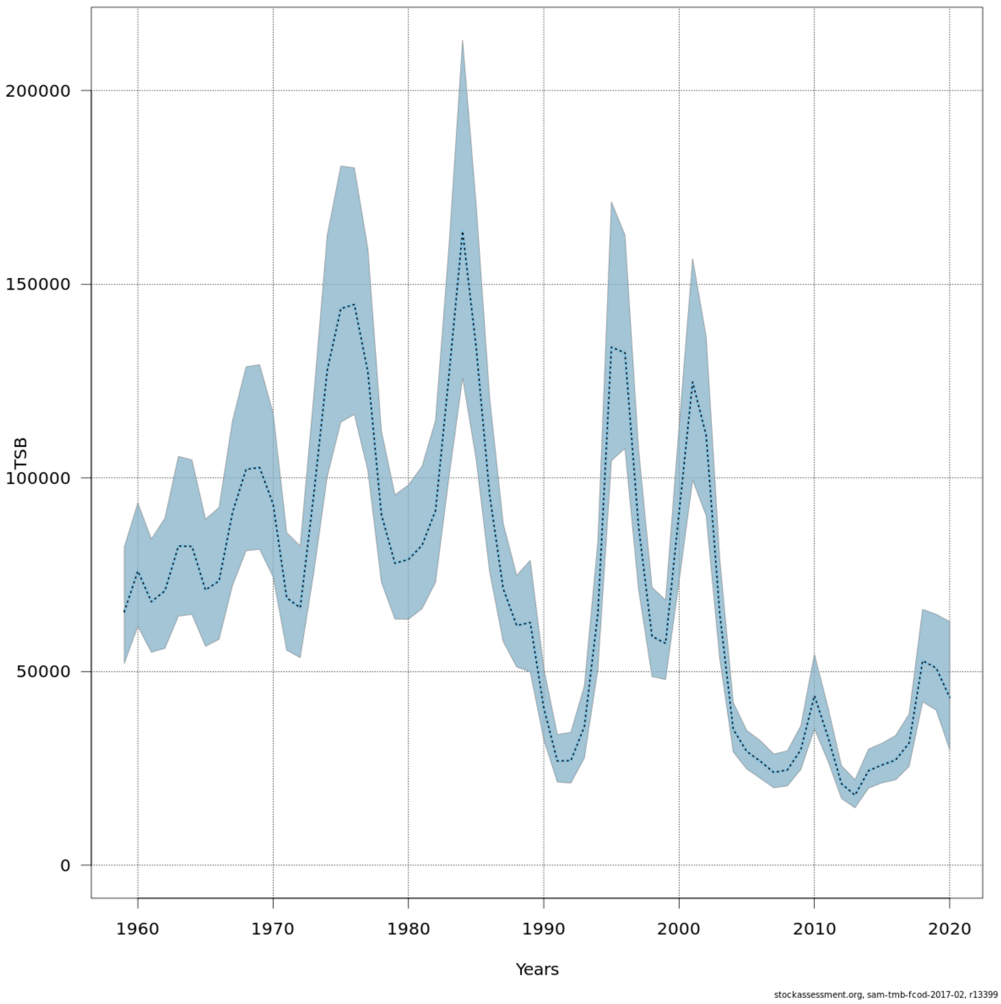


Figure 4.6.4. Faroe Plateau cod (Subdivision 5.b.1). Development of the total stock over time.

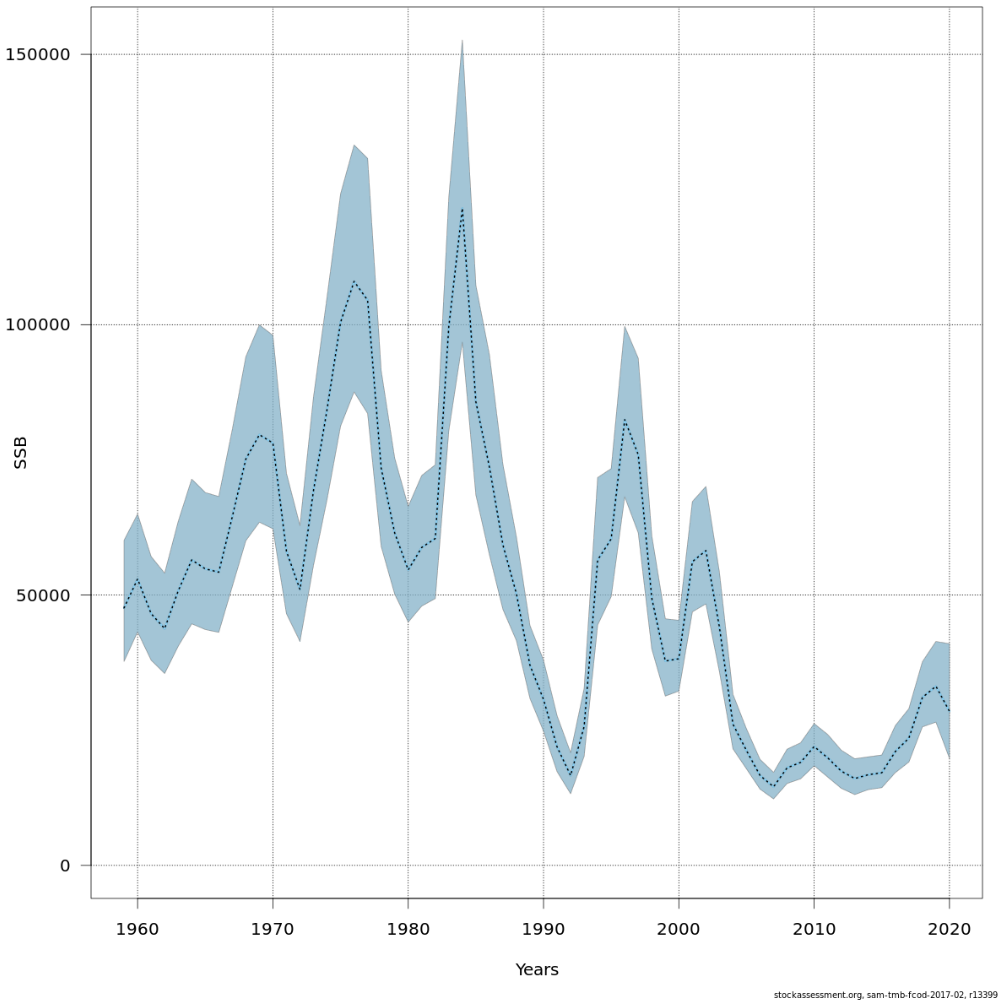


Figure 4.6.5. Faroe Plateau cod (Subdivision 5.b.1). Development of the spawning stock biomass over time.

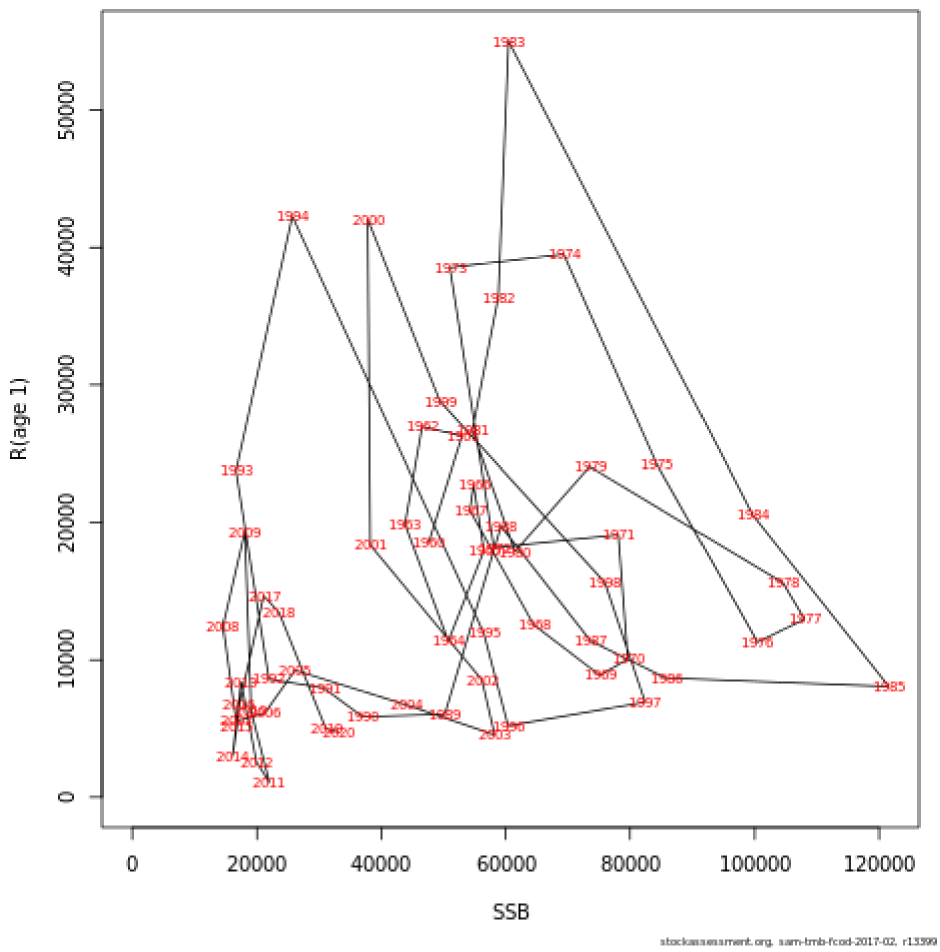


Figure 4.6.6. Faroe Plateau cod (Subdivision 5.b.1). Spawning stock (tons) – recruitment (thousands) relationship. Years are shown at each data point.

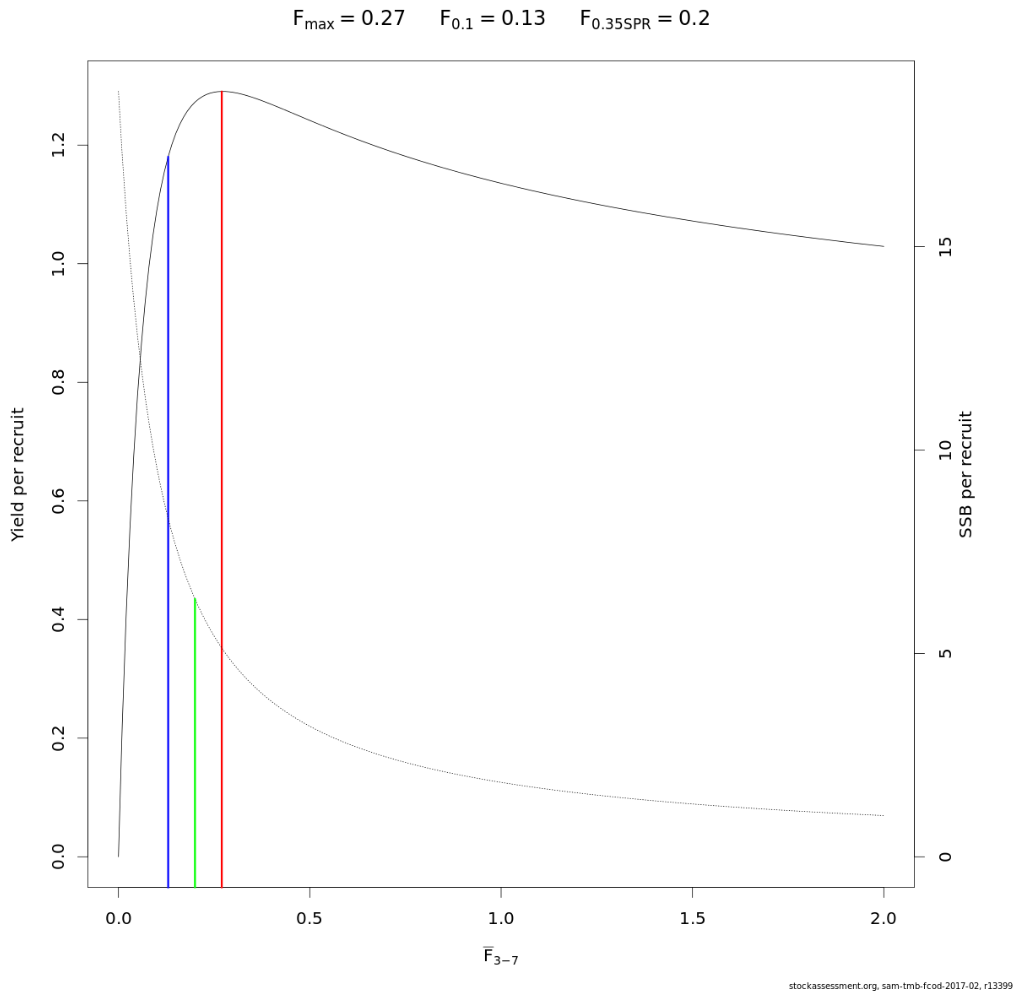


Figure 4.8.1. Faroe Plateau cod (Subdivision 5.b.1). Yield per recruit and spawning stock biomass (SSB) per recruit versus fishing mortality.

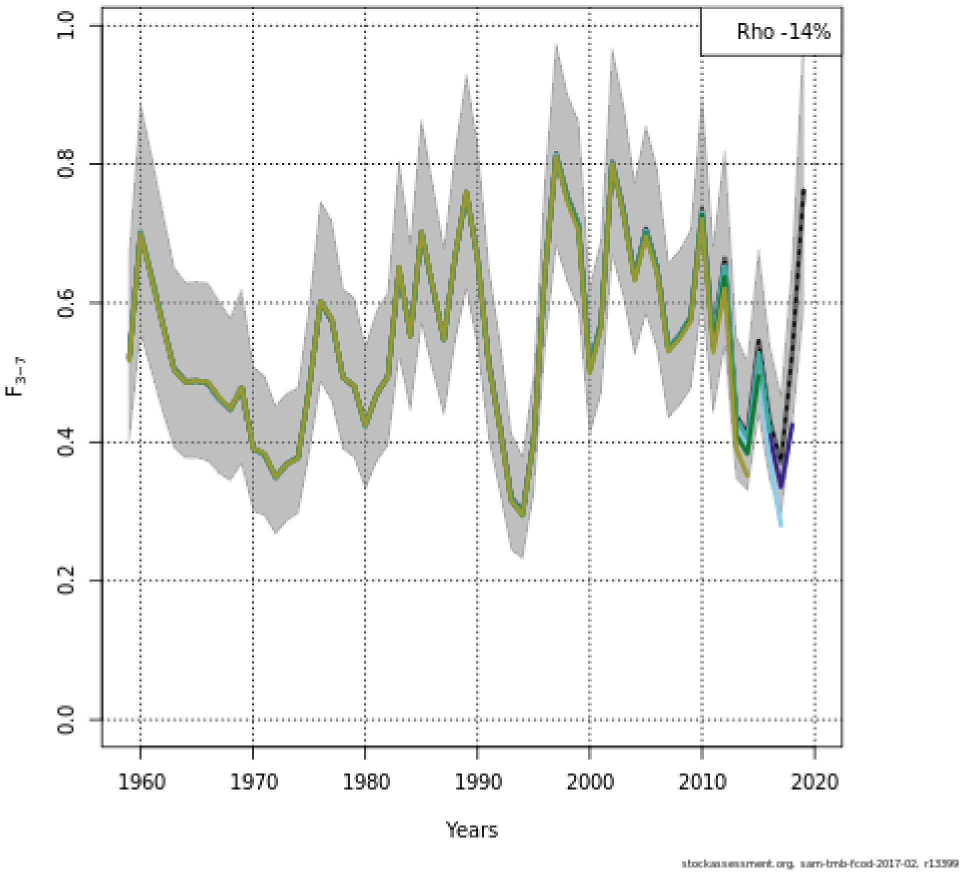


Figure 4.9.1. Faroe Plateau cod (Subdivision 5.b.1). Results from the SAM retrospective analysis of fishing mortality (ages 3-7).

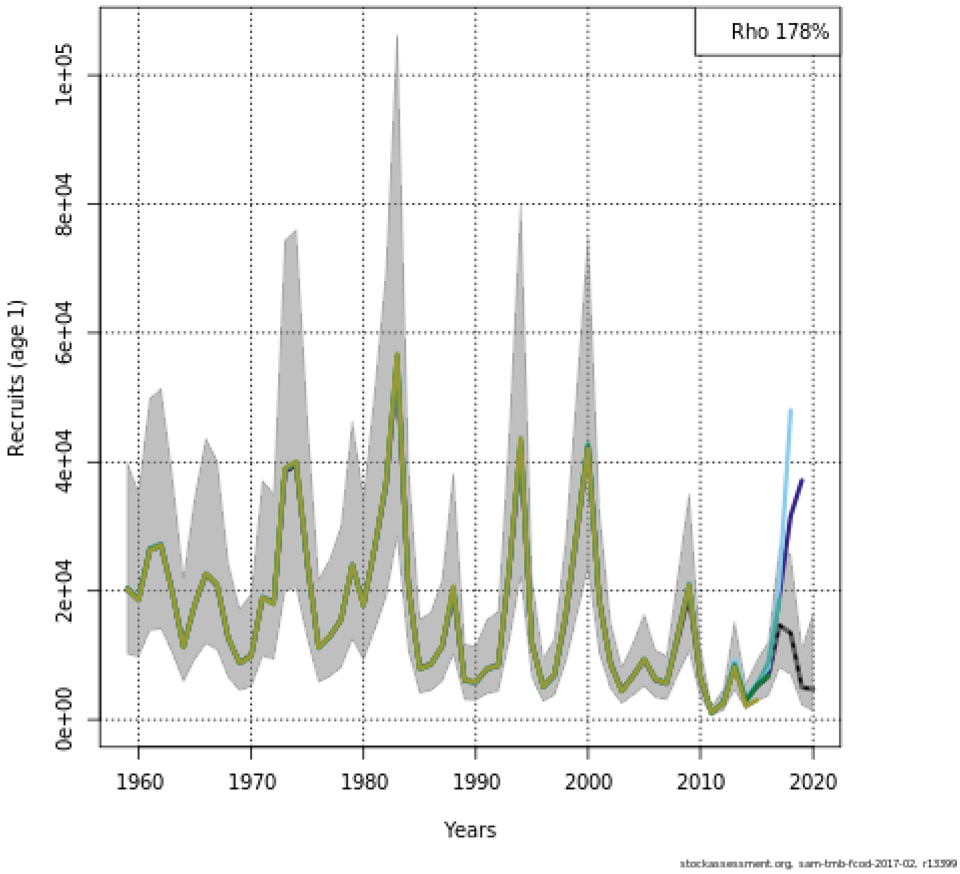


Figure 4.9.1. Faroe Plateau cod (Subdivision 5.b.1). Results from the SAM retrospective analysis (continued). Recruitment at age 1.

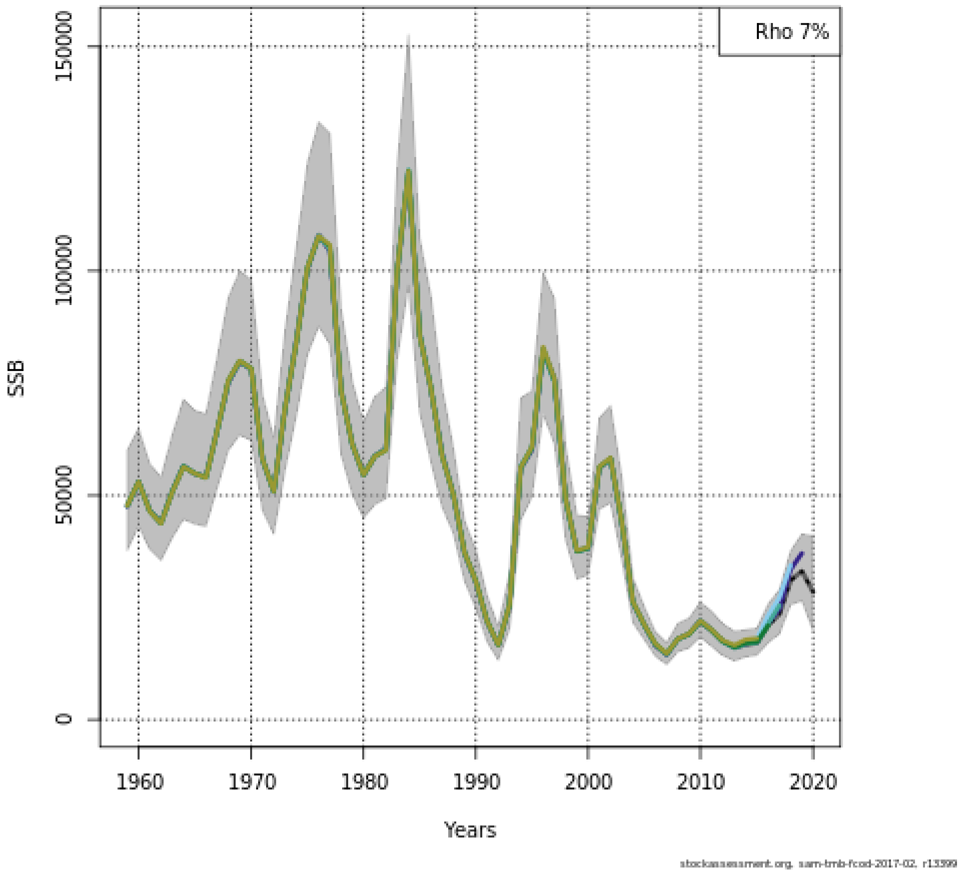


Figure 4.9.1. Faroe Plateau cod (Subdivision 5.b.1). Results from the SAM retrospective analysis (continued). Spawning stock biomass.

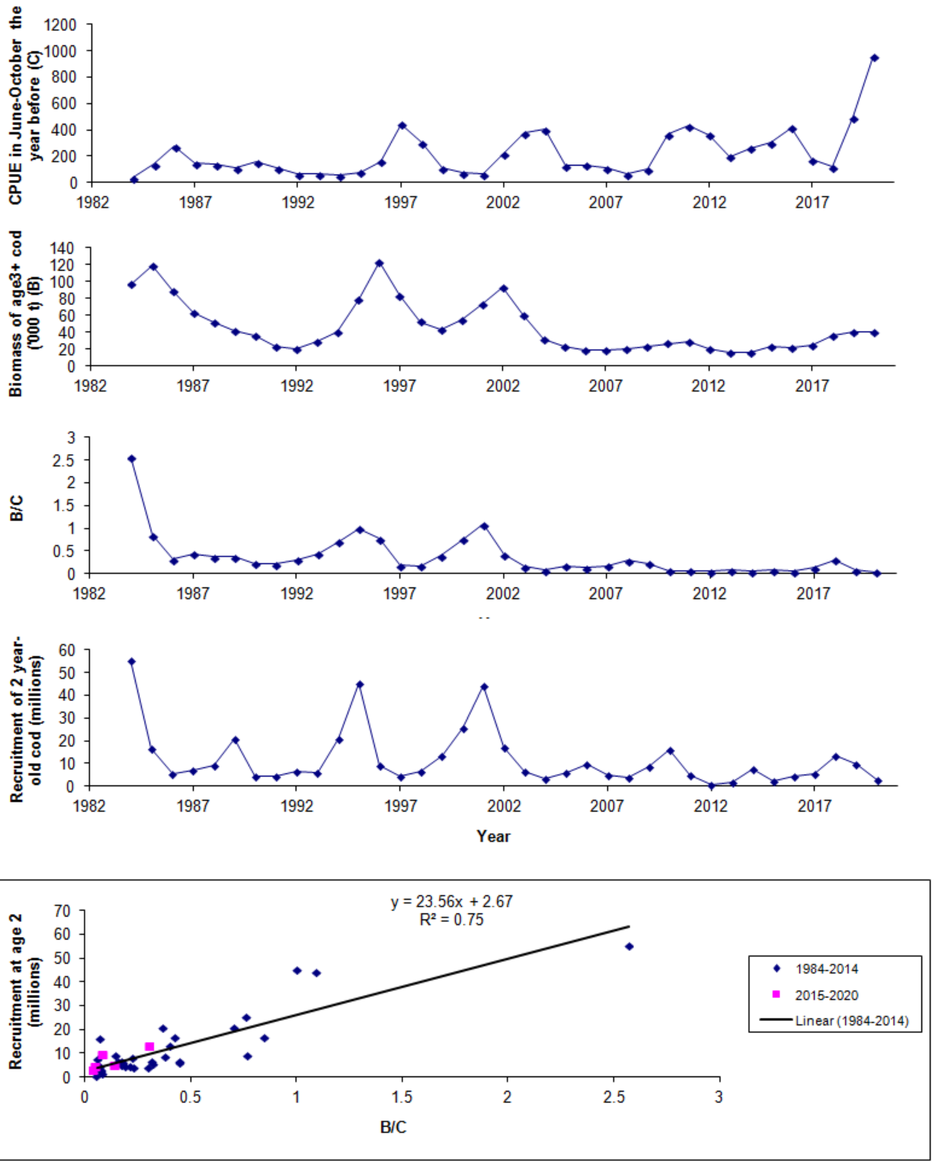


Figure 4.9.2. Faroe Plateau cod (Subdivision 5.b.1). Modelling cod recruitment in three steps. First, the catch-per-unit-effort of cod (C) for small boats operating close to land, as being indicative of the amount of cannibalistic cod. Second, the amount of cod (older than the recruiting cod) (B), as being indicative of e.g. culling-down of potential predators/competitors of recruiting cod. Third, the ratio between B and C, as indicative of recruitment success. Fourth and fifth, a comparison with observed recruitment.

Figure 4.9.3. Faroe Plateau cod (Subdivision 5.b.1). The current assessment (accepted assessment) compared with an assessment that included a preliminary catch-at-age for 2020.

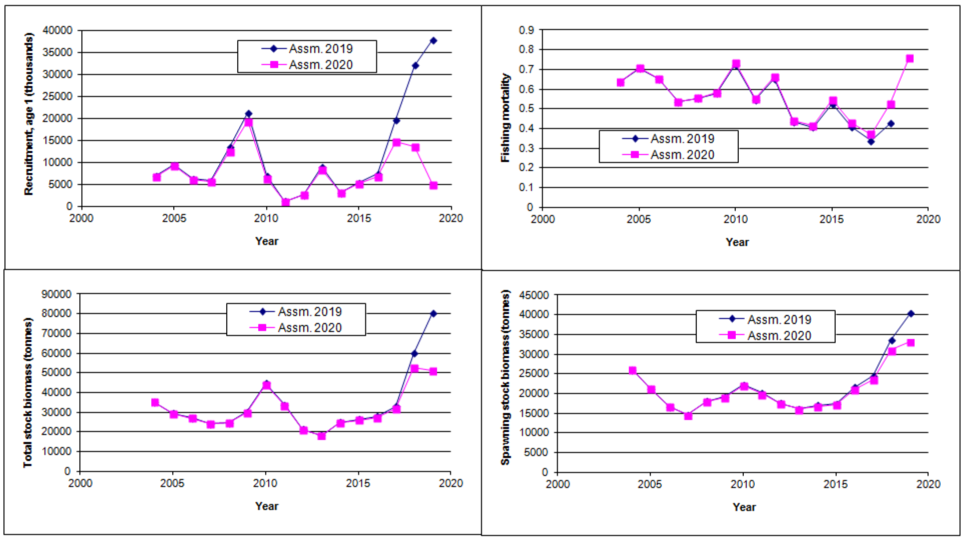


Figure 4.10.1. Faroe Plateau cod (Subdivision 5.b.1). Comparison between the results from the current autumn assessment compared with last year's assessment.

5 Faroe haddock

This section was updated in November 2020.

5.1 Stock description and management units

Haddock in Faroese Waters, i.e. ICES subdivisions 5.b.1 and 5.b.2 and in the southern part of ICES Division 2.a, close to the border of Subdivision 5.b.1, 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 Faroese 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 5.8.

5.2 Scientific data

5.2.1 Trends in landings and fisheries

Nominal landings of Faroe haddock gradually decreased since its peak in 2003 with 27 000 t and amounted in 2017 to only about 2800 t but is now increasing again with 9334 t in 2019. Most of the landings are taken from the Faroe Plateau; the 2019 landings from the Faroe Bank (Subdivision 5.b.2), where the area shallower than 200 m depths has been closed to the bulk of fisheries since the fiscal year 2008–2009, amounted to about 330 t (tables 5.1 and 5.2).

Faroese vessels have taken almost the entire catch since the late 1970s (Figure 5.1). The longliners have taken most of the catches in recent years followed by the trawlers. This was also the case in 2017, where the share by longliners was 67% and the trawler's share was 15%. Small open boats and jiggers, which mainly fish near shore, caught 19% of the total catch of 2019 (Figure 5.2).

5.2.2 Catch-at-age

Catch-at-age data was provided for fish taken by the Faroese fleets from 5.b. The sampling intensity in the terminal year is shown in Table 5.3. All longliners were grouped into two fleets (above and below 100 GRT, Gross Register Tons), and all trawlers were also grouped to one fleet, and the samples were treated by using 2 seasons (Jan–Jun, Jul–Dec.). The results are given in Table 5.3. The most recent data were revised according to the final catch figures and the results are shown in Table 5.4. Catch curves are shown in Figure 5.3.

5.2.3 Weight-at-age

Mean weight-at-age data are provided for the Faroese fishery (Table 5.5). Figure 5.4 shows the mean weights-at-age in the landings for age groups 2–8 since 1977. During this period, weights have shown cyclical changes. They were at a minimum in 2007–2009, but have increased again since then. 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 from 1982 and onwards. The survey is carried out in February–March. This means the maturity-at-age is determined just prior to the spawning of haddock in Faroese waters happening in April and the determination of the different maturity stages is relatively easy.

In order to reduce year-to-year variation, 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 5.5).

5.3 Information from the fishing industry

There exists a considerable amount of data on fish size in the fishing industry. No such information was used directly in the current assessment but catch per unit effort for some selected fleets (logbook data) is used as additional information on the status of the stock (see Section 5.3.1.1).

5.3.1 Methods

The benchmark in February 2017 decided to change the traditional assessment tool from XSA to SAM although it was recognized that the results of the assessment were mainly data-driven. The SAM model has some beneficial characteristics as compared to XSA, e.g. it provides uncertainty estimates for the catch in numbers, surveys and the output from the assessment (biomasses and fishing mortalities). See the stock annex for more information.

In the NWWG meeting in 2018, it was proposed to change the settings for the model (Table 5.9). Default settings used the same sdLogN for all ages (1–7/8 years) in the two tuning series, but different for each survey. Comparisons of the results from the two different settings were presented in the first version of the NWWG report 2018 (June 2018). The Advice Drafting Group 2018 (May 2018) adopted the revised model settings for future assessments and advice.

From mid-1990s to 2017/2018 the fishing year was from September 1st to August 31th and the ICES advice to Faroese authorities provided in June. The assessment was based on catch data up to the year before the interim year and the last tuning data point was from spring in the interim year. This was the situation when the benchmark assessment was performed in February 2017. However, the fishing year was changed to be equal to the calendar year and this change was first applied to the calendar year 2018. Faroese authorities needed the ICES advice in November and this implied that the tuning data point in August in the interim year could be added as input in the assessment. These settings were applied for the first time in the stock assessment performed in November 2019, i.e. using catch data up to 2018 and tuning data (both surveys) up to 2019.

No preliminary assessment was conducted in April 2020 as the working group meeting was cancelled due to the COVID-19 outbreak; the 2020 assessment was done in November at a webex NWWG-meeting. Comparison between the 2019 assessment and the latest assessments is shown in Figure 5.9.

5.3.1.1 Tuning and estimates of fishing mortality

Commercial CPUE series

The age-aggregated CPUE series for longliners and pair trawlers are presented in Figure 5.6. In general, the two series show the same trends although in some periods the two series are conflicting; this has been explained by variations in catchability of the longlines due to changes in productivity of the Faroe Shelf ecosystem. Both series, however, show that the total stock biomass has been low, but is now increasing. The longliner CPUE does not decrease as much as the trawler CPUE 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). Survey catch at age data is presented in Table 5.7. The main trends from the surveys are the same but the summer survey indicates a more depleted stock in recent years than the summer survey; both surveys indicate a slow increase in recent years. 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 Gaussian smoother applied. This is a useful method but some artefacts may be introduced since 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 is presented in Figures 5.9–5.10. The distribution of haddock catches for spring and summer survey is shown in Figure 5.8.

These surveys have shown similar signal through the time series, however, since 2019, the signal has been conflicting, showing highly above average in the spring survey and the opposite, beneath average, in the summer survey. This is presented in Figure 5.7. This conflicting signal is furthermore exposed in the residual plot, see Figure 5.11, where SAM delimits the signal from the summer survey, especially for the older ages. The reasons for this difference between surveys is unclear and urge for further investigations.

5.4 Reference points

Since the assessment model was replaced at the benchmark in February 2017, it was necessary to recalculate reference points at the NWWG meeting in 2017 (this was not finally conducted during the benchmark).

The B_{lim} was changed from 22 thousand tonnes to 16 780 tonnes, the lowest spawning biomass from which the stock had made a recovery. The biomass was lower later in the time series, but the stock had not recovered by the time of the determination of this reference point.

The $B_{pa} = B_{trigger} = 22\,843$ tonnes (changed from 35 000 tonnes). The uncertainty in the SAM assessment in the final year of SSB was found to be $\sigma = 0.188$ and the B_{pa} was found by using the formula $B_{pa} = B_{lim} \times \exp(\sigma \times 1.645)$. The $B_{trigger}$ was, according to ICES guidelines, set equal to B_{pa} since the stock had not been fished at F_{MSY} for five or more years.

$F_{lim} = 0.54$ (changed from 0.4). F_{lim} was derived from B_{lim}. A stock was simulated with a segmented regression on the spawning stock – recruitment function having the point of inflection at B_{lim}. F_{lim} was set to the F that, in equilibrium, gave a 50% probability that SSB > B_{lim}. This simulation was based on a fixed F, i.e., without inclusion of a $B_{trigger}$ and without inclusion of assessment/advice errors.

$F_{pa} = 0.40$ (changed from 0.25). F_{pa} was derived from F_{lim} in the reverse of the way B_{pa} was derived from B_{lim}, i.e., $F_{pa} = F_{lim} \times \exp(-\sigma \times 1.645)$, where $\sigma = 0.185$.

The calculations were conducted using EQSIM following ICES guidelines. Decisions made involved the spawning stock – recruitment relationship, the weights at age, the selection pattern and the level of advice error. The period since 1978 was used as basis for the spawning stock – recruitment relationship where the S-R function was based on the segmented regression (weight 0.7), Ricker (weight 0.24), and Beverton and Holt (weight 0.06). The autocorrelation between SSB-R data points was approximately 0.52. The weights at age were based on the last 20 years. The selection pattern was based on the last 5 years. The advice error was estimated from advice sheets back to 1999: cvF = 0.48, phiF = 0.37, cvSSB = 0.40, phiSSB = 0.43. In total, 2000 iterations were performed that projected the stock 200 years into the future, of which, the last 50 years were kept to calculate ‘equilibrium’ values.

The result of the analyses was that F_{MSY} = 0.165 (changed from 0.25). The fishing mortality that is associated with a risk of 5% to fall below B_{lim}, $F_{p0.5}$, was estimated to be 0.09. The value was in the first simulations 0.13 assuming autocorrelation in the recruitment. At a web-ex meeting in June 2017 it was assumed there was no autocorrelation in the recruitment that led to Fmsy = 0.165.

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

At the benchmark in February 2017 the traditional XSA was replaced by a SAM assessment model. The SAM model settings and the model parameters are shown in Table 5.8. AR covariance structure has been applied for both surveys, eliminating year effects. The observation residuals look quite random (Figure 5.11) as well as the process residuals (Figure 5.12).

The results from the SAM-run show that fishing mortality (F3–7) has decreased in recent years (Table 5.13, Figure 5.14). The spawning stock biomass has been low since 2009 but is now increasing (Table 5.13 Figure 5.16). The poor state of the stock since 2009 has been due to poor recruitment combined with high F but with the successful recruitment recently, the state of the stock has now improved (Table 5.13 Figure 5.17). The spawning stock biomass is now above B_{lim} and the fishing mortality around F_{MSY} (Table 5.13).

5.6 Short term forecast

Input data

The SAM model provides predictions that carry the signals from the assessment into the short term forecast. The forecast procedure starts from the assessment year's estimate of the state (log(N) and log(F) at age. One thousand replicates of the last state are simulated from its estimated joint distribution. Each of these replicates are then simulated forward according to the assumptions and parameter estimates found by the assessment model. In the forward simulations, a 5 year average (years up to and including the assessment year) is used for catch mean weight, stock mean weight, proportion mature, and natural mortality. Recruitment is re-sampled from the period 2001 to terminal year. In each forward simulation step the fishing mortality is scaled so that the median of the distribution is matching the requirement in the scenario (e.g. hitting a specific mean F value or a specific catch).

Results

The landings in 2020 were originally expected to be 12 thousand tonnes with status quo fishing mortality. However, the observed landings hidherto (January-September) in 2020 suggest that the landings at the end of 2020 will be close to 7 thousand tonnes, based on landings in January-September 2019 and January-December 2019. Therefore, in technical terms, a “TAC constraint” was set on the landings in 2020 of 7146 tonnes and forecasts based on this assumption (Table

5.14). The spawning stock biomass is expected to be 90 392 tonnes in 2021, 94 854 tonnes in 2022 and eventually 96 132 tonnes in 2023, if the Fmsy is applied.

5.7 Yield per recruit

The yield-per-recruit calculations were performed in the SAM model based on the last 20 years. The F_{max} was estimated at 0.72, but due to the very flat topped curve this value is poorly defined. $F_{0.1}$ was estimated at 0.15 and $F_{0.35SPR}$ at 0.29 (Figure 5.13).

5.8 Uncertainties in assessment and forecast

Retrospective analyses indicate periods with tendencies to overestimate recruitment and underestimate fishing mortality (Figures 5.14–5.16). Mohn´s Rho was 14% for SSB, 49% for recruitment and -18% for F(ages 3–7).

5.9 Comparison with previous assessment and forecast

The assessment settings were according to the Stock Annex. The assessment this year showed downscaling of the recruitment and based on, TAC constraint in 2020, similar fishing mortality compared with last year's assessment, however, spawning stock biomass is essentially unvaried (Figure 5.19).

5.10 Management plans and evaluations

An effort management system has been in use from 1996 to 2020. There is still ongoing work on a new management system. The catch quota needs to be converted into fishing days. Management of fisheries on haddock also needs to take into account measures for cod, as cod and haddock are caught in mixed fishery. Further development of management measures that includes the mixed-fishery issue would be useful.

The spawning-stock biomass (SSB) decreased significantly from 2003 and is estimated to have been below B_{lim} in the period between 2009–2017, but has been improving the past three years. The fishing mortality (F) has decreased in recent years but is still above F_{MSY}. Recruitment (age 1) from 2004 onwards has been well below the long-term average. However, the 2016 and 2017 year classes are estimated to be above average.

5.11 Ecosystem considerations

Since on average about 75% of the catches are taken by longliners and the remaining by trawls, effects of the haddock fishery on the bottom is moderate (Figure 5.2).

5.12 Regulations and their effects

As explained in the overview (Section 2), the fishery for haddock in 5.b 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. Afterwards, however, the parties managed to get an agreement in place again. Since there is no incentive to discard fish or misreport catches under the effort management system, the catch figures are considered adequate.

5.13 Changes in fishing technology and fishing patterns

See Section 2.

5.14 Changes in the environment

See Section 2.

Table 5.1. Faroe Plateau (Sub-division 5b1) HADDOCK. Nominal catches (tonnes) by countries 2000-2020 and Working group estimates in 5b.

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Faroe Islands	13620	13457	20776	21615	18995	18172	15600	11689	6728	4895	4932	3350	2490	2877	2756	2919	3090	2575	5192	8679
France	6	8	2	4	+		12	4	3	2	1	2	1	+	+	1	+	1	+	+
Germany	1	2	6	1	6		1													
Greenland							1	9		6										
Iceland			4										2							
Ireland																+				
Norway	355	257	227	265	229	212	57	61	31	8	6				+	5	11	1	21	41
Russia					16				10	0										
Spain					49															
UK (Engl. And Wales)	19	4	11	14	8	1	1													
UK (Scotland)	185	148	177	185	186	1,070	106	35	60	65	40									
United Kingdom														+	350	428	237	72	121	283
Total (tonnes)	14186	13876	21203	22084	19489	19455	15778	11798	6832	4976	4979	3352	2493	2877	3105	3352	3339	2649	5334	9003
Used in the assessment in 5b	15799	15891	24929	26941.97	23100	21944	17154	12631	7393	5197	5203	3546	2634	2924	3252	3421	3470	2863	5549	9334

Table 5.2 Faroe Bank (Sub-division 5b2) HADDOCK. Nominal catches (tonnes) by countries, 2000–2020.

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Faroe Islands	1565	1948	3698	4804	3594	2444	1374.84	810	556	192	178	194	141	47	71	48	111	196	192	330
France	+									1							5			
Greenland											12									
Norway	48	66	28	54	17	45	1	8	+	3	1				2	1	+	5	1	1
UK (Scotland)								15	5	26	33									
United Kingdom															74	21	15	14	22	
Total (tonnes)	1613	2014	3726	4858	3611	2489	1376	833	561	222	224	194	141	47	147	69	131	214	215	332

Table 5.3. Faroe Plateau (Subdivision 5.b) haddock. Catch at age and sampling intensity of terminal year.

Fleet	Size	Samples	Lengths	Otoliths	Weights
Open boats		2	429	120	429
Longliners	< 100 GRT	4	888	239	888
Longliners	> 100 GRT	24	5224	1419	5224
Jiggers		0	0	0	0
Gillnetters		0	0	0	0
Single trawlers	< 400 HP	0	0	0	0
Single trawlers	400-1000 HP	3	654	119	654
Single trawlers	> 1000 HP	0	0	0	0
Pair trawlers	< 1000 HP	0	0	0	0
Pair trawlers	> 1000 HP	23	4613	1255	4405
Total		56	11808	3152	11600

Table 5.4. Faroe haddock. Catch in numbers at age per fleet in terminal years.

27.5.b - Faroese fleet				
Age	Longliners < 100 GRT	Longliners > 100 GRT	Trawlers	Others
0	0	0	0	0
1	0	0	0	0
2	0	155	46	0
3	820	1,036	398	0
4	987	1,189	458	0
5	318	505	160	0
6	187	246	75	0
7	58	60	24	0
8	34	35	15	0
9	3	14	9	0
10	0	1	2	0
11	0	0	0	0
12	0	0	0	0
13	0	0	0	0
14	0	0	0	0
15	0	0	0	0
Total no.	2,407	3,242	1,186	0
Catch, t.	4002	3392	827	0

Numbers in 1000'

Catch, gutted weight in tonnes

Others include netters, jiggers, other small categories and catches not otherwise accounted for

Table 5.4. Faroe haddock. Catch in numbers at age 1957–2019.

Year \ age	0	1	2	3	4	5	6	7	8	9	10
1957	0	45	4133	7130	8442	1615	894	585	227	94	58
1958	0	116	6255	8021	5679	3378	1299	817	294	125	105
1959	0	525	3971	7663	4544	2056	1844	721	236	98	47
1960	0	854	6061	10659	6655	2482	1559	1169	243	85	28
1961	0	941	7932	7330	5134	1937	1305	838	236	59	13
1962	0	784	9631	13977	5233	2361	1407	868	270	72	22
1963	0	356	13552	8907	7403	2242	1539	860	257	75	23
1964	0	46	2284	7457	3899	2360	1120	728	198	49	7
1965	0	39	1368	4286	5133	1443	1209	673	1345	43	8
1966	0	90	1081	3304	4804	2710	1112	740	180	54	9
1967	0	70	1425	2405	2599	1785	1426	631	197	52	13
1968	0	49	5881	4097	2812	1524	1526	923	230	68	12
1969	0	95	2384	7539	4567	1565	1485	1224	378	114	20
1970	0	57	1728	4855	6581	1624	1383	1099	326	68	10
1971	0	55	717	4393	4727	3267	1292	864	222	147	102
1972	0	43	750	3744	4179	2706	1171	696	180	113	95
1973	0	665	3311	8416	1240	2795	919	1054	150	68	11
1974	0	253	5633	2899	3970	451	976	466	535	68	147
1975	0	94	7337	7952	2097	1371	247	352	237	419	187
1976	0	40	4396	7858	6798	1251	1189	298	720	258	318
1977	0	0	255	4039	5168	4918	2128	946	443	731	855
1978	0	0	32	1022	4248	4054	1841	717	635	243	312
1979	0	1	1	1162	1755	3343	1851	772	212	155	74
1980	0	0	143	58	3724	2583	2496	1568	660	99	86
1981	0	0	74	455	202	2586	1354	1559	608	177	36
1982	0	0	539	934	784	298	2182	973	1166	1283	214
1983	0	0	441	1969	383	422	93	1444	740	947	795
1984	0	25	1195	1561	2462	147	234	42	861	388	968
1985	0	0	985	4553	2196	1242	169	91	61	503	973
1986	0	0	230	2549	4452	1522	738	39	130	71	712
1987	0	0	283	1718	3565	2972	1114	529	83	48	334
1988	0	0	655	444	2463	3036	2140	475	151	18	128
1989	0	0	63	1518	658	2787	2554	1976	541	133	81
1990	0	0	105	1275	1921	768	1737	1909	885	270	108
1991	0	0	77	1044	1774	1248	651	1101	698	317	32
1992	0	0	40	154	776	1120	959	335	373	401	162
1993	0	43	113	298	274	554	538	474	131	201	185
1994	0	1	277	191	307	153	423	427	383	125	301
1995	0	0	804	452	235	226	132	295	290	262	295

Year \ age	0	1	2	3	4	5	6	7	8	9	10
1996	0	1	326	5234	1019	179	163	161	270	234	394
1997	0	0	77	2913	10517	710	116	123	93	220	516
1998	0	0	106	1055	5269	9856	446	99	87	95	502
1999	0	9	174	1142	942	4677	6619	226	26	20	192
2000	0	73	1459	3057	210	681	2681	2842	79	1	71
2001	0	19	4380	3128	2423	173	451	1151	1375	17	18
2002	0	0	1515	14036	2878	1200	133	239	843	1095	33
2003	0	0	132	3419	13486	2213	944	162	332	854	920
2004	0	3	243	2007	4802	10425	1163	409	89	166	811
2005	0	0	91	1793	4132	7245	6573	581	158	30	165
2006	0	0	247	446	2566	3949	5423	3278	136	63	70
2007	0	0	76	982	547	2732	3309	2758	1117	89	9
2008	0	6	66	204	919	424	1472	1707	1255	320	39
2009	0	0	27	329	402	555	514	1133	739	285	48
2010	0	0	389	445	426	279	484	553	718	444	159
2011	0	0	170	774	325	198	186	280	354	368	187
2012	0	0	8	960	513	156	114	123	94	171	114
2013	0	0	82	506	1108	217	94	77	87	70	118
2014	0	0	236	392	637	1133	101	61	32	15	48
2015	0	0	387	1153	320	564	324	49	27	23	20
2016	0	8	280	982	638	220	454	116	22	24	12
2017	0	1	156	391	812	321	113	143	70	14	10
2018	0	0	583	1809	768	583	213	85	78	28	9
2019	0	0	198	2212	2584	964	498	140	82	25	3

Table 5.5 Faroe Haddock. Mean weight at age (kg) in the catches, 1957–2019.

Year \ age	1	2	3	4	5	6	7	8	9	10
1957	0.250	0.470	0.730	1.130	1.550	1.970	2.410	2.760	3.070	3.550
1958	0.250	0.470	0.730	1.130	1.550	1.970	2.410	2.760	3.070	3.550
1959	0.250	0.470	0.730	1.130	1.550	1.970	2.410	2.760	3.070	3.550
1960	0.250	0.470	0.730	1.130	1.550	1.970	2.410	2.760	3.070	3.550
1961	0.250	0.470	0.730	1.130	1.550	1.970	2.410	2.760	3.070	3.550
1962	0.250	0.470	0.730	1.130	1.550	1.970	2.410	2.760	3.070	3.550
1963	0.250	0.470	0.730	1.130	1.550	1.970	2.410	2.760	3.070	3.550
1964	0.250	0.470	0.730	1.130	1.550	1.970	2.410	2.760	3.070	3.550
1965	0.250	0.470	0.730	1.130	1.550	1.970	2.410	2.760	3.070	3.550
1966	0.250	0.470	0.730	1.130	1.550	1.970	2.410	2.760	3.070	3.550
1967	0.250	0.470	0.730	1.130	1.550	1.970	2.410	2.760	3.070	3.550
1968	0.250	0.470	0.730	1.130	1.550	1.970	2.410	2.760	3.070	3.550
1969	0.250	0.470	0.730	1.130	1.550	1.970	2.410	2.760	3.070	3.550
1970	0.250	0.470	0.730	1.130	1.550	1.970	2.410	2.760	3.070	3.550
1971	0.250	0.470	0.730	1.130	1.550	1.970	2.410	2.760	3.070	3.550
1972	0.250	0.470	0.730	1.130	1.550	1.970	2.410	2.760	3.070	3.550
1973	0.250	0.470	0.730	1.130	1.550	1.970	2.410	2.760	3.070	3.550
1974	0.250	0.470	0.730	1.130	1.550	1.970	2.410	2.760	3.070	3.550
1975	0.250	0.470	0.730	1.130	1.550	1.970	2.410	2.760	3.070	3.550
1976	0.250	0.470	0.730	1.130	1.550	1.970	2.410	2.760	3.070	3.550
1977	0.000	0.311	0.633	1.044	1.426	1.825	2.241	2.205	2.570	2.591
1978	0.000	0.357	0.790	1.035	1.398	1.870	2.350	2.597	3.014	2.920
1979	0.300	0.357	0.672	0.894	1.156	1.590	2.070	2.525	2.696	3.519
1980	0.000	0.643	0.713	0.941	1.157	1.493	1.739	2.095	2.465	3.310
1981	0.000	0.452	0.725	0.957	1.237	1.651	2.053	2.406	2.725	3.250
1982	0.000	0.700	0.896	1.150	1.444	1.498	1.829	1.887	1.961	2.856
1983	0.000	0.470	0.740	1.010	1.320	1.660	2.050	2.260	2.540	3.040
1984	0.359	0.681	1.011	1.255	1.812	2.061	2.059	2.137	2.368	2.686
1985	0.000	0.528	0.859	1.391	1.777	2.326	2.440	2.401	2.532	2.686
1986	0.000	0.608	0.887	1.175	1.631	1.984	2.519	2.583	2.570	2.922
1987	0.000	0.605	0.831	1.126	1.462	1.941	2.173	2.347	3.118	2.933
1988	0.000	0.501	0.781	0.974	1.363	1.680	1.975	2.344	2.248	3.295
1989	0.000	0.580	0.779	0.923	1.207	1.564	1.746	2.086	2.424	2.514
1990	0.000	0.438	0.699	0.939	1.204	1.384	1.564	1.818	2.168	2.335
1991	0.000	0.547	0.693	0.884	1.086	1.276	1.477	1.574	1.930	2.153
1992	0.000	0.525	0.724	0.817	1.038	1.249	1.430	1.564	1.633	2.126
1993	0.360	0.755	0.982	1.027	1.192	1.378	1.643	1.796	1.971	2.240
1994	0.000	0.754	1.103	1.254	1.465	1.593	1.804	2.049	2.225	2.423
1995	0.000	0.666	1.054	1.489	1.779	1.940	2.182	2.357	2.490	2.678

Year \ age	1	2	3	4	5	6	7	8	9	10
1996	0.360	0.534	0.858	1.459	1.993	2.330	2.351	2.469	2.777	2.582
1997	0.000	0.519	0.771	1.066	1.799	2.270	2.340	2.475	2.501	2.676
1998	0.000	0.622	0.846	1.016	1.283	2.080	2.556	2.572	2.452	2.753
1999	0.278	0.504	0.624	0.974	1.220	1.490	2.456	2.658	2.598	2.953
2000	0.280	0.661	0.936	1.166	1.483	1.616	1.893	2.821	3.749	3.196
2001	0.280	0.608	0.940	1.374	1.779	1.971	2.119	2.373	2.750	3.966
2002	0.000	0.584	0.857	1.405	1.799	1.974	2.301	2.370	2.626	3.130
2003	0.000	0.571	0.715	1.008	1.537	1.911	2.091	2.301	2.406	2.535
2004	0.367	0.574	0.770	0.887	1.159	1.638	1.870	2.438	2.357	2.417
2005	0.000	0.538	0.649	0.797	1.020	1.245	1.843	2.061	2.263	2.579
2006	0.000	0.475	0.601	0.768	0.911	1.126	1.374	2.158	2.211	2.569
2007	0.000	0.628	0.669	0.859	0.969	1.060	1.245	1.475	2.266	2.256
2008	0.491	0.636	0.754	0.860	0.991	1.082	1.151	1.379	1.727	2.435
2009	0.000	0.482	0.734	0.985	1.130	1.264	1.357	1.545	1.792	2.154
2010	0.000	0.692	0.870	1.149	1.308	1.386	1.429	1.568	1.740	1.841
2011	0.000	0.553	0.815	1.086	1.303	1.387	1.469	1.538	1.702	1.862
2012	0.000	0.619	0.786	1.069	1.405	1.616	1.656	1.675	1.727	1.905
2013	0.000	0.576	0.830	1.149	1.465	1.710	1.827	1.886	1.856	2.085
2014	0.000	0.547	0.902	1.165	1.354	1.693	1.841	1.872	1.856	1.823
2015	0.424	0.533	0.889	1.353	1.640	1.729	2.424	2.003	2.218	2.302
2016	0.396	0.645	0.934	1.220	1.571	1.908	2.066	2.187	2.276	2.789
2017	0.343	0.790	0.904	1.169	1.595	2.137	2.291	2.666	2.697	3.791
2018	0.000	0.642	1.000	1.584	1.944	2.281	2.544	2.597	2.818	3.288
2019	0.000	0.694	0.824	1.240	1.999	2.351	3.011	2.890	3.151	2.803

Table 5.6 Faroe haddock. Proportion mature at age 1957–2020.

Year/Age	0	1	2	3	4	5	6	7	8	9	10
1957	0	0	0.06	0.48	0.91	1	1	1	1	1	1
1958	0	0	0.06	0.48	0.91	1	1	1	1	1	1
1959	0	0	0.06	0.48	0.91	1	1	1	1	1	1
1960	0	0	0.06	0.48	0.91	1	1	1	1	1	1
1961	0	0	0.06	0.48	0.91	1	1	1	1	1	1
1962	0	0	0.06	0.48	0.91	1	1	1	1	1	1
1963	0	0	0.06	0.48	0.91	1	1	1	1	1	1
1964	0	0	0.06	0.48	0.91	1	1	1	1	1	1
1965	0	0	0.06	0.48	0.91	1	1	1	1	1	1
1966	0	0	0.06	0.48	0.91	1	1	1	1	1	1
1967	0	0	0.06	0.48	0.91	1	1	1	1	1	1
1968	0	0	0.06	0.48	0.91	1	1	1	1	1	1
1969	0	0	0.06	0.48	0.91	1	1	1	1	1	1
1970	0	0	0.06	0.48	0.91	1	1	1	1	1	1
1971	0	0	0.06	0.48	0.91	1	1	1	1	1	1
1972	0	0	0.06	0.48	0.91	1	1	1	1	1	1
1973	0	0	0.06	0.48	0.91	1	1	1	1	1	1
1974	0	0	0.06	0.48	0.91	1	1	1	1	1	1
1975	0	0	0.06	0.48	0.91	1	1	1	1	1	1
1976	0	0	0.06	0.48	0.91	1	1	1	1	1	1
1977	0	0	0.06	0.48	0.91	1	1	1	1	1	1
1978	0	0	0.06	0.48	0.91	1	1	1	1	1	1
1979	0	0	0.06	0.48	0.91	1	1	1	1	1	1
1980	0	0	0.06	0.48	0.91	1	1	1	1	1	1
1981	0	0	0.06	0.48	0.91	1	1	1	1	1	1
1982	0	0	0.08	0.62	0.89	1	1	1	1	1	1
1983	0	0	0.08	0.62	0.89	1	1	1	1	1	1
1984	0	0	0.08	0.76	0.98	1	1	1	1	1	1
1985	0	0	0.03	0.62	0.96	1	1	1	1	1	1
1986	0	0	0.03	0.43	0.95	0.99	1	1	1	1	1
1987	0	0	0.05	0.32	0.91	0.98	1	1	1	1	1
1988	0	0	0.05	0.24	0.89	0.98	1	1	1	1	1
1989	0	0	0.02	0.22	0.87	0.99	1	1	1	1	1
1990	0	0	0.08	0.37	0.9	1	1	1	1	1	1
1991	0	0	0.16	0.58	0.93	1	1	1	1	1	1
1992	0	0	0.18	0.65	0.91	1	1	1	1	1	1
1993	0	0	0.11	0.5	0.85	0.97	0.99	1	1	1	1
1994	0	0	0.05	0.42	0.86	0.96	0.99	1	1	1	1
1995	0	0	0.03	0.47	0.91	0.96	0.99	1	1	1	1

Year/Age	0	1	2	3	4	5	6	7	8	9	10
1996	0	0	0.03	0.47	0.93	0.98	1	1	1	1	1
1997	0	0	0.01	0.47	0.91	1	1	1	1	1	1
1998	0	0	0.01	0.36	0.87	0.99	1	1	1	1	1
1999	0	0	0.01	0.35	0.86	0.99	1	1	1	1	1
2000	0	0	0.02	0.36	0.87	0.99	1	1	1	1	1
2001	0	0	0.09	0.54	0.93	1	1	1	1	1	1
2002	0	0	0.08	0.49	0.97	1	1	1	1	1	1
2003	0	0	0.07	0.45	0.97	0.99	1	1	1	1	1
2004	0	0	0	0.35	0.94	0.99	1	1	1	1	1
2005	0	0	0.01	0.34	0.91	0.99	1	1	1	1	1
2006	0	0	0.01	0.42	0.91	1	1	1	1	1	1
2007	0	0	0.02	0.52	0.91	1	1	1	1	1	1
2008	0	0	0.01	0.64	0.95	1	1	1	1	1	1
2009	0	0	0.01	0.61	0.93	1	1	1	1	1	1
2010	0	0	0.03	0.65	0.96	1	1	1	1	1	1
2011	0	0	0.09	0.74	0.97	1	1	1	1	1	1
2012	0	0	0.13	0.79	0.99	1	1	1	1	1	1
2013	0	0	0.17	0.83	0.99	1	1	1	1	1	1
2014	0	0	0.17	0.83	1	1	1	1	1	1	1
2015	0	0	0.19	0.9	1	1	1	1	1	1	1
2016	0	0	0.14	0.89	1	1	1	1	1	1	1
2017	0	0	0.12	0.9	1	1	1	1	1	1	1
2018	0	0	0.08	0.80	0.99	1	1	1	1	1	1
2019	0	0	0.21	0.76	0.97	1	1	1	1	1	1
2020	0	0	0.24	0.69	0.95	1	1	1	1	1	1

Table 5.7. Faroe haddock. Spring survey tuning series (number of individuals per 100 stations) and summer survey tuning series (numbers of individuals per 200 stations) used as tuning series in the assessment model.

Spring survey							
Year	**Age 1**	**Age 2**	**Age 3**	**Age 4**	**Age 5**	**Age 6**	**Age 7**
1994	19584.95	2380.56	207.72	322.62	169.51	308.20	414.41
1995	53978.57	21905.74	747.98	234.72	164.36	54.35	158.08
1996	5981.52	35319.54	20186.24	716.49	102.12	77.29	58.57
1997	272.73	7907.90	15993.99	26430.77	689.35	156.07	39.94
1998	3533.88	1359.68	3410.17	9792.94	13430.09	372.01	16.06
1999	4555.20	6952.91	112.76	1499.15	4402.16	3361.94	54.43
2000	29967.78	8695.48	5247.12	222.17	455.29	1686.01	2035.75
2001	27317.40	37138.52	3548.95	1126.13	27.90	111.92	448.01
2002	21041.18	17601.09	26398.34	2088.51	717.88	42.22	107.10
2003	9109.99	22709.63	13017.25	13605.55	855.42	240.61	20.44
2004	1699.15	15554.18	10921.06	7157.62	12092.03	560.05	90.15
2005	5859.86	5455.46	7921.11	6402.22	4678.30	5303.56	269.20
2006	732.72	6206.61	1514.38	4485.32	3326.55	3450.18	1756.37
2007	1257.94	1403.39	3055.62	815.95	2900.21	3078.51	2363.20
2008	691.37	2144.92	782.76	1711.25	611.54	1705.82	1534.32
2009	4157.33	2081.85	1073.28	406.99	940.92	375.79	969.90
2010	6528.81	5191.86	651.55	419.10	197.85	287.49	276.91
2011	103.23	6360.19	1893.70	462.76	268.11	221.49	256.59
2012	439.29	367.60	4957.25	908.04	227.77	142.50	293.35
2013	3513.08	1254.01	263.93	3987.46	674.00	132.21	116.00
2014	3643.42	4175.07	830.45	918.25	2285.83	295.32	100.93
2015	1597.84	3363.12	4089.89	1078.58	2086.55	1373.34	204.49
2016	14092.83	4497.12	2471.24	1381.97	278.55	460.98	114.54
2017	60511.01	15358.50	2763.07	2351.99	713.93	169.90	339.60
2018	85580.40	24602.97	3849.20	1009.64	734.25	267.01	65.81
2019	14547.66	38586.53	21129.77	7090.88	1381.72	768.48	217.57
2020	2521.22	47592.45	24449.45	16663.34	2197.35	868.83	300.86

Summer survey									
Year	**Age 0**	**Age 1**	**Age 2**	**Age 3**	**Age 4**	**Age 5**	**Age 6**	**Age 7**	**Age 8**
1996	375.07	47,759.22	42,901.43	64,256.98	1,277.88	213.98	299.07	248.07	425.46
1997	27.46	7,737.70	14,052.02	25,104.26	49,757.64	976.89	183.48	86.61	175.79
1998	1,484.77	20,209.15	2,762.85	2,501.85	14,016.63	19,433.07	320.61	99.18	81.98
1999	1,441.11	24,140.84	9,549.22	6,383.13	1,619.95	8,472.84	10,331.00	235.36	5.64
2000	5,147.88	169,563.21	19,482.99	7,956.12	390.22	1,299.72	4,695.60	6,007.12	105.17
2001	1,913.36	96,784.20	98,147.35	13,071.95	4,631.77	181.06	647.30	2,714.02	3,428.66
2002	2,046.73	95,406.61	53,532.20	62,497.82	6,157.50	1,973.65	169.62	412.18	1,336.13
2003	260.63	45,045.10	38,176.64	21,475.96	37,993.50	4,369.62	666.63	110.39	466.25
2004	670.23	7,951.41	33,766.22	10,717.98	15,150.84	17,821.70	1,002.83	206.61	26.69
2005	5.73	14,509.66	7,191.19	12,562.85	16,713.24	12,085.49	12,958.34	591.96	42.55
2006	76.42	2,504.28	8,700.40	1,790.00	8,008.98	8,237.30	6,979.66	3,494.06	129.22
2007	24.04	3,986.34	6,586.86	1,744.47	1,565.30	4,322.01	5,364.04	2,731.04	630.36
2008	684.02	4,798.42	1,877.20	1,134.60	2,505.22	1,000.51	3,183.09	3,286.96	1,513.27
2009	4,062.57	10,597.00	1,336.75	411.30	1,302.54	1,273.39	948.13	2,299.72	1,303.78
2010	21.26	24,890.62	3,636.25	1,457.01	1,071.91	575.75	827.88	775.56	1,329.29
2011	32.24	669.93	12,058.69	2,107.80	530.30	485.52	293.68	319.40	423.83
2012	2,733.46	2,453.60	356.96	5,617.18	1,176.14	223.48	148.97	161.11	105.46
2013	156.94	9,446.92	211.63	1,330.08	5,020.65	1,128.75	223.54	113.89	175.68
2014	247.47	13,909.70	3,989.20	890.52	1,033.76	2,943.59	427.92	94.19	84.31
2015	130.67	7,676.15	9,319.60	4,085.51	872.80	1,449.06	1,094.43	128.99	73.67
2016	3,861.49	36,510.61	3,302.94	3,101.37	1,988.92	284.21	567.38	378.31	45.85
2017	4,182.10	144,744.70	16,698.23	1,813.40	2,528.86	1,114.64	293.04	301.62	134.34
2018	4,675.03	135,364.13	54,715.62	12,800.05	4,557.00	3,435.03	1,106.35	528.31	597.60
2019	539.66	38,265.57	6,901.51	13,595.25	9,888.80	2,665.25	1,322.19	510.20	356.30
2020	44.26	13,004.82	3,651.55	11,020.39	12,441.80	1,024.32	463.45	126.45	35.69

Table 5.8 Faroe haddock. Configuration in the SAM-run and the model parameters.

```
$minAge
[1] 1

$maxAge
[1] 10

$maxAgePlusGroup
[1] 1

$keyLogFsta
     [,1] [,2] [,3] [,4] [,5] [,6] [,7] [,8] [,9] [,10]
[1,]    0    1    2    3    4    5    6    7    8     8
[2,]   -1   -1   -1   -1   -1   -1   -1   -1   -1    -1
[3,]   -1   -1   -1   -1   -1   -1   -1   -1   -1    -1

$corFlag
[1] 2

$keyLogFpar
     [,1] [,2] [,3] [,4] [,5] [,6] [,7] [,8] [,9] [,10]
[1,]   -1   -1   -1   -1   -1   -1   -1   -1   -1    -1
[2,]    0    1    2    3    4    5    6    6   -1    -1
[3,]    7    8    9   10   11   12   12   -1   -1    -1

$keyQpow
     [,1] [,2] [,3] [,4] [,5] [,6] [,7] [,8] [,9] [,10]
[1,]   -1   -1   -1   -1   -1   -1   -1   -1   -1    -1
[2,]   -1   -1   -1   -1   -1   -1   -1   -1   -1    -1
[3,]   -1   -1   -1   -1   -1   -1   -1   -1   -1    -1

$keyVarF
     [,1] [,2] [,3] [,4] [,5] [,6] [,7] [,8] [,9] [,10]
[1,]    0    0    0    0    0    0    0    0    0     0
[2,]   -1   -1   -1   -1   -1   -1   -1   -1   -1    -1
[3,]   -1   -1   -1   -1   -1   -1   -1   -1   -1    -1

$keyVarLogN
 [1] 0 1 1 1 1 1 1 1 1 1

$keyVarObs
     [,1] [,2] [,3] [,4] [,5] [,6] [,7] [,8] [,9] [,10]
[1,]    0    0    0    0    0    0    0    0    0     0
[2,]    1    1    1    1    1    1    1    1   -1    -1
[3,]    2    2    2    2    2    2    2   -1   -1    -1

$obsCorStruct
[1] ID AR AR
Levels: ID AR US

$keyCorObs
     1-2 2-3 3-4 4-5 5-6 6-7 7-8 8-9 9-10
[1,]  NA  NA  NA  NA  NA  NA  NA  NA   NA
[2,]   0   0   0   0   0   0   0  -1   -1
[3,]   1   1   1   1   1   1   1  -1   -1

$stockRecruitmentModelCode
[1] 0

$noScaledYears
[1] 0

$keyScaledYears
numeric(0)
```

```
$keyParScaledYA
<0 x 0 matrix>

$fbarRange
[1] 3 7

$keyBiomassTreat
[1] -1 -1 -1

$obsLikelihoodFlag
[1] LN LN LN
Levels: LN ALN

$fixVarToWeight
[1] 0
```

Table 5.9 Faroe haddock 2018. Changes in the SAM settings to incorporate the different variance on age 1–2 in summer survey and age 1 in spring survey.

Default settings:

```
$keyVarObs
     [,1] [,2] [,3] [,4] [,5] [,6] [,7] [,8] [,9] [,10]
[1,]    0    0    0    0    0    0    0    0    0     0
[2,]    1    1    1    1    1    1    1    1   -1    -1
[3,]    2    2    2    2    2    2    2   -1   -1    -1
```

Revised settings:

```
$keyVarObs
     [,1] [,2] [,3] [,4] [,5] [,6] [,7] [,8] [,9] [,10]
[1,]    0    0    0    0    0    0    0    0    0     0
[2,]    1    1    2    2    2    2    2    2   -1    -1
[3,]    3    4    4    4    4    4    4   -1   -1    -1
```

Table 5.10 Faroe haddock. Model parameters, model fitting and selected sd from SAM run.

Parameter name	par	sd(par)	exp(par)	Low	High
logFpar_0	-4.834	0.181	0.008	0.006	0.011
logFpar_1	-5.543	0.169	0.004	0.003	0.005
logFpar_2	-5.631	0.116	0.004	0.003	0.005
logFpar_3	-5.478	0.112	0.004	0.003	0.005
logFpar_4	-5.526	0.111	0.004	0.003	0.005
logFpar_5	-5.478	0.112	0.004	0.003	0.005
logFpar_6	-5.374	0.111	0.005	0.004	0.006
logFpar_7	-5.604	0.221	0.004	0.002	0.006
logFpar_8	-5.080	0.142	0.006	0.005	0.008
logFpar_9	-5.597	0.131	0.004	0.003	0.005
logFpar_10	-5.590	0.126	0.004	0.003	0.005
logFpar_11	-5.731	0.122	0.003	0.003	0.004
logFpar_12	-5.800	0.114	0.003	0.002	0.004
logSdLogFsta_0	-0.921	0.100	0.398	0.326	0.486
logSdLogN_0	-0.056	0.112	0.945	0.756	1.181
logSdLogN_1	-1.257	0.089	0.284	0.238	0.340
logSdLogObs_0	-1.119	0.087	0.327	0.275	0.389
logSdLogObs_1	-0.378	0.124	0.685	0.535	0.878
logSdLogObs_2	-0.951	0.080	0.386	0.329	0.454
logSdLogObs_3	-0.019	0.166	0.981	0.704	1.368
logSdLogObs_4	-0.597	0.083	0.551	0.466	0.650
transfIRARdist_0	0.699	0.299	2.013	1.106	3.662
transfIRARdist_1	-0.129	0.244	0.879	0.539	1.432
itrans_rho_0	1.235	0.122	3.440	2.694	4.391

Model	log(L)	#par	AIC
Current	-964.81	24	1977.62
base	-964.81	24	1977.62

Year	sd(log(R))	sd(log(SSB))	sd(log(Fbar))
2019	0.379	0.148	0.181
2020	0.561	0.198	0.745

Table 5.11. Faroe haddock (Division 5.b.). Fishing mortality at age from the SAM model.

Year Age	1	2	3	4	5	6	7	8	9	10
1957	0.003	0.121	0.343	0.492	0.390	0.482	0.740	0.745	0.843	0.843
1958	0.005	0.174	0.447	0.608	0.497	0.641	1.025	1.078	1.290	1.290
1959	0.007	0.190	0.448	0.574	0.472	0.629	1.033	1.129	1.406	1.406
1960	0.010	0.232	0.534	0.672	0.545	0.719	1.194	1.303	1.599	1.599
1961	0.010	0.216	0.475	0.578	0.465	0.606	0.996	1.123	1.307	1.307
1962	0.010	0.237	0.534	0.649	0.516	0.661	1.087	1.337	1.554	1.554
1963	0.008	0.219	0.529	0.691	0.566	0.709	1.184	1.656	2.025	2.025
1964	0.004	0.109	0.309	0.466	0.420	0.546	0.872	1.364	1.613	1.613
1965	0.003	0.091	0.278	0.447	0.431	0.626	1.116	1.748	1.808	1.808
1966	0.003	0.088	0.278	0.444	0.418	0.589	1.003	1.342	1.503	1.503
1967	0.002	0.071	0.231	0.362	0.340	0.490	0.847	1.070	1.309	1.309
1968	0.002	0.088	0.280	0.412	0.366	0.506	0.851	0.982	1.230	1.230
1969	0.003	0.097	0.325	0.484	0.432	0.589	0.983	1.036	1.296	1.296
1970	0.003	0.082	0.302	0.444	0.407	0.517	0.801	0.696	0.749	0.749
1971	0.002	0.072	0.304	0.450	0.441	0.524	0.804	0.737	0.893	0.893
1972	0.002	0.072	0.328	0.440	0.418	0.426	0.613	0.576	0.762	0.762
1973	0.004	0.114	0.428	0.482	0.397	0.341	0.378	0.323	0.349	0.349
1974	0.003	0.078	0.293	0.363	0.305	0.281	0.306	0.313	0.380	0.380
1975	0.002	0.057	0.224	0.292	0.258	0.241	0.253	0.304	0.418	0.418
1976	0.001	0.043	0.202	0.311	0.323	0.342	0.357	0.445	0.578	0.578
1977	0.001	0.017	0.123	0.266	0.390	0.511	0.597	0.821	1.145	1.145
1978	0.000	0.007	0.070	0.180	0.293	0.408	0.547	0.823	1.165	1.165
1979	0.000	0.006	0.060	0.149	0.219	0.266	0.330	0.487	0.674	0.674
1980	0.000	0.015	0.121	0.261	0.318	0.320	0.339	0.446	0.575	0.575
1981	0.001	0.018	0.140	0.273	0.298	0.268	0.240	0.270	0.332	0.332
1982	0.001	0.033	0.243	0.434	0.459	0.400	0.335	0.388	0.473	0.473
1983	0.001	0.030	0.199	0.364	0.389	0.379	0.327	0.418	0.502	0.502
1984	0.001	0.029	0.171	0.316	0.332	0.352	0.286	0.402	0.489	0.489
1985	0.001	0.028	0.164	0.311	0.357	0.408	0.330	0.483	0.594	0.594
1986	0.000	0.021	0.125	0.250	0.316	0.395	0.366	0.592	0.723	0.723
1987	0.000	0.025	0.134	0.259	0.340	0.455	0.484	0.716	0.808	0.808
1988	0.000	0.021	0.111	0.213	0.280	0.361	0.394	0.533	0.635	0.635
1989	0.000	0.016	0.104	0.209	0.299	0.414	0.514	0.681	0.830	0.830
1990	0.000	0.022	0.143	0.263	0.336	0.453	0.572	0.722	0.953	0.953
1991	0.000	0.029	0.172	0.291	0.323	0.388	0.439	0.462	0.544	0.544
1992	0.000	0.026	0.143	0.252	0.280	0.318	0.349	0.357	0.426	0.426
1993	0.001	0.037	0.191	0.304	0.294	0.292	0.293	0.282	0.318	0.318
1994	0.000	0.017	0.117	0.233	0.259	0.282	0.301	0.302	0.334	0.334
1995	0.000	0.016	0.119	0.258	0.304	0.327	0.351	0.345	0.361	0.361

Year Age	1	2	3	4	5	6	7	8	9	10
1996	0.000	0.012	0.111	0.272	0.360	0.420	0.473	0.457	0.442	0.442
1997	0.000	0.013	0.121	0.262	0.380	0.493	0.620	0.619	0.570	0.570
1998	0.000	0.024	0.208	0.362	0.489	0.693	0.983	1.110	0.892	0.892
1999	0.000	0.028	0.261	0.397	0.486	0.643	0.902	1.292	0.928	0.928
2000	0.001	0.038	0.283	0.396	0.431	0.483	0.532	0.676	0.534	0.534
2001	0.000	0.031	0.227	0.359	0.408	0.429	0.409	0.454	0.401	0.401
2002	0.000	0.024	0.182	0.329	0.425	0.488	0.474	0.521	0.529	0.529
2003	0.000	0.013	0.115	0.260	0.437	0.650	0.746	0.812	0.888	0.888
2004	0.000	0.014	0.113	0.244	0.424	0.690	0.955	1.128	1.322	1.322
2005	0.000	0.017	0.124	0.244	0.396	0.618	0.904	1.124	1.412	1.412
2006	0.001	0.023	0.151	0.260	0.378	0.569	0.857	1.078	1.588	1.588
2007	0.001	0.028	0.175	0.275	0.355	0.489	0.721	0.945	1.246	1.246
2008	0.001	0.028	0.172	0.266	0.305	0.404	0.602	0.850	1.238	1.238
2009	0.001	0.022	0.169	0.266	0.287	0.350	0.467	0.594	0.838	0.838
2010	0.001	0.034	0.256	0.386	0.393	0.456	0.575	0.686	0.969	0.969
2011	0.000	0.023	0.200	0.335	0.367	0.438	0.584	0.697	0.994	0.994
2012	0.000	0.017	0.146	0.252	0.300	0.363	0.476	0.576	0.809	0.809
2013	0.000	0.030	0.219	0.302	0.335	0.388	0.506	0.616	0.841	0.841
2014	0.000	0.035	0.239	0.325	0.351	0.357	0.413	0.452	0.586	0.586
2015	0.000	0.036	0.238	0.326	0.354	0.360	0.380	0.406	0.507	0.507
2016	0.000	0.029	0.197	0.301	0.354	0.375	0.376	0.395	0.437	0.437
2017	0.000	0.011	0.092	0.177	0.234	0.268	0.292	0.319	0.307	0.307
2018	0.000	0.012	0.106	0.209	0.273	0.294	0.299	0.285	0.226	0.226
2019	0.000	0.010	0.098	0.237	0.352	0.383	0.373	0.282	0.149	0.149
2020	0.000	0.017	0.191	0.521	0.918	1.055	1.102	0.795	0.358	0.358

Table 5.12 Faroe haddock (Division 5.b). Stock number at age from the SAM model.

Year Age	1	2	3	4	5	6	7	8	9	10
1957	26820	36850	25505	21011	5421	2609	1227	470	201	118
1958	31703	30905	25205	14218	9578	2981	1339	481	183	129
1959	59229	28861	23334	12773	6284	4395	1270	389	134	68
1960	77343	39008	24200	13439	6229	3303	1793	378	104	39
1961	79034	54085	23729	12825	5741	3043	1353	412	89	22
1962	78269	51112	35472	12316	6521	3031	1368	400	108	27
1963	40403	61218	26725	16419	5488	3577	1270	369	85	25
1964	18221	28748	33057	11429	6563	2594	1718	302	60	11
1965	17660	16894	20922	17214	5195	3097	1146	836	63	11
1966	33079	15189	14082	13616	8412	2719	1271	299	97	11
1967	47321	25104	12629	9311	7091	4128	1210	358	68	19
1968	28342	49118	19035	8990	5628	4231	1919	419	102	19
1969	32483	26250	33393	11997	5278	3471	2148	666	131	29
1970	20273	25902	20776	19534	5789	3219	1651	682	199	29
1971	24127	13969	20030	13557	9931	3215	1607	516	280	123
1972	27140	19106	10471	13228	7336	5027	1501	576	186	142
1973	121306	24401	20131	4700	7791	3609	3262	595	313	81
1974	110652	80846	15309	12060	2240	4170	1966	2029	314	343
1975	70384	93556	49065	9345	6772	1453	2416	1120	1273	455
1976	27558	69416	53594	28185	5831	4296	1114	1854	701	938
1977	10193	20165	44464	29248	14963	3979	2417	774	1032	955
1978	957	9443	16973	29353	17230	6757	1686	1095	312	488
1979	6091	535	14262	13705	18775	9757	3270	639	362	184
1980	6189	6319	638	14697	10090	11580	6188	1821	270	211
1981	18038	4604	4258	747	10711	6127	7215	3742	838	182
1982	21259	16022	3441	2742	636	7361	3819	4488	3003	615
1983	46165	16455	12536	1608	1439	349	4617	2259	2639	2047
1984	41009	40956	12442	8584	749	791	220	2662	1185	2589
1985	19889	34692	32107	9019	4667	442	422	172	1352	2086
1986	13608	15774	26038	21467	5687	2488	204	262	110	1548
1987	25284	10173	15117	18894	12873	3358	1280	132	108	670
1988	9518	23910	6249	12984	12897	7782	1734	532	48	294
1989	7185	7313	16483	4402	9666	8257	4625	1012	261	154
1990	3259	6158	8263	10249	3117	5659	4625	2103	391	157
1991	2767	2520	5802	6843	5935	2026	3018	2153	847	127
1992	4091	2153	1664	3962	4464	3706	1168	1493	1156	480
1993	28915	2906	1916	1203	2563	2687	2253	666	859	839
1994	25899	11948	1750	1463	769	1678	1780	1509	447	1115
1995	45828	43198	5275	1128	927	515	1127	1129	952	1004

Year Age	1	2	3	4	5	6	7	8	9	10
1996	11088	38198	59609	3252	599	511	401	761	704	1222
1997	4345	8588	32312	54327	1930	353	238	261	465	1184
1998	15483	3541	6419	23152	34580	1017	136	133	139	862
1999	28580	13732	2630	3948	14788	17893	436	27	36	363
2000	130661	25657	13899	915	2266	7753	8585	161	4	147
2001	58546	116284	18836	8018	460	1309	3977	4705	64	68
2002	38312	48694	96503	10691	3899	328	789	2400	2805	79
2003	25407	25792	35976	60639	6172	1768	218	597	1357	1553
2004	8036	23033	22906	25590	37179	2737	639	105	228	1060
2005	10170	6150	18461	20253	19813	18592	1114	197	34	277
2006	3201	9523	3945	13427	13990	12704	6697	338	62	70
2007	3282	2825	6184	2736	9021	9103	6036	1845	124	18
2008	4222	2770	1994	4239	1948	5444	4652	2349	502	43
2009	8709	2457	1907	1595	2532	1600	3366	1967	685	111
2010	11986	7545	2042	1438	980	1412	1246	1756	822	278
2011	1117	11075	4513	1122	757	600	657	714	653	326
2012	2594	953	9858	2318	587	374	378	256	310	263
2013	8665	2230	1707	6758	1205	332	218	190	123	210
2014	10385	7283	1923	1971	3858	518	185	111	57	109
2015	9007	8713	6239	1291	1945	1470	215	103	56	61
2016	29690	7549	6574	3375	768	1281	540	91	60	46
2017	36812	19776	5243	4755	1845	518	680	248	50	47
2018	48034	38581	16527	4586	3183	1077	410	430	115	49
2019	30788	31677	30413	11795	3433	1753	519	331	234	56
2020	9946	27296	27217	25859	5272	2021	762	191	204	205

Table 5.13 Faroe haddock (Division 5.b). Summary table from the SAM model (catch is also provided).

Year	Recruitment	High	Low	SSB	High	Low	Catch	F	High	Low
	Age 1 thousands			tonnes			tonnes	Ages 3–7		
1957	26820	51017	14099	50418	66163	38420	20995	0.49	0.67	0.36
1958	31703	57612	17446	50614	64275	39857	23871	0.64	0.84	0.49
1959	59229	105893	33129	45313	56972	36039	20239	0.63	0.82	0.49
1960	77343	138341	43241	45384	56662	36351	25727	0.73	0.94	0.57
1961	79034	142556	43817	42668	53477	34044	20831	0.62	0.81	0.48
1962	78269	141355	43338	47440	59375	37905	27151	0.69	0.89	0.53
1963	40403	73345	22256	47955	60573	37965	27571	0.74	0.95	0.57
1964	18221	33315	9966	44624	57081	34886	19490	0.52	0.69	0.40
1965	17660	32356	9639	44963	57909	34911	18479	0.58	0.76	0.44
1966	33079	60506	18084	41982	54265	32479	18766	0.55	0.72	0.42
1967	47321	86617	25853	38015	48649	29705	13381	0.45	0.60	0.34
1968	28342	51776	15514	40519	50840	32293	17852	0.48	0.64	0.37
1969	32483	59217	17819	47315	59551	37593	23272	0.56	0.74	0.43
1970	20273	37055	11092	49985	64466	38757	21361	0.49	0.66	0.37
1971	24127	44056	13213	49672	63849	38643	19393	0.51	0.68	0.37
1972	27140	49693	14822	45366	58757	35027	16485	0.45	0.61	0.32
1973	121306	229078	64236	42510	54809	32971	18035	0.41	0.56	0.29
1974	110652	209584	58420	44251	56769	34494	14773	0.31	0.43	0.22
1975	70384	134511	36829	57234	73924	44312	20715	0.25	0.36	0.181
1976	27558	53426	14215	80503	105922	61184	26211	0.31	0.43	0.22
1977	10193	22733	4570	82523	109790	62028	25555	0.38	0.53	0.27
1978	957	2170	422	80178	109241	58847	19200	0.30	0.43	0.21
1979	6091	11981	3096	62983	85784	46243	12424	0.21	0.30	0.140
1980	6189	13058	2934	57950	77448	43361	15016	0.27	0.39	0.190
1981	18038	38076	8545	52313	70325	38914	12233	0.24	0.34	0.173
1982	21259	44959	10052	40659	52890	31256	11937	0.37	0.52	0.27
1983	46165	98130	21718	37790	49320	28955	12894	0.33	0.47	0.24
1984	41009	80526	20884	41236	53171	31981	12378	0.29	0.41	0.21
1985	19889	42397	9330	49483	65354	37467	15143	0.31	0.44	0.22
1986	13608	29112	6361	54297	73062	40352	14477	0.29	0.41	0.21
1987	25284	54471	11736	54040	72263	40412	14882	0.34	0.47	0.24
1988	9518	20448	4430	49075	65248	36911	12178	0.27	0.38	0.195
1989	7185	15294	3376	42115	54830	32349	14325	0.31	0.43	0.22
1990	3259	6908	1538	34870	44978	27034	11726	0.35	0.50	0.25
1991	2767	5846	1310	26963	35138	20690	8429	0.32	0.46	0.23
1992	4091	8697	1924	20106	26584	15206	5476	0.27	0.38	0.188
1993	28915	57344	14580	17332	22960	13083	4026	0.28	0.39	0.196

Year	Recruitment	High	Low	SSB	High	Low	Catch	F	High	Low
	Age 1 thousands			tonnes			tonnes	Ages 3–7		
1994	25899	48501	13830	16566	21528	12748	4252	0.24	0.33	0.172
1995	45828	88783	23655	17756	22376	14090	4948	0.27	0.37	0.199
1996	11088	19129	6428	39355	51068	30328	9642	0.33	0.44	0.25
1997	4345	7998	2361	74261	98088	56222	17924	0.38	0.50	0.28
1998	15483	27871	8601	71880	92562	55820	22210	0.55	0.72	0.42
1999	28580	48262	16924	50779	64682	39865	18482	0.54	0.70	0.41
2000	130661	221664	77020	38998	48587	31300	15799	0.43	0.56	0.32
2001	58546	99582	34421	49607	60037	40988	15891	0.37	0.49	0.28
2002	38312	69746	21045	80146	101095	63539	24929	0.38	0.50	0.29
2003	25407	46022	14027	93699	120944	72591	26942	0.44	0.58	0.34
2004	8036	13810	4676	79205	100560	62385	23100	0.49	0.64	0.37
2005	10170	18324	5644	65202	80769	52635	21944	0.46	0.60	0.35
2006	3201	5778	1773	47723	58420	38985	17154	0.44	0.58	0.34
2007	3282	5912	1822	33274	40505	27335	12631	0.40	0.53	0.31
2008	4222	7395	2410	21829	26345	18087	7393	0.35	0.46	0.26
2009	8709	15685	4835	16285	19608	13526	5197	0.31	0.41	0.23
2010	11986	21789	6594	12614	14995	10610	5203	0.41	0.55	0.31
2011	1117	2095	596	10054	12085	8364	3546	0.39	0.52	0.29
2012	2594	4732	1422	12173	15515	9551	2634	0.31	0.42	0.23
2013	8665	15681	4788	12839	16544	9964	2924	0.35	0.48	0.26
2014	10385	18728	5758	11364	14395	8972	3252	0.34	0.46	0.25
2015	9007	16371	4956	14346	17971	11453	3421	0.33	0.46	0.24
2016	29690	51903	16983	15493	19529	12291	3470	0.32	0.45	0.23
2017	36812	67126	20187	18282	23186	14416	2863	0.21	0.30	0.151
2018	48034	91863	25116	33685	43695	25968	5549	0.24	0.33	0.168
2019	30788	65741	14418	52245	70306	38824	9334	0.29	0.41	0.20
2020	9946	30514	3242	53760	79871	36185				

Table 5.14 Faroe haddock (Division 5.b). Prediction tables with different F scenarios.

Forecast table 1. TAC 7146 in 2020, then Fmsy=0.165.

Year	fbar:median	fbar:low	fbar:high	rec:median	rec:low	rec:high	ssb:median	ssb:low	ssb:high	catch:median	catch:low	catch:high	tsb:median	tsb:low	tsb:high
2020	0.162	0.035	0.722	10207	3244	32531	55080	38012	80118	7147	1540	28747	80006	54256	116467
2021	0.165	0.033	0.952	10277	1117	130661	90392	56238	145627	11440	2415	41822	107247	65062	169470
2022	0.165	0.024	1.146	10170	1117	130661	94854	46483	174184	14448	2661	45406	112890	58464	209191
2023	0.165	0.021	1.254	10170	1117	130661	96132	34438	204423	14297	2364	43339	114934	47750	238498

Forecast table 4. TAC then Fpa.

Year	fbar:median	fbar:low	fbar:high	rec:median	rec:low	rec:high	ssb:median	ssb:low	ssb:high	catch:median	catch:low	catch:high	tsb:median	tsb:low	tsb:high
2020	0.162	0.035	0.722	10207	3244	32531	55080	38012	80118	7147	1540	28747	80006	54256	116467
2021	0.400	0.081	2.307	10277	1117	130661	90392	56238	145627	24277	5760	69898	107247	65062	169470
2022	0.400	0.058	2.778	10170	1117	130661	79692	31127	158850	22960	5801	54825	96734	43757	188956
2023	0.400	0.050	3.040	10170	1117	130661	70770	17289	179203	18191	4581	47188	89782	27589	208263

Forecast table 5. TAC then Flim.

Year	fbar:median	fbar:low	fbar:high	rec:median	rec:low	rec:high	ssb:median	ssb:low	ssb:high	catch:median	catch:low	catch:high	tsb:median	tsb:low	tsb:high
2020	0.162	0.035	0.722	10207	3244	32531	55080	38012	80118	7147	1540	28747	80006	54256	116467
2021	0.540	0.109	3.115	10277	1117	130661	90392	56238	145627	30378	7703	81069	107247	65062	169470
2022	0.540	0.078	3.751	10170	1117	130661	72440	25540	150578	24958	7308	57448	90034	37630	181658
2023	0.540	0.068	4.104	10170	1117	130661	60561	13232	168291	18217	5286	46954	79735	22686	198716

Forecast table 2. TAC then zero.

Year	fbar:median	fbar:low	fbar:high	rec:median	rec:low	rec:high	ssb:median	ssb:low	ssb:high	catch:median	catch:low	catch:high	tsb:median	tsb:low	tsb:high
2020	0.162	0.035	0.722	10207	3244	32531	55080	38012	80118	7147	1540	28747	80006	54256	116467
2021	0.000	0.000	0.000	10277	1117	130661	90392	56238	145627	0	0	0	107247	65062	169470
2022	0.000	0.000	0.000	10170	1117	130661	110764	63906	192264	0	0	1	129588	74293	221244
2023	0.000	0.000	0.000	10170	1117	130661	129839	68619	250850	0	0	1	150427	77646	278349

Forecast table 6. TAC 7146 in 2020, then SQ.

Year	fbar:median	fbar:low	fbar:high	rec:median	rec:low	rec:high	ssb:median	ssb:low	ssb:high	catch:median	catch:low	catch:high	tsb:median	tsb:low	tsb:high
2020	0.162	0.041	0.628	10249	3406	29861	55476	37246	82945	7146	1929	24615	80554	51661	122011
2021	0.167	0.035	0.745	10385	1117	130661	90135	54717	154917	11585	2403	39854	106481	63465	175623
2022	0.167	0.034	0.934	10170	1117	130661	95787	48399	169188	14074	3192	45100	112266	61754	205381
2023	0.169	0.027	1.110	10385	1117	130661	96334	37961	195569	14294	2949	46609	115566	48316	238157

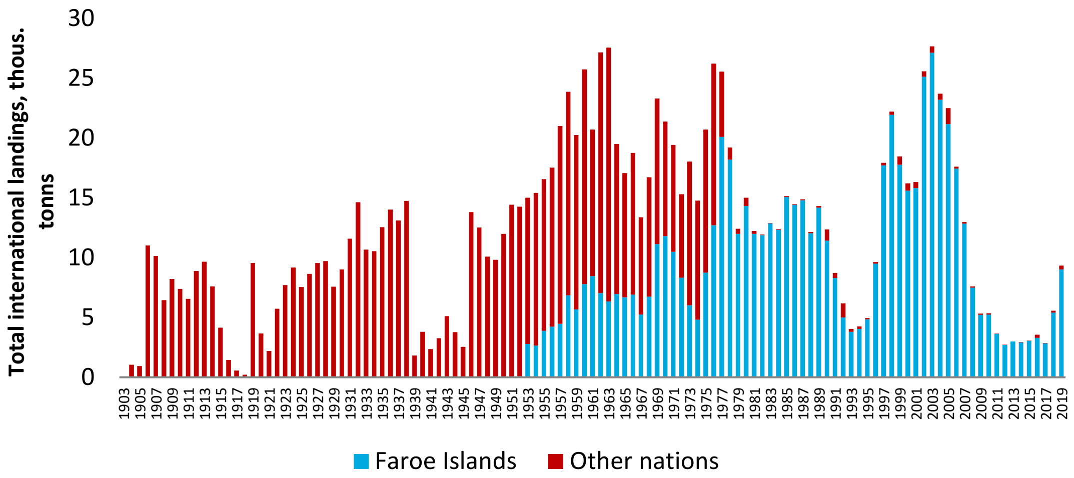


Figure 5.1. Haddock in ICES Division 5.b. Landings by all nations 1904–2019.

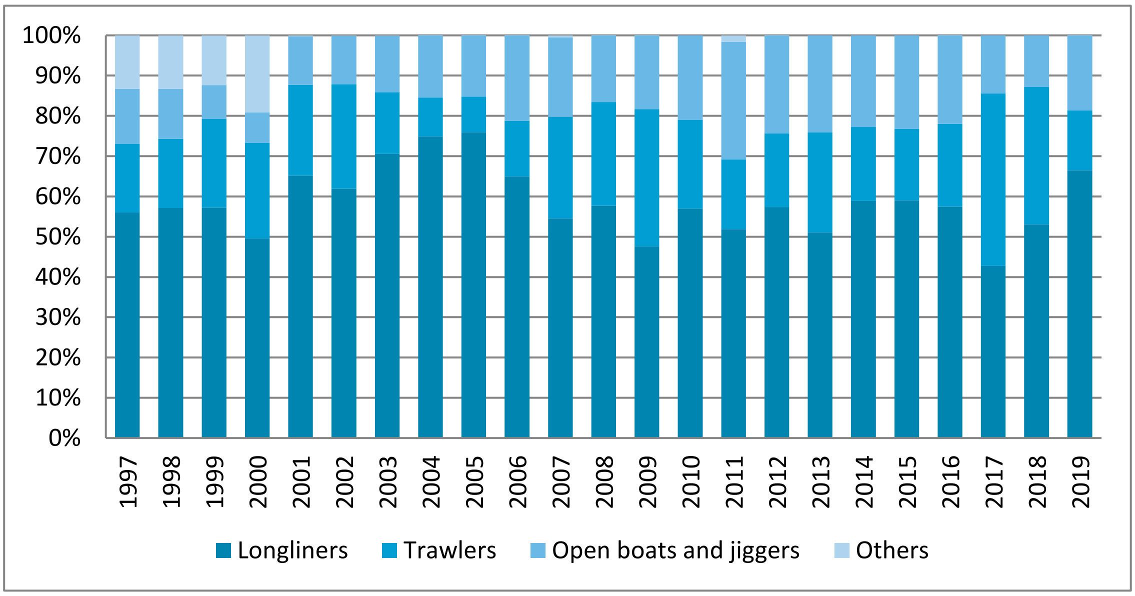


Figure 5.2. Faroe haddock. Distribution (%) between trawlers and longliners to the total Faroese landings 1997–2019.

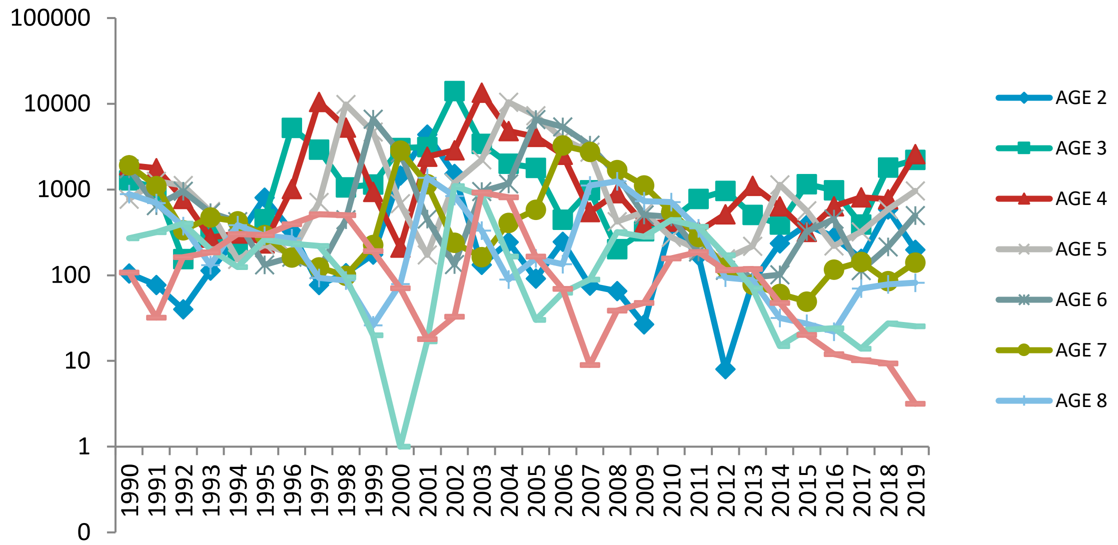


Figure 5.3. Faroe Haddock. Catch in numbers at age shown in catch curves.

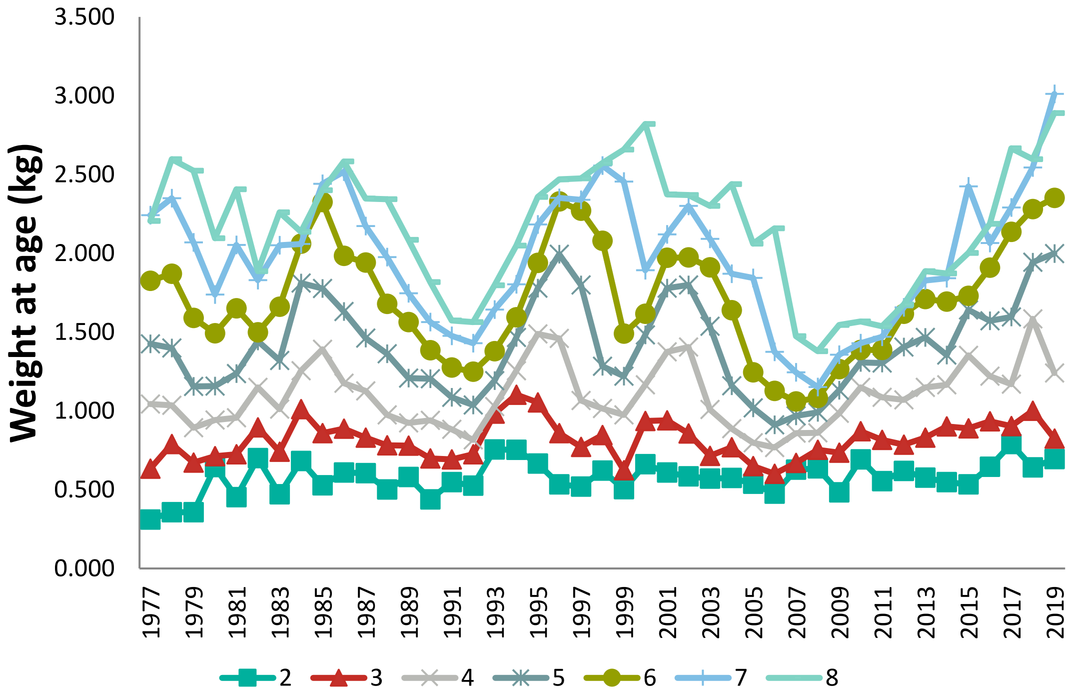


Figure 5.4. Faroe haddock. Mean weight (kg) at age (2–8).

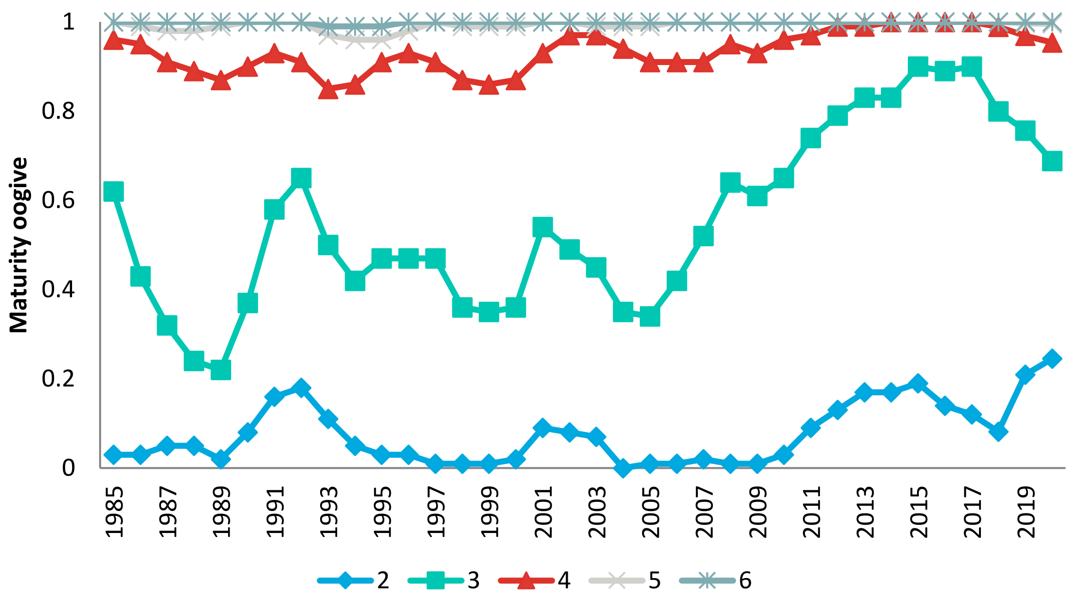


Figure 5.5. Faroe haddock. Maturity at age since 1985. Running 3-years average of spring survey observations for ages 2–6.

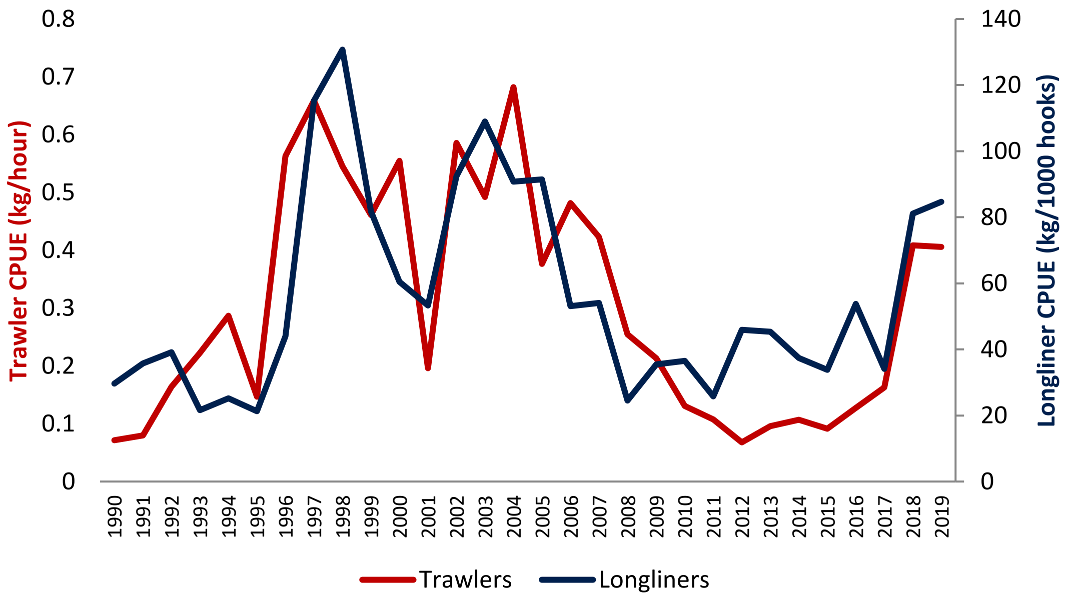
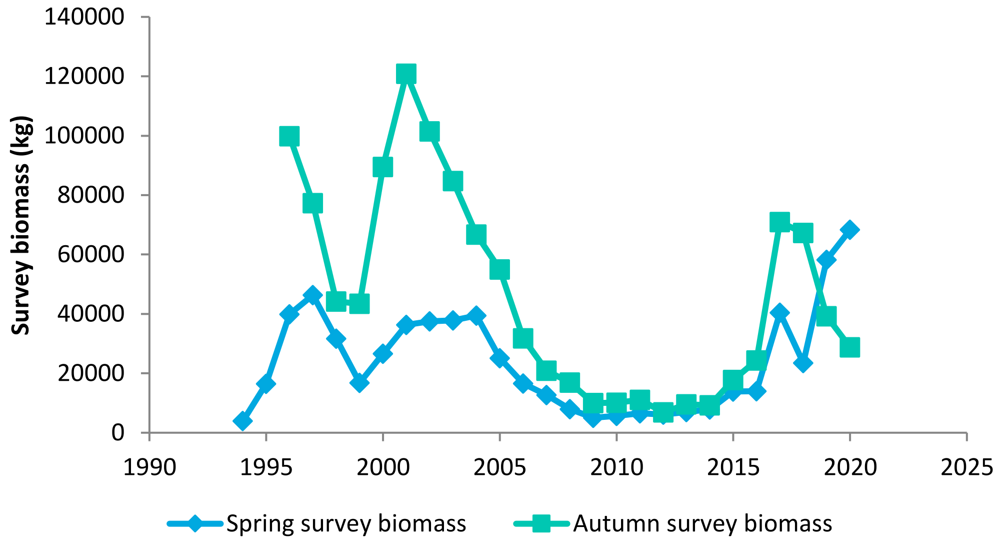


Figure 5.6. Commercial CPUEs for trawlers and longliners.



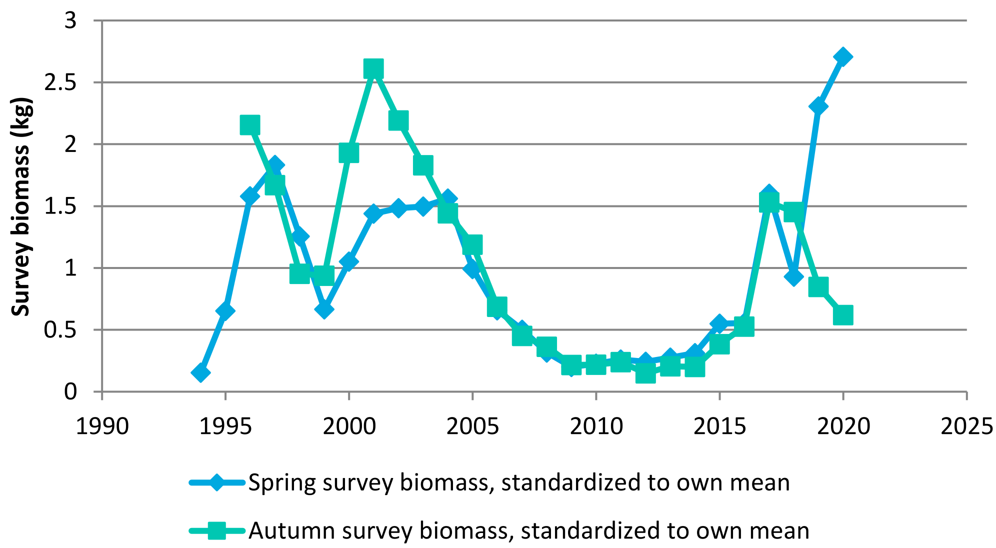


Figure 5.7. Tuning series biomass for spring surveys (1994-2020) and summer surveys (1996–2020). The total biomass (kg) for each series is shown on the first figure and on the second figure the biomass is standardised to series mean biomass.

Figure 5.8a. Distribution of Faroe haddock catches in the spring survey.

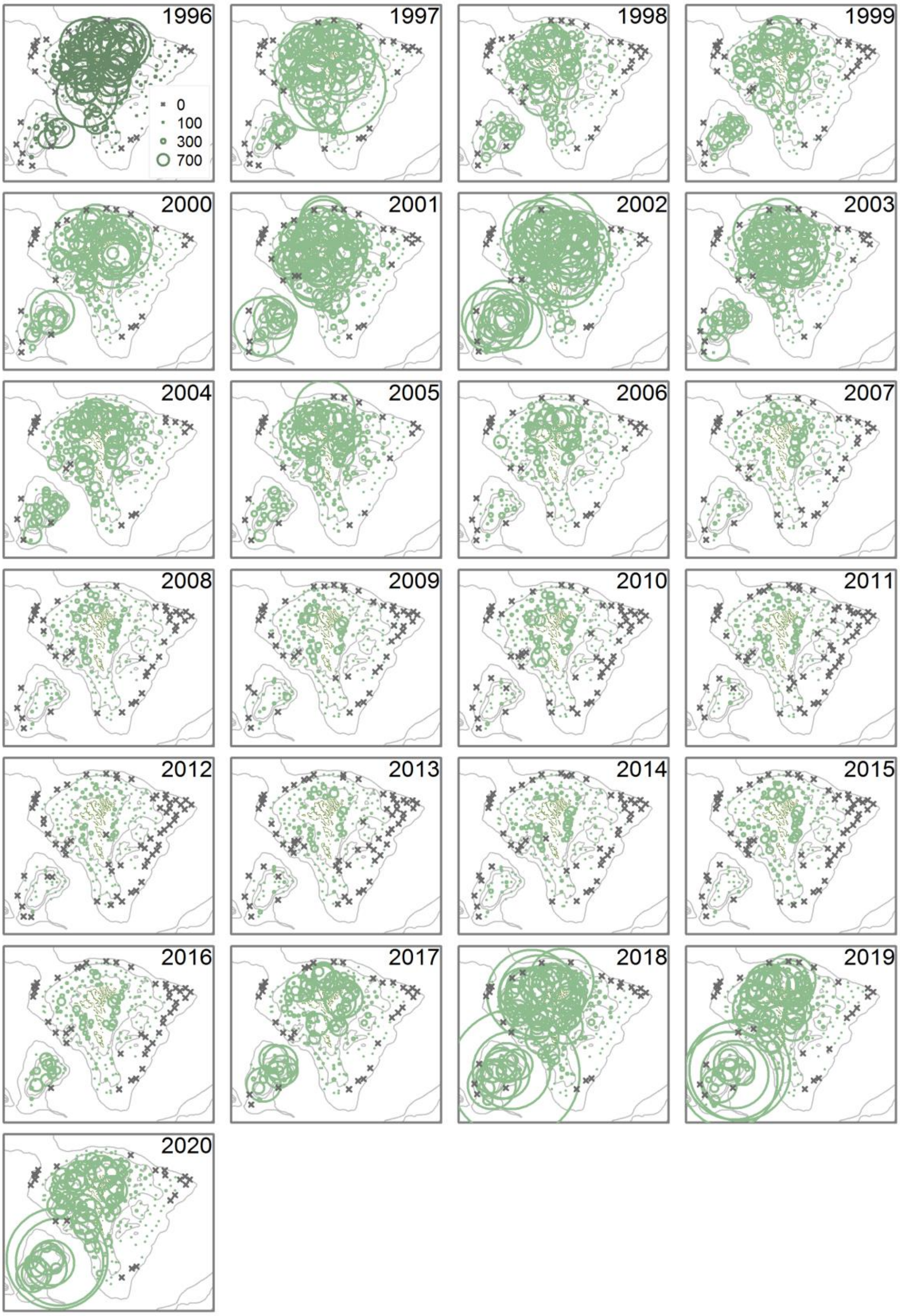


Figure 5.8b. Distribution of Faroe haddock catches in the summer survey.

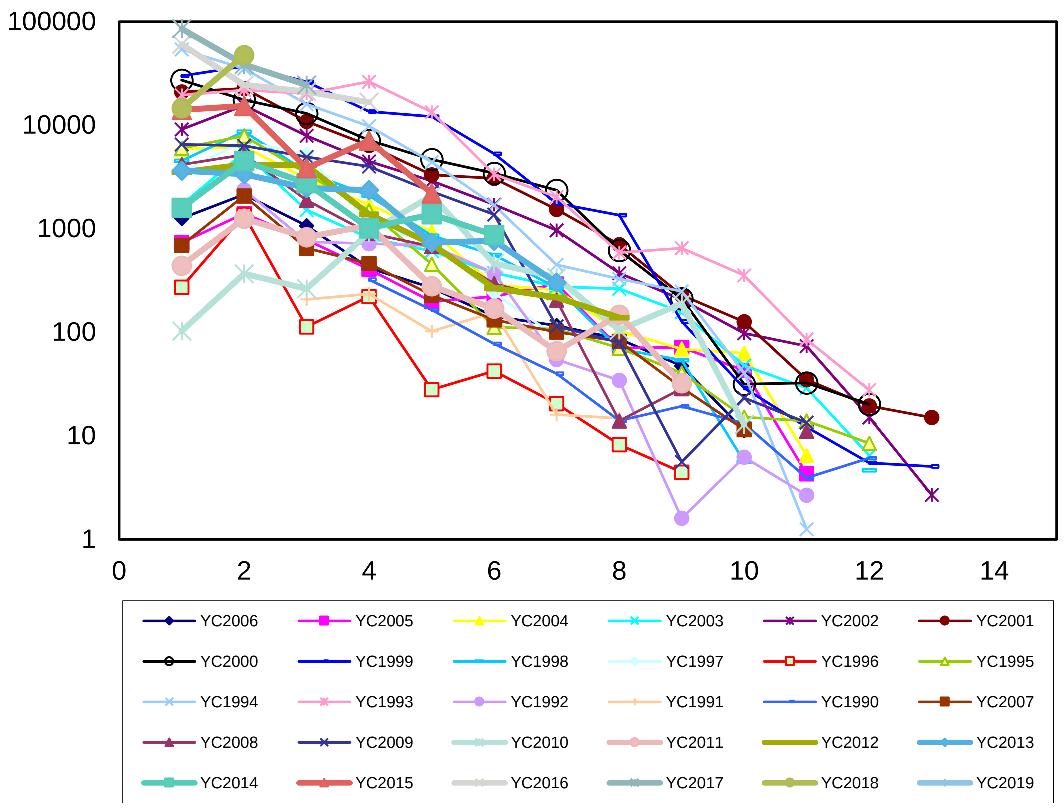


Figure 5.9. Faroe haddock. LN (catch at age in numbers) in the spring survey 1994–2020.

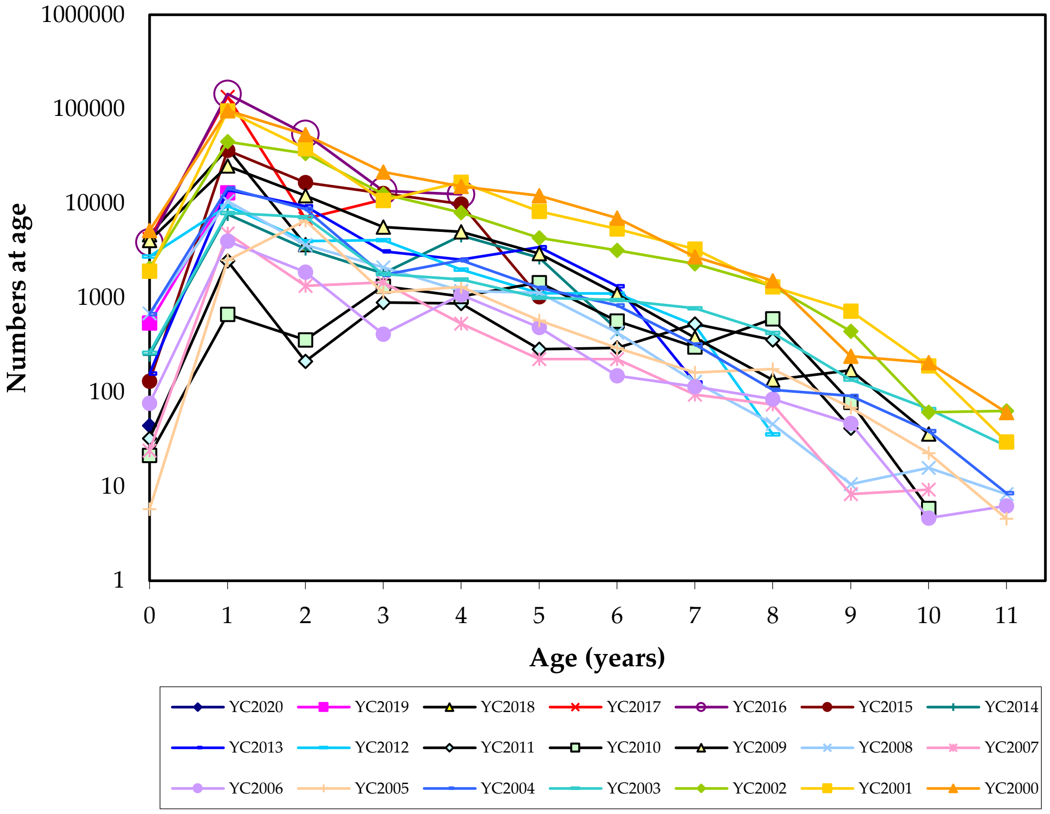


Figure 5.10. Faroe haddock. LN (catch at age in numbers) in the summer survey 2000–2020.

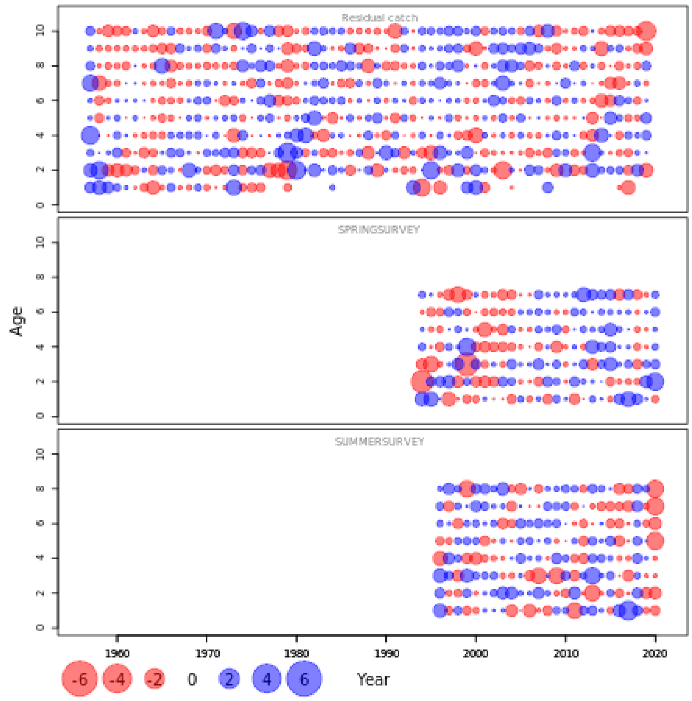


Figure 5.11. Faroe haddock (Division 5.b). Observation residuals for the catch, spring survey and the summer survey as estimated by the SAM model.

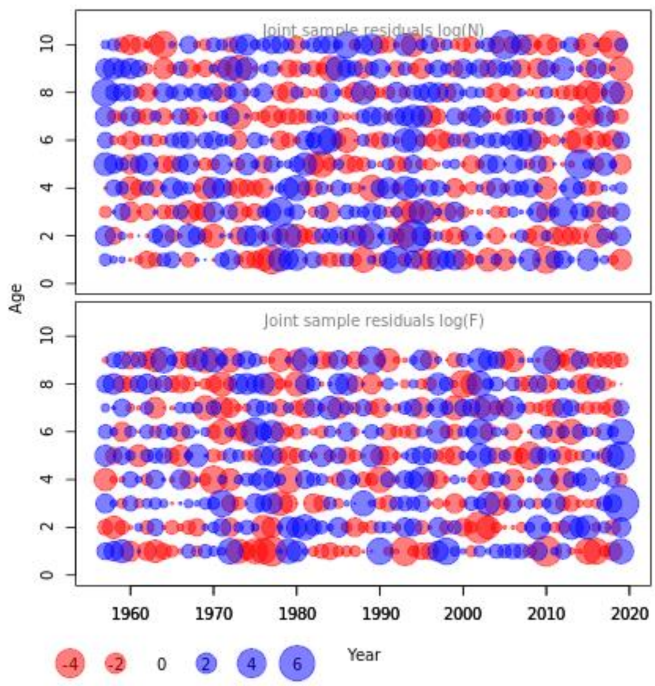


Figure 5.12. Faroe haddock (Division 5.b). Joint sample residuals for the population numbers and fishing mortality as estimated by the SAM model.

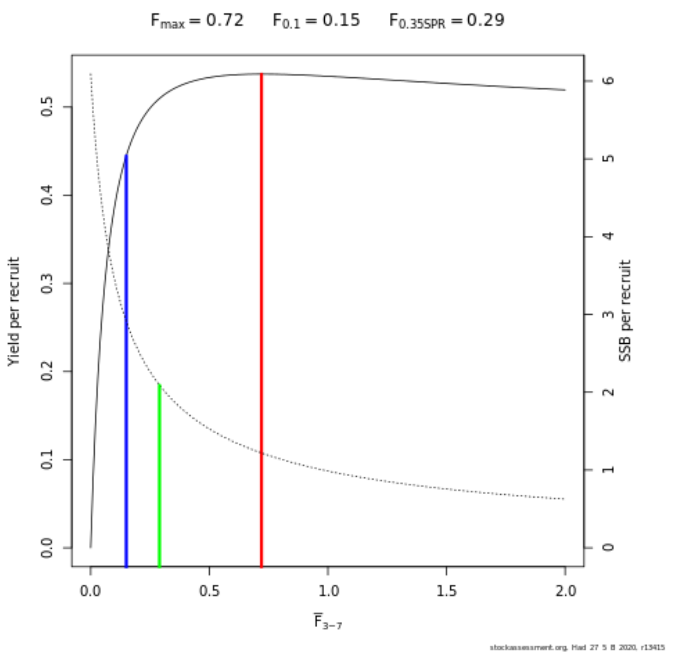


Figure 5.13. Faroe haddock (Division 5.b). Yield per recruit and spawning stock biomass (SSB) per recruit versus fishing mortality.

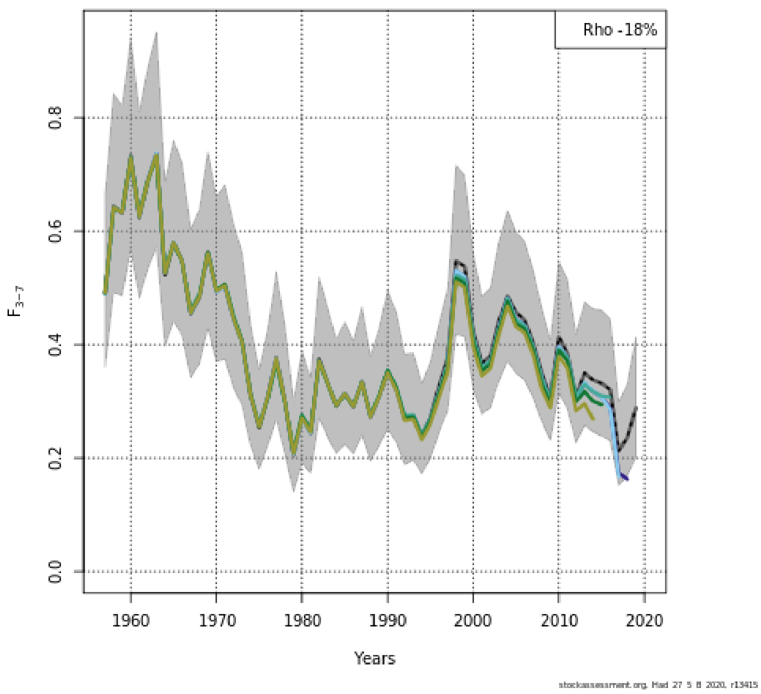


Figure 5.14. Faroe haddock (Division 5.b). Results from the SAM retrospective analysis of fishing mortality (ages 3–7).

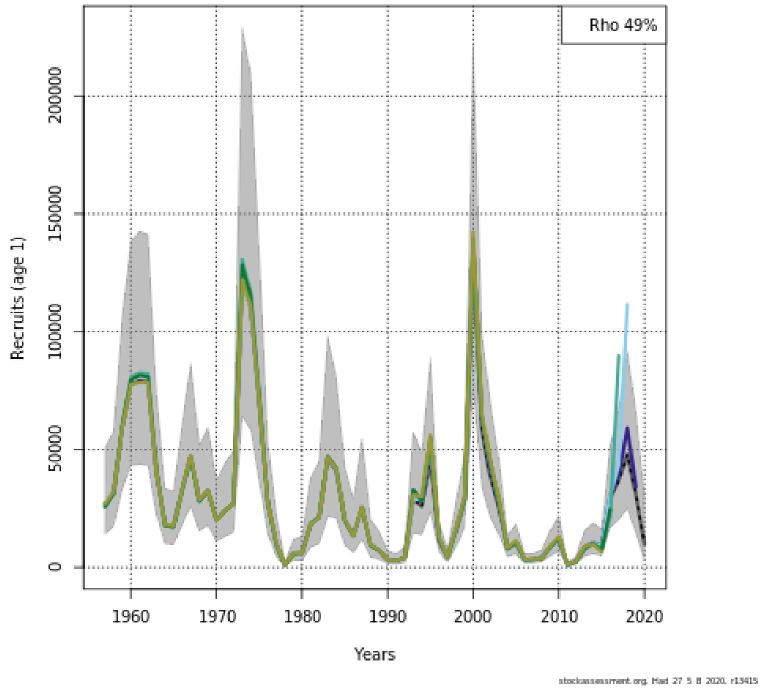


Figure 5.15. Faroe haddock (Division 5.b). Results from the SAM retrospective analysis. Recruitment at age 1.

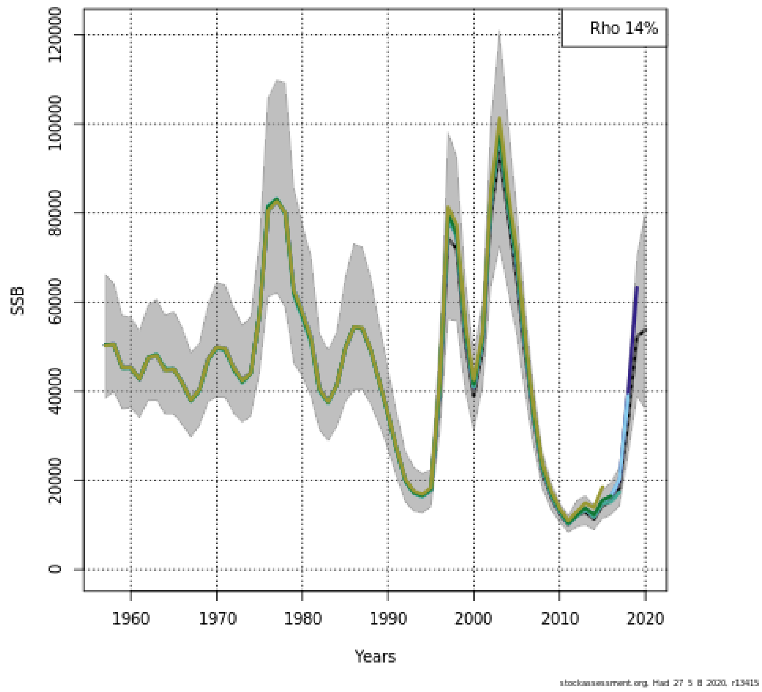
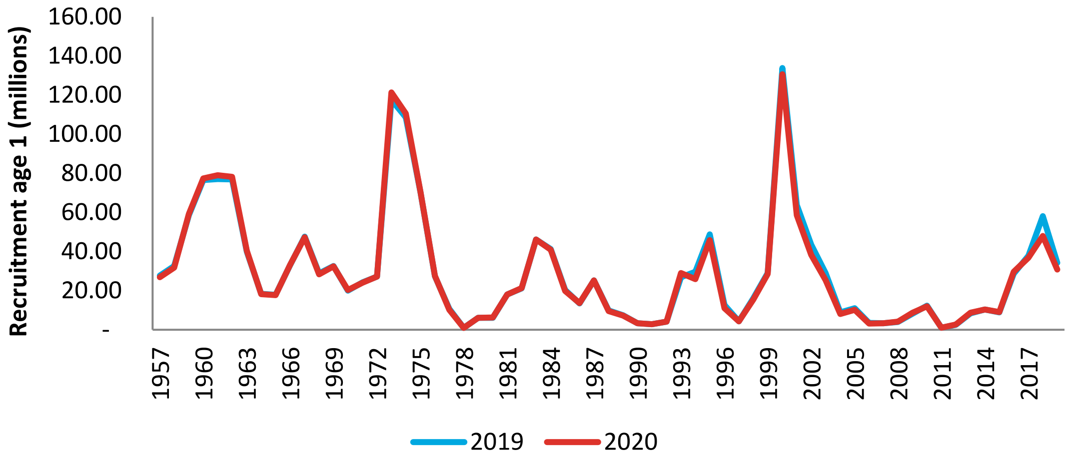
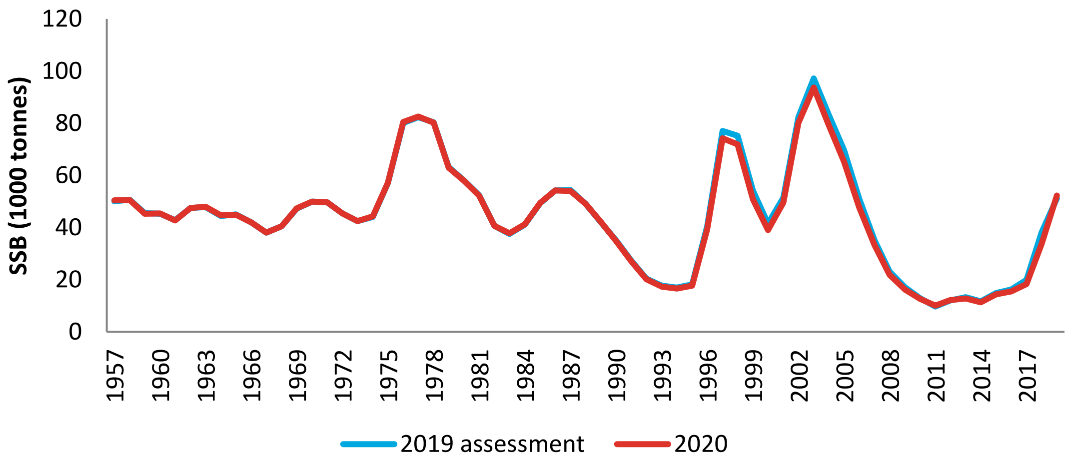


Figure 5.16. Faroe haddock (Division 5.b). Results from the SAM retrospective analysis (continued). Spawning stock biomass.





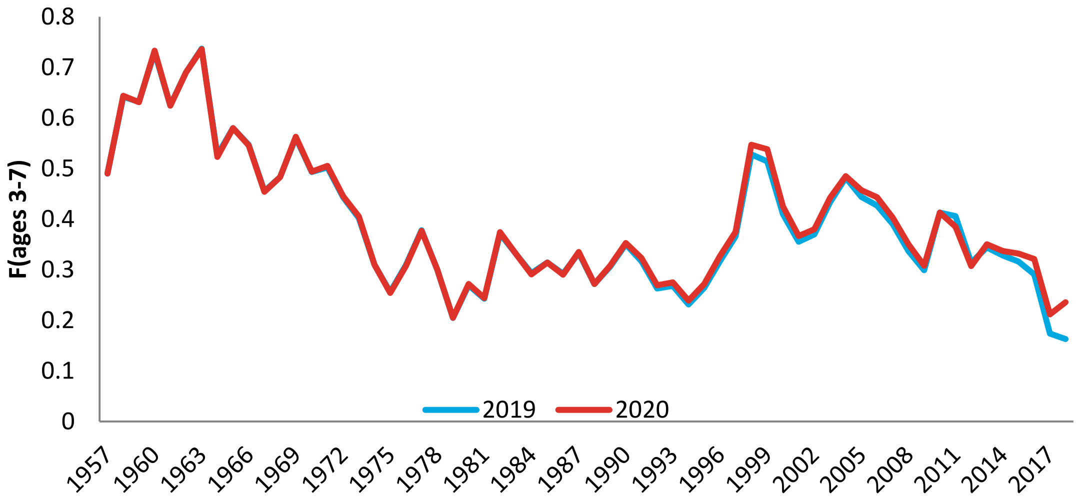


Figure 5.19. Faroe haddock (Division 5.b). Comparison between the November 2019 assessment (dark blue line) with the assessment (light green) in the terminal year.

6 Faroe saithe

This section was updated in November 2020.

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 5.b) have varied cyclically between 10 000 tonnes and 68 000 tonnes since 1961. After a third high of about 60 000 tonnes 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 tonnes) landings increased by 20% in 2012 up to 35 000 tonnes. Since 2011, landings have remained below historical average (37 000 tonnes.) The total tonnage has decreased from 30 853 tonnes in 2017 to 21 303 tonnes in 2019.

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 pairtrawlers (>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 pairtrawlers (<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 pairtrawler fleet has accounted for about 75% of the total tonnage for saithe but since 2007 it has increased gradually up to 97% in 2019 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 1% of the total domestic landings for saithe in 2019. 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 2.a, 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 2013/2014 fishing year, only 58% and 41% of fishing days were utilized in the inner and outer areas respectively while in the 2014/2015 fishing year these ratios went up to 97% and 74%, i.e. 29% of fishing days were not used. In the 2015/2016 and 2016/2017 fishing seasons 20% and 31% of the allocated days for the trawl fleet were not used respectively. In the 2017/2018 fishing year 19% of allocated days were not used. Around 10% of total fishing days were not activated in 2019.

Cumulative landings of saithe for the domestic fleets are shown in Figure 6.2.1.2. The period from 2011 to 2019 is among the poorest in the time-series. The progression of landings from January to April of 2020 is below monthly averages.

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 pairtrawlers, 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 2014 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 (Figure 6.2.2.2). 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. The progression of the strong 2012 year class (age 3 in 2015) can be easily tracked in the catch matrix. Numbers of age 4 to 6 are lower in 2019 compared to 2018 whereas individuals aged 3 are the most numerous in the catch since 2008.

The sampling program and sampling intensity in 2019 as well as the approach used in compiling catch numbers is the same as in preceding years. A summary of sampling levels since 2011 is illustrated in table 6.2.2.3.

6.2.3 Weight at age

Mean weights at age have varied by a factor of about 2 during since 1961. 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 Figures 6.2.3.1.a and 6.2.3.1.b). Mean weights increased again in the period 1992–1996 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. In 2011, age classes 4 to 6 were close or at long-term average. From 2012 to 2014, weight was below average for age groups 3 to 7. Age classes 7 and older are above historical average since 2014 whereas younger age groups (4–6) are lower than average. Mean weight of 3 years old saithe increased from 1.07 kg in 2016 to 1.57 kg in 2018 (50% increase) and it's now 1.42 kg in 2019. Weights for all age groups but age 7 have increased to above historical average from 2018 to 2019. For the short-term forecast, weights are predicted according to the following model:

$\log(CWy, a) = \beta0 + \beta1*\log(CWy\text{-}1, a\text{-}1) + \beta2*\log(SWy, a)$ (Eq.1)

where CWy,a is catch-weight-at age *a* and year *y* and SWy, a is stock-weight-at age *a* and year *y*

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 benchmark workshop (WKFAROE) in 2017, maturity ogives were smoothed via a 10-year running average. The time period for averaging was chosen as a compromise between retaining long-term trends and reducing noise in the data. For 1962–1982, the average maturity of estimated maturities of the 1983–1996 period was used. Maturity decreased from the mid-1990s to 2006 and it shows a increasing trend for all age groups since 2010 (Table 6.2.4.1 and Figure 6.2.4.1.).

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 surveys design is a classical random stratified design with fixed stations. The number of stations in the spring survey are 100 and the number of stations in the summer are 200. Both survey cover depths from 60 to 500 meters. The coverage of both surveys is however very poor for juvenile saithe, which is largely distributed in coastal areas very close to shore and therefore the surveys do not provide reliable measurements of incoming recruits. Moreover, as a result of the schooling nature of saithe variability in indices is higher than that for species like cod and haddock. The spring survey consists of time series data since 1994 while the summer series were initiated in 1996. Historical data dating back to early 1980s exist but are unfortunately not available for analysis although work is in progress to recover and compile these data in upcoming meetings. Both time series cover to a large degree the traditional fishing grounds of saithe in the Faroe shelf.

Standardized biomass and abundance indices from both surveys are shown figure 6.2.5.1.1.

In addition abundances of fish 50 cm and smaller as a proxy for recruitment is calculated from the surveys. Catch rates (kg/hour) is also presented in figure 6.2.5.1.2. There are seasonal effects in the series but both surveys suggest low abundances of saithe in the 1990s, followed by an increase in stock biomass until 2004 and a decline from 2005 to around 2010. Since 2010, both indices are in good agreement and indicate that stock abundance is quite stable. However, both stock indeces disagree in 2019. The summer survey index decreased from 2016 to 2020. The spring survey suggests a drop in stock biomass from 2017 to 2018 with a substantial increase of the stock in 2019 to the second highest level since 2001. Both surveys indicate a drop in stock size from 2019 to 2020. The coefficient of variation (CV) of the summer index (CV = 18%, log-scale) is higher than the spring survey (CV = 13%, log-scale). The agreement between the survey indices measured by their correlation is estimated at $R^2 = 0.37$.

The progression of the 2012 year-class in the fishery is also confirmed in both age-disaggregated indices (figure 6.2.5.1.3 and table 6.2.5.1.1). There is conflicting signals regarding recruitment estimates in survey indices. The recruitment index for 2019 from the spring survey (numbers of aged 3 individuals) is estimated to be the largest since 1994 whereas the summer survey indicates that recruitment strength is very low. In general, both surveys suggest poor incoming recruitment and a general lack of year classes in the stock. Length compositions support the trends observed in the age-disaggregated indices (figures 6.2.5.1.4 and 6.2.5.1.5).

The internal consistency of the summer survey measured as the correlation between the indices for the same year class in two adjacent years is good with R^2 ranging from 0.5 to 0.7 for the best-defined age groups, and R^2 varying between 0.2 and 0.4 for other age classes (figures 6.2.5.1.6 and 6.2.5.1.7). The internal consistency of the summer index is overall inferior to the spring index. The spring survey shows a stronger internal consistency with R^2 ranging from 0.70 to 0.9 for the best-defined ages.

6.2.5.2 Commercial CPUE

The CPUE data from pair-trawlers have been used for tuning the assessment of saithe from 2000 to 2016. At the benchmark working group (WKFAROE, 2017), the series were replaced by fisheries-independent survey indices. A description of the commercial CPUE data can be found in the stock annex. The commercial CPUE data have not been compiled since 2016.

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

Faroe saithe was benchmarked in 2017 (WKFAROE). The SAM (state-space assessment model) framework was adopted as the basis for advice. Input data for the assessment was revised, e.g., maturity ogives (Section 6.2.4) and survey indices (Section 6.2.5.1). Configuration of the SAM model was slightly modified at the NWWG meeting in 2017. Some changes were incorporated into the SAM model in 2020. The modifications were carried out intersessionally and agreed to by external experts (see Annex 6). The changes caused improvements in the model performance and diagnostics. See stock annex http://www.ices.dk/sites/pub/Publication%20Reports/Stock%20Annexes/2020/pok.27.5b_SA.pdf) for detailed information on the configuration options for the adopted SAM model. Biological reference points were re-calculated but the adopted reference points from the benchmark in 2017 are still used.

6.4 Reference points

6.4.1 Biological reference points and MSY framework

At the NWWG in 2017, reference points were revised according to the ICES guidelines (ICES fisheries management reference points for category 1 and 2 stocks, January 2017. The software used to implement the calculations was EqSim. The procedure was as follows:

$B_{pa} = B_{trigger}$ was set to 41 4000 t (lowest historical SSB).

B_{lim} was calculated according the equation: $B_{pa} = B_{lim} \times \exp(\sigma \times 1.645) = 29\,571$ t. where $\sigma = 0.20$ (as suggested by ACOM)

The F_{MSY} estimation process consisted of 3 simulations:

1. Simulation 1. Get F_{lim}

F_{lim} is derived from B_{lim} by simulating the stock with segmented regression S-R function with the point of inflection at B_{lim}.

F_{lim} is the F that, in equilibrium, gives a 50% probability of SSB > B_{lim}

The simulation was conducted with:

- fixed F (i.e. without inclusion of a $B_{trigger}$)
- without inclusion of assessment/advice errors.

2. Simulation 2. Get initial F_{MSY}

F_{MSY} should initially be calculated based on:

- a constant F evaluation
- with the inclusion of stochasticity in population and exploitation as well as assessment/advice error.
- SRRs (using all; Ricker, Beverton-Holt, Segmented)
- Uncertainty parameters used:

  ## Assessment error

sigmaF <- 0.18 # SAM value of uncertainty from 2016

sigmaSSB <- 0.2 # 0.23 SAM value of uncertainty from 2017 ,changed to default=0.2 (ACOM)

Advice error

cvF <- 0.39 ; phiF <- 0.81

cvSSB <- 0.28 ; phiSSB <- 0.82

Biological parameters and selectivity

numAvgYrsB <- 20 # Biological

numAvgYrsS <- 20 # Selection

To ensure consistency between the precautionary and MSY frameworks, F_{MSY} is not allowed to be above F_{pa}, i.e., F_{MSY} is set to F_{pa} if this initial F_{MSY} estimate is higher than F_{pa}.

3. Simulation 3. Get final F_{MSY}

MSY $B_{trigger}$ should be selected to safeguard against an undesirable or unexpected low SSB when fishing at F_{MSY}. The ICES MSY advice rule should be evaluated to check that the F_{MSY} and MSY $B_{trigger}$ combination adheres to precautionary considerations; in the long term, $P(SSB < B_{lim}) < 5\%$

The evaluation includes:

- realistic assessment/advice error (see above)
- stochasticity in population biology and fishery exploitation.
- SRRs (using all; Ricker, Beverton-Holt, Segmented)

The new reference points are illustrated in the table below:

Biological reference points	NWWG 2017	Basis
$B_{trigger}$	41 400 t.	B_{loss}
B_{lim}	29 571 t.	B_{pa}/1.4
B_{pa}	41 400 t.	B_{loss}
F_{lim}	0.7	Stochastic simulations (ICES, 2017) F50% F that gives a 50% probability of SSB > B_{lim}
F_{pa}	0.30	Fp05, P(SSB<Blim)<5%
F_{MSY}	0.30	Stochastic simulations (ICES, 2017).

Graphical output of the simulations are presented in figures 6.4.1.1 and 6.4.1.2.

6.5 State of the stock

Recruitment of saithe (numbers of 3-years old individuals) oscillated between 9 to 38 million from 1961 to 2000 with higher numbers than the historical average (26 millions) from late 1960s to early 1970s and in late 1980s followed by a period of low recruitment from 1988 to 1997 (Figure 6.5.1). Estimated recruitment increased substantially to 66 million in 2001 as the strong 1998 yearclass entered the fishery. Recruitment has fluctuated with no clear trend around an average of 35 million since 2000. Average fishing mortality (F_{bar} = average F for ages 4–8) increased steadily from F_{bar} = 0.29 in 1973 to F_{bar} = 0.64 in 1991 causing a decrease in spawning stock biomass (SSB) from 161 kt to 81 kt. Although fishing mortality dropped substantially in the mid and late 1990s SSB continued to be low coupled with a period of poor incoming year classes. The spawning stock biomass (SSB) was estimated at its highest in the mid-1970s due to low fishing mortality (~F_{bar} = 0.26) and higher than average recruitment. Estimated F in 1991 (F_{bar} = 0.64) was the highest in the time series and although it went down to 0.35 in 2000 this did not prevent the SSB to decrease at around 49 kt in 1996. SSB increased substantially from 1997 to 2005 due to the maturation of the strongest observed 1998 year class (age 3 in 2001). F increased from F_{bar} = 0.42 in 2005 to F_{bar} = 0.62 in 2010 resulting in the largest landings of the whole time period (above 60 kt). SSB has not been below MSY $B_{trigger}$ (41 400 tonnes) since 1961. The 2016 year-class (age 3 in 2019) is estimated at around 4 million. SSB has increased since 2016 as a result of low catches and subsequently low Fs. The saithe fishery is characterised with significant changes in the selection pattern (Figure 6.5.1.a).

Patterns in landings follow approximately a cycle of three distinctive peaks. Catches have remained below historical average (37 000 tonnes) since 2010. Nominal landings of saithe were 21 303 tonnes in 2019. Catches are assumed equal to landings.

Age-disaggregated fishing mortalities and stock numbers are presented in tables 6.5.1 and 6.5.2, respectively. The stock summary table is shown in Table 6.5.3 and a summary of the model parameter estimates is presented in Table 6.5.4. The residuals plots show a reasonably random distribution in all the series (Figure 6.5.2). The relation between SSB and recruitment of saithe is shown in Figure 6.5.3.

6.6 Short-term forecast

6.6.1 Input data

SAM provides a forecast module which can simulate the stock in the period following the assessment year under certain assumptions and taking into account the uncertainty estimated in the model fit. The input data for the short-term forecast are described in the stock annex. The main features of the input for prognosis is the estimation of catch-weights in the assessment year by the model described in Section 6.2.3 and assuming mean maturity ogives over the previous five years. Recruitment is taken randomly from the last five years and therefore the uncertainty in the recruitment pattern is captured in the forecast. The exploitation pattern used is a 3 year average.

Input data for the prediction are presented in Table 6.6.1.1 and the stock projection in Figure 6.6.2.1.

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. Catch options are presented for five different scenarios, F_{MSY}, F_{pa}, F_{lim}, F-status-quo and F = 0.

According to the F_{MSY} advice (F_{MSY} = 0.30) catches are projected to 27 368 t in 2021 resulting in a SSB of 73 012 t. assuming a recruitment estimate of 33 mill. in 2020 and 23 mill. in 2021, respectively. In these conditions, SSB will go up to 89 455 t in 2022.

Landings in 2019 are predicted to rely on the 2012, 2013 and 2014 year classes (73%) while these year classes will contribute to around 71% of the spawning stock biomass in the same year (Figure 6.6.2.2.)

6.7 Yield-per-recruit

Input data to yield-per-recruit

For the yield-per-recruit calculations the average of last 15 years are assumed both in the selection pattern and in the biological parameters. F_{max} and $F_{0.1}$ are estimated at F_{max}= 0.35 and $F_{0.1}$=0.13, respectively.

Results from the yield-per-recruit analysis are shown in Table 6.7.1 and Figure 6.7.1.

6.8 Uncertainties in assessment and forecast

Historically, the assessment of saithe was based on a XSA model calibrated with fisheries-dependent data (see Section 6.2.5.2). In 2017, the assessment framework adopted was SAM using fisheries-independent indices (see Section 6.2.5.1).

The assessment of Faroe saithe is relatively uncertain due to lack of good tuning data. Survey data for saithe are not as reliable of stock trends as for other gadoid species like cod and haddock. Saithe is a highly schooling, widely migrating and partly pelagic species. Moreover, saithe shows up in surveys with few year classes (usually one or two) dominating the entire haul composition making difficult to assess the true state of the stock. There are also indications of time-varying selectivity, so changes in the commercial catch at age may not reflect changes in the age distribution of the population

The retrospective pattern of the SAM model shows that F is underestimated and subsequently SSB is overestimated. (Figure 6.8.1) All of the retrospective runs but one are within the confidence intervals of the final assessment. The retrospective pattern in recruitment estimates has stabilised in comparison with the historical XSA model. Recruitment estimates for saithe stocks are notoriously unreliable as no measurements of juveniles are available until they reach age 3 or older and therefore forecasts are rather uncertain. Time-varying selectivity leads to high uncertainty in the estimates of current and future SSB and fishing mortality. Mohn's rho parameter (in percentage) are estimated at 32%, -13% and 52% for the spawning stock biomass, F and recruitment, respectively.

6.9 Comparison with previous assessment and forecast

The Faroe saithe assessment was benchmarked in 2017 (WKFAROE). Input data (new maturity ogives and adoption of survey indices) and assessment method were modified and therefore the historical stock perception of the stock has changed to some extent. Some changes were incorporated into the SAM model in 2020. The modifications were carried out intersessionally and agreed to by external experts (see Annex 6 and the Stock Annex). The updated assessment suggests a downwards revision in SSB with respect to the 2019 assessment and subsequently higher estimates in F (Figure 6.9.1). The 2019 assessment estimated $F_{4\text{-}8}$=0.271 while the 2020 assessment suggests that fishing mortality was higher ($F_{4\text{-}8}$=0.362). Recruitment f the 2016 year class (age 3 in 2019) were 20% lower in last year assessment compared to the newest assessment estimate.

6.10 Management plans and evaluations

Currently, no management plan exists for saithe in Division 5.b. An effort management system has been in place since 1996. Work on a new management system started in 2018 and will continue in 2019. A reform in the current management system establishes the fishing year to start on 1 January.

6.11 Management considerations

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

From 2019, advice for saithe will be issued in June and fall as a consequence of the availability of the summer index to the WG before the end of the assessment year.

Biological reference points were revised in 2017 (see Section 6.4). F_{MSY} was estimated at the current $F_{MSY} = 0.30$ while $F_{lim} = 0.7$ and $B_{lim} = 29\ 571$ tonnes were defined (see Section 6.4.1.). Other biological reference points were estimated as follows; $F_{pa} = 0.52$, B_{pa} = MSY $B_{trigger} = 41\ 400$ t. In 2020, work was done intersessionally where the SAM model configuration was adjusted (see Annex 6). The changes caused improvements in the model performance. Reference points were re-calculated but there were negligible differences with the current estimates. The decision was to maintain reference points from the 2017 benchmark assessment.

6.12 Ecosystem considerations

No evidence is available to indicate that the fishery is impacting the marine environment.

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. Seasonal area restriction is an alternative to reduce fishing mortality and additional real-time closures are also implemented to protect small saithe in Faroese waters.

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 (Figures 6.15.1 and 6.15.2)

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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6.17 Tables

Table 6.2.1.1. Faroe saithe (Division 5.b). Nominal catches (tonnes round weight) by countries 1988–2019 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	44402	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	45027	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]	45285	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	2015	2016	2017	2018	2019 [1]
Denmark	-	-	-	-	34	-	-	-	-	-	-	-	-	-	-	-	-	-
Estonia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Faroe Islands	55,165	47,933	48,222	71,496	72,169	66,319	63,424	63,339	48,279	32,357	38,278	28,655	25,655	27,496	30,849	32,966	25,692	22,908
France	607	370	147	123	315	108	97	68	46	135	40	31	28	122	336	40		
Germany	422	281	186	1	49	3	3	0	-	-		-	-	-	-	-	-	-
Greenland	125	-			73	239	0	1			1	-	-	-	-	-	1	-
Irland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Iceland	-	-	-	-	-	-	-	148	-	-	-	-	-	-	-	-	-	2
Netherlands	0	0	0	0	0	3	0	0	-	-	-	-	-	-	1	-	-	-
Norway	77	62	82	82	35	81	38	23	28	-	-	-	4	40	198	27	40	38
Portugal	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Russia	10	32	71	210	104	160	38	44	3	-	-	1	-	-	-	-	-	0
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	304	601	292	214	73
Total	57,004	49,377	49,546	76,266	73,878	67,325	64,000	64,308	49,062	32,511	38,319	28,688	26,027	27,962	31,985	33,325	25,947	23,021
Working Group estimate [4,5,6,7]	53,546	46,555	46,355	67,967	68,465	62,351	59,243	59,558	45,441	30,084	35,448	26,539	24,103	25,900	29,671	30,853	24,019	21,303

Table 6.2.1.2. Faroe saithe (Division 5.b). Total Faroese landings (rightmost column) and the contribution (%) by each fleet category (1985–2019).

	Open boats	LL <100	LL >100	Gillnet	Jigger	ST <400	ST 400-1000	ST >1000	PT <1000	PT >1000	IT	Other	Total
1985	0.2	0.1	0.1	0	2.6	0.1	6.6	33.7	28.2	28.2	0.2	0.2	38377
1986	0.3	0.2	0.1	0.1	3.6	0.1	2.8	27.3	27.5	36.5	0.7	0.9	36130
1987	0.7	0.1	0.1	0.4	5.6	0.3	4.1	20.4	22.8	44.3	1.1	0	35671
1988	0.4	0.3	0.1	0.3	6.5	0.1	6.8	20.8	19.6	43.7	1.3	0.1	39486
1989	0.9	0.1	0.1	0.2	9.3	0.3	5.4	17.7	23.5	41.1	1.3	0	40132
1990	0.6	0.2	0.2	0.2	7.4	0.2	3.9	19.6	24	42.8	0.9	0	54722
1991	0.6	0.1	0.1	0.6	9.8	0.1	1.3	13.9	26.5	46.2	0.8	0	48911
1992	0.4	0.4	0.1	0	10.5	0	0.5	7.1	24.4	55.6	1	0	31473
1993	0.6	0.2	0.1	0	9.3	0.1	0.6	6.5	21.4	60.6	0.7	0	29110
1994	0.4	0.4	0.2	0	12.6	0.1	1.1	6.8	18.5	59.1	0.7	0	29194
1995	0.2	0.1	0.3	0	9.6	0.4	0.9	9.9	17.7	60.9	0	0	24246
1996	0	0	0.2	0	9.2	0.1	1.2	6.8	23.7	58.6	0	0	17353
1997	0	0.1	0.4	0	8.9	0.1	2.5	10.7	17.8	58.9	0.4	0	19561
1998	0.1	0.4	0.3	0	7.5	0.1	2.6	19.3	15.4	53.9	0.4	0	23417
1999	0	0.1	0.2	0	5.7	0.1	1.2	12.6	18.5	60	1.6	0	29781
2000	0.1	0.1	0.1	0	3.7	0.2	0.3	15	17.5	62.3	0.7	0	33736
2001	0.1	0.1	0.2	0	2.8	0.1	0.3	20.2	16.5	58.8	0.8	0.1	41896
2002	0.1	0.2	0.1	0	1.6	0.1	0.1	26.5	10.5	60.8	0	0	48377

	Open boats	LL <100	LL >100	Gillnet	Jigger	ST <400	ST 400-1000	ST >1000	PT <1000	PT >1000	IT	Other	Total
2003	0	0	0.1	0	0.9	1.9	0.4	17.4	14.7	64.7	0	0	35778
2004	0.1	0.2	0.2	0	1.9	3.7	0.4	15.1	14.4	63.8	0	0	34622
2005	0.2	0.1	0.2	0	2.4	4.4	0.2	12.7	20.6	59.2	0	0	47349
2006	0.2	0.4	0.6	0	3.9	0.3	0.1	19.8	20.6	54.1	0	0	41997
2007	0.2	0.2	0.3	0	2	0.2	0.1	30.4	16	50.6	0	0	33553
2008	0.2	0.3	0.5	0	3.2	1.5	0.2	20.4	16	57.7	0	0	24752
2009	0.4	0.2	0.2	0	4.3	3.3	0.1	9.6	15.1	66.8	0	0	42452
2010	0.1	0.1	0.6	0	3.9	1.2	2.4	8.3	15.1	68.3	0	0	34498
2011	0.1	0.1	0.5	0	3.6	0.5	1.3	2.6	14.1	77.1	0	0	24193
2012	0.2	0.1	1	0	2.4	1.9	0.1	2.2	18.6	73.5	0	0	28498
2013	0.1	0.3	0.5	0	3.2	1	0.2	0.6	24.9	69	0	0.1	20125
2014	0.2	0.3	0.3	0	1.9	0.5	0.2	0.2	15.6	80.7	0	0.1	18732
2015	0.2	0.4	0.3	0	2.3	1.1	0	2	18	75.5	0	0	18879
2016	0.1	0.1	0.3	0	1.6	1.7	0.2	0.2	21.7	73.8	0	0.4	20282
2017	0.1	0	0.1	0.1	0.7	0.7	0.3	0.2	20.6	76.9	0	0.1	22682
2018	0.2	0	0.1	0	0.8	0.9	0.2	0.8	20.5	76.3	0	0	17780
2019	0.1	0.1	0.3	0	0.3	0.4	0.4	1.3	18.4	78.6	0	0	15294

Table 6.2.2.1. Faroe saithe (Division 5.b). Catch number-at-age by fleet categories in 2019 (calculated from gutted weights).

Age	Jiggers	Single trawlers >1000 HP	Pair trawlers <1000 HP	Pair trawlers >1000HP	Others	Total Division 5.b
0	0	0	0	0	0	0
1	0	0	0	0	0	0
2	0	0	1	0	0	1
3	2	16	319	2178	10	2526
4	1	10	98	527	5	642
5	2	11	186	662	9	870
6	6	22	314	1216	21	1579
7	7	16	148	681	22	874
8	1	3	24	99	2	129
9	1	2	18	58	2	81
10	0	0	9	24	1	34
11	0	0	2	2	0	4
12	0	0	2	0	0	2
13	0	0	2	0	0	2
14	0	0	0	0	0	0
15	0	0	0	0	0	0
Total No.	20	80	1124	5447	72	6743
Catch, t.	63	224	3106	13212	218	16823

Table 6.2.2.2. Faroe saithe (Division 5.b). Catch number-at-age (thousands) from the commercial fleet (1961–2019)

Year-Age	3	4	5	6	7	8	9	10	11	12	13	14	15
1961	183	379	483	403	216	129	116	82	45	27	6	1	48
1962	562	542	617	495	286	131	129	113	71	29	13	16	47
1963	614	340	340	415	406	202	174	158	94	169	61	8	36
1964	684	1908	1506	617	572	424	179	150	100	83	47	30	14
1965	996	850	1708	965	510	407	306	201	156	120	89	30	46
1966	488	1540	1201	1686	806	377	294	205	156	94	52	34	45
1967	595	796	1364	792	1192	473	217	190	97	75	38	11	16
1968	614	1689	1116	1095	548	655	254	128	89	59	40	29	59
1969	1191	2086	2294	1414	1118	589	580	239	115	100	36	30	24
1970	1445	6577	1558	1478	899	730	316	241	86	48	46	15	23
1971	2857	3316	5585	1005	828	469	326	164	100	54	13	18	15
1972	2714	1774	2588	2742	1529	1305	1017	743	330	133	28	28	21
1973	2515	6253	7075	3478	1634	693	550	403	215	103	25	21	37
1974	3504	4126	4011	2784	1401	640	368	340	197	124	45	44	52
1975	2062	3361	3801	1939	1045	714	302	192	193	126	64	41	67
1976	3178	3217	1720	1250	877	641	468	223	141	96	60	54	77
1977	1609	2937	2034	1288	767	708	498	338	272	129	80	57	64
1978	611	1743	1736	548	373	479	466	473	407	211	146	95	83
1979	287	933	1341	1033	584	414	247	473	368	206	136	98	251
1980	996	877	720	673	726	284	212	171	196	156	261	133	236
1981	411	1804	769	932	908	734	343	192	92	128	176	310	407
1982	387	4076	994	1114	380	417	296	105	88	56	49	110	687
1983	2483	1103	5052	1343	575	339	273	98	98	99	25	127	289
1984	368	11067	2359	4093	875	273	161	52	65	59	18	25	151
1985	1224	3990	5583	1182	1898	273	103	38	26	72	41	8	154
1986	1167	1997	4473	3730	953	1077	245	104	67	33	56	7	62
1987	1581	5793	3827	2785	990	532	333	81	43	5	11	15	66

Year-Age	3	4	5	6	7	8	9	10	11	12	13	14	15
1988	866	2950	9555	2784	1300	621	363	159	27	43	15	1	1
1989	451	5981	5300	7136	793	546	185	83	55	10	2	11	16
1990	294	3833	10120	9219	5070	477	123	61	60	18	19	9	33
1991	1030	5125	7452	5544	3487	1630	405	238	128	77	22	8	11
1992	521	4067	3667	2679	1373	894	613	123	63	37	52	8	11
1993	1316	2611	4689	1665	858	492	448	245	54	34	10	6	2
1994	690	3961	2663	2368	746	500	307	303	150	28	19	1	1
1995	398	1019	3468	1836	1177	345	241	192	104	73	25	14	5
1996	297	1087	1146	1449	1156	521	132	77	64	45	29	1	7
1997	344	832	2440	1767	1335	624	165	71	29	48	29	15	8
1998	163	1689	1934	3475	1379	683	368	77	32	28	24	14	7
1999	322	655	3096	2551	4113	915	380	147	24	27	5	23	14
2000	811	2830	1484	4369	2226	2725	348	186	56	18	2	3	2
2001	1125	2452	8437	2155	3680	1539	1334	293	90	24	19	13	0
2002	302	8399	5962	9786	862	1280	465	362	33	36	8	1	0
2003	330	2432	11152	3994	4287	417	419	304	91	40	3	0	0
2004	76	2011	8544	8762	2125	1807	265	293	146	100	10	2	0
2005	454	2948	9486	16606	7099	843	810	32	102	27	3	0	0
2006	1509	5163	7963	7892	10537	3848	655	289	33	12	12	5	0
2007	852	3406	11596	6640	3878	4405	1578	416	83	11	9	3	0
2008	4968	3228	3737	9731	3733	2309	2127	461	165	12	6	0	0
2009	472	7618	5116	1893	5310	2065	1743	1099	300	42	3	1	0
2010	2406	3019	5486	1165	1045	2172	1292	861	389	53	23	0	0
2011	1924	2783	1968	1830	484	538	714	529	446	140	34	4	0
2012	863	9870	4157	1257	905	305	308	401	230	137	91	21	0
2013	723	5186	4231	2249	512	210	122	97	146	85	39	33	3
2014	887	2344	3172	1696	873	333	100	93	71	55	16	1	0
2015	2201	2338	2656	1988	889	292	185	89	71	34	32	9	6

Year-Age	3	4	5	6	7	8	9	10	11	12	13	14	15
2016	889	10550	1984	1924	723	293	113	67	93	9	19	1	1
2017	487	3638	8927	1074	555	462	121	25	1	10	17	2	1
2018	329	1419	4067	3585	370	201	90	41	22	4	12	5	3
2019	3170	805	1091	1981	1096	162	101	43	6	3	3	0	0

Table 6.2.2.3. Faroe saithe (Division 5.b). Sampling intensity in 2007–2019.

Year		Jiggers	Single trawlers >1000 HP	Pair trawlers <1000 HP	Pair trawlers >1000 HP	Others	Total
2007	Lengths	683	10525	10593	18045	381	40227
	Otoliths	120	748	960	1977	0	3805
	Weights	120	697	5603	9884	120	16424
2008	Lengths	0	6892	3694	13995	234	24815
	Otoliths	0	690	600	1500	0	2790
	Weights	0	0	2517	12914	234	15665
2009	Lengths	511	5273	3695	23352	0	32831
	Otoliths	97	301	599	2519	0	3516
	Weights	511	0	3494	19060	0	23065
2010	Lengths	209	1442	3663	25793	151	31258
	Otoliths	5	119	480	2459	0	3063
	Weights	5	0	3060	18749	151	21965
2011	Lengths	583	18	1874	19990	753	23218
	Otoliths	60	0	300	2459	60	2879
	Weights	583	18	1458	14256	753	17068
2012	Lengths	6	0	1060	24924	211	26201
	Otoliths	6	0	120	2516	0	2642
	Weights	6	0	1060	17593	211	18870
2013	Lengths	0	0	1465	18015	920	20400
	Otoliths	0	0	360	1979	120	2459
	Weights	0	0	1465	13544	1325	16334
2014	Lengths	0	201	0	22131	920	23252
	Otoliths	0	0	0	2542	120	2662
	Weights	0	0	0	15448	920	16368
2015	Lengths	0	0	173	22455	753	23381
	Otoliths	0	0	20	2169	90	2279
	Weights	0	0	173	17199	753	18125
2016	Lengths	479	0	671	20282	2613	24045
	Otoliths	120	0	179	3118	776	4193
	Weights	479	0	671	15512	2613	19275
2017	Lengths	0	0	225	16874	1824	18923
	Otoliths	0	0	60	2253	538	2851
	Weights	0	0	225	11222	1824	13271
2018	Lengths	799	0	2284	14559	196	17838
	Otoliths	239	0	478	2931	60	3708
	Weights	799	0	2284	10922	196	14201

Year		Jiggers	Single trawlers >1000 HP	Pair trawlers <1000 HP	Pair trawlers >1000 HP	Others	Total
2019	Lengths	616	0	7748	6062	264	14690
	Otoliths	180	0	1645	1257	124	3206
	Weights	616	0	5720	5261	264	11861

Table 6.2.3.1. Faroe saithe (Division 5.b). Catch weights at age (kg) (equal to stock-weights) from the commercial fleet (1961–2020). Catch weights in 2020 used for short-term prediction.

Year-Age	3	4	5	6	7	8	9	10	11	12	13	14	15
1961	1.43	2.302	3.348	4.287	5.128	6.155	7.06	7.265	7.497	8.198	9.154	9.6	10
1962	1.273	2.045	3.293	4.191	5.146	5.655	6.469	6.706	7.15	7.903	8.449	8.654	10
1963	1.28	2.197	3.212	4.568	5.056	5.932	6.259	8	7.265	8.551	9.02	9	10
1964	1.175	2.055	3.266	4.255	5.038	5.694	6.662	6.837	7.686	8.348	8.123	9.154	10
1965	1.181	2.125	2.941	4.096	4.878	5.932	6.321	7.288	8.074	7.878	9.479	9.617	10
1966	1.361	2.026	3.055	3.658	4.585	5.52	6.837	7.265	7.662	8.123	10.21	9.728	10
1967	1.273	1.78	2.534	3.572	4.368	5.313	5.812	6.554	7.806	7.591	8.551	7.878	10
1968	1.302	1.737	2.036	3.12	4.049	5.183	6.238	7.52	8.049	8.654	8.298	9.234	10
1969	1.188	1.667	2.302	2.853	3.673	5.002	5.714	6.405	6.554	7.591	7.951	8.373	10
1970	1.244	1.445	2.249	2.853	3.515	4.418	5.444	5.733	6.662	7.31	9.047	9.073	10
1971	1.101	1.316	1.818	2.978	3.702	4.271	5.388	5.972	6.49	7.173	7.38	9.288	10
1972	1.043	1.485	2.055	2.829	3.791	4.175	4.808	5.294	6.948	6.727	7.591	9.315	10
1973	1.306	1.754	1.899	2.7	4.426	5.264	6.156	6.334	8.076	8.777	9.782	9.546	12.006
1974	1.615	1.723	2.493	2.824	3.524	5.197	6.279	6.454	7.07	7.773	8.763	10.279	11.296
1975	1.293	1.924	2.623	3.621	4.128	4.754	5.952	7.073	8.352	9.032	9.984	10.225	11.607
1976	1.162	1.79	3.074	3.291	4.579	4.648	5.116	6.314	7.069	7.069	7.808	8.337	10.68
1977	1.223	1.641	2.66	3.79	4.239	5.597	5.35	5.912	6.837	6.727	6.948	8.424	10
1978	1.493	2.324	3.068	3.746	4.913	4.368	5.276	5.832	6.053	6.706	7.686	7.219	10
1979	1.22	1.88	2.62	3.4	4.18	4.95	5.69	6.38	7.02	7.26	8.15	8.64	10
1980	1.23	2.12	3.32	4.28	5.16	6.42	6.87	7.09	7.93	8.07	8.59	9.79	10.34
1981	1.31	2.13	3	3.81	4.75	5.25	5.95	6.43	7	7.47	8.14	8.55	10.1
1982	1.337	1.851	2.951	3.577	4.927	6.243	7.232	7.239	8.346	8.345	8.956	9.584	10.33
1983	1.208	2.029	2.965	4.143	4.724	5.901	6.811	7.051	7.248	8.292	9.478	10.893	10.34
1984	1.431	1.953	2.47	3.85	5.177	6.347	7.825	6.746	8.636	8.467	8.556	11.127	10.748
1985	1.401	2.032	2.965	3.596	5.336	7.202	6.966	9.862	10.67	10.46	10.202	9.644	13.232
1986	1.718	1.986	2.618	3.277	4.186	5.589	6.05	6.15	9.536	9.823	7.303	11.869	12.875
1987	1.609	1.835	2.395	3.182	4.067	5.149	5.501	6.626	6.343	10.245	8.491	11.634	10.22
1988	1.5	1.975	1.978	2.937	3.798	4.419	5.115	6.712	9.04	9.364	9.142	10.346	10.086
1989	1.309	1.735	1.907	2.373	3.81	4.667	5.509	5.972	6.939	8.543	9.514	11.73	9.627

Year-Age	3	4	5	6	7	8	9	10	11	12	13	14	15
1990	1.223	1.633	1.83	2.052	2.866	4.474	5.424	6.469	6.343	8.418	7.383	5.822	9.408
1991	1.24	1.568	1.864	2.211	2.648	3.38	4.816	5.516	6.407	7.395	8.079	7.187	9.756
1992	1.264	1.602	2.069	2.554	3.057	4.078	5.012	6.768	7.754	8.303	7.786	9.575	9.102
1993	1.408	1.86	2.323	3.131	3.73	4.394	5.209	6.54	8.403	7.275	9.414	9.281	10.715
1994	1.503	1.951	2.267	2.936	4.214	4.971	5.657	5.95	6.891	8.752	9.752	8.629	7.349
1995	1.456	2.177	2.42	2.895	3.651	5.064	5.44	6.167	7.08	7.736	7.295	5.885	10.518
1996	1.432	1.875	2.496	3.229	3.744	4.964	6.375	6.745	7.466	7.284	8.47	10.001	10.143
1997	1.476	1.783	2.032	2.778	3.598	4.766	5.982	7.658	7.882	8.539	9.488	10.355	10.523
1998	1.388	1.711	1.954	2.405	3.3	4.22	4.999	6.391	6.665	8.214	8.485	8.668	9.2
1999	1.374	1.712	1.905	2.396	2.845	4.124	5.256	5.526	6.956	8.03	8.349	8.083	10.262
2000	1.477	1.606	2.077	2.36	2.977	3.48	4.851	5.268	6.523	4.727	8.807	8.002	10.427
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	10
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	10
2003	1.123	1.304	1.614	1.977	2.532	3.97	4.834	5.499	6.099	6.987	5.961	9.044	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	10
2005	1.148	1.325	1.516	1.672	2.087	2.975	3.79	6.087	6.134	6.651	7.424	9.113	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	10
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	10
2008	1.146	1.312	1.672	1.816	2.395	2.902	3.1	3.728	4.769	6.072	6.451	7.96	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	10
2010	1.429	1.706	2.166	2.551	3.172	3.411	3.972	4.352	5.083	4.941	5.305	9.011	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	10
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	10
2013	1.208	1.466	1.778	2.069	3.553	4.292	5.191	5.742	5.919	6.417	7.941	7.154	6.963
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	10
2015	0.932	1.555	2.091	3.17	4.208	5.032	6.715	7.858	7.428	7.565	7.629	9.87	8.613
2016	1.07	1.246	2.091	2.613	3.98	4.927	5.876	7.426	6.967	8.153	7.89	7.36	8.233
2017	1.472	1.534	1.689	3.083	3.977	5.92	6.415	6.833	8.192	9.013	8.314	9.036	8.545

Year-Age	3	4	5	6	7	8	9	10	11	12	13	14	15
2018	1.574	1.849	2.055	2.452	3.95	4.879	6.138	7.481	8.217	7.567	7.924	8.179	8.09
2019	1.417	1.919	2.582	3.078	3.704	6.081	6.474	8.167	8.724	11.051	9.763	8.179	8.09
2020	1.488	1.785	2.020	2.588	3.439	4.619	6.342	7.494	8.378	9.210	8.667	8.465	8.242

Table 6.2.4.1. Faroe saithe (Division 5.b). Proportion mature at age (1983–2020). Maturities for ages 11 to 15 are set to 1.00

Year-Age	3	4	5	6	7	8	9	10
1983	0.04	0.25	0.55	0.84	0.92	0.98	1	1
1984	0.03	0.26	0.58	0.85	0.93	0.98	1	1
1985	0.04	0.26	0.57	0.86	0.93	0.99	1	1
1986	0.04	0.28	0.6	0.87	0.94	0.99	1	1
1987	0.05	0.28	0.58	0.86	0.95	0.99	1	1
1988	0.06	0.28	0.57	0.86	0.95	0.98	1	1
1989	0.06	0.27	0.58	0.85	0.94	0.97	1	1
1990	0.05	0.26	0.58	0.82	0.92	0.97	1	1
1991	0.05	0.26	0.57	0.82	0.91	0.97	1	1
1992	0.04	0.24	0.54	0.81	0.91	0.98	1	1
1993	0.04	0.25	0.56	0.79	0.91	0.98	1	1
1994	0.05	0.22	0.54	0.78	0.9	0.97	1	1
1995	0.05	0.22	0.57	0.79	0.91	0.97	1	1
1996	0.04	0.18	0.54	0.77	0.9	0.97	1	1
1997	0.02	0.17	0.55	0.77	0.89	0.97	1	1
1998	0.01	0.16	0.53	0.73	0.88	0.98	1	1
1999	0.01	0.16	0.5	0.71	0.86	0.99	0.99	1
2000	0.02	0.17	0.48	0.72	0.87	0.98	0.99	1
2001	0.02	0.16	0.47	0.72	0.87	0.98	0.99	1
2002	0.02	0.18	0.48	0.68	0.84	0.96	0.98	1
2003	0.02	0.17	0.47	0.67	0.82	0.96	0.98	1
2004	0.02	0.16	0.42	0.62	0.79	0.94	0.98	1
2005	0.01	0.16	0.39	0.59	0.77	0.92	0.98	1
2006	0.01	0.18	0.38	0.58	0.75	0.91	0.97	1
2007	0.01	0.19	0.37	0.57	0.74	0.9	0.97	1
2008	0.01	0.2	0.39	0.59	0.75	0.9	0.97	1
2009	0.01	0.19	0.38	0.61	0.77	0.9	0.98	1
2010	0.01	0.18	0.41	0.63	0.79	0.91	0.98	1
2011	0.01	0.19	0.44	0.64	0.8	0.91	0.98	1
2012	0.01	0.2	0.43	0.65	0.81	0.91	0.98	1
2013	0.01	0.19	0.42	0.64	0.83	0.91	0.97	1
2014	0.02	0.25	0.48	0.69	0.86	0.94	0.97	1
2015	0.03	0.24	0.47	0.7	0.88	0.94	0.98	1
2016	0.04	0.26	0.5	0.73	0.91	0.96	0.98	1
2017	0.05	0.26	0.53	0.75	0.91	0.97	0.99	1
2018	0.07	0.25	0.5	0.74	0.89	0.97	0.99	1
2019	0.07	0.28	0.53	0.76	0.91	0.98	0.99	1
2020	0.07	0.28	0.52	0.75	0.90	0.98	0.99	1

Table 6.2.5.1. Faroe saithe (Division 5.b). Effort (hours) and catch in number-at-age for the survey indices used in the SAM model. Summer index (ages 3–10, years 1996–2020). Spring index (ages 3–10, years 1994–2020)

Summer Survey									
Year/age	**Effort**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1996	200	293	818	403	334	166	84	31	26
1997	200	1266	981	1614	644	459	236	77	19
1998	200	223	843	798	1101	220	110	56	19
1999	200	302	418	1298	918	1235	206	80	39
2000	200	1621	5005	1338	2958	1198	1325	171	95
2001	200	27060	14830	28221	1878	2494	783	799	192
2002	200	4640	13148	4691	5021	334	419	208	144
2003	200	15749	21047	14624	2277	1986	162	105	93
2004	200	1372	14471	32436	11964	1619	711	51	49
2005	200	4693	5808	6037	6801	1787	262	168	32
2006	200	8986	20294	8842	3767	3057	791	72	57
2007	200	1647	2081	5559	2046	1007	722	252	69
2008	200	6864	2415	965	2373	690	378	233	72
2009	200	2350	2339	6939	938	1690	669	431	359
2010	200	2790	1240	1461	213	134	245	126	98
2011	200	5895	1713	519	388	107	88	163	94
2012	200	6457	6018	3012	393	193	86	58	86
2013	200	1086	3777	3931	1853	202	86	30	31
2014	200	2481	1484	1251	550	235	39	26	20
2015	200	5882	2177	2122	847	333	88	38	23
2016	200	4357	11484	1620	669	205	110	39	44
2017	200	2435	4588	3680	423	315	170	58	22
2018	200	264	699	1549	1352	77	54	17	7
2019	200	4343	813	874	1113	622	107	59	41
2020	200	378	1140	151	287	252	74	34	23
Spring Survey									
Year/age	**Effort**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1994	100	127	847	470	423	108	68	51	54
1995	100	157	527	914	916	357	85	58	24
1996	100	63	270	115	131	105	57	34	16
1997	100	79	107	252	131	94	63	23	26
1998	100	335	941	805	1358	323	145	104	23
1999	100	218	208	699	557	662	89	39	19
2000	100	215	381	310	1256	503	568	28	12
2001	100	797	363	1112	291	427	163	130	23
2002	100	419	6989	2717	2574	206	211	79	39
2003	100	838	927	3306	964	585	76	49	46
2004	100	531	5326	7993	4765	297	120	13	28
2005	100	1417	1208	2774	4592	1497	218	83	26
2006	100	2726	1145	1991	1470	1480	457	41	25
2007	100	254	410	1401	536	226	242	111	13
2008	100	5922	648	481	1333	334	343	223	27
2009	100	1292	7699	978	274	466	217	206	16
2010	100	146	401	674	180	200	297	194	14
2011	100	3723	647	210	235	65	46	92	60
2012	100	255	2305	602	140	73	43	58	64
2013	100	281	2203	1130	524	89	82	32	31
2014	100	488	1215	1434	447	238	65	55	26
2015	100	2343	988	1067	538	139	88	20	6
2016	100	1001	6118	176	189	59	47	19	12
2017	100	1126	4372	5213	190	83	72	27	21
2018	100	216	517	1228	803	56	32	33	5
2019	100	13608	1772	828	771	442	90	74	46
2020	100	733	2724	247	224	191	113	29	14

Table 6.3.2. Faroe saithe (Division 5.b). Parameter estimates of the SAM model.

Parameter name	par	sd(par)	exp(par)	Low	High
logFpar_0	-7.655	0.251	0.000	0.000	0.001
logFpar_1	-7.031	0.197	0.001	0.001	0.001
logFpar_2	-6.683	0.189	0.001	0.001	0.002
logFpar_3	-6.743	0.122	0.001	0.001	0.002
logFpar_4	-6.921	0.132	0.001	0.001	0.001
logFpar_5	-6.999	0.134	0.001	0.001	0.001
logFpar_6	-7.008	0.155	0.001	0.001	0.001
logFpar_7	-8.388	0.247	0.000	0.000	0.000
logFpar_8	-7.481	0.202	0.001	0.000	0.001
logFpar_9	-7.205	0.131	0.001	0.001	0.001
logFpar_10	-7.085	0.092	0.001	0.001	0.001
logFpar_11	-7.258	0.092	0.001	0.001	0.001
logFpar_12	-7.146	0.099	0.001	0.001	0.001
logFpar_13	-7.066	0.117	0.001	0.001	0.001
logSdLogFsta_0	-1.438	0.120	0.237	0.187	0.302
logSdLogN_0	-0.626	0.141	0.535	0.403	0.709
logSdLogN_1	-1.373	0.106	0.253	0.205	0.313
logSdLogObs_0	-0.920	0.046	0.399	0.364	0.437
logSdLogObs_1	0.082	0.147	1.085	0.809	1.457
logSdLogObs_2	-0.198	0.150	0.820	0.607	1.108
logSdLogObs_3	-0.251	0.148	0.778	0.579	1.047
logSdLogObs_4	-0.845	0.160	0.430	0.312	0.592
logSdLogObs_5	-0.769	0.149	0.463	0.344	0.624
logSdLogObs_6	-0.825	0.159	0.438	0.319	0.602
logSdLogObs_7	-0.699	0.158	0.497	0.362	0.682
logSdLogObs_8	-0.469	0.181	0.626	0.436	0.898
logSdLogObs_9	0.178	0.137	1.195	0.909	1.570
logSdLogObs_10	-0.021	0.128	0.979	0.757	1.265
logSdLogObs_11	-0.522	0.130	0.593	0.458	0.769
logSdLogObs_12	-1.019	0.138	0.361	0.274	0.476
logSdLogObs_13	-1.026	0.137	0.359	0.273	0.471
logSdLogObs_14	-0.906	0.142	0.404	0.304	0.537
logSdLogObs_15	-0.677	0.160	0.508	0.369	0.699
logSdLogObs_16	-0.042	0.147	0.958	0.715	1.285
transfIRARdist_0	-1.560	0.279	0.210	0.120	0.367
transfIRARdist_1	-0.599	0.207	0.550	0.363	0.832
itrans_rho_0	1.406	0.156	4.081	2.987	5.576

Table 6.5.1. Faroe saithe (Division 5.b). Estimated fishing mortality-at-age (1961–2019) from the SAM model (median F).

Year Age	3	4	5	6	7	8	9	10	11	12	13	14	15
1961	0.029	0.064	0.098	0.116	0.126	0.121	0.134	0.161	0.199	0.199	0.199	0.199	0.199
1962	0.033	0.073	0.112	0.132	0.144	0.141	0.158	0.192	0.238	0.238	0.238	0.238	0.238
1963	0.034	0.074	0.116	0.14	0.16	0.163	0.188	0.233	0.291	0.291	0.291	0.291	0.291
1964	0.042	0.096	0.15	0.177	0.2	0.202	0.222	0.265	0.317	0.317	0.317	0.317	0.317
1965	0.045	0.105	0.166	0.2	0.232	0.243	0.273	0.328	0.393	0.393	0.393	0.393	0.393
1966	0.044	0.107	0.168	0.203	0.235	0.251	0.281	0.333	0.389	0.389	0.389	0.389	0.389
1967	0.04	0.097	0.149	0.174	0.198	0.211	0.232	0.267	0.297	0.297	0.297	0.297	0.297
1968	0.043	0.107	0.158	0.178	0.197	0.212	0.234	0.27	0.301	0.301	0.301	0.301	0.301
1969	0.054	0.136	0.196	0.211	0.224	0.235	0.255	0.286	0.307	0.307	0.307	0.307	0.307
1970	0.061	0.152	0.207	0.208	0.207	0.207	0.215	0.232	0.239	0.239	0.239	0.239	0.239
1971	0.068	0.162	0.215	0.204	0.191	0.181	0.18	0.186	0.183	0.183	0.183	0.183	0.183
1972	0.084	0.205	0.278	0.272	0.257	0.246	0.243	0.244	0.232	0.232	0.232	0.232	0.232
1973	0.104	0.26	0.339	0.312	0.271	0.244	0.226	0.217	0.2	0.2	0.2	0.2	0.2
1974	0.112	0.282	0.353	0.313	0.26	0.228	0.207	0.196	0.186	0.186	0.186	0.186	0.186
1975	0.108	0.278	0.34	0.295	0.238	0.207	0.184	0.172	0.167	0.167	0.167	0.167	0.167
1976	0.101	0.269	0.326	0.285	0.232	0.203	0.179	0.163	0.157	0.157	0.157	0.157	0.157
1977	0.09	0.258	0.325	0.3	0.254	0.23	0.205	0.182	0.174	0.174	0.174	0.174	0.174
1978	0.069	0.212	0.281	0.278	0.255	0.25	0.233	0.212	0.204	0.204	0.204	0.204	0.204
1979	0.056	0.19	0.269	0.29	0.284	0.289	0.278	0.251	0.242	0.242	0.242	0.242	0.242
1980	0.049	0.18	0.264	0.304	0.308	0.321	0.313	0.278	0.274	0.274	0.274	0.274	0.274
1981	0.046	0.188	0.3	0.379	0.401	0.429	0.422	0.364	0.369	0.369	0.369	0.369	0.369
1982	0.043	0.186	0.31	0.404	0.424	0.454	0.447	0.376	0.399	0.399	0.399	0.399	0.399
1983	0.046	0.211	0.374	0.492	0.515	0.546	0.541	0.45	0.499	0.499	0.499	0.499	0.499
1984	0.042	0.212	0.39	0.512	0.522	0.533	0.519	0.433	0.491	0.491	0.491	0.491	0.491
1985	0.04	0.206	0.395	0.517	0.519	0.524	0.512	0.443	0.524	0.524	0.524	0.524	0.524
1986	0.039	0.208	0.432	0.598	0.606	0.627	0.623	0.55	0.645	0.645	0.645	0.645	0.645
1987	0.035	0.195	0.418	0.582	0.578	0.581	0.564	0.492	0.554	0.554	0.554	0.554	0.554
1988	0.03	0.171	0.375	0.526	0.514	0.494	0.454	0.38	0.404	0.404	0.404	0.404	0.404
1989	0.028	0.166	0.364	0.502	0.48	0.447	0.404	0.349	0.391	0.391	0.391	0.391	0.391
1990	0.032	0.201	0.454	0.619	0.585	0.527	0.479	0.441	0.537	0.537	0.537	0.537	0.537
1991	0.043	0.267	0.603	0.815	0.781	0.718	0.682	0.658	0.818	0.818	0.818	0.818	0.818
1992	0.039	0.238	0.533	0.717	0.705	0.666	0.66	0.67	0.86	0.86	0.86	0.86	0.86
1993	0.036	0.209	0.455	0.603	0.599	0.565	0.551	0.546	0.666	0.666	0.666	0.666	0.666
1994	0.032	0.18	0.395	0.535	0.557	0.536	0.515	0.494	0.561	0.561	0.561	0.561	0.561
1995	0.026	0.152	0.358	0.518	0.588	0.603	0.601	0.591	0.68	0.68	0.68	0.68	0.68
1996	0.019	0.107	0.258	0.395	0.472	0.502	0.5	0.484	0.542	0.542	0.542	0.542	0.542
1997	0.016	0.092	0.23	0.368	0.462	0.518	0.538	0.54	0.621	0.621	0.621	0.621	0.621
1998	0.014	0.085	0.217	0.355	0.464	0.545	0.586	0.595	0.696	0.696	0.696	0.696	0.696
1999	0.014	0.084	0.22	0.366	0.483	0.584	0.637	0.656	0.782	0.782	0.782	0.782	0.782

Year Age	3	4	5	6	7	8	9	10	11	12	13	14	15
2000	0.014	0.088	0.233	0.383	0.492	0.574	0.603	0.599	0.693	0.693	0.693	0.693	0.693
2001	0.016	0.104	0.296	0.513	0.687	0.824	0.899	0.919	1.127	1.127	1.127	1.127	1.127
2002	0.013	0.09	0.264	0.457	0.608	0.725	0.777	0.78	0.971	0.971	0.971	0.971	0.971
2003	0.011	0.079	0.233	0.412	0.558	0.68	0.757	0.747	0.961	0.961	0.961	0.961	0.961
2004	0.012	0.081	0.236	0.412	0.568	0.721	0.848	0.845	1.144	1.144	1.144	1.144	1.144
2005	0.017	0.111	0.292	0.454	0.567	0.662	0.738	0.681	0.911	0.911	0.911	0.911	0.911
2006	0.028	0.167	0.394	0.559	0.647	0.73	0.813	0.751	0.999	0.999	0.999	0.999	0.999
2007	0.036	0.212	0.455	0.587	0.629	0.697	0.793	0.746	1.034	1.034	1.034	1.034	1.034
2008	0.049	0.279	0.553	0.65	0.636	0.661	0.743	0.702	0.985	0.985	0.985	0.985	0.985
2009	0.055	0.317	0.605	0.686	0.645	0.641	0.701	0.655	0.902	0.902	0.902	0.902	0.902
2010	0.063	0.356	0.662	0.747	0.682	0.667	0.711	0.666	0.912	0.912	0.912	0.912	0.912
2011	0.055	0.306	0.564	0.652	0.601	0.597	0.641	0.63	0.906	0.906	0.906	0.906	0.906
2012	0.056	0.318	0.576	0.677	0.647	0.656	0.71	0.726	1.105	1.105	1.105	1.105	1.105
2013	0.054	0.3	0.541	0.628	0.604	0.619	0.653	0.666	1.034	1.034	1.034	1.034	1.034
2014	0.053	0.287	0.525	0.625	0.6	0.616	0.607	0.572	0.8	0.8	0.8	0.8	0.8
2015	0.061	0.331	0.625	0.779	0.76	0.813	0.802	0.723	0.922	0.922	0.922	0.922	0.922
2016	0.056	0.299	0.571	0.706	0.675	0.701	0.675	0.56	0.598	0.598	0.598	0.598	0.598
2017	0.049	0.249	0.47	0.567	0.526	0.522	0.483	0.375	0.366	0.366	0.366	0.366	0.366
2018	0.047	0.231	0.428	0.517	0.485	0.477	0.454	0.365	0.363	0.363	0.363	0.363	0.363
2019	0.045	0.209	0.371	0.437	0.405	0.386	0.353	0.276	0.268	0.268	0.268	0.268	0.268
2020	0.046	0.215	0.382	0.449	0.42	0.407	0.365	0.283	0.274	0.274	0.274	0.274	0.274

Table 6.5.2. Faroe saithe (Division 5.b). Stock number-at-age (start of year) (Thousands)(1961–2020).

Year Age	3	4	5	6	7	8	9	10	11	12	13	14	15
1961	8835	7250	5775	3517	1931	1344	1016	679	314	120	59	6	291
1962	13699	6983	5729	4314	2422	1371	1004	727	495	223	71	49	199
1963	19920	9680	4887	4124	3089	1644	1049	734	496	377	178	41	144
1964	16844	17597	8405	3782	3084	2169	1144	746	472	332	208	115	94
1965	20120	11798	13100	5874	2644	2071	1367	796	502	297	215	116	132
1966	15521	15889	8511	9330	3910	1733	1331	793	500	291	153	113	134
1967	19396	11899	11551	5760	6203	2436	1081	826	434	289	164	75	120
1968	20374	16778	9482	8254	3961	3879	1484	670	505	250	175	101	138
1969	32318	16015	13095	7470	5992	2841	2420	921	420	336	144	108	125
1970	30150	31288	10932	9057	5385	4118	1897	1356	514	241	204	82	128
1971	33405	23402	22474	7466	6304	3926	2831	1321	797	319	146	125	121
1972	33840	22488	16155	13181	5588	4809	3226	2224	1034	531	200	116	157
1973	27203	25860	17935	11314	7423	3539	3059	2059	1323	624	300	135	203
1974	24406	19355	15608	10609	6977	4154	2275	2005	1295	828	388	231	266
1975	20371	15456	11754	8770	6261	4600	2617	1549	1330	845	532	275	380
1976	22069	13634	8347	6191	5330	4221	3319	1930	1160	895	548	370	472
1977	15284	14746	7477	4671	3606	3641	3065	2518	1556	912	661	387	544
1978	9502	10392	8552	3765	2520	2132	2454	2254	1999	1151	711	516	644
1979	8189	6576	6346	5033	2352	1620	1210	1647	1524	1437	797	497	948
1980	14598	6196	4205	3684	3069	1403	963	689	941	918	1128	562	1051
1981	17521	10390	4237	2719	2301	1853	878	583	375	536	593	839	1194
1982	14501	18614	6162	2856	1460	1169	908	455	313	196	297	341	1355
1983	36575	10190	14924	3816	1567	809	548	438	269	167	102	203	878
1984	20904	32379	7313	9243	1977	770	384	212	247	140	66	56	522

Year Age	3	4	5	6	7	8	9	10	11	12	13	14	15
1985	26083	18660	18462	4232	4619	927	382	178	102	151	69	29	307
1986	39692	17556	12868	8708	2414	2197	477	218	106	52	81	27	152
1987	40480	36406	11771	6848	3301	1287	887	206	111	44	20	32	73
1988	36785	30083	28709	6289	3129	1437	697	389	97	56	33	7	28
1989	24065	33053	22711	17773	2818	1456	629	357	178	52	22	24	29
1990	18199	20803	23288	15169	9284	1442	687	305	216	79	34	15	39
1991	23775	16145	14484	11047	6782	3957	740	411	174	123	38	16	24
1992	19402	19660	9649	6182	3682	2544	1557	301	184	59	49	13	15
1993	25158	15307	12997	4409	2433	1496	1179	681	129	80	18	14	7
1994	16229	19119	10213	6702	1951	1147	753	618	343	57	43	6	7
1995	17919	10431	10069	6633	3225	870	579	394	291	163	25	25	7
1996	15880	16576	6551	4412	2955	1234	404	247	193	125	69	7	16
1997	22480	12397	14219	4406	3084	1656	532	185	103	105	63	32	13
1998	14746	20117	11242	13061	3328	1579	818	226	87	44	51	28	18
1999	30330	10240	17711	8585	11636	1842	765	350	87	38	16	23	19
2000	39256	34175	7133	14740	6235	7011	780	366	132	36	13	6	11
2001	75782	27800	33107	5056	8092	3120	2631	424	154	50	15	8	7
2002	46810	74700	20956	24622	2327	2815	1257	762	124	39	13	3	4
2003	43422	49512	54254	11957	10655	1099	852	583	245	46	10	4	2
2004	20545	40865	53861	39016	5973	3722	383	391	222	78	15	3	2
2005	38781	25498	31618	44860	17327	2447	1259	150	134	56	15	4	1
2006	33201	40744	24169	19508	23123	7967	950	506	64	38	19	6	2
2007	26211	19029	36779	14827	9333	8377	2942	558	143	21	12	5	2
2008	42656	17738	9706	21983	7761	5463	3853	1077	245	30	7	4	2
2009	17425	22248	11806	4345	9539	4273	3092	1769	459	80	8	2	2
2010	26465	11213	12776	2895	2416	4148	2355	1362	815	149	29	3	1

Year Age	3	4	5	6	7	8	9	10	11	12	13	14	15
2011	40208	16726	5408	4148	1324	1050	1806	1026	579	308	57	9	1
2012	23629	27975	11934	2533	1576	714	588	782	430	169	126	21	3
2013	14525	19683	12431	6885	1152	727	312	280	289	119	36	40	6
2014	17089	11499	10661	4721	2538	549	346	198	141	84	33	7	14
2015	39611	9914	7824	4777	2001	804	298	185	110	62	28	12	8
2016	22766	39803	4742	3659	1450	753	227	109	103	41	24	6	5
2017	12494	20190	22881	2173	1415	824	274	95	25	47	27	10	4
2018	9500	8745	13555	10992	1003	690	341	118	51	16	31	16	9
2019	44243	5935	5260	6618	3905	663	380	199	52	24	10	18	14
2020	31734	36181	3520	3352	3557	1363	426	239	124	33	15	6	20

Table 6.5.3. Faroe saithe (Division 5.b). Summary table (1961–2020).

Year	R (age 3)	Low	High	SSB	Low	High	Fbar (4-8)	Low	High	TSB	Low	High
1961	8835	4834	16148	64301	48739	84831	0.105	0.071	0.156	100866	76011	133849
1962	13699	7864	23864	68616	52644	89433	0.121	0.084	0.173	108567	82874	142226
1963	19920	11522	34436	77390	60275	99365	0.13	0.092	0.184	129345	99344	168406
1964	16844	9827	28871	88083	69064	112339	0.165	0.118	0.23	150190	115134	195919
1965	20120	11744	34468	98242	76614	125977	0.189	0.136	0.264	161909	124495	210568
1966	15521	9029	26680	102777	79338	133142	0.193	0.138	0.27	166006	127270	216532
1967	19396	11336	33186	97862	74864	127925	0.166	0.118	0.233	156225	119483	204264
1968	20374	11994	34608	99365	76312	129383	0.171	0.122	0.239	161179	123810	209827
1969	32318	19147	54549	105424	81159	136945	0.201	0.144	0.28	181101	139311	235429
1970	30150	18039	50390	110665	85159	143811	0.196	0.141	0.273	197417	152010	256389
1971	33405	20129	55438	122720	94676	159072	0.191	0.137	0.264	204825	159571	262914
1972	33840	20489	55891	140769	109787	180495	0.252	0.183	0.346	222661	175931	281803
1973	27203	16483	44894	160538	125646	205119	0.285	0.209	0.39	251683	200210	316390
1974	24406	14670	40603	152133	119192	194177	0.287	0.21	0.393	239418	190895	300275
1975	20371	12217	33966	155171	121635	197953	0.272	0.198	0.373	224199	179420	280153
1976	22069	13162	37002	136245	107575	172556	0.263	0.192	0.361	196214	157863	243881
1977	15284	9149	25535	128119	102363	160356	0.273	0.199	0.375	177494	143970	218825
1978	9502	5700	15839	115300	93413	142315	0.255	0.187	0.347	161912	131881	198782
1979	8189	4903	13677	102726	83704	126070	0.264	0.196	0.357	132740	109347	161138
1980	14598	8798	24220	100700	82769	122515	0.275	0.206	0.367	138104	114434	166669
1981	17521	10524	29169	81549	67560	98434	0.339	0.257	0.448	128467	105634	156236
1982	14501	8695	24184	76219	63308	91764	0.356	0.271	0.466	130780	105947	161433
1983	36575	21796	61375	78468	63787	96527	0.428	0.33	0.555	159520	125638	202539
1984	20904	12586	34718	86928	69336	108983	0.434	0.335	0.562	176477	137267	226889
1985	26083	15796	43069	97256	77592	121903	0.432	0.335	0.559	187855	148242	238055
1986	39692	23888	65953	87798	70621	109154	0.494	0.383	0.638	196280	152165	253186
1987	40480	24408	67134	85056	68442	105702	0.471	0.364	0.609	210659	160848	275895
1988	36785	22156	61072	93952	74293	118814	0.416	0.318	0.544	216322	166171	281608
1989	24065	14545	39817	103090	81108	131031	0.392	0.3	0.511	199930	156316	255713
1990	18199	11018	30058	99365	79121	124789	0.477	0.372	0.613	171472	137159	214368
1991	23775	14489	39013	81293	65951	100203	0.637	0.499	0.814	146057	118301	180326
1992	19402	11836	31807	64907	53319	79014	0.572	0.448	0.73	125791	101334	156150
1993	25158	15288	41402	63679	52263	77588	0.486	0.38	0.622	136170	108217	171344
1994	16229	9979	26394	61523	50969	74262	0.44	0.342	0.566	129764	103458	162760
1995	17919	10970	29270	59656	49250	72261	0.443	0.342	0.575	117857	94461	147049
1996	15880	9832	25648	49601	40849	60229	0.347	0.266	0.452	109007	85442	139071
1997	22480	13966	36185	54640	44672	66832	0.334	0.259	0.431	122777	95802	157347
1998	14746	9147	23770	63804	52360	77751	0.333	0.259	0.429	133238	106265	167056
1999	30330	18565	49550	78026	64025	95089	0.348	0.271	0.446	161594	129081	202296
2000	39256	24492	62918	89687	74339	108203	0.354	0.275	0.456	212446	168151	268409
2001	75782	47029	122112	94969	78447	114971	0.485	0.378	0.622	269429	208043	348928
2002	46810	28573	76686	96825	79395	118081	0.429	0.332	0.554	273843	212127	353516
2003	43422	26749	70487	104437	84109	129677	0.392	0.302	0.51	265137	206376	340628
2004	20545	12286	34355	113943	92074	141007	0.404	0.313	0.52	258483	205280	325475
2005	38781	24327	61824	110285	90030	135097	0.417	0.324	0.537	251727	203874	310811
2006	33201	21022	52436	102379	84631	123848	0.499	0.393	0.634	230276	188486	281331
2007	26211	16742	41035	89128	74108	107193	0.516	0.41	0.65	190656	157100	231380
2008	42656	26254	69304	80286	67200	95919	0.556	0.442	0.699	180156	147049	220717
2009	17425	11060	27455	73512	61724	87551	0.579	0.459	0.729	141672	117530	170773
2010	26465	16960	41297	58912	49589	69986	0.623	0.491	0.79	134168	109426	164504
2011	40208	25418	63602	45490	38634	53562	0.544	0.429	0.689	125347	99563	157809
2012	23629	15133	36895	39546	33357	46884	0.574	0.456	0.723	108410	86465	135925
2013	14525	9292	22704	36567	30374	44023	0.538	0.424	0.684	96284	77142	120175
2014	17089	10884	26830	41505	34314	50203	0.53	0.414	0.679	96925	77826	120711
2015	39611	24984	62802	39406	32648	47563	0.662	0.519	0.844	101440	79975	128666
2016	22766	14325	36179	38055	30829	46975	0.59	0.459	0.759	106374	81354	139087

Year	R (age 3)	Low	High	SSB	Low	High	Fbar (4-8)	Low	High	TSB	Low	High
2017	12494	7586	20577	47709	37476	60735	0.467	0.351	0.62	108609	83115	141922
2018	9500	5330	16932	49701	38625	63954	0.428	0.309	0.592	97228	73600	128440
2019	44243	21047	93005	52506	38671	71290	0.362	0.241	0.543	131690	82949	209071
2020	31734	10902	92374	54921	33781	89291	0.374	0.208	0.675	152293	77233	300298

Table 6.6.1.1. Faroe saithe (Division 5.b). Input data for short-term forecast for the SAM assessment. Natural mortality (nm), maturity (mat), catch weights (cw), selection pattern (sel), stock weights (sw). Units for catch and stock weights are kg.

"age"	"N"	"nm"	"mat"	"pf"	"pm"	"sw"	"sel"	"cw"
3	31734	0.2	0.06	0	0	1.488	0.131	1.488
4	36181	0.2	0.266	0	0	1.785	0.645	1.785
5	3520	0.2	0.516	0	0	2.02	1.182	2.02
6	3352	0.2	0.746	0	0	2.588	1.417	2.588
7	3557	0.2	0.904	0	0	3.439	1.327	3.439
8	1363	0.2	0.972	0	0	4.619	1.309	4.619
9	426	0.2	0.988	0	0	6.342	1.217	6.342
10	239	0.2	1	0	0	7.494	0.966	7.494
11	124	0.2	1	0	0	8.378	0.961	8.378
12	33	0.2	1	0	0	9.21	0.961	9.21
13	15	0.2	1	0	0	8.667	0.961	8.667
14	6	0.2	1	0	0	8.465	0.961	8.465
15	20	0.2	1	0	0	8.242	0.961	8.242

Table 6.6.2.1. Faroe saithe (Division 5.b). Output of the SAM short-term-forecast including confidence intervals (low and high columns). Units for ssb and catch are tonnes, thousands for recruitment. F_{MSY} advice.

Year	fbar:median	fbar:low	fbar:high	rec:median	rec:low	rec:high	ssb:median	ssb:low	ssb:high	catch:median	catch:low	catch:high	tsb:median	tsb:low	tsb:high
2020	0.343	0.196	0.602	32527	10909	98185	56308	35345	92246	23659	13795	41445	156289	81836	325688
2021	0.300	0.171	0.526	22766	9500	44243	73012	37367	143337	27368	14383	56238	169111	86684	338626
2022	0.300	0.171	0.526	22766	9500	44243	89455	41383	189390	32070	16517	65349	180509	88883	341110

Table 6.7.1. Faroe saithe (Division 5.b). Input data for the yield-per-recruit calculations of the SAM assessment. Natural mortality (nm), maturity (mat), catch weights (cw), selection pattern (sel), stock weights (sw). Units for catch and stock weights are kg.

"age"	"nm"	"mat"	"pf"	"pm"	"sw"	"sel"	"cw"
3	0.2	0.029	0	0	1.224	0.093	1.224
4	0.2	0.223	0	0	1.548	0.491	1.548
5	0.2	0.45	0	0	1.93	0.921	1.93
6	0.2	0.669	0	0	2.529	1.104	2.529
7	0.2	0.833	0	0	3.34	1.06	3.34
8	0.2	0.933	0	0	4.326	1.077	4.326
9	0.2	0.979	0	0	5.082	1.092	5.082
10	0.2	1	0	0	5.907	0.976	5.907
11	0.2	1	0	0	6.44	1.237	6.44
12	0.2	1	0	0	7.21	1.237	7.21
13	0.2	1	0	0	7.465	1.237	7.465
14	0.2	1	0	0	8.202	1.237	8.202
15	0.2	1	0	0	9.118	1.237	9.118

6.18 Figures

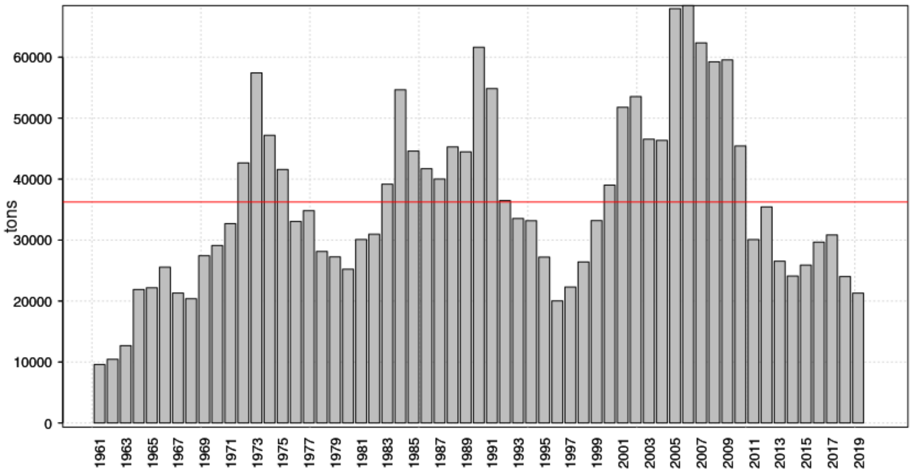

Figure 6.2.1.1. Faroe saithe (Division 5.b). Landings (tonnes)(1961–2019). Horizontal red line represents average landings.

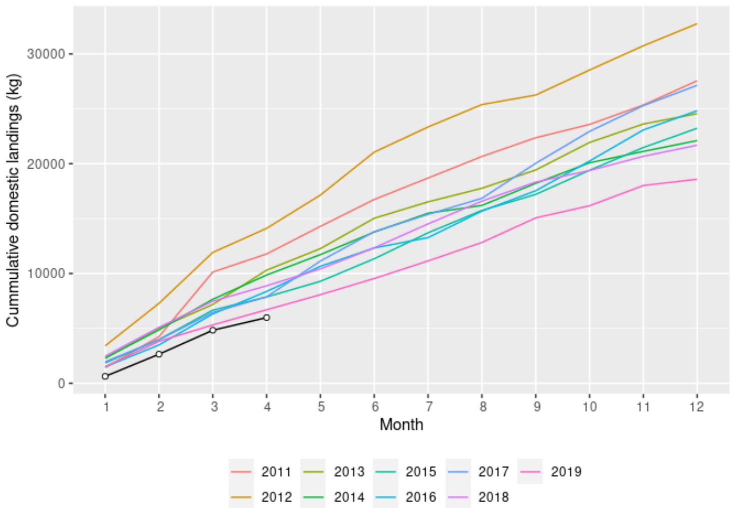

Figure 6.2.1.2. Saithe in the Faroes (Division 5.b). Cumulative domestic landings (2011–2020). Black line shows the first quarter of 2020.

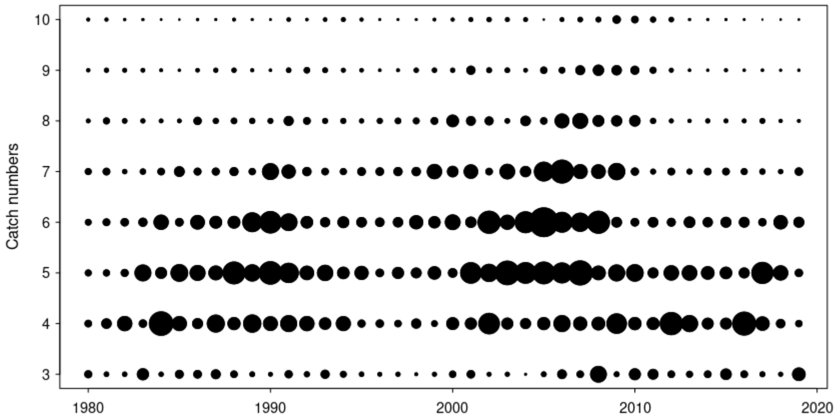

Figure 6.2.2.2. Faroe saithe (Division 5.b). Cath-at-age numbers in the commercial catches (ages 3–10) (1961–2019).

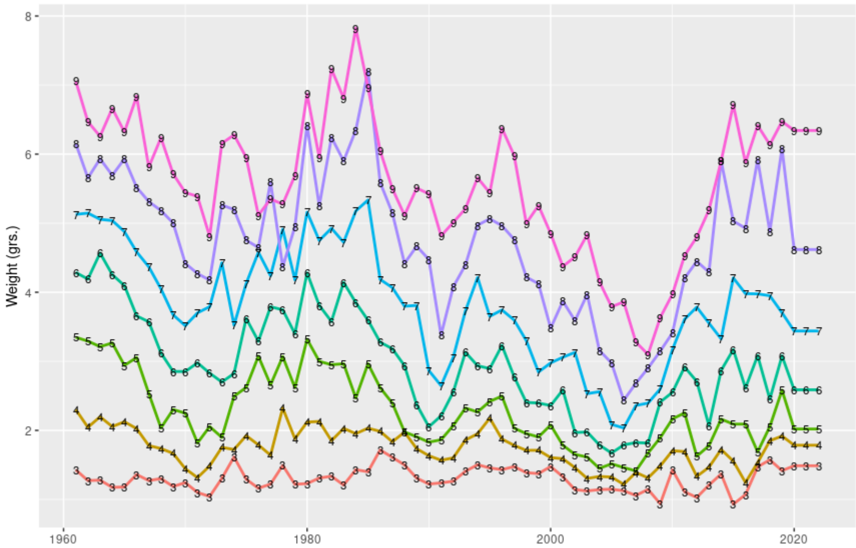

Figure 6.2.3.1.a Faroe saithe (Division 5.b). Mean weight at age (kg) in commercial catches (ages 3–9) (1961–2022). Estimated weights in 2020–2022 are used in projections.

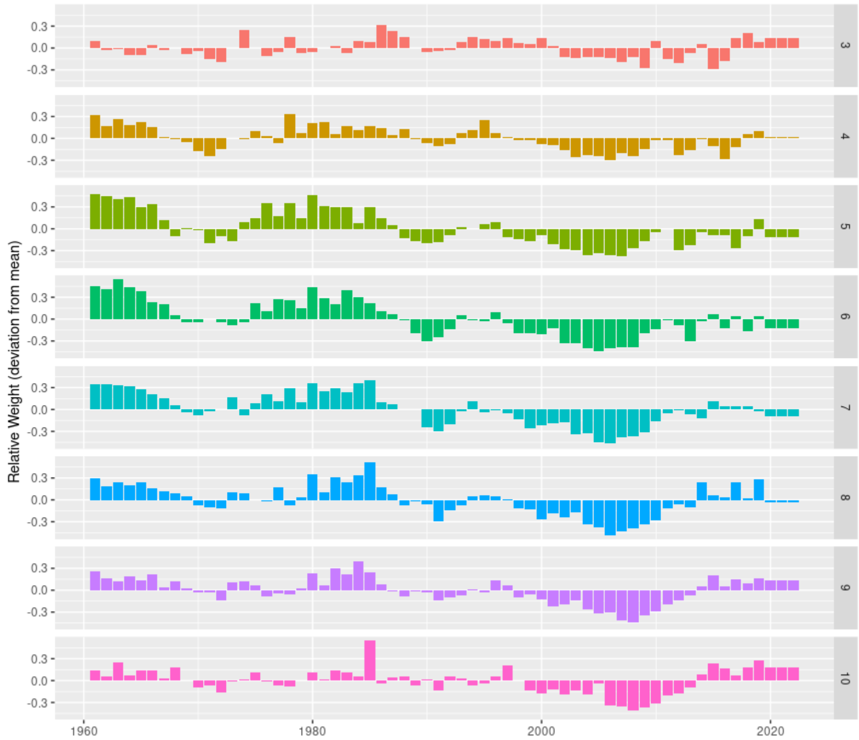

Figure 6.2.3.1.b Faroe saithe (Division 5.b). Deviations of mean weight at age (kg) from historical average in commercial catches (ages 3–10) (1961–2022). Weights in 2020–2022 are estimated.

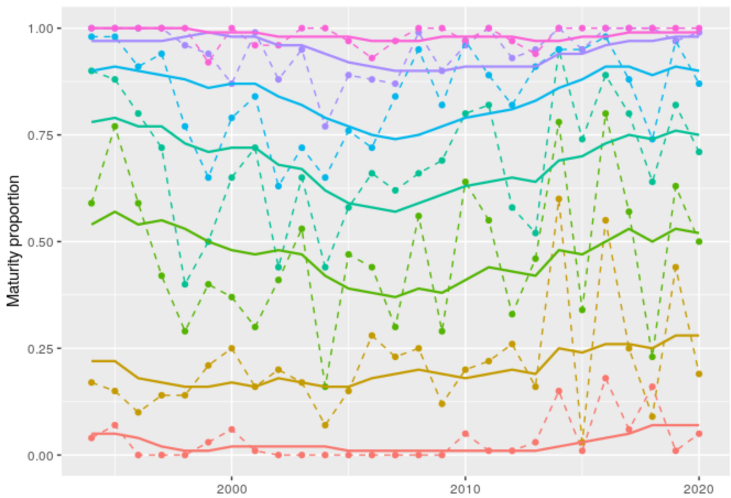

Figure 6.2.4.1. Faroe saithe (Division 5.b). Observed and smoothed maturity ogives (ages 3–9) (1994–2020) from FGFS1 (spring survey).

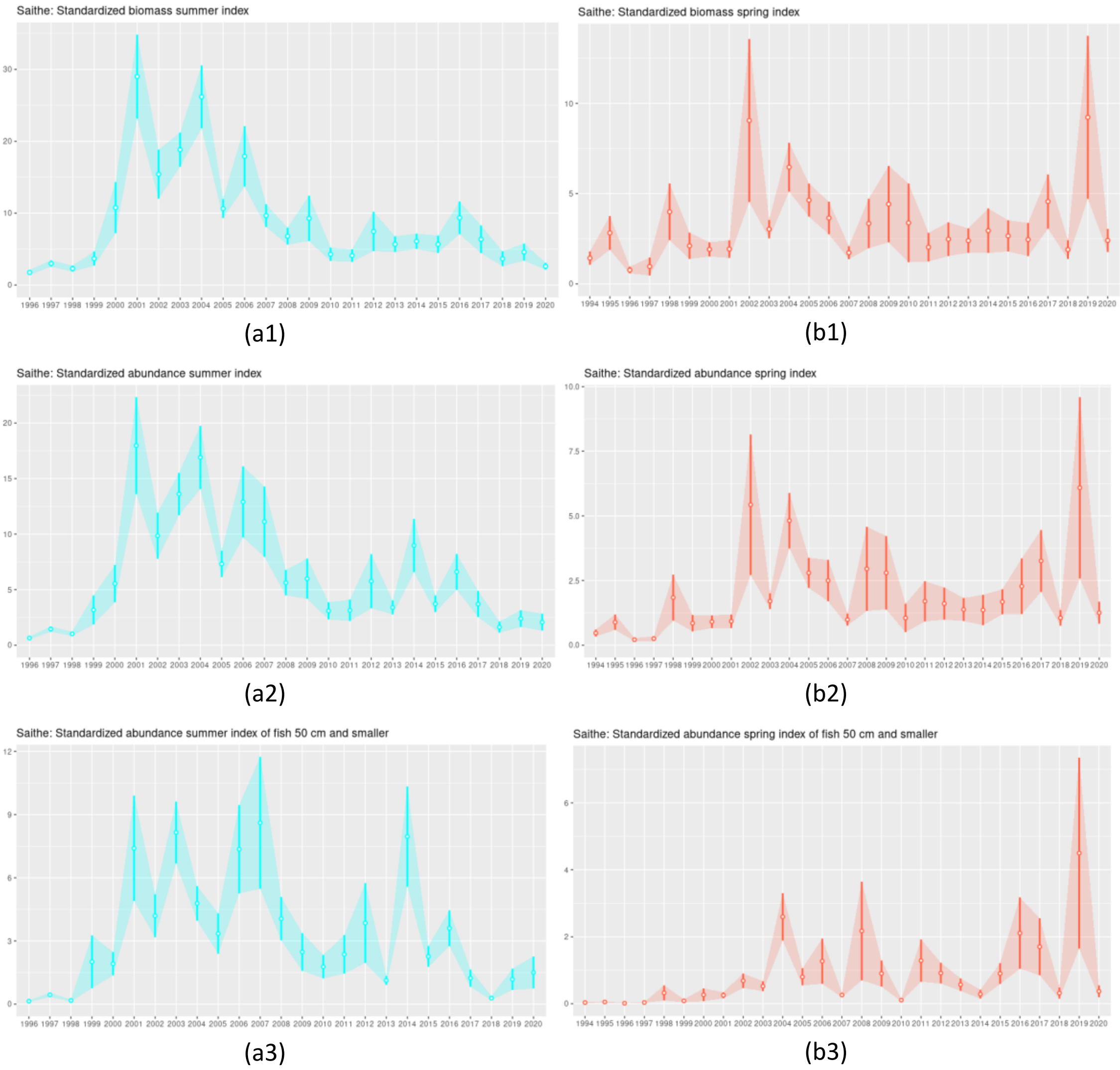

Figure 6.2.5.1.1. Faroe saithe (Division 5.b). Standardised biomass (a1)(b1) and abundance (a2)(b2) indices from the Faroese bottom-trawl summer FGFS1 (1996–2020) and spring surveys FGFS2 (1994–2020). Abundance indeces of fish 50 cm and smaller are proxies for recruitment strength (a3)(b3). Shade areas show standard errors in the estimation of indices.

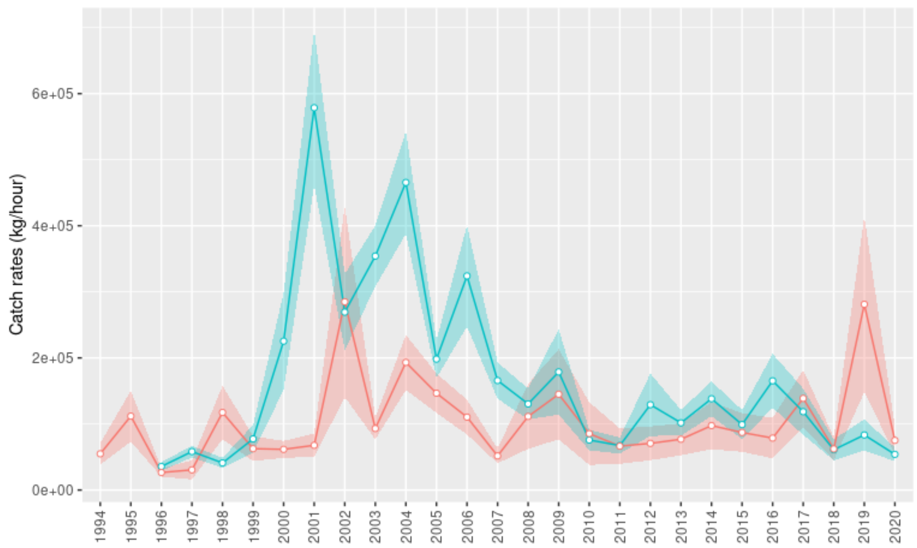

Figure 6.2.5.1.2. Faroe saithe (Division 5.b). Catch rates (kg/hour) from the Faroese bottom-trawl spring FGFS1 (1994–2020)(red line) and summer survey FGFS2 (1996–2020) (cyan line). Shade areas show standard errors in the estimation of indices.

Figure 6.2.5.1.3. Faroe saithe (Division 5.b). Age-disaggregated (ages 3–10) numbers from the commercial fleet (left panel), the Faroese bottom-trawl spring FGFS1 (middle panel) and summer survey FGFS2 (right panel) since 1995.

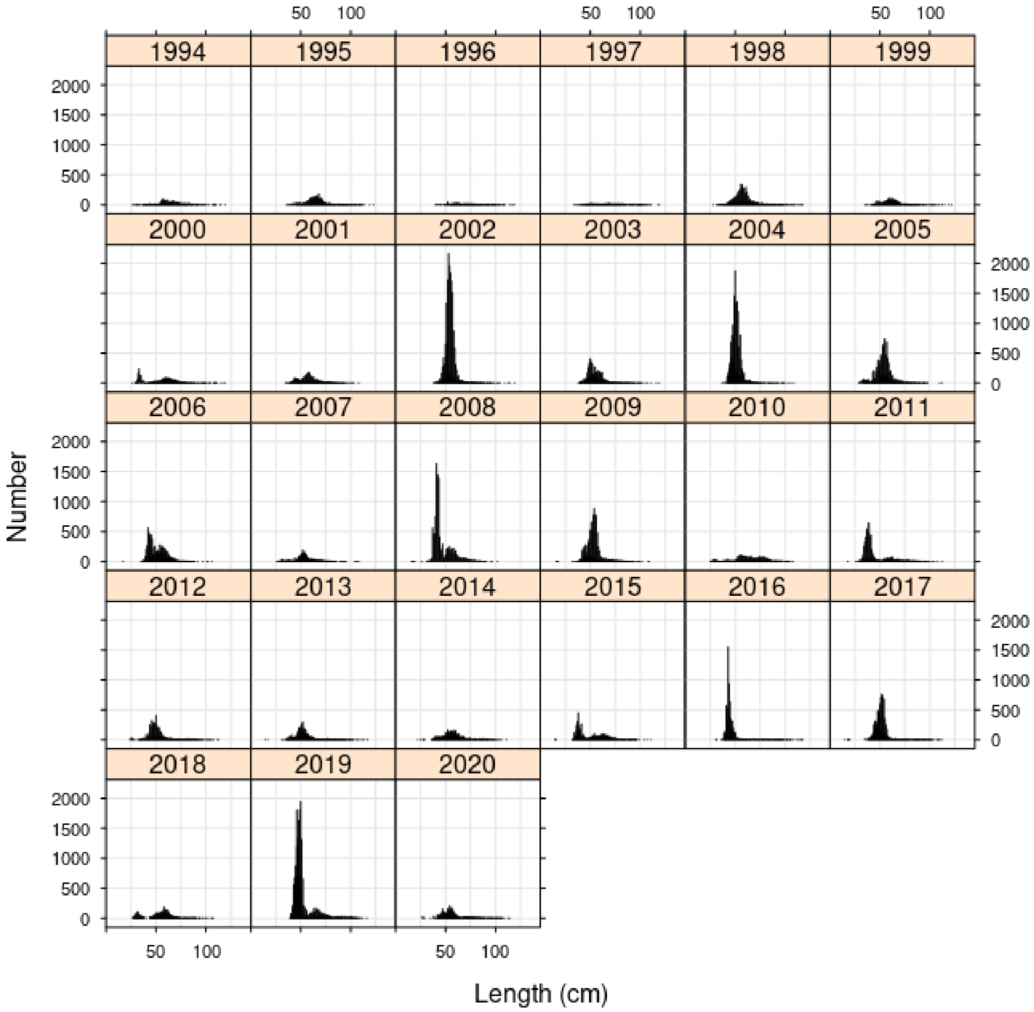

Figure 6.2.5.1.4. Faroe saithe (Division 5.b). Length composition from the Faroese bottom-trawl spring survey FGFS1 (1994–2020).

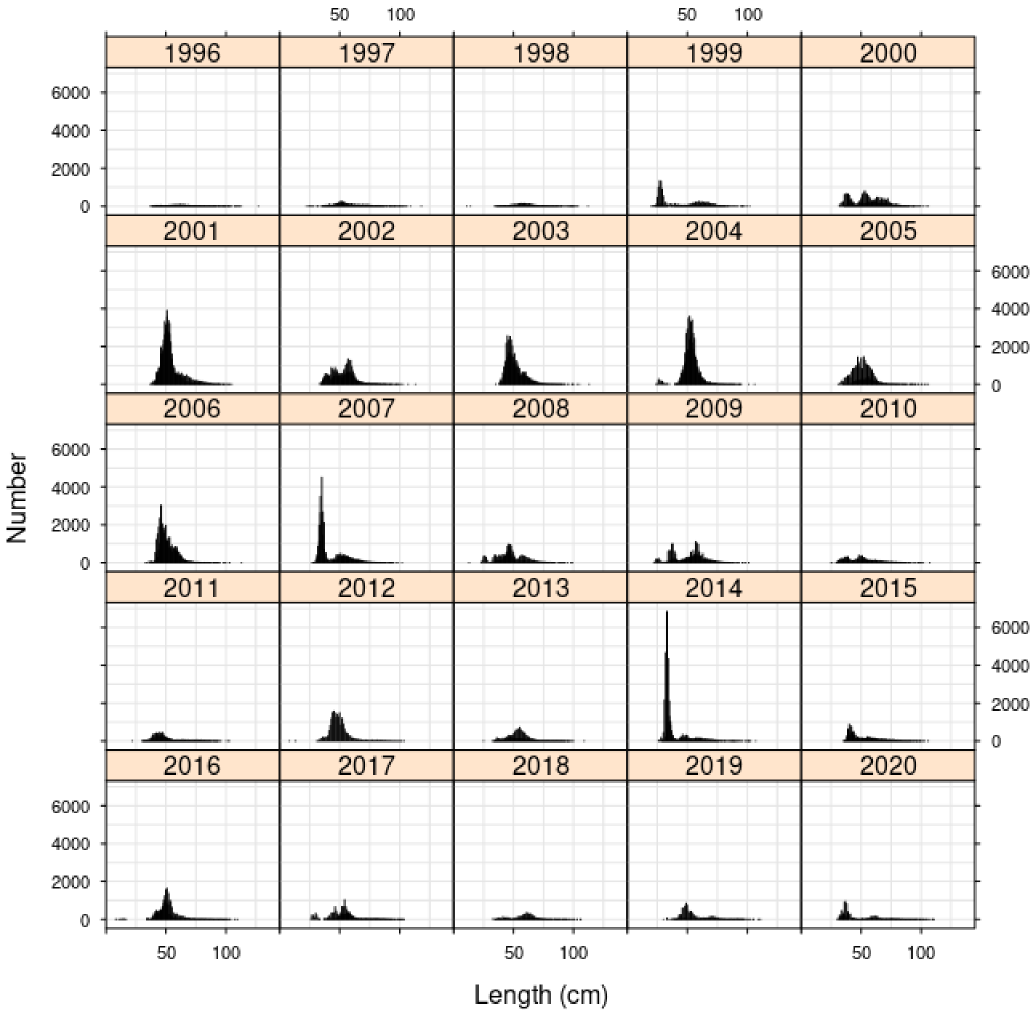

Figure 6.2.5.1.5. Faroe saithe (Division 5.b). Length composition from the Faroese bottom-trawl summer survey FGFS2 (1996–2020).

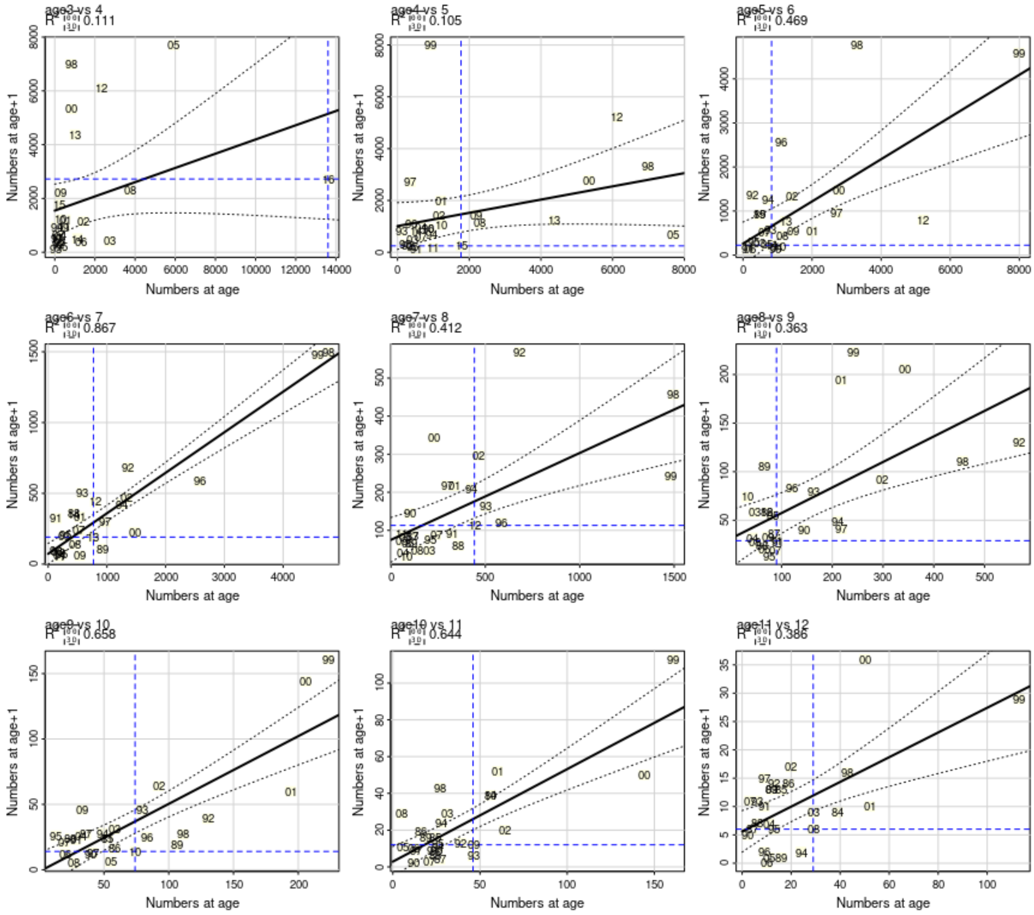

Figure 6.2.5.1.6. Faroe saithe (Division 5.b). Numbers from spring survey (FGFS1) plotted against numbers of the same year class one year later. Letters in the figures represent year classes. Horizontal and vertical lines crossing is the most recent pair.

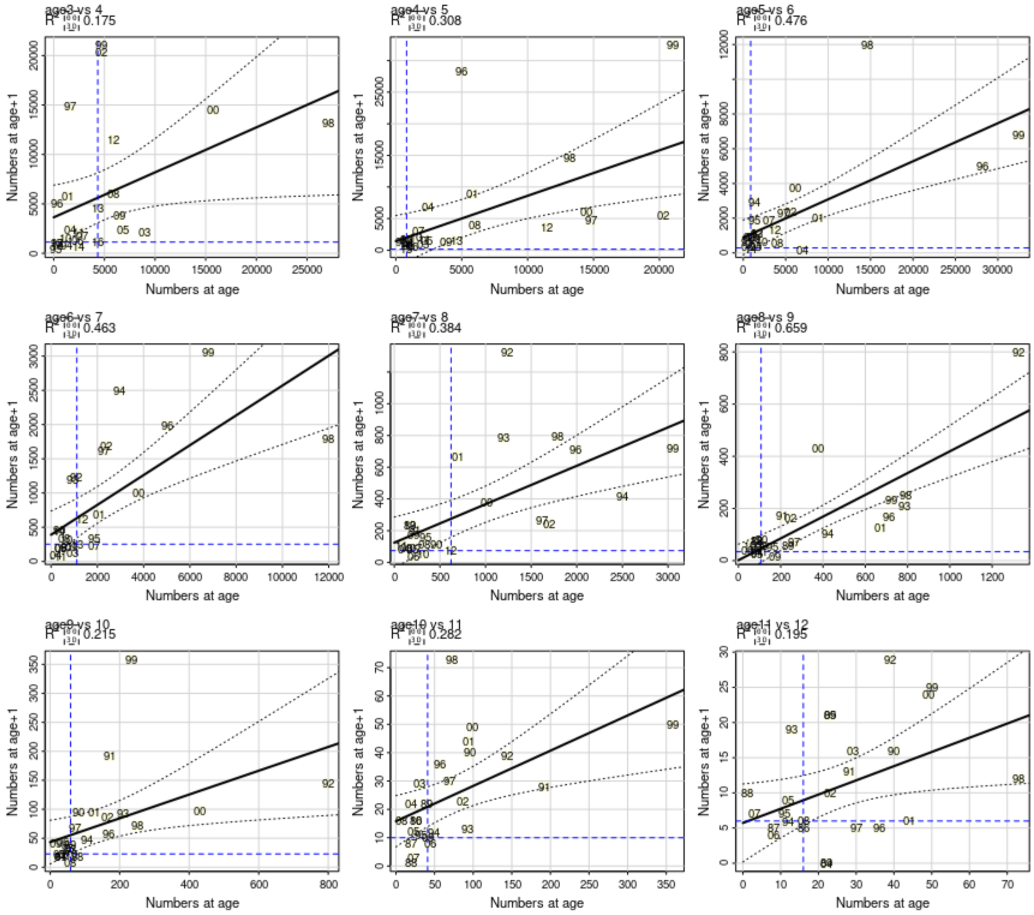

Figure 6.2.5.1.7. Faroe saithe (Division 5.b). Numbers from summer survey (FGFS2) plotted against numbers of the same year class one year later. Letters in the figures represent year classes. Horizontal and vertical lines crossing is the most recent pair.

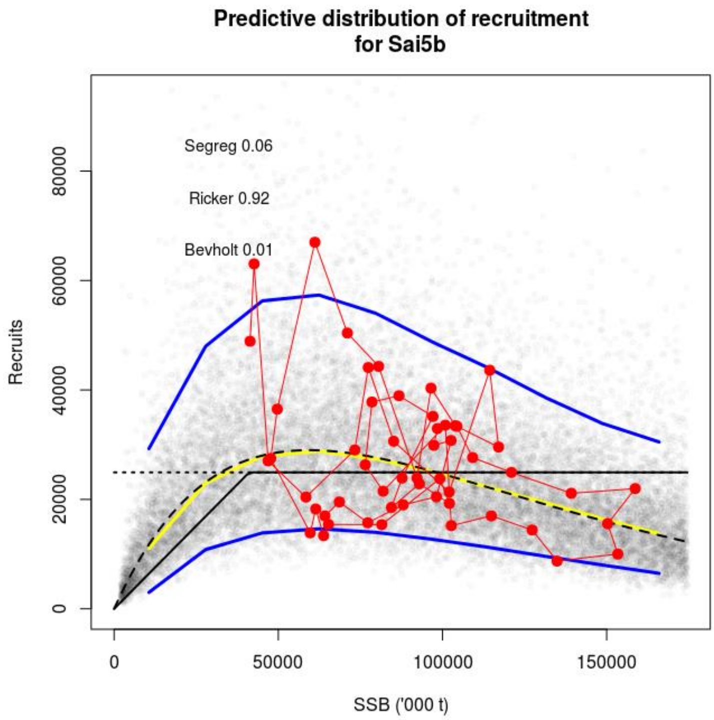

Figure 6.4.1.1. Faroe saithe (Division 5.b). EqSim simulations. Stock–recruitment functions used in the simulations (Ricker, Bevton-Holt and Segmented).

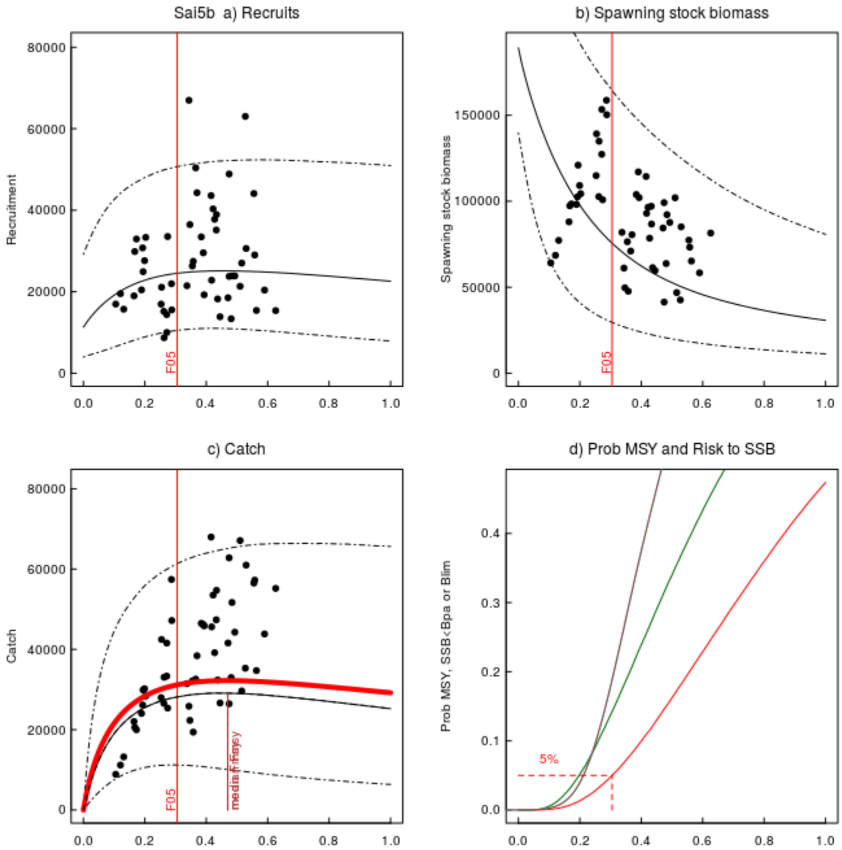

Figure 6.4.1.2. Faroe saithe (Division 5.b). EqSim simulation results. F_{MSY} = 0.30 is the vertical red line in the bottom-left graph.

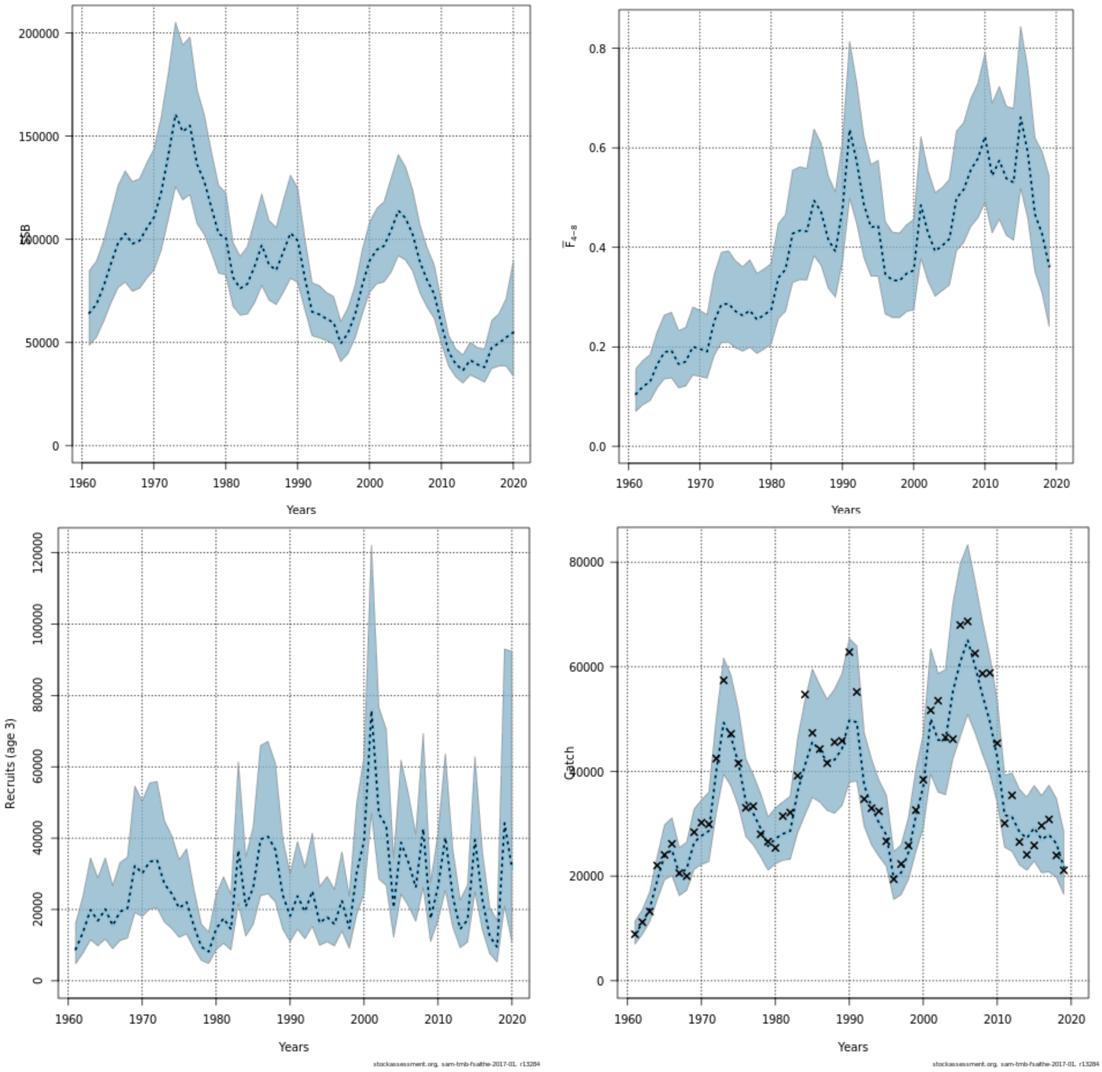

Figure 6.5.1. Faroe saithe (Division 5.b). Spawning-stock biomass (tonnes) (top-left), recruitment (age 3) in millions (bottom-left), , F_{bar} (ages 4 to 8)(top-right) and landings (tonnes)(bottom-right) from the SAM assessment. Reference points ($B_{trigger} = B_{pa}$ = 41 400 t and F_{MSY} = 0.30 respectively).

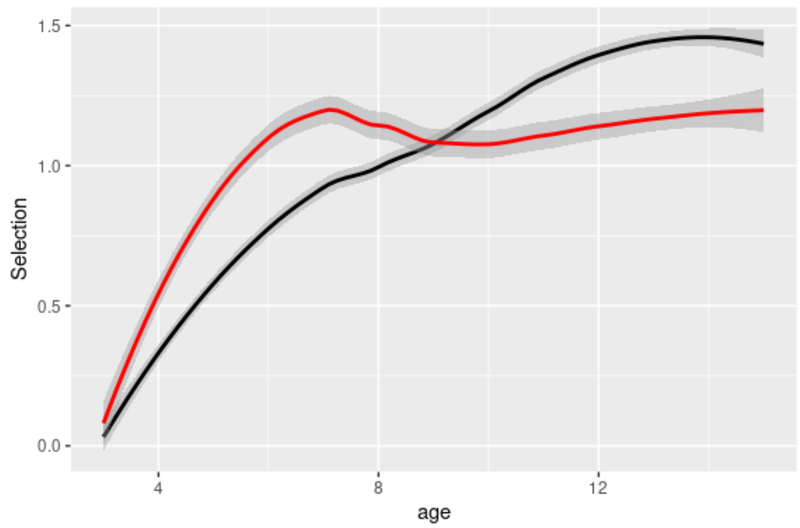

Figure 6.5.1.a Faroe saithe (Division 5.b). Selection pattern by periods in the fishery. Average selection from 2000 to 2014 (black line) and from 2015 to 2019 (red line).

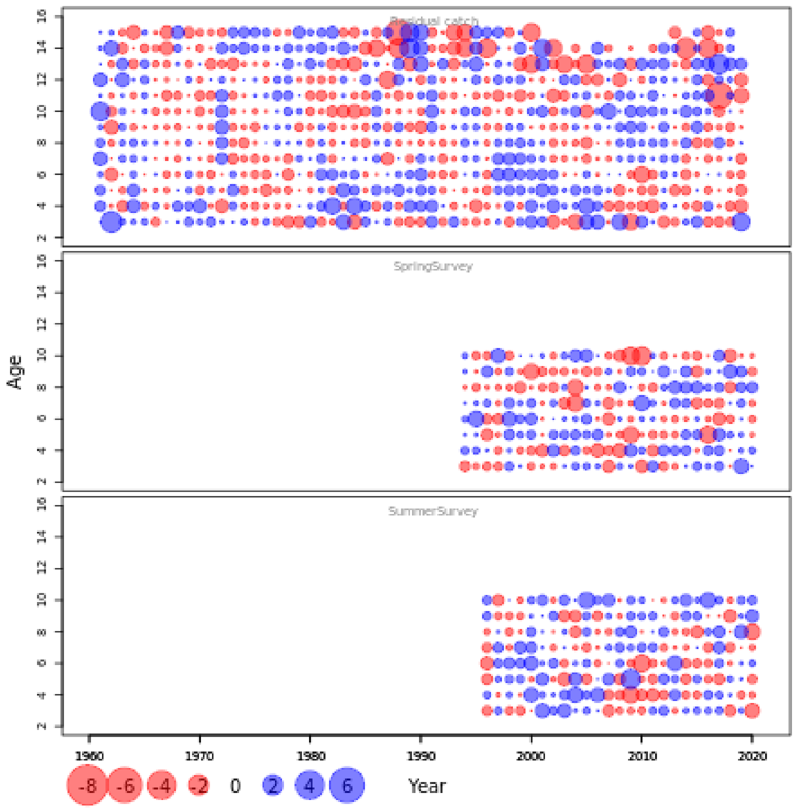

Figure 6.5.2. Faroe saithe (Division 5.b). Residuals of the SAM assessment calibrated with both survey indices. Blue and red bubbles represent positive and negative residuals respectively.

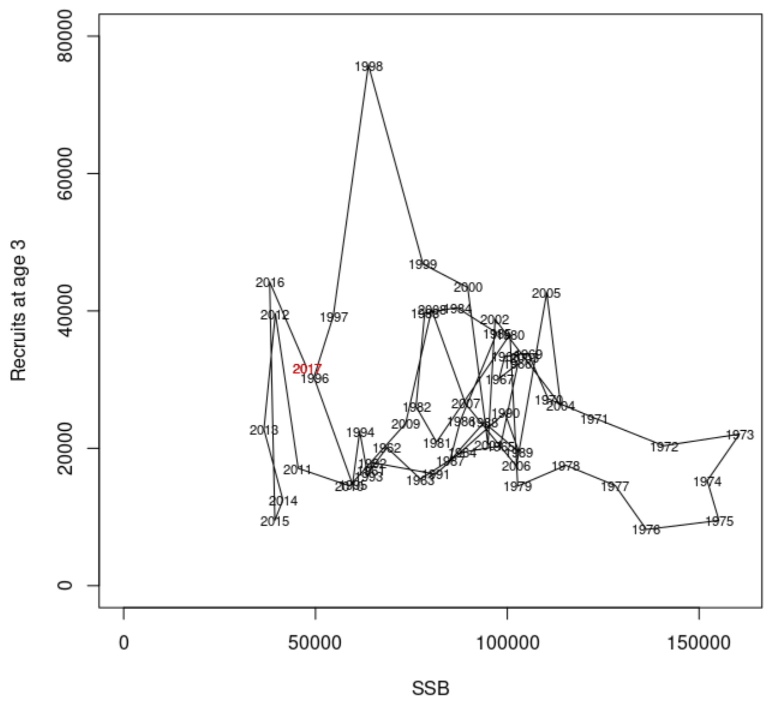

Figure 6.5.3. Faroe saithe (Division 5.b). Relation between SSB and recruitment (age 3). Numbers represent year-classes. The most recent year-class (2017) is highlighted in red.

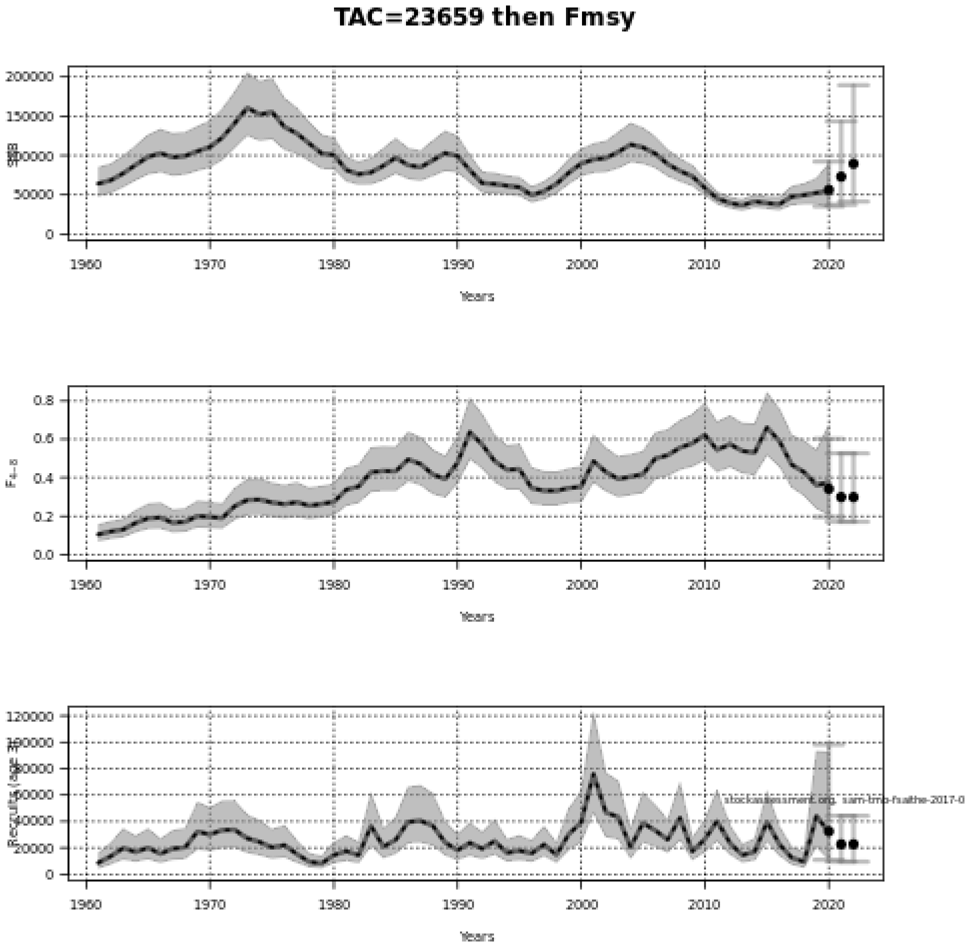

Figure 6.6.2.1. Faroe saithe (Division 5.b). Short-term forecast based on the F_{MSY} advice including historical assessment. Spawning stock biomass (top, red line represents $B_{trigger}$), average fishing mortality (F_{4-8}) (middle) and recruitment (numbers age3, bottom).

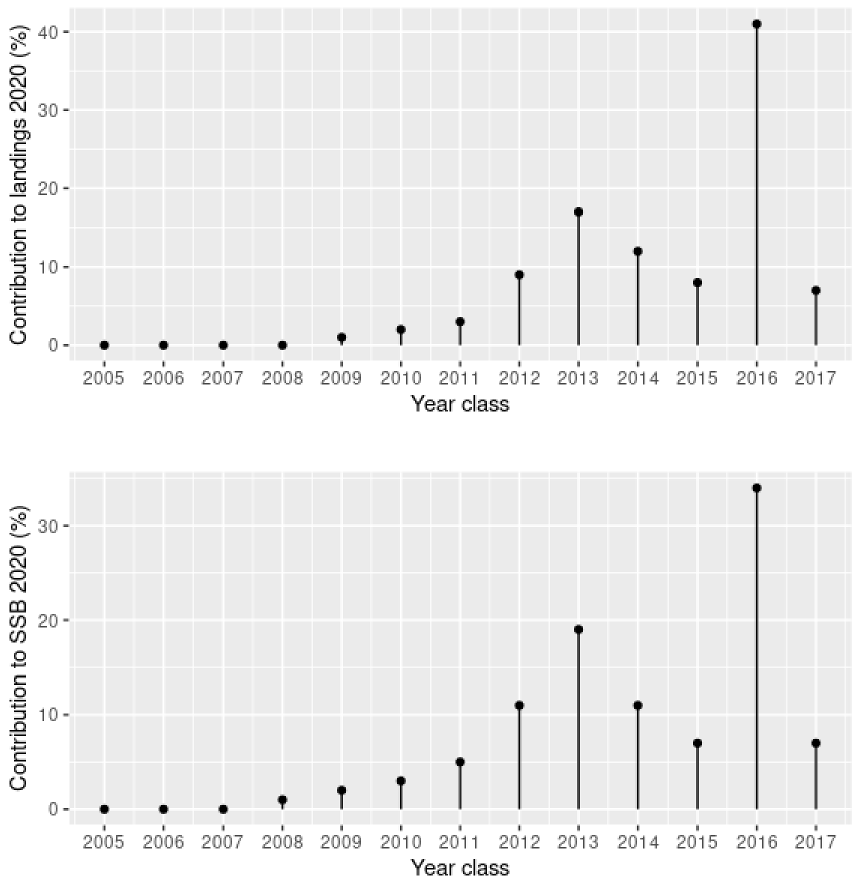

Figure 6.6.2.2. Faroe saithe (Division 5.b). Contribution of year classes to landings (top) and spawning stock biomass (bottom) in 2020.

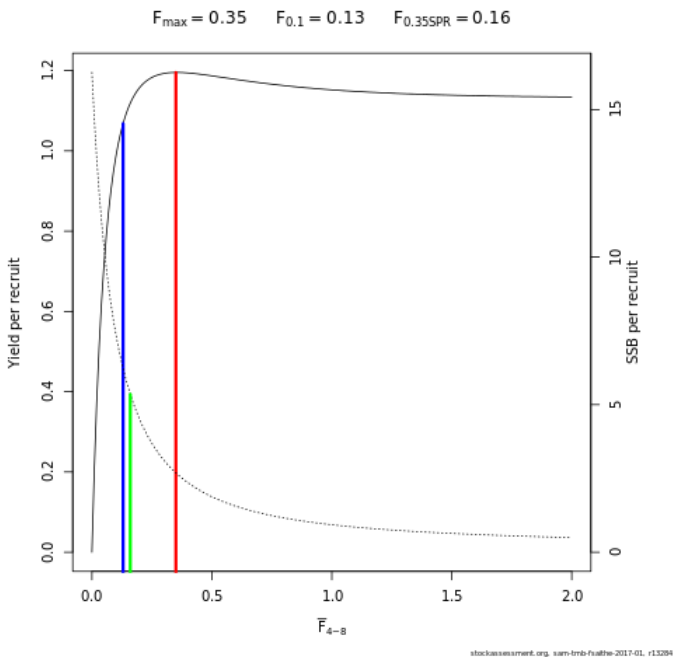

Figure 6.7.1. Faroe saithe (Division 5.b). Yield-per-recruit analysis.

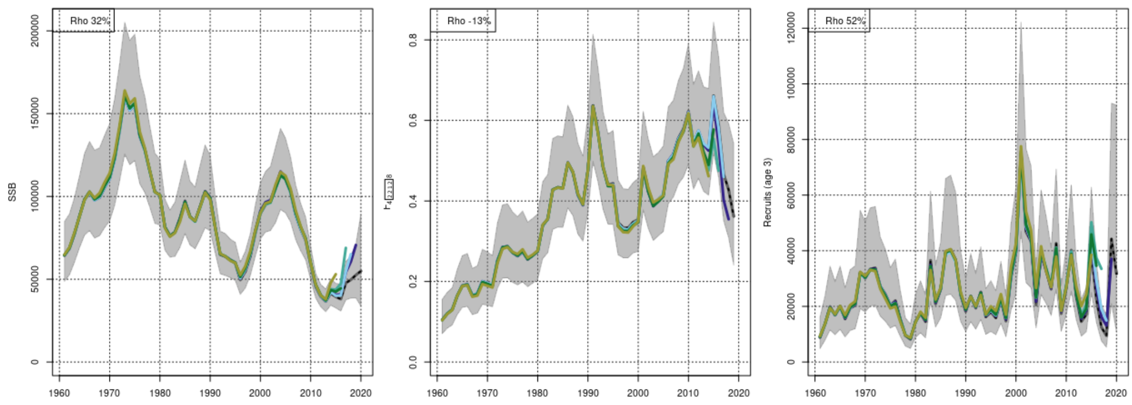

Figure 6.8.1. Faroe saithe (Division 5.b). Retrospective analysis of spawning-stock biomass (tonnes)(left), average fishing mortality over age groups 4–8 (middle) and recruitment-at-age 3 ('000)(right) from the SAM assessment.

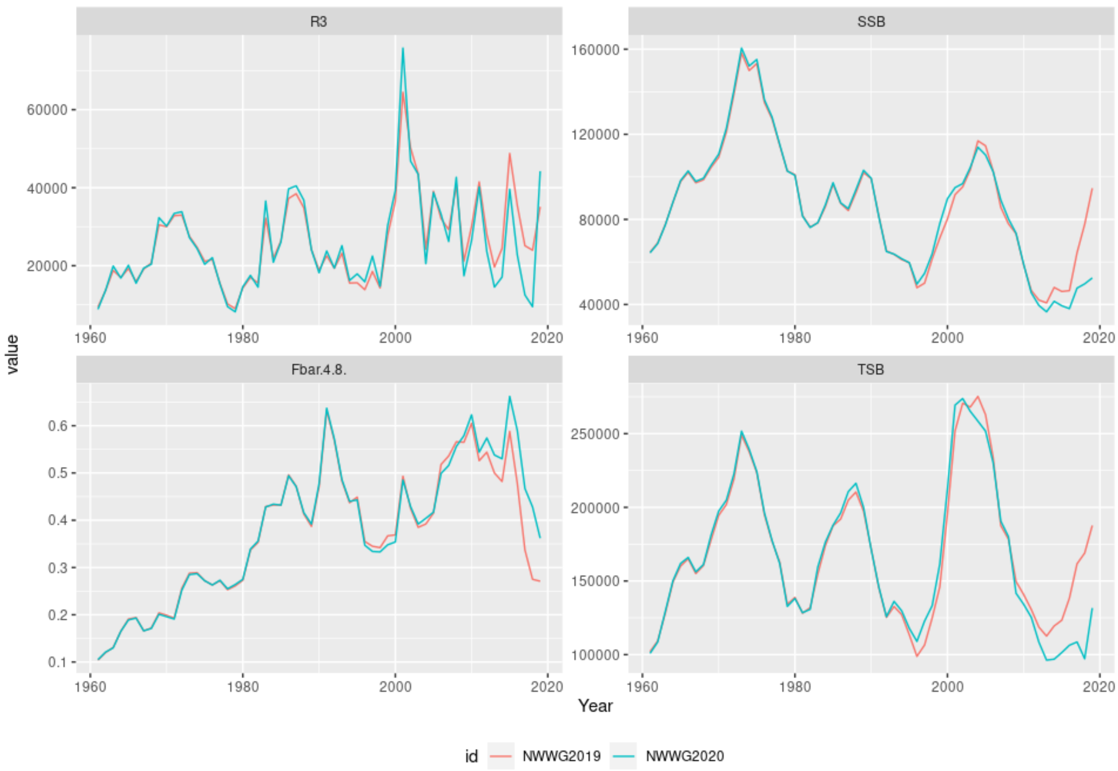

Figure 6.9.1. Faroe saithe (Division 5.b). Comparison with previous assessment. Recruitment-at-age 3 ('000)(top-left), spawning-stock biomass (tonnes)(top-right), average fishing mortality over age groups 4–8 (bottom-left) and total biomass (tonnes)(bottom-right) from the 2019 (red) and 2020 (cyan) assessments

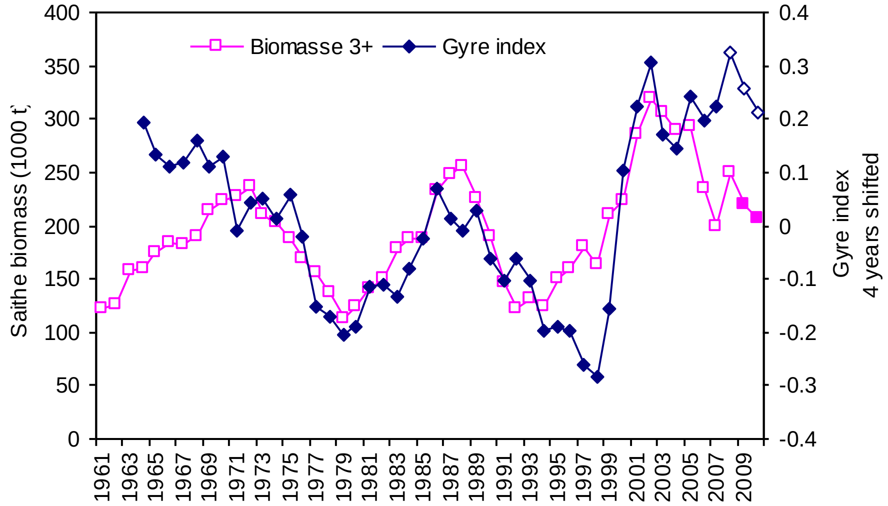

Figure 6.15.1. Faroe saithe (Division 5.b). Relationship between the Gyre index (4 years shifted) and saithe biomass (age 3+) in Faroese waters.

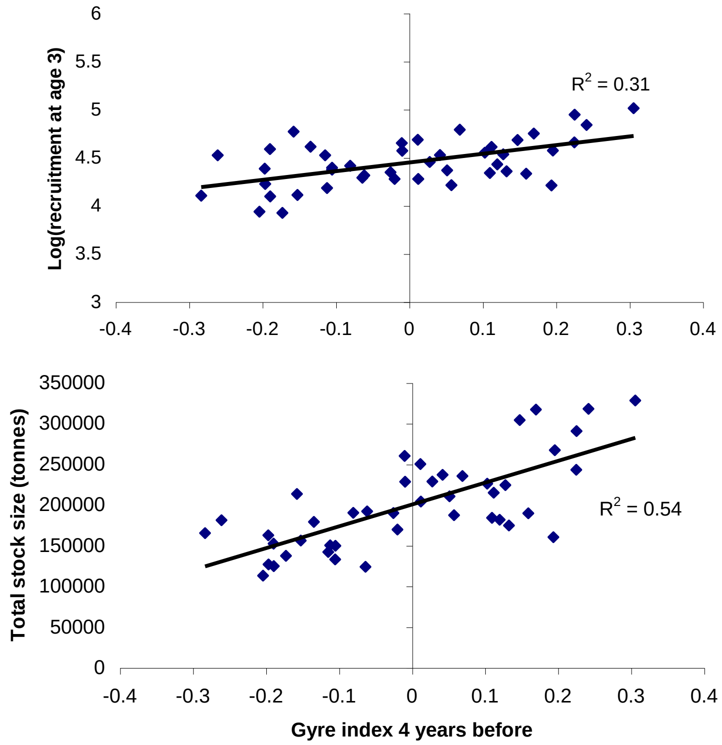

Figure 6.15.2. Relationship between the gyre index and both recruitment (top figure) and total stock biomass estimates (bottom figure.) Note that a large gyre index indicates a small subpolar gyre, and, consequently, a large influx of plankton-rich warmer-than-average water to the outer areas (bottom depth > 150 m) around the Faroes, where saithe typically are found.

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

In 2017, the Icelandic Waters ecoregion – Ecosystem overview has been published as an ICES advice
www.ices.dk/sites/pub/Publication%20Reports/Advice/2017/2017/Ecosystem_overview-Icelandic_Waters_ecoregion.pdf

In 2019, the Icelandic Waters ecoregion – Fisheries overview has been published as an ICES advice.

http://ices.dk/sites/pub/Publication%20Reports/Advice/2019/2019/FisheriesOverview_IcelandicWaters_2019.pdf

This contains the information previously given in this section.

8 Icelandic saithe

Because of the Covid-19 outbreak the Ministry of Industries and Innovation in Iceland does not require advice from ICES for Icelandic saithe for 2021. This is done to reduce travelling of Icelandic experts and the workload of both MRFI and ICES (see letter to ICES dated March 12, 2020 in the Introduction chapter).

The assessment of Icelandic saithe was therefore not presented and discussed during the NWWG in April. Data input tables in the report were updated but not text and figures.

Table 8.1. Saithe in Division 5.a. 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	4930			52 436	1				58 347
1981	532	3545			54 921	3				59 001
1982	201	3582	23		65 124	1				68 931
1983	224	2138			55 904					58 266
1984	269	2044			60 406					62 719
1985	158	1778			55 135	1	29			57 101
1986	218	2291			63 867					66 376
1987	217	2139			78 175					80 531
1988	268	2596			74 383					77 247
1989	369	2246			79 796					82 411
1990	190	2905			95 032					98 127
1991	236	2690			99 811					102 737
1992	195	1570			77 832					79 597
1993	104	1562			69 982					71 648
1994	30	975		1	63 333					64 339
1995		1161		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

	Belgium	Faroes	France	Germany	Iceland	Norway	UK (E/W/NI)	UK (Scot)	UK	Total
2002		366		6	41 687	3	7	2		42 071
2003		143		56	51 857	164			35	52 255
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
2015		499			47 973	3				48 473
2016		287			48 920	5				49 212
2017		261			48 786	4			4	49 057
2018		222			66 016	10				66 248
2019		230			64 295	6				64 531

Table 8.2. Saithe in Division 5.a. Commercial catch at age (thousands).

Year	3	4	5	6	7	8	9	10	11	12+
1980	275	2540	5214	2596	2169	1341	387	262	155	209
1981	203	1325	3503	5404	1457	1415	578	242	61	417
1982	508	1092	2804	4845	4293	1215	975	306	59	129
1983	107	1750	1065	2455	4454	2311	501	251	38	18
1984	53	657	800	1825	2184	3610	844	376	291	546
1985	376	4014	3366	1958	1536	1172	747	479	74	166
1986	3108	1400	4170	2665	1550	1116	628	1549	216	95
1987	956	5135	4428	5409	2915	1348	661	496	498	133

Year	3	4	5	6	7	8	9	10	11	12+
1988	1318	5067	6619	3678	2859	1775	845	226	270	132
1989	315	4313	8471	7309	1794	1928	848	270	191	221
1990	143	1692	5471	10112	6174	1816	1087	380	151	168
1991	198	874	3613	6844	10772	3223	858	838	228	51
1992	242	2928	3844	4355	3884	4046	1290	350	196	125
1993	657	1083	2841	2252	2247	2314	3671	830	223	281
1994	702	2955	1770	2603	1377	1243	1263	2009	454	428
1995	1573	1853	2661	1807	2370	905	574	482	521	154
1996	1102	2608	1868	1649	835	1233	385	267	210	447
1997	603	2960	2766	1651	1178	599	454	125	95	234
1998	183	1289	1767	1545	1114	658	351	265	120	251
1999	989	732	1564	2176	1934	669	324	140	72	75
2000	850	2383	896	1511	1612	1806	335	173	57	57
2001	1223	2619	2184	591	977	943	819	186	94	69
2002	1187	4190	3147	2970	519	820	570	309	101	53
2003	2284	4363	6031	2472	1942	285	438	289	196	72
2004	952	7841	7195	5363	1563	1057	211	224	157	124
2005	2607	3089	7333	6876	3592	978	642	119	149	147
2006	1380	10051	2616	5840	4514	1989	667	485	118	229
2007	1244	6552	8751	2124	2935	1817	964	395	190	99
2008	1432	3602	5874	6706	1155	1894	1248	803	262	307
2009	2820	5166	2084	2734	2883	777	1101	847	555	373
2010	2146	6284	3058	997	1644	1571	514	656	522	409
2011	2004	4850	4006	1502	677	1065	1145	323	433	469
2012	1183	4816	3514	2417	903	432	883	1015	354	549
2013	1163	5538	6366	2963	1610	664	375	537	460	320
2014	668	3499	4867	2805	1276	725	347	241	312	401
2015	781	2712	6461	2917	1509	694	589	249	133	347
2016	1588	6230	2653	2838	1648	1059	526	337	148	131

Year	3	4	5	6	7	8	9	10	11	12+
2017	750	3333	7542	1806	1449	813	648	229	127	237
2018	689	6681	4267	7908	1446	962	455	258	192	175
2019	1292	1585	6325	2752	4543	693	675	339	242	231

Table 8.3. Saithe in Division 5.a. Mean weight at age (g) in the catches and in the spawning stock, with predictions in grey.

Year	3	4	5	6	7	8	9	10	11	12+
1980	1428	1983	2667	3689	5409	6321	7213	8565	9147	9979
1981	1585	2037	2696	3525	4541	6247	6991	8202	9537	9523
1982	1547	2194	3015	3183	5114	6202	7256	7922	8924	10021
1983	1530	2221	3171	4270	4107	5984	7565	8673	8801	9445
1984	1653	2432	3330	4681	5466	4973	7407	8179	8770	10520
1985	1609	2172	3169	3922	4697	6411	6492	8346	9401	10767
1986	1450	2190	2959	4402	5488	6406	7570	6487	9616	11080
1987	1516	1715	2670	3839	5081	6185	7330	8025	7974	10886
1988	1261	2017	2513	3476	4719	5932	7523	8439	8748	9823
1989	1403	2021	2194	3047	4505	5889	7172	8852	10170	11194
1990	1647	1983	2566	3021	4077	5744	7038	7564	8854	11284
1991	1224	1939	2432	3160	3634	4967	6629	7704	9061	9547
1992	1269	1909	2578	3288	4150	4865	6168	7926	8349	10181
1993	1381	2143	2742	3636	4398	5421	5319	7006	8070	9842
1994	1444	1836	2649	3512	4906	5539	6818	6374	8341	10388
1995	1370	1977	2769	3722	4621	5854	6416	7356	6815	8799
1996	1229	1755	2670	3802	4902	5681	7182	7734	9256	9601
1997	1325	1936	2409	3906	5032	6171	7202	7883	8856	9865
1998	1347	1972	2943	3419	4850	5962	6933	7781	8695	10043
1999	1279	2106	2752	3497	3831	5819	7072	8078	8865	10872
2000	1367	1929	2751	3274	4171	4447	6790	8216	9369	10443
2001	1280	1882	2599	3697	4420	5538	5639	7985	9059	10419
2002	1308	1946	2569	3266	4872	5365	6830	7067	9240	10190

Year	3	4	5	6	7	8	9	10	11	12+
2003	1310	1908	2545	3336	4069	5792	7156	8131	8051	10825
2004	1467	1847	2181	2918	4017	5135	7125	7732	8420	9547
2005	1287	1888	2307	2619	3516	5080	6060	8052	8292	8569
2006	1164	1722	2369	2808	3235	4361	6007	7166	8459	9583
2007	1140	1578	2122	2719	3495	4114	5402	6995	7792	9848
2008	1306	1805	2295	2749	3515	4530	5132	6394	7694	9589
2009	1412	1862	2561	3023	3676	4596	5651	6074	7356	9237
2010	1287	1787	2579	3469	4135	4850	5558	6289	6750	8785
2011	1175	1801	2526	3680	4613	5367	5685	6466	6851	7739
2012	1160	1668	2369	3347	4430	5486	6161	6448	7220	8236
2013	1056	1675	2219	3244	4529	5628	6397	7055	7378	8342
2014	1211	1575	2229	2983	4378	5598	6773	8023	7875	9020
2015	1072	1639	2141	3122	4262	5555	6633	7697	8269	8773
2016	1105	1468	2260	3071	4127	5272	6379	7247	8566	8969
2017	1282	1674	2199	3255	4314	5718	6361	7630	8590	9238
2018	1346	1724	2335	3005	4178	5319	6544	7773	8530	9324
2019	1485	2054	2449	3128	4104	5694	6483	7750	8563	9488
2020	1371	1996	2693	3241	4136	5131	6874	7718	8561	9345
2021	1371	1996	2693	3241	4136	5131	6874	7718	8561	9355

Table 8.4. Saithe in Division 5.a. Maturity at age, with predictions in grey.

Year	3	4	5	6	7	8	9	10	11	12
1980	0	0.083	0.189	0.374	0.605	0.797	0.91	1	1	1
1981	0	0.083	0.189	0.374	0.605	0.797	0.91	1	1	1
1982	0	0.083	0.189	0.374	0.605	0.797	0.91	1	1	1
1983	0	0.083	0.189	0.374	0.605	0.797	0.91	1	1	1
1984	0	0.083	0.189	0.374	0.605	0.797	0.91	1	1	1
1985	0	0.083	0.189	0.374	0.605	0.797	0.91	1	1	1
1986	0	0.075	0.172	0.348	0.578	0.778	0.9	1	1	1
1987	0	0.068	0.158	0.325	0.552	0.76	0.89	1	1	1
1988	0	0.062	0.146	0.304	0.528	0.742	0.88	1	1	1
1989	0	0.058	0.136	0.288	0.509	0.726	0.872	1	1	1
1990	0	0.055	0.13	0.276	0.494	0.715	0.865	1	1	1

Year	3	4	5	6	7	8	9	10	11	12
1991	0	0.053	0.126	0.27	0.487	0.709	0.862	1	1	1
1992	0	0.053	0.126	0.27	0.487	0.709	0.862	1	1	1
1993	0	0.055	0.13	0.278	0.497	0.717	0.866	1	1	1
1994	0	0.06	0.14	0.294	0.516	0.732	0.875	1	1	1
1995	0	0.067	0.155	0.32	0.547	0.756	0.888	1	1	1
1996	0	0.078	0.178	0.357	0.588	0.785	0.904	1	1	1
1997	0	0.093	0.208	0.403	0.634	0.816	0.919	1	1	1
1998	0	0.111	0.243	0.452	0.679	0.844	0.933	1	1	1
1999	0	0.13	0.278	0.496	0.716	0.866	0.943	1	1	1
2000	0	0.147	0.306	0.531	0.744	0.881	0.95	1	1	1
2001	0	0.157	0.323	0.55	0.758	0.889	0.954	1	1	1
2002	0	0.161	0.33	0.558	0.764	0.892	0.955	1	1	1
2003	0	0.16	0.328	0.556	0.762	0.892	0.955	1	1	1
2004	0	0.156	0.321	0.548	0.756	0.888	0.953	1	1	1
2005	0	0.15	0.312	0.538	0.749	0.884	0.951	1	1	1
2006	0	0.145	0.303	0.527	0.741	0.88	0.949	1	1	1
2007	0	0.14	0.295	0.517	0.733	0.876	0.948	1	1	1
2008	0	0.135	0.286	0.507	0.725	0.871	0.945	1	1	1
2009	0	0.13	0.277	0.496	0.716	0.866	0.943	1	1	1
2010	0	0.124	0.267	0.482	0.705	0.86	0.94	1	1	1
2011	0	0.118	0.255	0.467	0.692	0.852	0.937	1	1	1
2012	0	0.111	0.243	0.451	0.678	0.844	0.933	1	1	1
2013	0	0.105	0.231	0.435	0.664	0.835	0.928	1	1	1
2014	0	0.099	0.221	0.42	0.65	0.827	0.924	1	1	1
2015	0	0.095	0.212	0.408	0.639	0.819	0.921	1	1	1
2016	0	0.092	0.206	0.4	0.631	0.814	0.918	1	1	1
2017	0	0.09	0.202	0.394	0.625	0.81	0.916	1	1	1
2018	0	0.089	0.2	0.391	0.622	0.808	0.915	1	1	1
2019	0	0.088	0.199	0.389	0.62	0.807	0.915	1	1	1
2020	0	0.088	0.198	0.387	0.618	0.806	0.914	1	1	1
2021	0	0.088	0.198	0.387	0.618	0.806	0.914	1	1	1

Table 8.5. Saithe in Division 5.a. Survey indices at age.

Year	2	3	4	5	6	7	8	9	10
1985	0.59	0.56	3.1	5.31	1.8	1.09	0.51	1.4	0.15
1986	2.31	2.46	2.15	2.2	1.49	0.65	0.3	0.19	0.33
1987	0.38	11.84	13.22	6.61	4.09	3.18	0.81	0.37	0.27
1988	0.31	0.47	2.74	2.86	1.75	0.98	0.41	0.07	0.08
1989	1.42	3.95	5.09	6.68	2.64	1.73	0.89	0.37	0.01

Year	2	3	4	5	6	7	8	9	10
1990	0.73	1.32	4.96	6.42	12.51	3.37	1.23	0.65	0.12
1991	0.22	1.38	1.7	2.18	1.12	2.49	0.31	0.02	0.04
1992	0.14	0.91	5.91	5.67	2.84	2.69	1.93	0.28	0.06
1993	1.27	11.03	1.89	6.6	2.33	2.2	1.02	3.92	0.65
1994	0.83	0.72	1.96	1.79	2.07	0.72	1.13	1.2	2.76
1995	0.49	1.98	1.12	0.52	0.29	0.34	0.1	0.15	0.15
1996	0.13	0.49	3.78	1.16	1.03	0.59	0.98	0.06	0.09
1997	0.32	0.91	4.73	3.98	0.95	0.4	0.16	0.1	0.05
1998	0.13	1.66	2.36	2.55	1.27	0.72	0.3	0.09	0.07
1999	0.73	3.74	0.94	1.27	1.7	0.59	0.16	0.02	0.02
2000	0.38	2.01	2.55	0.61	0.86	0.54	0.45	0.08	0.03
2001	0.92	2.06	2.73	1.68	0.22	0.23	0.4	0.14	0.07
2002	1.02	2.23	3.01	3.11	2.19	0.42	0.47	0.32	0.22
2003	0.05	9.79	5.14	2.98	1.37	0.78	0.21	0.05	0.1
2004	0.9	1.39	9.6	6.27	4.52	1.52	0.84	0.17	0.17
2005	0.25	4.29	2.41	7.5	4.72	2.36	0.88	0.45	0.13
2006	0	2.19	6.76	1.98	8.86	3.5	1.21	0.29	0.25
2007	0.06	0.31	1.75	3.27	0.82	1.64	0.71	0.29	0.16
2008	0.08	2.26	1.81	2.88	4.05	0.62	0.79	0.34	0.15
2009	0.21	2.45	1.85	0.69	0.91	0.84	0.12	0.26	0.15
2010	0.07	1.24	5.07	2.55	0.64	0.61	0.47	0.07	0.12
2011	0.15	3.84	4.24	3.1	1.17	0.41	0.39	0.44	0.17
2012	0.02	1.77	12.01	6.75	2.76	0.63	0.17	0.38	0.5
2013	0.11	4.28	7.57	6.85	4.67	2.58	1.12	0.3	0.43
2014	0.03	0.39	3.89	3.74	2.02	0.87	0.42	0.15	0.11
2015	0.04	1.08	1.93	3.22	1.73	0.82	0.72	0.66	0.43
2016	0.05	3.17	16.21	2.75	2.27	1.08	0.53	0.44	0.28
2017	0.02	1.48	6.67	14.64	3.03	1.68	0.87	0.45	0.3
2018	0.03	0.5	17.92	10.5	15.28	1.51	0.84	0.43	0.32
2019	0.08	3.75	1.22	3.46	2.61	4.07	0.82	0.61	0.14
2020	0.09	1.88	2.58	0.7	2.14	1.19	2.36	0.35	0.18

Table 8.6. Saithe in Division 5.a. Main population estimates Stock sizes are in 1000 tonnes, recruitment in million fishes at age 3.

Year	B4+	SSB	N3	Yield	f4–9	HR
1980	313	114	28	58	0.29	0.18
1981	306	121	20	58	0.26	0.21
1982	296	138	22	68	0.3	0.2
1983	271	138	32	57	0.24	0.22
1984	288	141	42	60	0.23	0.19

Year	B4+	SSB	N3	Yield	f4–9	HR
1985	300	139	35	54	0.24	0.2
1986	319	137	67	65	0.28	0.24
1987	336	129	91	80	0.35	0.23
1988	416	126	51	77	0.32	0.19
1989	399	129	32	82	0.31	0.23
1990	378	136	21	98	0.35	0.27
1991	338	146	30	102	0.37	0.26
1992	289	138	15	80	0.36	0.26
1993	232	115	20	72	0.39	0.29
1994	189	95	18	64	0.45	0.28
1995	155	71	30	48	0.45	0.27
1996	151	63	26	39	0.4	0.25
1997	159	64	17	37	0.36	0.21
1998	157	71	9	31	0.29	0.2
1999	136	75	31	31	0.3	0.24
2000	148	77	32	33	0.31	0.22
2001	169	84	55	32	0.26	0.23
2002	228	101	65	42	0.28	0.21
2003	291	125	73	52	0.28	0.21
2004	332	146	26	65	0.25	0.2
2005	298	158	73	69	0.27	0.25
2006	324	167	42	75	0.29	0.21
2007	294	164	19	64	0.27	0.23
2008	263	162	26	69	0.32	0.24
2009	237	149	38	60	0.3	0.24
2010	234	137	37	54	0.27	0.22
2011	237	127	44	51	0.26	0.22
2012	241	122	41	51	0.26	0.23
2013	246	121	43	58	0.29	0.2
2014	244	119	29	46	0.22	0.2
2015	243	124	96	48	0.21	0.2
2016	314	135	45	49	0.2	0.16
2017	351	157	56	49	0.16	0.17
2018	391	183	16	66	0.2	0.16
2019	370	205	47	63	0.19	0.19
2020	382	216	43			
Average	275	128	39	59	0.29	0.22

Table 8.7. Saithe in Division 5.a. Stock in numbers. Shaded area is input to prediction.

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1980	32.2	24.7	28.2	46.9	31	10.3	8.2	3.7	1.3	0.7	0.7	0.5	0.3	0.1
1981	48	26.4	20.2	22.7	35.3	21.3	6.3	4.7	2	0.7	0.4	0.4	0.3	0.2
1982	62.6	39.3	21.6	16.3	17.2	24.7	13.4	3.7	2.6	1.1	0.4	0.2	0.2	0.2
1983	52.7	51.2	32.2	17.4	12.2	11.8	14.9	7.5	2	1.4	0.6	0.2	0.1	0.1
1984	100.3	43.2	41.9	26	13.3	8.7	7.6	9.1	4.3	1.1	0.8	0.4	0.1	0.1
1985	136.1	82.1	35.3	33.9	19.9	9.5	5.6	4.6	5.3	2.6	0.7	0.5	0.2	0.1
1986	75.6	111.4	67.2	28.5	25.8	14	6.1	3.4	2.6	3.1	1.5	0.4	0.3	0.1
1987	47.9	61.9	91.2	54.2	21.5	17.8	8.7	3.5	1.8	1.5	1.7	0.9	0.2	0.2
1988	31.1	39.2	50.7	73.2	40.1	14.3	10.3	4.6	1.7	0.9	0.7	0.9	0.5	0.1
1989	44	25.5	32.1	40.7	54.6	27	8.5	5.7	2.3	0.9	0.5	0.4	0.5	0.3
1990	22.2	36	20.9	25.8	30.5	37.1	16.3	4.7	2.9	1.3	0.5	0.3	0.2	0.3
1991	29.8	18.2	29.5	16.7	19.1	20.2	31.4	8.6	2.3	1.5	0.6	0.3	0.1	0.1
1992	26.6	24.4	14.9	23.7	12.3	12.5	11.4	16.2	4.1	1.1	0.7	0.3	0.1	0.1
1993	45	21.8	20	11.9	17.4	8.1	7.1	5.9	7.7	2	0.5	0.4	0.2	0.1
1994	38.8	36.8	17.8	16	8.7	11.2	4.4	3.6	2.7	3.7	0.9	0.3	0.2	0.1
1995	25.6	31.8	30.2	14.2	11.5	5.4	5.9	2.1	1.5	1.2	1.5	0.5	0.1	0.1
1996	13.3	21	26	24.1	10.2	7.1	2.8	2.7	0.9	0.7	0.5	0.8	0.2	0.1
1997	46.5	10.9	17.2	20.8	17.6	6.6	3.9	1.4	1.2	0.4	0.3	0.3	0.4	0.1
1998	47.9	38.1	8.9	13.6	14.8	11.4	4	2.1	0.7	0.6	0.2	0.1	0.1	0.2
1999	82.5	39.2	31.2	7.1	9.9	10.1	7.3	2.3	1.2	0.4	0.3	0.1	0.1	0.1
2000	96.5	67.5	32.1	24.8	5.1	6.7	6.4	4.3	1.2	0.6	0.2	0.2	0.1	0
2001	108.8	79	55.3	25.5	17.9	3.4	4.2	3.6	2.2	0.6	0.3	0.1	0.1	0
2002	38.6	89.1	64.7	44.1	18.8	12.4	2.2	2.5	2.1	1.2	0.4	0.2	0.1	0.1

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14
2003	108.7	31.6	72.9	51.5	32.2	12.8	7.9	1.3	1.4	1.1	0.7	0.2	0.1	0
2004	62.6	89	25.9	58.1	37.7	22.1	8.2	4.7	0.7	0.7	0.6	0.4	0.1	0.1
2005	27.8	51.3	72.9	20.4	39.5	23.7	13.7	5.2	3	0.5	0.5	0.4	0.2	0.1
2006	39.1	22.7	42	57.3	13.6	24.2	14.3	8.4	3.3	1.9	0.3	0.3	0.2	0.1
2007	57.2	32	18.6	32.9	37.6	8.2	14.3	8.6	5.2	2	1.1	0.2	0.2	0.1
2008	54.6	46.9	26.2	14.6	22	23	4.9	8.8	5.4	3.2	1.2	0.7	0.1	0.1
2009	65.4	44.7	38.4	20.5	9.5	12.8	13.2	2.9	5.3	3.2	1.9	0.7	0.4	0.1
2010	60.6	53.6	36.6	30	13.4	5.6	7.5	7.9	1.8	3.2	1.9	1.1	0.4	0.2
2011	63.7	49.6	43.9	28.7	20	8.2	3.4	4.6	5	1.1	1.9	1.1	0.6	0.2
2012	43.8	52.2	40.6	34.5	19.4	12.4	5	2.1	2.9	3.1	0.7	1.2	0.7	0.4
2013	142.8	35.8	42.7	32	23.3	12.1	7.6	3.1	1.3	1.8	1.9	0.4	0.7	0.4
2014	67.2	116.9	29.3	33.5	21.1	14.1	7.2	4.6	1.9	0.8	1.1	1.1	0.2	0.4
2015	83.8	55	95.7	23.2	23.2	13.6	9	4.6	3.1	1.3	0.5	0.7	0.7	0.2
2016	24.3	68.6	45.1	75.9	16.2	15.1	8.8	5.9	3.1	2	0.8	0.3	0.4	0.5
2017	69.4	19.9	56.2	35.8	53.6	10.7	9.9	5.8	4	2.1	1.3	0.5	0.2	0.3
2018	64.9	56.8	16.3	44.9	26	37	7.4	6.9	4.1	2.8	1.4	0.9	0.4	0.2
2019	53	53.1	46.5	12.9	31.7	17.3	24.4	4.9	4.7	2.7	1.8	0.9	0.6	0.2
2020	52.3	43.4	43.5	37	9.2	21.2	11.5	16.3	3.3	3.1	1.8	1.2	0.6	0.4
2021	52.2	42.8	35.6	34.4	25.4	5.9	13.4	7.3	10.7	2.2	2	1.1	0.8	0.4
2022	52.2	42.8	35.1	28	23.3	15.9	3.6	8.4	4.7	6.7	1.3	1.2	0.7	0.5

Table 8.8. Saithe in Division 5.a. Fishing mortality rate. Shaded areas show predictions i.e where catches are unknown.

Year	3	4	5	6	7	8	9	10	11	12	13	14
1980	0.016	0.085	0.177	0.294	0.362	0.434	0.403	0.434	0.336	0.355	0.355	0.355
1981	0.015	0.076	0.158	0.262	0.323	0.388	0.36	0.388	0.301	0.318	0.318	0.318
1982	0.017	0.088	0.183	0.303	0.373	0.448	0.415	0.448	0.347	0.367	0.367	0.367
1983	0.014	0.07	0.146	0.243	0.299	0.359	0.333	0.359	0.278	0.294	0.294	0.294
1984	0.013	0.067	0.14	0.231	0.285	0.342	0.317	0.342	0.265	0.28	0.28	0.28
1985	0.014	0.071	0.148	0.245	0.302	0.363	0.336	0.363	0.281	0.297	0.297	0.297
1986	0.016	0.082	0.171	0.283	0.348	0.418	0.388	0.418	0.324	0.342	0.342	0.342
1987	0.02	0.102	0.212	0.352	0.434	0.52	0.482	0.52	0.403	0.426	0.426	0.426
1988	0.018	0.094	0.195	0.323	0.398	0.478	0.443	0.478	0.37	0.391	0.391	0.391
1989	0.017	0.089	0.185	0.307	0.378	0.454	0.421	0.454	0.352	0.372	0.372	0.372
1990	0.019	0.101	0.211	0.35	0.431	0.518	0.48	0.518	0.401	0.424	0.424	0.424
1991	0.021	0.108	0.226	0.374	0.461	0.553	0.513	0.553	0.429	0.453	0.453	0.453
1992	0.02	0.106	0.221	0.366	0.451	0.542	0.502	0.542	0.42	0.443	0.443	0.443
1993	0.022	0.115	0.239	0.396	0.488	0.586	0.543	0.586	0.454	0.48	0.48	0.48
1994	0.025	0.13	0.271	0.448	0.553	0.663	0.615	0.663	0.514	0.543	0.543	0.543
1995	0.025	0.132	0.276	0.457	0.563	0.675	0.626	0.675	0.523	0.553	0.553	0.553
1996	0.022	0.115	0.24	0.397	0.49	0.588	0.545	0.588	0.455	0.481	0.481	0.481
1997	0.035	0.143	0.228	0.308	0.408	0.508	0.539	0.507	0.508	0.46	0.46	0.46
1998	0.028	0.116	0.184	0.248	0.329	0.41	0.435	0.409	0.41	0.372	0.372	0.372
1999	0.03	0.12	0.191	0.258	0.342	0.425	0.452	0.425	0.426	0.386	0.386	0.386
2000	0.031	0.126	0.201	0.271	0.359	0.446	0.474	0.446	0.447	0.405	0.405	0.405
2001	0.026	0.105	0.168	0.226	0.3	0.373	0.397	0.373	0.374	0.339	0.339	0.339
2002	0.028	0.115	0.183	0.246	0.326	0.406	0.431	0.405	0.406	0.368	0.368	0.368

Year	3	4	5	6	7	8	9	10	11	12	13	14
2003	0.028	0.112	0.179	0.24	0.319	0.397	0.421	0.396	0.397	0.36	0.36	0.36
2004	0.037	0.186	0.264	0.277	0.261	0.239	0.254	0.267	0.286	0.284	0.284	0.284
2005	0.041	0.203	0.289	0.303	0.286	0.262	0.278	0.293	0.314	0.311	0.311	0.311
2006	0.044	0.22	0.313	0.329	0.31	0.284	0.301	0.317	0.34	0.337	0.337	0.337
2007	0.041	0.204	0.29	0.304	0.286	0.262	0.279	0.293	0.314	0.311	0.311	0.311
2008	0.048	0.237	0.337	0.354	0.333	0.305	0.324	0.341	0.366	0.363	0.363	0.363
2009	0.046	0.226	0.321	0.337	0.317	0.291	0.309	0.325	0.348	0.345	0.345	0.345
2010	0.042	0.206	0.293	0.307	0.289	0.265	0.282	0.296	0.317	0.315	0.315	0.315
2011	0.039	0.193	0.275	0.289	0.272	0.249	0.265	0.278	0.298	0.296	0.296	0.296
2012	0.039	0.192	0.273	0.287	0.27	0.248	0.263	0.277	0.296	0.294	0.294	0.294
2013	0.044	0.216	0.307	0.322	0.303	0.278	0.295	0.311	0.333	0.33	0.33	0.33
2014	0.033	0.166	0.236	0.248	0.233	0.214	0.227	0.239	0.256	0.254	0.254	0.254
2015	0.033	0.161	0.229	0.241	0.227	0.208	0.221	0.232	0.249	0.247	0.247	0.247
2016	0.03	0.148	0.21	0.221	0.208	0.19	0.202	0.213	0.228	0.226	0.226	0.226
2017	0.024	0.119	0.169	0.177	0.167	0.153	0.163	0.171	0.183	0.182	0.182	0.182
2018	0.03	0.147	0.209	0.219	0.206	0.189	0.201	0.211	0.226	0.225	0.225	0.225
2019	0.029	0.142	0.202	0.212	0.199	0.183	0.194	0.204	0.219	0.217	0.217	0.217
2020	0.035	0.175	0.25	0.262	0.247	0.226	0.24	0.252	0.271	0.268	0.268	0.268
2021	0.038	0.189	0.268	0.281	0.265	0.243	0.258	0.271	0.291	0.288	0.288	0.288

Table 8.9. Saithe in Division 5.a. Output from short-term projections.

2020						
B4+	SSB	F_{bar}	Landings			
382	216	0.23	74			
2021				**2022**		
B4+	SSB	F_{bar}	Landings	B4+	SSB	Rationale
377	213	0.25	78	347	197	20% HCR

20% HCR = average between 0.2 B4+ (current year) and last year's TAC.

9 Icelandic cod in Va

Table 9.1. Icelandic cod in Division Va. Estimated catch in numbers (millions) by year and age in millions of fish in 1955-2019.

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	13.553	26.000	9.111	20.213	5.850	3.760	2.028	0.508	0.199	0.137	0.013	0.031
2002	6.019	17.776	24.030	7.160	9.424	2.451	1.555	0.738	0.150	0.058	0.041	0.004
2003	5.490	16.313	22.045	16.628	4.840	4.933	1.201	0.507	0.211	0.046	0.026	0.033
2004	1.784	17.960	24.043	17.901	10.166	2.880	1.978	0.499	0.162	0.087	0.019	0.008
2005	5.271	5.302	26.183	16.922	8.543	4.890	1.292	0.790	0.216	0.096	0.037	0.005
2006	3.446	13.108	8.834	22.063	10.540	4.683	2.164	0.471	0.240	0.040	0.016	0.010
2007	2.054	11.639	15.937	8.599	9.894	5.680	2.281	1.139	0.332	0.088	0.067	0.006
2008	3.104	5.126	12.849	11.641	5.153	4.708	2.139	0.880	0.280	0.067	0.043	0.004
2009	3.458	7.926	9.626	17.895	10.503	3.888	2.295	0.742	0.315	0.089	0.022	0.012
2010	3.511	7.730	9.591	8.448	10.922	5.546	1.566	0.924	0.299	0.144	0.063	0.017

2011	4.001	7.845	10.576	10.820	6.287	6.292	2.429	0.680	0.419	0.134	0.040	0.016
2012	4.056	11.249	10.814	9.560	8.918	5.009	3.213	1.152	0.292	0.227	0.081	0.026
2013	5.778	12.224	15.347	11.414	7.594	5.792	2.571	1.832	0.653	0.209	0.146	0.036
2014	4.630	8.365	14.898	13.262	8.426	4.930	2.816	1.395	0.964	0.376	0.127	0.107
2015	5.229	13.361	10.350	13.897	9.409	5.616	2.441	1.552	0.953	0.407	0.125	0.036
2016	2.667	11.179	11.886	10.989	12.746	7.345	3.232	1.590	0.847	0.537	0.184	0.056
2017	5.174	8.033	13.630	13.590	7.632	7.459	3.904	2.005	0.761	0.517	0.251	0.143
2018	4.905	12.805	8.403	14.206	11.364	7.124	4.418	2.047	0.852	0.506	0.176	0.105
2019	2.916	8.467	13.461	9.095	8.974	7.801	4.182	3.973	2.033	0.748	0.354	0.184

Table 9.2. Icelandic cod in Division Va. Estimated mean weight at age in the catch (kg) in period the 1955-2019. The weights for age groups 3 to 9 in 2020 are based on predictions from the 2020 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	1.484	2.017	2.629	3.362	4.555	6.187	7.124	8.445	9.311	9.566	10.242	9.503
2002	1.309	1.947	2.664	3.638	4.551	5.927	7.083	8.100	9.276	11.660	11.221	14.029

2003	1.350	1.866	2.459	3.391	4.380	4.756	6.141	7.138	9.580	10.260	11.479	10.720
2004	1.139	1.754	2.413	3.373	4.288	5.185	5.741	7.376	10.038	10.322	12.428	11.452
2005	1.196	1.735	2.421	3.395	4.292	5.059	6.233	6.124	7.964	10.075	12.776	13.719
2006	1.088	1.622	2.205	3.052	4.265	4.978	5.287	6.028	8.455	11.154	12.608	15.381
2007	1.063	1.595	2.179	2.791	3.861	5.159	5.871	6.405	7.182	9.506	10.406	10.532
2008	1.098	1.598	2.364	3.140	3.990	5.264	6.483	7.367	7.784	10.505	11.621	18.092
2009	1.096	1.666	2.206	3.187	4.059	5.024	6.649	8.354	9.529	11.193	11.761	14.918
2010	1.100	1.824	2.355	3.213	4.481	5.463	6.740	8.026	8.969	10.419	11.648	12.205
2011	1.109	1.660	2.512	3.443	4.404	5.783	6.526	7.828	8.806	9.662	12.941	11.649
2012	1.180	1.625	2.442	3.744	4.707	5.925	7.369	7.988	9.111	10.720	12.042	11.608
2013	1.132	1.743	2.451	3.612	4.936	6.125	7.367	8.137	9.173	10.121	10.421	12.702
2014	1.118	1.741	2.522	3.518	4.677	6.158	7.486	8.586	8.967	10.518	10.286	12.354
2015	1.196	1.643	2.663	3.599	4.643	5.919	7.589	8.600	9.686	11.208	11.328	10.392
2016	1.101	1.791	2.510	3.749	4.659	5.967	7.188	8.535	10.130	10.719	11.421	13.899
2017	1.011	1.760	2.501	3.459	4.789	5.929	7.190	8.467	9.496	11.025	11.535	12.853
2018	1.181	1.797	2.808	3.768	4.591	6.126	7.102	8.723	9.471	10.127	10.422	11.617
2019	1.155	1.662	2.480	3.773	4.783	5.504	6.604	8.095	8.842	10.596	11.687	12.003
2020	1.263	1.821	2.349	3.346	4.784	5.792	6.850	8.574	8.842	10.596	11.687	12.003

Table 9.3. Icelandic cod in Division Va. Estimated survey weight (kg) at age in the spring survey (SMB).

year	1	2	3	4	5	6	7	8	9
1985	0.014	0.137	0.388	1.124	1.743	2.601	3.264	4.757	6.009
1986	0.015	0.159	0.619	1.225	2.264	3.006	4.362	5.595	7.186
1987	0.014	0.117	0.469	1.202	1.763	3.004	4.229	6.301	6.876
1988	0.011	0.122	0.496	1.082	1.977	3.119	3.622	4.482	8.046
1989	0.022	0.151	0.547	1.159	1.973	3.081	4.404	6.212	6.942
1990	0.019	0.135	0.462	1.042	1.832	2.643	3.870	5.871	7.746
1991	0.018	0.147	0.555	1.170	1.859	2.636	3.344	5.675	7.316
1992	0.024	0.134	0.500	1.017	1.863	2.619	3.766	5.101	7.355
1993	0.012	0.173	0.576	1.170	1.954	3.043	4.048	5.410	6.080
1994	0.013	0.174	0.686	1.417	2.055	3.230	4.193	6.229	8.156

1995	0.010	0.133	0.606	1.380	2.297	3.009	4.466	5.350	8.035
1996	0.011	0.155	0.551	1.352	2.084	3.322	4.044	5.257	7.460
1997	0.018	0.139	0.546	1.194	2.170	3.211	4.858	5.501	6.463
1998	0.015	0.154	0.482	1.193	2.041	3.017	4.249	5.417	6.333
1999	0.014	0.140	0.578	1.070	1.849	2.869	3.826	4.993	5.657
2000	0.016	0.124	0.486	1.195	1.817	2.771	4.068	5.345	8.472
2001	0.017	0.149	0.530	1.184	1.845	2.625	3.781	5.491	6.472
2002	0.013	0.131	0.510	1.206	1.998	2.920	3.784	5.791	6.321
2003	0.016	0.131	0.466	1.179	1.919	2.786	4.136	4.672	6.246
2004	0.021	0.142	0.480	1.073	1.896	2.791	3.413	4.866	5.069
2005	0.011	0.118	0.440	1.033	1.771	2.669	3.680	4.365	7.207
2006	0.013	0.106	0.412	0.980	1.710	2.624	4.039	4.709	5.587
2007	0.014	0.100	0.412	0.970	1.665	2.382	3.694	5.052	6.052
2008	0.011	0.121	0.376	0.943	1.811	2.612	3.586	4.919	6.301
2009	0.012	0.111	0.411	0.847	1.616	2.646	3.690	4.698	5.836
2010	0.013	0.098	0.386	1.010	1.706	2.593	4.052	4.931	6.235
2011	0.012	0.102	0.392	1.128	2.127	3.003	4.258	5.866	6.638
2012	0.012	0.143	0.467	1.144	1.936	3.210	4.281	5.812	7.897
2013	0.014	0.110	0.495	1.053	1.790	3.033	4.781	6.372	8.078
2014	0.011	0.114	0.359	1.076	1.713	2.641	3.992	6.138	8.025
2015	0.013	0.150	0.417	0.897	2.062	3.029	4.405	6.058	8.606
2016	0.010	0.119	0.478	1.007	1.583	3.164	4.000	5.510	7.192
2017	0.014	0.091	0.418	1.223	1.938	2.726	5.160	6.445	7.570
2018	0.020	0.133	0.383	0.974	2.141	3.167	3.978	6.540	7.593
2019	0.010	0.094	0.468	0.908	1.796	3.407	4.389	5.319	7.434
2020	0.012	0.130	0.390	1.069	1.710	2.922	4.669	5.894	7.180

Table 9.4. Icelandic cod in Division Va. Estimated weight at age in the spawning stock (kg) in period the 1955-2020. 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	1.312	1.399	1.766	2.738	3.483	4.762	7.301	10.320	12.197	14.683	16.175	19.050
1986	1.312	1.612	2.915	3.279	4.591	5.803	7.199	9.084	10.356	15.283	14.540	15.017
1987	1.718	1.598	2.439	3.532	4.886	6.408	7.499	9.243	10.697	10.622	15.894	12.592
1988	0.931	1.486	2.281	3.287	4.423	4.678	8.147	8.822	9.977	11.732	14.156	13.042
1989	0.823	1.526	2.364	3.426	4.702	7.273	8.436	9.831	11.986	10.003	12.611	16.045
1990	0.733	1.044	2.199	2.841	4.367	6.177	8.919	10.592	10.993	14.570	15.732	17.290
1991	0.114	1.288	2.069	2.799	3.477	6.007	8.823	9.804	9.754	14.344	14.172	20.200
1992	0.449	1.349	2.117	3.086	3.861	5.196	7.429	8.127	12.679	13.410	15.715	11.267
1993	0.773	1.374	2.316	3.276	4.179	5.729	6.441	8.641	10.901	12.517	14.742	16.874
1994	1.618	1.733	2.259	3.384	4.563	6.471	9.803	8.896	10.847	12.874	14.742	17.470
1995	0.514	1.639	2.353	3.197	4.493	5.544	8.579	10.273	11.022	11.407	13.098	15.182
1996	0.542	1.756	2.490	3.530	4.251	5.621	8.263	9.772	10.539	13.503	13.689	16.194
1997	1.111	1.346	2.267	3.723	5.415	5.963	6.964	8.537	10.797	11.533	10.428	12.788
1998	1.111	1.605	2.262	3.262	4.461	5.759	6.793	9.304	10.759	14.903	16.651	18.666
1999	1.311	1.471	1.936	2.999	3.968	5.132	6.522	9.946	11.088	12.535	14.995	15.151
2000	0.497	1.355	1.916	2.881	4.318	5.573	8.464	9.203	10.240	11.172	13.172	17.442
2001	0.816	1.583	2.080	2.676	4.112	6.236	6.926	8.445	9.311	9.566	10.242	9.503
2002	0.782	1.591	2.260	3.120	3.991	5.991	9.225	8.100	9.276	11.660	11.221	14.029
2003	1.150	1.326	2.241	3.049	4.226	5.051	6.823	7.138	9.580	10.260	11.479	10.720
2004	1.150	1.456	2.095	3.011	3.678	5.192	5.400	7.376	10.038	10.322	12.428	11.452
2005	0.648	1.123	1.908	2.979	3.901	4.789	7.238	6.124	7.964	10.075	12.776	13.719
2006	0.907	1.407	2.016	2.913	4.351	5.057	6.472	6.028	8.455	11.154	12.608	15.381
2007	1.439	1.261	2.023	2.640	4.116	5.697	6.632	6.405	7.182	9.506	10.406	10.532
2008	0.912	1.845	2.232	2.911	3.897	5.400	6.927	7.367	7.784	10.505	11.621	18.092
2009	0.644	1.465	2.041	2.887	3.943	4.923	7.044	8.354	9.529	11.193	11.761	14.918
2010	0.644	1.590	2.154	3.149	4.207	5.207	6.460	8.024	8.968	10.419	11.647	12.208
2011	0.794	2.467	2.666	3.216	4.546	5.989	6.851	7.828	8.805	9.662	12.941	11.649
2012	1.404	1.702	2.606	3.717	4.516	6.016	8.038	7.988	9.111	10.720	12.042	11.608

2013	0.944	2.323	2.991	3.834	5.207	6.532	8.260	8.137	9.173	10.121	10.421	12.702
2014	0.944	1.332	2.549	3.316	4.459	6.390	8.178	8.586	8.967	10.518	10.286	12.354
2015	0.704	1.043	3.320	3.836	4.895	6.218	8.677	8.600	9.687	11.205	11.330	10.360
2016	0.972	2.247	3.042	4.213	4.614	6.000	7.351	8.486	10.111	10.701	11.362	13.899
2017	1.773	2.582	3.513	3.936	5.698	6.716	7.636	8.486	9.509	11.095	11.575	12.800
2018	1.029	2.372	3.230	3.862	4.574	6.671	7.711	8.699	9.445	10.072	10.269	11.638
2019	0.599	3.044	3.260	4.221	4.700	5.498	7.481	8.095	8.842	10.596	11.687	12.003
2020	0.949	1.651	3.012	3.867	4.967	5.984	7.191	8.574	8.842	10.596	11.687	12.003

Table 9.5 Icelandic cod in Division Va. Estimated maturity at age in period the 1955-2020.

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
1956	0.019	0.025	0.033	0.111	0.577	0.782	0.818	0.980	0.980	1.000	1.000	1
1957	0.019	0.026	0.043	0.100	0.549	0.801	0.842	0.990	1.000	1.000	1.000	1
1958	0.019	0.028	0.086	0.520	0.682	0.801	0.834	1.000	1.000	1.000	1.000	1
1959	0.019	0.029	0.070	0.535	0.772	0.818	0.834	0.990	1.000	1.000	1.000	1
1960	0.019	0.026	0.066	0.577	0.782	0.826	0.834	0.990	1.000	1.000	1.000	1
1961	0.019	0.025	0.053	0.450	0.772	0.818	0.834	0.990	0.990	1.000	1.000	1
1962	0.019	0.025	0.048	0.281	0.791	0.834	0.834	0.990	0.990	1.000	1.000	1
1963	0.019	0.025	0.048	0.237	0.706	0.834	0.849	1.000	1.000	1.000	1.000	1
1964	0.019	0.026	0.048	0.329	0.762	0.826	0.849	1.000	1.000	1.000	1.000	1
1965	0.019	0.025	0.045	0.354	0.751	0.826	0.842	1.000	1.000	1.000	1.000	1
1966	0.019	0.026	0.045	0.394	0.791	0.849	0.849	1.000	1.000	1.000	1.000	1
1967	0.019	0.028	0.051	0.341	0.772	0.842	0.849	1.000	1.000	1.000	1.000	1
1968	0.019	0.025	0.051	0.292	0.682	0.801	0.842	1.000	1.000	1.000	1.000	1
1969	0.019	0.028	0.043	0.227	0.682	0.801	0.842	1.000	1.000	1.000	1.000	1
1970	0.019	0.023	0.041	0.227	0.644	0.772	0.818	1.000	1.000	1.000	1.000	1
1971	0.019	0.025	0.037	0.074	0.657	0.706	0.772	0.979	0.994	0.982	0.993	1
1972	0.019	0.023	0.035	0.106	0.450	0.772	0.809	0.979	0.994	0.982	0.993	1
1973	0.022	0.028	0.163	0.382	0.697	0.801	0.834	0.996	0.996	1.000	1.000	1
1974	0.020	0.031	0.085	0.346	0.636	0.790	0.818	0.989	1.000	1.000	1.000	1

1975	0.020	0.035	0.118	0.287	0.715	0.809	0.839	1.000	1.000	1.000	1.000	1
1976	0.025	0.026	0.086	0.253	0.406	0.797	0.841	1.000	1.000	1.000	1.000	1
1977	0.019	0.024	0.060	0.382	0.742	0.817	0.842	1.000	1.000	1.000	1.000	1
1978	0.025	0.025	0.052	0.192	0.737	0.820	0.836	1.000	1.000	1.000	1.000	1
1979	0.019	0.021	0.053	0.282	0.635	0.790	0.836	0.919	1.000	1.000	1.000	1
1980	0.026	0.021	0.047	0.225	0.653	0.777	0.834	0.977	1.000	0.964	1.000	1
1981	0.019	0.022	0.030	0.090	0.448	0.751	0.811	0.962	0.988	1.000	1.000	1
1982	0.021	0.025	0.038	0.065	0.297	0.705	0.815	0.967	1.000	1.000	1.000	1
1983	0.019	0.030	0.047	0.116	0.264	0.530	0.715	0.979	0.985	1.000	1.000	1
1984	0.019	0.024	0.053	0.169	0.444	0.620	0.716	0.949	0.969	0.948	1.000	1
1985	0.000	0.021	0.186	0.414	0.495	0.730	0.580	0.746	1.000	1.000	1.000	1
1986	0.001	0.023	0.154	0.398	0.681	0.727	0.936	0.667	1.000	1.000	1.000	1
1987	0.001	0.033	0.094	0.359	0.487	0.879	0.777	0.805	1.000	1.000	1.000	1
1988	0.006	0.029	0.220	0.498	0.446	0.677	0.932	0.890	1.000	1.000	1.000	1
1989	0.008	0.026	0.141	0.363	0.621	0.639	0.619	1.000	1.000	1.000	1.000	1
1990	0.006	0.012	0.154	0.428	0.576	0.781	0.774	0.714	1.000	1.000	1.000	1
1991	0.000	0.055	0.149	0.368	0.629	0.787	0.654	0.901	1.000	1.000	1.000	1
1992	0.002	0.062	0.265	0.407	0.813	0.916	0.880	1.000	1.000	1.000	1.000	1
1993	0.006	0.085	0.267	0.462	0.684	0.795	0.843	0.834	1.000	1.000	1.000	1
1994	0.008	0.109	0.338	0.590	0.706	0.921	0.694	0.830	1.000	1.000	1.000	1
1995	0.005	0.109	0.383	0.527	0.747	0.790	0.859	1.000	1.000	1.000	1.000	1
1996	0.002	0.032	0.186	0.501	0.653	0.733	0.810	0.774	1.000	1.000	1.000	1
1997	0.006	0.037	0.247	0.427	0.686	0.786	0.804	0.539	1.000	1.000	1.000	1
1998	0.000	0.061	0.208	0.486	0.782	0.807	0.809	0.852	1.000	1.000	1.000	1
1999	0.012	0.044	0.239	0.517	0.650	0.836	0.691	0.974	1.000	1.000	1.000	1
2000	0.001	0.065	0.248	0.512	0.611	0.867	0.998	0.999	1.000	1.000	1.000	1
2001	0.003	0.046	0.286	0.599	0.761	0.766	0.883	1.000	1.000	1.000	1.000	1
2002	0.006	0.086	0.321	0.656	0.759	0.920	0.559	0.724	1.000	1.000	1.000	1
2003	0.005	0.048	0.222	0.532	0.873	0.798	0.879	0.833	1.000	1.000	1.000	1
2004	0.000	0.040	0.249	0.549	0.631	0.833	0.807	0.854	1.000	1.000	1.000	1

2005	0.003	0.108	0.281	0.494	0.795	0.808	0.949	0.904	1.000	1.000	1.000	1
2006	0.002	0.023	0.298	0.446	0.749	0.874	0.739	0.741	1.000	1.000	1.000	1
2007	0.012	0.031	0.156	0.504	0.696	0.797	0.836	0.926	1.000	1.000	1.000	1
2008	0.001	0.042	0.275	0.546	0.728	0.833	0.850	0.958	1.000	1.000	1.000	1
2009	0.002	0.015	0.134	0.451	0.684	0.884	0.752	0.631	1.000	1.000	1.000	1
2010	0.000	0.015	0.057	0.380	0.821	0.868	0.927	0.813	1.000	1.000	1.000	1
2011	0.002	0.012	0.136	0.427	0.732	0.923	0.941	0.961	1.000	1.000	1.000	1
2012	0.004	0.031	0.127	0.414	0.730	0.884	0.963	0.850	1.000	1.000	1.000	1
2013	0.003	0.008	0.062	0.344	0.738	0.922	0.965	1.000	1.000	1.000	1.000	1
2014	0.000	0.026	0.069	0.238	0.615	0.893	0.967	0.956	1.000	1.000	1.000	1
2015	0.003	0.007	0.110	0.353	0.636	0.907	0.978	0.988	1.000	1.000	1.000	1
2016	0.001	0.009	0.025	0.289	0.543	0.731	0.941	0.986	1.000	1.000	1.000	1
2017	0.005	0.008	0.089	0.262	0.765	0.906	0.979	0.987	1.000	1.000	1.000	1
2018	0.002	0.013	0.147	0.434	0.605	0.935	0.953	1.000	1.000	1.000	1.000	1
2019	0.004	0.004	0.062	0.452	0.707	0.898	0.987	0.993	1.000	1.000	1.000	1
2020	0.003	0.036	0.056	0.273	0.784	0.897	0.966	1.000	1.000	1.000	1.000	1

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	11	12	13	14
1985	17.18	111.13	35.38	48.27	64.85	23.21	15.46	5.21	3.56	1.94	0.31	0.32	0.09	0.08
1986	15.61	61.06	96.43	22.58	21.75	27.73	7.36	2.85	0.96	0.85	0.31	0.08	0.06	0.04
1987	3.66	28.16	104.43	82.67	21.47	12.83	13.01	2.81	0.99	0.41	0.45	0.23	0.13	0.13
1988	3.45	7.08	73.15	103.77	69.56	8.47	6.57	7.28	0.70	0.29	0.12	0.27	0.06	0.05
1989	4.02	16.39	21.28	75.16	71.44	38.41	4.82	1.71	1.41	0.27	0.19	0.06	0.01	0.01
1990	5.47	11.74	26.44	14.30	27.98	35.30	16.78	1.76	0.58	0.47	0.13	NA	0.04	0.04
1991	3.95	15.97	18.11	30.13	15.44	18.90	22.46	4.93	0.94	0.31	0.22	NA	0.08	0.08
1992	0.71	16.96	33.51	18.78	16.44	6.80	6.33	5.75	1.48	0.23	0.04	0.04	0.04	NA
1993	3.55	4.66	30.75	36.67	13.49	10.59	2.42	2.02	1.39	0.41	0.13	0.03	0.03	0.01
1994	14.22	14.72	9.02	26.93	22.45	6.08	3.95	0.79	0.53	0.50	0.18	0.02	0.03	0.01
1995	1.08	29.27	24.77	9.07	24.56	18.47	4.04	1.92	0.39	0.20	0.24	0.14	0.03	NA
1996	3.70	5.42	42.50	29.69	13.25	15.43	15.22	4.21	1.16	0.21	0.07	0.22	0.10	0.05

1997	1.20	22.39	13.61	56.71	29.74	9.98	9.47	7.29	0.62	0.25	0.19	0.04	0.15	0.10
1998	8.04	5.46	30.11	16.08	63.24	29.99	7.01	5.78	3.33	0.76	0.20	NA	0.02	NA
1999	7.38	33.15	6.99	42.29	13.27	24.77	12.00	2.61	1.47	0.83	0.19	0.07	NA	NA
2000	18.79	27.69	55.16	7.01	30.86	8.71	8.85	4.60	0.56	0.35	0.08	0.03	0.04	0.01
2001	12.24	23.59	36.46	38.18	5.07	15.70	3.53	2.15	0.90	0.34	0.12	0.09	0.05	0.02
2002	0.96	38.56	41.31	40.59	37.26	7.47	8.99	1.66	0.81	0.35	0.07	0.01	NA	NA
2003	11.16	4.20	46.55	36.90	29.21	17.76	4.13	4.79	1.13	0.23	0.13	0.01	0.09	NA
2004	7.34	27.62	8.24	66.84	41.29	30.95	17.60	3.27	3.57	0.57	0.32	0.01	NA	0.01
2005	2.69	17.79	41.72	9.95	46.31	24.99	12.10	6.45	1.01	1.03	0.27	0.24	0.03	NA
2006	9.09	7.43	25.06	40.53	11.73	31.64	11.66	4.11	1.62	0.28	0.16	0.02	NA	NA
2007	5.65	19.04	9.07	22.77	29.88	10.06	11.37	6.10	2.44	0.86	0.30	0.13	0.01	NA
2008	6.75	12.41	23.00	9.84	22.36	22.94	9.44	8.00	3.03	0.77	0.44	0.09	0.05	NA
2009	22.14	12.74	16.46	22.41	15.49	25.86	16.60	4.81	3.15	1.16	0.28	0.11	0.07	0.03
2010	18.62	21.51	18.89	18.10	24.64	14.13	18.36	9.87	3.24	1.93	0.58	0.26	0.05	0.02
2011	3.55	22.96	27.54	20.10	23.07	26.66	14.70	13.37	5.02	1.01	1.01	0.21	0.07	0.02
2012	20.36	11.03	39.37	56.70	41.90	31.19	28.43	10.88	7.06	3.21	0.97	0.48	0.36	0.13
2013	10.89	33.70	18.22	44.39	47.10	25.89	17.15	14.44	7.19	3.47	1.68	0.71	0.16	0.25
2014	3.29	24.25	39.05	23.75	47.55	38.29	17.83	8.45	4.37	2.24	0.84	0.52	0.12	0.12
2015	21.06	10.98	28.05	42.23	21.22	41.98	29.41	17.09	5.13	3.18	1.48	0.60	0.17	0.10
2016	31.71	31.65	15.21	37.62	54.80	28.19	38.46	19.05	7.00	2.33	1.24	0.85	0.26	0.12
2017	3.83	24.95	33.72	18.16	36.43	40.35	23.62	22.55	11.86	5.15	2.09	0.88	0.54	0.09
2018	11.48	14.52	29.97	36.88	16.11	28.81	26.66	15.32	7.85	3.72	1.24	0.59	0.25	0.10
2019	7.99	22.09	14.63	30.72	31.46	14.13	20.34	17.31	9.43	5.98	2.56	0.95	0.38	0.04
2020	29.45	13.21	19.32	10.07	18.48	15.32	7.49	10.27	7.34	4.13	3.56	2.04	0.48	0.02

Table 9.7. 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	11	12	13	14
1996	6.323	3.433	19.594	14.191	5.568	7.699	6.489	1.652	0.310	0.083	0.020	0.051	0.014	NA
1997	0.634	16.657	6.651	29.249	16.338	5.401	3.737	2.134	0.306	0.145	0.013	0.029	0.042	NA

1998	5.713	2.588	15.335	7.293	16.104	16.161	5.241	2.251	1.272	0.204	0.050	0.025	0.011	NA
1999	7.996	13.794	5.581	23.159	7.449	10.045	4.085	0.587	0.341	0.367	0.032	NA	0.062	NA
2000	4.520	12.736	15.236	3.757	11.543	3.642	2.705	1.142	0.344	0.284	0.109	0.018	0.012	NA
2001	6.888	11.288	19.321	21.271	3.398	6.932	1.651	0.792	0.176	0.029	0.103	0.016	NA	NA
2002	0.934	13.189	15.838	23.389	16.207	5.534	4.865	1.132	0.627	0.078	0.167	0.019	0.037	NA
2003	5.198	2.732	26.051	17.313	13.473	9.114	1.915	2.588	0.368	0.104	0.088	0.017	0.016	NA
2004	3.568	15.837	6.907	30.306	19.384	12.070	7.603	1.922	1.683	0.232	0.109	0.073	NA	NA
2005	2.128	8.866	19.967	6.772	26.102	11.297	4.004	1.962	0.312	0.316	0.031	0.059	0.024	NA
2006	4.407	4.409	15.878	22.852	7.785	14.450	6.309	2.118	1.052	0.165	0.113	NA	0.014	NA
2007	3.668	9.571	4.901	12.101	16.261	6.526	6.105	3.210	0.802	0.533	0.040	0.084	NA	NA
2008	6.680	12.737	15.075	8.063	17.949	18.807	5.891	5.588	1.411	0.739	0.281	0.093	0.018	0.026
2009	6.776	9.260	13.727	17.711	12.756	16.890	10.571	3.289	2.760	0.923	0.305	0.162	0.013	0.048
2010	11.902	22.213	16.448	15.980	18.080	9.886	11.301	6.762	2.264	1.239	0.548	0.070	0.106	0.027
2011	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2012	9.677	10.794	24.846	21.580	12.811	11.131	9.587	5.406	3.248	1.434	0.553	0.161	0.111	0.123
2013	8.099	28.823	14.070	26.048	21.290	12.617	7.876	6.014	3.061	1.872	0.989	0.459	0.211	0.078
2014	4.031	20.359	30.521	15.918	24.264	19.850	8.463	5.719	3.676	2.112	1.375	0.693	0.313	0.112
2015	18.852	12.839	34.955	43.590	18.982	27.606	16.135	5.387	3.099	1.097	0.578	0.467	0.190	0.079
2016	12.001	18.443	8.685	17.909	22.236	10.988	11.949	6.710	2.673	1.527	0.760	0.464	0.173	NA
2017	6.072	25.957	32.338	16.856	31.308	31.987	12.129	9.742	4.370	1.526	0.971	0.460	0.348	0.188
2018	8.692	10.623	21.844	20.996	8.404	13.432	12.872	7.421	4.993	2.306	0.851	0.395	0.143	0.070

2019	8.327	20.053	19.377	26.604	18.012	9.066	8.658	5.302	2.465	1.679	0.737	0.264	0.155	0.023

Table 9.8. 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	-0.12	-0.21	0.08	0.12	0.21	-0.11	-0.16	0.13	-0.10	-0.45	-0.21	0.00
1956	-0.03	-0.05	0.03	0.00	-0.13	-0.20	-0.01	0.01	0.17	0.09	0.23	0.22
1957	0.09	0.02	-0.01	0.17	-0.13	0.09	0.06	-0.15	-0.10	-0.12	-0.38	0.52
1958	0.15	0.18	-0.26	-0.07	0.06	0.08	0.13	-0.23	0.23	0.00	-0.23	0.39
1959	-0.21	0.21	0.26	-0.24	-0.22	-0.06	-0.07	0.28	-0.26	0.38	-0.23	-0.41
1960	0.10	-0.36	0.14	0.19	0.06	0.07	-0.03	-0.11	-0.04	0.03	-0.64	0.90
1961	0.05	0.04	-0.40	0.12	-0.02	0.27	0.20	-0.14	0.09	-0.19	-0.98	0.82
1962	0.09	-0.01	0.12	-0.24	0.12	-0.30	0.09	0.26	-0.06	0.03	-0.40	0.69
1963	-0.06	0.29	-0.18	0.01	-0.03	-0.07	-0.38	0.21	0.35	0.06	0.07	-0.62
1964	-0.13	-0.02	0.13	-0.25	-0.12	0.38	-0.10	-0.45	-0.01	0.27	-0.16	0.00
1965	-0.03	-0.11	0.09	0.16	-0.13	0.05	0.47	-0.48	-0.05	-0.51	-0.36	0.63
1966	-0.04	-0.04	-0.18	0.10	-0.07	0.12	-0.35	0.59	-0.83	0.28	0.01	1.06
1967	0.19	-0.13	0.02	-0.20	0.02	-0.37	0.49	0.05	0.67	-0.73	-0.84	-0.18
1968	0.03	-0.02	-0.27	-0.12	0.23	0.16	-0.42	0.37	-0.12	0.60	-0.66	0.65
1969	-0.09	-0.03	0.15	-0.01	0.05	-0.15	-0.33	-0.25	-0.04	-0.26	-0.81	-0.14
1970	-0.09	0.14	-0.05	-0.14	0.05	-0.16	0.48	-0.58	-0.12	0.24	0.29	0.45
1971	-0.10	0.07	0.09	0.18	-0.18	0.28	-0.17	0.06	-0.45	-0.02	0.12	0.36
1972	-0.17	-0.13	0.07	-0.03	0.12	-0.05	-0.10	0.29	-0.07	0.17	0.52	-2.76
1973	0.28	-0.02	-0.10	0.03	0.00	-0.24	0.09	0.17	0.16	-0.20	-1.25	-2.09
1974	-0.16	0.21	-0.02	-0.18	-0.01	0.00	-0.22	0.29	0.01	0.18	-0.44	0.82
1975	0.19	-0.07	0.04	-0.05	0.03	-0.15	-0.21	-0.01	0.41	-0.02	-0.12	0.11
1976	0.10	0.00	-0.17	0.08	-0.09	0.25	-0.16	-0.15	0.06	0.27	-0.23	0.26
1977	-0.40	-0.06	0.05	-0.09	0.13	0.05	0.31	0.03	-0.70	-0.48	-1.22	-2.47
1978	0.08	-0.02	0.04	-0.10	0.04	-0.21	0.12	-0.19	0.02	-0.05	0.53	1.22
1979	0.15	0.10	-0.22	0.10	-0.05	0.03	-0.31	-0.08	0.05	-0.15	0.40	-0.19
1980	0.22	0.00	0.09	0.06	-0.01	-0.09	0.12	-0.49	0.30	0.09	0.15	-1.08

1981	-0.30	-0.20	0.07	-0.13	0.07	0.11	0.01	0.32	-0.08	0.59	-0.03	1.17
1982	0.01	0.15	0.08	-0.06	-0.22	0.18	0.20	0.13	-0.24	-0.87	0.04	-0.85
1983	-0.32	-0.36	0.11	0.15	0.03	0.01	-0.05	0.00	0.00	0.37	-0.20	0.61
1984	0.35	0.03	-0.06	-0.05	-0.09	-0.02	0.05	-0.14	-0.32	0.17	0.71	0.13
1985	0.03	0.18	-0.10	0.12	-0.09	-0.02	-0.15	0.14	0.04	-0.28	0.50	0.53
1986	0.14	-0.13	0.02	-0.01	0.18	-0.04	0.12	-0.22	0.10	0.08	-0.51	0.28
1987	-0.15	0.12	0.00	-0.16	0.07	0.04	-0.02	0.13	-0.38	-0.09	0.17	-0.14
1988	-0.08	-0.06	-0.06	0.12	-0.08	0.08	0.16	0.04	0.49	0.01	0.58	0.23
1989	-0.21	0.06	0.15	-0.08	-0.02	-0.15	-0.31	-0.08	-0.01	0.53	-0.03	-1.32
1990	0.00	-0.13	-0.09	-0.01	0.03	0.08	-0.07	-0.20	0.31	0.13	-0.20	0.13
1991	0.07	0.05	-0.12	-0.05	0.09	-0.08	0.11	-0.05	-0.27	0.43	-0.55	0.18
1992	-0.24	0.08	0.05	0.03	0.12	-0.01	-0.04	-0.07	-0.72	-0.73	-0.55	-0.10
1993	0.25	0.04	-0.20	-0.06	-0.08	-0.11	0.07	0.49	0.50	-0.20	-0.97	0.47
1994	0.02	0.24	-0.13	-0.20	-0.04	0.06	-0.18	-0.14	0.43	0.49	0.49	-0.38
1995	0.27	-0.05	0.08	-0.04	-0.04	-0.11	-0.13	-0.26	-0.20	0.71	1.04	0.58
1996	0.01	-0.06	-0.19	0.07	0.05	0.02	0.13	0.18	-0.34	-0.41	0.54	-0.15
1997	-0.16	0.04	-0.03	-0.14	-0.10	0.22	0.18	0.28	0.44	-0.69	-0.27	0.09
1998	-0.17	-0.17	0.09	0.07	0.00	-0.17	0.26	0.07	0.14	0.31	0.17	-0.77
1999	-0.11	0.06	0.05	0.05	0.09	-0.05	-0.23	-0.15	-0.20	-0.34	-0.45	-0.87
2000	0.17	-0.24	0.14	-0.03	0.01	0.10	0.03	-0.11	0.07	0.20	-0.09	-0.05
2001	0.27	0.24	-0.19	0.04	0.03	-0.25	0.07	0.32	-0.08	0.27	-0.56	1.18
2002	-0.08	0.07	0.05	-0.06	0.01	0.02	-0.09	0.24	0.33	-0.11	0.23	-0.59
2003	-0.05	0.04	0.03	-0.10	0.10	0.07	0.20	-0.18	0.11	0.22	0.13	1.03
2004	-0.28	0.09	0.10	-0.03	-0.04	0.23	-0.03	0.22	-0.33	0.17	0.26	-0.14
2005	0.20	-0.28	0.16	-0.05	-0.10	-0.07	0.30	0.01	0.42	0.16	0.29	-0.09
2006	-0.06	0.06	-0.12	0.09	0.06	-0.07	-0.08	0.19	-0.19	-0.27	-0.67	-0.02
2007	-0.17	0.15	-0.03	-0.01	-0.10	0.08	0.01	0.19	0.78	-0.25	1.14	-0.73
2008	0.14	-0.21	0.07	-0.15	0.03	-0.17	0.02	0.15	-0.07	0.36	0.20	-0.47
2009	0.07	-0.08	0.02	0.16	0.00	0.19	-0.22	-0.25	-0.02	-0.37	0.10	-0.24
2010	0.08	0.02	-0.12	-0.02	0.08	-0.07	0.13	-0.18	-0.16	0.14	0.28	0.80

2011	-0.02	-0.04	0.07	0.00	-0.05	0.00	-0.15	0.06	-0.13	-0.22	-0.28	-0.32
2012	-0.14	0.03	0.00	-0.06	0.03	0.13	0.00	-0.25	-0.08	-0.16	-0.03	-0.14
2013	0.27	-0.03	0.05	0.01	-0.06	-0.02	0.08	0.00	-0.20	0.07	0.00	-0.36
2014	-0.11	-0.02	0.03	-0.02	0.02	-0.07	-0.08	0.06	0.02	-0.19	0.24	0.29
2015	0.09	0.08	0.03	0.01	-0.10	0.02	-0.10	-0.07	0.39	-0.18	-0.46	-0.22
2016	-0.13	0.02	-0.18	0.08	0.11	-0.02	0.04	-0.06	-0.08	0.32	-0.31	-0.63
2017	0.00	0.06	0.05	-0.06	-0.05	-0.07	-0.04	0.07	-0.16	-0.04	0.24	0.12
2018	-0.03	0.07	-0.07	0.04	-0.02	0.18	-0.03	-0.22	-0.16	-0.05	-0.44	0.08
2019	0.01	-0.19	0.00	0.04	-0.10	-0.10	0.13	0.18	0.17	-0.02	-0.03	0.09

Table 9.9. 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	11	12	13	14
1985	-0.54	0.03	0.24	0.49	0.17	0.28	0.39	0.17	0.27	0.64	0.16	-0.10	0.01	0.23
1986	0.46	-0.05	-0.36	-0.20	-0.03	0.02	-0.16	-0.31	-0.29	-0.12	-0.15	-0.11	-0.41	-0.02
1987	0.69	0.03	0.18	-0.45	-0.01	-0.06	0.04	-0.13	-0.15	-0.10	0.15	0.21	0.36	0.21
1988	-0.19	0.03	0.58	0.19	-0.10	-0.34	0.09	0.46	-0.15	-0.15	-0.15	0.37	-0.01	0.17
1989	0.39	0.07	0.54	0.56	0.24	0.17	-0.16	-0.14	0.16	0.04	0.22	0.01	-0.23	-0.09
1990	-0.53	0.11	0.13	0.12	-0.09	-0.15	0.05	-0.20	-0.09	0.07	0.10	-0.30	0.08	0.09
1991	-0.18	-0.45	0.13	0.21	0.29	0.06	0.10	-0.20	0.15	0.13	0.13	-0.26	0.28	0.35
1992	-0.22	0.02	-0.15	0.16	-0.06	-0.13	-0.15	-0.20	-0.20	-0.09	-0.27	-0.15	0.12	-0.07
1993	-0.55	-0.06	0.22	0.00	0.08	-0.03	-0.23	-0.19	-0.31	-0.32	0.12	-0.05	0.00	0.01
1994	0.51	-0.27	0.04	0.16	-0.15	-0.32	-0.18	-0.26	-0.23	-0.18	-0.11	-0.09	0.09	-0.01
1995	-0.20	0.15	-0.19	-0.02	0.20	0.00	-0.23	-0.12	-0.10	-0.26	-0.07	0.15	0.08	-0.05
1996	-0.63	-0.12	0.15	-0.09	0.23	-0.03	0.25	0.36	0.17	0.00	-0.28	0.27	0.23	0.23
1997	0.23	-0.02	0.16	0.33	-0.01	-0.05	-0.06	0.21	-0.39	-0.33	0.33	-0.13	0.34	0.35
1998	-0.09	0.12	-0.11	0.16	0.55	0.29	0.06	0.15	0.38	0.44	0.10	-0.24	-0.06	-0.18
1999	-0.02	0.22	-0.02	0.11	-0.02	0.08	-0.01	-0.08	-0.10	0.07	0.10	0.04	-0.10	-0.08
2000	0.90	0.16	0.36	-0.13	-0.03	-0.22	-0.24	-0.08	-0.35	-0.33	-0.59	-0.14	0.09	0.03
2001	0.25	0.06	0.08	-0.02	-0.43	-0.22	-0.43	-0.65	-0.46	0.07	-0.21	0.00	0.16	0.07
2002	-0.09	0.32	0.22	0.15	0.12	-0.15	-0.20	-0.36	-0.53	-0.30	-0.13	-0.28	-0.19	-0.05

2003	0.08	-0.13	0.16	0.04	-0.04	-0.18	-0.22	-0.10	0.09	-0.66	-0.19	-0.16	0.33	-0.08
2004	-0.02	0.29	-0.07	0.42	0.25	0.35	0.29	0.16	0.49	0.31	0.25	-0.32	-0.09	0.01
2005	-0.16	0.12	0.32	-0.06	0.19	0.13	0.00	0.03	0.01	0.26	0.38	0.52	0.02	-0.03
2006	0.30	-0.06	0.06	0.19	-0.05	0.21	-0.09	-0.32	-0.34	-0.21	-0.34	-0.18	-0.19	-0.07
2007	0.04	0.25	-0.29	-0.14	-0.06	-0.16	-0.26	-0.05	0.06	-0.05	0.42	0.08	-0.06	-0.08
2008	-0.02	0.03	0.06	-0.37	-0.19	-0.04	0.14	0.00	0.14	-0.12	0.16	0.15	0.04	-0.05
2009	0.40	-0.09	-0.11	-0.10	-0.14	0.00	0.00	0.05	-0.09	0.02	-0.23	-0.17	0.23	0.06
2010	0.02	-0.14	-0.13	-0.16	-0.07	-0.17	0.02	0.04	0.42	0.20	0.09	0.21	-0.11	0.05
2011	-0.64	-0.22	-0.27	-0.21	-0.04	0.14	0.13	0.21	0.11	0.02	0.22	-0.15	-0.10	-0.10
2012	0.05	-0.23	-0.09	0.27	0.39	0.34	0.50	0.31	0.28	0.32	0.52	0.11	0.56	0.33
2013	-0.23	0.07	-0.20	-0.08	0.12	0.10	0.08	0.31	0.58	0.23	0.31	0.71	-0.17	0.57
2014	-0.27	0.00	-0.13	-0.10	0.03	0.21	0.03	-0.13	-0.15	0.11	-0.44	-0.11	-0.05	0.04
2015	0.22	0.03	-0.22	-0.16	-0.26	0.22	0.23	0.42	0.03	0.16	0.32	-0.12	-0.32	0.15
2016	0.68	0.10	-0.07	-0.07	0.13	0.14	0.39	0.23	0.19	-0.14	-0.13	0.37	-0.19	-0.09
2017	-0.56	-0.06	-0.18	-0.06	-0.09	0.15	0.23	0.29	0.40	0.49	0.35	0.15	0.51	-0.29
2018	-0.15	-0.02	-0.24	-0.20	-0.26	-0.04	0.01	0.22	-0.12	-0.15	-0.27	-0.19	-0.23	-0.10
2019	-0.14	-0.06	-0.38	-0.32	-0.32	-0.29	-0.11	0.01	0.37	0.20	0.10	0.09	0.07	-0.49
2020	0.30	-0.23	-0.52	-0.80	-0.77	-0.65	-0.63	-0.35	-0.19	0.19	0.36	0.56	0.20	-0.51

Table 9.10. 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	11	12	13	14
1996	-0.18	-0.12	-0.12	-0.22	-0.02	-0.09	0.17	0.19	-0.22	-0.11	-0.29	-0.10	-0.08	-0.03
1997	-0.22	0.00	-0.04	0.21	0.05	-0.04	-0.16	-0.13	-0.29	-0.18	-0.20	-0.03	0.04	-0.09
1998	-0.40	-0.03	-0.28	0.00	-0.06	0.31	0.46	0.08	0.21	0.01	-0.13	0.03	-0.02	-0.09
1999	0.04	-0.24	0.12	0.08	0.05	-0.05	-0.16	-0.35	-0.42	0.05	-0.20	-0.18	0.30	-0.04
2000	-0.43	-0.19	-0.34	-0.10	-0.22	-0.25	-0.42	-0.37	-0.07	0.10	-0.04	-0.05	0.01	-0.02
2001	-0.28	-0.25	-0.02	-0.01	-0.23	-0.27	-0.28	-0.55	-0.66	-0.45	0.10	-0.14	-0.06	-0.02
2002	-0.20	-0.30	-0.20	0.15	0.01	0.09	-0.03	-0.02	-0.09	-0.53	0.48	-0.06	0.13	-0.02
2003	-0.17	-0.11	0.06	-0.14	-0.09	-0.17	-0.16	0.06	-0.12	-0.51	0.00	0.00	0.03	-0.04
2004	-0.23	0.10	0.12	0.17	0.19	0.10	0.23	0.33	0.47	0.16	0.03	0.19	-0.04	-0.03

2005	-0.01	-0.13	0.07	0.06	0.29	0.00	-0.25	-0.26	-0.21	-0.09	-0.17	0.10	0.07	-0.02
2006	0.06	-0.12	0.06	0.14	0.08	0.08	0.05	-0.17	-0.04	-0.05	-0.08	-0.16	0.00	-0.03
2007	0.05	-0.01	-0.35	-0.22	-0.03	-0.02	-0.13	0.08	-0.19	0.17	-0.14	0.15	-0.06	-0.04
2008	0.39	0.29	0.08	-0.12	0.13	0.26	0.31	0.32	0.07	0.38	0.26	0.31	-0.03	0.13
2009	-0.23	-0.06	0.12	0.13	0.16	0.12	0.22	0.32	0.40	0.37	0.25	0.29	0.00	0.21
2010	0.10	0.15	0.13	0.15	0.16	-0.02	0.19	0.32	0.61	0.32	0.45	-0.13	0.29	0.12
2011	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2012	-0.14	0.01	-0.08	-0.16	-0.16	-0.10	0.08	0.26	0.10	0.08	0.44	-0.22	0.11	0.42
2013	-0.02	0.19	-0.02	-0.12	-0.04	-0.07	-0.03	0.11	0.32	0.18	0.32	0.70	0.28	0.17
2014	0.26	0.11	0.07	-0.01	-0.03	0.07	-0.06	0.10	0.23	0.57	0.50	0.57	0.73	0.22
2015	0.61	0.38	0.39	0.31	0.14	0.28	0.25	-0.06	0.08	-0.32	-0.03	0.14	0.08	0.20
2016	0.24	-0.09	-0.14	-0.28	-0.14	-0.23	-0.12	-0.15	-0.18	-0.02	-0.06	0.32	-0.06	-0.43
2017	0.26	0.24	0.21	0.29	0.32	0.39	0.17	0.08	-0.03	-0.15	0.14	0.10	0.53	0.33
2018	0.07	0.01	-0.09	-0.25	-0.32	-0.24	-0.09	0.12	-0.03	-0.10	-0.11	-0.03	-0.15	0.01
2019	0.35	0.12	0.24	-0.02	-0.26	-0.22	-0.31	-0.48	-0.34	-0.45	-0.46	-0.34	-0.02	-0.26

Table 9.11. Icelandic cod in Division Va. Estimates of fishing mortality 1955-2019 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	0.04	0.17	0.25	0.27	0.30	0.30	0.28	0.32	0.32	0.31	0.32	0.32
1956	0.05	0.18	0.25	0.26	0.29	0.30	0.29	0.34	0.35	0.33	0.33	0.33
1957	0.08	0.21	0.27	0.27	0.30	0.33	0.33	0.36	0.36	0.33	0.30	0.30
1958	0.11	0.25	0.30	0.29	0.32	0.37	0.40	0.44	0.44	0.38	0.32	0.32
1959	0.09	0.23	0.28	0.26	0.30	0.34	0.35	0.40	0.38	0.32	0.23	0.23
1960	0.10	0.23	0.29	0.29	0.34	0.40	0.43	0.48	0.47	0.38	0.27	0.27
1961	0.09	0.23	0.26	0.26	0.33	0.40	0.42	0.46	0.44	0.35	0.23	0.23
1962	0.11	0.25	0.28	0.26	0.35	0.42	0.47	0.51	0.49	0.38	0.24	0.24
1963	0.13	0.28	0.33	0.31	0.38	0.49	0.59	0.65	0.63	0.46	0.28	0.28
1964	0.13	0.29	0.37	0.36	0.43	0.57	0.74	0.81	0.84	0.61	0.39	0.39
1965	0.12	0.28	0.38	0.40	0.47	0.60	0.74	0.85	0.88	0.65	0.43	0.43
1966	0.09	0.25	0.34	0.38	0.49	0.62	0.78	0.92	1.01	0.79	0.53	0.53

1967	0.08	0.23	0.30	0.34	0.48	0.61	0.75	0.88	0.93	0.73	0.46	0.46
1968	0.08	0.25	0.34	0.41	0.58	0.77	1.04	1.20	1.36	1.09	0.74	0.74
1969	0.06	0.23	0.32	0.35	0.50	0.61	0.72	0.84	0.87	0.72	0.45	0.45
1970	0.07	0.27	0.39	0.43	0.55	0.65	0.76	0.89	0.95	0.81	0.52	0.52
1971	0.09	0.31	0.48	0.53	0.62	0.72	0.80	0.96	1.04	0.89	0.59	0.59
1972	0.09	0.30	0.48	0.55	0.65	0.73	0.79	0.96	1.06	0.92	0.61	0.61
1973	0.12	0.32	0.49	0.56	0.67	0.75	0.80	0.96	1.05	0.91	0.60	0.60
1974	0.11	0.32	0.50	0.58	0.70	0.83	0.92	1.06	1.19	1.04	0.71	0.71
1975	0.11	0.31	0.50	0.60	0.72	0.89	1.03	1.13	1.26	1.12	0.80	0.80
1976	0.07	0.26	0.43	0.55	0.70	0.86	0.95	1.02	1.08	0.97	0.68	0.68
1977	0.03	0.20	0.33	0.43	0.61	0.72	0.73	0.75	0.71	0.65	0.43	0.43
1978	0.03	0.17	0.28	0.35	0.53	0.60	0.55	0.56	0.49	0.46	0.30	0.30
1979	0.03	0.17	0.27	0.34	0.50	0.57	0.50	0.50	0.43	0.40	0.26	0.26
1980	0.03	0.17	0.31	0.38	0.54	0.62	0.56	0.55	0.48	0.45	0.31	0.31
1981	0.02	0.18	0.35	0.49	0.65	0.82	0.86	0.83	0.77	0.72	0.56	0.56
1982	0.03	0.19	0.40	0.56	0.70	0.90	0.98	0.89	0.78	0.71	0.55	0.55
1983	0.02	0.18	0.38	0.56	0.71	0.89	0.93	0.88	0.77	0.72	0.58	0.58
1984	0.04	0.20	0.38	0.53	0.68	0.81	0.77	0.73	0.64	0.61	0.49	0.49
1985	0.05	0.23	0.42	0.58	0.72	0.83	0.77	0.72	0.62	0.61	0.50	0.50
1986	0.06	0.26	0.52	0.72	0.83	0.96	0.88	0.78	0.68	0.66	0.54	0.54
1987	0.06	0.27	0.55	0.82	0.91	1.06	1.00	0.85	0.75	0.73	0.63	0.63
1988	0.05	0.26	0.52	0.80	0.92	1.11	1.09	0.95	0.89	0.86	0.78	0.78
1989	0.04	0.24	0.46	0.66	0.80	0.90	0.80	0.72	0.65	0.65	0.55	0.55
1990	0.05	0.25	0.47	0.66	0.79	0.86	0.75	0.68	0.62	0.61	0.51	0.51
1991	0.09	0.30	0.56	0.81	0.88	0.94	0.83	0.76	0.70	0.68	0.59	0.59
1992	0.10	0.32	0.60	0.87	0.93	1.00	0.88	0.78	0.71	0.69	0.60	0.60
1993	0.14	0.31	0.55	0.81	0.89	1.04	1.01	0.91	0.85	0.81	0.74	0.74
1994	0.09	0.24	0.39	0.54	0.68	0.77	0.72	0.68	0.62	0.60	0.53	0.53
1995	0.06	0.20	0.32	0.43	0.57	0.63	0.56	0.57	0.50	0.50	0.42	0.42
1996	0.04	0.16	0.28	0.41	0.56	0.63	0.58	0.59	0.53	0.52	0.45	0.45

1997	0.03	0.14	0.27	0.42	0.59	0.67	0.66	0.68	0.63	0.60	0.54	0.54
1998	0.03	0.15	0.33	0.52	0.66	0.78	0.81	0.82	0.78	0.74	0.70	0.70
1999	0.04	0.17	0.38	0.63	0.73	0.85	0.89	0.87	0.83	0.79	0.75	0.75
2000	0.06	0.18	0.38	0.61	0.73	0.85	0.90	0.89	0.85	0.82	0.79	0.79
2001	0.07	0.19	0.38	0.57	0.69	0.83	0.93	0.94	0.91	0.88	0.88	0.88
2002	0.05	0.16	0.33	0.49	0.60	0.72	0.81	0.85	0.81	0.79	0.78	0.78
2003	0.04	0.15	0.33	0.49	0.58	0.69	0.75	0.79	0.76	0.75	0.74	0.74
2004	0.03	0.14	0.33	0.52	0.59	0.70	0.77	0.80	0.79	0.78	0.78	0.78
2005	0.03	0.13	0.30	0.49	0.57	0.67	0.73	0.78	0.77	0.76	0.77	0.77
2006	0.03	0.12	0.27	0.48	0.56	0.68	0.74	0.76	0.76	0.74	0.76	0.76
2007	0.03	0.11	0.24	0.41	0.52	0.66	0.75	0.78	0.80	0.78	0.80	0.80
2008	0.02	0.09	0.19	0.32	0.44	0.55	0.60	0.63	0.61	0.61	0.60	0.60
2009	0.03	0.10	0.20	0.33	0.44	0.56	0.61	0.61	0.59	0.59	0.57	0.57
2010	0.03	0.09	0.17	0.28	0.39	0.48	0.49	0.50	0.48	0.49	0.45	0.45
2011	0.03	0.09	0.17	0.27	0.36	0.45	0.45	0.45	0.43	0.44	0.39	0.39
2012	0.03	0.10	0.17	0.27	0.35	0.43	0.43	0.45	0.42	0.45	0.40	0.40
2013	0.04	0.10	0.18	0.27	0.35	0.44	0.44	0.47	0.47	0.50	0.48	0.48
2014	0.03	0.10	0.16	0.25	0.33	0.41	0.42	0.46	0.48	0.54	0.53	0.53
2015	0.03	0.10	0.16	0.23	0.31	0.38	0.38	0.43	0.43	0.49	0.48	0.48
2016	0.03	0.10	0.16	0.23	0.30	0.38	0.38	0.44	0.45	0.51	0.51	0.51
2017	0.03	0.10	0.16	0.23	0.29	0.36	0.36	0.42	0.44	0.52	0.53	0.53
2018	0.03	0.10	0.17	0.25	0.30	0.36	0.36	0.41	0.42	0.51	0.55	0.55
2019	0.02	0.09	0.15	0.24	0.29	0.38	0.40	0.48	0.53	0.66	0.80	0.80

Table 9.12. Icelandic cod in Division Va. Estimates of numbers at age in the stock 1955-2020 (in millions) 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	254.498	186.563	151.953	217.539	211.871	115.461	36.062	24.597	12.976	87.905	9.237	7.845	8.178	2.656
1956	329.342	208.365	152.745	119.527	150.235	134.756	71.884	21.833	14.872	8.014	52.160	5.481	4.727	4.852
1957	431.205	269.643	170.595	118.843	81.564	95.866	85.220	44.060	13.203	9.076	4.668	30.004	3.217	2.782
1958	230.254	353.041	220.765	128.780	78.490	50.796	59.831	51.670	35.182	7.799	5.176	2.661	17.674	1.960
1959	287.828	188.516	289.046	161.218	82.243	47.522	31.103	35.448	51.470	19.371	4.123	2.726	1.486	10.504
1960	192.354	235.654	154.344	216.102	104.535	50.770	30.105	18.889	20.630	37.503	10.652	2.307	1.623	0.970
1961	264.724	157.486	192.937	114.256	140.124	63.725	31.045	17.577	10.390	11.004	19.076	5.429	1.286	1.016
1962	304.135	216.738	128.939	143.803	74.684	88.501	40.155	18.205	23.590	5.597	5.693	10.065	3.138	0.841
1963	322.663	249.004	177.450	94.412	91.855	46.126	55.656	23.244	9.752	12.103	2.743	2.863	5.649	2.025
1964	341.754	264.174	203.868	127.600	58.236	54.159	27.720	31.058	11.628	4.437	5.191	1.201	1.477	3.479
1965	477.427	279.805	216.288	147.189	78.139	32.863	30.918	14.692	14.371	4.539	1.615	1.844	0.535	0.820
1966	256.271	390.884	229.085	156.966	90.728	43.562	17.987	15.806	6.591	5.592	1.592	0.549	0.785	0.286
1967	368.946	209.817	320.029	170.727	99.750	52.820	24.358	9.014	6.947	2.472	1.832	0.476	0.205	0.377
1968	269.064	302.067	171.783	242.689	111.175	60.314	30.847	12.294	4.011	2.689	0.841	0.592	0.189	0.106
1969	281.147	220.291	247.312	130.247	155.250	64.664	32.919	41.199	4.680	1.165	0.662	0.176	0.164	0.073
1970	207.550	230.184	180.359	191.474	84.520	92.058	37.149	32.887	18.347	1.865	0.412	0.226	0.070	0.085
1971	406.957	169.927	188.459	137.866	119.719	46.889	49.237	17.528	14.051	7.022	0.626	0.130	0.083	0.034
1972	266.977	333.189	139.125	141.250	82.878	60.755	22.547	21.681	23.278	5.170	2.206	0.182	0.044	0.038
1973	389.143	218.582	272.792	104.345	85.511	42.001	28.598	9.640	8.553	8.631	1.619	0.623	0.059	0.019

1974	548.257	318.604	178.960	198.339	61.996	42.956	19.556	12.008	3.710	3.148	2.719	0.466	0.205	0.026
1975	214.317	448.875	260.851	130.828	117.381	30.819	19.786	7.955	4.276	1.208	0.894	0.680	0.134	0.082
1976	337.771	175.468	367.508	191.672	78.596	58.158	13.831	7.864	2.684	1.255	0.318	0.207	0.181	0.050
1977	366.321	276.544	143.661	281.595	121.224	41.952	27.409	5.646	2.737	0.846	0.371	0.089	0.064	0.075
1978	207.762	299.918	226.415	114.096	189.675	71.393	22.378	12.193	2.241	1.076	0.328	0.149	0.038	0.034
1979	209.096	170.101	245.552	180.387	78.507	117.229	41.011	10.835	5.452	1.057	0.505	0.164	0.077	0.023
1980	196.797	171.193	139.267	195.459	124.530	48.873	71.975	20.324	5.025	2.709	0.527	0.270	0.090	0.049
1981	345.304	161.124	140.161	110.863	134.398	75.136	27.233	45.879	8.943	2.349	1.278	0.268	0.140	0.054
1982	206.927	282.711	131.917	112.168	76.107	77.303	37.725	11.658	16.464	3.090	0.836	0.483	0.106	0.066
1983	211.708	169.417	231.464	105.059	75.761	41.974	36.223	15.342	3.863	5.060	1.035	0.315	0.194	0.050
1984	495.641	173.332	138.707	185.103	71.944	42.527	19.714	14.646	5.175	1.242	1.711	0.390	0.125	0.089
1985	387.806	405.796	141.912	109.257	123.987	40.328	20.430	8.210	5.334	1.963	0.490	0.740	0.173	0.063
1986	257.718	317.508	332.238	110.544	71.082	66.483	18.487	8.181	2.917	2.018	0.786	0.215	0.329	0.086
1987	132.478	211.001	259.954	255.880	69.720	34.727	26.549	6.625	2.574	0.990	0.761	0.326	0.091	0.156
1988	193.819	108.464	172.753	201.348	159.729	32.849	12.537	8.762	1.875	0.777	0.346	0.293	0.129	0.040
1989	159.689	158.686	88.802	134.894	127.305	77.474	12.120	4.071	2.365	0.517	0.247	0.117	0.101	0.048
1990	259.918	130.742	129.921	69.800	86.693	100.745	32.894	4.476	1.356	0.866	0.205	0.105	0.050	0.048
1991	203.019	212.803	107.043	101.153	44.491	44.353	42.478	12.233	1.554	0.525	0.358	0.091	0.047	0.025
1992	117.757	166.218	174.228	80.440	61.257	20.759	16.126	14.371	3.895	0.553	0.202	0.146	0.038	0.021
1993	226.738	96.411	136.088	128.699	47.800	27.608	7.132	5.230	4.319	1.323	0.207	0.081	0.060	0.017
1994	245.106	185.637	78.935	97.004	76.938	22.467	10.073	2.391	1.519	1.283	0.438	0.072	0.029	0.023

1995	132.429	200.676	151.987	59.175	62.339	42.826	10.756	4.166	0.904	0.606	0.531	0.194	0.032	0.014
1996	237.608	108.423	164.299	117.038	39.855	37.120	22.890	4.956	1.813	0.422	0.282	0.263	0.096	0.017
1997	106.767	194.537	88.770	129.740	81.650	24.653	20.123	10.676	2.161	0.828	0.191	0.135	0.128	0.050
1998	251.130	87.413	159.273	70.845	91.927	50.868	13.262	9.178	4.457	0.912	0.344	0.084	0.061	0.061
1999	236.632	205.608	71.568	126.699	49.782	54.380	24.865	5.604	3.457	1.619	0.330	0.129	0.032	0.025
2000	232.883	193.738	168.337	56.040	87.095	27.793	23.645	9.768	1.969	1.165	0.555	0.118	0.048	0.013
2001	255.761	190.668	158.619	129.830	38.344	48.720	12.393	9.331	3.410	0.657	0.391	0.193	0.043	0.018
2002	119.696	209.400	156.106	120.501	87.868	21.518	22.447	5.094	3.324	1.102	0.210	0.128	0.066	0.014
2003	219.384	97.999	171.442	121.905	83.704	51.493	10.835	10.058	2.028	1.211	0.387	0.076	0.048	0.025
2004	195.646	179.617	80.235	135.160	85.712	49.322	25.745	4.953	4.144	0.785	0.450	0.148	0.029	0.019
2005	145.666	160.181	147.058	63.551	95.829	50.610	23.922	11.641	2.014	1.576	0.288	0.168	0.056	0.011
2006	186.325	119.261	131.145	116.487	45.706	58.370	25.511	11.129	4.863	0.793	0.594	0.109	0.064	0.021
2007	174.269	152.550	97.643	104.054	84.220	28.459	29.665	11.958	4.634	1.898	0.303	0.227	0.042	0.025
2008	189.789	142.679	124.897	77.747	76.135	54.240	15.532	14.466	5.085	1.788	0.711	0.112	0.085	0.015
2009	248.856	155.386	116.816	99.818	57.945	58.635	32.204	8.211	6.839	2.286	0.783	0.315	0.050	0.038
2010	268.982	203.746	127.219	92.723	73.965	38.965	34.355	16.909	3.854	3.051	1.017	0.355	0.143	0.023
2011	194.858	220.224	166.813	101.223	69.102	50.858	24.118	19.057	8.529	1.930	1.508	0.517	0.179	0.074
2012	275.063	159.536	180.304	132.889	75.520	47.697	31.901	13.786	9.984	4.464	1.003	0.807	0.274	0.099
2013	244.444	225.203	130.617	143.414	98.925	52.083	29.907	18.351	7.336	5.304	2.330	0.538	0.423	0.149
2014	163.799	200.134	184.380	102.947	106.042	67.796	32.471	17.231	9.714	3.887	2.705	1.190	0.266	0.215
2015	261.573	134.107	163.856	146.292	76.557	73.843	43.335	19.149	9.345	5.217	2.008	1.368	0.569	0.129

2016	254.909	214.158	109.798	129.840	108.667	53.660	48.042	26.145	10.714	5.222	2.778	1.064	0.683	0.288
2017	193.333	208.702	175.337	87.162	96.436	76.170	34.843	29.060	14.668	5.975	2.763	1.449	0.522	0.335
2018	241.268	158.288	170.870	138.874	64.567	67.322	49.441	21.308	16.587	8.361	3.214	1.463	0.706	0.250
2019	211.211	197.534	129.595	135.317	102.895	44.727	42.896	30.067	12.113	9.499	4.565	1.735	0.722	0.333
2020	286.048	172.925	161.727	103.492	101.592	72.149	28.733	26.194	16.907	6.618	4.792	2.195	0.736	0.266

Table 9.13. Icelandic cod in Division Va. Catch (kt), average fishing mortality of age groups 5 to 10, recruitment to the fisheries at age 3 (millions), reference fishing biomass (B4+, kt), spawning stock biomass (kt) at spawning time and harvest ratio.

Year	Yield	F5-10	SSB	Reference biomass	Recruits	Harvest rate
1955	545.250	0.29	945.606	2364.920	151.953	0.23
1956	486.909	0.29	799.370	2089.070	152.745	0.23
1957	455.182	0.31	778.674	1884.730	170.595	0.24
1958	517.359	0.35	877.887	1870.080	220.765	0.28
1959	459.081	0.32	855.177	1830.880	289.046	0.25
1960	470.121	0.37	709.418	1754.340	154.344	0.27
1961	377.291	0.36	467.527	1496.830	192.937	0.25
1962	388.985	0.38	569.047	1492.540	128.939	0.26
1963	408.800	0.46	507.712	1315.430	177.450	0.31
1964	437.012	0.55	450.842	1218.590	203.868	0.36
1965	387.106	0.58	317.425	1021.840	216.288	0.38
1966	353.357	0.59	277.116	1030.970	229.085	0.34
1967	335.721	0.56	256.354	1102.400	320.029	0.30
1968	381.770	0.72	221.443	1222.260	171.783	0.31
1969	403.205	0.56	313.420	1324.760	247.312	0.30
1970	475.077	0.61	330.739	1335.770	180.359	0.36
1971	444.248	0.68	242.236	1096.990	188.459	0.40
1972	395.166	0.69	221.470	996.127	139.125	0.40
1973	369.205	0.71	245.002	842.839	272.792	0.44

1974	368.133	0.76	186.590	917.046		178.960	0.40
1975	364.754	0.81	167.820	894.333		260.851	0.41
1976	346.253	0.75	137.978	954.541		367.508	0.36
1977	340.086	0.60	197.978	1288.680		143.661	0.26
1978	329.602	0.48	211.687	1297.660		226.415	0.25
1979	366.462	0.45	303.616	1395.190		245.552	0.26
1980	432.237	0.49	356.565	1491.700		139.267	0.29
1981	465.032	0.67	259.370	1235.430		140.161	0.38
1982	380.068	0.74	163.691	966.227		131.917	0.39
1983	298.049	0.72	127.030	787.767		231.464	0.38
1984	282.022	0.65	138.131	908.167		138.707	0.31
1985	323.428	0.67	158.815	920.782		141.912	0.35
1986	364.797	0.78	191.950	851.574		332.238	0.43
1987	389.915	0.87	147.234	1032.790		259.954	0.38
1988	377.554	0.90	166.531	1034.360		172.753	0.37
1989	363.125	0.72	169.661	999.045		88.802	0.36
1990	335.316	0.70	208.898	839.118		129.921	0.40
1991	307.759	0.80	164.358	695.232		107.043	0.44
1992	264.834	0.84	151.895	549.320		174.228	0.48
1993	250.704	0.87	120.606	594.108		136.088	0.42
1994	178.138	0.63	156.424	575.623		78.935	0.31
1995	168.592	0.51	176.594	557.673		151.987	0.30
1996	180.701	0.51	158.476	672.544		164.299	0.27
1997	203.112	0.55	187.474	783.237		88.770	0.26
1998	243.987	0.65	198.497	721.633		159.273	0.34
1999	260.147	0.73	180.465	730.796		71.568	0.36
2000	235.092	0.73	170.831	595.599		168.337	0.39
2001	236.707	0.72	169.179	676.595		158.619	0.35
2002	209.535	0.63	196.911	716.179		156.106	0.29
2003	207.241	0.61	188.590	729.609		171.442	0.28

2004	228.330	0.62	192.702	782.534		80.235	0.29
2005	213.863	0.59	221.223	702.699		147.058	0.30
2006	197.200	0.58	212.261	669.925		131.145	0.29
2007	171.641	0.56	193.998	649.529		97.643	0.26
2008	147.663	0.45	242.836	666.780		124.897	0.22
2009	183.315	0.46	221.789	729.672		116.816	0.25
2010	170.018	0.39	250.713	780.062		127.219	0.22
2011	172.197	0.36	306.336	825.365		166.813	0.21
2012	196.188	0.35	340.311	942.236		180.304	0.21
2013	223.593	0.36	365.326	1070.900		130.617	0.21
2014	222.013	0.34	336.185	1091.410		184.380	0.20
2015	230.168	0.31	446.609	1182.890		163.856	0.19
2016	251.238	0.31	393.841	1259.230		109.798	0.20
2017	243.922	0.30	539.956	1205.810		175.337	0.20
2018	267.222	0.31	552.852	1288.310		170.870	0.21
2019	263.015	0.33	515.922	1247.570		129.595	0.21
2020	NA	NA	486.482	1207.663		161.727	NA
2021	NA	NA	NA	NA		141.579	NA
2022	NA	NA	NA	NA		191.744	NA

Table 9.14. Icelandic cod in Division Va. Inputs in the deterministic predictions.

Age	2020	2021	2022	2023	Variable
3	1.155	1.263	1.263	1.263	Catch weights
4	1.662	1.821	1.821	1.821	Catch weights
5	2.480	2.349	2.349	2.349	Catch weights
6	3.773	3.346	3.346	3.346	Catch weights
7	4.783	4.784	4.784	4.784	Catch weights
8	5.504	5.792	5.792	5.792	Catch weights
9	6.604	6.850	6.850	6.850	Catch weights
10	8.095	8.574	8.574	8.574	Catch weights
11	8.842	8.842	8.842	8.842	Catch weights

12	10.596	10.596	10.596	10.596	Catch weights
13	11.687	11.687	11.687	11.687	Catch weights
14	12.003	12.003	12.003	12.003	Catch weights
3	0.949	0.949	0.949	0.949	SSB weights
4	1.651	1.651	1.651	1.651	SSB weights
5	3.012	3.012	3.012	3.012	SSB weights
6	3.867	3.867	3.867	3.867	SSB weights
7	4.967	4.967	4.967	4.967	SSB weights
8	5.984	5.984	5.984	5.984	SSB weights
9	7.191	7.191	7.191	7.191	SSB weights
10	8.574	8.574	8.574	8.574	SSB weights
11	8.842	8.842	8.842	8.842	SSB weights
12	10.596	10.596	10.596	10.596	SSB weights
13	11.687	11.687	11.687	11.687	SSB weights
14	12.003	12.003	12.003	12.003	SSB weights
3	0.003	0.003	0.003	0.003	Maturity
4	0.036	0.036	0.036	0.036	Maturity
5	0.056	0.056	0.056	0.056	Maturity
6	0.273	0.273	0.273	0.273	Maturity
7	0.784	0.784	0.784	0.784	Maturity
8	0.897	0.897	0.897	0.897	Maturity
9	0.966	0.966	0.966	0.966	Maturity
10	1.000	1.000	1.000	1.000	Maturity
11	1.000	1.000	1.000	1.000	Maturity
12	1.000	1.000	1.000	1.000	Maturity
13	1.000	1.000	1.000	1.000	Maturity
14	1.000	1.000	1.000	1.000	Maturity
3	0.097	0.097	0.097	0.097	Selection
4	0.306	0.306	0.306	0.306	Selection
5	0.514	0.514	0.514	0.514	Selection

6	0.774	0.774	0.774	0.774	Selection
7	0.941	0.941	0.941	0.941	Selection
8	1.175	1.175	1.175	1.175	Selection
9	1.199	1.199	1.199	1.199	Selection
10	1.397	1.397	1.397	1.397	Selection
11	1.823	1.823	1.823	1.823	Selection
12	1.823	1.823	1.823	1.823	Selection
13	1.823	1.823	1.823	1.823	Selection
14	1.823	1.823	1.823	1.823	Selection
3	161.727	141.579	191.744	0.000	Stock numbers
4	103.492	NA	NA	NA	Stock numbers
5	101.592	NA	NA	NA	Stock numbers
6	72.149	NA	NA	NA	Stock numbers
7	28.733	NA	NA	NA	Stock numbers
8	26.194	NA	NA	NA	Stock numbers
9	16.907	NA	NA	NA	Stock numbers
10	6.618	NA	NA	NA	Stock numbers
11	4.792	NA	NA	NA	Stock numbers
12	2.195	NA	NA	NA	Stock numbers
13	0.736	NA	NA	NA	Stock numbers
14	0.266	NA	NA	NA	Stock numbers

Table 9.15. Icelandic cod in Division Va. Output of the deterministic predictions.

Year	B4+	Fmult	Fbar	SSB	Landings	2022 B4+	2022 SSB	SSB change	TAC change
2020	1207.663	NA	NA	NA	NA	NA	NA	NA	NA
2021	1210.903	0.000	0.00	582.191	0.000	1481.452	799.183	0.37	-1.00
NA	NA	0.179	0.06	565.390	54.789	1419.939	730.079	0.29	-0.80
NA	NA	0.209	0.07	562.645	63.611	1410.034	719.230	0.28	-0.77
NA	NA	0.239	0.08	559.915	72.346	1400.225	708.562	0.27	-0.73
NA	NA	0.268	0.09	557.202	80.997	1390.511	698.073	0.25	-0.70

NA	NA	0.298	0.10	554.503	89.563	1380.892	687.759	0.24	-0.67
NA	NA	0.328	0.11	551.819	98.047	1371.365	677.616	0.23	-0.64
NA	NA	0.358	0.12	549.151	106.449	1361.930	667.643	0.22	-0.61
NA	NA	0.388	0.13	546.498	114.770	1352.585	657.835	0.20	-0.58
NA	NA	0.417	0.14	543.860	123.011	1343.331	648.189	0.19	-0.55
NA	NA	0.447	0.15	541.236	131.172	1334.165	638.703	0.18	-0.52
NA	NA	0.477	0.16	538.628	139.256	1325.087	629.374	0.17	-0.49
NA	NA	0.507	0.17	536.034	147.262	1316.095	620.198	0.16	-0.46
NA	NA	0.537	0.18	533.455	155.191	1307.190	611.174	0.15	-0.43
NA	NA	0.566	0.19	530.890	163.045	1298.369	602.298	0.13	-0.40
NA	NA	0.596	0.20	528.339	170.824	1289.631	593.567	0.12	-0.37
NA	NA	0.626	0.21	525.803	178.530	1280.977	584.980	0.11	-0.35
NA	NA	0.656	0.22	523.281	186.162	1272.405	576.533	0.10	-0.32
NA	NA	0.686	0.23	520.774	193.722	1263.913	568.224	0.09	-0.29
NA	NA	0.716	0.24	518.280	201.211	1255.502	560.050	0.08	-0.26
NA	NA	0.745	0.25	515.800	208.630	1247.170	552.009	0.07	-0.24
NA	NA	0.775	0.26	513.334	215.978	1238.916	544.099	0.06	-0.21
NA	NA	0.805	0.27	510.882	223.258	1230.740	536.317	0.05	-0.18
NA	NA	0.835	0.28	508.444	230.469	1222.640	528.662	0.04	-0.16
NA	NA	0.865	0.29	506.019	237.613	1214.616	521.129	0.03	-0.13
NA	NA	0.894	0.30	503.608	244.691	1206.667	513.719	0.02	-0.10
NA	NA	0.924	0.31	501.210	251.702	1198.792	506.427	0.01	-0.08
NA	NA	0.954	0.32	498.825	258.648	1190.990	499.253	0.00	-0.05
NA	NA	0.984	0.33	496.454	265.530	1183.261	492.194	-0.01	-0.03
NA	NA	1.014	0.34	494.096	272.349	1175.603	485.249	-0.02	0.00
NA	NA	1.043	0.35	491.751	279.104	1168.016	478.414	-0.03	0.02
NA	NA	1.073	0.36	489.419	285.797	1160.498	471.689	-0.04	0.05
NA	NA	1.103	0.37	487.100	292.428	1153.051	465.070	-0.05	0.07
NA	NA	1.133	0.38	484.794	298.999	1145.671	458.557	-0.05	0.10
NA	NA	1.163	0.39	482.501	305.509	1138.360	452.148	-0.06	0.12

NA	NA	1.193	0.40	480.221	311.960	1131.115	445.840	-0.07	0.14
NA	NA	1.222	0.41	477.953	318.352	1123.937	439.633	-0.08	0.17
NA	NA	1.252	0.42	475.697	324.686	1116.824	433.523	-0.09	0.19
NA	NA	1.282	0.43	473.455	330.962	1109.776	427.510	-0.10	0.21
NA	NA	1.312	0.44	471.224	337.181	1102.792	421.592	-0.11	0.24
NA	NA	1.342	0.45	469.006	343.344	1095.871	415.766	-0.11	0.26
NA	NA	1.371	0.46	466.800	349.451	1089.014	410.033	-0.12	0.28

Table 9.16. Icelandic cod in Division Va - Alternative assessment (survey indices for age groups 1-14 included in the assessment). Catch (kt), average fishing mortality of age groups 5 to 10, recruitment to the fisheries at age 3 (millions), reference fishing biomass (B4+, kt), spawning stock biomass (kt) at spawning time and harvest ratio.

Year	Yield	F5-10	SSB	Reference biomass	Recruits	Harvest rate
1955	545.250	0.29	945.740	2365.090	151.953	0.23
1956	486.909	0.29	799.496	2089.220	152.745	0.23
1957	455.182	0.31	778.792	1884.870	170.595	0.24
1958	517.359	0.35	877.998	1870.200	220.763	0.28
1959	459.081	0.32	855.290	1831.010	289.038	0.25
1960	470.121	0.37	709.472	1754.390	154.347	0.27
1961	377.291	0.36	467.556	1496.870	192.939	0.25
1962	388.985	0.38	569.080	1492.570	128.944	0.26
1963	408.800	0.46	507.738	1315.460	177.453	0.31
1964	437.012	0.55	450.868	1218.620	203.866	0.36
1965	387.106	0.58	317.438	1021.850	216.288	0.38
1966	353.357	0.59	277.128	1030.980	229.084	0.34
1967	335.721	0.56	256.364	1102.420	320.026	0.30
1968	381.770	0.72	221.450	1222.270	171.781	0.31
1969	403.205	0.56	313.425	1324.760	247.307	0.30
1970	475.077	0.61	330.746	1335.770	180.356	0.36
1971	444.248	0.68	242.244	1096.990	188.456	0.40
1972	395.166	0.69	221.483	996.142	139.124	0.40
1973	369.205	0.71	245.011	842.847	272.788	0.44
1974	368.133	0.76	186.596	917.048	178.958	0.40

1975	364.754	0.81	167.824	894.335		260.850	0.41
1976	346.253	0.75	137.982	954.544		367.502	0.36
1977	340.086	0.60	197.983	1288.670		143.662	0.26
1978	329.602	0.48	211.690	1297.660		226.407	0.25
1979	366.462	0.45	303.616	1395.170		245.552	0.26
1980	432.237	0.49	356.577	1491.710		139.277	0.29
1981	465.032	0.67	259.367	1235.420		140.160	0.38
1982	380.068	0.74	163.687	966.228		131.907	0.39
1983	298.049	0.72	127.027	787.754		231.570	0.38
1984	282.022	0.65	138.132	908.306		138.700	0.31
1985	323.428	0.67	158.828	920.926		141.897	0.35
1986	364.797	0.78	191.973	851.658		332.386	0.43
1987	389.915	0.87	147.248	1033.040		260.165	0.38
1988	377.554	0.90	166.572	1034.900		172.796	0.36
1989	363.125	0.72	169.735	999.590		88.791	0.36
1990	335.316	0.70	208.936	839.261		129.951	0.40
1991	307.759	0.80	164.387	695.352		107.041	0.44
1992	264.834	0.84	151.914	549.378		174.284	0.48
1993	250.704	0.87	120.618	594.217		136.108	0.42
1994	178.138	0.63	156.442	575.717		78.918	0.31
1995	168.592	0.51	176.615	557.719		152.057	0.30
1996	180.701	0.51	158.494	672.673		164.379	0.27
1997	203.112	0.55	187.508	783.490		88.795	0.26
1998	243.987	0.65	198.551	721.894		159.375	0.34
1999	260.147	0.73	180.521	731.123		71.585	0.36
2000	235.092	0.73	170.883	595.844		168.426	0.39
2001	236.702	0.72	169.238	676.913		158.701	0.35
2002	209.544	0.63	196.988	716.524		156.175	0.29
2003	207.246	0.61	188.670	729.980		171.525	0.28
2004	228.342	0.62	192.787	782.923		80.271	0.29

2005	213.867	0.59	221.319	703.044		147.160	0.30
2006	197.202	0.58	212.356	670.294		131.284	0.29
2007	171.646	0.56	194.097	649.986		97.706	0.26
2008	147.676	0.45	243.019	667.316		124.954	0.22
2009	183.320	0.46	221.932	730.067		116.938	0.25
2010	170.025	0.39	250.884	780.632		127.565	0.22
2011	172.218	0.36	306.589	826.377		166.748	0.21
2012	196.171	0.35	340.697	943.245		180.181	0.21
2013	223.582	0.36	365.905	1071.770		131.038	0.21
2014	222.021	0.34	336.773	1092.820		185.631	0.20
2015	230.165	0.31	447.353	1186.120		165.100	0.19
2016	251.219	0.31	394.821	1264.860		110.675	0.20
2017	243.945	0.30	542.291	1213.500		175.665	0.20
2018	267.221	0.31	556.644	1297.770		170.129	0.21
2019	263.022	0.34	515.455	1212.000		129.961	0.22
2020	NA	NA	490.119	1176.540		161.943	NA
2021	NA	NA	NA	NA		141.679	NA
2022	NA	NA	NA	NA		192.375	NA

10 Haddock in 5.a

Because of the Covid-19 outbreak the Ministry of Industries and Innovation in Iceland does not require advice from ICES for Icelandic haddock for 2021. This is done to reduce travelling of Icelandic experts and the workload of both MRFI and ICES (see letter to ICES dated March 12, 2020 in the Introduction chapter).

The assessment of Icelandic summer spawning herring was therefore not presented and discussed during the NWWG in April. Data input tables in the report were updated but not text and figures.

Table 10.1: Haddock in division 5a. Landings by nation.

Year	Belgium	Faroe Islands	Germany	Greenland	Iceland	Norway	Russia	UK
1979	1010	2161			52152	11		
1980	1144	2029			47916	23		
1981	673	1839			61033	15		
1982	377	1982			66998	28		
1983	268	1783			63815	3		
1984	359	707			47167	3		
1985	391	987			49573	0		2
1986	257	1289			47335			
1987	238	1043			39751	1		
1988	352	797			52999	0		
1989	483	606			61715			
1990	595	603			65897			
1991	485	733			53491			
1992	361	757			46067			
1993	458	754			46231			
1994	271	915	1046	2	58677	13	492	173
1995		968	0		60424		2	57
1996		764			56317	4	17	0
1997		340			43717			
1998		513			40882			
1999		885			44523	18		0

Year	Belgium	Faroe Islands	Germany	Greenland	Iceland	Norway	Russia	UK
2000		5			41229	4		1
2001		690			39101	56		
2002		847			49602	8		
2003		968			59991	1		51
2004		1125			83801	1		
2005		1515			95878	3		44
2006		1588			96130	4		
2007		1686		2	108181	11		
2008		1197			101680	11		
2009		824			81439	5		
2010		360			63869	8		
2011		214			49232	3		
2012		325			45711	13		
2013		654			43370	23		
2014		1626			33048	22		
2015		2337			38393	26		
2016		2858			36648	14		
2017		2515			35695	22		
2018		2209			47677	30		
2019		1774			57075	1		

Table 10.2: Haddock in 5a. Number of Icelandic boats and catches by fleet segment participating in the haddock fishery in 5a.

Year	Bottom trawl	Danish seine	Longlines	Bottom trawl	Danish seine	Longlines	Other	Total catch
1993	223	79	130	31192	1308	3832	4068	40400
1994	186	90	163	42057	2861	3833	4743	53494
1995	159	97	140	43851	3766	3965	3543	55125
1996	145	107	146	41049	4887	4767	2410	53113
1997	139	93	157	28545	4706	4848	1770	39869
1998	133	77	200	24820	3162	6451	1595	36028
1999	130	68	222	26314	2213	9130	1041	38698
2000	118	63	223	23000	2533	7576	866	33975
2001	109	63	222	21858	2473	7031	921	32283
2002	101	63	238	29820	3026	9157	1295	43298
2003	101	77	259	36005	4002	12421	1142	53570
2004	104	74	290	50940	7167	16880	1274	76261
2005	103	72	307	52927	9821	23567	1561	87876
2006	91	77	308	46716	11904	28512	760	87892
2007	94	66	283	57009	11875	29814	1204	99902
2008	83	65	266	50572	15554	26064	551	92741
2009	79	65	228	38476	14418	20160	300	73354
2010	68	56	206	28551	9582	17528	872	56533
2011	64	52	203	20443	6337	15365	250	42395
2012	68	48	195	19988	5583	13227	459	39257
2013	69	47	198	18454	4440	13501	201	36596
2014	62	44	207	13043	3304	11489	202	28038
2015	62	41	199	16926	3851	12680	243	33700
2016	62	40	182	16735	3961	11754	87	32537
2017	63	41	164	16081	3982	11536	169	31768
2018	64	39	157	26316	4960	12639	175	44090
2019	61	41	142	35583	5829	12337	267	54016

Table 10.3: Haddock in 5.a. Number of available length measurements and samples from Icelandic commercial catches.

Year	Bottom Trawl	Danish Seine	Gillnets	Long Line	Other
2000	62409/326	3114/21	1353/11	12854/77	356/2
2001	69392/346	3900/24	3023/18	26610/151	3864/19
2002	83052/453	7644/47	2063/17	29578/196	1392/12
2003	70828/419	7066/47	2965/26	30259/203	1713/20
2004	82474/503	10201/74	1705/16	35405/252	785/12
2005	94529/514	14880/102	2426/25	53472/375	1778/18
2006	74451/416	29743/172	3395/35	75069/480	685/5
2007	101635/599	34293/196	3721/30	87705/499	1572/11
2008	82671/524	29062/177	3542/30	88912/570	378/4
2009	55862/347	34904/202	831/7	63816/406	658/6
2010	59118/330	19504/116	827/10	56533/343	229/4
2011	53239/278	8304/53	1350/9	43198/237	325/2
2012	41074/223	10084/59	1508/10	60838/302	3/1
2013	34131/198	2498/23	176/1	43132/237	560/4
2014	13529/79	3128/22	289/6	37035/217	
2015	25969/154	2742/18	125/1	41593/221	
2016	21303/129	2425/17	333/3	37490/202	849/6
2017	23123/144	6305/39	375/2	42360/232	1367/7
2018	21780/134	5611/94	414/29	35621/231	558/3
2019	50698/295	3254/30	431/4	25692/187	567/3

Table 10.4: Haddock in 5.a. Number of available age measurements and samples from Icelandic commercial catches.

Year	Bottom Trawl	Danish Seine	Gillnets	Long Line	Other
2000	62409/326	3114/21	1353/11	12854/77	356/2
2001	69392/346	3900/24	3023/18	26610/151	3864/19
2002	83052/453	7644/47	2063/17	29578/196	1392/12
2003	70828/419	7066/47	2965/26	30259/203	1713/20
2004	82474/503	10201/74	1705/16	35405/252	785/12
2005	94529/514	14880/102	2426/25	53472/375	1778/18
2006	74451/416	29743/172	3395/35	75069/480	685/5
2007	101635/599	34293/196	3721/30	87705/499	1572/11
2008	82671/524	29062/177	3542/30	88912/570	378/4
2009	55862/347	34904/202	831/7	63816/406	658/6
2010	59118/330	19504/116	827/10	56533/343	229/4
2011	53239/278	8304/53	1350/9	43198/237	325/2
2012	41074/223	10084/59	1508/10	60838/302	3/1
2013	34131/198	2498/23	176/1	43132/237	560/4
2014	13529/79	3128/22	289/6	37035/217	
2015	25969/154	2742/18	125/1	41593/221	
2016	21303/129	2425/17	333/3	37490/202	849/6
2017	23123/144	6305/39	375/2	42360/232	1367/7
2018	21780/134	5611/94	414/29	35621/231	558/3
2019	50698/295	3254/30	431/4	25692/187	567/3

Table 10.5: Haddock in 5.a. Catch at age from the commercial fishery in Icelandic waters.

Year	2	3	4	5	6	7	8	9	10
1979	0.149	1.908	3.762	6.057	9.022	1.743	0.438	0.056	0.112
1980	0.595	1.385	11.481	4.298	3.798	3.732	0.544	0.091	0.037
1981	0.010	0.514	4.911	16.9	5.999	2.825	1.803	0.168	0.057
1982	0.107	0.245	3.149	10.851	14.049	2.068	1.00	0.725	0.201
1983	0.034	1.010	1.589	4.596	9.850	8.839	0.766	0.207	0.280
1984	0.241	1.069	4.946	1.341	4.772	3.742	4.076	0.238	0.080
1985	1.320	1.728	4.562	6.796	0.855	1.682	1.914	1.903	0.296
1986	1.012	4.223	4.068	4.686	5.139	0.494	0.796	0.897	0.400
1987	1.939	8.308	6.965	2.728	2.042	1.094	0.132	0.165	0.339
1988	0.237	9.831	15.164	5.824	1.304	1.084	0.609	0.066	0.213
1989	0.188	2.474	22.560	9.571	3.196	0.513	0.556	0.144	0.141
1990	1.857	2.415	8.628	23.611	6.331	0.816	0.150	0.067	0.074
1991	8.617	2.145	5.397	7.342	14.103	2.648	0.338	0.040	0.027
1992	5.405	10.693	5.721	4.610	3.691	5.209	0.999	0.120	0.016
1993	0.769	12.333	12.815	2.968	1.722	1.425	2.239	0.343	0.038
1994	3.198	3.343	28.258	10.682	1.469	0.726	0.358	0.647	0.108
1995	4.015	7.323	5.744	23.927	5.769	0.615	0.290	0.187	0.331
1996	3.090	10.552	7.639	4.468	12.896	2.346	0.208	0.079	0.125
1997	1.364	3.939	10.915	4.895	2.610	5.035	0.719	0.064	0.069
1998	0.279	8.257	5.667	7.856	2.418	1.422	1.897	0.261	0.045
1999	1.434	1.550	17.243	4.516	4.837	0.915	0.620	0.481	0.064
2000	2.659	6.317	2.352	13.615	1.945	1.706	0.324	0.222	0.192
2001	2.515	11.098	6.954	1.446	6.262	0.675	0.478	0.105	0.094
2002	1.082	10.434	15.998	5.099	1.131	3.149	0.262	0.169	0.100
2003	0.401	6.352	16.265	12.548	2.968	0.748	1.236	0.091	0.070
2004	1.597	4.063	17.652	19.358	8.871	1.940	0.471	0.489	0.155
2005	2.405	9.450	6.929	25.421	13.778	4.584	0.809	0.251	0.237
2006	0.241	10.038	21.246	6.646	18.840	7.6	2.180	0.323	0.202
2007	0.782	3.884	42.224	22.239	3.354	9.952	2.740	0.519	0.181

Year	2	3	4	5	6	7	8	9	10
2008	2.316	4.508	9.706	53.022	11.014	1.717	3.033	0.815	0.192
2009	1.066	3.185	4.886	8.892	35.011	5.733	0.726	1.381	0.509
2010	0.121	6.032	7.061	4.806	6.766	17.503	1.874	0.354	0.528
2011	0.253	1.584	11.797	5.080	2.853	3.983	6.220	0.494	0.183
2012	0.196	1.322	3.421	13.107	2.223	1.231	2.480	2.662	0.370
2013	0.250	1.042	2.865	4.008	9.222	1.206	0.668	1.248	1.599
2014	0.238	1.478	1.751	2.725	2.737	4.742	0.447	0.387	1.403
2015	0.232	1.532	4.155	2.317	2.916	2.623	2.715	0.226	0.823
2016	0.481	1.773	3.437	4.130	1.727	1.953	1.420	1.293	0.455
2017	0.573	3.680	3.079	3.013	3.135	1.097	1.182	0.751	0.940
2018	0.353	3.570	10.356	2.908	3.063	2.419	0.964	0.622	1.066
2019	0.387	2.42112	6.437	13.909	1.870	1.366	1.469	0.552	1.108

Table 10.6: Haddock in 5a. Catch weights from the commercial fishery in Icelandic waters.

Year	2	3	4	5	6	7	8	9	10
1979	620	960	1410	2030	2910	3800	4560	4720	5956
1980	837	831	1306	2207	2738	3188	3843	4506	4982.84
1981	584	693	1081	1656	2283	3214	3409	4046	5261.02
1982	289	959	1455	1674	2351	3031	3481	3874	4122.51
1983	320	1006	1496	1921	2371	2873	3678	4265	4501.74
1984	691	1007	1544	2120	2514	3027	2940	3906	4033.31
1985	652	1125	1811	2260	2924	3547	3733	4039	4658.72
1986	336	1227	1780	2431	2771	3689	3820	4258	4455.68
1987	452	1064	1692	2408	3000	3565	4215	4502	4024.82
1988	362	780	1474	2217	2931	3529	3781	4467	4418.39
1989	323	857	1185	1996	2893	4066	3866	4734	4989.60
1990	269	700	1054	1562	2364	3414	4134	4946	4451.01
1991	288	699	979	1412	1887	2674	3135	4341	4956.93
1992	313	806	1167	1524	1950	2357	3075	4053	4703.25
1993	303	705	1333	1875	2386	2996	3059	3363	4408.79
1994	337	668	1019	1717	2391	2717	3280	3156	3277.94
1995	351	746	1096	1318	2044	2893	3049	3675	3136.79
1996	311	787	1187	1560	1849	2670	3510	3567	3731.34
1997	379	764	1163	1649	1943	2342	3020	3337	3235.90
1998	445	724	1147	1683	2250	2475	2834	3333	3596.42
1999	555	908	1101	1658	2216	2659	2928	3209	3512.52
2000	495	978	1333	1481	2119	2696	3307	3597	3756.94
2001	541	945	1456	1731	1832	2243	3020	3328	4235.94
2002	564	928	1253	1737	2219	2230	2911	3365	4387.08
2003	498	922	1283	1704	2274	2744	2635	2819	3741.91
2004	559	1006	1258	1579	2044	2809	3123	2945	3759.31
2005	339	886	1265	1506	1916	2323	3028	3211	2890.52
2006	402	749	1093	1495	1758	2163	2555	3054	3589.48
2007	510	748	988	1346	1840	2062	2350	2525	3142.71

Year	2	3	4	5	6	7	8	9	10
2008	383	636	857	1125	1575	2149	2417	2802	2600.47
2009	452	841	960	1131	1352	1757	2364	2497	3073.67
2010	447	756	1092	1294	1448	1685	2188	2366	2645.85
2011	588	905	1122	1455	1688	1914	2094	2455	2985.68
2012	668	978	1222	1492	1903	2164	2366	2704	2939.96
2013	678	1084	1358	1675	2036	2400	2554	3097	3097.31
2014	536	1080	1433	1793	2121	2504	2624	3178	3349.39
2015	573	1084	1486	2011	2332	2823	3306	3258	3768.15
2016	513	1071	1590	2035	2607	2952	3616	3734	4096.66
2017	643	997	1587	2032	2546	3016	3518	3839	3915.67
2018	627	1070	1383	2007	2536	2919	3377	3671	4026.36
2019	541.285	1005.15	1457.86	1820.85	2702.88	3091.86	3352.01	3694.17	4015.07

Table 10.7: Haddock in 5a. Stock weights from the March survey in Icelandic waters.

Year	1	2	3	4	5	6	7	8	9	10
1979	37	185	481	910	1409	1968	2496	3077	3300	5956.00
1980	37	185	481	910	1409	1968	2496	3077	3300	4982.84
1981	37	185	481	910	1409	1968	2496	3077	3300	5261.02
1982	37	185	481	910	1409	1968	2496	3077	3300	4122.51
1983	37	185	481	910	1409	1968	2496	3077	3300	4501.74
1984	37	185	481	910	1409	1968	2496	3077	3300	4033.31
1985	35	241	562	1195	1690	2418	2814	3245	3369	3901.80
1986	34	240	671	1134	1963	2425	3236	2964	3767	3824.29
1987	31	163	514	1219	1758	2605	3024	3524	3896	3773.70
1988	37	176	456	973	1851	2711	3118	3485	3277	4986.42
1989	27	181	438	888	1514	2372	2905	3509	3255	3748.60
1990	29	183	454	842	1232	1985	2714	3067	3337	4042.05
1991	31	176	496	1004	1417	1890	2510	3833	3719	4545.56
1992	29	157	497	893	1381	1866	2325	3009	3732	4753.75
1993	40	167	381	878	1488	1786	2581	2576	3277	4000.00
1994	33	179	402	704	1267	1721	1866	2628	2050	1844.64
1995	37	163	444	759	1062	1855	2664	5319	1313	4000.00
1996	40	174	447	816	1053	1452	2149	2365	4830	3133.12
1997	51	173	422	815	1223	1422	1883	2373	3771	2877.68
1998	41	201	400	737	1221	1677	1991	2338	3091	4000.00
1999	34	205	481	715	1191	1932	2387	2724	2933	2581.52
2000	29	179	553	897	1152	1694	2601	2910	3162	3370.46
2001	36	188	484	1048	1425	1501	2179	2803	4000	3958.89
2002	63	172	473	892	1467	1957	2017	1962	3756	4357.30
2003	40	231	412	800	1259	1869	3153	2314	3303	3945.97
2004	34	177	557	807	1280	1685	2444	2920	2927	3333.11
2005	41	153	448	921	1188	1564	2103	2792	2548	3633.75
2006	33	135	333	736	1134	1510	1927	2227	3270	3528.55
2007	48	170	350	615	1053	1493	1781	2067	2157	3801.33

Year	1	2	3	4	5	6	7	8	9	10
2008	27	178	383	593	868	1295	1831	2204	2286	2924.73
2009	29	139	442	687	883	1137	1491	1905	2548	2937.31
2010	32	150	392	777	936	1181	1462	1784	2037	2719.15
2011	35	175	443	759	1131	1307	1585	1867	2044	2956.30
2012	28	202	482	801	1145	1480	1908	2072	2352	2520.06
2013	33	202	589	967	1313	1709	2001	2264	2746	2658.79
2014	36	223	573	1005	1373	1751	2141	2299	2653	3134.85
2015	32	254	614	1073	1638	1924	2451	2772	3186	3388.15
2016	29	162	642	1101	1565	2094	2296	3067	3441	3486.42
2017	34	197	459	1258	1657	2162	2768	3200	3558	3675.10
2018	30	195	544	924	1836	2342	2660	2968	3204	3585.57
2019	29	166	505	962	1341	2472	2814	3035	3477	3532.69

Table 10.8: Haddock in 5.a. Sexual maturity-at-age in the stock (from the March survey). The numbers for age 10 only apply to the spawning stock.

Year	1	2	3	4	5	6	7	8	9	10
1979	0.000	0.080	0.301	0.539	0.722	0.821	0.868	0.904	0.963	1.000
1980	0.000	0.080	0.301	0.539	0.722	0.821	0.868	0.904	0.963	1.000
1981	0.000	0.080	0.301	0.539	0.722	0.821	0.868	0.904	0.963	1.000
1982	0.000	0.080	0.301	0.539	0.722	0.821	0.868	0.904	0.963	1.000
1983	0.000	0.080	0.301	0.539	0.722	0.821	0.868	0.904	0.963	1.000
1984	0.000	0.080	0.301	0.539	0.722	0.821	0.868	0.904	0.963	1.000
1985	0.000	0.016	0.149	0.541	0.577	0.767	0.764	0.962	0.933	0.984
1986	0.000	0.022	0.203	0.410	0.672	0.842	0.884	0.956	0.986	0.991
1987	0.000	0.020	0.146	0.487	0.597	0.879	0.900	1.000	0.988	0.968
1988	0.000	0.013	0.215	0.392	0.767	0.791	0.927	0.913	1.000	0.971
1989	0.000	0.040	0.199	0.530	0.723	0.802	1.000	1.000	1.000	1.000
1990	0.000	0.115	0.327	0.632	0.816	0.843	0.918	0.897	1.000	1.000
1991	0.000	0.066	0.219	0.587	0.738	0.818	0.893	0.505	1.000	1.000
1992	0.000	0.050	0.223	0.416	0.801	0.905	0.902	0.859	1.000	1.000
1993	0.005	0.123	0.362	0.484	0.667	0.905	0.977	0.910	0.868	1.000
1994	0.035	0.238	0.325	0.611	0.791	0.865	1.000	0.908	1.000	1.000
1995	0.000	0.130	0.481	0.389	0.757	0.754	0.619	0.986	1.000	1.000
1996	0.000	0.197	0.379	0.606	0.643	0.790	0.745	0.946	0.897	1.000
1997	0.016	0.092	0.432	0.585	0.682	0.751	0.787	0.874	1.000	1.000
1998	0.000	0.030	0.494	0.686	0.778	0.754	0.855	0.901	1.000	1.000
1999	0.000	0.048	0.384	0.679	0.725	0.756	0.896	0.773	0.920	1.000
2000	0.000	0.103	0.247	0.619	0.808	0.875	0.875	1.000	0.781	0.960
2001	0.002	0.097	0.372	0.515	0.752	0.897	0.918	0.915	1.000	1.000
2002	0.000	0.045	0.278	0.629	0.800	0.935	0.933	1.000	1.000	1.000
2003	0.005	0.062	0.347	0.688	0.869	0.923	0.948	0.984	1.000	1.000
2004	0.000	0.038	0.363	0.571	0.831	0.913	1.000	1.000	1.000	1.000
2005	0.000	0.024	0.231	0.564	0.751	0.923	0.937	0.968	1.000	1.000
2006	0.000	0.028	0.118	0.467	0.618	0.741	0.920	1.000	1.000	1.000

Year	1	2	3	4	5	6	7	8	9	10
2007	0.000	0.078	0.207	0.417	0.681	0.760	0.876	0.960	1.000	1.000
2008	0.000	0.027	0.262	0.415	0.621	0.829	0.870	0.904	0.974	1.000
2009	0.000	0.017	0.299	0.469	0.581	0.848	0.890	1.000	0.967	1.000
2010	0.010	0.030	0.183	0.615	0.780	0.789	0.887	0.935	1.000	0.966
2011	0.000	0.046	0.176	0.425	0.822	0.816	0.838	0.898	0.976	1.000
2012	0.000	0.107	0.168	0.446	0.627	0.820	0.903	0.853	0.911	0.973
2013	0.000	0.047	0.225	0.382	0.716	0.795	0.921	0.986	0.974	0.989
2014	0.000	0.108	0.192	0.390	0.567	0.676	0.736	0.925	0.906	0.951
2015	0.000	0.138	0.283	0.444	0.670	0.795	0.773	0.892	1.000	0.961
2016	0.000	0.008	0.360	0.485	0.594	0.779	0.787	0.882	0.902	0.971
2017	0.000	0.073	0.131	0.591	0.664	0.741	0.911	0.939	1.000	0.970
2018	0.000	0.035	0.235	0.395	0.824	0.856	0.892	0.881	0.974	1.000
2019	0.009	0.036	0.335	0.591	0.669	0.890	0.938	0.960	1.000	0.964

Table 10.9: Haddock in division 5.a. Age disaggregated survey indices from the groundfish survey in March.

Year	1	2	3	4	5	6	7	8	9	10
1985	29.91	32.25	17.67	23.26	26.30	3.73	11.01	4.87	5.68	0.63
1986	122.05	109.77	61.10	13.39	16.84	13.57	1.00	3.17	1.27	2.43
1987	21.50	324.64	148.07	44.69	7.77	7.53	4.77	0.40	0.62	1.28
1988	15.71	39.99	184.56	90.07	23.12	1.37	2.23	1.81	0.17	0.26
1989	10.45	23.09	40.59	145.63	45.09	12.92	0.79	0.81	0.42	0.41
1990	72.10	31.55	26.67	38.57	92.00	30.73	3.43	0.88	0.23	0.00
1991	88.43	147.01	42.92	17.86	20.17	32.71	7.64	0.31	0.10	0.09
1992	17.21	211.29	139.98	35.42	16.63	13.63	16.15	2.25	0.18	0.05
1993	30.58	38.93	252.31	88.40	11.35	3.89	1.68	4.51	0.89	0.00
1994	58.68	61.57	40.90	147.33	40.55	5.47	2.82	1.37	3.67	0.22
1995	37.07	84.74	47.12	19.82	69.91	7.71	1.31	0.12	0.34	0.00
1996	96.53	67.19	121.31	36.89	19.78	41.00	5.84	0.60	0.13	0.13
1997	8.41	122.61	51.08	53.11	10.80	7.28	10.85	1.34	0.07	0.09
1998	23.17	18.73	110.23	28.45	23.27	4.89	3.48	4.52	0.34	0.00
1999	80.92	86.14	25.79	98.86	12.99	9.88	1.43	1.78	1.04	0.09
2000	60.41	88.73	43.92	8.33	24.82	3.12	1.58	0.40	0.15	0.56
2001	81.03	153.29	116.21	21.70	4.03	10.45	0.89	0.55	0.00	0.10
2002	20.68	304.47	198.83	110.43	22.88	3.45	7.39	0.30	0.34	0.21
2003	112.29	97.95	283.72	247.05	115.11	18.26	2.60	4.57	0.49	0.91
2004	325.12	291.10	70.86	208.82	110.08	34.24	6.82	1.26	0.83	0.16
2005	57.55	693.57	288.64	44.58	157.39	57.69	15.78	3.36	0.32	0.28
2006	39.87	78.50	575.82	181.71	19.34	63.24	16.54	6.80	0.70	0.29
2007	34.23	65.13	89.00	437.40	85.58	7.84	21.32	4.67	2.13	0.07
2008	88.07	67.69	71.12	75.02	220.74	29.75	3.51	7.42	1.63	0.27
2009	10.87	112.24	53.00	40.53	41.31	104.80	12.76	2.19	3.04	0.65
2010	15.25	27.69	137.03	29.60	18.10	20.48	31.38	2.90	0.46	0.80
2011	8.76	27.46	24.33	76.71	13.95	5.88	9.40	14.89	1.28	0.54
2012	12.33	14.76	31.18	27.15	58.16	5.22	2.92	5.28	6.85	1.05

Year	1	2	3	4	5	6	7	8	9	10
2013	13.93	23.05	19.56	22.61	22.25	41.48	4.76	2.49	3.82	5.16
2014	14.15	24.53	30.15	17.69	16.40	14.76	16.39	1.33	1.04	3.14
2015	62.08	19.53	26.50	34.10	12.62	11.11	9.57	9.85	1.16	1.70
2016	29.85	162.26	23.51	22.09	22.24	7.17	7.27	5.05	4.25	1.39
2017	26.66	66.57	140.89	23.02	20.29	22.05	6.47	5.05	3.53	2.21
2018	64.07	70.39	73.53	118.35	13.70	11.54	10.06	3.41	3.29	2.11
2019	7.14	85.21	47.89	40.85	67.31	4.13	3.80	3.08	1.61	0.86
2020	111.97	13.95	97.24	35.18	27.72	42.48	2.86	1.87	2.17	1.79

Table 10.10: Haddock in 5.a. Age disaggregated survey indices from the groundfish survey in October.

Year	1	2	3	4	5	6	7	8	9	10
1985	29.91	32.25	17.67	23.26	26.30	3.73	11.01	4.87	5.68	0.63
1986	122.05	109.77	61.10	13.39	16.84	13.57	1.00	3.17	1.27	2.43
1987	21.50	324.64	148.07	44.69	7.77	7.53	4.77	0.40	0.62	1.28
1988	15.71	39.99	184.56	90.07	23.12	1.37	2.23	1.81	0.17	0.26
1989	10.45	23.09	40.59	145.63	45.09	12.92	0.79	0.81	0.42	0.41
1990	72.10	31.55	26.67	38.57	92.00	30.73	3.43	0.88	0.23	0.00
1991	88.43	147.01	42.92	17.86	20.17	32.71	7.64	0.31	0.10	0.09
1992	17.21	211.29	139.98	35.42	16.63	13.63	16.15	2.25	0.18	0.05
1993	30.58	38.93	252.31	88.40	11.35	3.89	1.68	4.51	0.89	0.00
1994	58.68	61.57	40.90	147.33	40.55	5.47	2.82	1.37	3.67	0.22
1995	37.07	84.74	47.12	19.82	69.91	7.71	1.31	0.12	0.34	0.00
1996	96.53	67.19	121.31	36.89	19.78	41.00	5.84	0.60	0.13	0.13
1997	8.41	122.61	51.08	53.11	10.80	7.28	10.85	1.34	0.07	0.09
1998	23.17	18.73	110.23	28.45	23.27	4.89	3.48	4.52	0.34	0.00
1999	80.92	86.14	25.79	98.86	12.99	9.88	1.43	1.78	1.04	0.09
2000	60.41	88.73	43.92	8.33	24.82	3.12	1.58	0.40	0.15	0.56
2001	81.03	153.29	116.21	21.70	4.03	10.45	0.89	0.55	0.00	0.10
2002	20.68	304.47	198.83	110.43	22.88	3.45	7.39	0.30	0.34	0.21
2003	112.29	97.95	283.72	247.05	115.11	18.26	2.60	4.57	0.49	0.91
2004	325.12	291.10	70.86	208.82	110.08	34.24	6.82	1.26	0.83	0.16
2005	57.55	693.57	288.64	44.58	157.39	57.69	15.78	3.36	0.32	0.28
2006	39.87	78.50	575.82	181.71	19.34	63.24	16.54	6.80	0.70	0.29
2007	34.23	65.13	89.00	437.40	85.58	7.84	21.32	4.67	2.13	0.07
2008	88.07	67.69	71.12	75.02	220.74	29.75	3.51	7.42	1.63	0.27
2009	10.87	112.24	53.00	40.53	41.31	104.80	12.76	2.19	3.04	0.65
2010	15.25	27.69	137.03	29.60	18.10	20.48	31.38	2.90	0.46	0.80
2011	8.76	27.46	24.33	76.71	13.95	5.88	9.40	14.89	1.28	0.54
2012	12.33	14.76	31.18	27.15	58.16	5.22	2.92	5.28	6.85	1.05
2013	13.93	23.05	19.56	22.61	22.25	41.48	4.76	2.49	3.82	5.16

Year	1	2	3	4	5	6	7	8	9	10
2014	14.15	24.53	30.15	17.69	16.40	14.76	16.39	1.33	1.04	3.14
2015	62.08	19.53	26.50	34.10	12.62	11.11	9.57	9.85	1.16	1.70
2016	29.85	162.26	23.51	22.09	22.24	7.17	7.27	5.05	4.25	1.39
2017	26.66	66.57	140.89	23.02	20.29	22.05	6.47	5.05	3.53	2.21
2018	64.07	70.39	73.53	118.35	13.70	11.54	10.06	3.41	3.29	2.11
2019	7.14	85.21	47.89	40.85	67.31	4.13	3.80	3.08	1.61	0.86
2020	111.97	13.95	97.24	35.18	27.72	42.48	2.86	1.87	2.17	1.79

Table 10.11: Haddock in 5.a. ICES advice and official landings. All weights are in tonnes. * Calendar year. ** January to August.

Year	ICES advice	Predicted catch corresp. to advice	Agreed TAC	ICES landings for the fishing year	ICES landings for the calendar year
1987*	National advice	< 50000	60000		40760
1988*	National advice	< 60000	65000		54204
1989*	National advice	< 60000	65000		62885
1990*	National advice	< 60000	65000		67198
1991**	National advice	< 38000	48000		54692
1991/1992	National advice	< 50000	50000	48123	47121
1992/1993	National advice	< 60000	65000	47255	48123
1993/1994	National advice	< 65000	65000	58443	59502
1994/1995	National advice	< 65000	65000	60829	60884
1995/1996	National advice	< 55000	60000	53972	56890
1996/1997	National advice	< 40000	45000	49764	43764
1997/1998	National advice	< 40000	45000	37811	41192
1998/1999	National advice	< 35000	35000	45146	45411
1999/2000	F reduced below F_{med}	< 35000	35000	41150	42105
2000/2001	F reduced below provisional F_{pa}	< 31000	30000	39143	39654
2001/2002	F reduced below provisional F_{pa}	< 30000	41000	41069	50498
2002/2003	F reduced below provisional F_{pa}	< 55000	55000	55269	60883
2003/2004	F reduced below provisional F_{pa}	< 75000	75000	77916	84828
2004/2005	F reduced below provisional F_{pa}	< 97000	90000	96617	97225
2005/2006	F reduced below provisional F_{pa}	< 110000	105000	99926	97614
2006/2007	F reduced below provisional F_{pa}	< 112000	105000	99763	109966
2007/2008	F reduced below provisional F_{pa}	< 120000	100000	109810	102872
2008/2009	F reduced below 0.35	< 83000	93000	88617	82045
2009/2010	F reduced below 0.35	< 57000	63000	67579	64169

2010/2011	F reduced below 0.35	< 51000	50000	50042	49433
2011/2012	F reduced below 0.35	< 42000	45000	49179	46208
2012/2013	F reduced below 0.35	< 32000	36000	40512	44097
2013/2014	TAC 0.4 × B45+cm,2014	< 38000	38000	39628	33900
2014/2015	TAC 0.4 × B45+cm,2015	< 30400	30400	36656	39646
2015/2016	TAC 0.4 × B45+cm,2016	< 36400	36400	40117	38109
2016/2017	TAC 0.4 × B45+cm,2017	< 34600	34600	36340	37062
2017/2018	TAC 0.4 × B45+cm,2018	< 41390	41390	44905	49993
2018/2019	TAC 0.4 × B45+cm,2019	< 57982	57982	59382	58850
2019/2020	TAC 0.35 x B45+cm,2020	< 41823	41823		

11 Icelandic summer spawning herring

Because of the Covid-19 outbreak the Ministry of Industries and Innovation in Iceland does not require advice from ICES for Icelandic summer spawning herring for 2021. This is done to reduce travelling of Icelandic experts and the workload of both MRFI and ICES (see letter to ICES dated March 12, 2020 in the Introduction chapter).

The assessment of Icelandic summer spawning herring was therefore not presented and discussed during the NWWG in April. Data input tables in the report were updated but not text and figures.

Tables

Table 11.1.1.1. Icelandic summer-spawning herring. Acoustic estimates (in millions) in the winters 1973/74-2019/20 (age refers to the autumns). No surveys (and gaps in the time-series) were in 1976/77, 1982/83, 1986/87, 1994/95.

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
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
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
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
1995/96	216.991	133.810	761.581	277.893	385.027	176.906	98.150	48.503	16.226	29.390	47.945	4.476	0.000	0.000	2197
1996/97	33.363	270.706	133.667	468.678	269.888	325.664	217.421	92.979	55.494	39.048	30.028	53.216	18.838	12.612	2022
1997/98	291.884	601.783	81.055	57.366	287.046	155.998	203.382	105.730	35.469	27.373	14.234	36.500	14.235	11.570	1924
1998/99	100.426	255.937	1081.504	103.344	51.786	135.246	70.514	101.626	53.935	17.414	13.636	2.642	4.209	8.775	2001
1999/00	516.153	839.491	239.064	605.858	88.214	43.353	165.716	89.916	121.345	77.600	21.542	3.740	11.149	0.000	2823
2000/01	190.281	966.960	1316.413	191.001	482.418	34.377	15.727	37.940	14.320	15.413	14.668	1.705	3.259	0.000	3284
2001/02	1047.643	287.004	217.441	260.497	161.049	345.852	62.451	57.105	38.405	46.044	38.114	21.062	3.663	0.000	2586

Year\age	2	3	4	5	6	7	8	9	10	11	12	13	14	15+	Total
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
2015/16	381.900	164.221	174.507	312.350	225.836	215.207	93.743	62.753	75.339	41.961	15.696	26.756	20.159	5.401	1816
2016/17	97.036	220.642	137.217	151.937	262.488	136.801	241.382	61.220	55.869	62.805	11.435	20.135	13.733	0.313	1473
2017/18	32.749	22.947	95.097	171.664	201.944	319.933	209.174	255.348	75.813	34.505	83.460	54.903	25.370	28.115	1611
2018/19	306.295	137.402	67.933	201.362	101.946	110.810	167.397	163.804	73.346	30.040	29.950	38.499	9.138	7.271	1445
2019/20	1525	229.841	158.605	103.631	211.106	98.785	53.723	59.527	42.221	37.186	21.341	15.089	10.393	0.986	2568

Table 11.1.1.2. Icelandic summers-spawning herring. Number of fish aged (number of scales) and number of samples taken in the annual acoustic surveys in the seasons 1987/88-2019/20 (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.

Year	Number of scales															N of samples		
age	2	3	4	5	6	7	8	9	10	11	12	13	14	15+	Total	Totall	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
2015/16	229	112	131	208	148	123	47	32	32	22	13	7	12	4	1120	14	7	7§
2016/17	66	164	122	137	202	117	169	43	50	44	14	15	9	4	1162	14	12	2
2017/18	35	58	82	77	75	101	65	77	29	11	27	18	8	9	672	10	5	5
2018/19	28	39	31	98	50	53	77	75	36	15	15	21	5	4	547	7	5	2
2019/20	265	143	94	48	101	60	43	54	45	43	27	26	20	6	975	10	5	5

***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.

§Three samples were taken in the east and south in this survey (B1-2016), while four were taken in the west and used also in the age-length key.

Table 11.2.1. Icelandic summer spawners. Landings, catches, recommended TACs, and set National TACs (both covering 1 Sept. to 31 August following year) in thousand tonnes.

Year	Landings	Catches	Recom. TACs	Nat. TACs
1972	0.31	0.31		
1973	0.254	0.254		
1974	1.275	1.275		
1975	13.28	13.28		
1976	17.168	17.168		
1977	28.925	28.925		
1978	37.333	37.333		
1979	45.072	45.072		
1980	53.268	53.268		
1981	39.544	39.544		
1982	56.528	56.528		
1983	58.867	58.867		
1984	50.304	50.304		
1985	49.368	49.368	50	50
1986	65.5	65.5	65	65
1987	75	75.4	70	73
1988	92.8	92.8	90	90
1989	97.3	101.0	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	132.0	134.0	120	120
1995/1996	125.9	125.9	110	110
1996/1997	95.9	95.9	100	100
1997/1998	64.7	64.9	100	100
1998/1999**	87.2	87.2	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*	96.2	96.2	105	105
2003/2004*	125.7	125.7	110	110
2004/2005	114.2	114.2	110	110
2005/2006	103.0	103.0	110	110
2006/2007	135.3	135.3	130	130
2007/2008	158.9	158.9	130	150
2008/2009	151.8	151.8	130	150
2009/2010	46.3	46.3	40	47
2010/2011	43.5	43.5	40	40
2011/2012[‡]	49.4	49.4	40	45
2012/2013[‡]	72.0	72.0	67	68.5
2013/2014[‡]	72.1	72.1	87	87
2014/2015[‡§]	95.0	95.0	83	83
2015/2016[‡]	69.7	69.7	71	71
2016/2017[‡]	60.4	60.4	63	63
2017/2018[‡]	35.0	35.0	39	39
2018/2019[‡]	40.7	40.7	35.1	35.1
2019/2020[‡]	30.0	30.0	34.6	34.6
2020/2021			35.5	35.5

***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. 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	64.931
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	87.238
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	96.208
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	125.717
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	71.976
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
2015	0.089	6.024	29.89	53.573	43.501	43.015	15.533	10.76	8.664	8.161	6.981	2.726	2.467	1.587	69.729
2016	0.072	10.740	25.575	29.908	41.952	25.823	24.925	9.516	7.734	6.088	4.284	7.154	3.108	0.827	60.403
2017	1.262	5.236	31.855	18.113	10.239	15.506	10.223	8.830	5.676	3.399	1.616	2.220	1.533	1.596	35.034
2018	0.000	8.911	19.642	34.284	16.847	12.376	17.161	6.978	7.379	3.482	1.713	1.153	2.159	0.489	40.683
2019	0.461	4.601	15.845	12.970	16.084	12.244	6.944	9.531	6.167	4.732	2.983	2.808	2.200	1.866	30.038

*** Includes both the landings (73.4 kt) and the herring that died in the mass mortality (52.0 kt) in the winter 2012/13 in Kolgrafafjörður.**

Table 11.2.2.2. 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
2015	107	203	249	275	299	313	329	347	352	358	361	368	380	378
2016	129	202	242	281	303	322	336	355	359	368	369	379	386	402
2017	95	192	252	281	303	324	341	350	367	376	384	389	395	402
2018		191	252	293	317	333	347	350	366	375	389	388	392	383
2019	103	175	244	282	305	308	328	340	349	357	360	366	374	374

Table 11.2.2.3. 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
1986-2019	0	0.2	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 for the different years (refers to the autumn) where the deviation from the fixed M=0.1 is due to the *Ichthyophonus* infection (1981 refers to season 1981/1982 etc). The estimate of, for example, M for age 4 in 2018 represents estimated infection rate of age 3 in 2017.

Year\age	3	4	5	6	7	8	9	10	11	12	13	14	15	13+
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*	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22
2010*	0.29	0.29	0.28	0.26	0.25	0.24	0.24	0.24	0.23	0.23	0.23	0.23	0.23	0.23
2011*	0.13	0.26	0.26	0.25	0.23	0.24	0.25	0.24	0.20	0.21	0.21	0.21	0.21	0.21
2012-2016	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
2017**	0.111	0.118	0.124	0.173	0.175	0.175	0.207	0.187	0.256	0.279	0.210	0.180	0.191	0.183
2018**	0.116	0.112	0.172	0.162	0.175	0.228	0.226	0.247	0.275	0.338	0.307	0.184	0.186	0.250
2019**	0.111	0.135	0.144	0.168	0.216	0.169	0.171	0.183	0.245	0.189	0.243	0.182	0.140	0.189
2020***	0.110	0.116	0.152	0.186	0.158	0.154	0.196	0.195	0.238	0.226	0.179	0.225	0.308	0.235

*** Based on prevalence of infection estimates and acoustic measurements ($M_{infected}$ multiplied by 0.3 and added to 0.1; Óskarsson et al. 2018b).**
**** Based on prevalence of infection estimates in the winter 2016/17, 2017/18, 2018/19 (multiplied by 0.3 and added to 0.1; Óskarsson and Pálsson 2017; 2018; 2019).**
***** Based on prevalence of infection estimates in the winter 2019/20 (multiplied by 0.3 and added to 0.1) and should by applied in the prognosis in the 2020 assessment.**

Table 11.3.2.2. Model settings and results of model parameters from NFT-Adapt run in 2020 for Icelandic summer spawning herring.

```
VPA Version 3.3.0

 Model ID: Final run 2020
 Input File: C:\HAFRONET_GOGN\NWWG OG UTTEKTIR\NWWG2020\RUN1\RUN1.DAT
 Date of Run: 17-APR-2020                         Time of Run: 13:57


 Levenburg-Marquardt Algorithm Completed     5 Iterations
 Residual Sum of Squares =     57.1711

 Number of Residuals     =    256
 Number of Parameters    =      9
 Degrees of Freedom      =    247
 Mean Squared Residual   =     0.231462
 Standard Deviation      =     0.481105


 Number of Years =    33
 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 (2020)
 Age    Stock Predicted     Std. Error      CV

   4         227635.383   0.111347E+06   0.489146E+00
   5         114512.644   0.419559E+05   0.366386E+00
   6          35276.924   0.126362E+05   0.358199E+00
   7          86701.068   0.267123E+05   0.308096E+00
   8          50162.555   0.148560E+05   0.296158E+00
   9          37523.096   0.103559E+05   0.275988E+00
  10          54268.825   0.143971E+05   0.265292E+00
  11          42393.945   0.106972E+05   0.252328E+00
  12          44650.752   0.123525E+05   0.276647E+00

 Catchability Values for Each Survey Used in Estimate
 INDEX     Catchability    Std. Error      CV

   1       0.100969E+01   0.930178E-01   0.921252E-01
   2       0.128594E+01   0.106942E+00   0.831620E-01
   3       0.140231E+01   0.892475E-01   0.636431E-01
   4       0.148639E+01   0.968623E-01   0.651663E-01
   5       0.159025E+01   0.118133E+00   0.742861E-01
   6       0.177578E+01   0.144510E+00   0.813783E-01
   7       0.183505E+01   0.194530E+00   0.106008E+00
   8       0.172448E+01   0.188418E+00   0.109261E+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 2020
  =  Geometric Mean of First Age Populations
     Year Range Applied =  1991 to  2013
- Survey Weight Factors Were Used

Stock Estimates for Age 4 to Age 12

Full F in Terminal Year               =   0.1666

F in Oldest True Age in Terminal Year =   0.1298

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  Calc Partial   Fishing     Used In
     Recruitment    Recruitment    Mortality   Full F    Comments

  3      0.500          0.065       0.0189      NO      Stock Estimate in T+1
  4      0.800          0.414       0.1214      NO      Stock Estimate in T+1
  5      1.000          1.000       0.2931      YES     Stock Estimate in T+1
  6      1.000          0.536       0.1570      YES     Stock Estimate in T+1
  7      1.000          0.672       0.1971      YES     Stock Estimate in T+1
  8      1.000          0.534       0.1566      YES     Stock Estimate in T+1
  9      1.000          0.508       0.1490      YES     Stock Estimate in T+1
 10      1.000          0.424       0.1242      YES     Stock Estimate in T+1
 11      1.000          0.304       0.0893      YES     Stock Estimate in T+1
 12      1.000          0.443       0.1298              F-Oldest
```

Table 11.3.2.3. Icelandic summer spawners stock estimates (from NFT-Adapt in 2020) in numbers (millions) by age (years) at January 1st during 1987-2020.

Year\age	3	4	5	6	7	8	9	10	11	12	13+	Total
1987	529.83	988.97	300.67	84.60	69.14	107.46	42.63	38.03	26.41	34.26	34.29	2256
1988	271.00	476.42	852.47	214.85	56.99	43.83	53.49	24.15	21.19	14.26	36.99	2066
1989	447.33	240.69	391.82	676.97	128.70	29.84	20.62	18.03	10.18	9.48	26.10	2000
1990	300.83	383.26	192.47	280.67	433.68	75.61	19.30	13.07	9.41	4.69	26.46	1739
1991	840.57	258.05	292.67	140.37	178.35	243.51	39.78	9.72	7.68	5.31	24.86	2041
1992	1033.13	676.34	186.92	183.02	94.01	109.04	116.17	26.44	4.86	4.36	24.19	2458
1993	635.47	844.70	495.59	132.71	110.07	58.60	62.27	54.88	12.96	2.77	23.67	2434
1994	691.76	526.40	595.62	360.46	100.34	72.51	40.39	37.75	35.19	7.69	22.92	2491
1995	202.73	498.18	368.81	403.42	243.44	67.16	46.36	21.12	19.31	17.95	23.14	1912
1996	181.41	163.50	320.65	251.32	261.54	147.51	40.53	27.52	11.03	8.38	27.53	1441
1997	772.64	148.98	109.71	208.42	162.05	156.43	95.86	22.71	16.93	4.46	22.16	1720
1998	320.55	661.82	106.20	74.31	153.71	114.64	112.11	65.61	12.47	12.10	10.03	1644
1999	552.79	246.94	432.40	74.56	59.06	100.30	79.12	71.06	45.47	9.27	13.41	1684
2000	391.62	446.69	171.47	257.73	52.20	40.63	60.93	52.77	43.42	29.19	11.68	1558
2001	469.14	299.96	275.02	108.43	160.58	36.28	28.89	39.62	38.38	28.54	25.27	1510
2002	1458.58	384.30	189.49	160.18	69.35	93.67	22.99	17.84	24.24	25.33	32.48	2478
2003	1077.89	1242.93	280.53	128.19	93.58	42.65	44.85	11.44	11.68	15.75	25.71	2975
2004	667.12	774.60	853.31	198.69	89.45	60.41	25.13	30.20	8.24	7.32	28.29	2743
2005	994.44	543.45	568.44	599.00	141.36	67.90	45.79	17.27	20.66	4.49	24.08	3027
2006	742.30	875.01	451.72	402.46	415.40	101.75	49.98	32.70	10.72	13.85	20.52	3116
2007	666.62	559.14	585.29	356.68	318.28	321.51	79.15	39.53	25.51	8.85	26.70	2987
2008	532.34	514.21	427.87	377.91	262.40	203.04	202.34	49.41	24.62	16.11	21.48	2632
2009	450.12	444.79	378.96	311.47	239.90	180.84	124.77	131.56	27.54	14.47	22.98	2327
2010	469.30	342.77	326.54	276.51	233.87	172.79	136.24	92.20	97.36	20.17	27.90	2196
2011	601.03	342.85	236.48	222.00	192.18	169.47	120.05	98.19	65.97	69.31	34.53	2152
2012	389.92	519.00	243.09	165.52	152.82	131.39	121.42	78.87	68.53	47.04	75.07	1993
2013	464.95	335.87	384.72	171.32	108.91	89.74	79.23	77.01	45.58	38.38	80.25	1876
2014	212.64	376.20	280.31	314.79	138.63	80.94	63.14	51.00	54.55	26.28	79.78	1678
2015	207.92	189.04	289.85	205.60	218.38	92.82	52.30	36.17	33.54	32.53	79.79	1438
2016	272.03	182.41	142.67	211.42	144.76	156.78	69.24	37.11	24.51	22.60	88.56	1352
2017	96.93	235.94	140.76	100.72	151.48	106.47	118.20	53.61	26.24	16.40	85.99	1133
2018	175.61	81.80	179.71	107.36	75.35	113.00	80.04	88.16	39.32	17.34	77.06	1035
2019	259.22	147.98	54.62	120.00	75.82	51.96	74.74	57.64	62.37	26.85	67.61	999
2020	678.00	227.64	114.51	35.28	86.70	50.16	37.52	54.27	42.39	44.65	69.20	1330

Table 11.3.2.4. Estimated fishing mortality at age of Icelandic summer-spawning herring (from NFT-Adapt in 2020) by age (years) during 1987-2019 (referring to the autumn of the fishing season) and weighed average F by numbers for age 5-10.

Year\age	3	4	5	6	7	8	9	10	11	12	13+	WF5-10
1987	0.0063	0.0485	0.2361	0.2951	0.3557	0.5977	0.4684	0.4849	0.5164	0.5169	0.5169	0.347
1988	0.0186	0.0955	0.1305	0.4124	0.5471	0.654	0.9877	0.7636	0.7039	0.7773	0.5064	0.266
1989	0.0546	0.1236	0.2336	0.3453	0.4319	0.3355	0.3561	0.5502	0.6744	0.4791	0.1105	0.322
1990	0.0534	0.1697	0.2156	0.3534	0.4772	0.5422	0.5861	0.4312	0.4715	0.5078	0.071	0.400
1991	0.1174	0.2225	0.3694	0.3009	0.3921	0.6401	0.3086	0.5924	0.4662	0.5018	0.0553	0.436
1992	0.1014	0.211	0.2425	0.4085	0.3727	0.4602	0.6498	0.6133	0.4648	0.547	0.0233	0.415
1993	0.0883	0.2494	0.2184	0.1796	0.3174	0.2721	0.4004	0.3445	0.4214	0.3596	0.0114	0.248
1994	0.2283	0.2558	0.2896	0.2925	0.3014	0.3473	0.5484	0.5706	0.5733	0.5099	0.0898	0.312
1995	0.1151	0.3406	0.2836	0.3334	0.401	0.4051	0.4214	0.55	0.7345	0.5278	0.154	0.343
1996	0.097	0.299	0.3308	0.3388	0.414	0.331	0.4794	0.3863	0.8041	0.5002	0.3495	0.361
1997	0.0548	0.2385	0.2895	0.2045	0.2461	0.2332	0.2792	0.4995	0.2353	0.3118	1.0422	0.250
1998	0.1609	0.3257	0.2537	0.1297	0.3269	0.2709	0.356	0.2667	0.1967	0.2725	0.582	0.280
1999	0.1131	0.2647	0.4174	0.2566	0.2741	0.3984	0.305	0.3927	0.3433	0.3598	0.734	0.377
2000	0.1666	0.385	0.3583	0.3731	0.2639	0.2409	0.3306	0.2185	0.3196	0.2774	0.6987	0.335
2001	0.0995	0.3593	0.4406	0.3469	0.439	0.3562	0.3823	0.3912	0.3155	0.3613	0.456	0.414
2002	0.06	0.2147	0.2908	0.4374	0.3862	0.6366	0.5975	0.3237	0.3311	0.4722	0.9452	0.417
2003	0.2304	0.2761	0.245	0.2599	0.3377	0.4288	0.2955	0.2286	0.3671	0.33	0.2543	0.279
2004	0.105	0.2095	0.2539	0.2404	0.1756	0.177	0.2753	0.2794	0.508	0.3099	0.2864	0.244
2005	0.028	0.0849	0.2453	0.266	0.2288	0.2064	0.2367	0.3766	0.3005	0.28	0.2221	0.252
2006	0.1834	0.3021	0.1362	0.1347	0.1562	0.1512	0.1345	0.1485	0.0921	0.1316	0.1663	0.143
2007	0.1596	0.1676	0.3374	0.207	0.3495	0.3631	0.3711	0.3734	0.3596	0.3668	0.4163	0.320
2008	0.0797	0.2052	0.2175	0.3544	0.2723	0.3869	0.3305	0.4845	0.4314	0.4084	0.3804	0.307
2009	0.0555	0.0921	0.0982	0.0695	0.1111	0.0662	0.0856	0.0841	0.0946	0.0826	0.0738	0.087
2010	0.022	0.0792	0.1089	0.1048	0.0721	0.1202	0.0865	0.0967	0.1078	0.1028	0.0982	0.099
2011	0.0167	0.0849	0.1008	0.1234	0.1483	0.0954	0.1731	0.1217	0.1362	0.1316	0.0953	0.124
2012*	0.0492	0.1994	0.2499	0.3185	0.4323	0.4058	0.3553	0.4482	0.4797	0.4223	0.2606	0.349
2013	0.1118	0.0808	0.1006	0.1117	0.1968	0.2515	0.3405	0.2449	0.4509	0.322	0.285	0.162
2014	0.0176	0.1608	0.21	0.2657	0.3012	0.3367	0.4573	0.3192	0.417	0.3826	0.1271	0.276
2015	0.0309	0.1814	0.2155	0.2509	0.2314	0.1931	0.243	0.2892	0.2945	0.255	0.0934	0.230
2016	0.0424	0.1592	0.2482	0.2333	0.2072	0.1825	0.1558	0.2466	0.3017	0.2216	0.1409	0.214
2017	0.0587	0.1542	0.1469	0.1171	0.1181	0.1104	0.0862	0.1231	0.1582	0.1195	0.0708	0.118
2018	0.0552	0.2919	0.2319	0.1858	0.1966	0.1854	0.1023	0.099	0.1065	0.1233	0.0573	0.178
2019	0.0189	0.1214	0.2931	0.157	0.1971	0.1566	0.149	0.1242	0.0893	0.1298	0.1181	0.175

*** Derived from both the landings (WF_{5-10} ~0.209) and the herring that died in the mass mortality (0.148) in the winter 2012/13 in Kolgrafafjörður (Óskarsson et al. 2018a). WF5-10 without the mass mortality was 0.214.**

Table 11.3.2.5. Summary table from NFT-Adapt run in 2020 for Icelandic summer spawning herring

Year	Recruits, age 3 (millions)	Biomass age 3+ (kt)	Biomass age 4+ (kt)	SSB (kt)	Landings age 3+ (kt)	Yield/SSB	$WF_{age\ 5\text{-}10}$	HR 4+
1987	530	504	415	384	75	0.20	0.35	0.182
1988	271	495	452	423	93	0.22	0.27	0.205
1989	447	459	401	386	101	0.26	0.32	0.251
1990	301	410	371	350	104	0.30	0.40	0.281
1991	841	424	310	310	107	0.34	0.44	0.344
1992	1033	502	349	343	107	0.31	0.42	0.307
1993	635	546	454	424	103	0.24	0.25	0.226
1994	692	553	461	441	134	0.30	0.31	0.290
1995	203	462	435	406	125	0.31	0.34	0.288
1996	181	348	322	307	96	0.31	0.36	0.297
1997	773	368	267	269	65	0.24	0.25	0.243
1998	321	366	323	298	86	0.29	0.28	0.266
1999	553	373	297	290	93	0.32	0.38	0.312
2000	392	387	324	306	100	0.33	0.33	0.308
2001	469	348	283	272	94	0.34	0.41	0.331
2002	1459	513	278	298	96	0.32	0.42	0.345
2003	1078	580	412	390	129	0.33	0.28	0.313
2004	667	617	518	488	112	0.23	0.24	0.217
2005	994	708	539	528	102	0.19	0.25	0.190
2006	742	790	649	615	130	0.21	0.14	0.200
2007	667	704	599	572	158	0.28	0.32	0.264
2008	532	691	599	570	151	0.26	0.31	0.252
2009	450	636	551	495	46	0.09	0.09	0.083
2010	469	610	514	457	43	0.09	0.10	0.084
2011	601	594	482	437	49	0.11	0.12	0.102
2012*	390	557	476	450	125	0.28	0.35	0.263
2013	465	502	417	401	71	0.18	0.16	0.171
2014	213	492	449	421	95	0.23	0.28	0.212
2015	208	414	372	355	70	0.20	0.23	0.188
2016	272	392	337	324	60	0.19	0.21	0.179
2017	97	343	325	294	35	0.12	0.12	0.107
2018	176	317	283	259	41	0.16	0.18	0.144
2019	259	276	231	215	30	0.14	0.18	0.130
2020**	678§	363	237	219				
Mean	535	500	415	393	94	0.24	0.28	0.23

*** The mass mortality of 52 thousand tons in Kolgrafafjörður in the winter 2012/13 is not included in the landings, yield/SSB, or WF, even if included as landings in the analytical assessment.**

§ Number at age 3 in 2020 is predicted from a survey index of number at age 1 in 2018 (see section 11.6.1).

**** SSB in 2020 accounts for the estimated *Ichthyophonus* mortality in 2020.**

Table 11.3.2.6. The residuals from survey observations and NFT-Adapt 2020 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	-0.181	-0.245	0.022	-0.394	-0.762	-0.299	-0.188	-0.438
1989	-0.188	-0.772	-0.912	-0.015	-0.021	-0.004	0.000	0.000
1990	0.527	-0.322	-0.345	-0.084	0.402	-0.435	-0.001	-0.002
1991	-0.678	-0.375	-0.735	-0.328	0.284	0.116	0.007	-0.003
1992	0.430	0.389	0.220	-0.442	-0.226	0.219	-0.824	0.002
1993	-0.026	0.135	-0.159	-0.224	-0.543	-0.138	-0.041	0.094
1994	-0.051	0.142	-0.018	-0.801	-0.682	0.392	-0.349	-0.517
1995								
1996	-0.210	0.614	-0.238	-0.010	-0.282	0.310	-0.040	-0.159
1997	0.588	-0.054	0.472	0.114	0.269	0.245	0.803	0.643
1998	-0.105	-0.522	-0.597	0.228	-0.156	0.021	-0.130	0.501
1999	0.026	0.665	-0.012	-0.528	-0.165	-0.689	-0.249	-0.374
2000	0.621	0.081	0.517	0.128	-0.399	0.426	-0.074	0.483
2001	1.161	1.314	0.228	0.704	-0.518	-1.182	-0.650	-1.531
2002	-0.302	-0.114	0.148	0.446	0.842	0.425	0.557	-0.085
2003	0.425	0.427	0.135	0.635	0.814	1.244	1.553	0.861
2004	0.607	0.629	0.172	-0.197	0.048	-0.143	-0.195	-0.007
2005	0.263	0.335	0.220	-0.204	-0.548	-0.607	-1.063	-0.398
2006	-0.688	-0.521	0.372	0.682	0.554	0.320	0.770	1.378
2007	0.074	0.342	-0.198	-0.108	0.305	-0.381	0.534	0.103
2008	-0.128	-0.643	0.022	-0.231	0.221	0.671	0.894	1.752
2009	-0.828	-0.156	-0.416	0.250	-0.074	0.019	-0.357	-0.462
2010	-0.091	0.156	0.358	-0.247	0.175	-0.484	-0.702	-0.068
2011	-0.210	-0.284	-0.021	0.036	-0.664	0.346	-1.083	0.217
2012	0.623	0.330	0.301	0.181	0.136	-0.333	0.190	-0.334
2013	0.834	0.244	-0.366	-0.243	-0.005	-0.245	-0.376	-0.056
2014	-0.188	-0.500	-0.247	-0.307	0.031	0.074	0.235	-0.049
2015	-0.749	-0.121	-0.100	-0.225	0.241	0.187	0.323	-0.424
2016	-0.115	-0.050	0.052	0.048	-0.147	-0.271	-0.082	0.578
2017	-0.077	-0.277	0.073	0.153	-0.213	0.140	-0.474	0.211
2018	-1.281	-0.888	0.131	0.589	0.577	0.386	0.456	0.112
2019	-0.084	-0.033	0.180	-0.100	0.293	0.232	0.437	-0.383
2020	0.000	0.074	0.739	0.494	0.214	-0.215	-0.515	-0.549
Max. Residuals	1.161	1.314	0.517	0.704	0.842	1.244	1.553	1.752

Table 11.6.1.1. The input data used for prognosis of the Icelandic summer-spawning herring in the 2020 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	1 January 2020
3 (2017)	0.170	0.11	0.200	0.306	0.000	0.500	678.0
4 (2016)	0.226	0.12	0.850	0.692	0.000	0.500	227.6
5 (2015)	0.280	0.15	1.000	1.000	0.000	0.500	114.5
6 (2014)	0.309	0.19	1.000	1.000	0.000	0.500	35.3
7 (2013)	0.327	0.16	1.000	1.000	0.000	0.500	86.7
8 (2012)	0.330	0.15	1.000	1.000	0.000	0.500	50.2
9 (2011)	0.345	0.20	1.000	1.000	0.000	0.500	37.5
10 (2010)	0.355	0.19	1.000	1.000	0.000	0.500	54.3
11 (2009)	0.362	0.24	1.000	1.000	0.000	0.500	42.4
12 (2008)	0.368	0.23	1.000	1.000	0.000	0.500	44.7
13+ (2007+)	0.370	0.24	1.000	1.000	0.000	0.500	69.2

Table 11.6.2.1. Icelandic summer-spawning herring. Catch options table for the 2020/2021 season according to the Management plan where the basis is: SSB (1st July 2020) 219 kt (accounted for $M_{infection}$ in 2019); Biomass age 4+ (1st Jan. 2020) is 237 kt; Catch (2019/20) 30 kt; HR (2019) 0.144, and WF_{5-10} (2019) 0.175. Other options are also shown, including MSY approach, where SSB_{2019} < MSY $B_{trigger}$=273 kt, hence resulting F is $F_{MSY} \times SSB_{2020}/B_{trigger} = 0.22 \times 219/273 = 0.176$.

Rationale	Catches 2020/21	Basis	F (2020/2021)	Biomass of age 4+ (2021)	SSB 2021	%SSB change *	% TAC change **
Management plan	**35.5**	**HR =0.15**	**0.171**	**290**	**276**	**26**	**3**
MSY approach	36.6	F_{MSY}	0.176	289	275	26	6
Zero catch	0.0	F=0	0.000	324	307	40	-100
Fpa	44.8	Fpa=0.22	0.220	281	267	22	30
Flim	107.0	Flim=0.61	0.610	221	212	-3	209

***SSB 2021 relative to SSB 2020**
****TAC 2020/21 relative to landings 2019/20**

12 Capelin in the Iceland-East Greenland-Jan Mayen area

12.1 Stock description and management units

See stock annex.

12.2 Fishery independent abundance surveys

The capelin stock in Iceland-East Greenland-Jan Mayen area has been assessed by acoustics annually since 1978. The surveys have been conducted in autumn (September–December) and in winter (January–February). An overview is given in the stock annex.

12.2.1 Autumn survey during September and October 2019

The survey was conducted with the aim of assessing both the immature and the maturing part of the stock. Since 2010, the autumn surveys have started in September, a month earlier than in previous years because of difficulties in covering the stock due to drift ice and weather during later months. The survey was conducted on the research vessels Arni Fridriksson (21 September – 21 October) and Eros (12 September – 1 October).

The survey area was on and along the shelf edge off East Greenland from about 63° 50´N towards about 75°00´ N, also covering the Denmark Strait and the slope off west and north Iceland. The Iceland Sea, Jan Mayen ridges and Greenland basin were also surveyed but with less transect density (Bardarson et al., 2019). Survey tracks are shown on Figure 12.2.1.

Eros departed from Helguvik harbour on 12 September and sailed westwards over Irminger Sea to start surveying from the southwest end of the survey area. Eros followed preset transects covering the Greenlandic shelf areas until Tasiilaq region. There, the Kuumiut fjord was surveyed. Then Eros continued covering the East-Greenland shelf areas to northeast but could not cover the shallower end of four transects southwest of Kangerlussuaq fjord. Eros had to depart the shelf areas the 19. September and sail to Helguvik harbour due to bad weather and for personnel change. Eros was back on the research area on 22 September and continued measuring in rather difficult weather conditions and had to stop measuring during the night before 23 September. In continuance, Eros surveyed the preset transect through Denmark Strait mostly in good conditions until finishing his last transect on 30 September and arriving to Akureyri harbour on 1 October. Arni departed from Reykjavik harbour on 21 September and sailed north of the Westfjords peninsula starting first transect, just off Strandagrunn bank and crossing Denmark Strait. Then, continuing from the coverage of Eros, Arni surveyed to northeast out of Denmark Strait, covering northwards along the East-Greenland shelf and shelf edges. While in the Scoresby region Arni picked up a communication cable for whaletags from Constable Pynt airport. Arni followed preset transects until reaching the edge of drift ice at 73°30N, and then sailing by zigzag transects northeastwards along the ice edge until reaching 74°50N. From there, Arni sailed south to survey roughly the Jan Mayen ridges and then Iceland sea from east to west until the coverage was finished just west of Kolbeinsey ridge. Arni measured in relatively good weather conditions the whole survey. Arni arrived to Reykjavik harbour on 21 October. Maturing capelin was mainly observed along the East Greenlandic continental shelf and shelf edges in Denmark Strait and the Scoresby areas. In Denmark Strait maturing capelin was mixed with immature capelin, but mainly maturing capelin was found further north. No capelin was found by Jan Mayen ridges but in Iceland Sea small quantities of both maturing and immature capelin were found in the proximity of Kolbeinsey ridge. Considerable quantities of 0-group capelin (although not quantified) were observed along the continental shelf north of Iceland. Immature capelin was found along the Greenlandic shelf, dominating in southwestern part of the survey area and western Denmark Strait. High abundances of immature capelin were found near Inigsalik, west of Kuumiut fjord. The distribution of capelin was westerly as in recent years. Figure 12.2.2 shows the distribution and relative density of the capelin during the survey.

The total abundance of capelin was 91 billion, 83.3 billion of these were from the 1-group. The total estimate of 2 group capelin was about 7.2 billions. The total biomass estimate was 795 000 tonnes of which about 179 000 tonnes were 2 years and older. About 2.1 % in numbers of the 1-group was estimated to be maturing to spawn, about 84.4 % of the 2 year old and 99.1 % of the 3 year old capelin appeared to be maturing. This gives about 186 000 tonnes of maturing 1 - 4 year old capelin. Table 12.2.1 gives the age disaggregated biomass, numbers and weights of the capelin.

Tables 12.2.2 and 12.2.3 show the historic time series of abundance and mean weights by age and maturity in autumn. On the basis of the estimate of the maturing part of the stock the Marine and Freshwater Research Institute recommended no fishery (intermediate TAC of 0 tonnes) for the fishing season 2019/2020 (Anon, 2019). This recommendation was in accordance with existing HCR and management plan between Iceland, Norway and Greenland.

12.2.2 Surveys in winter 2020

Winter surveys were conducted in January–February resulting in 3 separate coverages of stock components. The main objective of the winter surveys was to assess the maturing part of the stock with coverages designed for acoustic stock assessment. This was a coordinated collaboration of several research and fishing vessels where each coverage was based on combined acoustic and trawl data from 3-6 vessels. Scientists from MFRI were on board each vessel performing acoustic stock estimates and all assessments were based on acoustic data from calibrated echosounders.

12.2.2.1 Winter surveys 1. Coverage in 13-25 January 2020

The acoustic measurements were conducted by R/V Arni Fridriksson and the fishing vessels Hakon and Polar Amaroq while the fishing vessels Bjarni Olafsson and Halldor Asgrimsson assisted by scouting peripheral areas. There were 3–6 scientist from the Marine and Freshwater Research Institute based on each vessel participating in acoustic measurements.

The survey area was on and along the shelf edge from north-west of Iceland to east of Iceland (Figure 12.2.3). The survey area was covered from east to west by all vessels. In the beginning, the echosounders of Arni Fridriksson and Hakon were calibrated in Nordfjordur, but Polar Amaroq had been calibrated in previous month. In spite of difficult weather conditions, the three vessels managed to cover the area from Hvalbakshalli southeast of Iceland towards Vikurall off Vestfjords, but sea ice hindered coverage considerably in Denmark Strait.

Only very limited quantities of mature capelin were observed east and northeast of Iceland. Mature capelin was mainly found in the region north of Strandagrunn bank about 30-60 nmi west of Kolbeinsey-ridge while scattered schools of mixed mature and immature capelin were in the proximity of the sea ice edge in Denmark Strait. Total SSB was estimated 65 000 tonnes but this estimate was not used in the final stock assessment, the combination of inclement weather and sea ice with possible late arrival of capelin to the survey area making the case for discounting this effort at assessing the stock.

12.2.2.2 Winter surveys 2. Coverage in 1.–9 February 2020

The acoustic measurements were conducted by R/V Arni Fridriksson and the fishing vessels Polar Amaroq and Adalsteinn Jonsson, while the fishing vessels Borkur and Margret assisted by scouting peripheral areas.

The survey area was on and along the shelf edge from north-west of Iceland to east of Iceland (Figure 12.2.4). Arni Fridriksson measured eastwards from Denmark Strait while the fishing vessels surveyed from the east to west. The vessels met and completed the coverage by Kolbeinsey ridge, where the coverage was adapted to improve the estimation of dense concentrations in that area.

Mature capelin was most abundant by the Reykjanes ridge while capelin was also found along the continental shelf edges northeast and northwest of Iceland. Total SSB was estimated 262 000 tonnes. This was the only estimate used in the final stock assessment, as this coverage was the most comprehensive.

12.2.2.3 Winter surveys 3. Coverage in 16.–22. February 2020

The acoustic measurements were conducted by R/V Arni Fridriksson and the fishing vessels Heimaey, Hakon, Adalsteinn Jonsson, Borkur and Polar Amaroq

The survey area was on and along the shelf edge from north-west of Iceland to east of Iceland, but with special emphasis on shallow areas north of Iceland and extra coverage in Dohrn Bank (Figure 12.2.4). This multi-vessel operation was aimed at a potential short weather window as predicted by weather forecast, but weather conditions turned out to be difficult for measurements during main part of this coverage. Overall, very limited quantities were observed during this coverage resulting in much less abundance estimates than in the preceding coverage few days earlier. Very limited quantities of capelin were observed in Dohrn Bank and Denmark Strait areas and in these areas immature capelin predominated along with scarce occurrences of mature capelin. Capelin was mainly observed in shallow areas in the proximity of Eyjafjörður but it can be very difficult to measure the migrating fish in such shallow waters. Further, heavy winds and waves are likely to have considerably reduced the quality of the acoustic measurements. SSB was estimated between 50 000 and 60 000 tonnes but this estimate was not used in the final stock assessment.

12.3 The fishery (fleet composition, behaviour and catch)

No initial catch quota was recommended for the 2019/2020 fishing season, and no summer or autumn fishery took place in 2019.

The intermediate TAC advice based on the autumn survey recommended no fisheries (TAC = 0 tonnes) and based on winter surveys in 2020 this advice was not changed. Hence, there were no fisheries in the 2019/2020 fishing season.

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.

Initial and final TAC as well as landings for the fishing seasons since 1992/93 are given in Table 12.3.4 and total catch by season is shown in Figure 12.3.1.

12.4 Biological data

12.4.1 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 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 Sigurdsson, 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.

Immature capelin has considerably low fat content, usually less than 3–4%. The fat content rises from approximately 5% in the summer to 20% in late autumn. In the 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 (Engilbertsson *et al.*, 2012).

12.5 Methods

The objective of the HCR for the stock is to leave at least 150 000 tonnes (= B_{lim}) for spawning (escapement strategy). The initial (preliminary), intermediate and final TACs are based on acoustic surveys.

a) The initial TAC advice for the subsequent fishing season is issued by ICES around 1 December. It is based on the autumn survey abundance estimate of immature 1 and 2 year old capelin. Before 2017, this advice was issued later (May/June).

b) The intermediate TAC advice is issued by MFRI in autumn based on the biomass estimate of maturing capelin.

c) The final TAC advice is issued by MFRI in January/February based on the biomass estimate of maturing capelin.

The initial (preliminary) quota follows a simple forecast that is based on a linear relation between historic observations of the abundance of 1 and 2 year old juveniles from the acoustic autumn surveys and the corresponding final TACs nearly 1½ year later. This rule was applied by ICES NWWG (subgroup online video conferencing meeting in November 2018) to advice the initial quota for the fishing season 2019/20. Figure 12.8.1 shows the relation and the associated precautionary initial quota.

The intermediate and final TACs are set so that there is at least 95% probability that there will be at least 150 000 tonnes (= B_{lim}) of mature capelin left for spawning at the spawning time (15 March). This was done for the first time in 2015/2016 by the Icelandic Marine Research Institute and was not evaluated by ICES.

These methods were endorsed by the benchmark working group WKICE in 2015. See WKICE (ICES, 2015) and the Stock Annex for the capelin in the Iceland-East Greenland-Jan Mayen area.

Previously, (since early 1980s) the stock has been managed according to an escapement strategy, leaving 400 000 tonnes to spawning (uncertainty of the estimates were not considered). To predict the TAC for the next fishing season a model was developed in the early 1990s (Gudmundsdottir and Vilhjalmsson, 2002). These models were not endorsed by the benchmark working group WKSHORT 2009.

12.6 Reference points

During WKICE, a B_{lim} of 150 000 tonnes was defined (ICES, 2015). No other reference points are defined for this stock.

12.7 State of the stock

The spawning stock biomass (SSB) was estimated to 262 000 tonnes in January–February 2019. The predation model (ICES, 2015), accounting for catches (in this case 0 t) and predation between survey and spawning by cod, saithe and haddock, estimated that 157 000 tonnes were left for spawning in spring 2019 (Table 12.7.1). Given the uncertainty estimates, there was 95% probability that at least 72 000 tonnes was left for spawning. This was below B_{lim} within the sustainable HCR.

The acoustic estimate of immature capelin at age 1 and 2 from the autumn survey in September 2018 was 82.6 billion. The estimate is above long term average (Figure 12.7.1) and the initial advice according to the HCR is 169 520 tonnes in the fishing season 2020/21 (Figure 12.7.2).

12.8 Uncertainties in assessment and forecast

The uncertainty of the assessment and forecast depends largely on the quality of the acoustic surveys in terms of coverage, conditions for acoustic measurements and the aggregation (high patchiness leads to high variance) of the capelin.

The uncertainty is estimated by bootstrapping (see stock annex). The CV for the immature abundance was estimated to 0.43 in the 2019 autumn survey. The CV for the mature biomass was estimated to 0.31 in the 2019 autumn survey but in the winter survey (February 1.-9.) used for the assessment in 2020 it was 0.19.

Effort and spatial coverage in the autumn survey 2019 give reason to believe that both the immature and mature components of the stock were successfully covered. The three winter survey coverages in January-February were made in difficult weather and/or sea ice conditions and hence only one of them was deemed usable for stock estimate. The final estimate was built on only one coverage, not allowing for repeated surveying with and against the migration direction. Although some components of the stock are likely to have been measured with the survey migration and others against it, there could be some bias due to migration direction.

12.9 Comparison with previous assessment and forecast

For the fishing season 2019/2020 no initial quota was advised and intermediate and final TAC was also set to 0 tonnes. This is the second fishing season in a row with zero catch adviced as a final TAC, but before that it had not happened since fishing season 2008/2009.

12.10 Management plans and evaluations

See Section 12.5.

12.11 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 have resulted in the setting of an initial (preliminary) catch quota. During summer, the availability of plankton is at its highest and the fishable stock of capelin is feeding very actively over large areas between Iceland, Greenland and Jan Mayen, increasing rapidly in length, weight and fat content. By late September/beginning of October this period of rapid growth is over. The growth is fastest the first two years, but the weight increase is highest in the year before spawning (Vilhjálmsson, 1994).

Given the large weight increase in the summer before spawning (Section 12.4) it is likely that there will be more biomass of maturing fish in autumn than in summer, even though the level of natural mortality is not well known during this time period. This should be considered for optimal timing of fishery in relation to yield and ecological impact. This is also supported by information for the Barents Sea capelin where it has been shown 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 and role in the ecosystem of these two capelin stocks are similar, this is considered to be valid for the capelin in the Iceland-East Greenland-Jan Mayen area as well - until it is studied for this specific stock.

During the autumn surveys, juvenile and adult capelin is often found together. This should be considered during summer fishing because the survival rate of juvenile capelin that escapes through the trawl net is unknown.

12.12 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).

The importance of capelin in East Greenlandic waters is not well documented but effort has been increased considerably during autumn surveys towards evaluation of capelin role in the ecosystem e.g. by research on feeding of capelin, estimates of prey availability, predators distributions and environmental monitoring.

In Icelandic waters, capelin is the main single item in the diet of Icelandic cod, 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).

12.13 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 juvenile capelin and to reduce the risk of affecting the spawning migration route (shuttering of migrating capelin schools by pelagic trawling has been hypothesized).

Taking precautionary measures to protect juvenile capelin, the coastal states (Iceland, Greenland and Norway) have agreed that from 2021 fishing shall not start until October 15.

12.14 Changes in fishing technology and fishing patterns

No fisheries took place this fishing season, but historically a variable amounts of the catches have been taken with pelagic trawl through the fishing seasons. Discards have been considered negligible.

12.15 Changes in the environment

Icelandic and East Greenlandic 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 that this temperature increase, may have led to a spatial shift in spawning and nursery areas (Vilhjálmsson, 2007). The acoustic surveys in autumn 2010, 2012–2019 confirmed this change in distribution of immatures and maturing capelin. Fisheries data suggests that the major part of the spawning still takes place on the usual grounds by the South and Southwest coasts of Iceland and possibly to increased extent by the North coast of Iceland.

A more detailed environmental description is in Section 7.3.

12.16 Recommendations

In coming years when experience of the new HCR will be gained it is recommended that assumptions and practical operation of the HCR will be evaluated. E.g. by refining the model for the initial TAC, reviewing the predation/prey relationships and how SSB estimates from autumn and winter surveys should be weighted when final TAC is calculated. NWWG therefore recommends that the assessment of this capelin stock goes through a benchmark workshop in near future. Further, it is recommended that the option to run this benchmark jointly with a benchmark workshop for the Barents Sea capelin stock will be examined.

Studies of optimal harvesting of capelin should be conducted. These estimates should take account of ecological impact, growth, mortality and gear selection in relation to the timing of the fishery.

Profound changes in the distribution, migration and productivity of this capelin stock, likely caused by environmental changes, urge the need for further biological studies i.e. regarding life history (including changes in spawning grounds, larval drift and migration at times not observed by autumn and winter surveys) and the role of capelin (predation/prey relationships) as a key species in the ecosystem.

The assessment and advice on the final TAC for capelin based on the autumn and winter surveys are issued directly to the Coastal States by the Icelandic Marine and Freshwater Research Institute. This process is not internationally peer reviewed prior to the release of the advice. Among the reasons for using this process is the need for fast advice once the survey result is available. The ICES ACOM procedure is more time consuming. NWWG has recommended that a fast track workflow based on online meetings is established if possible. The coastal states evaluated this recommendation in 2017 and concluded that a current regime for setting intermediate and final TAC should be maintained.

When planning acoustic surveys for capelin stock assessment, allocation of effort in terms of ship time, number of ships and manpower, should be sufficient for a likely full coverage in the first attempt given the demanding weather and ice conditions during autumn and winter surveys.

12.17 References

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12.18 Tables

Table 12.2.1 Capelin. Acoustic assessment of capelin in the Iceland/Greenland/Jan Mayen area, by r/v Arni Fridriksson and r/v Bjarni Saemundsson 6/9–9/10 2017 (Numbers in billions, biomass in tonnes).

Length (cm)	Numbers at Age (10^9)				Numbers (10^9)	Biomass (10^3 t)	Mean weight (g)
	1	2	3	4			
8.5	0.01	0	0	0	0.01	0.02	2.18
9	0.12	0	0	0	0.12	0.25	2.17
9.5	1.04	0	0	0	1.04	3.08	2.96
10	2.74	0	0	0	2.74	9.65	3.53
10.5	4.78	0	0	0	4.78	20.13	4.21
11	8.33	0	0	0	8.33	41.95	5.03
11.5	13.6	0	0	0	13.6	81.77	6.01
12	16.12	0.03	0	0	16.15	111.54	6.91
12.5	17.14	0.14	0	0	17.28	138.37	8.01
13	8.56	0.03	0	0	8.59	78.34	9.12
13.5	4.57	0.01	0	0	4.58	49.06	10.7
14	3.84	0.24	0	0	4.08	49.65	12.17
14.5	1.38	0.17	0	0	1.55	21.61	13.94
15	0.78	0.62	0.01	0	1.41	22.67	16.12
15.5	0.21	0.9	0.02	0	1.13	20.3	17.97
16	0.03	1.04	0.05	0	1.12	22.99	20.52
16.5	0	1.22	0.04	0	1.26	28.71	22.78
17	0	1.01	0.15	0.01	1.16	29.05	25.01
17.5	0	0.91	0.19	0	1.11	30.84	27.9
18	0.03	0.69	0.08	0.01	0.8	25.44	31.8
18.5	0	0.18	0.06	0	0.25	8.45	34.25
19	0	0.02	0	0	0.02	0.92	37.32
19.5	0	0.01	0	0	0.01	0.4	41.68
0	0.00	0.00		0.00	0.00	0.00	0.0
0	0.00	0.00		0.00	0.00	0.00	0.0

	Length (cm)	Numbers at Age (10^9)				Numbers (10^9)	Biomass (10^3 t)	Mean weight (g)
		1	2	3	4			
TSN (10^9)		83.3	7.2	0.6	0.0	91.1		
TSB (10^3 t)		616.3	162.2	16.4	0.3		795.2	
Mean W (g)		7.4	22.5	27.0	28.4			8.7
Mean L (cm)	12.5	12.1	16.3	17.3	17.5			
%TSN		91.4	7.9	0.7	0.0			
SSN (10^9)		1.8	6.1	0.6	0.0	8.5		
SSB (10^3 t)		23.7	146.1	16.3	0.3		186.4	
SMean W (g)		13.4	24.0	27.1	28.4			22.0
SMean L (cm)	16.2	14.1	16.7	17.3	17.5			
%SSN		20.9	71.9	7.1	0.1			
ISN (10^9)		81.5	1.1	0.0		82.6		
ISB (10^3 t)		592.4	16.3	0.1			608.8	
IMean W (g)		7.3	14.5	15.7				7.4
IMean L (cm)	12.,1	12.0	14.6	15.0				
%ISN		98.6	1.4	0.0				

Table 12.2.2. Icelandic Capelin. Abundance of age-classes in numbers (10^9) measured in acoustic surveys in autumn.

Year	Mon	Day	Age1	Age1	Age2	Age2	Age3	Age3	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	
2005	11									

Year	Mon	Day	Age1	Age1	Age2	Age2	Age3	Age3	Age4	Age5
			Imm.	Mat.	Imm.	Mat.	Imm.	Mat	Mat.	Mat.
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	
2011	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	
2015	9	16	5.0	0.4	1.2	21.2		6.7		
2016	9	10	8.7	0.5	0.7	4.5	0.0	0.9	0.01	
2017	9	7	24.6	1.3	1.5	35.5	0.0	5.1	0.05	
2018	9	6	10.3	1.5	0.4	8.8	0.0	1.0		
2019	9	12	81.5	1.8	1.1	6.1		0.6	0.0	

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 < 50 000 tonnes.

2011 - Only limited coverage of the traditional capelin distribution area.

2001–2009 and 2016 – Not full coverage of stock.

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	

Year	Mon.	Age1	Age1	Age2	Age2	Age3	Age3	Age4	Age5
		Imm.	Mat.	Imm.	Mat.	Imm.	Mat.	Mat.	Mat.
2014	9	4.2	9.9	12.7	18.3	16.6	21.2	25.0	
2015	9	8.5	12.3	13.4	18.4	21.5	23.1		
2016	9	9.0	15.1	13.1	25.5	11.5	31.7	39.2	
2017	9	8.0	12.6	15.0	22.2	22.3	27.2	33.2	
2018	9	8.8	12.9	16.5	21.7	21.2	27.1		
2019	9	7.3	13.4	14.5	24.0	15.7	27.1	28.4	

Table 12.2.4. Icelandic Capelin. Assessment of mature capelin in the Iceland/East Greenland/Jan Mayen area in winter (January–February) 2020 (Numbers in billions, biomass in thousand tonnes). Based on 2nd coverage of winter surveys.

	Length	Numbers at Age (10^9)				Numbers	Biomass	Mean
	(cm)	2	3	4	5	(10^9)	(10^3 t)	weight (g)
	10	0.01	0	0	0	0.01	0.02	3
	10.5	0.03	0	0	0	0.03	0.09	3.2
	11	0.08	0	0	0	0.08	0.37	4.3
	11.5	0.14	0	0	0	0.14	0.77	5.3
	12	0.29	0	0	0	0.29	1.78	6.1
	12.5	0.35	0	0	0	0.35	2.48	7
	13	0.46	0.01	0	0	0.47	3.77	8
	13.5	0.66	0.01	0	0	0.66	6.3	9.5
	14	0.93	0.04	0	0	0.97	10.68	11.1
	14.5	1.05	0.11	0	0	1.17	14.67	12.6
	15	0.76	0.17	0	0	0.93	13.22	14.2
	15.5	0.59	0.5	0.01	0	1.1	17.93	16.4
	16	0.36	0.82	0.01	0	1.2	22.26	18.6
	16.5	0.25	1.56	0.07	0	1.88	39.23	20.9
	17	0.1	1.55	0.15	0	1.8	42.15	23.4
	17.5	0.01	1.27	0.18	0	1.45	37.45	25.7
	18	0.01	1.05	0.27	0	1.33	38.54	29
	18.5	0	0.77	0.19	0	0.96	30.93	32.2
	19	0	0.15	0.03	0.01	0.19	6.47	34.4
	19.5	0	0.04	0.01	0	0.05	1.91	38.8
TSN (10^9)		6.08	8.04	0.93	0.01	15.06		
TSB (10^3 t)		74.04	191.04	25.69	0.24		291.01	
Mean W (g)		12.18	23.76	27.63	34.36			19.33
Mean L (cm)	15.92	14.2	17.01	17.75	19			
%TSN		40.39	53.39	6.18	0.05			

	Length	Numbers at Age (10^9)				Numbers	Biomass	Mean
	(cm)	2	3	4	5	(10^9)	(10^3 t)	weight (g)
SSN (10^9)		3.14	7.9	0.92	0.01	11.97		
SSB (10^3 t)		47.43	189.37	25.51	0.24		262.55	
SMean W (g)		15.12	23.97	27.63	34.36			21.94
SMean L (cm)	16.57	15.03	17.05	17.75	19			
%SSN		26.2	66.02	7.72	0.06			
ISN (10^9)		2.94	0.14	0.01		3.09		
ISB (10^3 t)		26.51	1.78	0.17			28.46	
IMean W (g)		9	12.81	26.6				9.21
IMean L (cm)	13.4	13.32	14.86	18				
%ISN		95.3	4.49	0.21				

Table 12.3.1 Capelin. The international catch since 1964 (thousand tonnes).

Year	Winter Season					Summer and autumn season						
	Iceland	Norway	Faroes	Greenland	Season total	Iceland	Norway	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	1,159.60

Year	Winter Season					Summer and autumn season						
	Iceland	Norway	Faroes	Greenland	Season total	Iceland	Norway	Faroes	Greenland	EU	Season total	Total
1979	521.7	-	18.2		539.9	442	124	22		-	588	1,127.90
1980	392.1	-	-		392.1	367.4	118.7	24.2		17.3	527.6	919.7
1981	156	-	-		156	484.6	91.4	16.2		20.8	613	769
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	65.9		16	919.7	1,268.20
1986	341.8	50	-		391.8	552.5	149.7	65.4		5.3	772.9	1,164.70
1987	500.6	59.9	-		560.5	311.3	82.1	65.2		-	458.6	1,019.10
1988	600.6	56.6	-		657.2	311.4	11.5	48.5		-	371.4	1,028.60
1989	609.1	56	-		665.1	53.9	52.7	14.4		-	121	786,1
1990	612	62.5	12.3		686.8	83.7	21.9	5.6		-	111.2	798
1991	202.4	-	-		202.4	56	-	-		-	56	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	127.5	23.9	10.2	-	611.6	1,101.20
1994	550.3	15	-	1.8	567.1	210.7	99	12.3	2.1	-	324.1	891.2

Year	Winter Season					Summer and autumn season						
	Iceland	Norway	Faroes	Greenland	Season total	Iceland	Norway	Faroes	Greenland	EU	Season total	Total
1995	539.4	-	-	0.4	539.8	175.5	28	-	2.2	-	205.7	745.5
1996	707.9	-	10	5.7	723.6	474.3	206	17.6	15	60.9	773.8	1,497.40
1997	774.9	-	16.1	6.1	797.1	536	153.6	20.5	6.5	47.1	763.6	1,561.50
1998	457	-	14.7	9.6	481.3	290.8	72.9	26.9	8	41.9	440.5	921.8
1999	607.8	14.8	13.8	22.5	658.9	83	11.4	6	2	-	102.4	761.3
2000	761.4	14.9	32	22	830.3	126.5	80.1	30	7.5	21	265.1	1,095.40
2001	767.2	-	10	29	806.2	150	106	12	9	17	294	1,061.20
2002	901	-	28	26	955	180	118.7	-	13	28	339.7	1,294.70
2003	585	-	40	23	648	96.5	78	3.5	2.5	18	198.5	846.5
2004	478.8	15.8	30.8	17.5	542.9	46	34	-	12		92	634.9
2005	594.1	69	19	10	692	9	-	-	-	-	9	701.1
2006	193	8	30	7	238	-	-	-	-		-	238
2007	307	38	19	12.8	376.8	-	-	-	-	-	-	376.8
2008	149	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

Year	Winter Season					Summer and autumn season						
	Iceland	Norway	Faroes	Greenland	Season total	Iceland	Norway	Faroes	Greenland	EU	Season total	Total
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	684.4
2013	454	40	30	17	541	-	-	-	-	-	-	541
2014	111.4	6.2	8	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	-	-	-	2.5	-	2.5	474.4
2016	101.1	58.2	8.5	3.3	171.1	-	-	-	-	-	-	171.1
2017	196.8	60.4	15	27.4	299.8	-	-	-	-	-	-	299.8
2018	186.3	74.5	14.3	11.4	286.5	-	-	-	-	-	-	286.5
2019*	-	-	-	-	-	-	-	-	-	-	-	-
2020	-	-	-	-	-							

*** 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

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Total number	Total weight
2012	-	0.2	0.2	-	-	0.4	10.4
2013	-	-	-	-	-	-	-
2014	0.01	2.22	0.6	0.02	-	2.8	45.5
2015	0.03	0.08	0.03			1.4	2.5
2016	-	-	-	-	-	-	-
2017	-	-	-	-	-	-	-
2018	-	-	-	-	-	-	-
2019	-	-	-	-	-	-	-

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

Year	age 1	age 2	age 3	age 4	age 5	Total number	Total weight
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
2016		0.4	5.5	2.0	0.02	8.0	171.1
2017		0.4	5.4	4.1	0.1	10.0	299.8
2018		0.6	10.4	0.9	0.01	11.91	286.5
2019	-	-	-	-	-	0	0
2020	-	-	-	-	-	-	-

Table 12.3.4. Initial quota and final TAC and landings by seasons.

Fishing season	Initial advice	Final TAC	Landings
1992/931	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	225[5]	580	517
2015/16	No fishery[5]	173	174
2016/17[6]	No fishery[5]	299	300
2017/18[6]	No fishery[5]	285	287
2018/19	No fishery[5]	0	0
2019/20	No fishery	0	0

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) Initial advice based on low probability of exceeding final TAC.

6) Preliminary landings.

Table 12.7.1 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 10^9) as measured in autumn survey. Spawning stock biomass ('000 t) is given at the time of spawning at the end of the fishing season. Landings ('000 t) are sum of total landings in the season.

Season (Summer/winter)	Recruitment	Landings	Spawning stock biomass
1978/79	-	1195	600
1979/80	22	980	300
1980/81	23.5	684	170
1981/82	21	626	140
1982/83	68	0	260
1983/84	44.1	573	440
1984/85	73.8	896	460
1985/86	33.8	1312	460
1986/87	58.6	1334	420
1987/88	2.6	1116	400
1988/89	43.9	1036	440
1989/90	29.2	807	115
1990/91	27.2	313	330
1991/92	60	677	475
1992/93	104.6	788	499
1993/94	100.4	1178	460
1994/95	119	864	420
1995/96	165	930	830
1996/97	111.9	1570	430
1997/98	66.8	1246	492
1998/99	121	1100	500
1999/00	89.8	932	650
2000/01	103.7	1071	450
2001/02	101.8	1249	475
2002/03	-	988	410
2003/04	4.9	742	535
2004/05	7.9	784	602
2005/06	-	247	400
2006/07	44.7	377	410
2007/08	5.7	203	406
2008/09	12.6	150	328
2009/10	15.4	151	410
2010/11	101.2	391	411
2011/12	9.6	747	418
2012/13	19.4	551	417
2013/14	60.7	142	424

Season (Summer/winter)	Recruitment	Landings	Spawning stock biomass
2014/15	58	518	460
2015/16	5.4	174	304*
2016/17	9.4	300	361*
2017/18	25.9	287	352*
2018/19	10.3	0	127*
2019/20	81.5	0	157

*** Based on predation model in current HCR.**

12.19 Figures

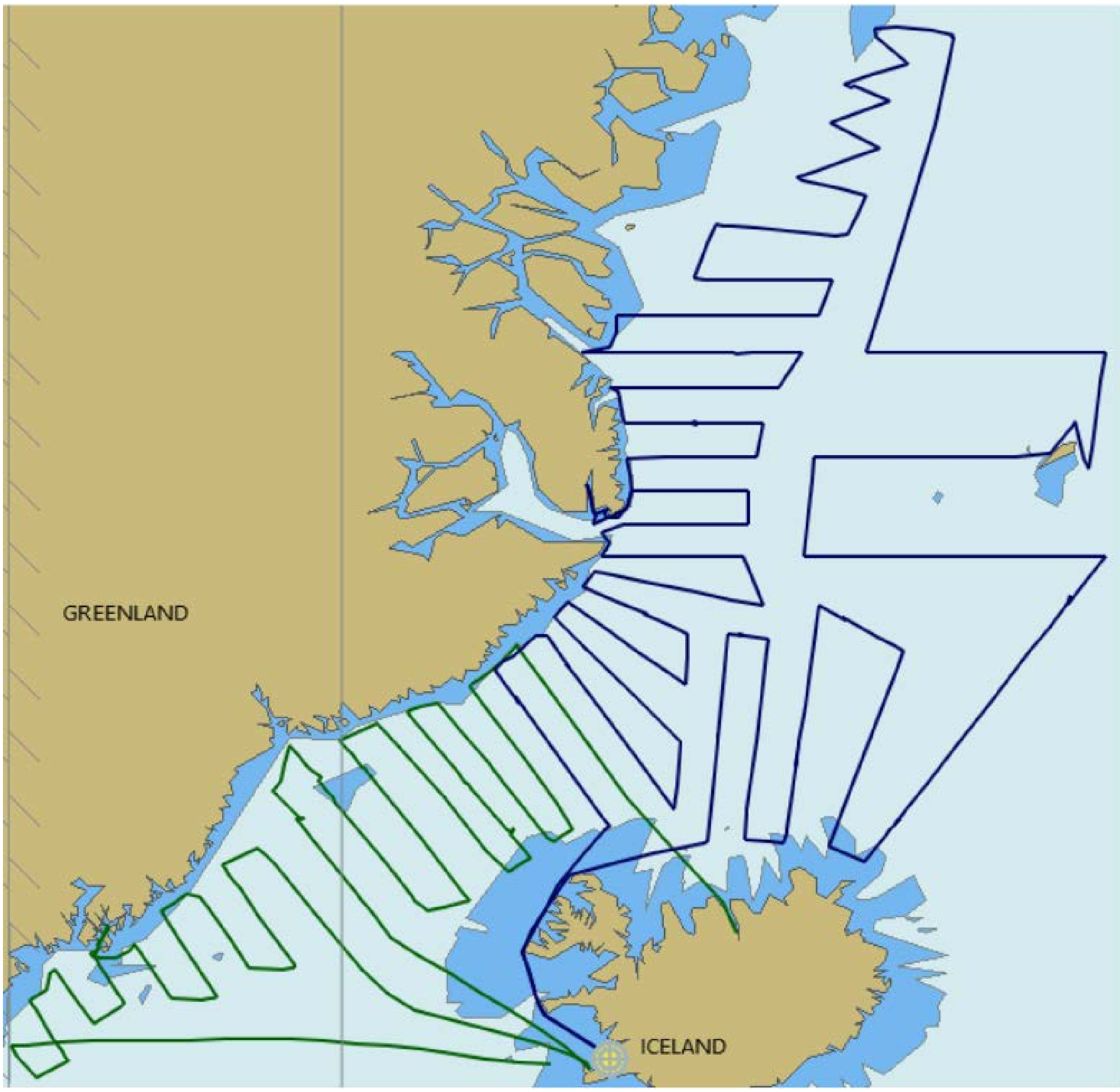

Figure 12.2.1. Icelandic capelin. Cruise tracks during an acoustic survey by r/v Arni Fridriksson (blue) and Eros (GREEN) during 12 September – 21 October 2019.

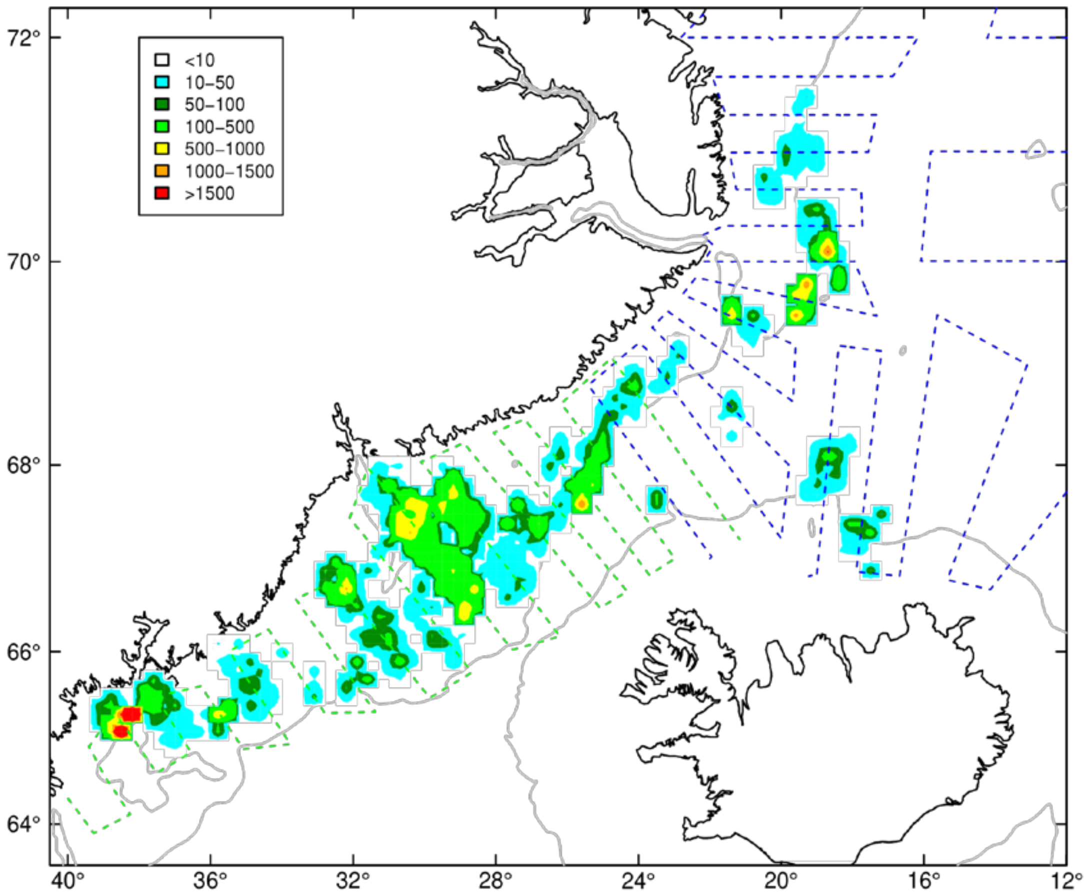

Figure 12.2.2. Icelandic capelin. Relative density and distribution of capelin during an acoustic survey by r/v Arni Fridriksson Eros during 12 September – 21 October 2019.

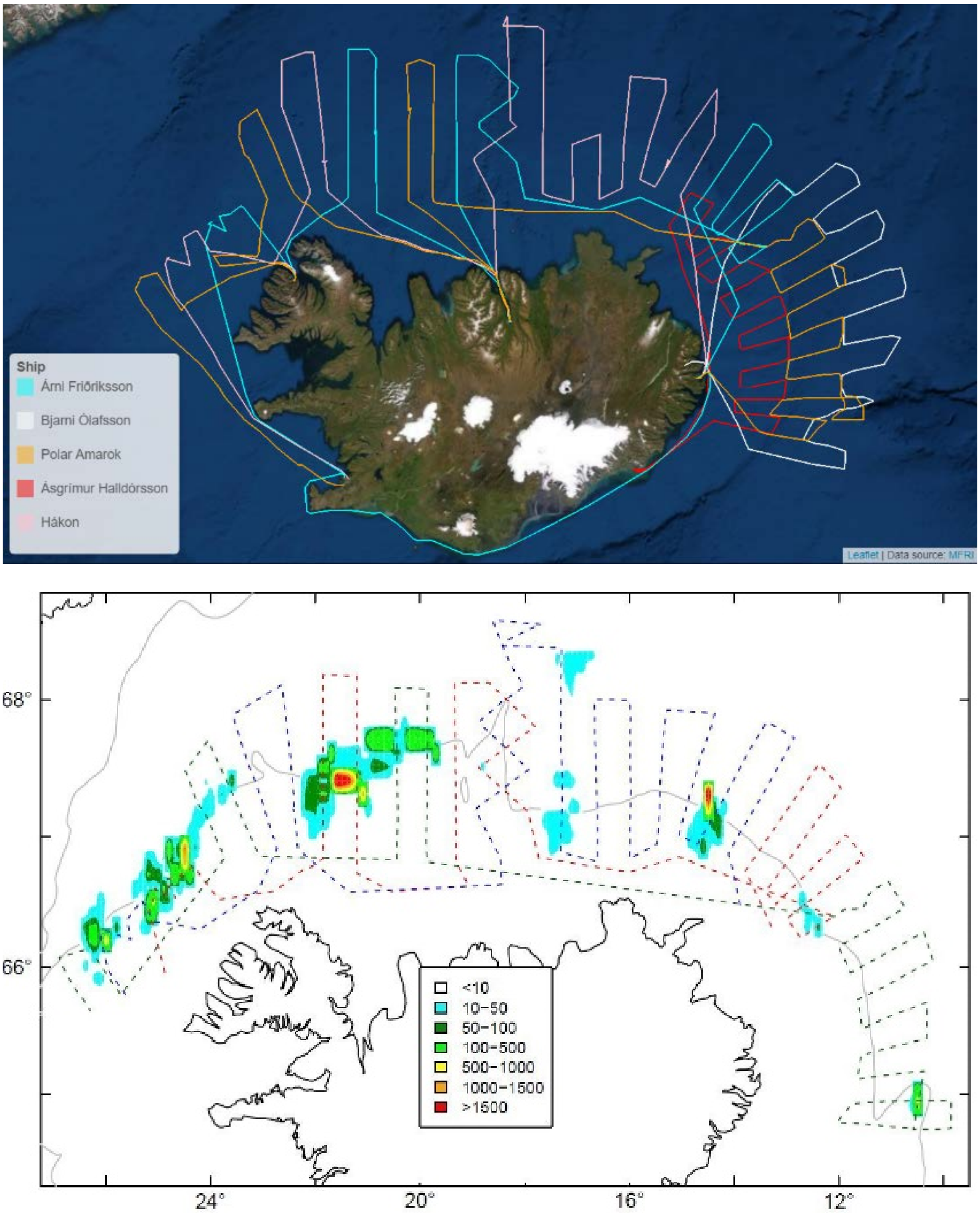

Figure 12.2.3. Icelandic capelin. Survey tracks (A) of the participating vessels during 13-25 January 2020 and distribution (B) of capelin.

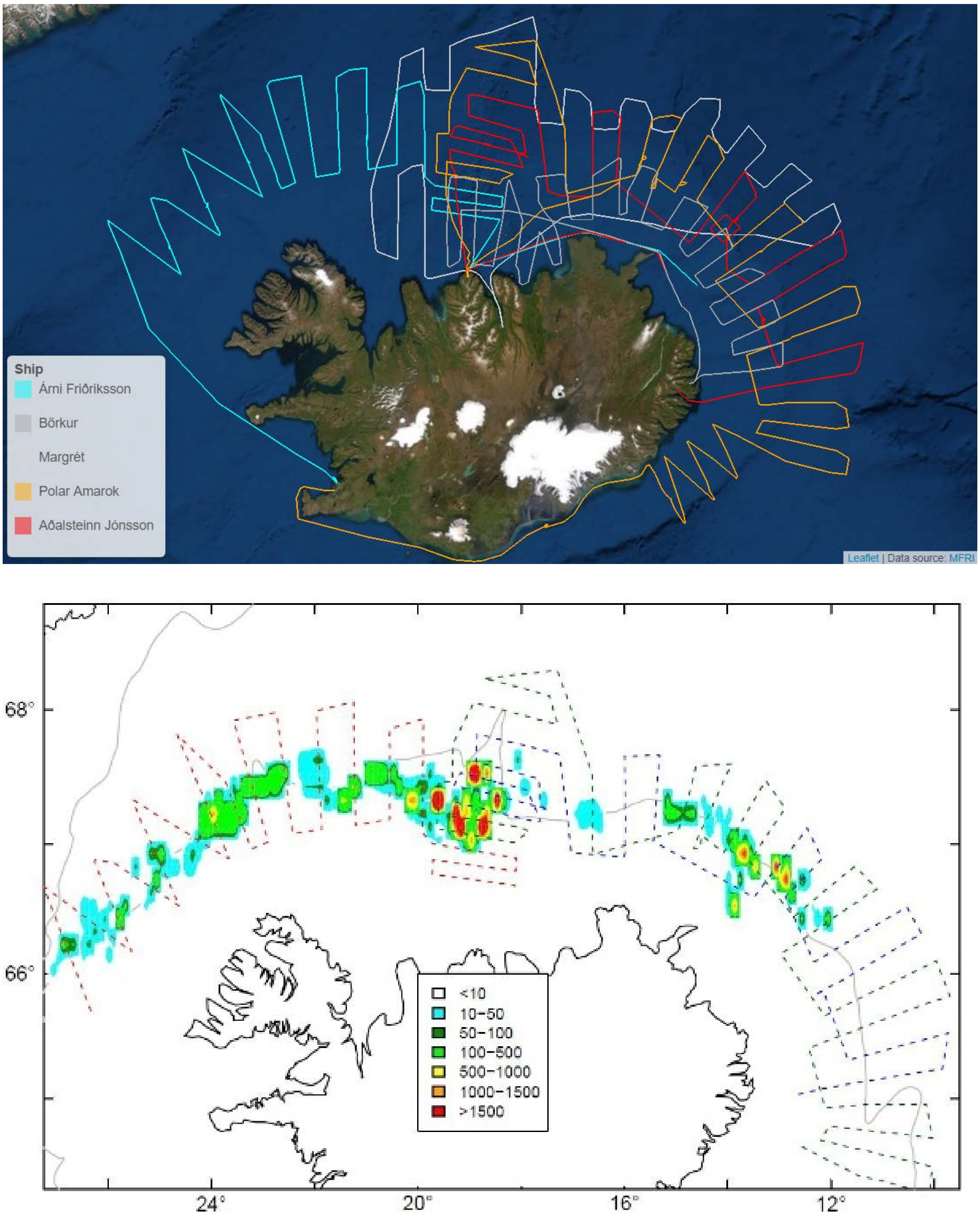

Figure 12.2.4. Icelandic capelin. Survey tracks (A) of participating vessels during 1-9 February 2020 and distribution (B) of capelin.

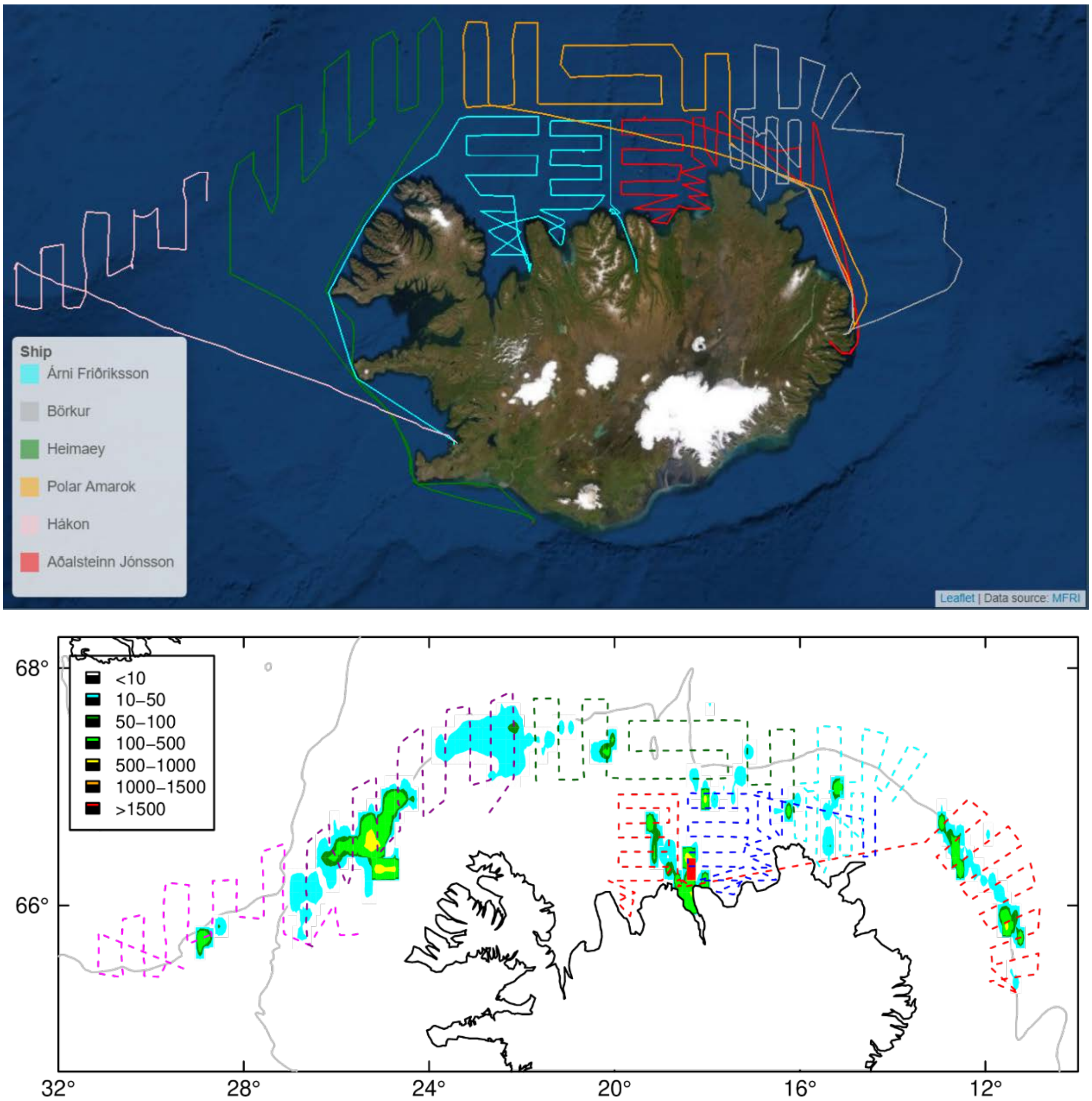

Figure 12.2.5. Icelandic capelin. Survey tracks (A) of participating vessels during 16-22 February 2020 and distribution (B) of capelin.

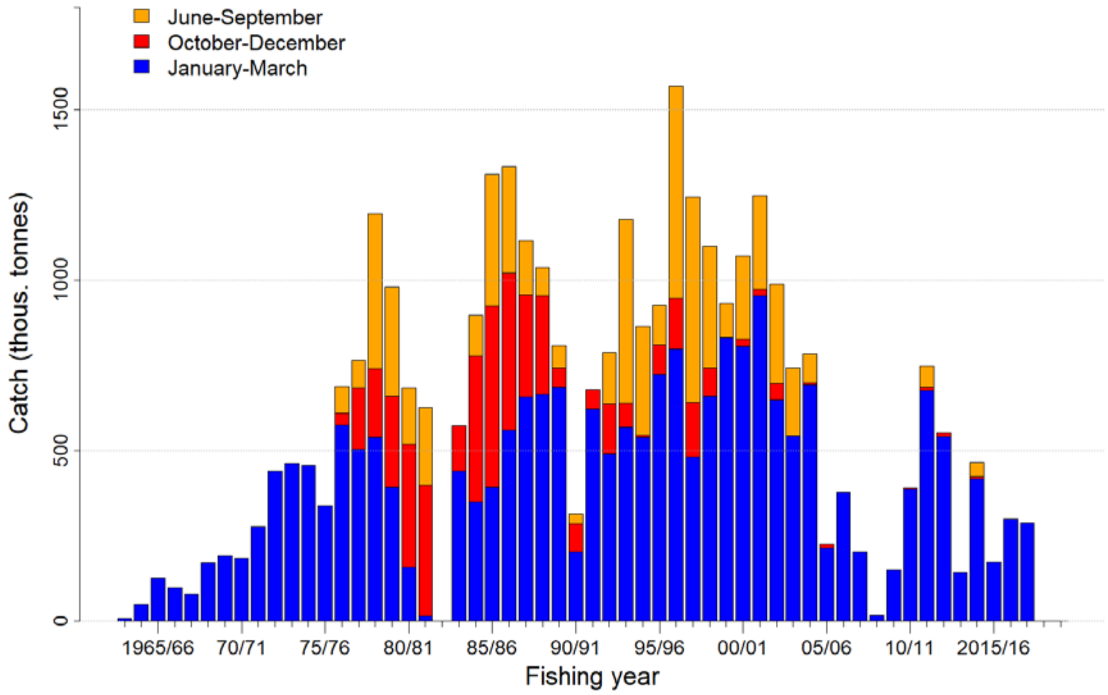

Figure 12.3.1. Icelandic capelin. The total catch (in thousand tonnes) of the Icelandic capelin since 1963/64 by season.

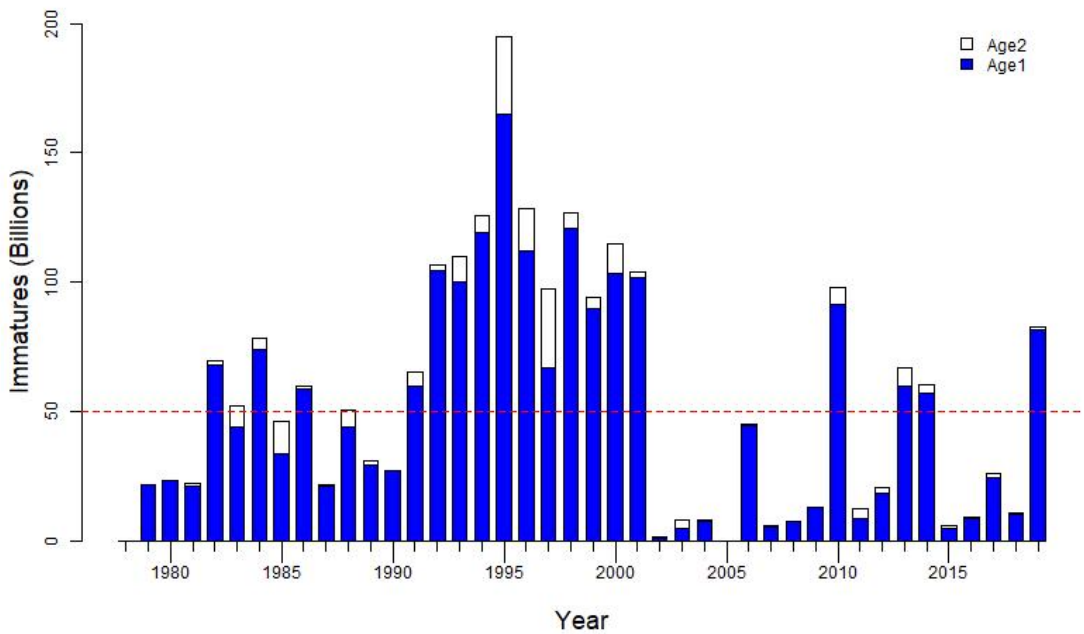

Figure 12.7.1. Icelandic capelin. Indices of immature 1 and immature 2 years old capelin from acoustic surveys in autumn since 1979.

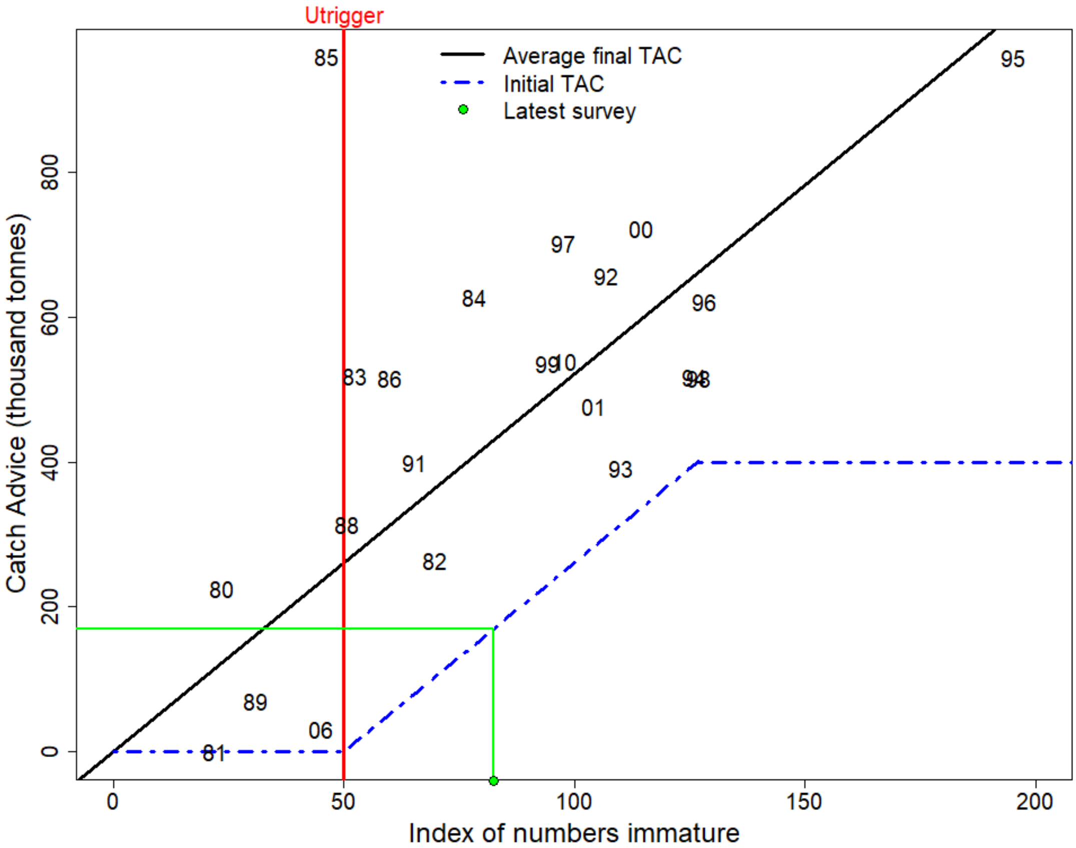

Figure 12.7.2 Capelin in Subareas 5 and 14 and Division 2.a west of 5°W. Catch advice according to the proposed stochastic HCR, based on the measured number of immature capelin about 15 months earlier. The figure shows the estimated final TAC (black unbroken line) and the initial (preliminary) TAC (blue dashed line). The latter is set using a Utrigger (red vertical line) of 50 billion immature fish, with a cap on the initial (preliminary) TAC of 400 kt. The green lines show the index value from the autumn survey 2019, with the corresponding initial TAC for 2020/2021 shown on the y-axis. (The figure adapted from stock-annex, WKICE 2015).

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).

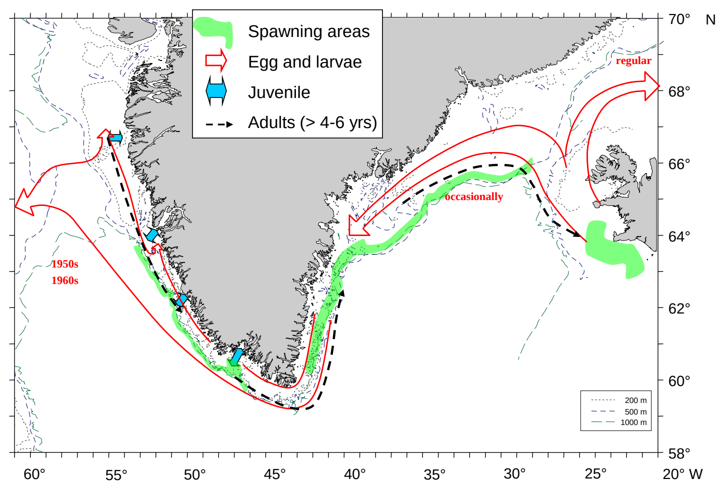

Figure 1. Spawning areas, egg and larval transport of Atlantic cod (*Gadus morhus*) in Greenlandic and Icelandic waters.

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 periods, and resulted in extensive distribution and productivity changes of many commercial stocks. Historically, cod is the most prominent example of such a change (Hovgård and Wieland, 2008).

In recent years, temperature have increased significantly in Greenland waters. In West Greenland the sea temperature have increased particularly compared to the years in 1970s–mid1990s and historical highs was registered in 2005 for the time-series 1880–2012 (Figure 2).

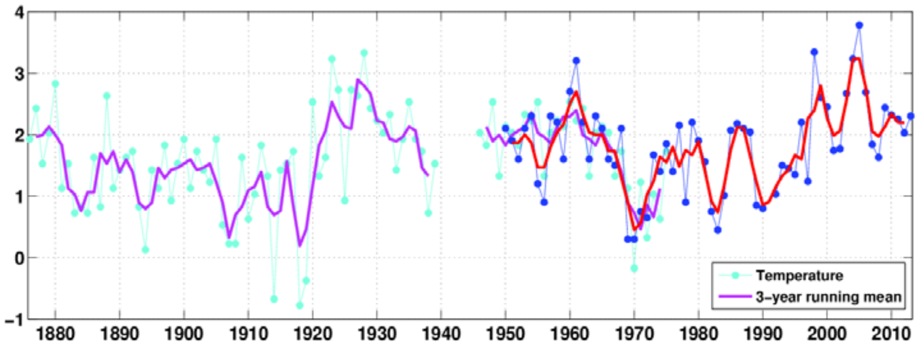

Figure 2. Mean temperature on top of Fylla Bank (located outside Nuuk Fjord, 0–40 m depth) in the middle of June for the period 1950–2013. The curves are 3 year running mean values. The magenta/purple line is extended back to 1876 using Smed-data for area A1. From Ribergaard (2014).

Temperature in the centre of the Irminger Sea, in the depth interval 200–400 m, shows no such clear long-term trend (ICES, 2013c). However, Rudels *et al.* (2012) finds that between 1998–2010, the salinity and temperature of the deep water in the Greenland Sea increased. Furthermore, increasing temperatures in 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 and 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*.

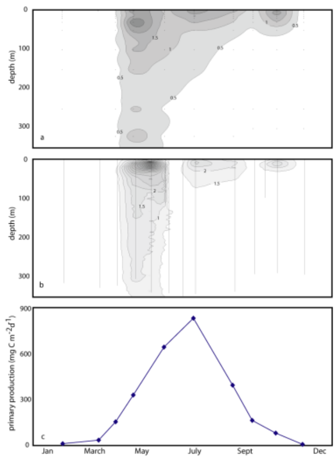

Figure 3. Annual variation in algal biomass and productivity at the inlet of Nuuk Fjord.
a: chlorophyll (µg l^{-1}), b: fluorescence, c: primary production (mg C m^{-2} d^{-1}). Dots represent sampling points. From Mikkelsen *et al.* (2008).

Recently, the distribution of commercial species such as cod and shrimp has shifted considerably in the 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 fish may also increase as a result of temperature changes as seen for both Greenland halibut (Sünksen *et al.*, 2010) 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 fish abundance and their distributional shifts on demersal fish 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.

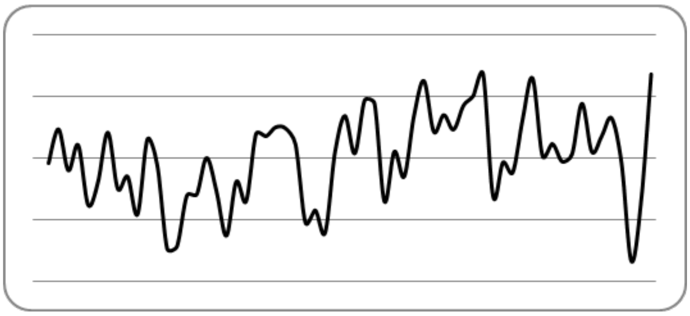

Figure 4. NAO Index (Dec–Feb) 1950–2012.

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 to 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 (Figure 5). The 2010 air temperature anomaly (4.0K) was the highest recorded, and was associated with the largest negative NAO anomaly (see Figure 6).

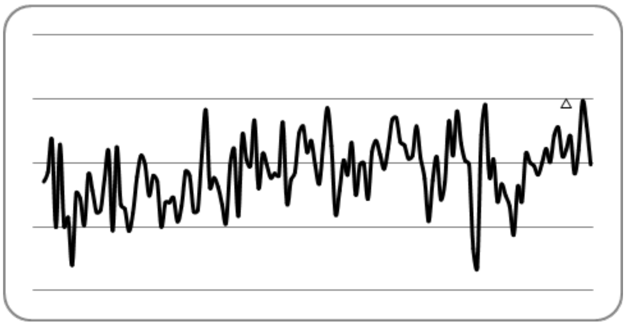

Figure 5. Time-series of annual mean winter (DEC–FEB) air temperature anomalies (K) at Nuuk (1876–2012, rel. 1961–1990)

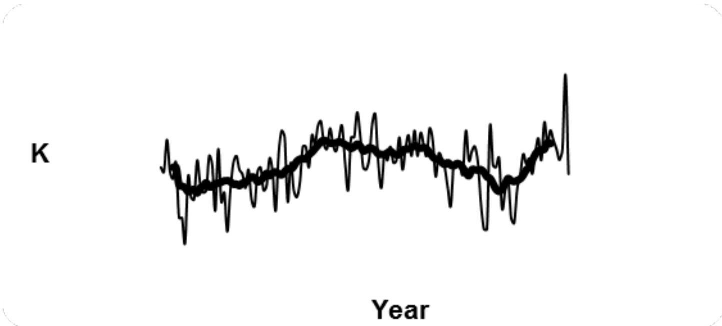

Figure 6. Time-series of annual mean air temperature anomalies (K) at Nuuk (1876–2011, rel. 1961–1990), and 13 year running mean.

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). 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.

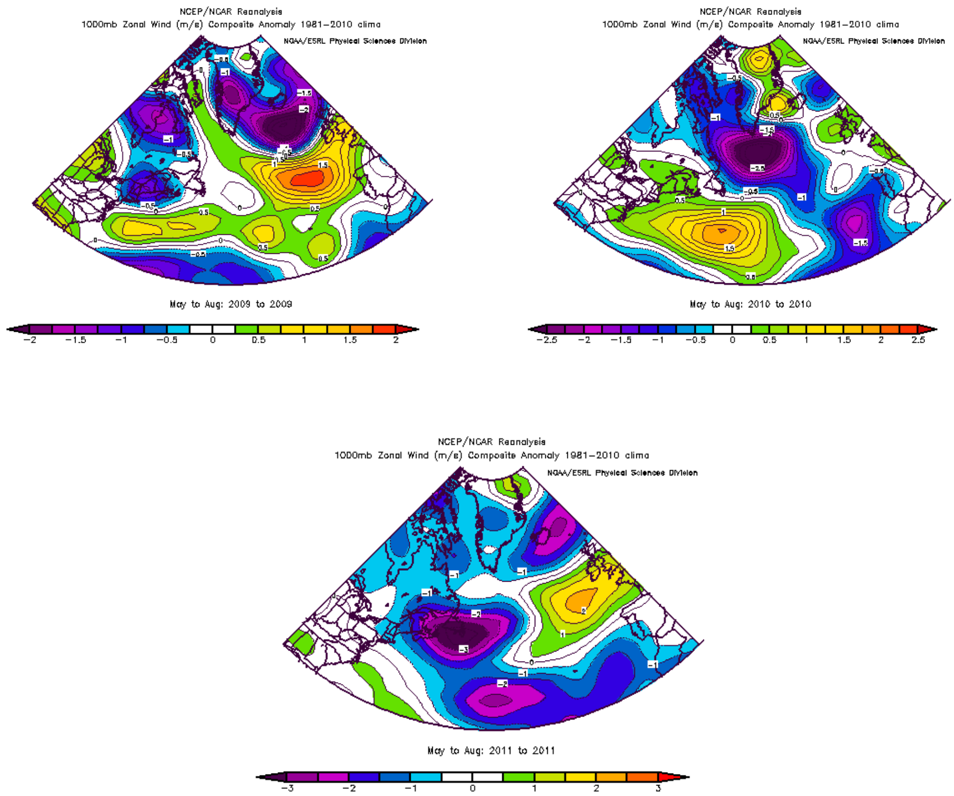

Figure 7. Zonal wind components for the North Atlantic (May–Aug), anomalies from 1981–2010.Top left: 2009; top right: 2010; bottom: 2011.

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 panel in Figure 8).

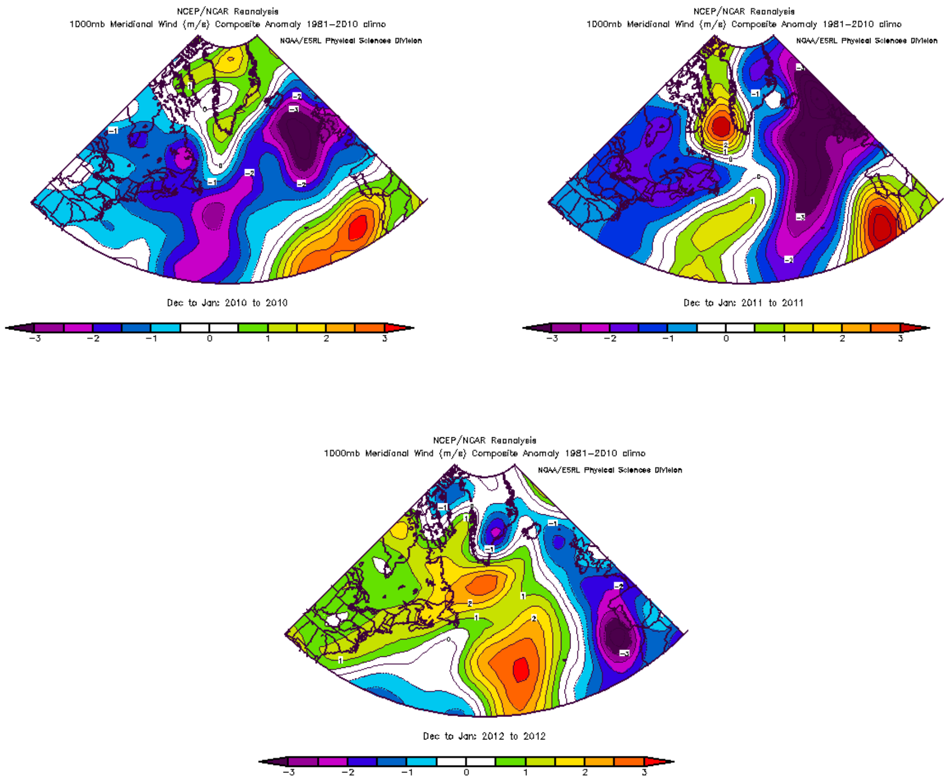

Figure 8. Meridional wind component (Dec–Jan), anomalies from 1981–2010. top left: 2009/2010; top right: 2010/2011; bottom: 2011/2012;

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 poundnet 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 gillnets, poundnets, 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 bycatch 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 bycatch 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 is accessible in shallow waters facilitating the use of the main gear types, pound and gillnets. Bycatches 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 gillnets. 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. Bycatch in this fishery is considered insignificant.

Snow crabs are caught in traps in areas 62–70ºN. Problems with bycatch 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 1992–2000s. 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 100 000 tonnes. The shrimp fleet is close to or above 80 BT and 75% of the fleet process the shrimp on board. Shrimp trawls are used with a minimum mesh size of 44 mm and a mandatory sorting grid (22 mm) to avoid bycatch 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 bycatch. However, when juvenile fish are caught, even small biomasses can correspond to relatively large numbers.

Longliners are operating on both the East and West coast with Greenland halibut and cod as targeted species. Bycatches 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 bycatch 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 1950s and 1960s landed large catches of cod reaching historic high in 1962 with about 450 000 tonnes. The offshore stock collapsed in the late 1960s–early 1970s due to heavy exploitation and possibly 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 tonnes. The stock decreased thereafter and is now at the low 1990 level with an advised TAC for 2015 of 60 000 tonnes. The advised TAC for 2016 increased to 90 000 tonnes.

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-1990s and offshore since 1999. Total landings have since 2010 been reported at around 2000 tonnes a decrease from a high level in 2001 at 15 000 tonnes. 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-1980s to the start 1990s landings were between 4–600 tonnes yearly, increased to around 2000 tonnes in late 1990s. Catches decreased again and is below 600 tonnes in 2014. The fishery is based on license and is exclusively at the west coast between 20–60 m. The growth rate is considered very low reaching the minimum landing size on 65 mm 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 three different stocks, based on spawning areas and genetics, are the basis for the cod fishery and the following management is therefore recommended for different three areas: a) inshore in Western Greenland (NAFO Subdivision 1A–1F), b) offshore Western Greenland (NAFO Subdivision 1A–1E) and offshore Eastern and South Greenland (ICES Subarea 14.b and NAFO Subdivision 1F). Current landings for inshore cod are 35 000 tonnes, and have steadily increased since 2009 where landings were 7000 tonnes. Landing from offshore Western Greenland was minor (less than 500 tonnes since 2006) until 2015 where catches increased to 4600 tonnes. From offshore Eastern Greenland area 2015 landing was 15 800 tonnes, an increase from the 2011–2013 level at 5000 tonnes.

Catches are high compared to the last three decades; however, they are only a fraction of the landings caught in the 1950s and 1960s. Recruitment has been negligible since the 1984- and 1985-year classes, though it has improved in the last decade, especially inshore, where the 2009 YC is the best seen in the time-series since 1982. In 2007 and 2009, dense concentrations of unusually 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 despite an increased fishing effort in later years. However, in 2015 signs of increasing fishing pressure is seen as the biomass index in the inshore survey is stable and recruitment is low.

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 catches in 2010–16 being around 8000 tonnes. This includes both redfish species. The majority (e.g. ~70%) has earlier been identified as *S. mentella*. However, recent East Greenland survey estimates indicate a decline in *S. mentella* while *S. norvegicus* is increasing, and based on samples from the fishery the proportion of *S. norvegicus* exceeded *S. mentella* in 2016 for the first time.

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 tonnes 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 tonnes annually (15 000 tonnes 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. In 2015, catches were around 9400 tonnes.

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 tonnes 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 East coast an offshore pelagic fleet have been conducting a fishery on capelin (2500 tonnes (summer/autumn) landed in 2015 by Greenland, EU, Norway and Iceland). The capelin has shifted distribution more west and north in recent years, and are believed to spend 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 tonnes and increased to more than 32 000 tonnes in 2015. 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 9000 tonnes. The herring has shifted distribution more west in recent years.

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14 Cod (*Gadus morhua*) in NAFO Subdivisions 1A–1E (Offshore West Greenland)

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), (Figure 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 14) 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 1990s (Table 14.2.1, Figure 14.2.1). More details on the historical development in the fisheries are provided in the Stock Annex.

14.2.2 The fishery in 2019

In the period 2015-2018 a TAC of 5 000 tonnes was introduced as an experimental fishery. Since 2015 it has been allowed to fish offshore on the inshore quota.

In 2019 the start TAC was 0 tons, but during the year 2 000 tons were allocated from the inshore TAC. The TAC was allocated with 500 t in each NAFO divisions 1B, 1C, 1D and 1E.

Offshore catches in the fishery in 2019 amounted to a total of 899 tonnes, of these 476 tonnes where fished on the inshore quota. Main fishing grounds were Tovqussaq Bank (NAFO division 1C, between 66°15–66°30N) where ¾ of the total catch was caught and on Dana Bank (NAFO Division 1D and 1E, between 62°00–63°00N) where ¼ of the total catch was caught (Table 14.2.2.1). Other areas of minor catches was on Narssalik Bank south of Dana Bank (NAFO 1E, figures 14.2.2.1 and 14.2.2.2).

The fishery was conducted from May to December with 70% caught in June-August (Table 14.2.2.1). The catch was taken by 1 longliner (20%) and 2 small trawlers (80%) (table 14.2.2.2).

Length measurement amounted to 3 359 cod measured. Length measurements were taken by crew members directly on the ships.

Overall mean length in the fishery was 63 cm and age 5–8 year old (YC 2011–2014) dominated the catches (table 14.2.2.3, figures 14.2.2.3 and 14.2.2.4).

A detailed description of the fishery is available in Retzel 2020a.

14.3 Surveys

At present, two offshore trawl surveys (Greenland and German) provide the core information relevant for stock assessment purposes.

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 German survey has not been conducted in the area since 2015. However in 2019 the southern part of the survey area (NAFO 1E) was covered.

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, but since 2005 the addition of additional fish stations implies a fair coverage of the West Greenland cod habitat in this survey.

For details of survey design, see stock annex.

In 2018 and 2019 the annual trawl survey was conducted with a chartered vessel. All the standard gear from the research vessel Paamiut (such as cosmos trawl, doors, all equipment such as bridles ect., Marport sensors on doors and headlines) were used, in attempt to make the 2018 and 2019 survey identical as possible with the previous years' survey (Burmeister and Riget, 2018; Burmeister and Riget, 2018).

14.3.1 Results of the Greenland Shrimp and Fish Survey

The numbers valid hauls were 174 in 2019 (Table 14.3.1.1).

The 2019 survey abundance index of Atlantic cod in West Greenland was estimated at 233 million individuals and the survey biomass index at 265 514 tonnes (tables 14.3.1.2 and 14.3.1.3).

Survey abundance increased with 516% and biomass with 2394% compared to 2018. The increase is caused by 2 very large hauls; one located in NAFO divisions 1D resulting in increase in abundance of 1263% and biomass 6016%, and one haul located in NAFO division 1E resulting in increase in abundance of 1812% and biomass 3581% (figures 14.3.1.1 and 14.3.1.2). As a result of these two large hauls CV's are high (55% in abundance and 69% in biomass).

The stock has been dominated by the 2009 YC since 2011 and by the 2010 YC since 2014 (Table 14.3.1.4, Figure 14.3.1.3). The numbers of these yearclasses reduced in 2016, but in the surveys in 2017, 2018 and 2019, they were the highest numbers seen in the survey compared to same ages in previous years.

In 2019 the 4 year old (2015 YC) dominated the survey followed by the 5 and 3 yr olds (2014 and 2016 YC). The 2014 and 2015 YC is more abundant in the southern part of the survey (NAFO 1D and E), whereas younger yearclasses (2017 and 2016 YC), at size range < 30 cm, are more abundant in the northern part of the survey (NAFO 1A, 1B and 1C, table 14.3.1.5, figure 14.3.1.4 and 14.3.1.5). The 3-5 yr olds corresponds to length distribution of 30-50 cm (figure 14.3.1.6). The distribution pattern is similar with previous years with 1 and 2 yr old in the northern part of the survey area, and at age 3 moving further to the south.

The main part of cod found offshore in West Greenland have since the beginning of the survey been younger than 5 years. However, since 2017 increasing numbers of older cod (especially the 2009 and 2010 YC) have been registered in the survey. As the survey takes place outside spawning season information on spawning is limited, however since 2014, increased numbers of spent females compared to immatures have been recorded in the southern part of the survey area 1C-1E (figure 14.3.1.7) confirming that a larger part of the stock is comprised of older cod.

In 2019 a massive increase in numbers and biomass was registered in the southern part of the survey (NAFO 1D and 1E), however interpretation of these findings must be precautious as they are caused by two very large hauls located in each NAFO division. The dominating yearclass is the 2015 YC, and this YC is also dominating the German survey in South Greenland and in NAFO division 1E (Werner & Fock, 2020). Unfortunately, the German survey have not managed to cover the West Greenland area north of NAFO division 1F since 2016 resulting in stock status being solely relying on the Greenland survey.

14.3.2 Results of the German groundfish survey

Due to technical problems and weather issues , the German survey did not manage to cover the West Greenland area in 2016, 2017 and 2018. In 2019 the survey managed to cover the southern part (NAFO 1E, strata 3). Results from the time series are shown in tables 14.3.2.1, 14.3.2.2, 14.3.2.3, 14.3.2.4, and 14.3.2.5. The German survey confirmed the findings of the Greenland survey in NAFO 1E, i.e. increasing abundance indices (table 14.3.2.2), a 2015 YC dominating the area and the presence of older yearclasses (table 14.3.2.6). The abundance indices pr station is similar to the stations taken in NAFO 1F (strata 4, figure 14.3.2.1).

14.4 Information on spawning

Before 2017 no spawning of significance has been documented on the banks in West Greenland (Retzel, 2015).

In 2017 and 2018, fishing was allowed outside a box covering Dana Bank in April and May with requirements of increased collection of biological sampling in order to investigate the maturity stage of the fish caught. In addition samples of whole cod was sent to GINR for investigation of maturity. In general, the majority of the cod sent to GINR from the commercial fishery in NAFO division 1C and 1D were spawning (Retzel, 2018).

In 2019 (just prior to the NWWG meeting) a pilot cruise with GINR small research vessel Sanna was undertaken on Tovqussaq Bank in NAFO 1C with the objection to locate and investigate spawning on the bank in combination with tagging of spawning cod. The survey found actively spawning cod with several yearclasses being part of the spawning stock (Retzel 2020b). Genetic analyses of samples from spawning cod will be analysed during 2020/2021.

14.5 Tagging experiments

A total of 24 919 cod have been tagged in different regions of Greenland in the period of 2003–2019 (Table 14.5.1). Cod on two banks in West Greenland have been tagged; 2 667 on Tovqussaq bank in NAFO division 1C and 6 649 on Dana Bank in NAFO division 1D+1E.

40% of recaptured fish tagged recently on the West Greenland banks are recaptured in the same area as tagged, 20 % are recaptured inshore and 40% are recaptured in East Greenland/Iceland (table 14.5.2). The majority of recaptures are tagged on the southern Dana Bank (NAFO 1E) while very few recaptures are tagged on Tovqussaq Bank which is located further to the north in NAFO 1C. None of the recaptured cod tagged on Tovqussaq Bank (NAFO 1C) have been recaptured in East Greenland or Iceland.

Limited fishing in several areas and years 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 1970s and collapsed in the 1990s. The surveys showed only an increase in biomass until 2015 and has since 2016 been low. 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.

Until 2015, the 2009 and 2010 YCs have been caught in considerable numbers in the survey. Since then few cod older than 3 yrs and larger than 40 cm have been caught especially in 2018. The fishery between 3000–5000 tonnes in 2015–2017 primarily fished the 2009 and 2010 YC's. The reason for the reduction of the 2009 and the 2010 YC in 2016 is considered to be caused by a combined effect of migration out of the area and fishery. However, abundance indices in the Greenland survey of these yearclasses are highest observed in the survey in 2017-2019 compared to same ages in previous years.

The stock is considered to be at a very low level compared to historic.

As described in Section 1.3, MSY proxies should be evaluated to determine stock status. ICES suggested four methods for this purpose, and all methods were tested on the stock (Hedeholm, 2017; ICES, 2017). All the length based indicators rely heavily on length distributions from the commercial fishery. For this stock, the fishery has been very limited since the early 1990 collapse. Hence, commercial data are limited and not really suited for such analysis; especially with the general assumptions of no migration underlying most of the approaches.

With these shortcomings, the results from all analysis support the general notion from surveys: this stock is at a low level and no fishing should take place until a spawning component is established that is composed of a number of year classes. Spawning investigations in 2017-2019 indicate that a spawning stock composed of several year classes is recovering.

14.7 Implemented management measures for 2020

No fishery is allowed in 2020 in NAFO subdivision 1A–1E. It is however allowed to fish parts of the inshore West Greenland quota in the offshore West Greenland areas.

14.8 Management plan

There is no management plan for the offshore fishery in NAFO Subdivision 1A–1E.

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.

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.

From 2016 it is allowed to fish parts of the inshore West Greenland quota in the offshore West Greenland areas. These catches are additional to the offshore TAC, and have been around 600 tonnes annually.

14.10 Basis for advice

Basis for advice is the precautionary approach where biomass is extremely low and ICES advised zero catch for 2020 and 2021.

14.11 Benchmark 2022

The stock is proposed to go through a benchmark in 2022.

Survey indices are variable and recent decline in offshore indices coincides with historic high catches inshore. Genetic analysis of inshore catches in this period revealed that 30% of the inshore catches belonged to the offshore WestGreenland cod stock. Further analysis of the genetic composition in combination with tagging studies is needed to gain further insight into migration pattern across areas and year classes.

Survey trends are basis for advice. Zero advice have been given for several decades. Data on spawning indicate stock is reproducing and spawning stock is established. Genetic data suggest large migration and mixing with the inshore cod stock (cod.21.1, Christensen, 2019). Aim of the benchmark is either:

- Scenario 1: Treat the inshore (cod 21.1) and offshore West Greenland stocks together in an combined analytical assessment.
- Scenario 2: Define criterions on data to base advice on other than survey trends.

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14.13 Tables

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	

Year	NAFO 1A	NAFO 1B	NAFO 1C	NAFO 1D	NAFO 1E	NAFO 1F	Unknown NAFO div.	NAFO 1A–1E
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*

Year	NAFO 1A	NAFO 1B	NAFO 1C	NAFO 1D	NAFO 1E	NAFO 1F	Unknown NAFO div.	NAFO 1A–1E
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*
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

Year	NAFO 1A	NAFO 1B	NAFO 1C	NAFO 1D	NAFO 1E	NAFO 1F	Unknown NAFO div.	NAFO 1A–1E
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
2015	0	0	341	954	3564	3984	0	4860
2016	0	0	67	1911	1762	2335	0	3740
2017	0	1	1442	730	852	2560	0	3025
2018	0	0	1988	678	1521	1820	0	4187
2019	0	0	656	57	186	916	0	899

[1] Estimates for assessment include estimates of unreported catches. The total estimated value for West Greenland (inshore + offshore) was 73 000 t in 1977 and 1978, 1979: 99 000 t, 1980: 54 000 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: 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					44	33	123	367	85	4			**656**	73%
1D									7	36	14		**57**	6%
1E	19						4		54	52	49	8	**186**	21%
Total	**19**				**44**	**33**	**127**	**367**	**146**	**92**	**63**	**8**	**899**	
%	2%				5%	4%	14%	41%	16%	10%	7%	1%		

Table 14.2.2.2: Cod catches (t) by gear, area and month in West Greenland.

Gear	NAFO	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Longline	1C										3			**3**
	1D										36	14		**50**
	1E	19									52	49		**120**
	Total	**19**									**91**	**63**		**173**
Trawl	1C					44	33	123	367	85	1			**653**
	1D									7				**7**
	1E							4		54			8	**66**
	Total					**44**	**33**	**127**	**365**	**146**	**1**		**8**	**726**

Table 14.2.3.1. Cod in Greenland. Catch at age ('000) and Weight at age (kg) for offshore fleets in West Greenland (NAFO 1A–1E).

CATCH AT AGE								
Year/age	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10+**
2007	6	167	66	42	6	1		
2008								
2009								
2010								
2011								
2012	8	33	107	38	18	2	0.01	0.003
2013		15	44	113	29	15	4	1
2014	1	18	45	7	9	2	0.02	
2015	6	67	502	1061	240	158	45	16
2016	1	12	198	923	490	69	20	5
2017	2	20	132	340	532	272	55	23
2018		37	130	521	600	434	173	51
2019		29	56	54	74	80	32	15
WEIGHT AT AGE								
2007	0.647	0.906	1.949	3.440	5.817	6.053		
2008								
2009								
2010								
2011								
2012	0.560	0.935	1.395	2.139	3.232	4.194	8.325	12.500
2013		1.120	1.462	1.947	2.978	3.754	6.398	7.342
2014	0.488	0.693	1.199	1.738	3.040	4.817	5.318	
2015	0.474	0.734	1.316	1.982	3.186	5.043	7.167	10.329
2016	0.345	0.810	1.237	1.931	2.560	4.299	5.573	7.947
2017	0.404	0.776	1.230	1.580	2.138	2.830	4.340	7.091
2018		0.813	1.114	1.562	1.988	2.807	3.259	4.445
2019	0.390	1.008	1.500	1.997	2.646	3.126	4.006	6.895

Table 14.3.1.1. Number of hauls in the Greenland Shrimp and Fish survey in West Greenland by year and NAFO sub-divisions.

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
2015	0	70	49	24	22	21	186
2016	0	59	38	26	14	19	156
2017	3	99	52	25	18	25	222
2018	0	78	42	26	23	20	189
2019	0	86	36	20	18	14	174

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
2015		6542	11213	27248	31703	26980	103685	33
2016		4892	3243	6961	1564	3437	20096	26
2017	451	2562	4302	15723	4877	6305	34220	35
2018		2725	14808	8019	6449	5889	37890	16
2019		3820	9124	19828	87909	112591	233272	55

Table 14.3.1.3. Cod biomass indices (tonnes) 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
2015		3463	4456	19705	33169	40525	101318	36
2016		2256	1174	5817	1347	2697	13290	32
2017	697	1273	1254	14111	3032	4721	25088	49
2018		1084	2108	2369	2796	2289	10646	20
2019		1350	1778	7123	171005	84258	265514	69

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
2015	0	2210	3932	15038	21509	34766	21117	1196	348	70	12
2016	0	1155	5103	2746	5680	3487	1442	418	56	0	0
2017	0	1214	6926	7128	3917	7452	5384	1905	288	6	0
2018	26	9205	9008	13155	4312	639	601	264	564	123	28
2019	290	147	14629	36174	107093	47797	10544	9593	5590	614	800

Table 14.3.1.5 Abundance indices ('000) by age and NAFO divisions from the Greenland Shrimp and Fish survey in West Greenland. NAFO division 1E furthest to the south.

WEST GREENLAND											
Year class	2019	2018	2017	2016	2015	2014	2013	2012	2011	2010	<2009
Age	0	1	2	3	4	5	6	7	8	9	10+
Div. 0A											
Div. 1A			952	2133	529	76	7	57	6	14	46
Div. 1B	0	80	5130	2932	699	205	26	52	0	0	0
Div. 1C	0	0	6348	8789	2174	1220	456	290	382	140	30
Div. 1D	0	33	1475	5606	36129	28832	6301	5345	3282	375	531
Div. 1E	290	33	724	16714	67562	17465	3755	3850	1920	85	193

Table 14.3.1.6 Mean weight of cod 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	0.002	0.031	0.146	0.298	0.596	1.208	1.800	3.338			
2006	0.004	0.025	0.120	0.338	0.477	0.680	2.581	2.714			
2007	0.002	0.026	0.138	0.320	0.601	1.446	4.375				
2008	0.006	0.025	0.098	0.239	0.497	0.939	1.774	2.742			
2009		0.024	0.104	0.329	0.620	1.353	2.103				
2010	0.003	0.017	0.136	0.291	0.683	1.191	1.952	3.066			
2011	0.001	0.038	0.164	0.377	0.626	1.151	2.081				
2012		0.019	0.137	0.419	0.763	1.200	1.371	3.396			
2013		0.038	0.112	0.337	0.611	0.781	1.722	2.905	3.560	6.460	
2014		0.014	0.133	0.300	0.675	0.977	1.708	2.704	4.108	5.710	9.245
2015		0.011	0.102	0.349	0.623	1.062	1.594	2.478	4.276	5.308	9.065
2016		0.028	0.094	0.314	0.711	1.145	1.742	2.542	3.844		
2017		0.015	0.097	0.262	0.622	1.009	1.404	1.843	3.254	5.345	
2018	0.003	0.012	0.078	0.272	0.551	0.867	1.409	1.923	2.536	3.419	3.529
2019	0.001	0.016	0.099	0.279	0.601	1.017	1.455	2.048	2.283	2.119	5.314

Table 14.3.2.1 ***German survey*****. Numbers of valid hauls by stratum in West Greenland (NAFO 1C–E): No survey in 2016, 2017 and 2018. 2019: only strata 3 covered.**

Year	NAFO 1C		NAFO 1D		NAFO 1E		Sum
	Str 1.1	Str 1.2	Str 2.1	Str 2.2	Str 3.1	Str 3.2	
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

Year	NAFO 1C		NAFO 1D		NAFO 1E		Sum
	Str 1.1	Str 1.2	Str 2.1	Str 2.2	Str 3.1	Str 3.2	
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
2015	7	7	7	4	5	5	35
2016	.	.	.	.	3	2	.
2017	.	.	.	.	.	.	.
2018	.	.	.	.	.	.	.
2019	.	.	.	.	9	7	

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: No survey in 2016, 2017 and 2018. 2019: only strata 3 covered. * Calculated by Greenland.**

Year	NAFO 1C		NAFO 1D		NAFO 1E		Sum	SD
	str1_1	str1_2	str2_1	str2_2	str3_1	str3_2		
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

Year	NAFO 1C		NAFO 1D		NAFO 1E		Sum	SD
	str1_1	str1_2	str2_1	str2_2	str3_1	str3_2		
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
2015	13315	906	73434	471	2432	102	90660	73453
2016	.	.	.	.	.	.	.	.
2017	.	.	.	.	.	.	.	.
2018	.	.	.	.	.	.	.	.
2019*					13032	59		

Table 14.3.2.3 *German survey,* Cod biomass indices (tonnes) from the German survey in West Greenland (NAFO 1C–1E) by year and stratum: No survey in 2016, 2017 and 2018. 2019: only strata 3 covered.

Year	NAFO 1C		NAFO 1D		NAFO 1E		Sum	SD
	str1_1	str1_2	str2_1	str2_2	str3_1	str3_2		
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

Year	NAFO 1C		NAFO 1D		NAFO 1E		Sum	SD
	str1_1	str1_2	str2_1	str2_2	str3_1	str3_2		
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
2015	17221	1105	109073	522	5999	216	134136	108717
2016	.	.	.	.	.	.	.	.
2017	.	.	.	.	.	.	.	.
2018	.	.	.	.	.	.	.	.
2019	.	.	.	.	9	7		2019

Table 14.3.2.4 ***German survey*****, West Greenland (NAFO 1C–E). Age disaggregated abundance indices ('1000): No survey in 2016, 2017 and 2018. 2019: only strata 3 covered.**

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
2015	159	189	1353	10921	16208	43991	16909	708	87	117	8	12	90660
2016	.	.	.	.	.	.	.	.	.	.	.	.	.
2017	.	.	.	.	.	.	.	.	.	.	.	.	.
2018	.	.	.	.	.	.	.	.	.	.	.	.	.

Year	0	1	2	3	4	5	6	7	8	9	10	11+	TOTAL
2019	17	0	0	1191	8374	1843	381	365	328	348	217	27	13091

***) calculated proportionally using age compositions reported by the ICES Working Group on Cod Stocks off East Greenland (ICES, 1984).**

Table 14.3.2.5 *German survey*, West Greenland (NAFO 1C–E). Mean weight at age. No survey in 2016, 2017 and 2018. 2019: only strata 3 covered.

Year	0	1	2	3	4	5	6	7	8	9	10	11+
1982												
1983												
1984												
1985												
1986												
1987												
1988												
1989		34	144	278	874	1636	1456				6535	
1990		20	135	288	474	877	2076					3935
1991		52	157	371	586	873	1173	1711	1260			
1992		61	220	332	797	974						
1993		35	119	356	457	832						
1994		50	157	418	573	1090		2240				
1995			172	410	511							
1996		51	90	480	690							
1997		65	288	360	1032							
1998		49		610	1320							
1999		67	354	658	950		2985					
2000		36	228	431	821							
2001		62	297	651	1229	1063						
2002		55	231	548	821							
2003		114	412	669	1169	1572	2415					
2004		78	314	534	1105	1508	3007					
2005		67	292	830	1254	3066	5383					
2006	21	49	226	543	1166	2314	4099	8710				

Year	0	1	2	3	4	5	6	7	8	9	10	11+
2007	21	121	227	540	937	3051	6899	5600	8010			
2008		52	143	449	738	1581	5246	0	5192			
2009		50	183	431	694	1453	3252	4796				
2010	59	102	294	540	944	1608	2010	6019	3729	8870		11360
2011		234	228	542	1041	1201	3356	4562	6962			
2012	93	135	355	665	1145	2147	3827	5337	7299	9150		
2013		71	269	706	1145	1907	3333	5707	8445	8907	18270	18200
2014			271	574	1099	1698	4118	4929	6418			28180
2015		57	216	697	1242	2003	2597	3211	6428	3145		
2016	.	.	.	.	.	.	.	.	.	.	.	.
2017	.	.	.	.	.	.	.	.	.	.	.	.
2018	.	.	.	.	.	.	.	.	.	.	.	.
2019	.	.	.	.	.	.	.	.	.	.	.	.

Table 14.3.2.6 *German survey*, The abundance indices ('000) by year class/age, 2019. West Greenland. Calculated by Greenland.

Year class	2019	2018	2017	2016	2015	2014	2013	2012	2011	2010	<2009
Age	0	1	2	3	4	5	6	7	8	9	10+
Strat 1 (NAFO 1C)											
Strat 2 (NAFO 1D)											
Strat 3 (NAFO 1E)	17	0	0	1191	8374	1843	381	365	328	348	255

Table 14.5.1. Number of tagged cod in the period of 2003 to 2019 in different regions. Bank (West) = NAFO Division 1D+1E. East Greenland = NAFO Division 1F + ICES Division 14.b.

		TAGGED		
Year	Fjord	Bank (West) NAFO 1C Tovqussaq	Bank (West) NAFO 1D+1E Dana	East Greenland
2003	599			
2004	658			
2005	565			
2006	41			

		TAGGED		
Year	Fjord	Bank (West) NAFO 1C Tovqussaq	Bank (West) NAFO 1D+1E Dana	East Greenland
2007	1137		1061	1047
2008	231			1296
2009	633			526
2010	88			
2011	28			403
2012	86		1563	2359
2013	186		2321	
2014				1203
2015		57		1220
2016		299	998	1912
2017	350	1871	706	
2018		115		
2019	1040	325		

Table 14.5.2: Number of recaptured cod in the period of 2003 to 2019 in different regions. Fjord (West) = NAFO divisions 1B–1F. Bank (West) = NAFO Division 1D+1E. East Greenland = NAFO division 1F + ICES Division 14.

		RECAPTURES		
	Fjord (West)	Bank (West) NAFO 1C Tovqussaq	Bank (West) NAFO 1D + 1E Dana	East Greenland
Fjord (West)	504	1	29	8
Bank (West) NAFO 1C, Tovqussaq		1		4
Bank (West) NAFO 1D+1E, Dana		2	35	
East Greenland			35	118
Iceland	3		41	183

14.14 Figures

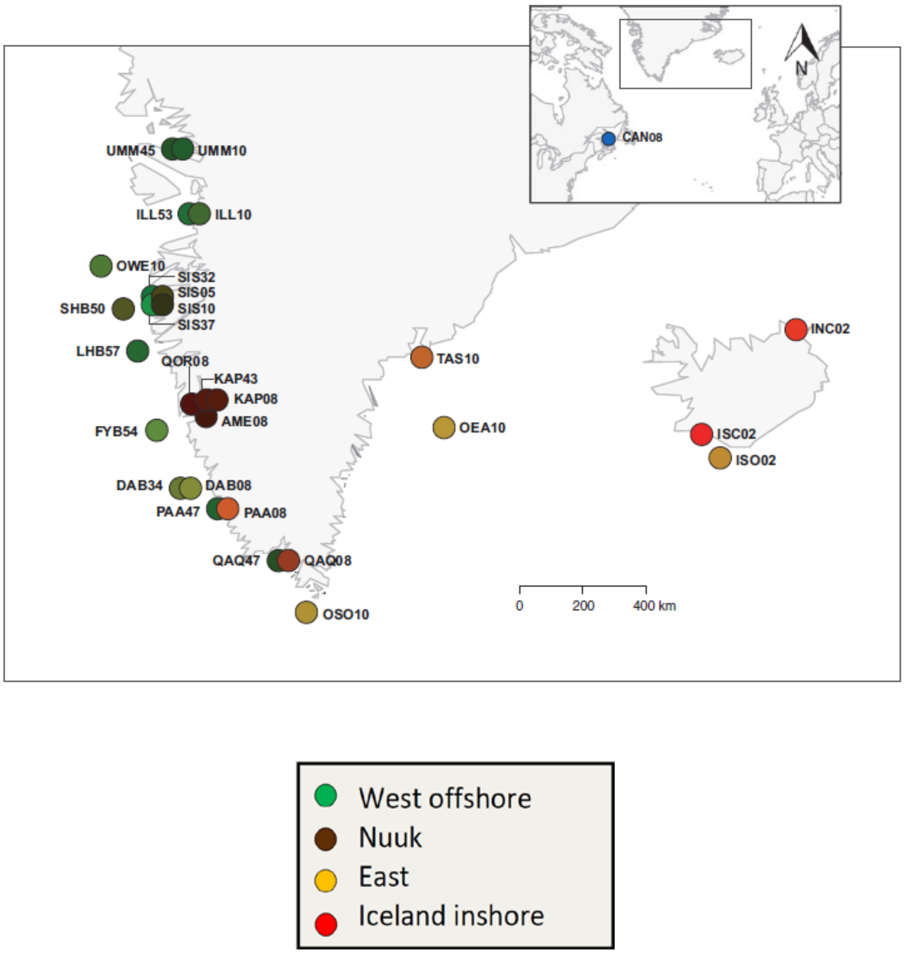

Figure. 14.1. Sampling location of spawning cod in Greenland and Iceland in the genetic project. The colours of the dots represent the blends of sample mean of the different spawning population: West offshore, Nuuk (inshore), East (Greenland and offshore Iceland) and Iceland inshore as signal intensities of green and red, respectively. After Therkildsen et al. (2013).

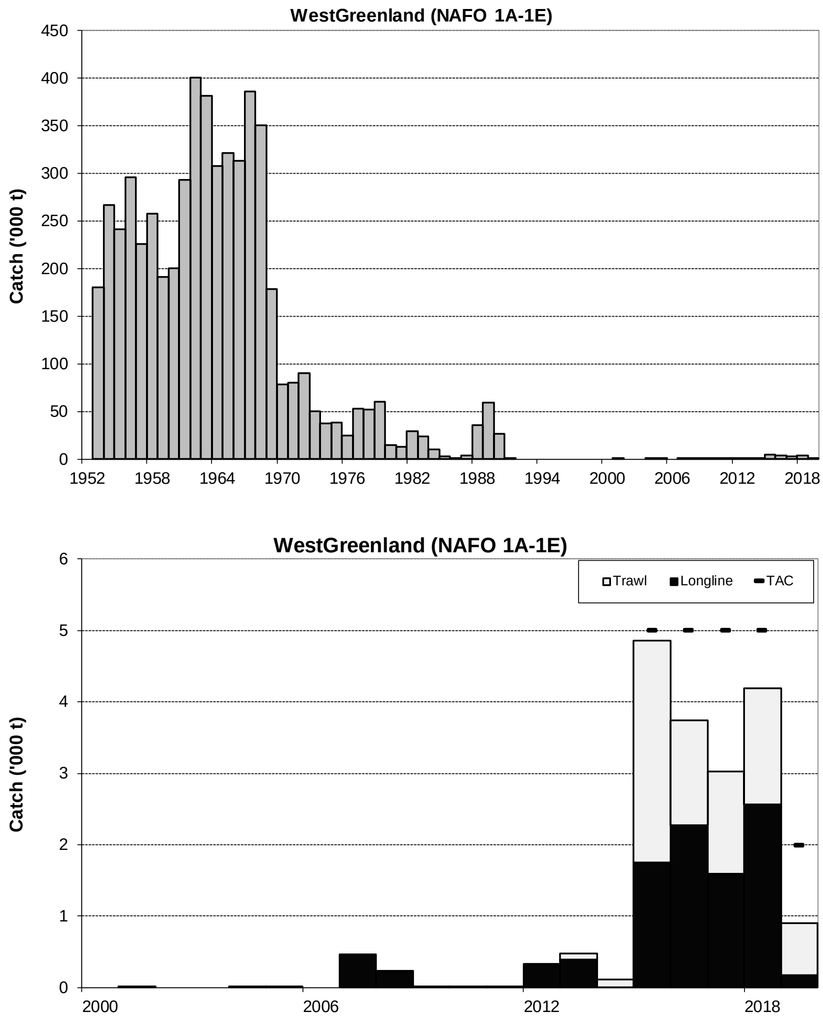

Figure 14.2.1. Annual catch of cod in offshore West Greenland (NAFO subdivisions 1A–1E) used by the Working Group. Top: from 1952, bottom from 2000.

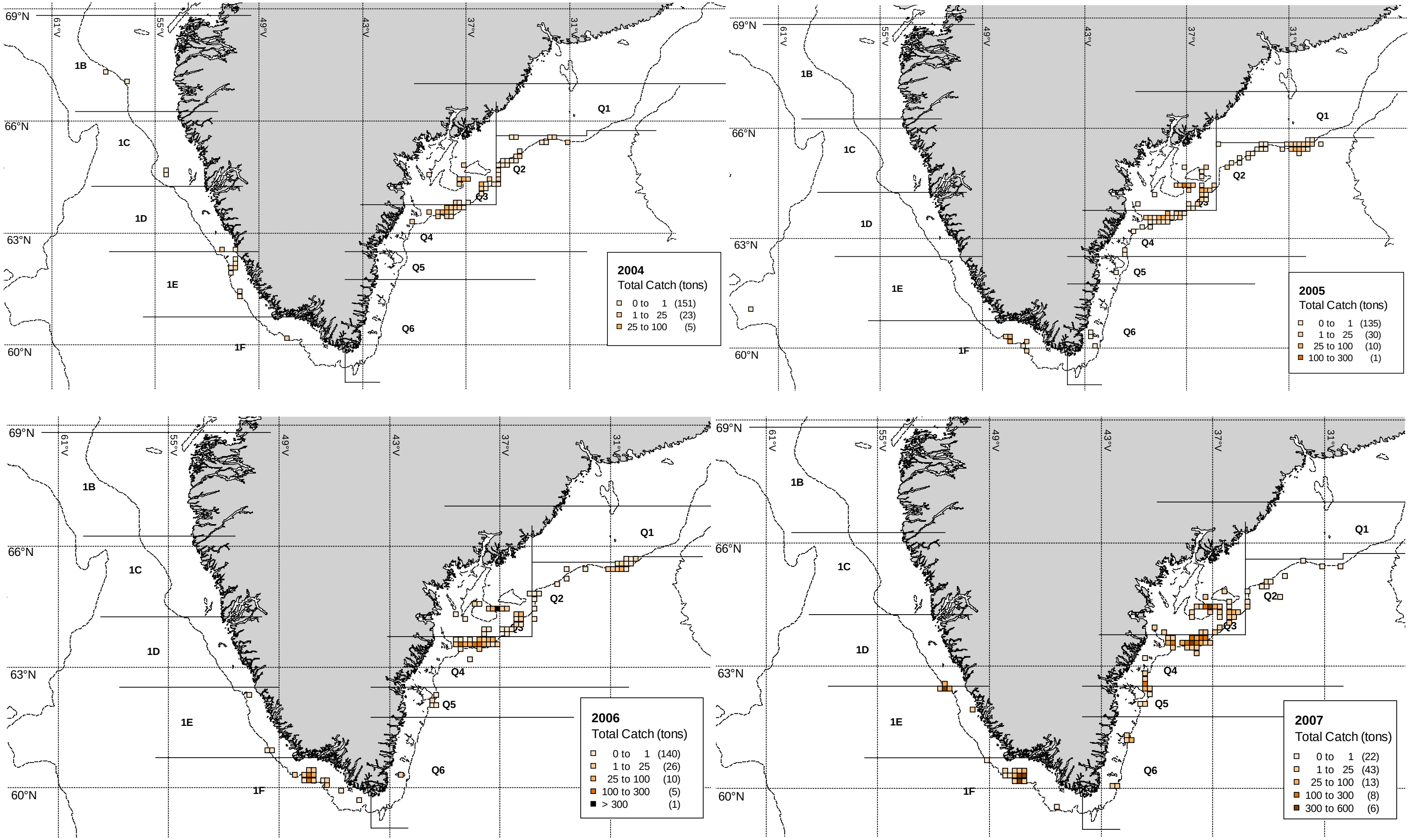

Figure 14.2.2.1: Annual distribution of total catches of Atlantic cod in West and East Greenland. Q1–Q6 illustrates survey areas (strata) in the East Greenland shrimp and fish survey.

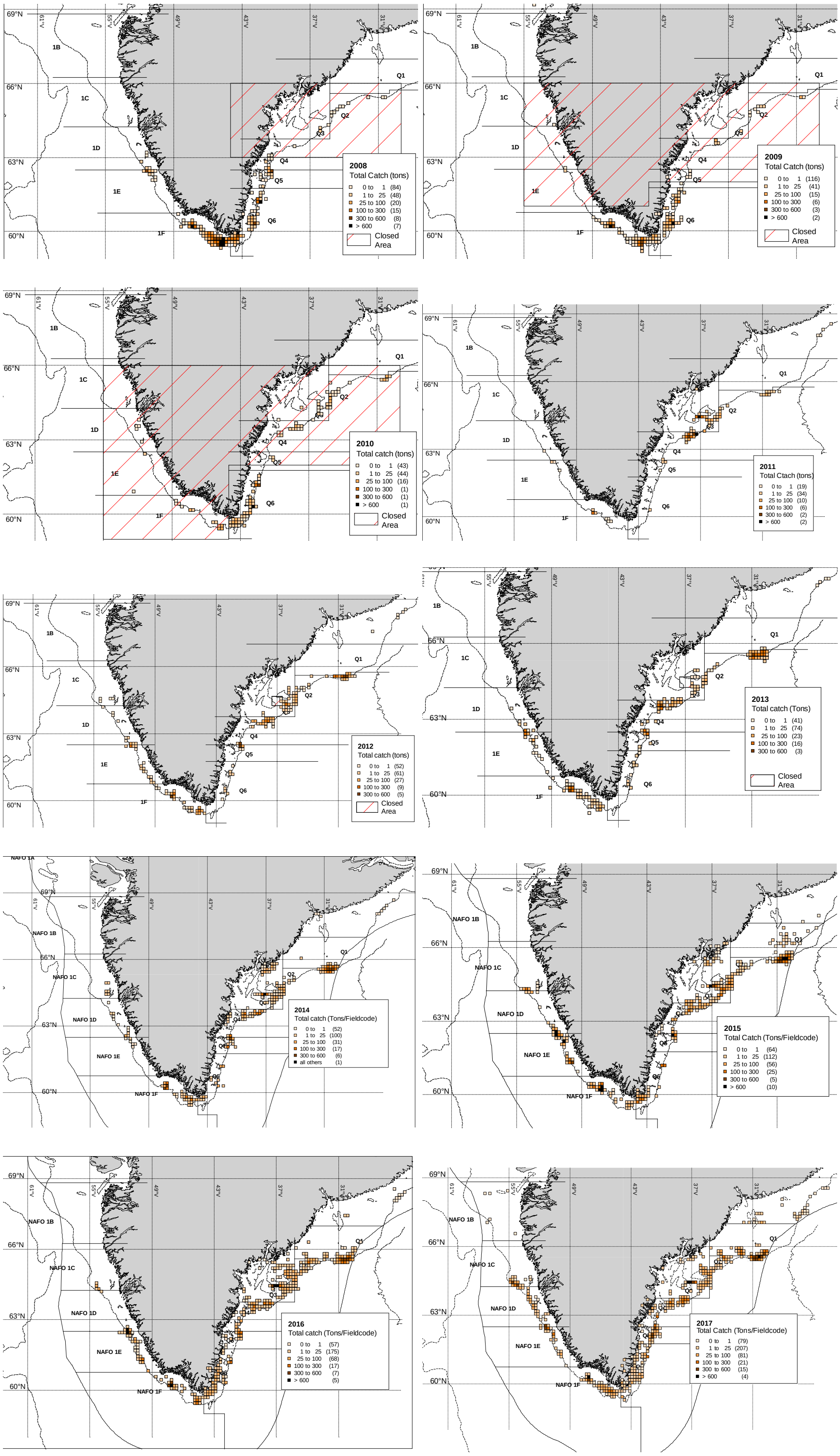

Figure 14.2.2.1: Continued. Annual distribution of total catches of Atlantic cod in West and East Greenland. Q1–Q6 illustrates survey areas (strata) in the East Greenland shrimp and fish survey.

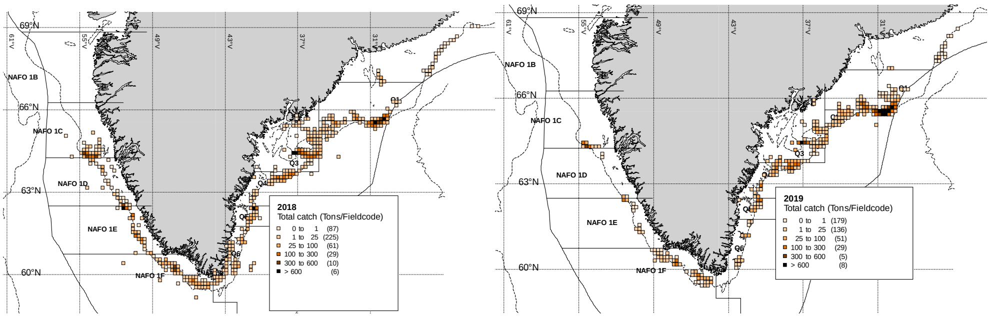

Figure 14.2.2.1: Continued. Annual distribution of total catches of Atlantic cod in West and East Greenland. Q1–Q6 illustrates survey areas (strata) in the East Greenland shrimp and fish survey.

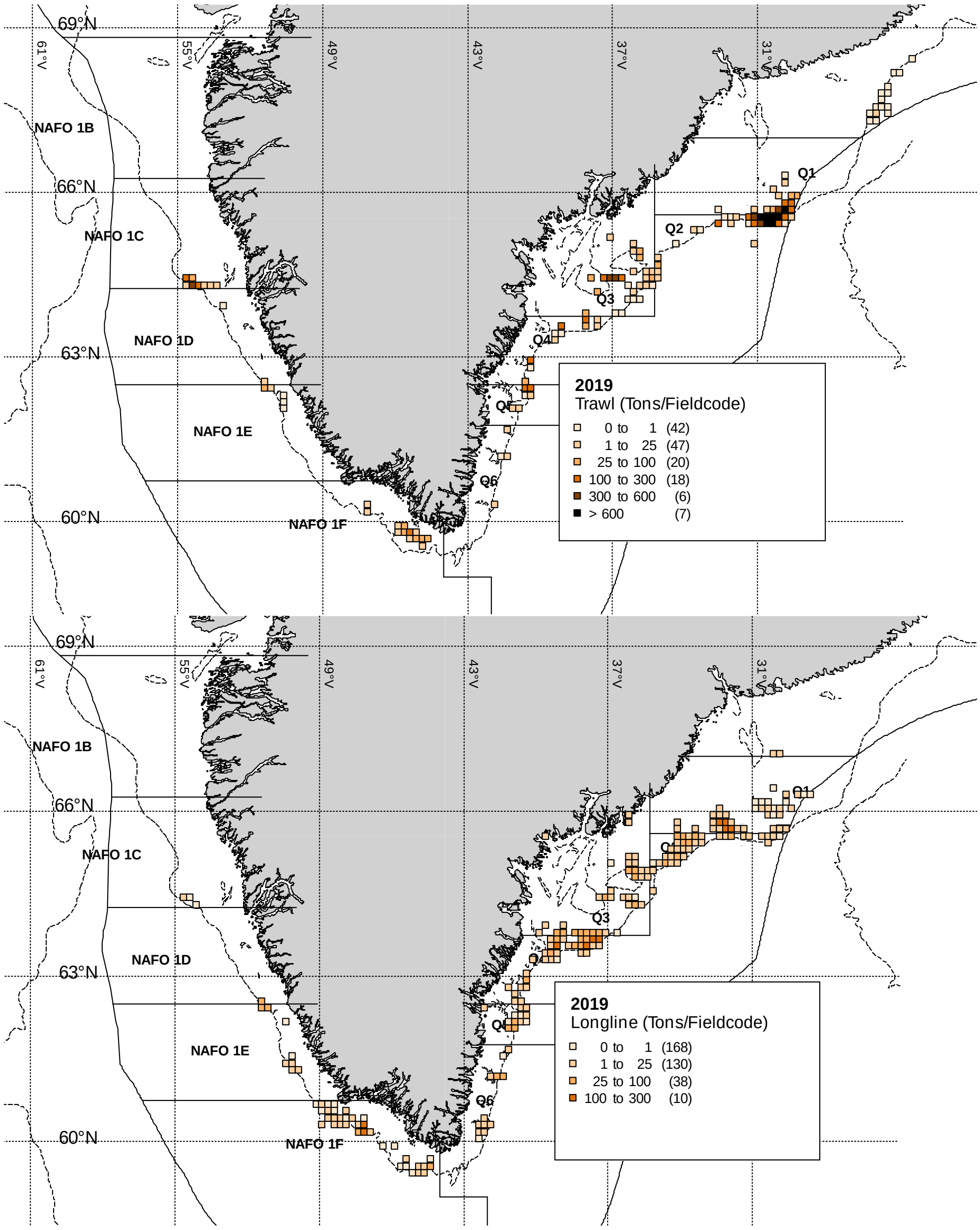

Figure 14.2.2.2: Distribution of Longline and Trawl catches of Atlantic cod in West and East Greenland. Q1–Q6 illustrates survey areas (strata) in the East Greenland shrimp and fish survey.

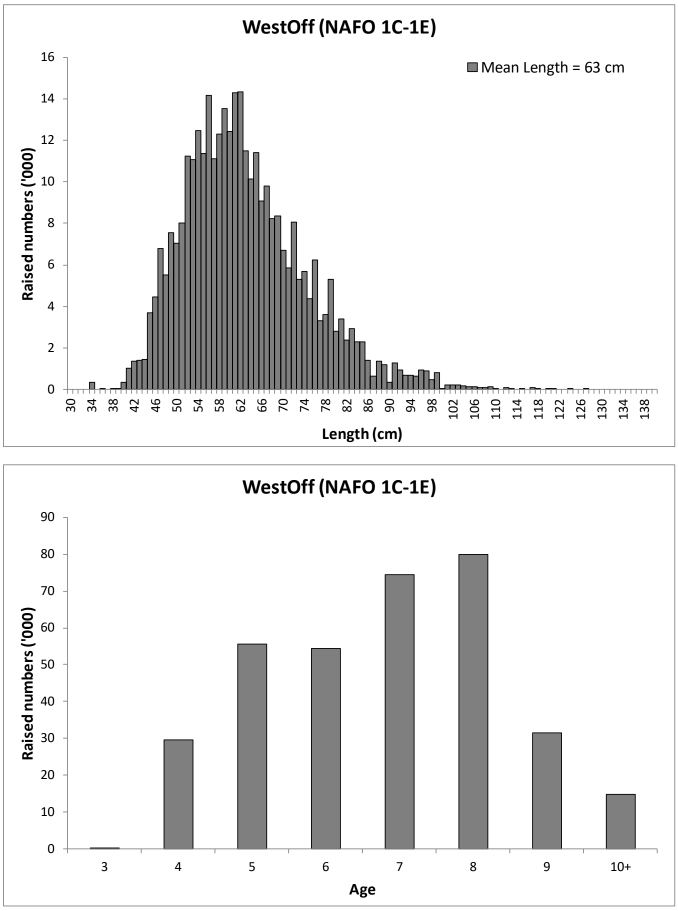

Figure 14.2.3.1: Total length (top) and age (bottom) distributions of commercial cod catches in the West Greenland (NAFO 1C–1E) offshore fishery.

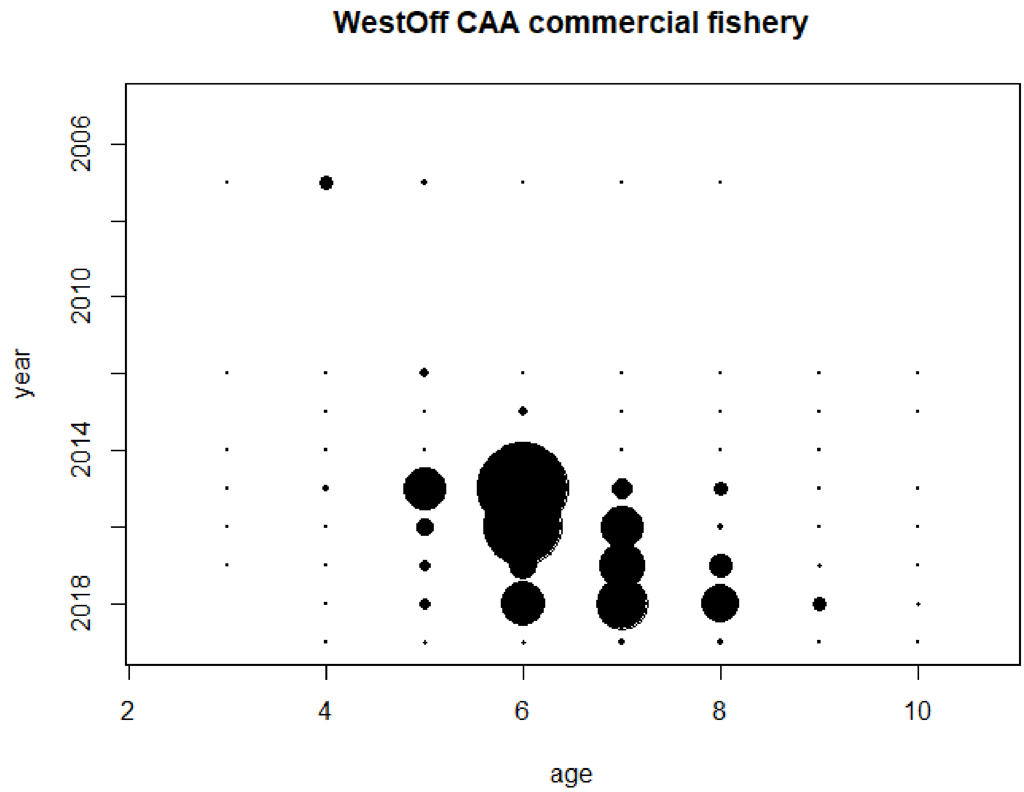

Figure 14.2.3.2: Catch at Age in the West Greenland (NAFO 1A–1E) commercial fishery. Size of circles represents size of catch numbers.

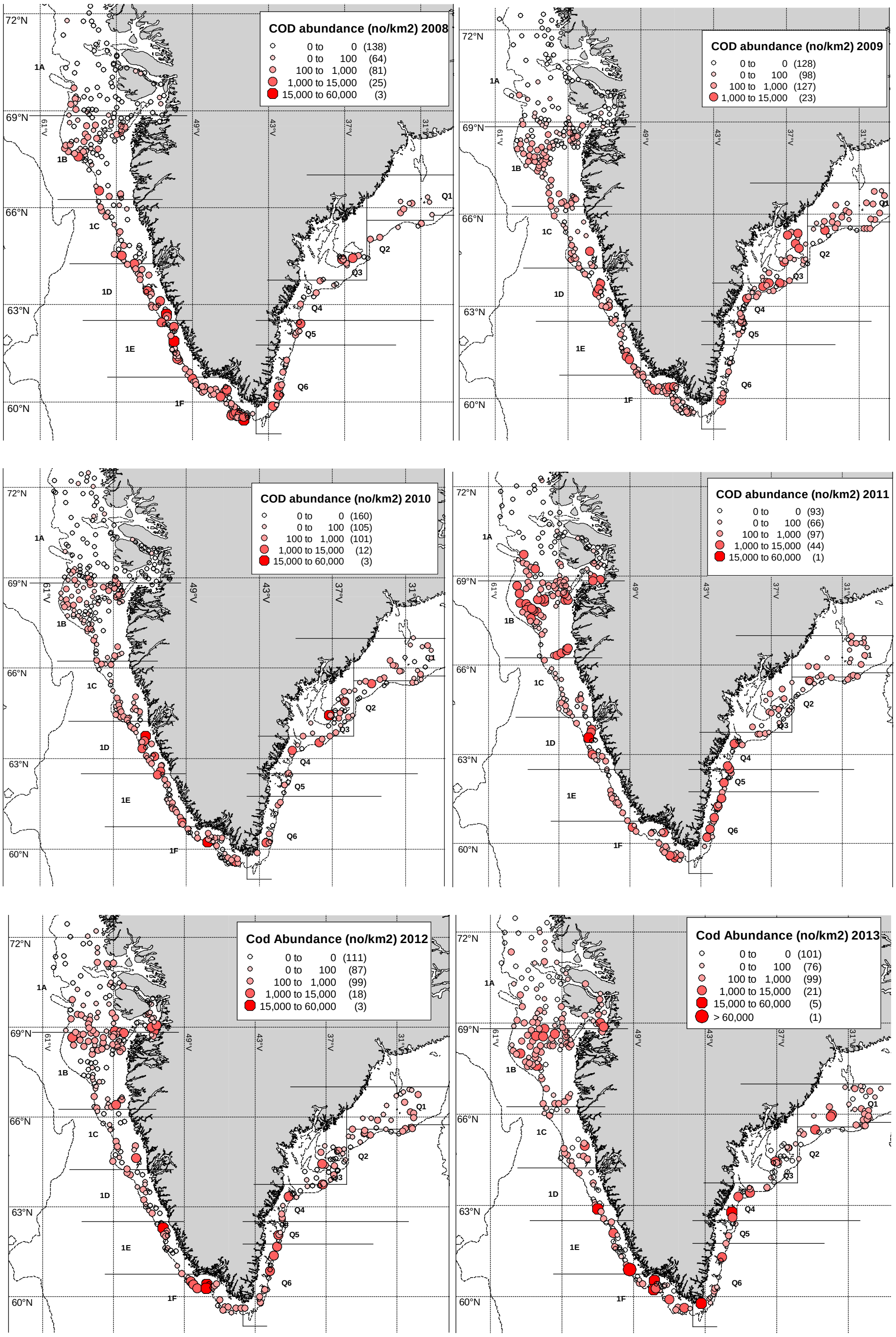

Figure 14.3.1.1. Greenland shrimp and fish survey. Abundance per km².

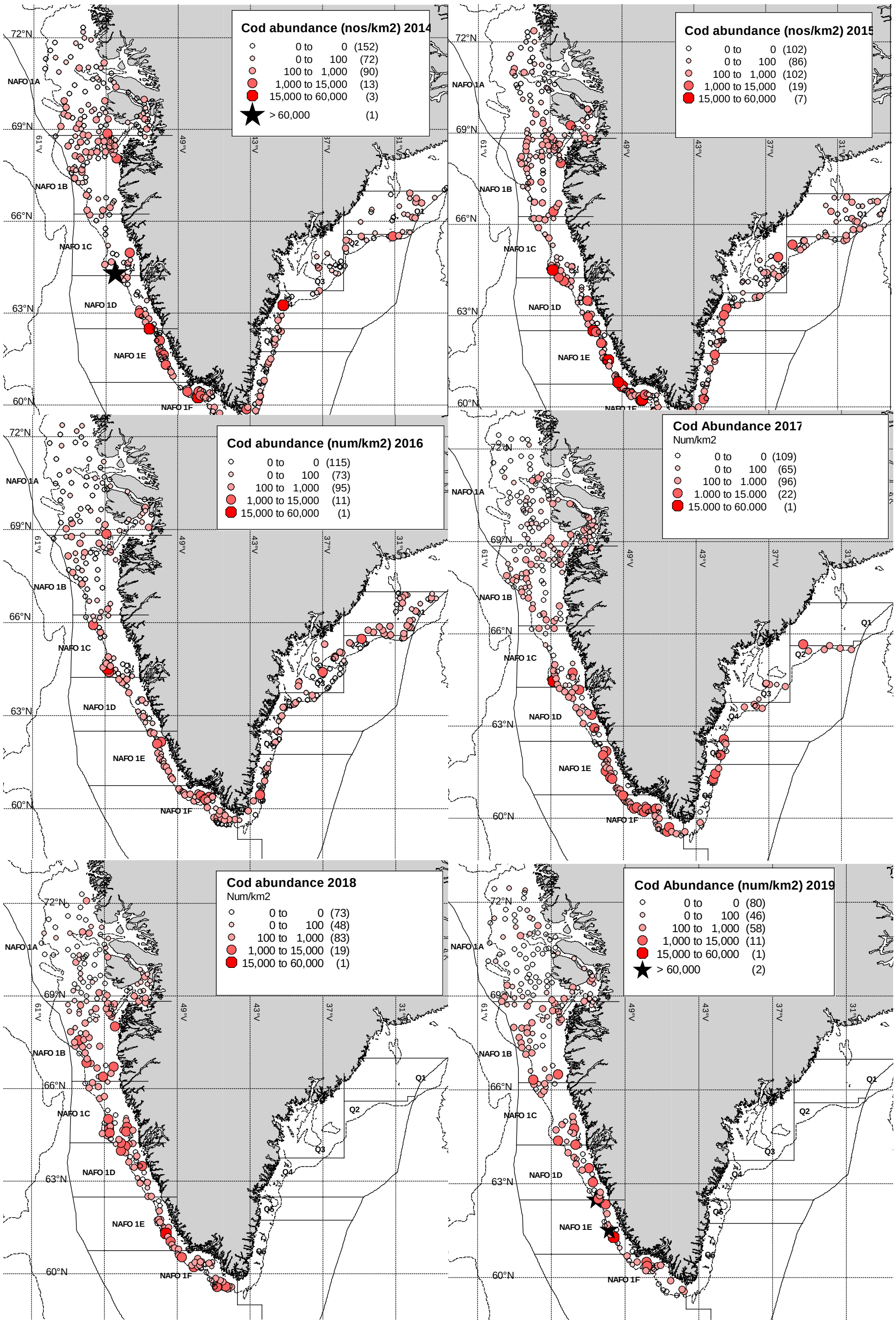

Figure14.3.1.1. continued. Greenland shrimp and fish survey. Abundance per km².

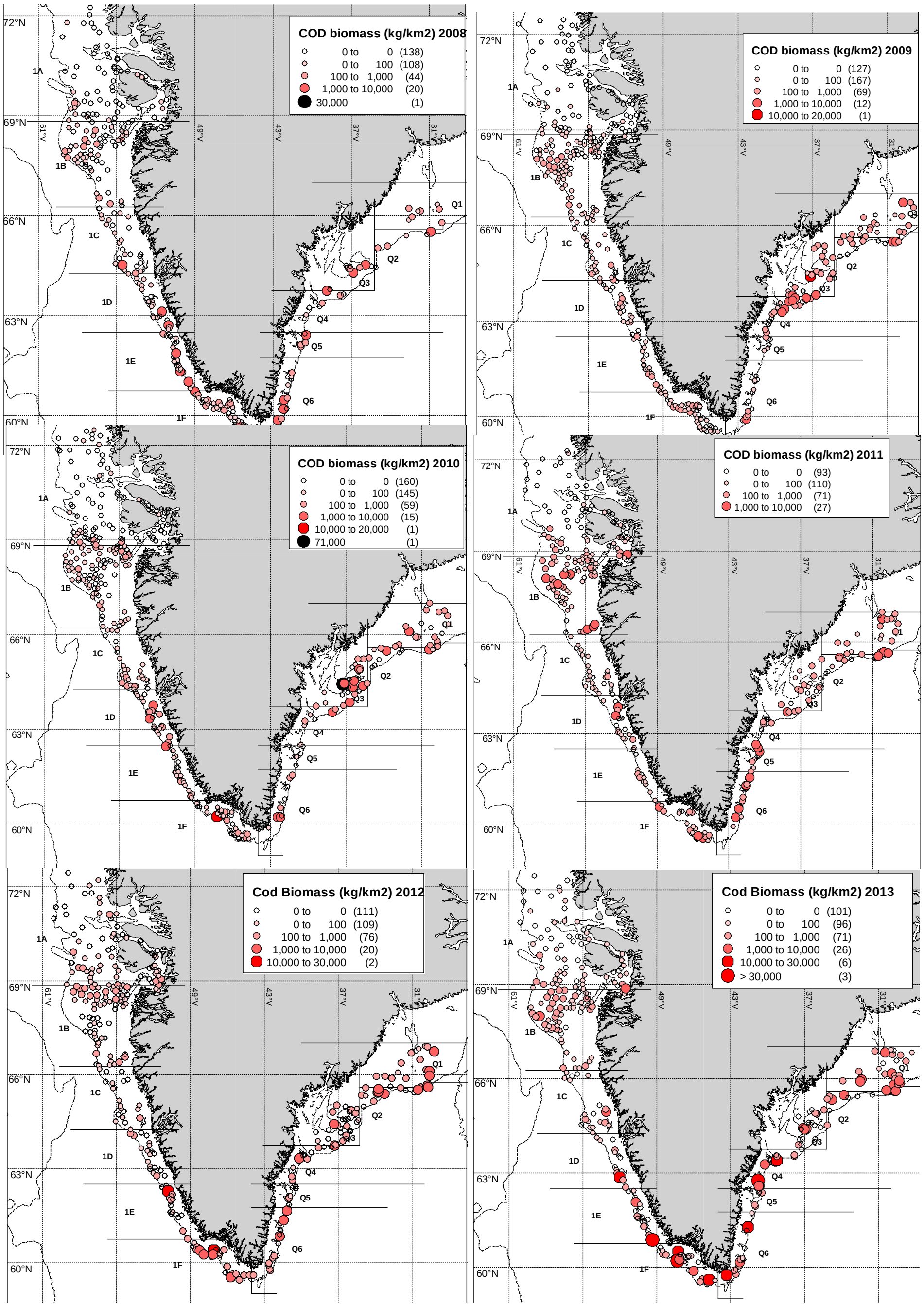

Figure 14.3.1.2. Greenland shrimp and fish survey. Catch weight kg per km².

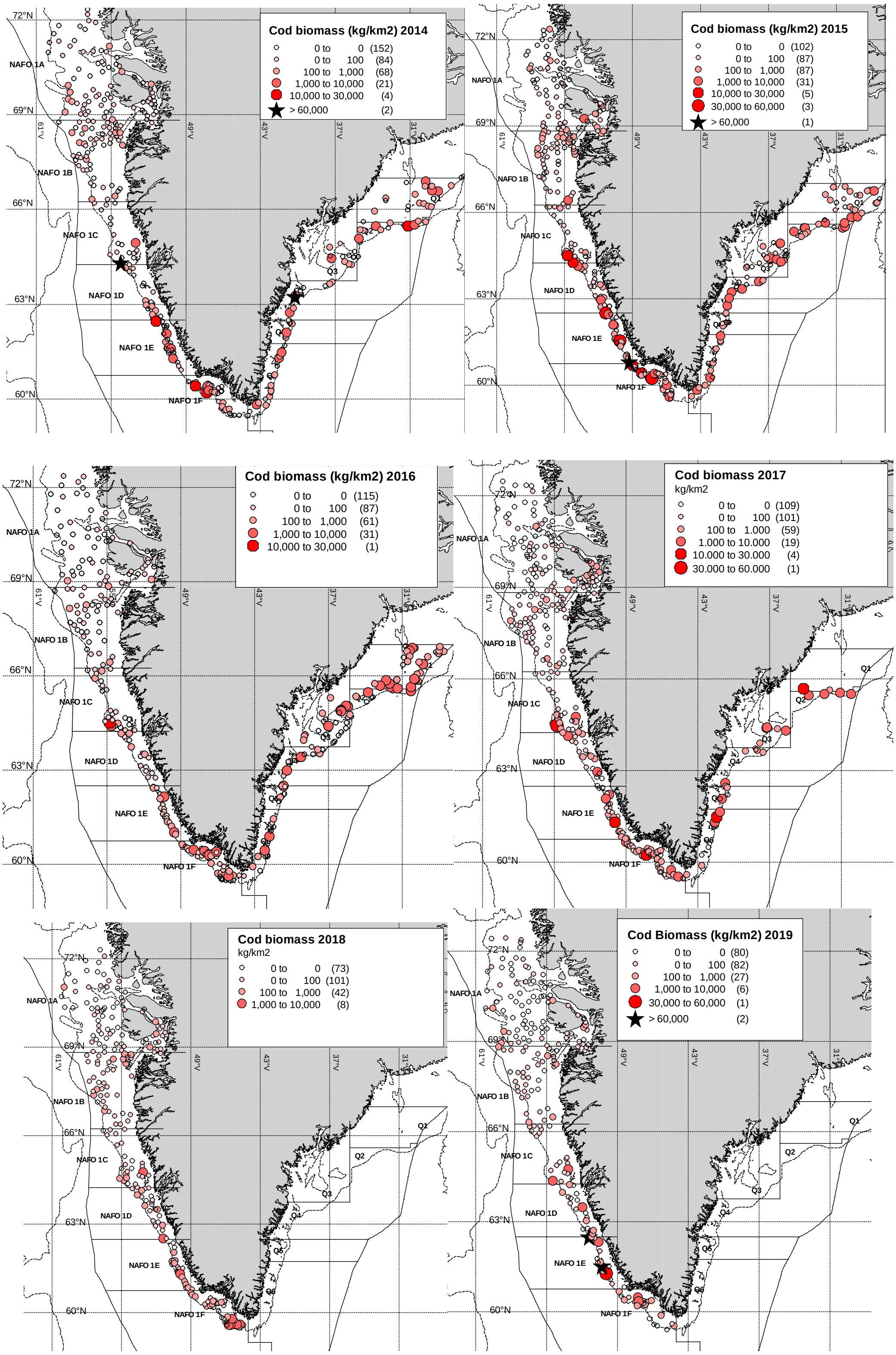

Figure 14.3.1.2. continued. Greenland shrimp and fish survey. Catch weight kg per km².

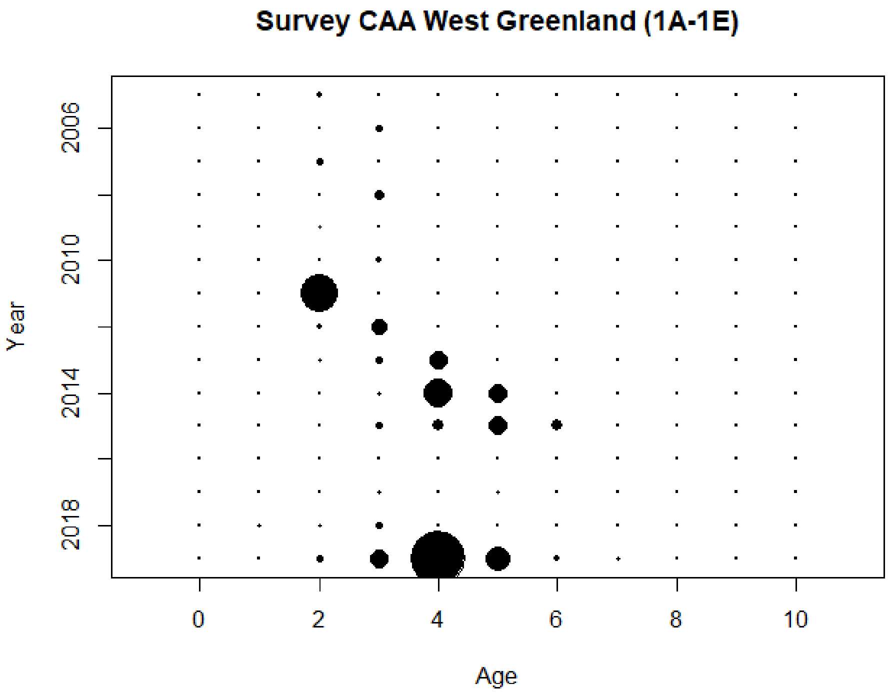

Figure 14.3.1.3: Abundance index by age in NAFO 1A–1E combined. Size of circles represents index size of index.

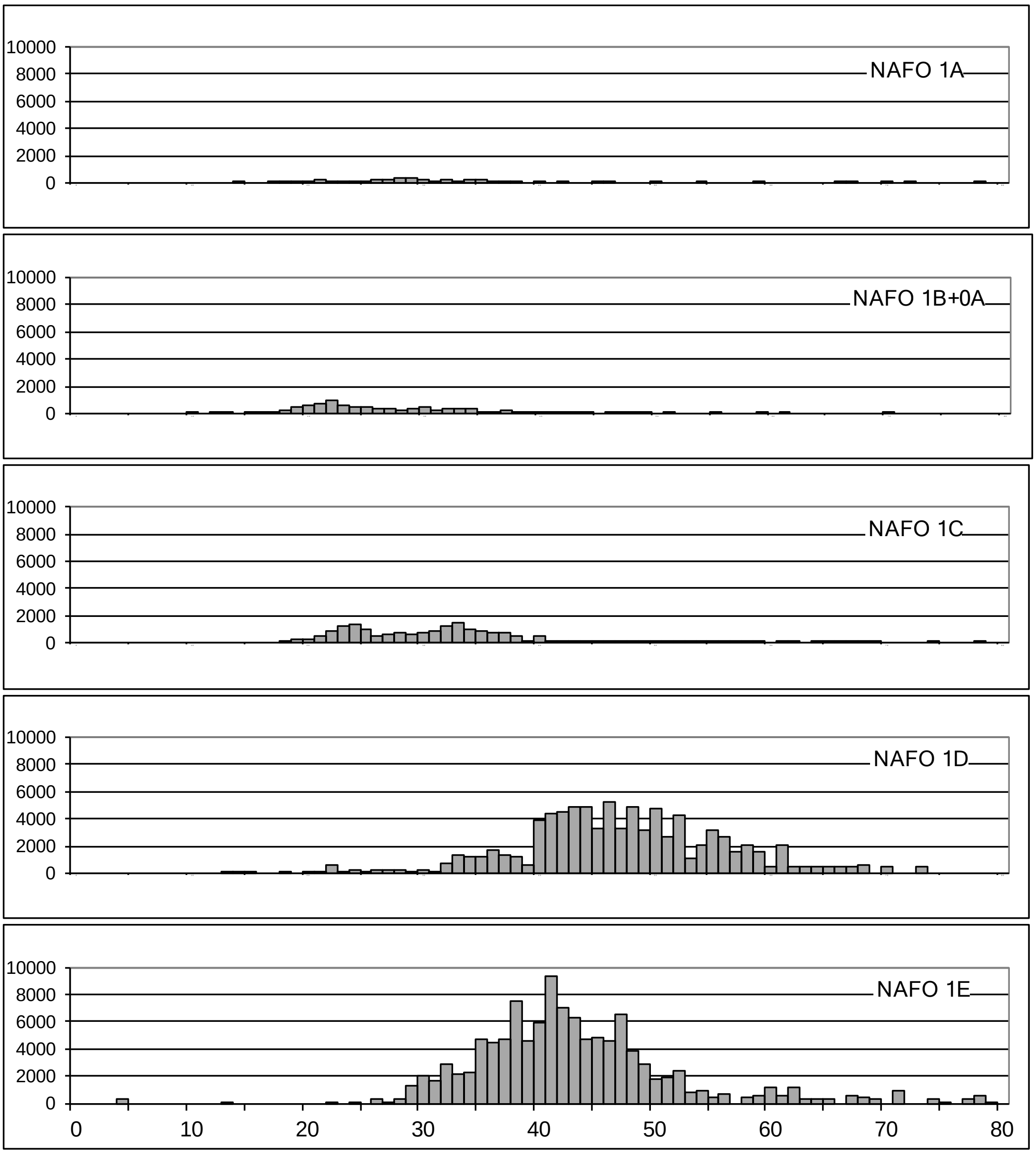

Figure 14.3.1.4: West Greenland Shrimp and fish survey. Abundance index by length (cm) and area. Areas from north (top) to south (bottom) are: NAFO division 1A; 1B+0A; 1C, 1D, 1E.

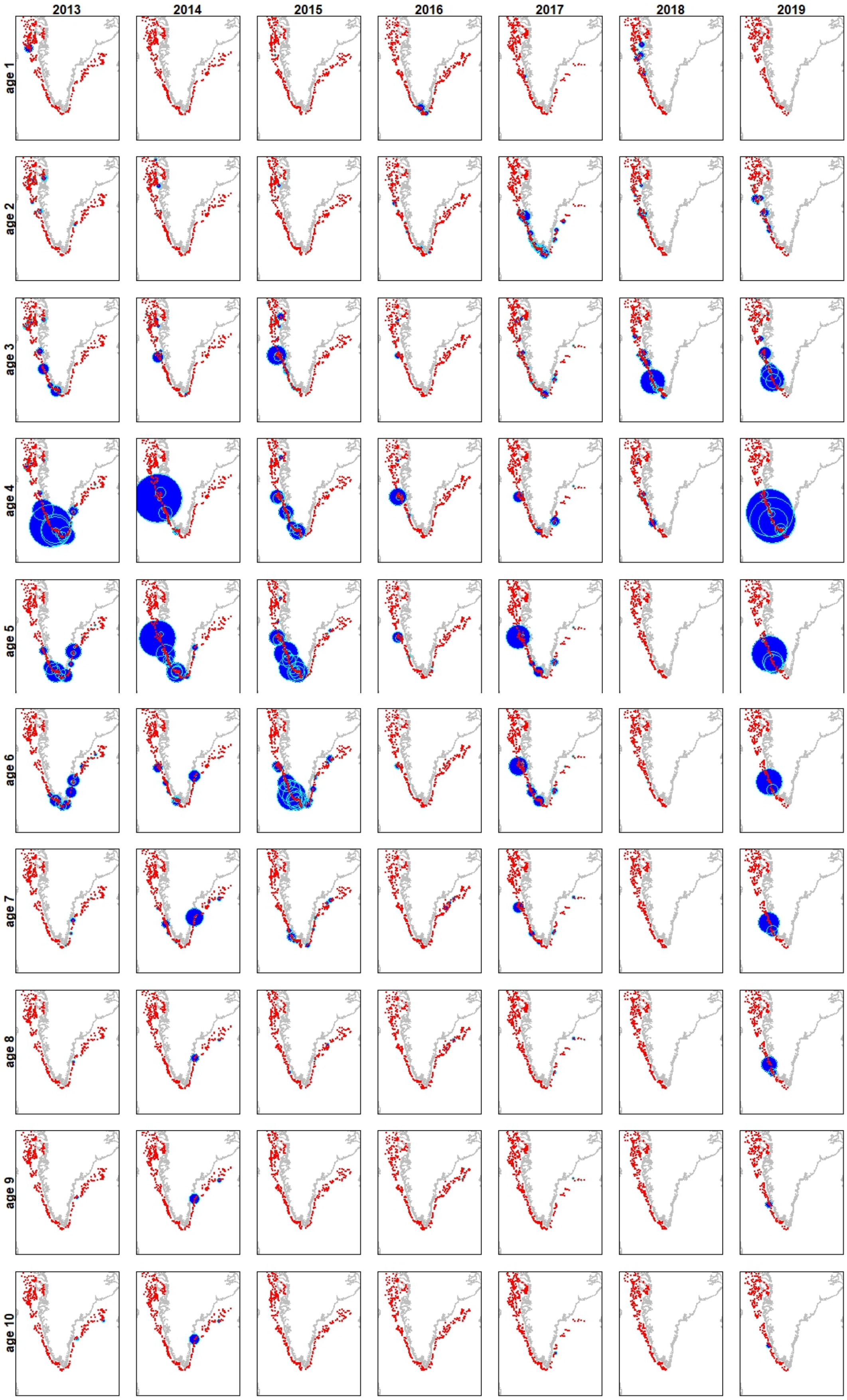

Figure 14.3.1.5. Abundance (no/km²) pr. station of ages 1–10.

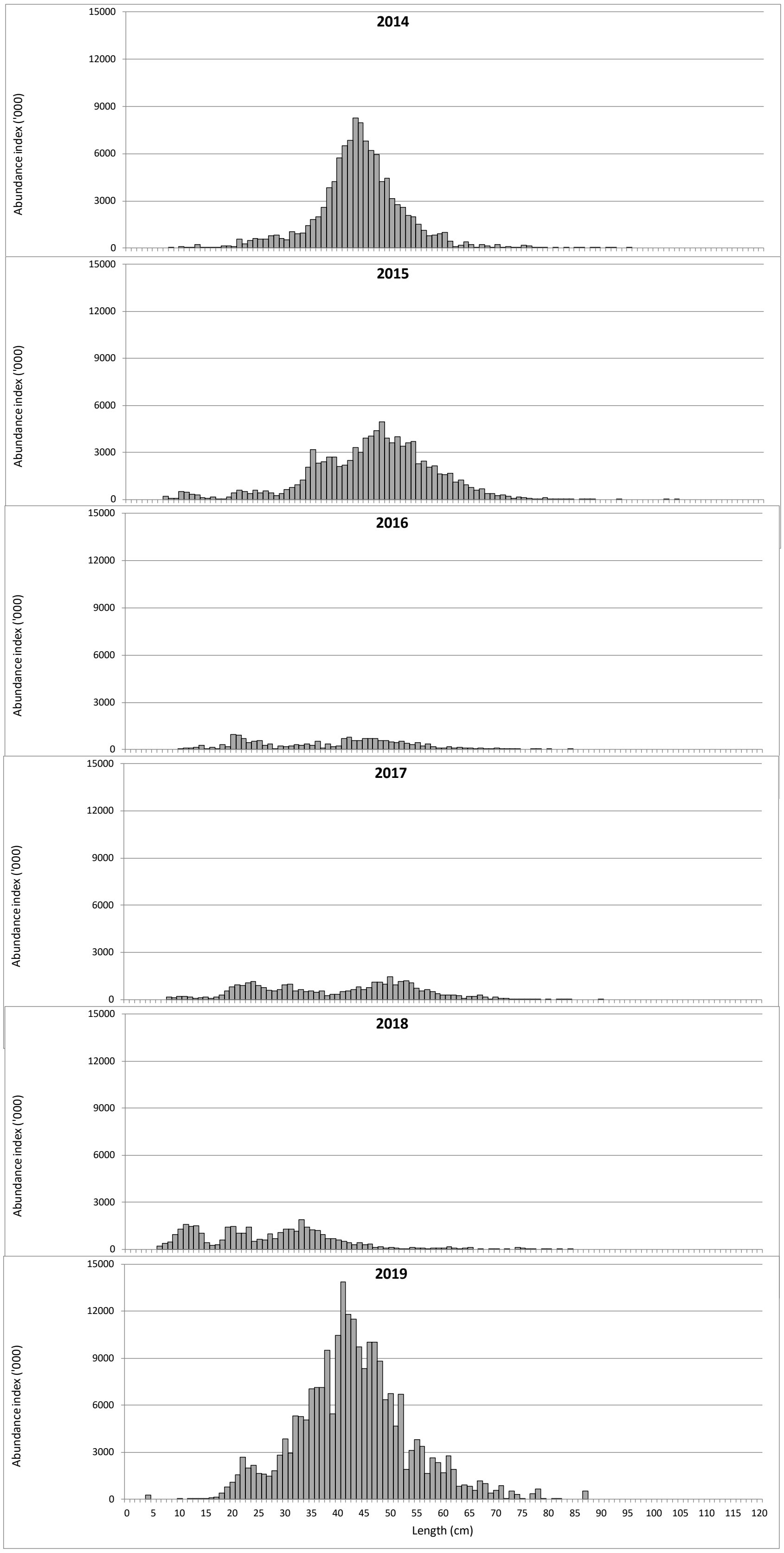

Figure 14.3.1.6: Total abundance indices by length in West Greenland shrimp and fish survey (NAFO 1A–1E).

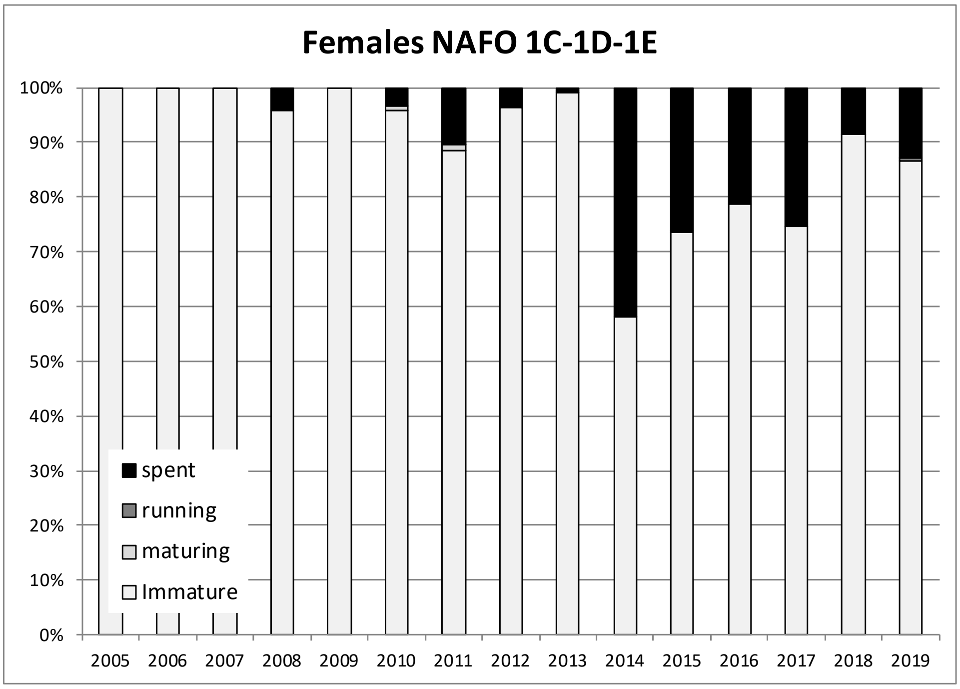

Figure 14.3.1.7: Composition of ogive state in females in survey in NAFO area 1D and 1E combined.

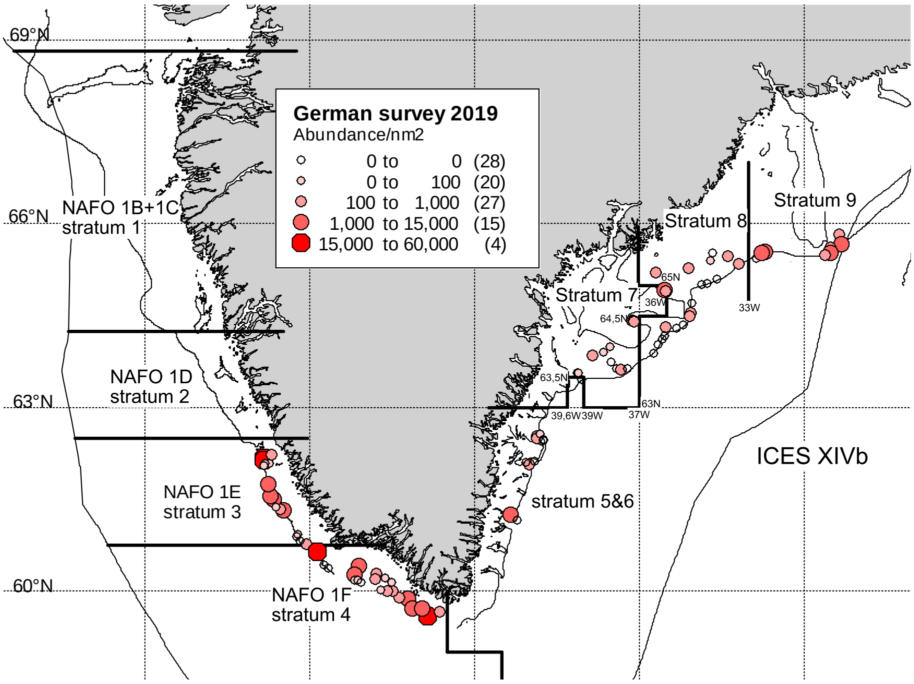

Figure 14.3.2.1. German ground fish survey. Abundance per nm².

15 Cod (*Gadus morhua*) in NAFO Subarea 1, inshore (West Greenland cod)

15.1 Stock description and management units

Cod in Greenland originate from four distinct stocks that are labelled by their spawning areas: I) offshore West Greenland; II) West Greenland fjords; III) offshore East Greenland and Icelandic and IV) inshore Icelandic waters (Therkildsen *et al*., 2013).
The inshore component (West Greenland, NAFO Subarea 1) has since 2012 been assessed separately from the offshore stocks. The Stock Annex provides more details on the stock identities including the references to the primary literature.

15.2 Scientific data

Historical trends in landings and fisheries

Details on the historical development of the fishery is described in the stock annex. The fishery developed in the yearly part of the 20th century, and by 1960 it peaked at 35 000 t (Figure 15.2.1). The fishery then declined but additional peaks in landings resulted from single large year classes during the 1970s and 1980s. Between 1990 and 2000, landings were below 5000 t, but has since increased gradually.

The present fishery

The TAC in 2019 was originally 30 000 tons, but 2 000 t. were transfered to the offshore fishery in West Greenland in the summer, and 200 t. were transferred to a trial fishery on capelin, resulting in an end TAC of 27 800 t. The 2019 catches were 19 753 t (Table 15.2.1). Poundnet remains the dominant gear, accounting for 61% of the catches followed by the longlines (122%), hooks (13%) and gill nets (4%) (Table 15.2.2, Figure 15.2.1,). Approximately 78% of the total catch is caught from May–October with a peak in June–July (Table 15.2.3). More details on the inshore fishery is found in Retzel 2020a.

North Greenland (NAFO division 1A, subarea 1AX (Disco Bay))

Catches in North Greenland have gradually increased from 500 t in 2012 to an historic high of nearly 6000 t comprising close to 20% of the catches in 2017 (Table 15.2.1, Figure 15.2.2). In 2018 and 2019 catches decreased around 60% to 1316 t. and they accounted for 7% of the total catch in 2019 (Table 15.2.3). Cod are caught as a combination of bycatch in the gillnet and longline fishery for Greenland Halibut and a poundnet directed fishery (Table 15.2.2).

Midgreenland (NAFO divisions 1B and 1C)

7139 tons where fished in midgreenland in 2019 which is a decrease of 70% to the historic high of 22 000 t in 2016 and 2017 (Table 15.2.1, Figure 15.2.2). In both areas the dominating gear are pound nets which caught 27% of the total catch in 2019 (Table 15.2.2). The fishery is concentrated around the towns of Kangatsiaq, Sisimiut and Maniitsoq (figure 15.2.3 and 15.2.4).

Midgreenland (NAFO divisions 1D)

The fishery in NAFO division 1D has in contrast to more northern areas increased from 2017 to 2019. Total catch in 1D (8632 t) is 44% of the total catch (Table 15.2.3). In 2017, the share was less than 15%, and the catch in Disko Bay (NAFOF 1AX) was higher than in 1D.

South Greenland (NAFO divisions 1E and 1F)

The catches in South Greenland have gradually declined and now correspond to 2% of the total inshore catch (Table 15.2.3, Figure 15.2.3, 15.2.4). However catches increased abruptlyfrom 390 t in 2018 to 1823 t in 2019 in NAFO 1F resulting in 9% of the total inshore catch in this region (table 15.2.3). The inshore cod stock is believed to be distributed from Midgreenland and northwards as there are no significant spawning taking place in South Greenland (Retzel and Hedeholm, 2012). Hence, the fishery in this area depends on offshore fish migrating inshore. Survey results from the offshore area found increasing numbers of cod in West and South Greenland (Retzel 2020b, Werner & Foc 2020).

East Greenland (ICES Subdivision 14.b)

Over the past five years, a small inshore fishery using hooks has developed in East Greenland, but less than 150 t are caught annually (Table 15.2.1, Figure 15.2.3). No length measurements are available from this fishery but individuals in this area do not belong to the West Greenland inshore cod stock. These fish are therefore not included in the overall calculations of catch and weight at age, but since the area is by definition part of the inshore area the catches are compiled here.

Catch-at-age

Catches in 2019 were comprised of the 2012-2015 yar classes (YC) and specially the 2014 YC dominating the fishery(Table 15.2.4, Figure 15.2.5, Figure 15.2.6). The mean catch length increased from 53 cm in 2010–2013 to 58 cm in 2014–2017. In 2018, the mean length decreased to 54 cm and further to 51 cm in 2019.

Weight-at-age

Geographical conditions, i.e., the existence of many small landing sites separated along more than 1000 km of coastline prevents a well-balanced sampling of the Greenland coastal fleets catches. . Cod are also landed without head, which hinder otolith sampling. This means that age information from the commercial fishery is limited. The mean weight-at-age in the landings are therefore primarily based on survey sampling and set equal to stock mean weight-at-age in the assessment. A more comprehensive description of the fishery and sampling procedures are provided in the stock annex.

Maturity-at-age

Maturity information from the early period of the assessment is only available for November 1987 (n = 484 cod). Although of limited size, the sample is from the bottom of the fjord where there is minimal mixing with the offshore stock (Storr-Poulsen *et al.*, 2004) and represents the best estimate of maturity during this period. Recent maturity (2007–2015) information is available from the spawning season (n = 3326 cod). The maturity ogive for the two periods was estimated by a general linear model (GLM) with binomial errors. The ogive for the two periods are different: L50 was 5.07 years in 1987 (SE = 0.18), and 4.32 years (SE = 0.04) from 2007 to 2015. It was decided to use the years with very low catches (600–800 t) as transition years between the two maturity ogives. The maturity ogive for the period 1976–2006 was set to that of the 1987 ogive. For the remaining period (2007–present) the maturity ogive was set constant based on maturity information from 2007–2015. The reason for not applying different maturity ogives for each year is due to high variation in number of samples between years that results in noisy data.

Even though the maturity ogive for the period 1976–2006 is based on relatively few fish caught outside spawning season it was decided to use it as this maturity ogive is supported by earlier maturity ogives from the 1930s with a similar L50 (Hansen, 1949).

Results of the West Greenland gillnet survey

The numbers of valid net settings in 2019 was 48 in NAFO 1B and 54 in NAFO 1D (Table 15.2.5). Area and site specific catch rates can be seen in Figure 15.2.7.

In NAFO 1B the abundance index of all ages except ages 1 and 4 increased in 2019 (Table 15.2.6). Ages 2 and 3 are above historic mean (figure 15.2.8).

In NAFO 1D the number of 2 year-olds increased by 107% compared to 2017 (Table 15.2.6). The 3 year-olds declined by 18%. The combined index for age 2 and 3 are around the time series mean (figure 15.2.8). The number of older fish is however high and the overall index including all ages (217) remains well above historical average (108) (Table 15.2.6). Hence, the number of 5, 6, 7 and 8 year-olds are the highest in the time series.

Combining 1B and 1D in a joint index results in an increase across all ages compared to 2018 (Figure 15.2.8). The index remains intermediate compared to 2010–2013 and is similar to the values in 2015-2017, but 2010–2013 was a period of historic high recruitment. Normally, catch rates are highest in 1B, but in the period 2014-2018, the two areas have had similar recruitment (Table 15.2.6, Figure 15.2.8). In 2019 recruitment was higher in 1B.

In 2017 and 2019 the survey was extended to include Kangaatsiaq (NAFO 1B) and since 2017 to include Maniitsoq (NAFO 1C). A similar number of stations as in the traditional areas were successfully fished (Table 15.2.5). In Maniitsoq, the index combining all ages was similar to 1B and 1D in 2017. The index decreased in 2018 and further in 2019 (Table 15.2.6). Similar to 1D, the number of 2 year olds decreased, whereas number of 3 year olds increased and older fish (especially 5 year olds) dominated the catches. In Kangatsiaq, the index combining all ages was much lower than in Sisimiut, Maniitsoq and Nuuk in both 2017 and 2019.

Disko Bay survey

For 2019 32 gillnets where set targeting Greenland Halibut at fixed stations corresponding to previous years in the Diko Bay. Catches in the Disko Bay gill net survey were low from 2005–2012 (Table 15.2.7). From 2013–2016, catches of cod increased substantially, mainly driven by the 2009 and 2010 YCs. Catches declined from 2017 to 2018 but they increased in 2019.

Disko Bay is also covered as part of the annual bottom trawl survey in West Greenland.. The trawl survey catches smaller cod, and a similar increase as seen in the gill net survey was documented two years earlier, driven by the 2009 YC and subsequently by the relatively large 2010 and 2011 YCs (Table 15.2.8). Since then, catches have remained substantial in both the gill net and the trawl survey, but the latest numbers indicates a decline in abundance, which is consistent with smaller year classes as observed in the 1B and 1D recruitment surveys in recent years. Jointly, the inshore surveys suggests that the increase in recruitment starting with the 2009 YC resulted in not only local biomass increases, but also an expansion of the stock into the northern part of the inshore area. Recent recruitment declines can therefore also be expected to have the largest effect in the northern part of the area.

More details on inshore survey results can be found in Retzel 2020c.

15.3 Tagging experiments

A total of 5642 cod have been tagged inshore in West Greenland from 2003–2019, primarily in NAFO 1B, 1D and 1F (table 15.3.1).

Inshore recaptures are found almost exclusively in the same fjord as tagged (Table 15.3.2). No tags from the inshore area have been recaptured offshore except three that were recaptured in Iceland. These three cod were tagged in the South Greenland (1F) inshore area. One cod tagged offshore in NAFO 1C was recaptured inshore in NAFO 1E, 29 cod tagged offshore on Dana Bank have been recaptured in the inshore fjord system. Most of these were recaptured in the inshore area south of Dana Bank, but four were recaptured inshore north of Dana Bank. These results confirm the general perception: adult cod present deep in the fjords tends to remain in the same area and that the southern part of the inshore area is a mixing area of different stocks.

15.4 Methods

The stock was benchmarked in 2018 (ICES, 2018). It was decided to use the SAM model and perform an analytical assessment. Hence, the assessment was upgraded from a category 3 (Data Limited Stock) to a category 1 stock. This is considered a vast improvement, as all data are now utilized, and the assessment is presented with uncertainty estimates and multiple catch options.

At the NWWG 2020 meeting a short presentation was given of the likely outcome of a SAM assessment would be if the inshore and offshore cod stocks in West Greenland were treated as one stock. F_{2019} would be 0.47 and applying the EQSIM programme F_{msy} is estimated to 0.24. Using MSY advise, the 2021 advise would be 19 326 t for the total West Greenland area (except NAFO Div. 1F). However, these values are only indicative and more work is needed. A benchmark for the stock is proposed to take place in 2022.

15.5 Reference points

Reference points were defined at IBPGCod (ICES, 2018). The estimations were conducted in EQSIM according to ICES guidelines (see ICES (2018) for details). The reference points are shown in Table 15.5.1. However, F_{lim} and F_{pa} has not be defined. In last year NWWG meeting attempts were presented using age 2 or age 3 as recruits, or removing certain years in the SSB-recruit relationship but further work is needed (Riget *et al.*, 2019).

15.6 State of the stock

There have been several years of high recruitment between 2003 and 2012 and the spawning stock biomass was at a level not seen for 25 years in 2015, since then it has declined in the past four years and recruitment is currently close to historically low levels. The recent decrease in stock size was expected as the failing recruitment begins to affect the number of adults. The catches have decreased since the time series highs in 2016 and 2017. Catches are comprised of ages 4–7 and low recruitment for a few consecutive years will quickly affect the fishable biomass, which is evident in the catches of 2019 that was around half compared to 2016. TACs have not been obtained the last two years and it is unlikely that the TAC of 29 800 t in 2020 will be caught. ICES has assumed that F_{2020} will equal F_{2019} corresponding to estimated catches in 2020 of 13 525 t.

Genetic studies have been carried out on catches from the surveys and the commercial catch in the Sisimiut (1B) and Nuuk (1D) fjord systems. The studies should be considered as preliminary and further work is needed before a more firm conclusion can be reached. The proportion of each stock were investigated in catches in Sisimiut (1B) and Nuuk (1D) in 2017. Results showed that the proportion of the inshore cod stock in the inshore catches were approximately 50% (Christensen, 2019).

A considerable proportion (30%) of the inshore catches belongs to the West Greenland offshore stock. The stock is in a depleted condition and the current ICES advice is zero catch. A continued high fishing pressure in the inshore areas can prolong the recovery time of the offshore stock.

The remaining part (20%) of the inshore catches belongs to the East Greenland/Icelandic stock. It is assumed that a large part of these cod migrate to East Greenland/Iceland to spawn. The spawning stock in East Greenland has in recent years declined. A continued high fishing pressure in the inshore areas can have a negative influence on the spawning stock in East Greenland.

15.7 Short term forecast

Input data

The SAM model provides predictions that carry the signals from the assessment into the short term forecast. The forecast procedure starts from the last year's estimate of the state (log(N) and log(F)). One thousand replicates of the last state are simulated from the estimated joint distribution. Each of these replicates are then simulated forward according to the assumptions and parameter estimates found by the assessment model.

In the forward simulations, a 5-year average (up to the assessment year) is used for catch mean weight, stock mean weight, proportion mature, and natural mortality. Recruitment is re-sampled from the entire time series. In each forward simulation step the fishing mortality is scaled, such that the median of the distribution is matching the requirement in the scenario (e.g. hitting a specific mean F value, a specific catch or level of SSB).

Results

The results from the assessment are shown as estimated numbers-at-age and F-at-age in tables 15.7.1 and 15.7.2. All other output can be found on stockassessment.org (run: cod-WestInsNWWG2020, Riget *et al.*, 2020).

The forecasts from the different scenarios are presented in Table 15.7.3. Fishing at F_{MSY} in 2021 will result in catches of 5283 t and a spawning stock biomass increase with 12% in 2022. Recently the catches have been above the ICES advice, and an F status quo will result in catches of 10 697 t, but at the same time a decrease in the spawning stock biomass of 26% in 2022.

15.8 Long term forecast

No long term forecast was performed for this stock.

15.9 Uncertainties in assessment and forecast

The major uncertainty of the assessment is related to mixing of cod stocks (West Greenland offshore and East Greenland/Icelandic).

There is no incentive to discard fish or misreport catches under the current management system and any small cod released from the poundnets survive. The surveys show relatively good internal consistency and jointly data input to the assessment is of high quality and the time series are long which should provide a good basis for a robust assessment.

The model fits the data relatively well (Figure 15.9.1), but does consistently underestimate the spawning stock biomass (Figure 15.9.2). Although this is consistently a way-residual, the Mohn's rho measure of uncertainty is -0.23, which is not considered high (Hurtado-Ferro *et al.*, 2015) and the 95% confidence intervals include all the retrospective runs. For the fishing mortality, there are also year-to-year changes in the perception. These are, however, both positive and negative, and the resulting Mohn's rho is only 0.03 with all retrospective runs being inside the model 95% confidence intervals (Figure 15.9.3).

The poorest model performance is in the fit between actual and estimated catches (Figure 15.9.4). Especially the poor fit to the catches in years with large catches is noteworthy, as catches are known with a high degree of certainty. The cause of this is emigration; immigration and mixing of stocks both in the survey and in the catches (see 'State of the stock'). The general picture of the stock dynamics is relatively well understood, but difficult to quantify, especially on an annual basis. It does present a challenge in the forecast. The TAC in the intermediate year is known at the time of the assessment meeting. This TAC is valid for the mixed fishery and does not reflect the expected catch of solely the inshore stock. Because of this, the TAC is not used in the forecast. Instead we have assumed than F will be similar and apply an F-scaler of 1 in the intermediate year. This then assumes that the model output is a valid estimate of the inshore cod stock landings and not total catches. In the current period, with very high landings, the model has estimated the actual landings to be roughly double the model estimate. This is consistent with sparse information from genetic studies on the actual proportions in the catches (Henriksen, 2015, Christensen, 2019).

Hence, the forecast should be considered as an estimate of the development of the inshore cod stock and not cod in the inshore area.

15.10 Comparison with previous assessment and forecast

The stock was benchmarked in 2018 (ICES, 2018) and the SAM model accepted. The spawning-stock biomass (SSB) of West Greenland inshore cod has decreased since 2015 after having been at a historical high level. Fishing mortality (F) has increased slightly in recent years and have been above F_{MSY} during the whole time-series. Recent recruitment has gradually decreased from a decade of high values and is currently close to historically low levels.

15.11 Management plans and evaluations

There is no management plan for this stock.

15.12 Management considerations

The TAC for this stock has consistently been set above the ICES advice. The quota is a common TAC for the entire inshore area and does not distinguish between stocks. Furthermore, it is allowed to fish offshore on the inshore quota. Historically, when the TAC was reached, the TAC was increased. Hence, the fishery in the West Greenland inshore area has always been an unlimited fishery.

Due to stock mixing, ICES is currently not able to accurately estimate the stock proportions in the catches. Therefore, the TAC can be set higher than the ICES advice, while still being in accordance with the advice. ICES cannot advice on such a TAC level.

15.13 Ecosystem considerations

The gear used for this fishery have little effect on the ecosystem, especially the main gear (pound-net).

15.14 Regulations and their effects

The fishery has never been limited by a TAC, as the TAC has always been set well above the fleet capacity or raised when reached. Therefore, it is unknown what the effect would be of limiting the fishery.

15.15 Changes in fishing technology and fishing patterns

With the northward expansion of the fishery over the past decade, there has been an increase in the importance of the gill nets, long liners and hooks. This has changed the selectivity of the fishery, as these gears have a higher selectivity for the older ages. This is also reflected in the assessment, were the F selectivity has gradually increased in recent years and the SAM model is explicitly able to handle time-varying selectively (Nielsen and Berg, 2014).

15.16 Changes in the environment

No data is collected to support any conclusions.

15.17 Benchmark 2022

Inshore catches have recently increased to historic heights. New genetic investigations of especially the inshore component reveals that the WestGreenland offshore component (cod.21.1.a-e) is mixing with the inshore component to a larger extent than previously thought (Christensen 2019).

Advice is based on analytical assessment (SAM) with catches from the inshore area going into the model. With high degree of mixing with other stocks the input data are not consistently expressing the status of the inshore stock component, and the model can produce unreliable estimates i.e. sustain fishing pressure well above F_{msy}, while staying above all reference points for biomass. Aim of the benchmark is either:

- Scenario 1: Treat the inshore and offshore West Greenland (cod.21.1.a-e) stocks together in an combined analytical assessment.
- Scenario 2: Reduce the catch in the inshore area by including genetic results.

15.18 References

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15.19 Tables

Table 15.2.1. 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 14.b = inshore East Greenland.

	NAFO divisions								
Year	1A	1B	1C	1D	1E	1F	Unknown NAFO div.	Total West Greenland	ICES 14b
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	

	NAFO divisions								
Year	1A	1B	1C	1D	1E	1F	Unknown NAFO div.	Total West Greenland	ICES 14b
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	
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	

	NAFO divisions								
Year	1A	1B	1C	1D	1E	1F	Unknown NAFO div.	Total West Greenland	ICES 14b
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	

	NAFO divisions								
Year	**1A**	**1B**	**1C**	**1D**	**1E**	**1F**	**Unknown NAFO div.**	**Total West Greenland**	**ICES 14b**
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	
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
2015	4088	7912	6426	6613	117	115		25272	50

	NAFO divisions								
Year	**1A**	**1B**	**1C**	**1D**	**1E**	**1F**	**Unknown NAFO div.**	**Total West Greenland**	**ICES 14b**
2016	5929	11466	11270	5279	87	173		34204	39
2017	5797	11110	10060	4066	56	131		31220	82
2018	2213	6422	6190	7043	31	390		22290	51
2019	1987	2925	4214	8673	131	1823		19753	143

Table 15.2.2: 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				2%	12%	17%	14%	5%	5%	3%	2%	0.5%	**61%**
Gillnet	0.2%	0.4%	0.3%	1%	0.3%	0.4%	0.3%	0.2%	0.3%	1%	0.4%	0.2%	**4%**
Jig	0.1%	0.1%	0.2%	0.3%	1%	1%	2%	2%	3%	2%	1%	0.3%	**13%**
Longline	2%	2%	2%	1%	1%	1%	0.5%	1%	2%	3%	3%	3%	**22%**
Total	**3%**	**2%**	**3%**	**4%**	**13%**	**19%**	**17%**	**9%**	**10%**	**10%**	**6%**	**4%**	

Gear/NAFO	1AUM	1AUP	1AX	1B	1C	1D	1E	1F	Total
Poundnet	1%		3%	12%	15%	26%		4%	**61%**
Gillnet			1%	1%	1%			1%	**4%**
Jig	1%		1%	1%	2%	6%	1%	1%	**13%**
Longline	2%		2%		4%	12%		2%	**22%**
Total	**4%**		**7%**	**14%**	**22%**	**44%**	**1%**	**8%**	

Table 15.2.3 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	%
1AUM	26	5	6	28	9	13	7	150	305	68	53	1	**671**	3%
1AUP														
1AX	10	41	44	63	69	112	251	215	178	303	30		**1316**	7%
1B			9	35	465	649	735	156	126	326	352	72	**2925**	15%
1C	121	72	41	37	592	833	1052	326	212	372	354	202	**4214**	21%
1D	363	279	414	607	1379	1695	1035	558	918	662	357	406	**8673**	44%
1E				1	2	21	11	49	23	17	7		**131**	1%
1F	24	44	44	8	119	398	358	323	257	130	70	48	**1823**	9%
Total	**544**	**441**	**558**	**779**	**2635**	**3721**	**3449**	**1777**	**2019**	**1878**	**1223**	**729**	**19753**	
%	3%	2%	3%	4%	13%	19%	17%	9%	10%	10%	6%	4%		
ICES 14b								16	58	63	6		**143**	

Table 15.2.4 Estimated commercial landings in numbers ('000) at age, and total tones by year. * no sampling.

	Age								Tonnes
Year	3	4	5	6	7	8	9	10+	Landed
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

	Age								Tonnes
Year	3	4	5	6	7	8	9	10+	Landed
2004	530	1669	1095	228	37	3			4948
2005	1392	2408	944	186	36	10	4	0	6043
2006	4256	3363	680	22	0	0	0		7388
2007	1944	7910	1010	116	38	13	8	4	11050
2008	1176	5012	2793	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	1389	4024	2292	328	168	103	52	18331
2015	20	2006	5680	3008	1337	133	9	8	25272
2016	32	2146	9701	5732	1179	239	57	7	34203
2017	44	1384	6351	5241	3370	498	168	48	31220
2018	21	2214	4255	4180	2319	850	169	76	22290
2019	47	1941	6727	3679	1885	624	145	46	19753

Table 15.2.5: Survey effort in the Greenland Inshore Gill-net survey (nos. of valid net settings)

Division (area)	1B (Kangatsiaq)	1B (Sisimiut)	1C	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

Division (area)	1B (Kangatsiaq)	1B (Sisimiut)	1C	1D	1F	Total
2013		58		52	-	110
2014		60		41	-	101
2015		59		44	-	103
2016		58		40	-	98
2017	60	57	59	46	-	222
2018		58	61	52	-	171
2019	50	48	47	54	-	199

Table 15.2.6: 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.

	Age								
Year	**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

	Age								
Year	1	2	3	4	5	6	7	8+	All
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
2015	2	39	44	59	49	39	3	1	236
2016	6	31	98	42	36	23	7	2	245
2017	1	6	71	79	33	23	10	2	225
2018	1	27	25	26	15	6	2	1	103
2019	0	80	136	19	35	12	1	2	285

Table 15.2.6, *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.

	Age								
Year	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	0	0	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	1	2	0	0	0	4
1997	3	3	1	0.2	0.5	0.4	0.1	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

	Age								
Year	1	2	3	4	5	6	7	8+	All
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
2015	2	42	79	68	30	7	2	0	229
2016	1	59	92	34	47	9	1	1	243
2017	0	8	81	57	51	18	1	1	217
2018	0	14	50	59	44	31	10	2	210
2019	0	29	41	60	60	20	7	0	217

Table 15.2.6, *continued* : NAFO division 1F, 1B (Kangatsiaq) and 1C 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.

	Age NAFO 1F								
Year	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
2010–2019	na	na	na	na	na	na	na	na	na

	Age NAFO 1B (Kangatsiaq)								
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8+**	**All**
2017	0	2	40	8	13	6	5	1	75
2018	na	na	ns	na	na	na	na	na	Na
2019	0	26	14	6	5	1	0	0	52

	Age NAFO 1C								
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8+**	**All**
2017	1	9	94	40	35	18	12	1	210
2018	0	13	19	47	19	11	10	3	122
2019	0	20	34	14	40	4	2	2	116

Table 15.2.7: Cod abundance indices (numbers of cod caught per 100 hours net settings) by age in the Greenland Halibut gill net survey in Disco Bay. Na = Data not available.

Year/age	1	2	3	4	5	6	7	8	9	10+	Total
2005	0	0.07	0.35	0.51	0.51	0.04	0.04	0	0	0	1.52
2006	0	0.21	0.12	0.02	0	0.07	0.04	0	0	0	0.46
2007	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
2008	0	0.01	0.01	0.63	3.38	1.80	0.46	0	0	0	6.29
2009	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
2010	0	0	0.01	0.98	2.71	1.81	0.13	0	0	0	5.64
2011	0	0.48	0.17	1.26	0.93	2.94	1.38	0.10	0	0	7.26
2012	0	0.01	2.09	2.75	1.65	1.09	0.24	0.16	0	0	7.99
2013	0	0	3.45	43.43	38.21	13.59	2.58	1.06	0.41	0	102.73
2014	0	0	0.37	23.92	46.16	20.56	0.78	0.08	0.26	0.23	92.36
2015	0	0	1.18	8.13	53.86	31.50	6.05	1.70	0	0.40	102.82
2016	0	0	0.6	11	29	59	17	1	0.4	0.1	119
2016 cod st.	0	0	0	5	9	12	4	0.1	0	0	30
2017	0	0	3	4	11	13	17	2	0	0	50
2018		0.2	1	3	3	7	6	8	1	0.3	28
2019			3	3	10	10	31	20	6	0.3	83

Table 15.2.8: Cod abundance indices ('000) by age and total in Disco Bay (NAFO 1AX) in the Greenland Shrimp and Fish bottom trawl survey.

Year/age	0	1	2	3	4	5	6	7	8	9	10+	All
2005	0	52	0	0	90	0	0	0	0	0	0	142
2006	0	0	117	1	1	0	0	0	0	0	0	119
2007	0	20	142	98	0	0	0	0	0	0	0	261
2008	0	38	21	25	24	0	0	0	0	0	0	108
2009	0	0	14	1	16	11	0	0	0	0	0	41
2010	0	0	7	0	9	0	0	0	0	0	0	16
2011	0	400	2907	324	47	26	5	0	0	0	0	3710
2012	0	0	1967	661	31	0	0	0	0	0	0	2659
2013	0	137	1420	1656	479	111	14	0	0	0	0	3817
2014	0	14	159	119	79	25	8	0	13	0	10	428
2015	0	93	411	1271	502	429	197	27	4	0	0	2935
2016	0	24	177	76	38	95	56	40	0	0	0	506
2017	0	19	42	386	84	50	21	64	15	0	0	681
2018	24	29	204	99	121	26	30	44	31	0	0	607
2019	0	0	103	341	139	71	0	22	18	1	0	693

Table 15.3.1. Number of tagged cod in the period of 2003 to 2019 in different regions. Bank (West) = NAFO Division 1D+1E. East Greenland = NAFO Division 1F + ICES Division 14.b.

		TAGGED		
Year	Fjord	Bank (West) NAFO 1C Tovqussaq	Bank (West) NAFO 1D+1E Dana	East Greenland
2003	599			
2004	658			
2005	565			
2006	41			
2007	1137		1061	1047
2008	231			1296
2009	633			526
2010	88			

		TAGGED		
Year	**Fjord**	**Bank (West) NAFO 1C Tovqussaq**	**Bank (West) NAFO 1D+1E Dana**	**East Greenland**
2011	28			403
2012	86		1563	2359
2013	186		2321	
2014				1203
2015		57		1220
2016		299	998	1912
2017	350	1871	706	
2018		115		
2019	1040	325		

Table 15.3.2: Number of recaptured cod in the period of 2003 to 2019 in different regions. Fjord (West) = NAFO divisions 1B–1F. Bank (West) = NAFO Division 1D+1E. East Greenland = NAFO division 1F + ICES Division 14.

		RECAPTURES		
	Fjord (West)	**Bank (West) NAFO 1C Tovqussaq**	**Bank (West) NAFO 1D + 1E Dana**	**East Greenland**
Fjord (West)	504	1	29	8
Bank (West) NAFO 1C, Tovqussaq		1		4
Bank (West) NAFO 1D+1E, Dana		2	35	
East Greenland			35	118
Iceland	3		41	183

Table 15.5.1: Reference points

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$	5983 t	Assumed at Bpa	ICES (2018a)
	F_{MSY}	0.27	Stochastic simulations with segmented regression and a Beverton–Holt stock–recruitment curve from 1973 to 2018.	ICES (2018a)
Precautionary approach	B_{lim}	4346 t	Breakpoint in segmented regression	ICES (2018a)
	B_{pa}	5983 t	$B_{lim} \times e^{1.645\sigma}$, $\sigma = 0.194$	ICES (2018a)
	F_{lim}	-	Not defined	
	F_{pa}	-	Not defined	
Management plan	SSB_{mgt}	-	-	
	F_{mgt}	-	-	

Table 15.7.1: Estimated number at age in the stock

Year / Age	1	2	3	4	5	6	7	8	9	10
1976	14543	12551	62593	3733	1955	416	65	282	64	30
1977	21261	11509	10276	48590	2293	968	147	19	179	54
1978	41381	16967	9108	7882	31483	1044	365	39	10	116
1979	16331	39079	13540	7561	4781	15504	504	143	20	64
1980	38876	11385	36904	10653	4485	2064	7024	216	69	45
1981	15992	37242	7937	30329	5506	1967	861	2368	105	50
1982	7906	12880	35677	5816	15303	1843	827	270	841	70
1983	2760	6678	10373	30528	2640	5818	518	247	106	253
1984	7678	1877	5640	8294	14767	895	1869	116	107	113
1985	37647	5975	1276	4206	3532	5689	292	610	51	96
1986	25119	36843	4650	980	1592	1370	2116	91	285	59
1987	12345	21136	36057	3283	438	491	471	849	45	127
1988	16935	9784	18953	30313	1147	158	91	168	384	44
1989	8324	15198	8041	16335	14376	402	46	23	81	132
1990	4077	7565	12597	6945	8503	4096	88	15	11	53
1991	12053	2842	6468	9713	3170	2050	433	29	7	20
1992	4420	9153	2333	4746	3357	515	241	85	13	8
1993	2084	3538	6507	1898	1372	323	68	67	24	7
1994	2666	1561	2924	4534	686	101	50	19	26	8
1995	1732	2148	1183	2349	1597	89	20	13	8	13
1996	2386	1251	1509	970	1034	244	29	7	5	9
1997	3074	1966	871	1137	467	234	92	11	3	7
1998	3025	2319	1622	695	498	72	109	38	5	5
1999	4502	2344	1741	1301	300	36	39	49	20	5
2000	6291	3707	1816	1255	609	39	22	18	28	12
2001	7516	5224	3314	1689	624	104	23	10	11	20
2002	9313	6134	4337	2893	973	129	55	12	6	15
2003	9673	6776	4574	3131	1367	247	60	28	8	10
2004	22882	8253	4997	3361	1371	298	97	23	17	7

Year / Age	1	2	3	4	5	6	7	8	9	10
2005	35693	18601	6860	3478	1272	257	108	39	13	10
2006	26131	28765	15284	5198	1154	202	89	44	23	11
2007	14349	21970	22320	10731	1676	206	82	33	25	15
2008	21182	10794	18156	16414	3896	311	73	35	17	20
2009	20276	18085	9038	13799	7022	708	98	32	21	19
2010	38539	15617	15005	7237	6799	1577	232	49	19	21
2011	33469	33698	11518	11335	4244	1817	420	101	26	17
2012	24278	26806	28160	9790	6696	1400	488	164	45	17
2013	18584	21853	21231	21724	6935	2667	423	196	83	23
2014	19321	15757	18423	17112	13357	3363	906	145	81	38
2015	14713	16678	13775	17277	13226	6426	1407	332	45	32
2016	8743	13890	15116	12998	13899	7248	2490	524	126	26
2017	8564	6953	13343	13494	10528	7538	3115	847	206	59
2018	7971	7833	6568	12375	9962	5622	3098	1009	287	94
2019	7971	7174	7484	6080	9592	5266	2260	953	313	124

Table 15.7.2: Estimated fishing mortality-at-age in the stock

Year Age	1	2	3	4	5	6	7	8	9	10
1976			0.037	0.278	0.525	0.813	1.03	0.322	0.414	0.414
1977			0.035	0.271	0.561	0.747	1.036	0.388	0.506	0.506
1978			0.032	0.302	0.564	0.6	0.788	0.444	0.489	0.489
1979			0.034	0.36	0.63	0.629	0.746	0.539	0.49	0.49
1980			0.039	0.435	0.679	0.676	0.881	0.606	0.614	0.614
1981			0.035	0.496	0.82	0.742	0.961	0.752	0.706	0.706
1982			0.038	0.541	0.795	0.963	1.047	0.717	0.974	0.974
1983			0.035	0.583	0.833	0.94	1.184	0.651	0.871	0.871
1984			0.034	0.648	0.792	0.896	0.966	0.586	0.689	0.689
1985			0.027	0.695	0.786	0.851	0.93	0.575	0.745	0.745
1986			0.03	0.639	0.895	0.949	0.809	0.543	0.847	0.847
1987			0.029	0.695	0.861	1.343	0.885	0.595	1.098	1.098
1988			0.019	0.624	0.895	1.141	1.053	0.557	1.013	1.013
1989			0.013	0.591	1.104	1.346	0.984	0.519	1.147	1.147
1990			0.012	0.66	1.287	1.794	0.973	0.603	1	1
1991			0.01	0.825	1.636	1.947	1.156	0.648	0.957	0.957
1992			0.007	0.912	2.102	1.808	1.093	0.763	0.945	0.945
1993			0.006	0.806	2.343	1.633	1.077	0.748	0.912	0.912
1994			0.005	0.765	1.857	1.357	1.066	0.705	0.683	0.683
1995			0.004	0.638	1.671	0.952	0.876	0.672	0.608	0.608
1996			0.004	0.555	1.399	0.761	0.801	0.586	0.542	0.542
1997			0.005	0.581	1.682	0.585	0.687	0.506	0.535	0.535
1998			0.008	0.574	2.27	0.435	0.62	0.437	0.529	0.529
1999			0.012	0.537	1.833	0.329	0.577	0.38	0.524	0.524
2000			0.014	0.499	1.567	0.361	0.549	0.337	0.525	0.525
2001			0.024	0.493	1.374	0.437	0.534	0.303	0.546	0.546
2002			0.04	0.573	1.204	0.529	0.544	0.276	0.601	0.601
2003			0.052	0.631	1.354	0.697	0.682	0.314	0.725	0.725
2004			0.072	0.771	1.475	0.779	0.69	0.312	0.655	0.655

Year Age	1	2	3	4	5	6	7	8	9	10
2005			0.089	0.89	1.578	0.796	0.695	0.335	0.589	0.589
2006			0.092	0.87	1.524	0.714	0.718	0.356	0.547	0.547
2007			0.074	0.781	1.515	0.827	0.667	0.375	0.492	0.492
2008			0.056	0.59	1.465	0.939	0.624	0.348	0.467	0.467
2009			0.04	0.445	1.251	0.954	0.559	0.359	0.518	0.518
2010			0.027	0.339	1.071	1.122	0.641	0.465	0.691	0.691
2011			0.018	0.291	0.893	1.123	0.714	0.557	0.719	0.719
2012			0.013	0.236	0.722	0.996	0.739	0.551	0.795	0.795
2013			0.009	0.203	0.585	0.858	0.83	0.698	0.874	0.874
2014			0.006	0.167	0.54	0.769	0.81	0.868	1.035	1.035
2015			0.004	0.156	0.496	0.741	0.836	0.797	0.848	0.848
2016			0.004	0.156	0.495	0.718	0.881	0.789	0.789	0.789
2017			0.004	0.159	0.492	0.721	0.948	0.879	0.866	0.866
2018			0.004	0.174	0.499	0.739	0.99	0.959	0.907	0.907
2019			0.005	0.193	0.523	0.752	1.028	0.974	0.873	0.873

Table 15.7.3: Cod in NAFO Subarea 1, inshore. Catch scenarios for 2020 assuming $F_{2019} = F_{2020}$. All weights are in tonnes.

Rationale	Catch (2020)	F (2020)	SSB (2021)	% SSB change *	% advice change **	% TAC change ***
ICES advice basis						
MSY approach: F_{MSY}	5283	0.268	24539	+12%	-5%	-82%
Other scenarios						
F = 0	0	0	31103	+42%	-100%	-100%
$F = F_{2019}$ (*status quo*)	10697	0.694	18469	-16%	+93%	-64%
$SSB_{2021} = B_{lim}$	25123	9.57	4367	-80%	+354%	-16%
$SSB_{2021} = B_{pa}$= MSY $B_{trigger}$	23040	5.15	5907	-73%	+316%	-23%

*** SSB_{2021} relative to SSB_{2020}.**

**** Advice value for 2020 relative to the advice value for 2019, from this updated assessment.**

***** Advice value for 2020 relative to the TAC in 2019, from this updated assessment.**

15.20 Figures

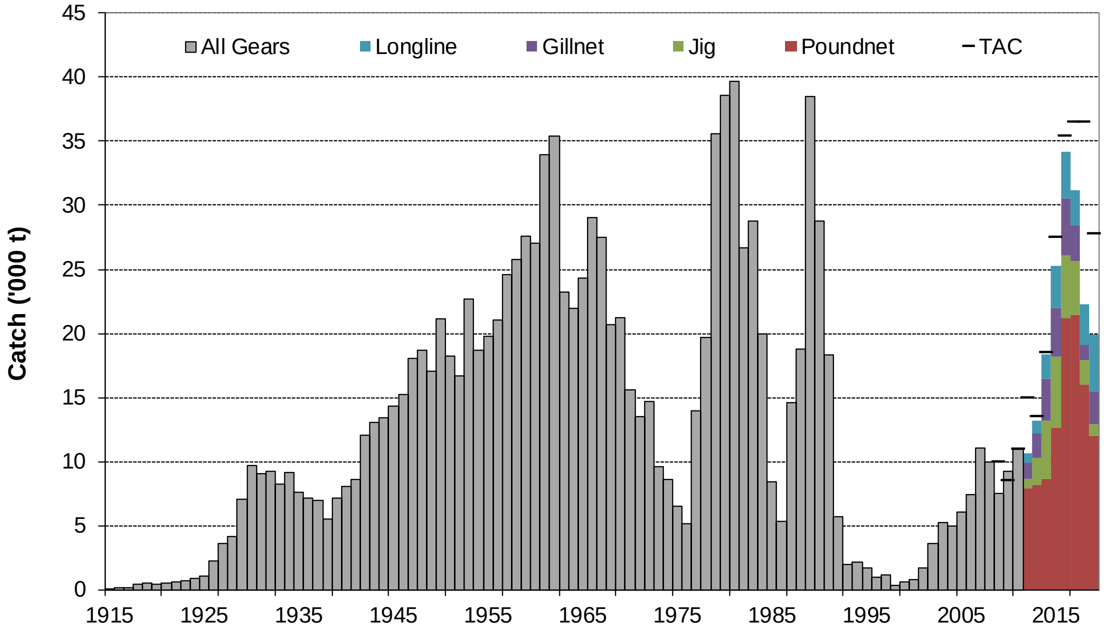


Figure 15.2.1 Inshore landings from West Greenland (Horsted, 1994; 2000). From 2012 divided into gears.

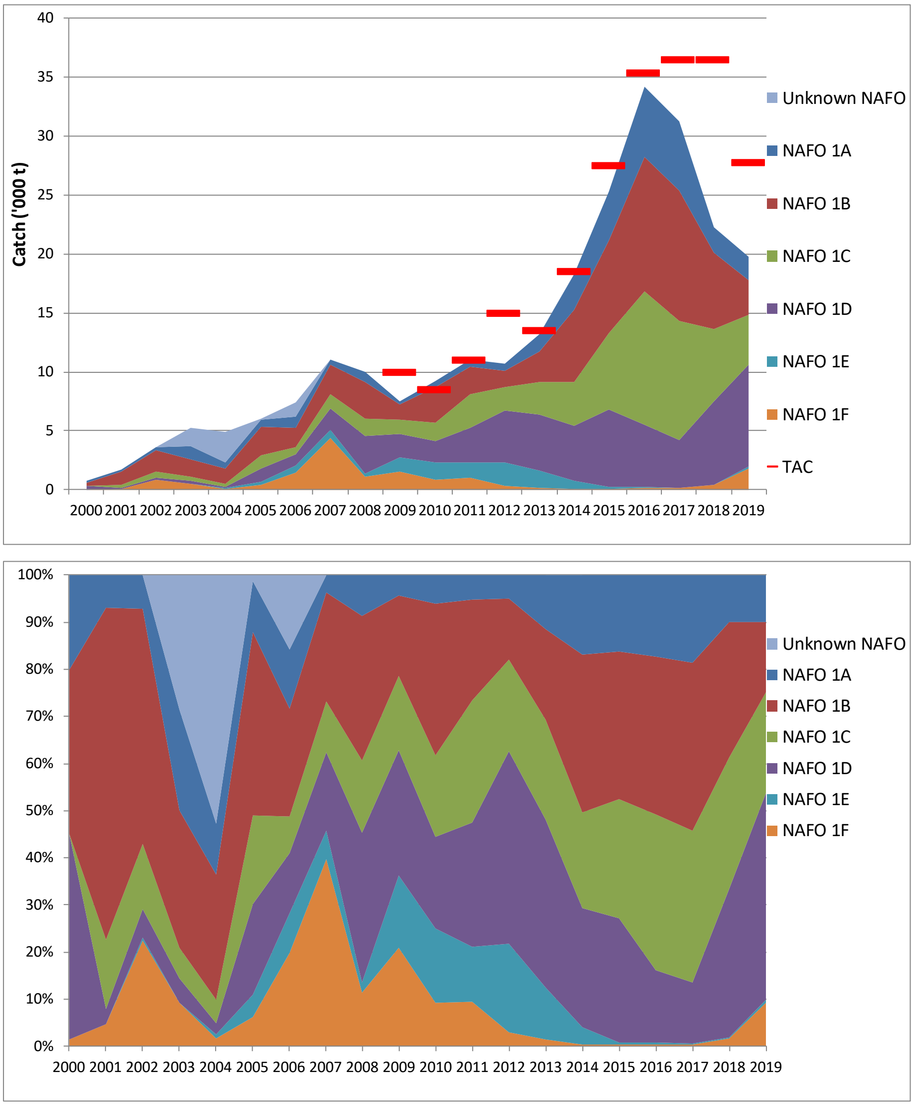


Figure 15.2.2. Total (top) and percentage (bottom) cod catches and TAC in the inshore fishery by NAFO divisions from 2000.

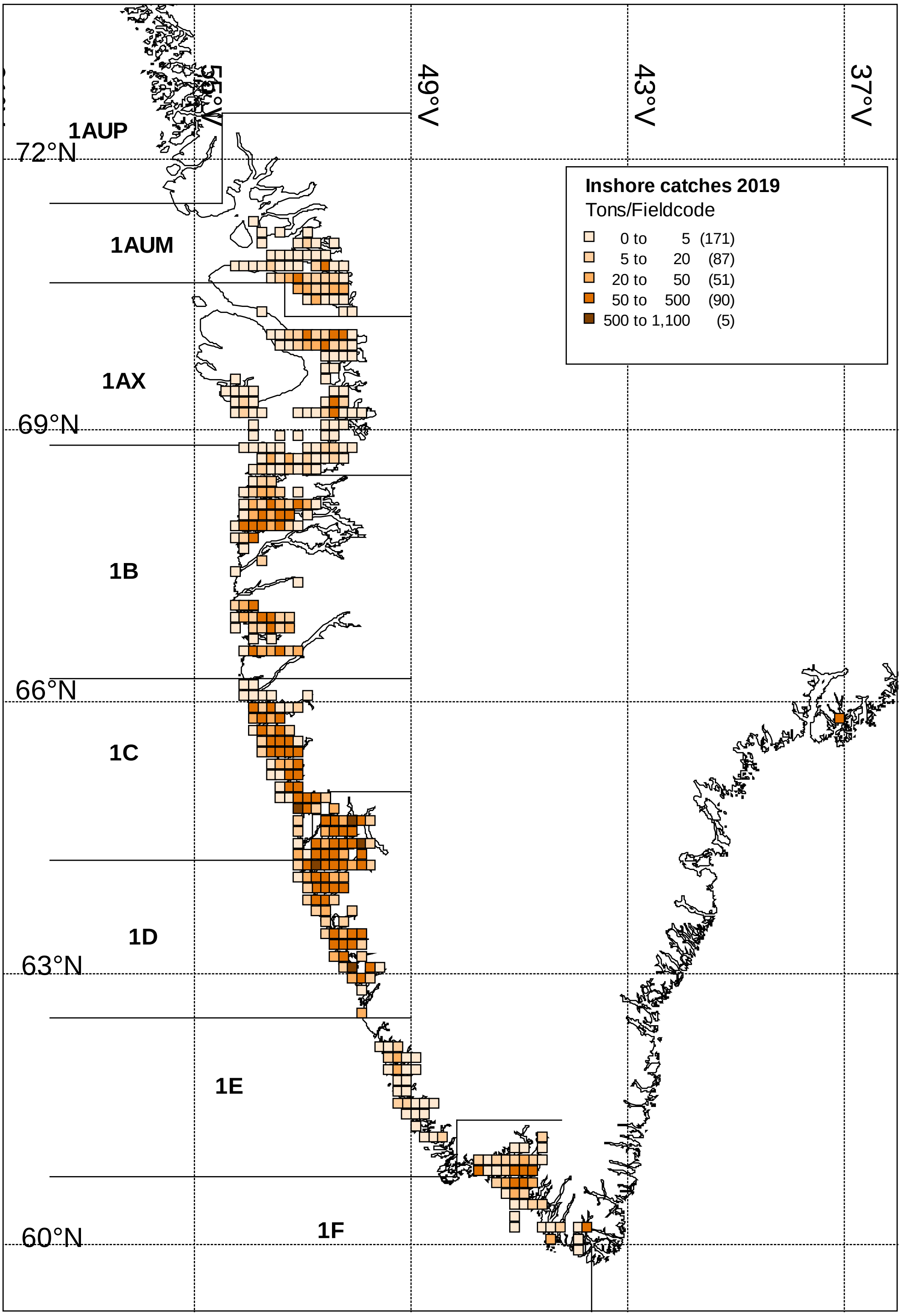


Figure 15.2.3. Distribution of commercial fishery along the coastline of West Greenland in total tonnes by field code.

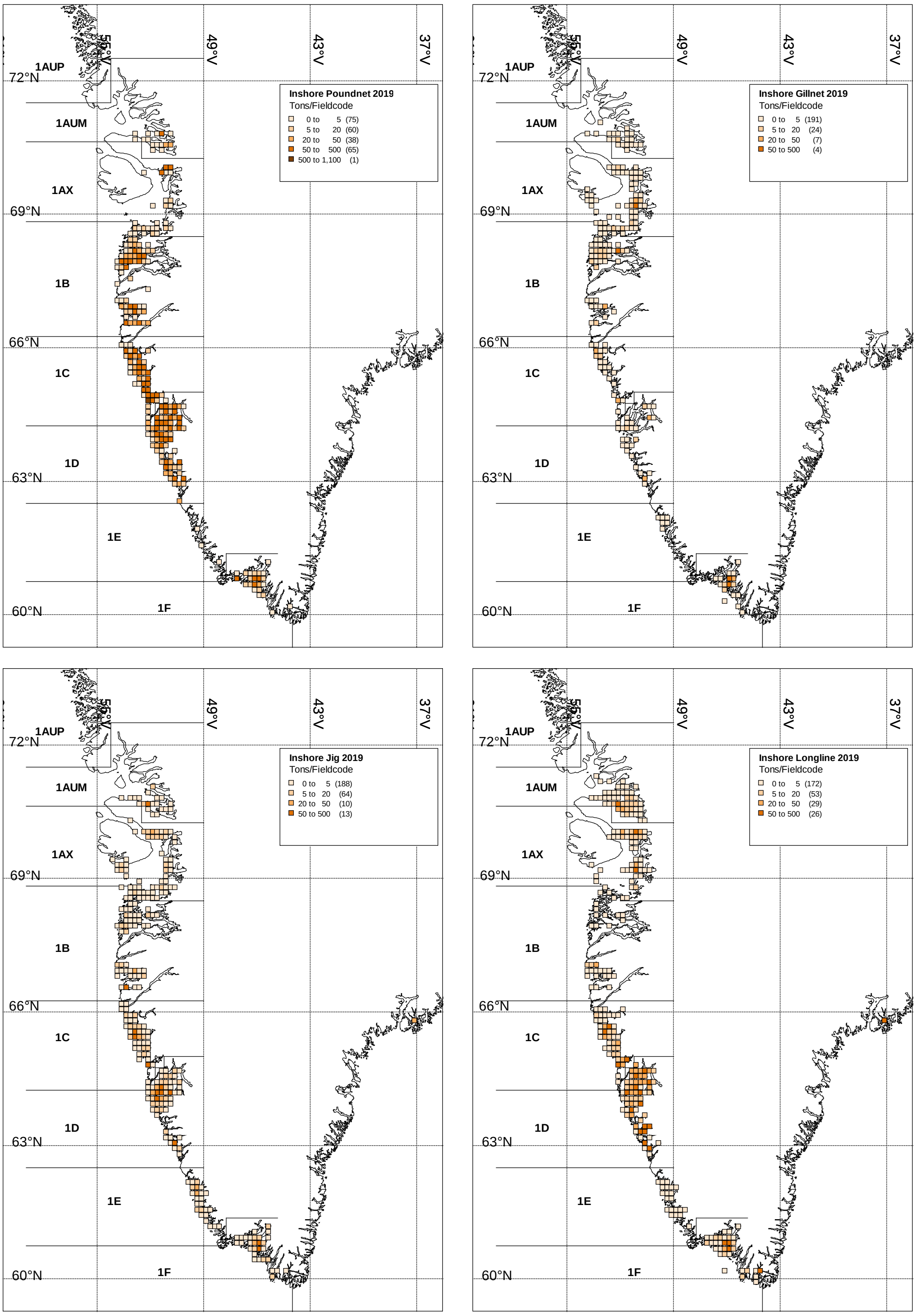


Figure 15.2.4 Distribution of the inshore commercial fishery by gear (tonnes/fieldcode).

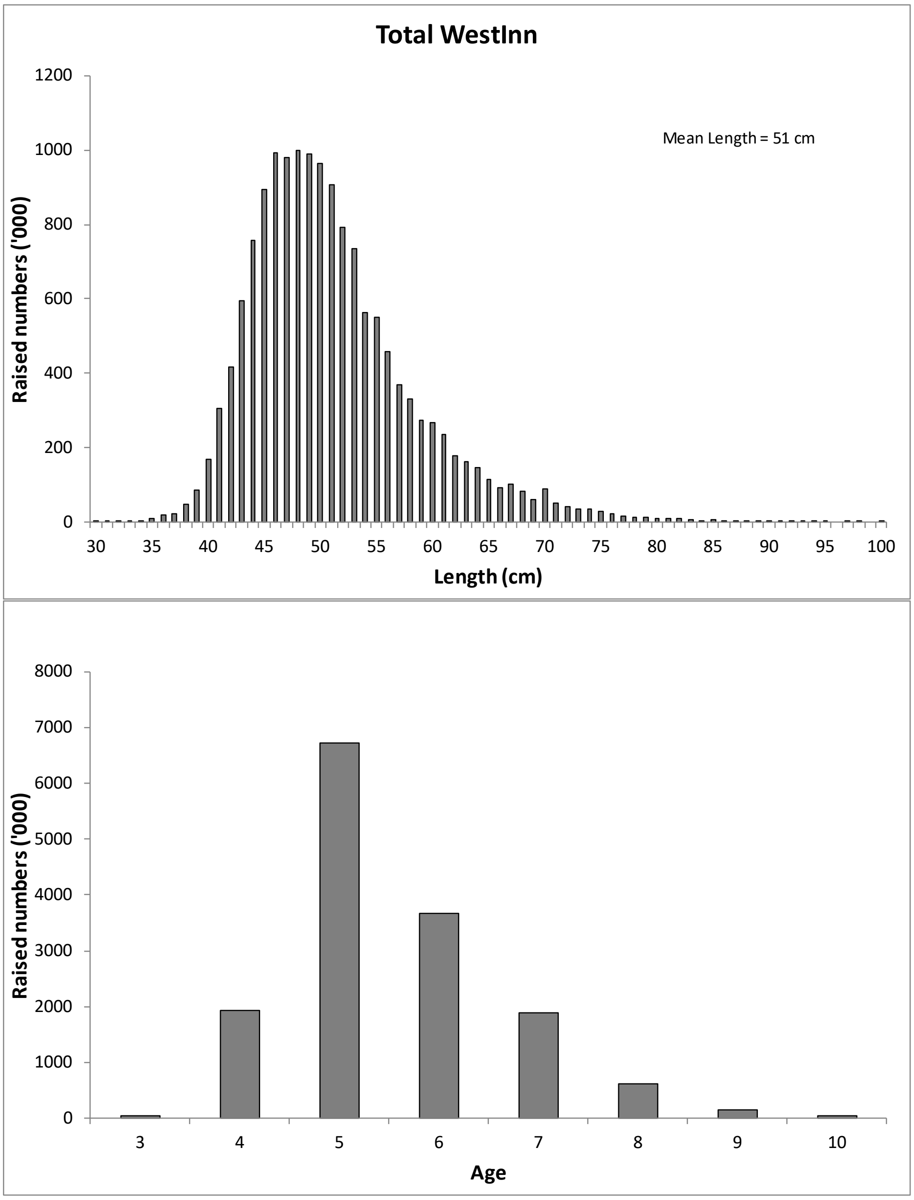


Figure 15.2.5. Total length and age distributions of inshore cod catches.

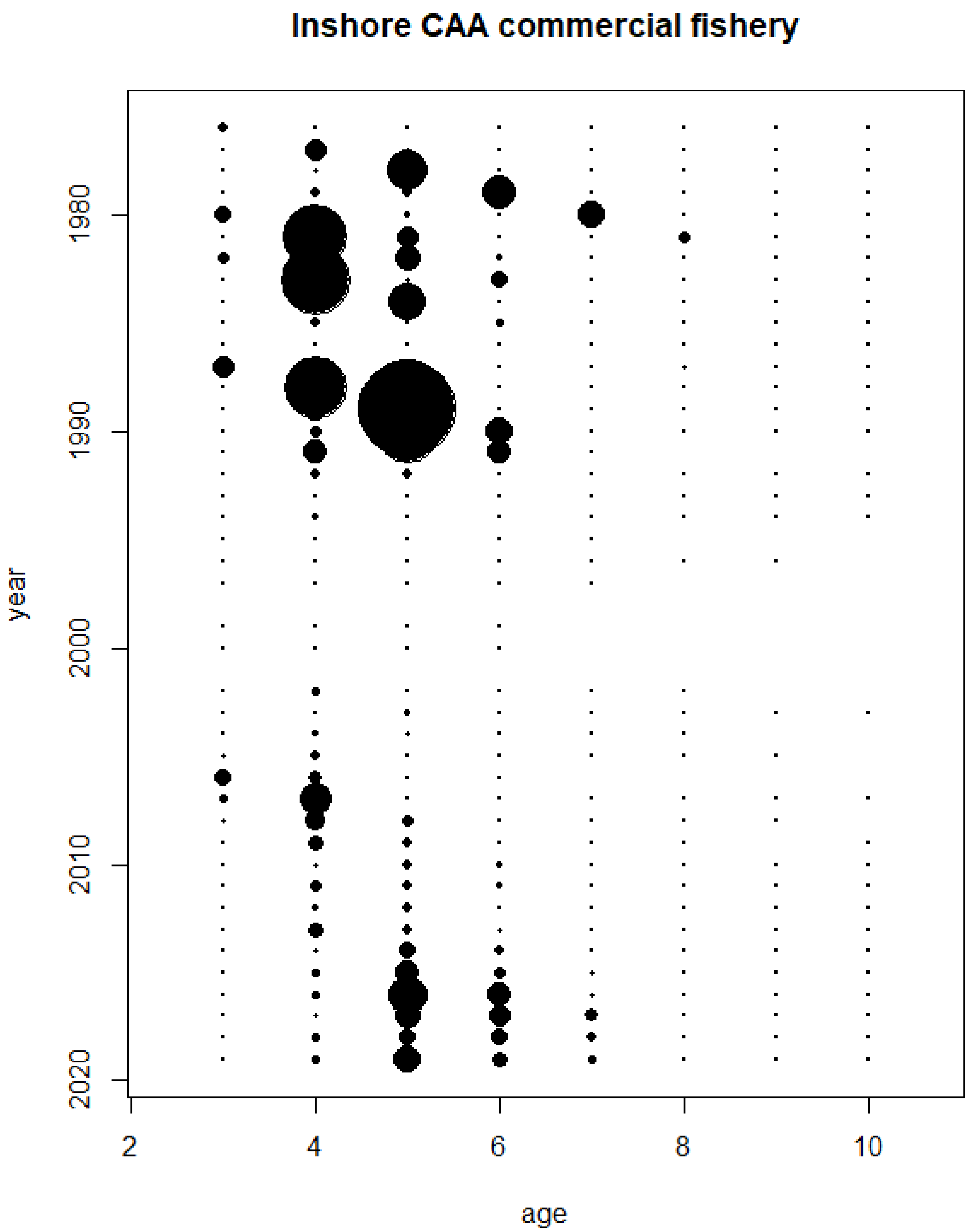


Figure 15.2.6. Catch at age in the commercial fishery in the West Greenland inshore area. Size of circles represents size of catch numbers.

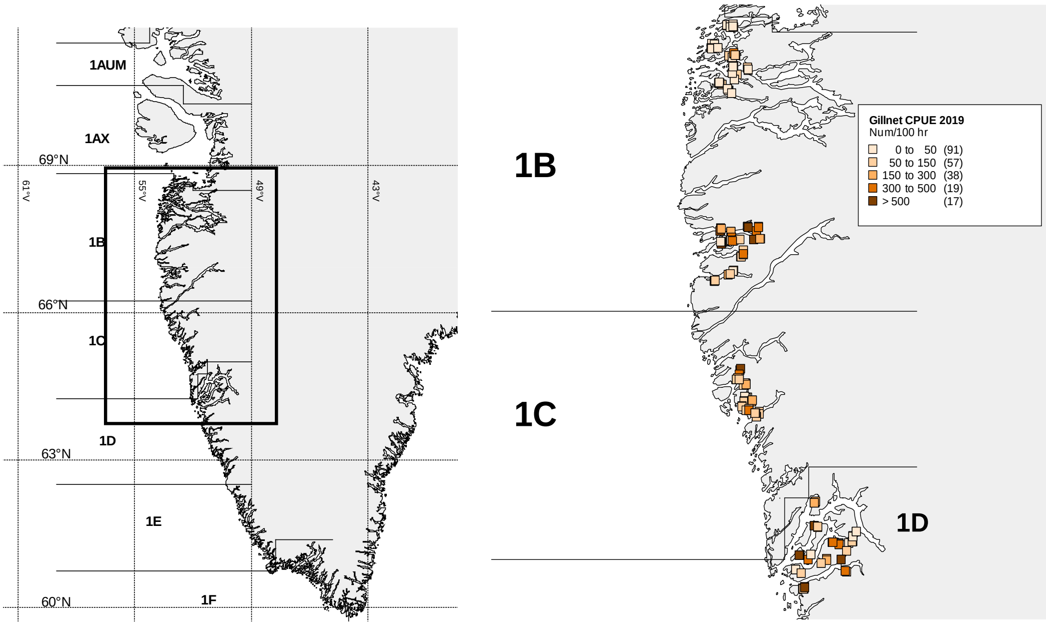


Figure 15.2.7. The inshore gill net survey area on the Greenland West coast. Survey catch rates are indicated on both as #caught/100h.

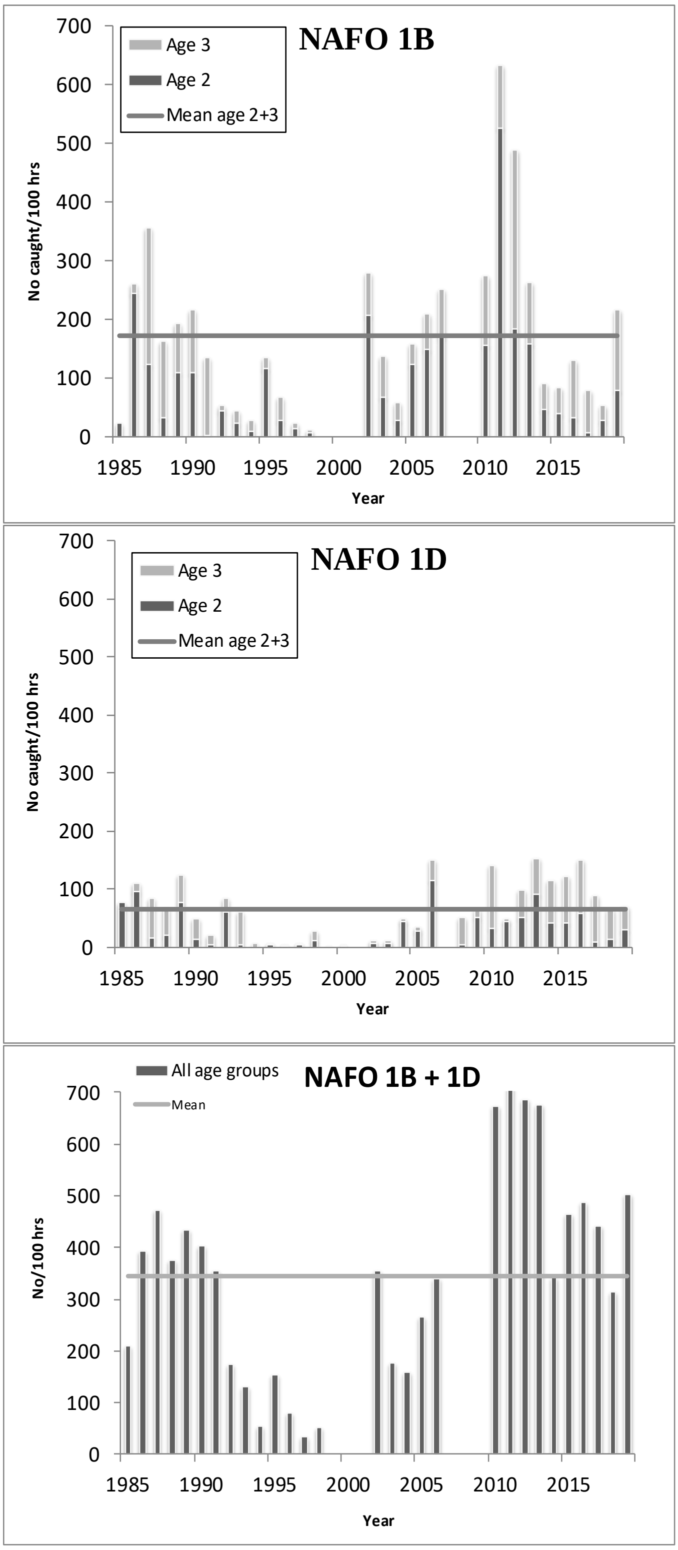


Figure 15.2.8: Recruitment indices (numbers caught/100 hr.) for ages 2 and 3 in 1B (top), 1D (middle) and all age groups (ages 1-8) 1B and 1D combined (lower) in West Greenland. Simultaneous surveys were not carried out 1999–2001 and 2007–2009.

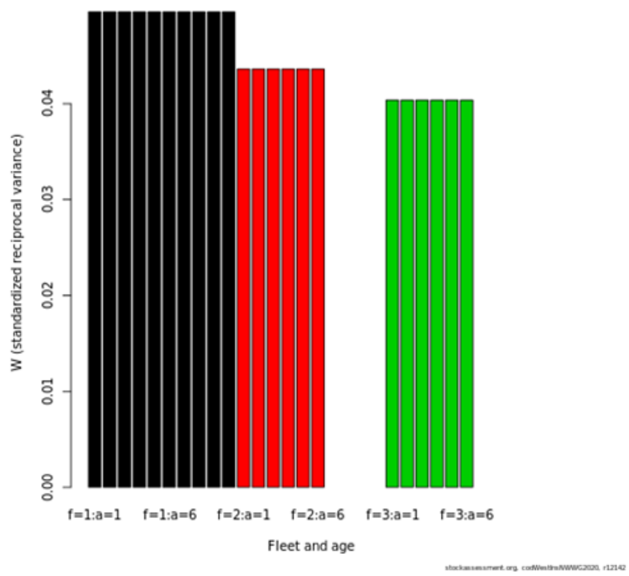


Figure 15.6.1: Standardized reciprocal variance from left to right: catches, 1B survey and 1D survey.

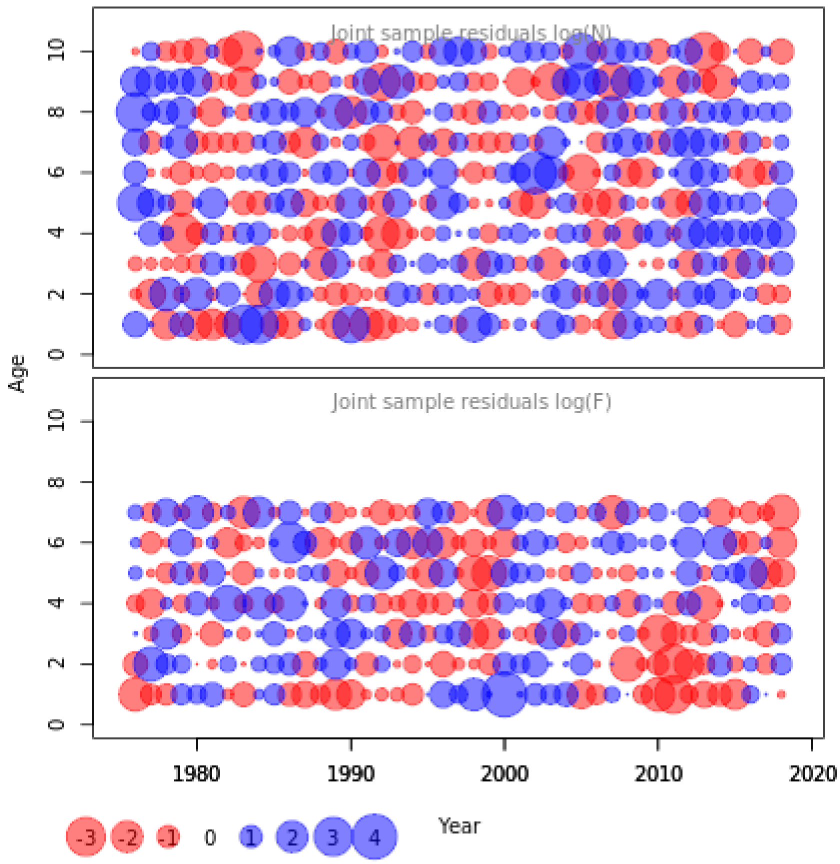


Figure 15.9.1: Normalized residuals derived from the SAM base run. Blue circles indicate positive residuals (observation larger than predicted) and filled red circles indicate negative residuals.

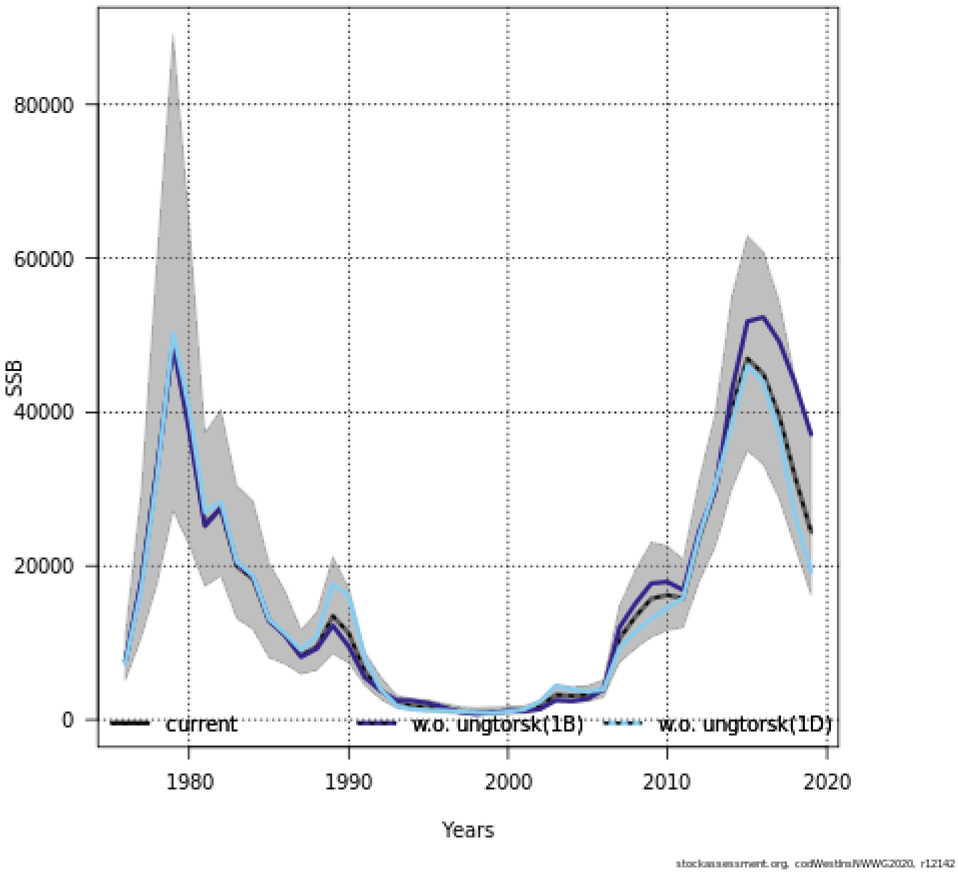


Figure 15.9.2: Analytical retrospective plots of spawning stock biomass. Mohn's rho is given in the upper right corner.

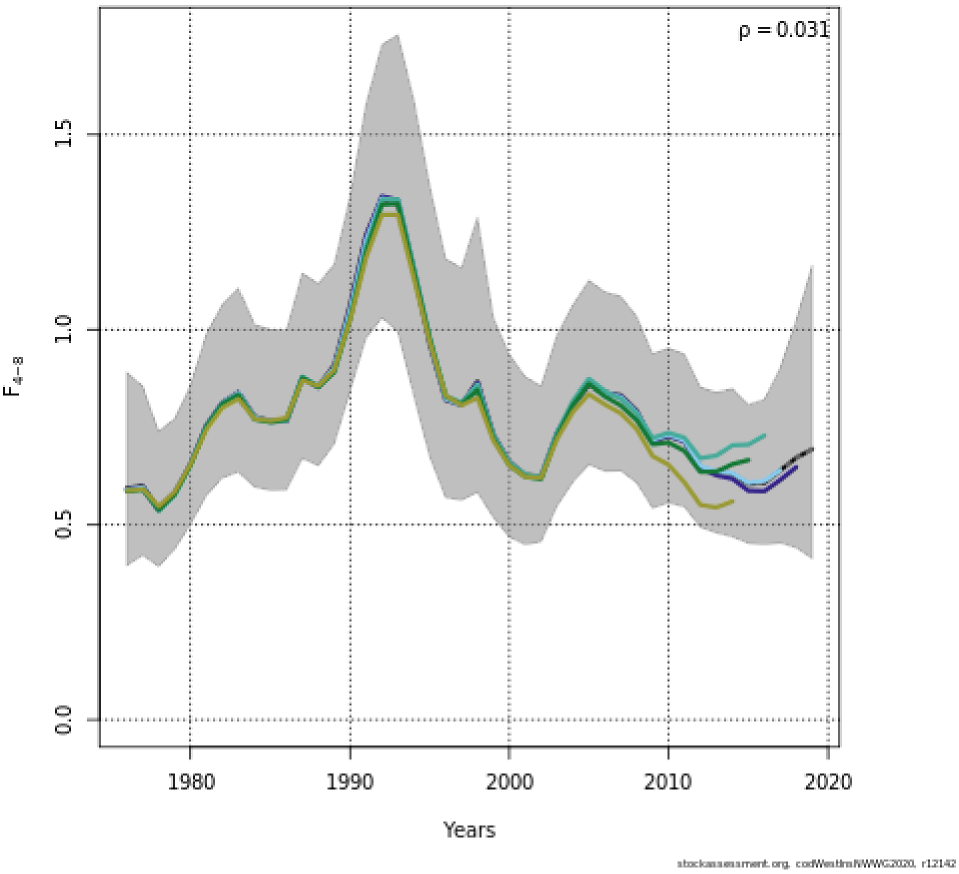


Figure 15.9.3: Analytical retrospective plots of fishing mortality. Mohn's rho is given in the upper right corner.

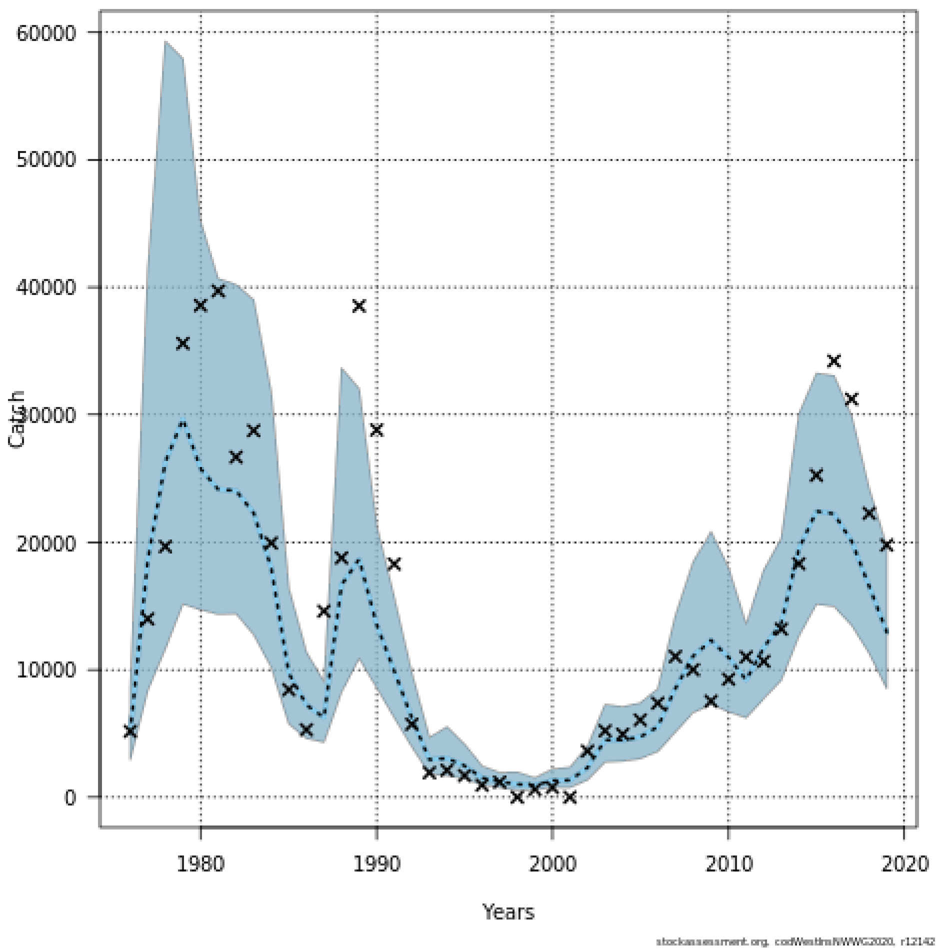


Figure 15.9.4: Estimated (line) and observed catch (x). Estimated catch is shown with 95% confidence intervals.

16 Cod (*Gadus morhua*) in ICES Subarea 14 and NAFO Division 1.F (East Greenland, South Greenland)

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), (Figure 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 14) components was assessed separately. The Stock Annex provides more details on the stock identities including the references to primary works.

16.2 Scientific data

16.2.1.1.1.1 Fishery

16.2.1.1.1.2 Historical trends in landings and fisheries

The Greenland commercial cod fishery in East Greenland started in 1954 but started earlier in Southwest Greenland (NAFO Subdivision 1F, Table 16.2.1, Figure 16.2.1). The fishery gradually developed culminating with catch levels above 40 000 tonnes annually in the 1960s. Due to overfishing, deteriorating environmental conditions and emigration to Iceland the stock size declined and the fishery completely collapsed in the early 1990s. More details on the historical development in the fisheries are provided in the stock annex.

16.2.1.1.1.3 The present fishery

TAC for 2019 was set at 20 000 t. The TAC was divided between the following countries and management areas (se section 16.12 for definition of management areas):

Management Area	TAC (tons)	Country
403 (Q1Q2)	9 638	Greenland
404 (Q3Q4)	3 340	Greenland
403+404	4 525	EU (2 000 t), Faeroes Island (1 325 t) and Norway (1 200 t)
415 (Q5Q61F)	2 497	Greenland

In 2019 a total of 18 074 tons with 1 667 tons caught in South Greenland (NAFO 1F + Q5Q6) and 16 406 tons caught in East Greenland (Tables 16.2.1 and 16.2.2).

Trawlers fished 77% of the total catch (Table 16.2.3, Figure 16.2.1) almost exclusively (80%) on Dohrn Bank in a small area between 65–66°N ; 29–31°W on the edge of the continental shelf close to the EEZ to Iceland. The longlining fishery was more evenly distributed than the trawl fishery and extended from Julianehåbs Bight in SouthWest Greenland (60°N, 1F) to Dohrn Bank (66°N, Q1Q2) in East Greenland (Figure 16.2.2 and 16.2.3). A detailed description of the fishery in 2019 is found in Retzel 2020.

16.2.1.1.1.4 Catch-at-age

The 2009 and older YC's dominated the total catches (Table 16.2.4, Figure 16.2.4). Younger fish of yearclass 2014 (age 5) is dominating the catch in SouthWest Greenland (NAFO 1F) whereas the oldest of ages 10+ is dominating the catch on Dohrn Bank (Q1Q2, table 16.2.5). The general pattern is that large fish (> 9 year old, mean length 85 cm) dominate the catch furthest to the north on Dorhn Bank and smaller fish (ages 5-6 years, mean length 64 cm) dominated the catch in South Greenland (Figure 16.2.5).

16.2.1.1.1.5 Weight-at-age

Annual weight-at-age are obtained from sampling on board fishing vessels since 2005, see stock annex for further details.

16.2.1.1.1.6 Maturity-at-age

Maturity at age is fixed for 1973-2017 and is based on samples from an experimental fishery in the spawning areas in 2007 (see stock annex for further details). Since 2018 a separate ogive was estimated based on cod sampled from an experimental fishery in the same spawning area as in 2007 (GINR, 2018). The two maturity ogives were similar.

16.2.1.1.1.7 Surveys

Two offshore bottom trawl surveys (Greenlandic and German) are conducted in the offshore region of Greenland. 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. For details of survey design see stock annex.

16.2.1.1.1.8 Greenland Shrimp and Fish survey

No survey was carried out in 2018 and 2019 as the Greenland research vessel (Paamiut) was scrapped. However West Greenland, including NAFO 1F (South West Greenland), was surveyed by a hired vessel with same gear rigging.

Number of hauls in NAFO 1F was 24 in 2019 compared to 35 in 2018 (table 16.2.6). The abundance and biomass indices in 2019 in NAFO 1F are low compared to the time series (tables 16.2.7 and 16.2.8). The 2015 yearclass (age 4) is dominating the survey in 2019 in NAFO 1F (table 16.2.9). Further results from the survey time series, including 2018 and 2019 results from NAFO 1F, can be seen in table 16.2.10 and figures 16.2.6 and 16.2.7.

16.2.1.1.1.9 German groundfish survey

No survey was carried out in 2018 due to mechanical problems.

In 2019, 78 valid trawl stations were sampled during the autumn in the German Greenland offshore groundfish survey (table 16.2.11). The abundance indices amounted to 15 mill. individuals and was highest in NAFO 1F (strata 4, table 16.2.12, figure 16.2.8). The 2015 yearclass (age 4) dominated the survey, followed by the 2014 yearclass (age 5, table 16.2.14). The 2015 yearclass dominated the survey especially in SouthGreenland (strata 4 and 5), but on Dohrn Bank (strata 9) much older fish of yearclass 2010 (age 9) and older dominated the survey (table 16.2.15). A detailed description of the survey in 2019 is found in Werner & Fock 2020.

16.2.1.1.1.10 Catch-at-age

During exploration of the survey data for the analytical assessment, it became clear that a substantial discrepancy between the German and the Greenland age-readings of cod otoliths exists. That became obvious, because mean weight-at-age data from both surveys differed systemically between German mean-weights-at-age, which were always considerably higher than the Greenlandic ones. An otolith exchange in order to compare age readings between both Institutes was conducted in the spring 2018 and showed that age readings of the same set of otoliths showed a one-year systemic difference between both institutes. Age readings were on average one year older for the same fish as read by the Greenlandic institute compared to the German institute (Hedeholm, 2018).

To investigate the issue a workshop on age reading of cod in Greenland was arranged with participants from the Greenland Institute of Natural Resources and the Thünen Institute of Sea Fisheries in Germany (Retzel, 2019). The Icelandic Marine and Freshwater Research Institute hosted the workshop that was held January 8-9, 2019, Reykjavik, Iceland. The cause for the discrepancy was identified as the German Institute not reading the last wintering on the edge of the otolith. Afterwards CAA were calculated for the German survey based on Greenland age-length keys in order to identify in which period age readings went wrong by the German Institute (Retzel, 2019). It was recommended that the German Institute reread their survey otolith from 2011 and onwards. By the time of the 2019 NWWG meeting the otoliths from the German surveys in 2016 and 2017 had been reread but there were still considerable differences in weight-at-age (Werner & Fock, 2019). By the time of the 2020 NWWG no further years in the German survey had been reread and the difference in weight-at-age not resolved. It is recommended that a data exchange with updated age readings take place between Germany and Greenland in order to resolve the issue.

16.3 Tagging

An extensive analysis of tagging results from the period 2003–2016 suggest that 50% of cod in East Greenland migrate to Iceland (Hedeholm, 2018). This has been incorporated in the assessment (ICES, 2018).

16.4 Methods

The stock was benchmarked in 2018 (ICES, 2018). It was decided to use the SAM model and perform an analytical assessment. Hence, the assessment was upgraded from a category 3 (Data Limited Stock) to a category 1 stock. This is considered a vast improvement, as all data are now utilized, and the assessment is presented with uncertainty estimates and multiple catch options.

16.5 Reference points

Reference points were defined at IBPGCod (ICES, 2018). The estimations were conducted in EQSIM according to ICES guidelines (see ICES (2018) for details). The reference points are shown in Table 16.5.1.

16.6 State of the stock

The offshore component has been decreasing the last six years. 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 led to a stock increase during the 00s and an increase in catches. Since 2014 the spawning stock biomass (SSB) has decreased and recruitment has been low.

The number of recruits estimated by SAM in 2019 is equal to the number of recruits in 2017 and 2018. The explanation for this is that no survey was carried out in 2018 and that number 1- and 2-years old cod was caught in the German survey in 2019 was zero. SAM handle such a situation that no information are available since 2017 and the value for the latest year with information is applied for the two coming years without new information. Consequently, the confidence limits of the number of recruits increase considerably in these two years.

According to the results from the SAM model F_{5-10} has been below F_{MSY} during the last two to three decades but is above F_{MSY} in 2019. The spawning-stock biomass (SSB) increased to above MSY $B_{trigger}$ from 2005 and has decreased since 2014 but is still above MSY $B_{trigger}$.

16.7 Short term forecast

The State-space model (SAM) was applied for the offshore cod stock in ICES Division 14. and NAFO Division 1F (Riget *et al.*, 2020).

16.7.1.1.1.1 Input data

The SAM model provides predictions that carry the signals from the assessment into the short term forecast. The forecast procedure starts from the last year's estimate of the state (log(N) and log(F)). One thousand replicates of the last state are simulated from the estimated joint distribution. Each of these replicates are then simulated forward according to the assumptions and parameter estimates found by the assessment model.

In the forward simulations a 5 year average (up to the assessment year) is used for catch mean weight, stock mean weight, proportion mature, and natural mortality. Recruitment is re-sampled from the entire time series. In each forward simulation step the fishing mortality is scaled, such that the median of the distribution is matching the requirement in the scenario (e.g. hitting a specific mean F value, a specific catch or level of SSB).

16.7.1.1.1.2 Results

Number at age and F at age estimated by SAM are shown in Table 16.7.1 and 16.7.2, respectively. The TAC for 2020 are set to 18 824 t and we assumed that managers will keep the already set TAC rather than following the advice. However, catching 18 824 t in 2020 implies a F on 1.333 which may be unrealistic high. Therefore, the catch will be followed through the year and if necessary a new national advice will be given. The forecasts for the assumption Catch = TAC_{2020}(18 824 t) from the different scenarios are presented in Table 16.7.3.

16.8 Long term forecast

No long term forecast was performed for this stock.

16.9 Uncertainties in assessment and forecast

There is no incentive to discard fish or misreport catches under the current management system. In 2018 no survey data were available, and in 2019 German survey data were available but no Greenland survey data. This add uncertainties to the assessment.

The model fits the data relatively well Figure 16.9.1. The retrospective runs show no patterns and all inside the model 95% confidence intervals. However, the Mohn's rho measure of uncertainty were high in case of $F_{5\text{–}10}$ (0.387) and recruits (-0.424). It is likely linked to the lack of surveys in 2018 and lack of the Greenland survey in 2019. In the coming years both the Greenland and the German surveys are expected to be performed, and that this will results in decreasing of the Mohn's rho again in future assessments. The Mohn's rho for SSB was estimated as -0.188.

16.10 Comparison with previous assessment and forecast

The analytical assessment model (SAM) was accepted at the benchmark January 2018 (ICES 2018) and only two years of the analytical assessment exist. In the years before the advice was based on a DLS assessment. Compared to last year assessment the SSB annual estimates has been up-scaled for the last 10-12 years equivalent to a year class pass trough the assessment. Some up-scaling has also happened in the number of recruits especially large year class such as the 2003-year class. Furthermore, the values of Mohn's rho of the retrospective has increased considerably in this year assessment. This has resulted in a relative high increase (79%) of the MSY based advice and assuming the catch in 2020 equal to the TAC. These changes are likely linked to the incomplete survey data in 2018 and 2019. In 2018 no survey was performed and in 2019 only the German survey was carried out. In the future years it is expected that both surveys will be performed as earlier, and that the assessment will become more robust again.

16.11 Implemented management measures for 2020

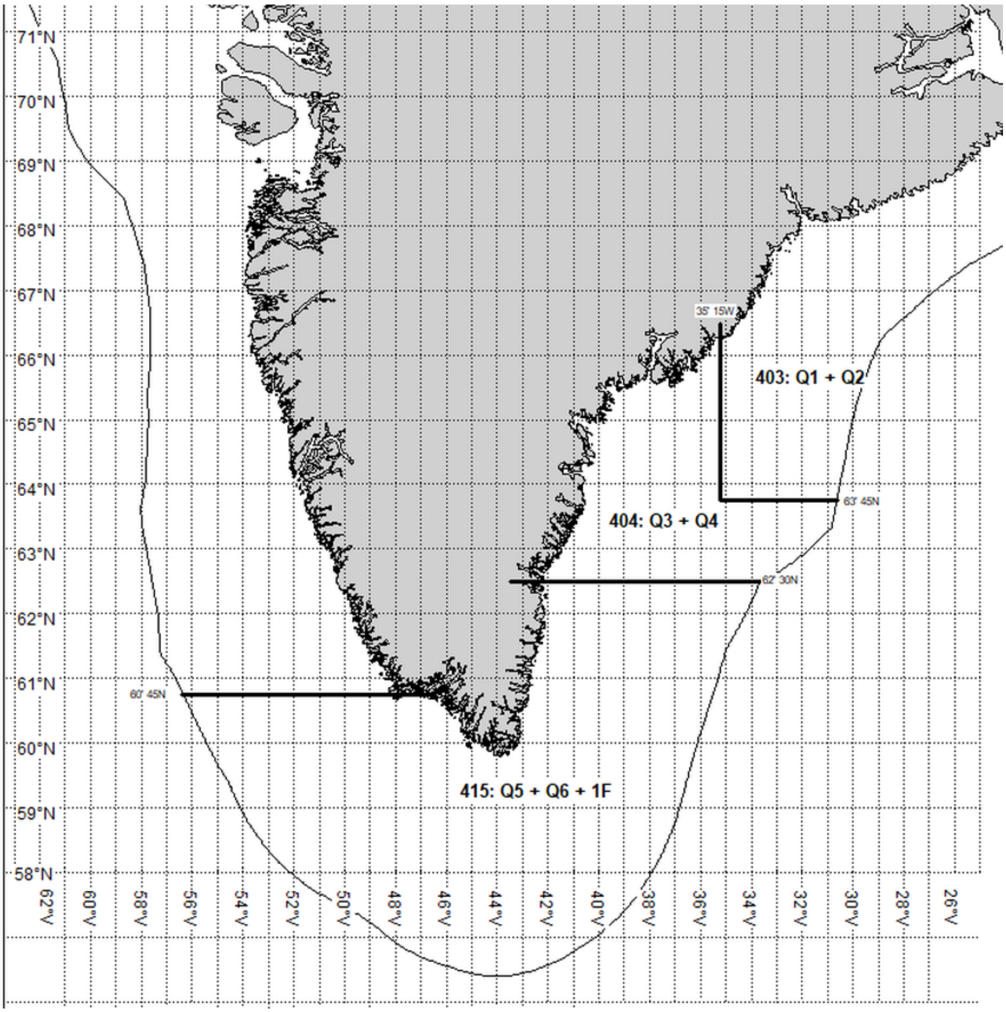
The offshore quota for the total international fishery is set at 18 824 t. The following table shows the distribution of the TAC across management areas and countries

Area	TAC (tons)	Countries
403 (Q1Q2, Dohrn Bank)	9 226	Greenland
404 (Q3Q4, Kleine Bank)	2 524	Greenland
403+404 (Dohrn Bank + Kleine Bank)	4 800	EU (1 950 t) Faeroes Island (1 500 t) Norway (1 350 t)
415 (South Greenland)	2 274	Greenland

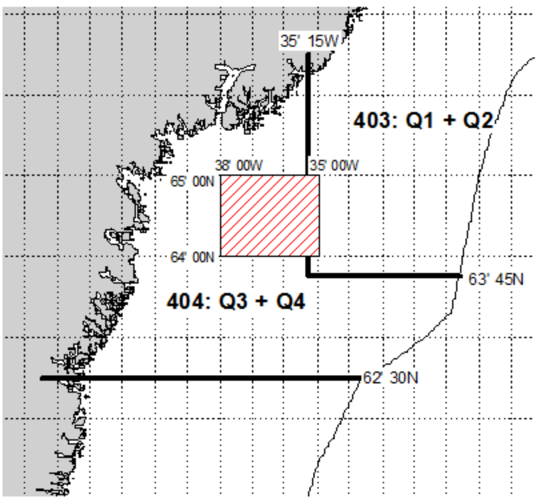
To protect the spawning stock no fishing is allowed from 1 March to 31 May in a square in area 404 (Kleine Bank, see figure below).

16.12 Management plan

In 2020, a management plan was implemented for the offshore cod fishery in Greenland but it has not been evaluated by ICES. The management plan distinguished between 3 areas: 403 comprising Dohrn Bank, 404 comprising Kleine Bank and 415 comprising South Greenland. The management plan tries to take the scientific advice, migration to Iceland and protection of spawning grounds into account.



In order to protect the spawning stock it is not allowed to fish from 1 March to 31 May in a square comprising Kleine Bank:



16.13 Management considerations

Larger and older fish (8+ year old) are located furthest to the north on Dohrn Bank, whereas younger fish dominate in the South (5–6 year old). This reflects the eastward migration behaviour towards the spawning grounds in East Greenland and Iceland. 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. Tagging suggest that a substantial part of the cod in East Greenland migrate to Iceland.

16.14 Basis for advice

The State-space model (SAM) was applied for the offshore cod stock in ICES Division 14. and NAFO Division 1F (Riget *et al.*, 2020).

16.15 Benchmark 2022

Analytical model (SAM) is used in assessment. A century of tagging studies has documented substantial migration from Greenland to Iceland of mature cod, and especially the East and South Greenland area is highly influenced by the inflow of egg and larvae from the spawning grounds in Iceland. This is currently solved in the model by increasing M. The inflow of recruits from outside the assessment area influences the SSB-R relationship which is characterized as Type 2 and a segmented regression results in a very low B_{lim}. The aim of the benchmark is to investigate if including more years in the assessment (years with stable recruitment from spawning stock in the assessment area) and ree-valuate the SSB-R relationship B_{lim} could be redefined.

Based on genetic analysis it is not possible to distinguish between an East Greenland and Icelandic offshore stock and especially the East and South Greenland area is highly influenced by the inflow of egg and larvae from the spawning grounds in Iceland. The potential for developing a combined assessment model for the East Greenland and Icelandic cod stocks requires robust methods for splitting up or combining catch-at-age and survey at age among areas. To gain further insight into stock structure and migration patterns across areas targeted work using both genetic and tagging data is needed.

The Greenland and German trawl surveys are fundamental to the assessment of cod in East Greenland. The two surveys provide similar signals and similar age compositions, but the mean weights-at-age differ considerably. A workshop in 2019 identified wrong age-readings in the German survey, but even after age-readings in the German survey have been corrected the difference in mean weight-at-age persist. In addition several inconsistencies in survey calculations have been identified in the German survey. A dedicated workshop prior to the benchmark to identify and solve these data issues is16.15 strongly recommended.

16.16 References

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16.17 Tables

Table 16.2.1. Offshore catches (t) divided into NAFO divisions in West Greenland and East Greenland (ICES 14.b). 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 14.b	NAFO 1F + ICES 14.b
1924							200		
1925							1871		
1926							4452		
1927							4427		
1928							5871		
1929							22304		
1930							94722		
1931							120858		
1932							87273		
1933							54351		
1934							88422		
1935							65796		

Year	NAFO 1A	NAFO 1B	NAFO 1C	NAFO 1D	NAFO 1E	NAFO 1F	Unknown NAFO div.	ICES 14.b	NAFO 1F + ICES 14.b
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		

Year	NAFO 1A	NAFO 1B	NAFO 1C	NAFO 1D	NAFO 1E	NAFO 1F	Unknown NAFO div.	ICES 14.b	NAFO 1F + ICES 14.b
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 14.b	NAFO 1F + ICES 14.b
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*

Year	NAFO 1A	NAFO 1B	NAFO 1C	NAFO 1D	NAFO 1E	NAFO 1F	Unknown NAFO div.	ICES 14.b	NAFO 1F + ICES 14.b
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

Year	NAFO 1A	NAFO 1B	NAFO 1C	NAFO 1D	NAFO 1E	NAFO 1F	Unknown NAFO div.	ICES 14.b	NAFO 1F + ICES 14.b
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
2015	0	0	341	954	3564	3984	0	11771	15755
2016	0	0	67	1911	1762	2335	0	12483	14818
2017	0	1	1442	730	852	2560	0	13740	16300
2018	0	0	1989	678	1520	1819	0	13249	15068
2019	0	0	654	57	186	916	0	17158	18074

1) Estimates for assessment include estimates of unreported catches. The total estimated value for West Greenland (inshore + offshore) was 73 000 t in 1977 and 1978, 1979: 99 000 t, 1980: 54 000 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: Cod catches (t) by area and month. East Greenland (14.b) divided into five areas. NQ1 furthest to the north.

ICES/NAFO	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	%
14.b (NQ1)							3	27	10		4		**44**	0.2%
14.b (Q1Q2)	294	615	344	45	945	2514	1142	1483	1313	794	1391	1276	**12156**	67%
14.b (Q3Q4)	214	569	260	626	517	1859	34	52		12		64	**4207**	23%
14.b (Q5Q6)	18	94	78	80	197	273	10					2	**752**	4%
1F	100	112	53	51	4					58	496	41	**915**	5%
Total	**626**	**1390**	**735**	**802**	**1663**	**4645**	**1189**	**1562**	**1323**	**864**	**1891**	**1383**	**18074**	
%	3%	8%	4%	4%	9%	26%	7%	9%	7%	5%	10%	8%		

Table 16.2.3: Cod catches (t) by gear, area and month. East Greenland (14.b) divided into five areas. NQ1 furthest to the north.

Gear	ICES/NAFO	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Longline	14.b (NQ1)									10		4		**14**
	14.b (Q1Q2)		130	68		3	33	90	360	96	33	130	275	**1218**
	14.b (Q3Q4)	214	10	238	615	79	822	34	51				64	**2127**
	14.b (Q5Q6)	18	94	78	70	49	3	7						**319**
	1F	100	112	53	51	4					23	157	5	**505**
	Total	**332**	**346**	**437**	**736**	**135**	**858**	**131**	**411**	**106**	**56**	**291**	**344**	**4183**
Trawl	14.b (NQ1)							3	27					**30**
	14.b (Q1Q2)	294	484	276	45	942	2479	1053	1123	1217	762	1261	1001	**10937**
	14.b (Q3Q4)		559	22	11	438	1037		1		12			**2080**
	14.b (Q5Q6)				9	149	270	3					2	**433**
	1F										35	340	36	**411**
	Total	**294**	**1043**	**298**	**65**	**1529**	**3788**	**1059**	**1151**	**1217**	**809**	**1601**	**1039**	**13891**

Table 16.2.4. Cod in Greenland. Catch at age ('000) and Weight at age (kg) for offshore fleets in East Greenland (ICES 14.b + NAFO 1F).

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
2015	3	57	457	1554	1324	828	242	182
2016	4	33	343	736	1130	766	427	257
2017	6	15	137	519	1214	1432	527	251
2018	7	27	67	217	498	1023	855	496
2019	0	150	331	358	426	679	948	1090

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
2015	0.484	0.833	1.435	2.097	3.460	4.699	6.846	9.115
2016	0.406	0.845	1.420	2.135	3.267	4.693	6.693	10.071
2017	0.392	0.711	1.641	2.213	3.063	4.167	6.094	8.034
2018	0.378	0.812	1.258	2.032	2.948	4.561	5.663	7.135
2019	0.307	1.168	1.775	2.687	3.257	4.052	5.291	6.601

Table 16.2.5. Cod in Greenland. Catch at age ('000) for offshore fleets by area (ICES 14b + NAFO 1F). Q1Q2 furthest to the north in East Greenland. NAFO 1F + 14b(Q5Q6) = South Greenland.

Catch at age								
Area/age	3	4	5	6	7	8	9	10+
14.b (Q1Q2)	0	43	93	150	213	399	652	822
14.b (Q3Q4)	0	56	70	87	115	189	223	235
14.b (Q5Q6)	0	13	42	42	41	48	34	24
NAGO 1F	0	38	126	79	57	43	39	9

Table 16.2.6. Number of hauls in the Greenland Shrimp and Fish survey in ICES 14.b and NAFO 1F.

	ICES 14.b						**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	

	ICES 14.b						NAFO	
Year/Strata	Q1	Q2	Q3	Q4	Q5	Q6	1F	Total
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
2015	26	11	24	12	8	14	36	131

	ICES 14.b						NAFO	
Year/Strata	Q1	Q2	Q3	Q4	Q5	Q6	1F	Total
2016	29	10	26	13	7	16	36	137
2017	2	4	7	6	6	11	35	71
2018	0	0	0	0	0	0	35	
2019	0	0	0	0	0	0	24	

Table 16.2.7 Cod abundance indices ('000) from the Greenland Shrimp and Fish survey by year and strata divisions in ICES 14.b and NAFO 1F. Q1 being the northern strata in East Greenland. * Incomplete coverage in strata Q1–Q4.

	ICES 14.b						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		

	ICES 14.b						NAFO		
Year	Q1	Q2	Q3	Q4	Q5	Q6	1F	Total	CV
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

	ICES 14.b						NAFO		
Year	Q1	Q2	Q3	Q4	Q5	Q6	1F	Total	CV
2015	6396	4074	6941	3093	231	8322	34032	63090	28
2016	8338	909	9737	1031	233	3412	4393	28052	16
2017*	7429	4559	5242	5816	627	18694	12466	54833	28
2018							5302		
2019							5233		

Table 16.2.8. Cod biomass indices (tonnes) from the Greenland Shrimp and Fish survey by year and strata divisions in ICES 14.b (Q1–Q6) and NAFO 1F. * Incomplete coverage in strata Q1–Q4.

	ICES 14.b						NAFO		
Year	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**1F**	**Total**	**CV**
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	21236	68952	23
2009	10844	8874	27251	7827	252	3094	503	58645	28
2010	16014	3151	81064	6202	23	4203	3142	113799	51
2011	27064	8128	5561	12486	5235	22664	3280	84418	19
2012	24736	10058	9347	5802	160	14322	16213	80638	16
2013	45018	9639	15017	48518	977	40319	47818	207306	22
2014	17182	20637	15574	90795	734	8884	30754	184560	45
2015	33105	13803	27050	11609	513	18724	49931	154735	20
2016	40580	4831	33065	4841	426	5670	4671	94084	18
2017	45774	27405	18257	4777	1749	31635	7823	137420	41
2018							8498		
2019							3841		

Table 16.2.9: Abundance indices ('000) by age from the Greenland Shrimp and Fish survey by year in ICES 14.b + NAFO 1F. *Incomplete coverage. Indices for 2019 is for NAFO 1F only.

East Greenland											
Year/age	0	1	2	3	4	5	6	7	8	9	10+
2008	4355	326	1168	7460	6937	24058	5279	2227	613	1225	671
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
2015	0	86	38	1259	4916	11445	29010	7407	4793	1954	2181
2016	279	3847	1818	998	555	2089	2399	6779	4874	3398	1018
2017*	242	111	14938	5234	6797	4470	5791	4307	7746	4352	845
2018					No	survey					
2019					No	survey					
2019 NAFO 1F	0	7	290	847	3043	711	124	10	127	51	24

Table 16.2.10: Mean weight (kg) at age from the Greenland Shrimp and Fish survey by year in ICES 14.b + NAFO 1F.

East Greenland											
Year/age	0	1	2	3	4	5	6	7	8	9	10+
2008	0.003	0.019	0.088	0.262	0.520	1.067	1.982	3.385	5.699	8.447	8.564
2009	0.004	0.059	0.140	0.452	0.976	1.730	2.977	4.186	5.447	7.423	10.800
2010	0.002	0.041	0.206	0.406	0.823	1.728	2.499	3.496	5.480	7.363	10.686
2011	0.001	0.017	0.152	0.366	0.783	1.408	2.209	3.891	5.711	7.218	10.859
2012		0.025	0.201	0.367	0.916	1.519	2.634	4.068	5.658	7.565	10.000
2013		0.020	0.194	0.450	0.771	1.396	2.353	3.663	5.140	7.062	10.354
2014	0.001	0.003	0.129	0.360	0.773	1.402	2.758	4.145	5.173	6.217	9.060
2015		0.017	0.100	0.357	0.697	1.194	1.808	3.241	4.835	6.809	10.000
2016	0.001	0.025	0.116	0.327	0.831	1.623	2.245	3.557	5.299	6.879	9.973
2017	0.001	0.047	0.186	0.369	0.782	1.485	2.338	3.995	5.714	8.168	10.674

2018	No	survey
2019	No	survey

Table 16.2.11 *German survey*. Numbers of valid hauls by stratum in South and East Greenland, stratum 9 furthest to the north.

	NAFO 1 F		ICES 14.b						
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

	NAFO 1 F		ICES 14.b						
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
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
2015	8	6	6	8	9	10	19	9	75
2016	11	6	5	8	8	6	13	6	63
2017	7	.	3	2	6	6	13	9	46
2018				No survey					
2019	16	7	3	8	8	9	19	8	78

Table 16.2.12 ***German survey*****. Cod abundance indices ('000) from the German survey in South and East Greenland by year and stratum. Incomplete coverage in 2017.**

	NAFO 1F		ICES 14.b							
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

	NAFO 1F		ICES 14.b							
year	str4_1	str4_2	str5_1	str5_2	str7_1	str7_2	str8_2	str9_2	Sum	SD
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
2015	3187	361	1186	267	113	834	2265	3395	11833	3703
2016	2875	361	1186	267	113	793	2152	4086	9114	1647
2017	1499	104	1498	262	336	1126	1126	3307	12421	3727
2018					No survey					
2019	11679	17	416	550	122	350	305	2123	15564	

Table 16.2.13 ***German survey*****. Cod biomass indices (tonnes) from the German survey in South and East Greenland by year and stratum. Incomplete coverage in 2017.**

	NAFO 1F		ICES 14.b							
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

	NAFO 1F		ICES 14.b							
year	str4_1	str4_2	str5_1	str5_2	str7_1	str7_2	str8_2	str9_2	Sum	SD
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
2015	10777	1534	3938	1804	522	3346	9396	24306	55623	17157
2016	4521	305	7360	1727	2129	6341	4906	9367	36656	6954
2017	5836	.	7687	0	616	9704	4067	31088	58998	20593
2018					No survey					
2019	19292	32	1927	1245	397	685	1610	11072	36260	11857

Table 16.2.14 German survey, South and East Greenland (NAFO 1F and ICES 14.). Age disaggregate abundance indices ('1000). Incomplete coverage in 2017.

Year	0	1	2	3	4	5	6	7	8	9	10	11+
1982		23	214	2500	1760	4451	1952	793	223	927	57	74
1983												
1984	23	8	54	1134	507	2434	582	1242	229	125	17	49
1985	279	2521	242	160	1658	947	1439	344	831	96	27	27
1986		3367	9255	1128	273	1631	603	1300	165	473	31	58
1987		4	10193	24656	2689	720	1368	296	966	80	487	49
1988	6	18	335	9769	23391	876	200	559	83	337	31	146
1989	12	2	111	732	23945	49864	1007	44	756	70	282	76
1990	58	36	58	715	706	11679	12101	139	15	74		148
1991		73	150	171	539	102	2128	1762	31	11	3	9
1992	214	10	196	103	61	53	67	67	51			21
1993		4	15	869	152	95	97	31	83	34		2
1994		71	5	16	84	39	22	38		8		0
1995		1	621	347	260	1399	372	120	403	32	192	102
1996		0	0	353	130	131	110	23	25			0
1997		0	12	17	687	557	191	78	48			5
1998	51	73	39	4	11	173	138	48	10			0

Year	0	1	2	3	4	5	6	7	8	9	10	11+
1999	105	426	389	346	118	257	174	156		29	16	0
2000		202	243	323	208	40	72	20	46	61	15	0
2001		166	568	493	631	362	190	60	50	18	10	2
2002	40	1	395	2119	601	477	454	217	61	21	11	7
2003	579	629	53	553	1761	1026	1015	541	220	37	.	4
2004	386	10687	1770	448	617	1667	921	620	228	39	10	8
2005	80	1603	39549	8091	1250	2819	2549	727	189	40		0
2006	80	439	3375	48140	9269	1328	2404	1309	193	30	9	0
2007	128	154	2007	5149	65974	8166	713	658	634	70		0
2008	14	265	513	8213	4401	22939	4201	516	220	199	44	29
2009	98	322	1057	391	1620	2863	11241	1964	111	134	64	17
2010	22	700	1425	1388	845	2887	2518	5707	1362	236	163	139
2011		120	1246	3475	4874	2402	2949	1179	2324	310	23	49
2012	6	50	1624	10093	10233	9846	2827	1778	1166	379	35	5
2013		17	35	4312	27014	11146	7455	1314	517	291	126	68
2014		7	55	602	20847	58174	9275	3284	1316	494	441	52
2015	105	37	68	341	752	3688	3598	1881	644	187	106	160

Year	0	1	2	3	4	5	6	7	8	9	10	11+
2016	35	419	98	56	255	677	874	3325	1741	1072	199	209
2017		8	1650	479	190	549	1243	2341	3640	1356	533	195
2018						No survey						
2019	52	.	.	679	8296	2301	516	468	554	820	626	2255

Table 16.2.15 *German survey*, The abundance indices ('000) by year class/age, 2019. South and East Greenland (NAFO 1F (Strat 4) and ICES 14.b, Strat 9 furthest to the north).

year	stratum	index0	index1	index2	index3	index4	index5	index6	index7	index8	index9	index10	index11	index12
2019	4.1	50	.	.	682	7821	1742	310	317	227	328	161	26	6
2019	4.2	0	.	.	0	11	3	1	0	1	0	0	0	0
2019	5.1	0	.	.	18	229	55	14	3	16	28	37	12	5
2019	5.2	7	.	.	7	219	140	35	19	29	31	42	13	8
2019	7.1	1	.	.	1	57	25	6	6	6	7	8	4	1
2019	7.2	0	.	.	5	219	110	12	3	1	0	0	0	0
2019	8.2	0	.	.	1	69	45	18	24	34	52	35	25	2
2019	9.2	0	.	.	6	231	292	138	124	274	442	382	159	67

Table 16.5.1. Reference point.

Reference point	Value	Technical basis
F_{MSY}	0.46	Equilibrium scenarios using segmented regression and capped by F_{p05}
F_{LIM}	2.34	Equilibrium scenarios prob (SSB < B_{lim}) < 50% with stochastic recruitment
F_{PA}	1.33	F_{lim} / $e^{1.645\sigma}$, $\sigma = 0.34$
B_{LIM}	10354 t.	Average of SSB 2002, 2003 and 2004
B_{PA}	14803 t	$B_{lim} \times e^{1.645\sigma}$, $\sigma = 0.217$
MSY $B_{trigger}$	14803 t.	B_{PA}

Table 16.7.1. Estimated stock numbers at age.

Year Age	1	2	3	4	5	6	7	8	9	10
1973	44195	11632	7056	4605	20754	3852	2827	678	2625	4183
1974	232950	33645	9524	6372	3310	14486	2417	1442	322	2819
1975	32390	223610	25614	7626	6341	2378	9540	1375	713	1311
1976	13062	25311	214644	19204	5467	4604	1455	5044	677	1001
1977	13071	10278	19780	151998	17363	3747	2448	697	1747	775
1978	30198	10317	8087	16189	91578	13484	1982	841	236	941
1979	7524	27255	8143	8460	11534	45293	7897	1234	257	224
1980	18792	5569	24599	7271	7025	5694	20726	2407	239	76
1981	4640	17025	4122	17794	6083	5385	3547	10126	820	124
1982	5092	3559	15424	3049	14361	5172	3772	2007	3785	330
1983	2573	4944	2636	14604	3137	11497	2597	1137	355	783
1984	4405	1997	4801	2646	9517	1818	5223	704	334	340
1985	168187	4354	1764	4078	2237	6080	771	1895	173	228
1986	126523	146402	4223	1077	3580	1510	3941	381	1049	155
1987	3150	95654	121777	3361	760	2553	828	2261	195	811
1988	2613	3294	62055	103955	2141	429	1690	399	984	421
1989	723	2359	2984	40800	77319	1108	161	763	172	474
1990	1470	688	2162	2428	25873	38781	442	54	251	147
1991	2456	982	590	1800	1221	10684	10869	134	27	78
1992	918	1669	523	436	730	299	2483	1635	36	11
1993	821	692	954	388	226	333	62	226	161	5
1994	3752	707	621	695	263	134	216	30	60	55
1995	239	3161	912	412	599	198	85	151	18	63
1996	313	200	2014	703	340	311	115	50	84	46
1997	1617	242	167	1257	599	260	163	72	28	74
1998	5544	1348	187	152	661	369	157	70	37	55
1999	10944	4276	1261	218	180	325	208	87	35	48
2000	14685	6702	2923	1064	226	155	160	108	57	48
2001	8970	11341	4398	2154	955	251	121	89	54	59

Year Age	1	2	3	4	5	6	7	8	9	10
2002	1594	6645	8780	3141	1671	855	241	85	50	68
2003	38267	1813	4764	6242	2346	1197	633	164	50	66
2004	362919	28665	2310	3676	4509	1602	706	372	88	67
2005	68473	274760	20617	2851	3179	3050	948	311	195	89
2006	35733	43793	167777	18138	2761	2491	1890	395	94	167
2007	15832	27486	25694	83099	13018	2078	1247	963	214	169
2008	22675	12052	19611	14087	37533	8347	1548	556	392	176
2009	54072	21677	11235	13497	9408	13009	3155	501	348	172
2010	57102	31849	15910	7349	9762	5866	7811	1790	322	246
2011	10678	44070	20699	17425	6129	6448	3484	3457	1013	344
2012	6165	10267	40776	20179	17651	5084	3578	1886	1454	654
2013	2764	4886	8545	38742	17299	15604	3725	2090	1062	1016
2014	976	2104	4751	6953	30446	12746	9135	2291	1301	1034
2015	5230	957	2125	4842	7708	18350	8301	4227	1149	1102
2016	50753	5520	1349	1836	3993	5690	9988	4466	2093	1114
2017	3009	41053	5713	1721	2091	3760	5329	6201	2579	1376
2018	3009	2729	26669	5130	1554	1685	2559	3498	3047	1861
2019	3009	2464	2476	21933	4364	1238	1111	1394	1814	2173

Table 16.7.2. Estimated fishing mortality at age.

Year Age	1	2	3	4	5	6	7	8	9	10
1973			0.001	0.022	0.044	0.073	0.141	0.265	0.356	0.356
1974			0.001	0.016	0.032	0.054	0.101	0.202	0.268	0.268
1975			0.003	0.039	0.078	0.114	0.167	0.265	0.253	0.253
1976			0.004	0.047	0.102	0.184	0.28	0.474	0.412	0.412
1977			0.003	0.056	0.135	0.237	0.375	0.627	0.616	0.616
1978			0.002	0.04	0.116	0.182	0.282	0.679	1.016	1.016
1979			0.003	0.059	0.176	0.257	0.549	1.201	1.313	1.313
1980			0.002	0.02	0.05	0.077	0.184	0.464	0.516	0.516
1981			0.001	0.006	0.024	0.064	0.175	0.45	0.504	0.504
1982			0.001	0.01	0.06	0.246	0.669	1.249	1.084	1.084
1983			0.005	0.056	0.215	0.477	0.745	0.855	0.709	0.709
1984			0.015	0.103	0.239	0.451	0.612	0.737	0.608	0.608
1985			0.027	0.098	0.18	0.254	0.265	0.272	0.253	0.253
1986			0.014	0.064	0.131	0.201	0.219	0.206	0.177	0.177
1987			0.008	0.054	0.109	0.184	0.268	0.343	0.432	0.432
1988			0.01	0.105	0.214	0.342	0.426	0.451	0.646	0.646
1989			0.008	0.111	0.242	0.355	0.463	0.459	0.888	0.888
1990			0.012	0.28	0.51	0.639	0.614	0.422	0.909	0.909
1991			0.017	0.512	1.045	1.127	1.3	0.932	1.52	1.52
1992			0.007	0.252	0.659	1.133	1.961	1.94	1.802	1.802
1993			0.003	0.043	0.112	0.206	0.338	0.632	0.637	0.637
1994			0.028	0.1	0.147	0.156	0.158	0.209	0.163	0.163
1995			0.018	0.038	0.063	0.059	0.056	0.083	0.075	0.075
1996			0.013	0.036	0.063	0.062	0.066	0.095	0.08	0.08
1997			0.013	0.049	0.094	0.1	0.115	0.164	0.126	0.126
1998			0.01	0.046	0.093	0.106	0.13	0.19	0.139	0.139
1999			0.004	0.019	0.036	0.04	0.052	0.079	0.061	0.061
2000			0.003	0.018	0.035	0.043	0.062	0.093	0.069	0.069
2001			0.001	0.011	0.021	0.028	0.043	0.064	0.047	0.047

Year Age	1	2	3	4	5	6	7	8	9	10
2002			0.002	0.017	0.037	0.052	0.084	0.12	0.08	0.08
2003			0.001	0.012	0.027	0.041	0.073	0.107	0.068	0.068
2004			0.001	0.011	0.027	0.047	0.096	0.139	0.079	0.079
2005			0	0.01	0.026	0.052	0.123	0.178	0.089	0.089
2006			0.001	0.02	0.05	0.068	0.084	0.062	0.027	0.027
2007			0.002	0.025	0.073	0.109	0.166	0.148	0.09	0.09
2008			0.005	0.062	0.21	0.266	0.316	0.168	0.09	0.09
2009			0.011	0.083	0.145	0.083	0.08	0.061	0.033	0.033
2010			0.001	0.012	0.039	0.043	0.054	0.047	0.029	0.029
2011			0	0.005	0.028	0.067	0.117	0.145	0.11	0.11
2012			0	0.004	0.028	0.07	0.114	0.168	0.137	0.137
2013			0	0.001	0.011	0.041	0.084	0.151	0.155	0.155
2014			0	0.001	0.011	0.041	0.092	0.173	0.177	0.177
2015			0.001	0.01	0.062	0.131	0.204	0.295	0.281	0.281
2016			0.002	0.017	0.096	0.168	0.202	0.27	0.288	0.288
2017			0.001	0.01	0.075	0.174	0.244	0.306	0.295	0.295
2018			0	0.005	0.053	0.167	0.266	0.376	0.398	0.398
2019			0.001	0.008	0.091	0.346	0.552	0.757	0.788	0.788

Table 16.7.3. Short-term forecast for 2020 assuming that Catch = TAC_{2020} (18824 t)

Variable				**Value**		
$F_{ages\ 5\text{–}10}$ (2020)				1.33		
SSB (2021)				28772		
$R_{age\ 1}$ (2021)				6165		
Total catch (2020)				18824 t		
Rationale	**Catch (2021)**	**F (2021)**	**SSB (2022)**	**% SSB change ***	**% advice change ****	**% TAC change *****
ICES advice basis						
MSY approach: F_{MSY}	6091	0.46	29918	+4%	+79%	-68%
Other scenarios						
F = 0	0	0	39071	+36%	-100%	-100%
F = F_{2020} (*status quo*)	13813	1.54	19151	-33%	+305%	-27%

16.18 Figures

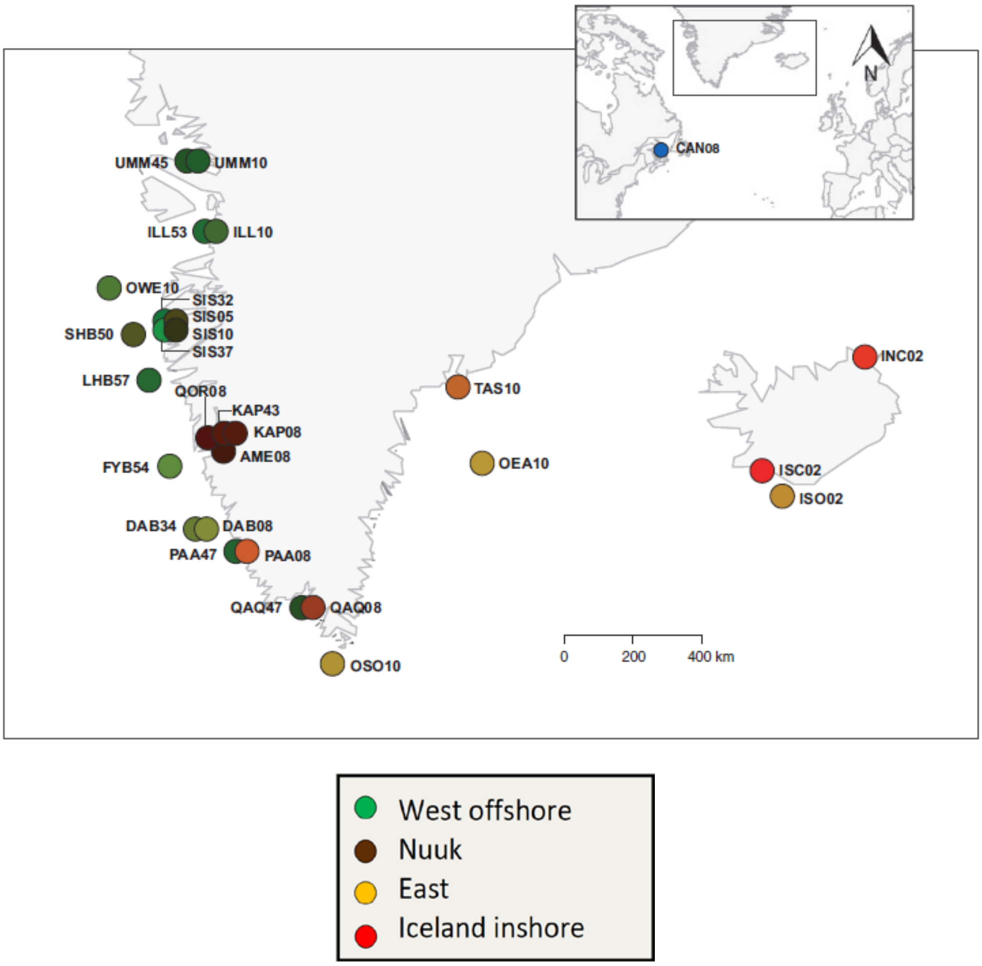


Figure. 16.1. Sampling location of spawning cod in Greenland and Iceland in the genetic project. The colours of the dots represent the blends of sample mean of the different spawning population: West offshore, Nuuk (inshore), East (Greenland and offshore Iceland) and Iceland inshore as signal intensities of green and red respectively. After Therkildsen *et al*., 2013.

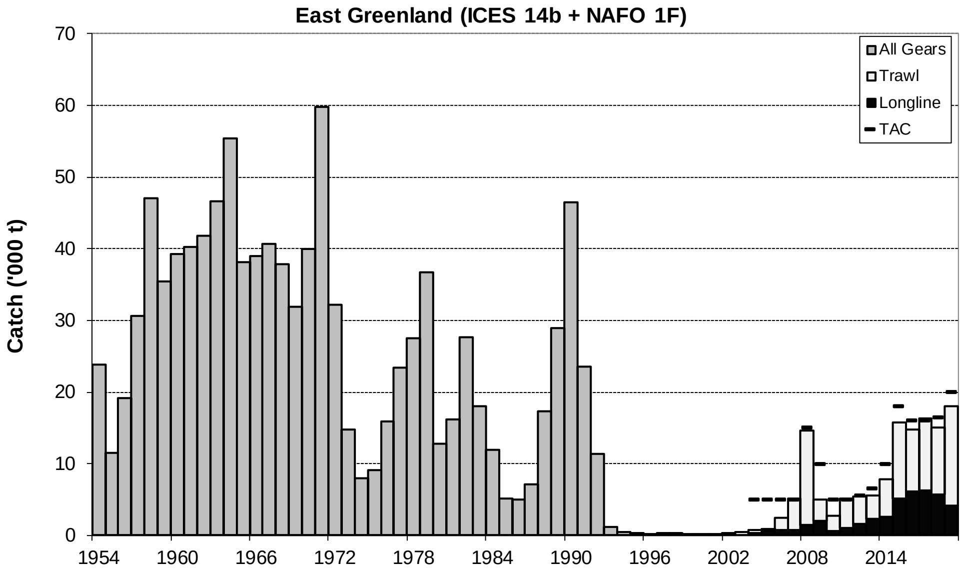


Figure 16.2.1. Annual total catch in South and East Greenland (NAFO Subarea 1F and ICES Subarea 14.b). From 2001 divided into gear. TAC until 2013 is for all the offshore area including West Greenland (NAFO Subarea 1A–1E).

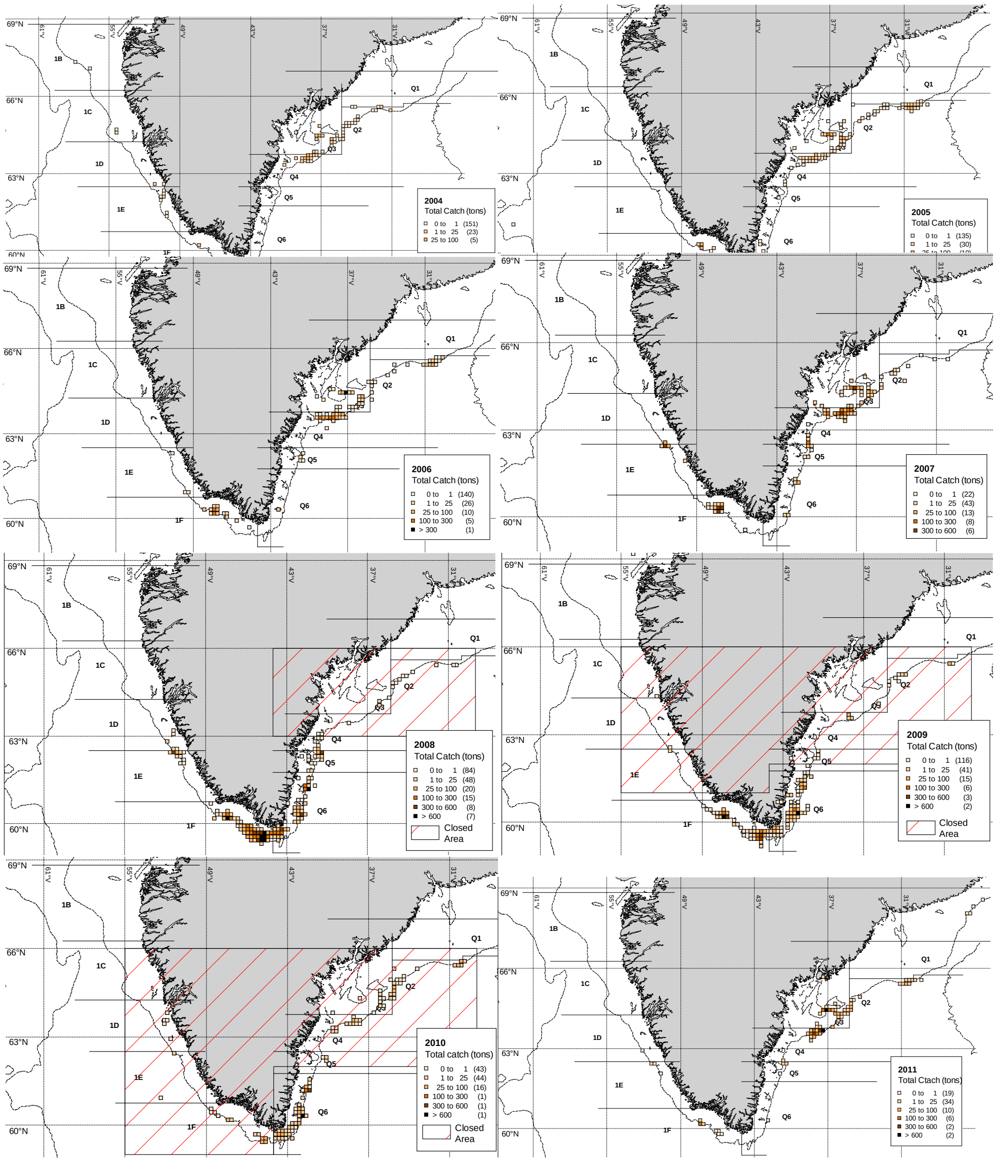


Figure 16.2.2: Annual distribution of total catches of Atlantic cod in West and East Greenland. Q1–Q6 illustrates survey areas (strata) in the East Greenland shrimp and fish survey.

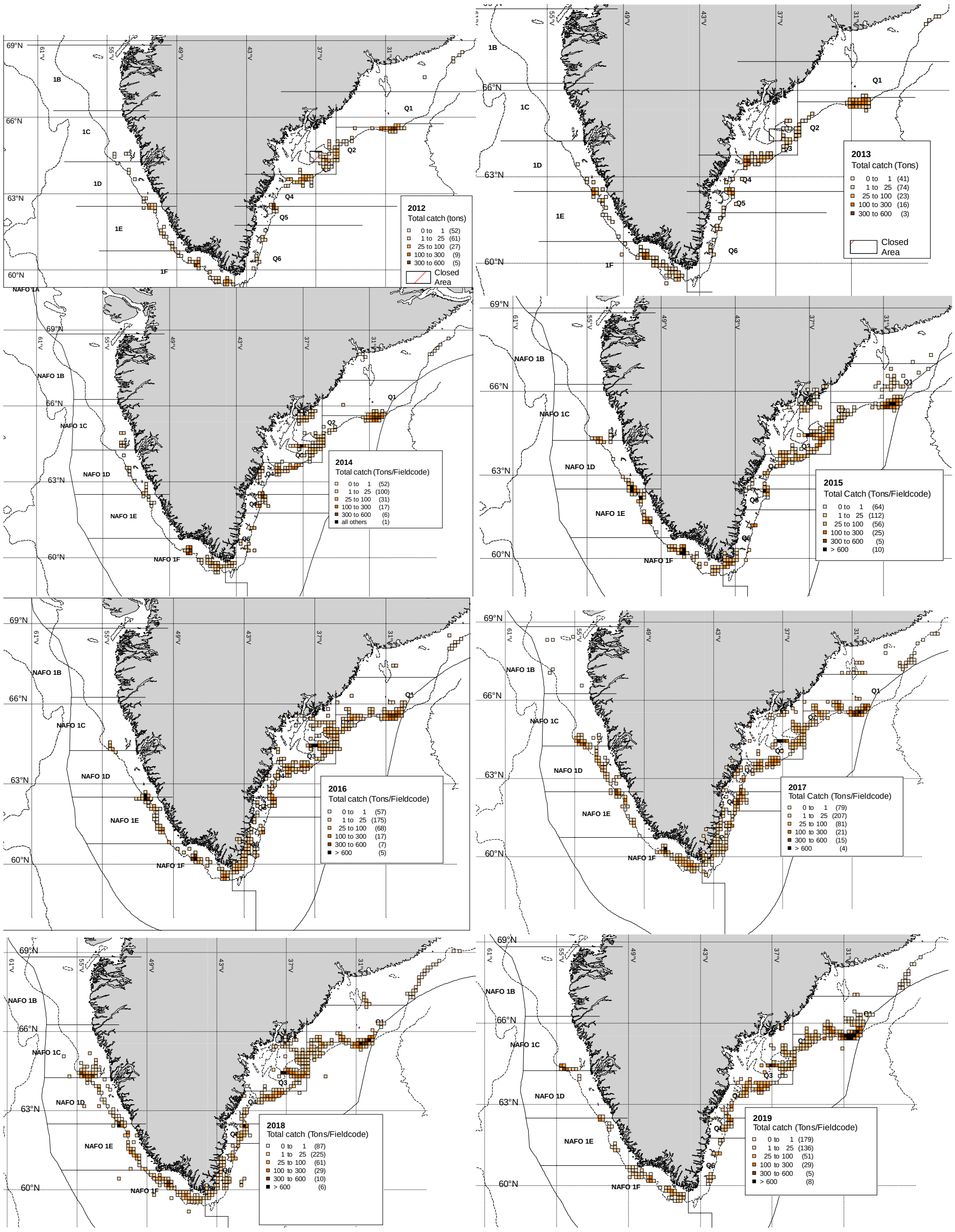


Figure 16.2.2: Continued. Annual distribution of total catches of Atlantic cod in West and East Greenland. Q1–Q6 illustrates survey areas (strata) in the East Greenland shrimp and fish survey.

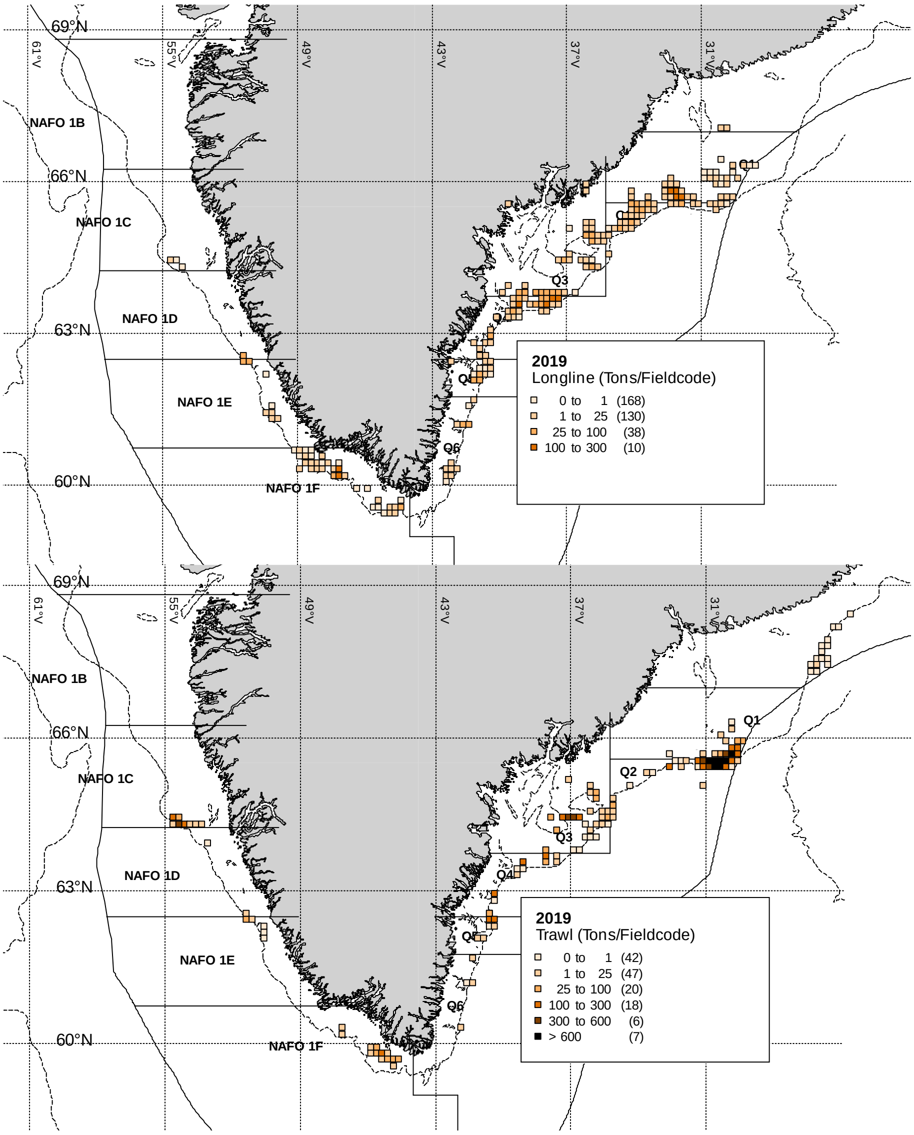


Figure 16.2.3: Distribution of Longline and Trawl catches of Atlantic cod in West and East Greenland. Q1–Q6 illustrates survey areas (strata) in the East Greenland shrimp and fish survey.

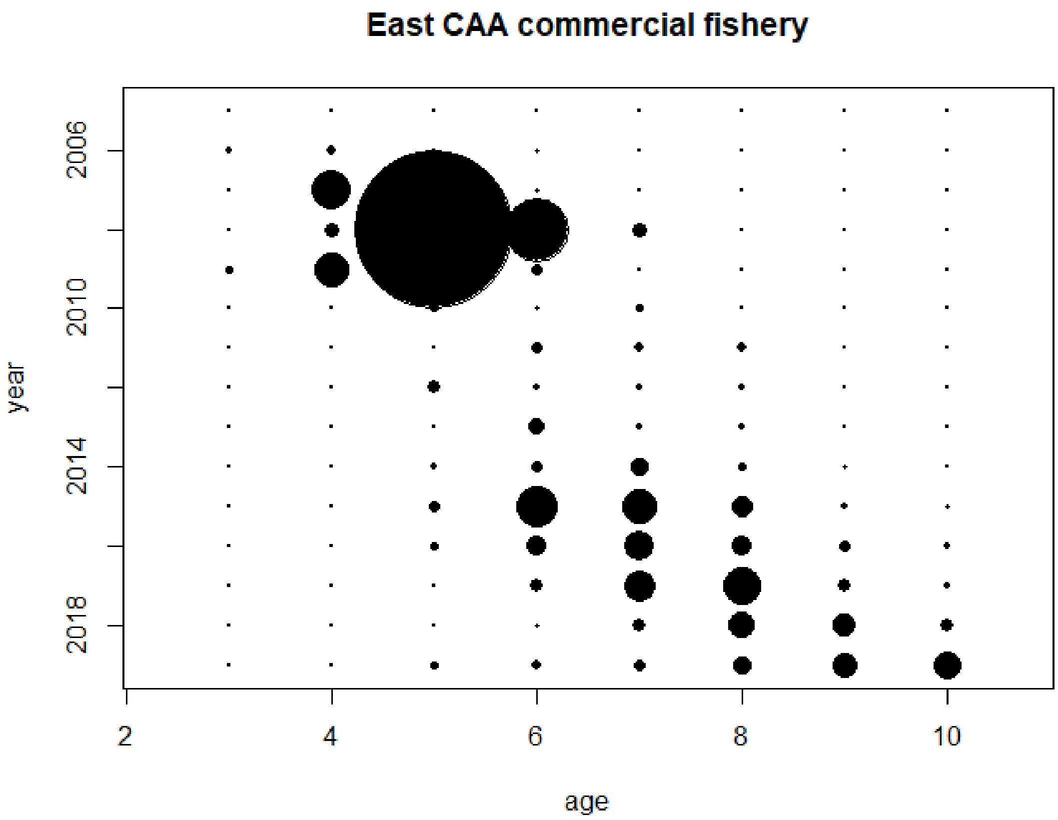


Figure 16.2.4: Catch at Age in the East Greenland (ICES 14. + NAFO 1F) commercial fishery. Size of circles represents size of catch numbers.

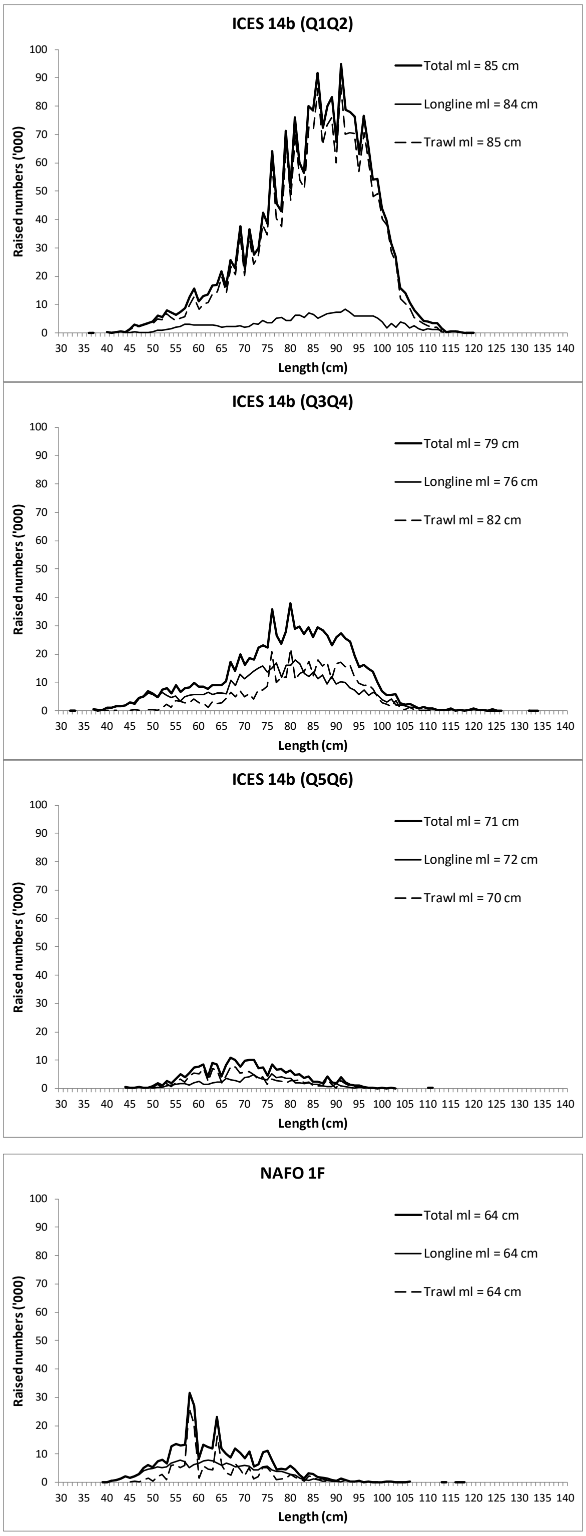
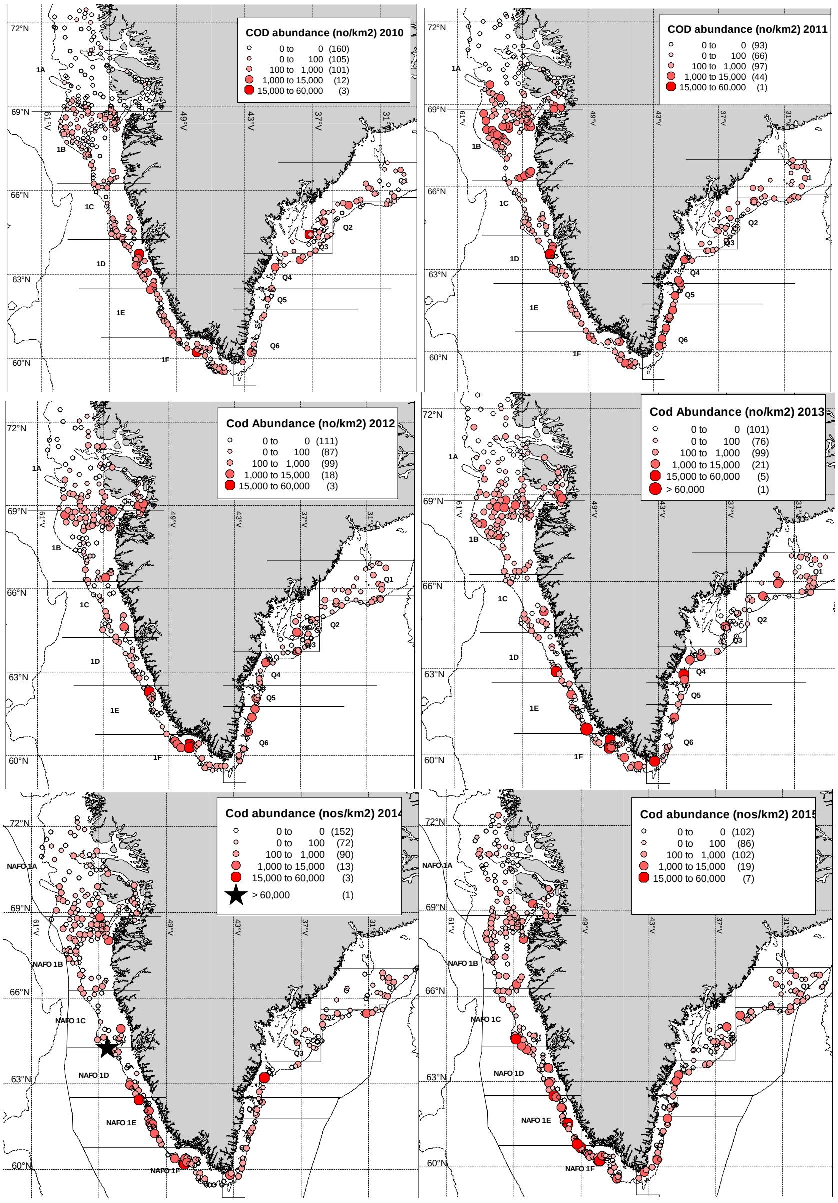


Figure 16.2.5. Length distributions with mean length (ml) of commercial cod catches in three areas in South and East Greenland. Dohrn Bank (Q1Q2) furthest to the north in East Greenland.



COD abundance (no/km2) 2010
0 to 0 (160)
0 to 100 (105)
100 to 1,000 (101)
1,000 to 15,000 (12)
15,000 to 60,000 (3)
COD abundance (no/km2) 2011
0 to 0 (93)
0 to 100 (66)
100 to 1,000 (97)
1,000 to 15,000 (44)
15,000 to 60,000 (1)
Cod Abundance (no/km2) 2012
0 to 0 (111)
0 to 100 (87)
100 to 1,000 (99)
1,000 to 15,000 (18)
15,000 to 60,000 (3)
Cod Abundance (no/km2) 2013
0 to 0 (101)
0 to 100 (76)
100 to 1,000 (99)
1,000 to 15,000 (21)
15,000 to 60,000 (5)
> 60,000 (1)
Cod abundance (nos/km2) 2014
0 to 0 (152)
0 to 100 (72)
100 to 1,000 (90)
1,000 to 15,000 (13)
15,000 to 60,000 (3)
> 60,000 (1)
Cod abundance (nos/km2) 2015
0 to 0 (102)
0 to 100 (86)
100 to 1,000 (102)
1,000 to 15,000 (19)
15,000 to 60,000 (7)
72°N
69°N
66°N
63°N
60°N
1A
1B
1C
1D
1E
1F
Q1
Q2
Q3
Q4
Q5
Q6
NAFO 1A
NAFO 1B
NAFO 1C
NAFO 1D
NAFO 1E
NAFO 1F

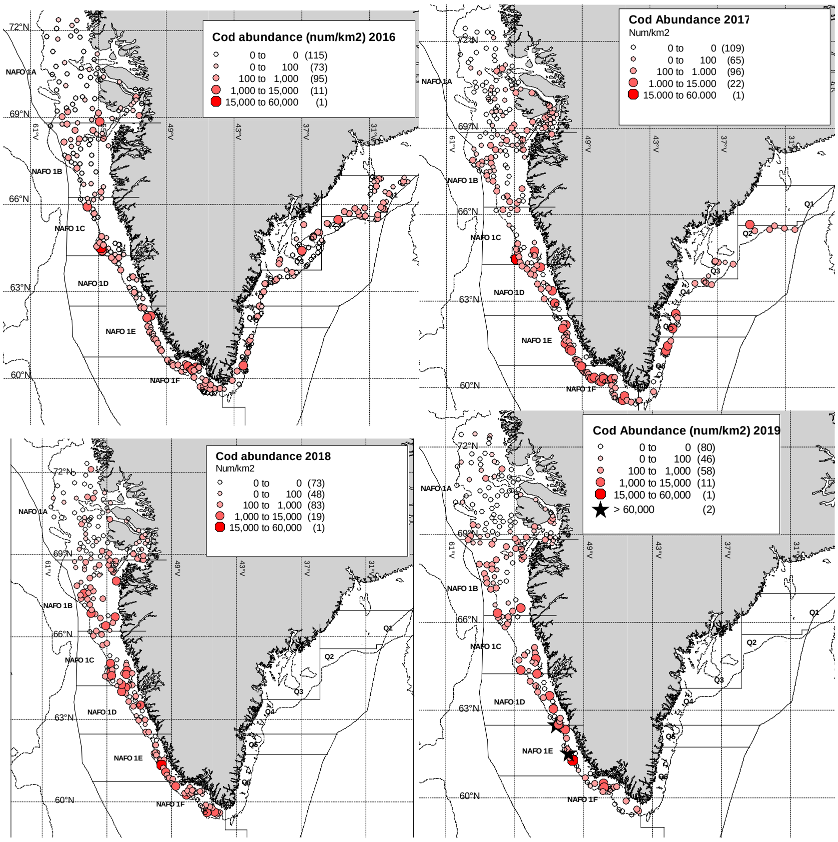
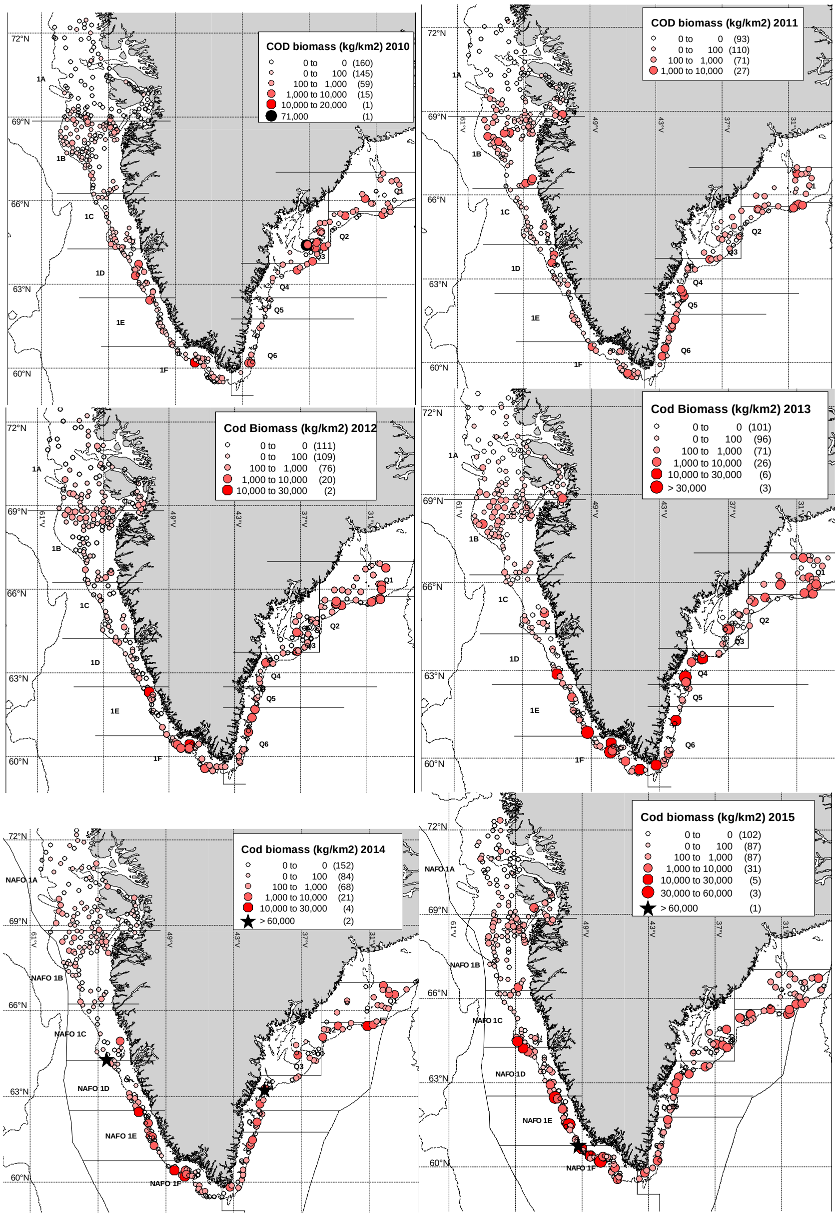


Figure16.2.6. Greenland shrimp and fish survey. Abundance per km².


COD biomass (kg/km2) 2010
0 to 0 (160)
0 to 100 (145)
100 to 1,000 (59)
1,000 to 10,000 (15)
10,000 to 20,000 (1)
71,000 (1)
COD biomass (kg/km2) 2011
0 to 0 (93)
0 to 100 (110)
100 to 1,000 (71)
1,000 to 10,000 (27)
Cod Biomass (kg/km2) 2012
0 to 0 (111)
0 to 100 (109)
100 to 1,000 (76)
1,000 to 10,000 (20)
10,000 to 30,000 (2)
Cod Biomass (kg/km2) 2013
0 to 0 (101)
0 to 100 (96)
100 to 1,000 (71)
1,000 to 10,000 (26)
10,000 to 30,000 (6)
> 30,000 (3)
Cod biomass (kg/km2) 2014
0 to 0 (152)
0 to 100 (84)
100 to 1,000 (68)
1,000 to 10,000 (21)
10,000 to 30,000 (4)
> 60,000 (2)
Cod biomass (kg/km2) 2015
0 to 0 (102)
0 to 100 (87)
100 to 1,000 (87)
1,000 to 10,000 (31)
10,000 to 30,000 (5)
30,000 to 60,000 (3)
> 60,000 (1)
72°N
69°N
66°N
63°N
60°N
1A
1B
1C
1D
1E
1F
NAFO 1A
NAFO 1B
NAFO 1C
NAFO 1D
NAFO 1E
NAFO 1F
Q1
Q2
Q3
Q4
Q5
Q6

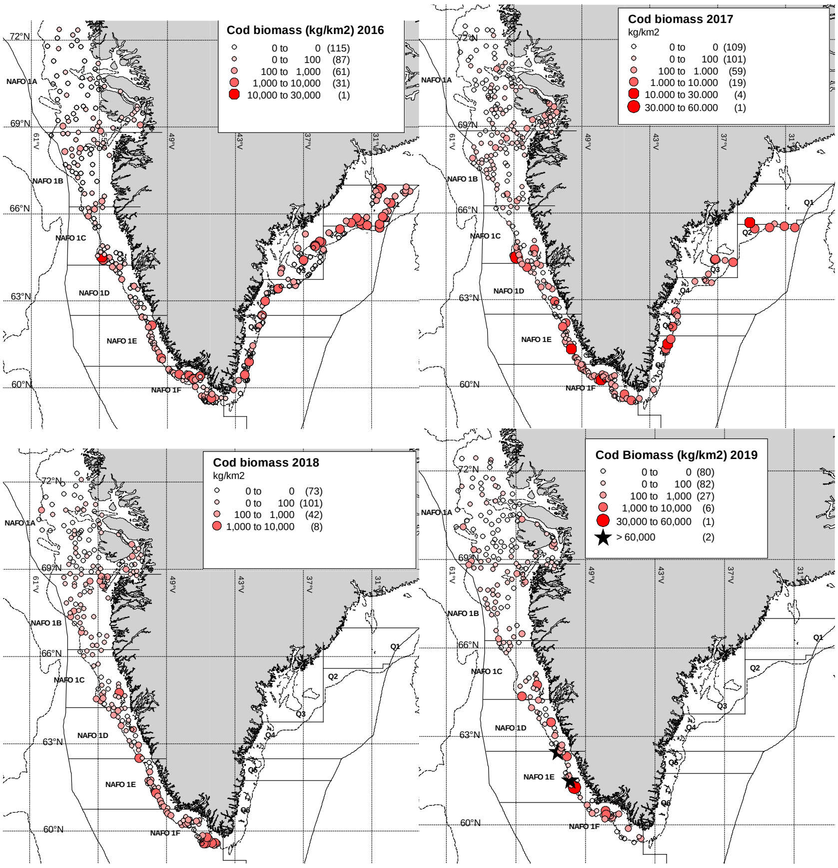


Figure 16.2.7. Greenland shrimp and fish survey. Catch weight kg per km²

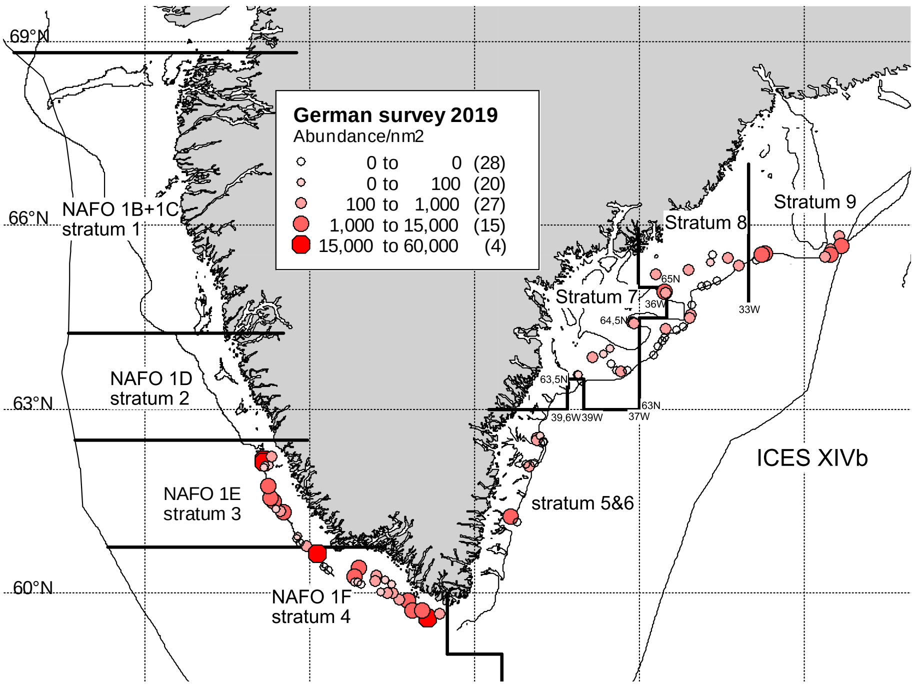


Figure 16.2.8. German ground fish survey. Abundance per nm².

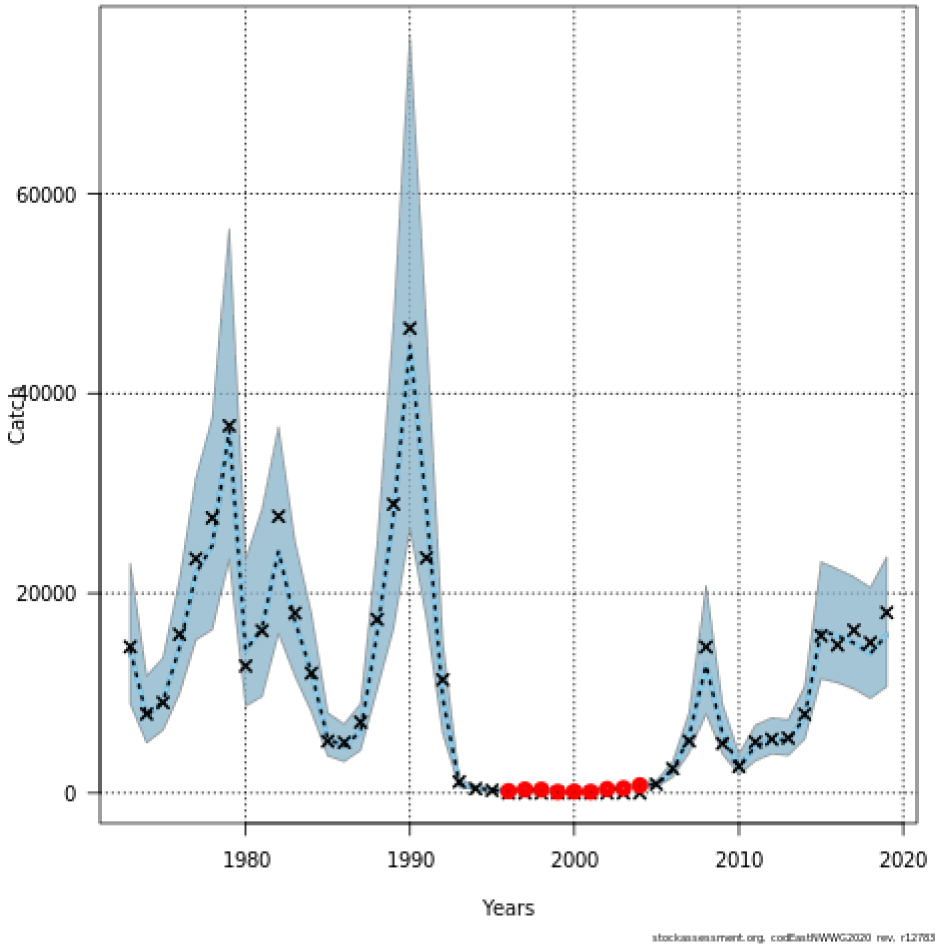


Figure 16.9.1. Estimated catch and with observed catch shown as crosses. Note the period 1996–2004 with near zero catches because no age disaggregated catch data were available.

16 Cod (*Gadus morhua*) in ICES Subarea 14 and NAFO Division 1.F (East Greenland, South Greenland)

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), (Figure 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 14) components was assessed separately. The Stock Annex provides more details on the stock identities including the references to primary works.

16.2 Scientific data

16.2.1.1.1.1 Fishery

16.2.1.1.1.2 Historical trends in landings and fisheries

The Greenland commercial cod fishery in East Greenland started in 1954 but started earlier in Southwest Greenland (NAFO Subdivision 1F, Table 16.2.1, Figure 16.2.1). The fishery gradually developed culminating with catch levels above 40 000 tonnes annually in the 1960s. Due to overfishing, deteriorating environmental conditions and emigration to Iceland the stock size declined and the fishery completely collapsed in the early 1990s. More details on the historical development in the fisheries are provided in the stock annex.

16.2.1.1.1.3 The present fishery

TAC for 2019 was set at 20 000 t. The TAC was divided between the following countries and management areas (se section 16.12 for definition of management areas):

Management Area	TAC (tons)	Country
403 (Q1Q2)	9 638	Greenland
404 (Q3Q4)	3 340	Greenland
403+404	4 525	EU (2 000 t), Faeroes Island (1 325 t) and Norway (1 200 t)
415 (Q5Q61F)	2 497	Greenland

In 2019 a total of 18 074 tons with 1 667 tons caught in South Greenland (NAFO 1F + Q5Q6) and 16 406 tons caught in East Greenland (Tables 16.2.1 and 16.2.2).

Trawlers fished 77% of the total catch (Table 16.2.3, Figure 16.2.1) almost exclusively (80%) on Dohrn Bank in a small area between 65–66°N ; 29–31°W on the edge of the continental shelf close to the EEZ to Iceland. The longlining fishery was more evenly distributed than the trawl fishery and extended from Julianehåbs Bight in SouthWest Greenland (60°N, 1F) to Dohrn Bank (66°N, Q1Q2) in East Greenland (Figure 16.2.2 and 16.2.3). A detailed description of the fishery in 2019 is found in Retzel 2020.

16.2.1.1.1.4 Catch-at-age

The 2009 and older YC's dominated the total catches (Table 16.2.4, Figure 16.2.4). Younger fish of yearclass 2014 (age 5) is dominating the catch in SouthWest Greenland (NAFO 1F) whereas the oldest of ages 10+ is dominating the catch on Dohrn Bank (Q1Q2, table 16.2.5). The general pattern is that large fish (> 9 year old, mean length 85 cm) dominate the catch furthest to the north on Dorhn Bank and smaller fish (ages 5-6 years, mean length 64 cm) dominated the catch in South Greenland (Figure 16.2.5).

16.2.1.1.1.5 Weight-at-age

Annual weight-at-age are obtained from sampling on board fishing vessels since 2005, see stock annex for further details.

16.2.1.1.1.6 Maturity-at-age

Maturity at age is fixed for 1973-2017 and is based on samples from an experimental fishery in the spawning areas in 2007 (see stock annex for further details). Since 2018 a separate ogive was estimated based on cod sampled from an experimental fishery in the same spawning area as in 2007 (GINR, 2018). The two maturity ogives were similar.

16.2.1.1.1.7 Surveys

Two offshore bottom trawl surveys (Greenlandic and German) are conducted in the offshore region of Greenland. 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. For details of survey design see stock annex.

16.2.1.1.1.8 Greenland Shrimp and Fish survey

No survey was carried out in 2018 and 2019 as the Greenland research vessel (Paamiut) was scrapped. However West Greenland, including NAFO 1F (South West Greenland), was surveyed by a hired vessel with same gear rigging.

Number of hauls in NAFO 1F was 24 in 2019 compared to 35 in 2018 (table 16.2.6). The abundance and biomass indices in 2019 in NAFO 1F are low compared to the time series (tables 16.2.7 and 16.2.8). The 2015 yearclass (age 4) is dominating the survey in 2019 in NAFO 1F (table 16.2.9). Further results from the survey time series, including 2018 and 2019 results from NAFO 1F, can be seen in table 16.2.10 and figures 16.2.6 and 16.2.7.

16.2.1.1.1.9 German groundfish survey

No survey was carried out in 2018 due to mechanical problems.

In 2019, 78 valid trawl stations were sampled during the autumn in the German Greenland offshore groundfish survey (table 16.2.11). The abundance indices amounted to 15 mill. individuals and was highest in NAFO 1F (strata 4, table 16.2.12, figure 16.2.8). The 2015 yearclass (age 4) dominated the survey, followed by the 2014 yearclass (age 5, table 16.2.14). The 2015 yearclass dominated the survey especially in SouthGreenland (strata 4 and 5), but on Dohrn Bank (strata 9) much older fish of yearclass 2010 (age 9) and older dominated the survey (table 16.2.15). A detailed description of the survey in 2019 is found in Werner & Fock 2020.

16.2.1.1.1.10 Catch-at-age

During exploration of the survey data for the analytical assessment, it became clear that a substantial discrepancy between the German and the Greenland age-readings of cod otoliths exists. That became obvious, because mean weight-at-age data from both surveys differed systemically between German mean-weights-at-age, which were always considerably higher than the Greenlandic ones. An otolith exchange in order to compare age readings between both Institutes was conducted in the spring 2018 and showed that age readings of the same set of otoliths showed a one-year systemic difference between both institutes. Age readings were on average one year older for the same fish as read by the Greenlandic institute compared to the German institute (Hedeholm, 2018).

To investigate the issue a workshop on age reading of cod in Greenland was arranged with participants from the Greenland Institute of Natural Resources and the Thünen Institute of Sea Fisheries in Germany (Retzel, 2019). The Icelandic Marine and Freshwater Research Institute hosted the workshop that was held January 8-9, 2019, Reykjavik, Iceland. The cause for the discrepancy was identified as the German Institute not reading the last wintering on the edge of the otolith. Afterwards CAA were calculated for the German survey based on Greenland age-length keys in order to identify in which period age readings went wrong by the German Institute (Retzel, 2019). It was recommended that the German Institute reread their survey otolith from 2011 and onwards. By the time of the 2019 NWWG meeting the otoliths from the German surveys in 2016 and 2017 had been reread but there were still considerable differences in weight-at-age (Werner & Fock, 2019). By the time of the 2020 NWWG no further years in the German survey had been reread and the difference in weight-at-age not resolved. It is recommended that a data exchange with updated age readings take place between Germany and Greenland in order to resolve the issue.

16.3 Tagging

An extensive analysis of tagging results from the period 2003–2016 suggest that 50% of cod in East Greenland migrate to Iceland (Hedeholm, 2018). This has been incorporated in the assessment (ICES, 2018).

16.4 Methods

The stock was benchmarked in 2018 (ICES, 2018). It was decided to use the SAM model and perform an analytical assessment. Hence, the assessment was upgraded from a category 3 (Data Limited Stock) to a category 1 stock. This is considered a vast improvement, as all data are now utilized, and the assessment is presented with uncertainty estimates and multiple catch options.

16.5 Reference points

Reference points were defined at IBPGCod (ICES, 2018). The estimations were conducted in EQSIM according to ICES guidelines (see ICES (2018) for details). The reference points are shown in Table 16.5.1.

16.6 State of the stock

The offshore component has been decreasing the last six years. 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 led to a stock increase during the 00s and an increase in catches. Since 2014 the spawning stock biomass (SSB) has decreased and recruitment has been low.

The number of recruits estimated by SAM in 2019 is equal to the number of recruits in 2017 and 2018. The explanation for this is that no survey was carried out in 2018 and that number 1- and 2-years old cod was caught in the German survey in 2019 was zero. SAM handle such a situation that no information are available since 2017 and the value for the latest year with information is applied for the two coming years without new information. Consequently, the confidence limits of the number of recruits increase considerably in these two years.

According to the results from the SAM model F_{5-10} has been below F_{MSY} during the last two to three decades but is above F_{MSY} in 2019. The spawning-stock biomass (SSB) increased to above MSY $B_{trigger}$ from 2005 and has decreased since 2014 but is still above MSY $B_{trigger}$.

16.7 Short term forecast

The State-space model (SAM) was applied for the offshore cod stock in ICES Division 14. and NAFO Division 1F (Riget *et al.*, 2020).

16.7.1.1.1.1 Input data

The SAM model provides predictions that carry the signals from the assessment into the short term forecast. The forecast procedure starts from the last year's estimate of the state (log(N) and log(F)). One thousand replicates of the last state are simulated from the estimated joint distribution. Each of these replicates are then simulated forward according to the assumptions and parameter estimates found by the assessment model.

In the forward simulations a 5 year average (up to the assessment year) is used for catch mean weight, stock mean weight, proportion mature, and natural mortality. Recruitment is re-sampled from the entire time series. In each forward simulation step the fishing mortality is scaled, such that the median of the distribution is matching the requirement in the scenario (e.g. hitting a specific mean F value, a specific catch or level of SSB).

16.7.1.1.1.2 Results

Number at age and F at age estimated by SAM are shown in Table 16.7.1 and 16.7.2, respectively. The TAC for 2020 are set to 18 824 t and we assumed that managers will keep the already set TAC rather than following the advice. However, catching 18 824 t in 2020 implies a F on 1.333 which may be unrealistic high. Therefore, the catch will be followed through the year and if necessary a new national advice will be given. The forecasts for the assumption Catch = TAC_{2020}(18 824 t) from the different scenarios are presented in Table 16.7.3.

16.8 Long term forecast

No long term forecast was performed for this stock.

16.9 Uncertainties in assessment and forecast

There is no incentive to discard fish or misreport catches under the current management system. In 2018 no survey data were available, and in 2019 German survey data were available but no Greenland survey data. This add uncertainties to the assessment.

The model fits the data relatively well Figure 16.9.1. The retrospective runs show no patterns and all inside the model 95% confidence intervals. However, the Mohn's rho measure of uncertainty were high in case of F_{5-10} (0.387) and recruits (-0.424). It is likely linked to the lack of surveys in 2018 and lack of the Greenland survey in 2019. In the coming years both the Greenland and the German surveys are expected to be performed, and that this will results in decreasing of the Mohn's rho again in future assessments. The Mohn's rho for SSB was estimated as -0.188.

16.10 Comparison with previous assessment and forecast

The analytical assessment model (SAM) was accepted at the benchmark January 2018 (ICES 2018) and only two years of the analytical assessment exist. In the years before the advice was based on a DLS assessment. Compared to last year assessment the SSB annual estimates has been up-scaled for the last 10-12 years equivalent to a year class pass trough the assessment. Some up-scaling has also happened in the number of recruits especially large year class such as the 2003-year class. Furthermore, the values of Mohn's rho of the retrospective has increased considerably in this year assessment. This has resulted in a relative high increase (79%) of the MSY based advice and assuming the catch in 2020 equal to the TAC. These changes are likely linked to the incomplete survey data in 2018 and 2019. In 2018 no survey was performed and in 2019 only the German survey was carried out. In the future years it is expected that both surveys will be performed as earlier, and that the assessment will become more robust again.

16.11 Implemented management measures for 2020

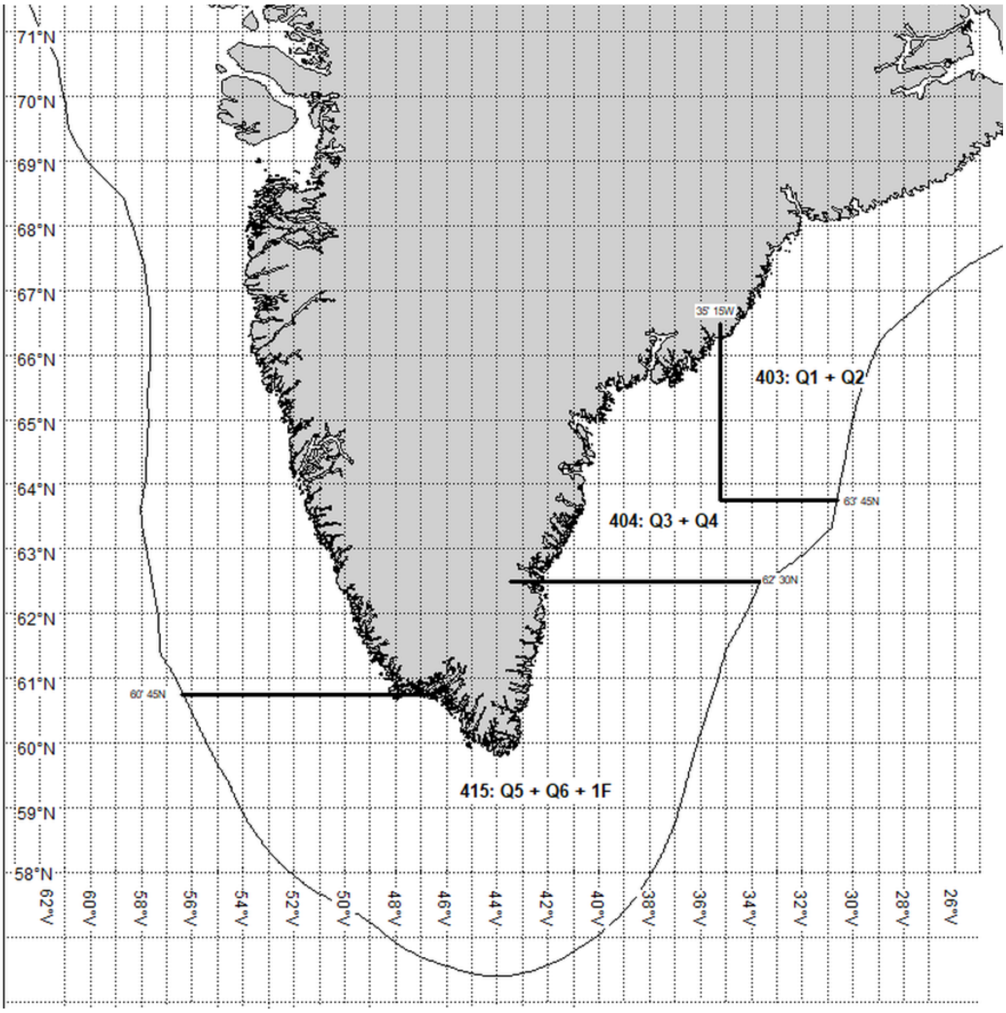
The offshore quota for the total international fishery is set at 18 824 t. The following table shows the distribution of the TAC across management areas and countries

Area	TAC (tons)	Countries
403 (Q1Q2, Dohrn Bank)	9 226	Greenland
404 (Q3Q4, Kleine Bank)	2 524	Greenland
403+404 (Dohrn Bank + Kleine Bank)	4 800	EU (1 950 t) Faeroes Island (1 500 t) Norway (1 350 t)
415 (South Greenland)	2 274	Greenland

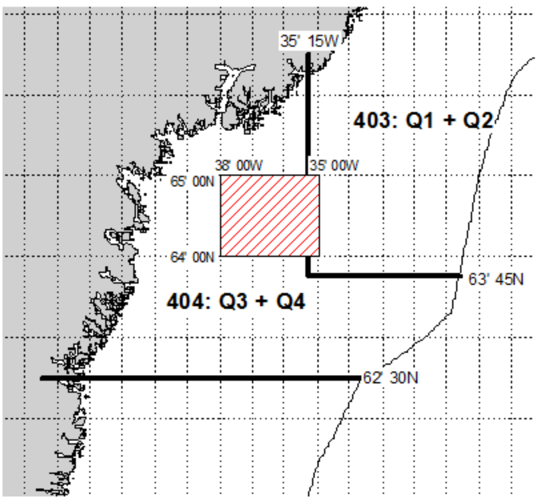
To protect the spawning stock no fishing is allowed from 1 March to 31 May in a square in area 404 (Kleine Bank, see figure below).

16.12 Management plan

In 2020, a management plan was implemented for the offshore cod fishery in Greenland but it has not been evaluated by ICES. The management plan distinguished between 3 areas: 403 comprising Dohrn Bank, 404 comprising Kleine Bank and 415 comprising South Greenland. The management plan tries to take the scientific advice, migration to Iceland and protection of spawning grounds into account.



In order to protect the spawning stock it is not allowed to fish from 1 March to 31 May in a square comprising Kleine Bank:



16.13 Management considerations

Larger and older fish (8+ year old) are located furthest to the north on Dohrn Bank, whereas younger fish dominate in the South (5–6 year old). This reflects the eastward migration behaviour towards the spawning grounds in East Greenland and Iceland. 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. Tagging suggest that a substantial part of the cod in East Greenland migrate to Iceland.

16.14 Basis for advice

The State-space model (SAM) was applied for the offshore cod stock in ICES Division 14. and NAFO Division 1F (Riget *et al.*, 2020).

16.15 Benchmark 2022

Analytical model (SAM) is used in assessment. A century of tagging studies has documented substantial migration from Greenland to Iceland of mature cod, and especially the East and South Greenland area is highly influenced by the inflow of egg and larvae from the spawning grounds in Iceland. This is currently solved in the model by increasing M. The inflow of recruits from outside the assessment area influences the SSB-R relationship which is characterized as Type 2 and a segmented regression results in a very low B_{lim}. The aim of the benchmark is to investigate if including more years in the assessment (years with stable recruitment from spawning stock in the assessment area) and ree-valuate the SSB-R relationship B_{lim} could be redefined.

Based on genetic analysis it is not possible to distinguish between an East Greenland and Icelandic offshore stock and especially the East and South Greenland area is highly influenced by the inflow of egg and larvae from the spawning grounds in Iceland. The potential for developing a combined assessment model for the East Greenland and Icelandic cod stocks requires robust methods for splitting up or combining catch-at-age and survey at age among areas. To gain further insight into stock structure and migration patterns across areas targeted work using both genetic and tagging data is needed.

The Greenland and German trawl surveys are fundamental to the assessment of cod in East Greenland. The two surveys provide similar signals and similar age compositions, but the mean weights-at-age differ considerably. A workshop in 2019 identified wrong age-readings in the German survey, but even after age-readings in the German survey have been corrected the difference in mean weight-at-age persist. In addition several inconsistencies in survey calculations have been identified in the German survey. A dedicated workshop prior to the benchmark to identify and solve these data issues is16.15 strongly recommended.

16.16 References

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16.17 Tables

Table 16.2.1. Offshore catches (t) divided into NAFO divisions in West Greenland and East Greenland (ICES 14.b). 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 14.b	NAFO 1F + ICES 14.b
1924							200		
1925							1871		
1926							4452		
1927							4427		
1928							5871		
1929							22304		
1930							94722		
1931							120858		
1932							87273		
1933							54351		
1934							88422		
1935							65796		

Year	NAFO 1A	NAFO 1B	NAFO 1C	NAFO 1D	NAFO 1E	NAFO 1F	Unknown NAFO div.	ICES 14.b	NAFO 1F + ICES 14.b
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		

Year	NAFO 1A	NAFO 1B	NAFO 1C	NAFO 1D	NAFO 1E	NAFO 1F	Unknown NAFO div.	ICES 14.b	NAFO 1F + ICES 14.b
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 14.b	NAFO 1F + ICES 14.b
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*

Year	NAFO 1A	NAFO 1B	NAFO 1C	NAFO 1D	NAFO 1E	NAFO 1F	Unknown NAFO div.	ICES 14.b	NAFO 1F + ICES 14.b
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

Year	NAFO 1A	NAFO 1B	NAFO 1C	NAFO 1D	NAFO 1E	NAFO 1F	Unknown NAFO div.	ICES 14.b	NAFO 1F + ICES 14.b
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
2015	0	0	341	954	3564	3984	0	11771	15755
2016	0	0	67	1911	1762	2335	0	12483	14818
2017	0	1	1442	730	852	2560	0	13740	16300
2018	0	0	1989	678	1520	1819	0	13249	15068
2019	0	0	654	57	186	916	0	17158	18074

1) **Estimates for assessment include estimates of unreported catches. The total estimated value for West Greenland (inshore + offshore) was 73 000 t in 1977 and 1978, 1979: 99 000 t, 1980: 54 000 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: Cod catches (t) by area and month. East Greenland (14.b) divided into five areas. NQ1 furthest to the north.

ICES/NAFO	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	%
14.b (NQ1)							3	27	10		4		**44**	0.2%
14.b (Q1Q2)	294	615	344	45	945	2514	1142	1483	1313	794	1391	1276	**12156**	67%
14.b (Q3Q4)	214	569	260	626	517	1859	34	52		12		64	**4207**	23%
14.b (Q5Q6)	18	94	78	80	197	273	10					2	**752**	4%
1F	100	112	53	51	4					58	496	41	**915**	5%
Total	**626**	**1390**	**735**	**802**	**1663**	**4645**	**1189**	**1562**	**1323**	**864**	**1891**	**1383**	**18074**	
%	3%	8%	4%	4%	9%	26%	7%	9%	7%	5%	10%	8%		

Table 16.2.3: Cod catches (t) by gear, area and month. East Greenland (14.b) divided into five areas. NQ1 furthest to the north.

Gear	ICES/NAFO	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Longline	14.b (NQ1)									10		4		**14**
	14.b (Q1Q2)		130	68		3	33	90	360	96	33	130	275	**1218**
	14.b (Q3Q4)	214	10	238	615	79	822	34	51				64	**2127**
	14.b (Q5Q6)	18	94	78	70	49	3	7						**319**
	1F	100	112	53	51	4					23	157	5	**505**
	Total	**332**	**346**	**437**	**736**	**135**	**858**	**131**	**411**	**106**	**56**	**291**	**344**	**4183**
Trawl	14.b (NQ1)							3	27					**30**
	14.b (Q1Q2)	294	484	276	45	942	2479	1053	1123	1217	762	1261	1001	**10937**
	14.b (Q3Q4)		559	22	11	438	1037		1		12			**2080**
	14.b (Q5Q6)				9	149	270	3					2	**433**
	1F										35	340	36	**411**
	Total	**294**	**1043**	**298**	**65**	**1529**	**3788**	**1059**	**1151**	**1217**	**809**	**1601**	**1039**	**13891**

Table 16.2.4. Cod in Greenland. Catch at age (‘000) and Weight at age (kg) for offshore fleets in East Greenland (ICES 14.b + NAFO 1F).

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
2015	3	57	457	1554	1324	828	242	182
2016	4	33	343	736	1130	766	427	257
2017	6	15	137	519	1214	1432	527	251
2018	7	27	67	217	498	1023	855	496
2019	0	150	331	358	426	679	948	1090

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
2015	0.484	0.833	1.435	2.097	3.460	4.699	6.846	9.115
2016	0.406	0.845	1.420	2.135	3.267	4.693	6.693	10.071
2017	0.392	0.711	1.641	2.213	3.063	4.167	6.094	8.034
2018	0.378	0.812	1.258	2.032	2.948	4.561	5.663	7.135
2019	0.307	1.168	1.775	2.687	3.257	4.052	5.291	6.601

Table 16.2.5. Cod in Greenland. Catch at age ('000) for offshore fleets by area (ICES 14b + NAFO 1F). Q1Q2 furthest to the north in East Greenland. NAFO 1F + 14b(Q5Q6) = South Greenland.

Catch at age								
Area/age	3	4	5	6	7	8	9	10+
14.b (Q1Q2)	0	43	93	150	213	399	652	822
14.b (Q3Q4)	0	56	70	87	115	189	223	235
14.b (Q5Q6)	0	13	42	42	41	48	34	24
NAGO 1F	0	38	126	79	57	43	39	9

Table 16.2.6. Number of hauls in the Greenland Shrimp and Fish survey in ICES 14.b and NAFO 1F.

	ICES 14.b						**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	

	ICES 14.b						NAFO	
Year/Strata	Q1	Q2	Q3	Q4	Q5	Q6	1F	Total
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
2015	26	11	24	12	8	14	36	131

	ICES 14.b						NAFO	
Year/Strata	Q1	Q2	Q3	Q4	Q5	Q6	1F	Total
2016	29	10	26	13	7	16	36	137
2017	2	4	7	6	6	11	35	71
2018	0	0	0	0	0	0	35	
2019	0	0	0	0	0	0	24	

Table 16.2.7 Cod abundance indices ('000) from the Greenland Shrimp and Fish survey by year and strata divisions in ICES 14.b and NAFO 1F. Q1 being the northern strata in East Greenland. * Incomplete coverage in strata Q1–Q4.

	ICES 14.b						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		

	ICES 14.b						NAFO		
Year	Q1	Q2	Q3	Q4	Q5	Q6	1F	Total	CV
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

	ICES 14.b						NAFO		
Year	Q1	Q2	Q3	Q4	Q5	Q6	1F	Total	CV
2015	6396	4074	6941	3093	231	8322	34032	63090	28
2016	8338	909	9737	1031	233	3412	4393	28052	16
2017*	7429	4559	5242	5816	627	18694	12466	54833	28
2018							5302		
2019							5233		

Table 16.2.8. Cod biomass indices (tonnes) from the Greenland Shrimp and Fish survey by year and strata divisions in ICES 14.b (Q1–Q6) and NAFO 1F. * Incomplete coverage in strata Q1–Q4.

	ICES 14.b						NAFO		
Year	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**1F**	**Total**	**CV**
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	21236	68952	23
2009	10844	8874	27251	7827	252	3094	503	58645	28
2010	16014	3151	81064	6202	23	4203	3142	113799	51
2011	27064	8128	5561	12486	5235	22664	3280	84418	19
2012	24736	10058	9347	5802	160	14322	16213	80638	16
2013	45018	9639	15017	48518	977	40319	47818	207306	22
2014	17182	20637	15574	90795	734	8884	30754	184560	45
2015	33105	13803	27050	11609	513	18724	49931	154735	20
2016	40580	4831	33065	4841	426	5670	4671	94084	18
2017	45774	27405	18257	4777	1749	31635	7823	137420	41
2018							8498		
2019							3841		

Table 16.2.9: Abundance indices ('000) by age from the Greenland Shrimp and Fish survey by year in ICES 14.b + NAFO 1F. *Incomplete coverage. Indices for 2019 is for NAFO 1F only.

East Greenland											
Year/age	0	1	2	3	4	5	6	7	8	9	10+
2008	4355	326	1168	7460	6937	24058	5279	2227	613	1225	671
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
2015	0	86	38	1259	4916	11445	29010	7407	4793	1954	2181
2016	279	3847	1818	998	555	2089	2399	6779	4874	3398	1018
2017*	242	111	14938	5234	6797	4470	5791	4307	7746	4352	845
2018					No	survey					
2019					No	survey					
2019 NAFO 1F	0	7	290	847	3043	711	124	10	127	51	24

Table 16.2.10: Mean weight (kg) at age from the Greenland Shrimp and Fish survey by year in ICES 14.b + NAFO 1F.

East Greenland											
Year/age	0	1	2	3	4	5	6	7	8	9	10+
2008	0.003	0.019	0.088	0.262	0.520	1.067	1.982	3.385	5.699	8.447	8.564
2009	0.004	0.059	0.140	0.452	0.976	1.730	2.977	4.186	5.447	7.423	10.800
2010	0.002	0.041	0.206	0.406	0.823	1.728	2.499	3.496	5.480	7.363	10.686
2011	0.001	0.017	0.152	0.366	0.783	1.408	2.209	3.891	5.711	7.218	10.859
2012		0.025	0.201	0.367	0.916	1.519	2.634	4.068	5.658	7.565	10.000
2013		0.020	0.194	0.450	0.771	1.396	2.353	3.663	5.140	7.062	10.354
2014	0.001	0.003	0.129	0.360	0.773	1.402	2.758	4.145	5.173	6.217	9.060
2015		0.017	0.100	0.357	0.697	1.194	1.808	3.241	4.835	6.809	10.000
2016	0.001	0.025	0.116	0.327	0.831	1.623	2.245	3.557	5.299	6.879	9.973
2017	0.001	0.047	0.186	0.369	0.782	1.485	2.338	3.995	5.714	8.168	10.674

2018				No	survey				
2019				No	survey				

Table 16.2.11 ***German survey*****. Numbers of valid hauls by stratum in South and East Greenland, stratum 9 furthest to the north.**

	NAFO 1 F		ICES 14.b						
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

	NAFO 1 F		ICES 14.b						
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**
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
2015	8	6	6	8	9	10	19	9	75
2016	11	6	5	8	8	6	13	6	63
2017	7	.	3	2	6	6	13	9	46
2018				No survey					
2019	16	7	3	8	8	9	19	8	78

Table 16.2.12 ***German survey*****. Cod abundance indices ('000) from the German survey in South and East Greenland by year and stratum. Incomplete coverage in 2017.**

	NAFO 1F		ICES 14.b							
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

	NAFO 1F		ICES 14.b							
year	str4_1	str4_2	str5_1	str5_2	str7_1	str7_2	str8_2	str9_2	Sum	SD
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
2015	3187	361	1186	267	113	834	2265	3395	11833	3703
2016	2875	361	1186	267	113	793	2152	4086	9114	1647
2017	1499	104	1498	262	336	1126	1126	3307	12421	3727
2018					No survey					
2019	11679	17	416	550	122	350	305	2123	15564	

Table 16.2.13 ***German survey*****. Cod biomass indices (tonnes) from the German survey in South and East Greenland by year and stratum. Incomplete coverage in 2017.**

	NAFO 1F		ICES 14.b							
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

	NAFO 1F		ICES 14.b							
year	str4_1	str4_2	str5_1	str5_2	str7_1	str7_2	str8_2	str9_2	Sum	SD
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
2015	10777	1534	3938	1804	522	3346	9396	24306	55623	17157
2016	4521	305	7360	1727	2129	6341	4906	9367	36656	6954
2017	5836	.	7687	0	616	9704	4067	31088	58998	20593
2018					No survey					
2019	19292	32	1927	1245	397	685	1610	11072	36260	11857

Table 16.2.14 German survey, South and East Greenland (NAFO 1F and ICES 14.). Age disaggregate abundance indices ('1000). Incomplete coverage in 2017.

Year	0	1	2	3	4	5	6	7	8	9	10	11+
1982		23	214	2500	1760	4451	1952	793	223	927	57	74
1983												
1984	23	8	54	1134	507	2434	582	1242	229	125	17	49
1985	279	2521	242	160	1658	947	1439	344	831	96	27	27
1986		3367	9255	1128	273	1631	603	1300	165	473	31	58
1987		4	10193	24656	2689	720	1368	296	966	80	487	49
1988	6	18	335	9769	23391	876	200	559	83	337	31	146
1989	12	2	111	732	23945	49864	1007	44	756	70	282	76
1990	58	36	58	715	706	11679	12101	139	15	74		148
1991		73	150	171	539	102	2128	1762	31	11	3	9
1992	214	10	196	103	61	53	67	67	51			21
1993		4	15	869	152	95	97	31	83	34		2
1994		71	5	16	84	39	22	38		8		0
1995		1	621	347	260	1399	372	120	403	32	192	102
1996		0	0	353	130	131	110	23	25			0
1997		0	12	17	687	557	191	78	48			5
1998	51	73	39	4	11	173	138	48	10			0

Year	0	1	2	3	4	5	6	7	8	9	10	11+
1999	105	426	389	346	118	257	174	156		29	16	0
2000		202	243	323	208	40	72	20	46	61	15	0
2001		166	568	493	631	362	190	60	50	18	10	2
2002	40	1	395	2119	601	477	454	217	61	21	11	7
2003	579	629	53	553	1761	1026	1015	541	220	37	.	4
2004	386	10687	1770	448	617	1667	921	620	228	39	10	8
2005	80	1603	39549	8091	1250	2819	2549	727	189	40		0
2006	80	439	3375	48140	9269	1328	2404	1309	193	30	9	0
2007	128	154	2007	5149	65974	8166	713	658	634	70		0
2008	14	265	513	8213	4401	22939	4201	516	220	199	44	29
2009	98	322	1057	391	1620	2863	11241	1964	111	134	64	17
2010	22	700	1425	1388	845	2887	2518	5707	1362	236	163	139
2011		120	1246	3475	4874	2402	2949	1179	2324	310	23	49
2012	6	50	1624	10093	10233	9846	2827	1778	1166	379	35	5
2013		17	35	4312	27014	11146	7455	1314	517	291	126	68
2014		7	55	602	20847	58174	9275	3284	1316	494	441	52
2015	105	37	68	341	752	3688	3598	1881	644	187	106	160

Year	0	1	2	3	4	5	6	7	8	9	10	11+
2016	35	419	98	56	255	677	874	3325	1741	1072	199	209
2017		8	1650	479	190	549	1243	2341	3640	1356	533	195
2018						No survey						
2019	52	.	.	679	8296	2301	516	468	554	820	626	2255

Table 16.2.15 *German survey*, The abundance indices (‘000) by year class/age, 2019. South and East Greenland (NAFO 1F (Strat 4) and ICES 14.b, Strat 9 furthest to the north).

year	stratum	index0	index1	index2	index3	index4	index5	index6	index7	index8	index9	index10	index11	index12
2019	4.1	50	.	.	682	7821	1742	310	317	227	328	161	26	6
2019	4.2	0	.	.	0	11	3	1	0	1	0	0	0	0
2019	5.1	0	.	.	18	229	55	14	3	16	28	37	12	5
2019	5.2	7	.	.	7	219	140	35	19	29	31	42	13	8
2019	7.1	1	.	.	1	57	25	6	6	6	7	8	4	1
2019	7.2	0	.	.	5	219	110	12	3	1	0	0	0	0
2019	8.2	0	.	.	1	69	45	18	24	34	52	35	25	2
2019	9.2	0	.	.	6	231	292	138	124	274	442	382	159	67

Table 16.5.1. Reference point.

Reference point	Value	Technical basis
F_{MSY}	0.46	Equilibrium scenarios using segmented regression and capped by F_{p05}
F_{LIM}	2.34	Equilibrium scenarios prob (SSB < B_{lim}) < 50% with stochastic recruitment
F_{PA}	1.33	F_{lim} / e $^{1.645\sigma}$, σ = 0.34
B_{LIM}	10354 t.	Average of SSB 2002, 2003 and 2004
B_{PA}	14803 t	B_{lim}×e $^{1.645\sigma}$, σ = 0.217
MSY $B_{trigger}$	14803 t.	B_{PA}

Table 16.7.1. Estimated stock numbers at age.

Year Age	1	2	3	4	5	6	7	8	9	10
1973	44195	11632	7056	4605	20754	3852	2827	678	2625	4183
1974	232950	33645	9524	6372	3310	14486	2417	1442	322	2819
1975	32390	223610	25614	7626	6341	2378	9540	1375	713	1311
1976	13062	25311	214644	19204	5467	4604	1455	5044	677	1001
1977	13071	10278	19780	151998	17363	3747	2448	697	1747	775
1978	30198	10317	8087	16189	91578	13484	1982	841	236	941
1979	7524	27255	8143	8460	11534	45293	7897	1234	257	224
1980	18792	5569	24599	7271	7025	5694	20726	2407	239	76
1981	4640	17025	4122	17794	6083	5385	3547	10126	820	124
1982	5092	3559	15424	3049	14361	5172	3772	2007	3785	330
1983	2573	4944	2636	14604	3137	11497	2597	1137	355	783
1984	4405	1997	4801	2646	9517	1818	5223	704	334	340
1985	168187	4354	1764	4078	2237	6080	771	1895	173	228
1986	126523	146402	4223	1077	3580	1510	3941	381	1049	155
1987	3150	95654	121777	3361	760	2553	828	2261	195	811
1988	2613	3294	62055	103955	2141	429	1690	399	984	421
1989	723	2359	2984	40800	77319	1108	161	763	172	474
1990	1470	688	2162	2428	25873	38781	442	54	251	147
1991	2456	982	590	1800	1221	10684	10869	134	27	78
1992	918	1669	523	436	730	299	2483	1635	36	11
1993	821	692	954	388	226	333	62	226	161	5
1994	3752	707	621	695	263	134	216	30	60	55
1995	239	3161	912	412	599	198	85	151	18	63
1996	313	200	2014	703	340	311	115	50	84	46
1997	1617	242	167	1257	599	260	163	72	28	74
1998	5544	1348	187	152	661	369	157	70	37	55
1999	10944	4276	1261	218	180	325	208	87	35	48
2000	14685	6702	2923	1064	226	155	160	108	57	48
2001	8970	11341	4398	2154	955	251	121	89	54	59

Year Age	1	2	3	4	5	6	7	8	9	10
2002	1594	6645	8780	3141	1671	855	241	85	50	68
2003	38267	1813	4764	6242	2346	1197	633	164	50	66
2004	362919	28665	2310	3676	4509	1602	706	372	88	67
2005	68473	274760	20617	2851	3179	3050	948	311	195	89
2006	35733	43793	167777	18138	2761	2491	1890	395	94	167
2007	15832	27486	25694	83099	13018	2078	1247	963	214	169
2008	22675	12052	19611	14087	37533	8347	1548	556	392	176
2009	54072	21677	11235	13497	9408	13009	3155	501	348	172
2010	57102	31849	15910	7349	9762	5866	7811	1790	322	246
2011	10678	44070	20699	17425	6129	6448	3484	3457	1013	344
2012	6165	10267	40776	20179	17651	5084	3578	1886	1454	654
2013	2764	4886	8545	38742	17299	15604	3725	2090	1062	1016
2014	976	2104	4751	6953	30446	12746	9135	2291	1301	1034
2015	5230	957	2125	4842	7708	18350	8301	4227	1149	1102
2016	50753	5520	1349	1836	3993	5690	9988	4466	2093	1114
2017	3009	41053	5713	1721	2091	3760	5329	6201	2579	1376
2018	3009	2729	26669	5130	1554	1685	2559	3498	3047	1861
2019	3009	2464	2476	21933	4364	1238	1111	1394	1814	2173

Table 16.7.2. Estimated fishing mortality at age.

Year Age	1	2	3	4	5	6	7	8	9	10
1973			0.001	0.022	0.044	0.073	0.141	0.265	0.356	0.356
1974			0.001	0.016	0.032	0.054	0.101	0.202	0.268	0.268
1975			0.003	0.039	0.078	0.114	0.167	0.265	0.253	0.253
1976			0.004	0.047	0.102	0.184	0.28	0.474	0.412	0.412
1977			0.003	0.056	0.135	0.237	0.375	0.627	0.616	0.616
1978			0.002	0.04	0.116	0.182	0.282	0.679	1.016	1.016
1979			0.003	0.059	0.176	0.257	0.549	1.201	1.313	1.313
1980			0.002	0.02	0.05	0.077	0.184	0.464	0.516	0.516
1981			0.001	0.006	0.024	0.064	0.175	0.45	0.504	0.504
1982			0.001	0.01	0.06	0.246	0.669	1.249	1.084	1.084
1983			0.005	0.056	0.215	0.477	0.745	0.855	0.709	0.709
1984			0.015	0.103	0.239	0.451	0.612	0.737	0.608	0.608
1985			0.027	0.098	0.18	0.254	0.265	0.272	0.253	0.253
1986			0.014	0.064	0.131	0.201	0.219	0.206	0.177	0.177
1987			0.008	0.054	0.109	0.184	0.268	0.343	0.432	0.432
1988			0.01	0.105	0.214	0.342	0.426	0.451	0.646	0.646
1989			0.008	0.111	0.242	0.355	0.463	0.459	0.888	0.888
1990			0.012	0.28	0.51	0.639	0.614	0.422	0.909	0.909
1991			0.017	0.512	1.045	1.127	1.3	0.932	1.52	1.52
1992			0.007	0.252	0.659	1.133	1.961	1.94	1.802	1.802
1993			0.003	0.043	0.112	0.206	0.338	0.632	0.637	0.637
1994			0.028	0.1	0.147	0.156	0.158	0.209	0.163	0.163
1995			0.018	0.038	0.063	0.059	0.056	0.083	0.075	0.075
1996			0.013	0.036	0.063	0.062	0.066	0.095	0.08	0.08
1997			0.013	0.049	0.094	0.1	0.115	0.164	0.126	0.126
1998			0.01	0.046	0.093	0.106	0.13	0.19	0.139	0.139
1999			0.004	0.019	0.036	0.04	0.052	0.079	0.061	0.061
2000			0.003	0.018	0.035	0.043	0.062	0.093	0.069	0.069
2001			0.001	0.011	0.021	0.028	0.043	0.064	0.047	0.047

Year Age	1	2	3	4	5	6	7	8	9	10
2002			0.002	0.017	0.037	0.052	0.084	0.12	0.08	0.08
2003			0.001	0.012	0.027	0.041	0.073	0.107	0.068	0.068
2004			0.001	0.011	0.027	0.047	0.096	0.139	0.079	0.079
2005			0	0.01	0.026	0.052	0.123	0.178	0.089	0.089
2006			0.001	0.02	0.05	0.068	0.084	0.062	0.027	0.027
2007			0.002	0.025	0.073	0.109	0.166	0.148	0.09	0.09
2008			0.005	0.062	0.21	0.266	0.316	0.168	0.09	0.09
2009			0.011	0.083	0.145	0.083	0.08	0.061	0.033	0.033
2010			0.001	0.012	0.039	0.043	0.054	0.047	0.029	0.029
2011			0	0.005	0.028	0.067	0.117	0.145	0.11	0.11
2012			0	0.004	0.028	0.07	0.114	0.168	0.137	0.137
2013			0	0.001	0.011	0.041	0.084	0.151	0.155	0.155
2014			0	0.001	0.011	0.041	0.092	0.173	0.177	0.177
2015			0.001	0.01	0.062	0.131	0.204	0.295	0.281	0.281
2016			0.002	0.017	0.096	0.168	0.202	0.27	0.288	0.288
2017			0.001	0.01	0.075	0.174	0.244	0.306	0.295	0.295
2018			0	0.005	0.053	0.167	0.266	0.376	0.398	0.398
2019			0.001	0.008	0.091	0.346	0.552	0.757	0.788	0.788

Table 16.7.3. Short-term forecast for 2020 assuming that Catch = TAC_{2020} (18824 t)

Variable	**Value**					
$F_{ages\ 5–10}$ (2020)	1.33					
SSB (2021)	28772					
$R_{age\ 1}$ (2021)	6165					
Total catch (2020)	18824 t					
Rationale	**Catch (2021)**	**F (2021)**	**SSB (2022)**	**% SSB change ***	**% advice change ****	**% TAC change *****
ICES advice basis						
MSY approach: F_{MSY}	6091	0.46	29918	+4%	+79%	-68%
Other scenarios						
F = 0	0	0	39071	+36%	-100%	-100%
F = F_{2020} (*status quo*)	13813	1.54	19151	-33%	+305%	-27%

16.18 Figures

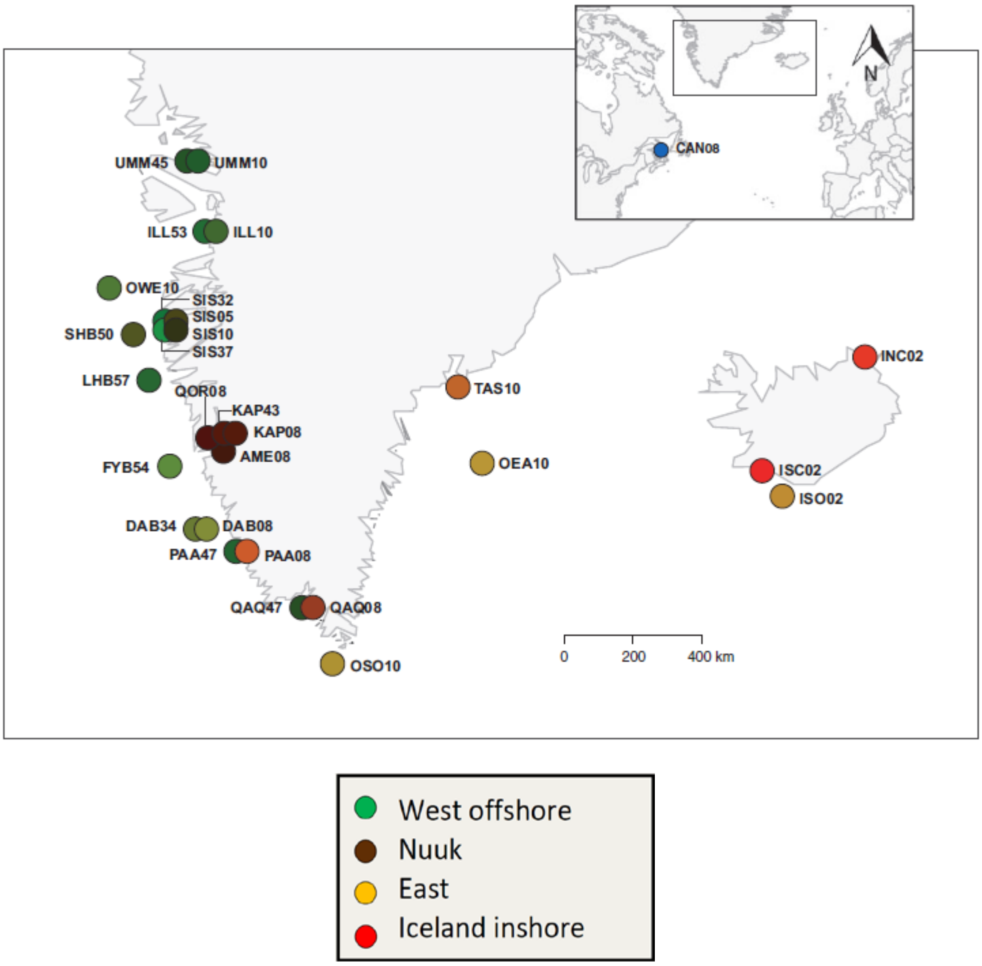


Figure. 16.1. Sampling location of spawning cod in Greenland and Iceland in the genetic project. The colours of the dots represent the blends of sample mean of the different spawning population: West offshore, Nuuk (inshore), East (Greenland and offshore Iceland) and Iceland inshore as signal intensities of green and red respectively. After Therkildsen *et al*., 2013.

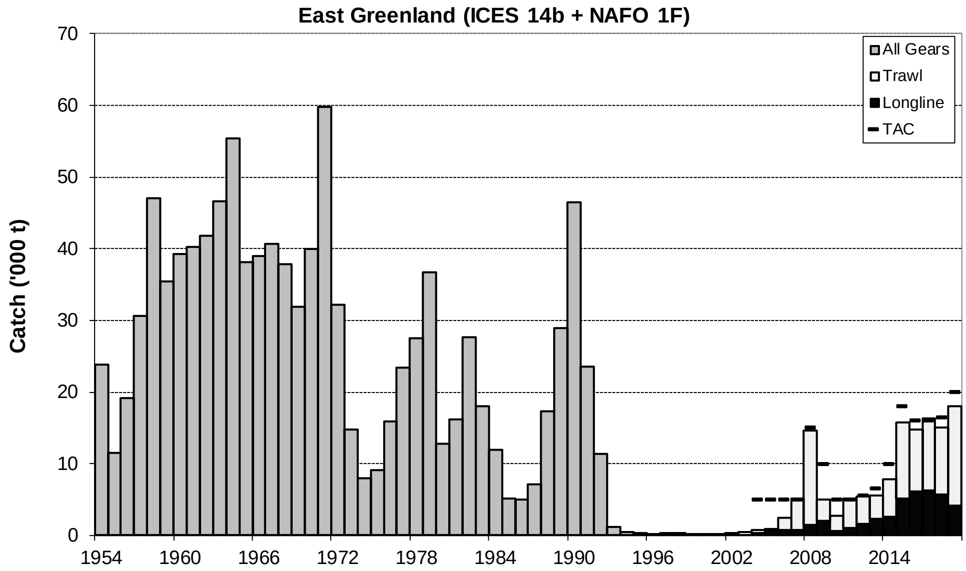


Figure 16.2.1. Annual total catch in South and East Greenland (NAFO Subarea 1F and ICES Subarea 14.b). From 2001 divided into gear. TAC until 2013 is for all the offshore area including West Greenland (NAFO Subarea 1A–1E).

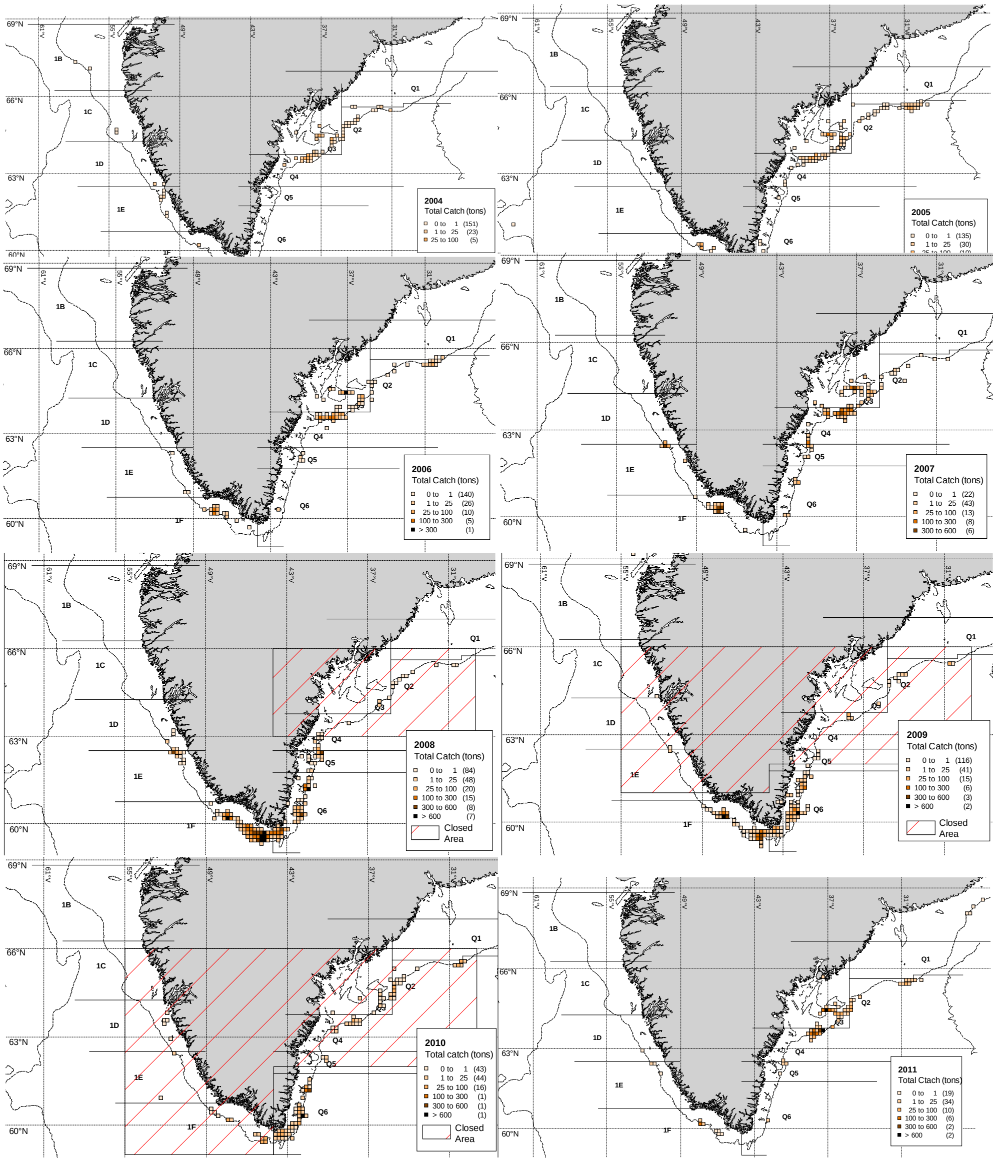


Figure 16.2.2: Annual distribution of total catches of Atlantic cod in West and East Greenland. Q1–Q6 illustrates survey areas (strata) in the East Greenland shrimp and fish survey.

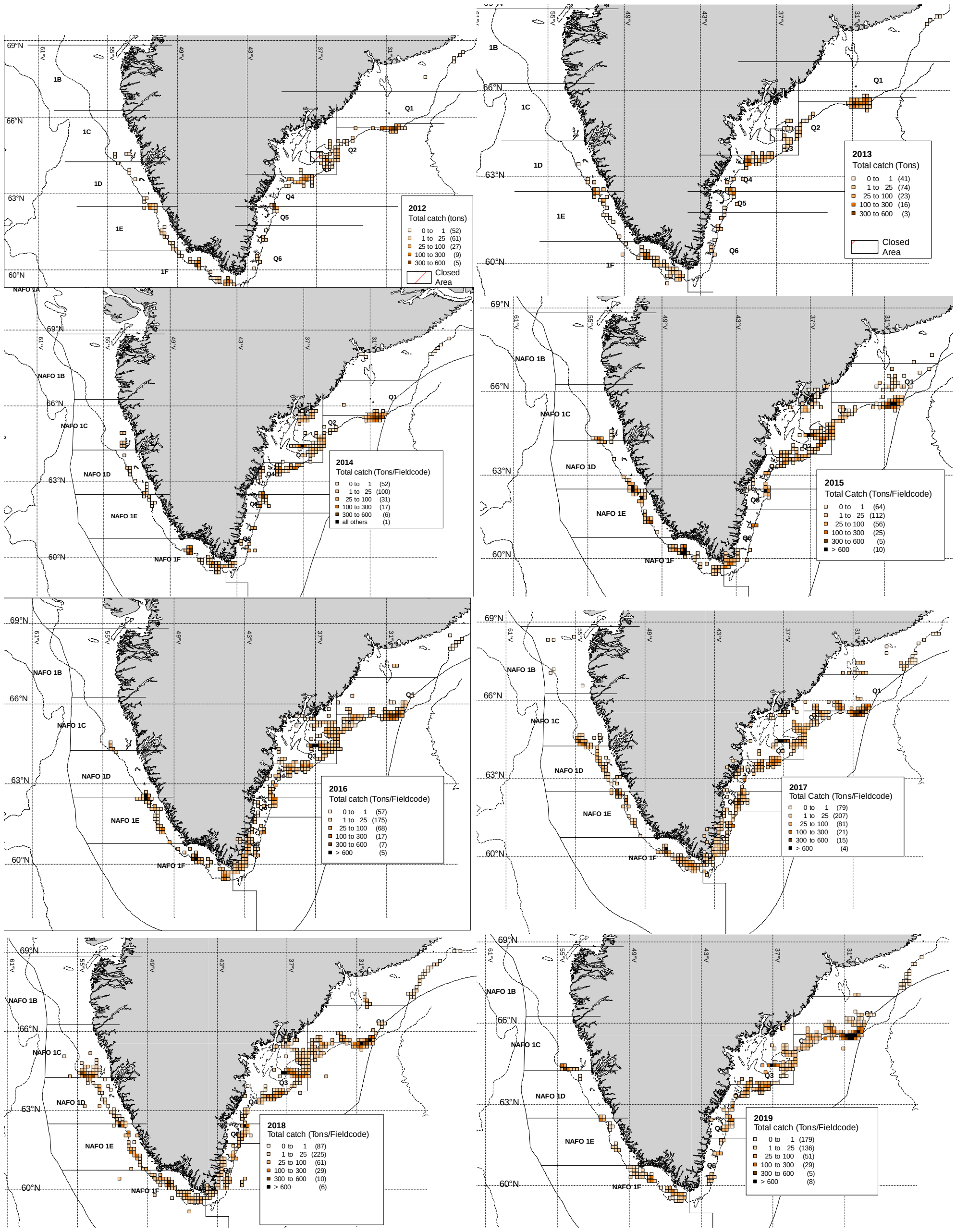


Figure 16.2.2: Continued. Annual distribution of total catches of Atlantic cod in West and East Greenland. Q1–Q6 illustrates survey areas (strata) in the East Greenland shrimp and fish survey.

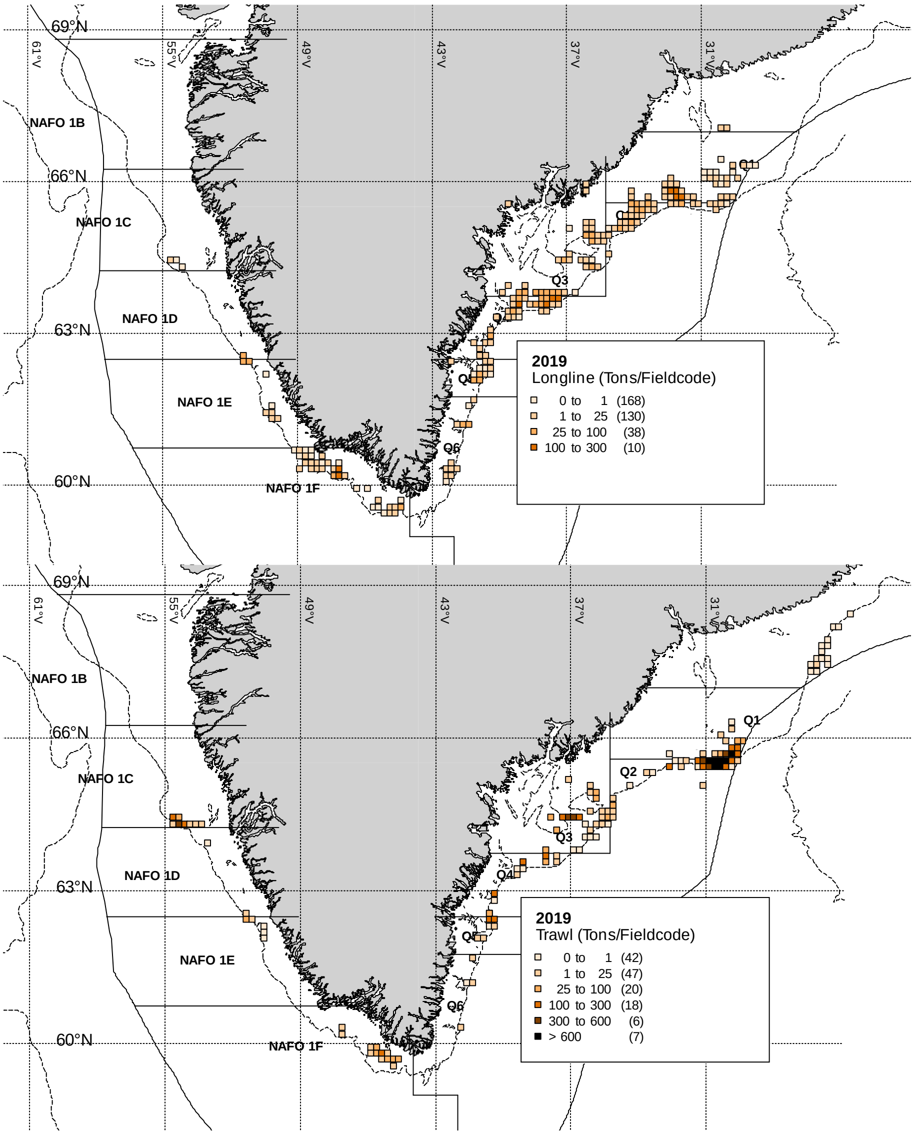


Figure 16.2.3: Distribution of Longline and Trawl catches of Atlantic cod in West and East Greenland. Q1–Q6 illustrates survey areas (strata) in the East Greenland shrimp and fish survey.

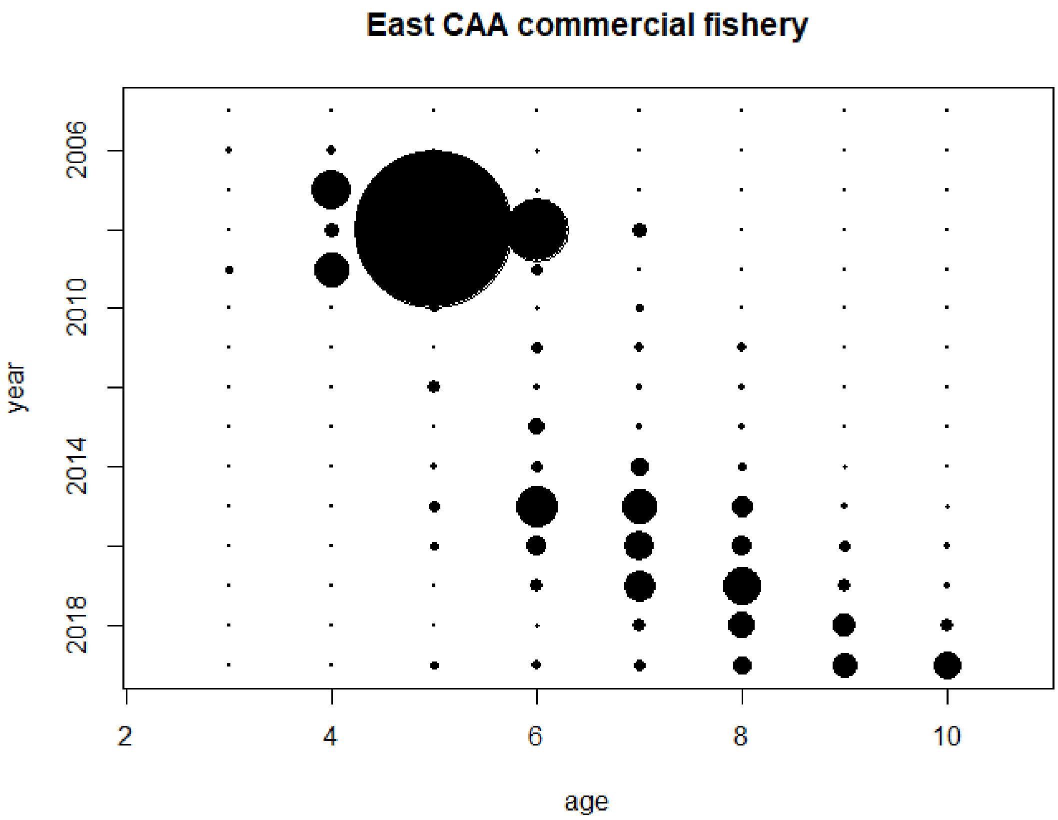


Figure 16.2.4: Catch at Age in the East Greenland (ICES 14. + NAFO 1F) commercial fishery. Size of circles represents size of catch numbers.

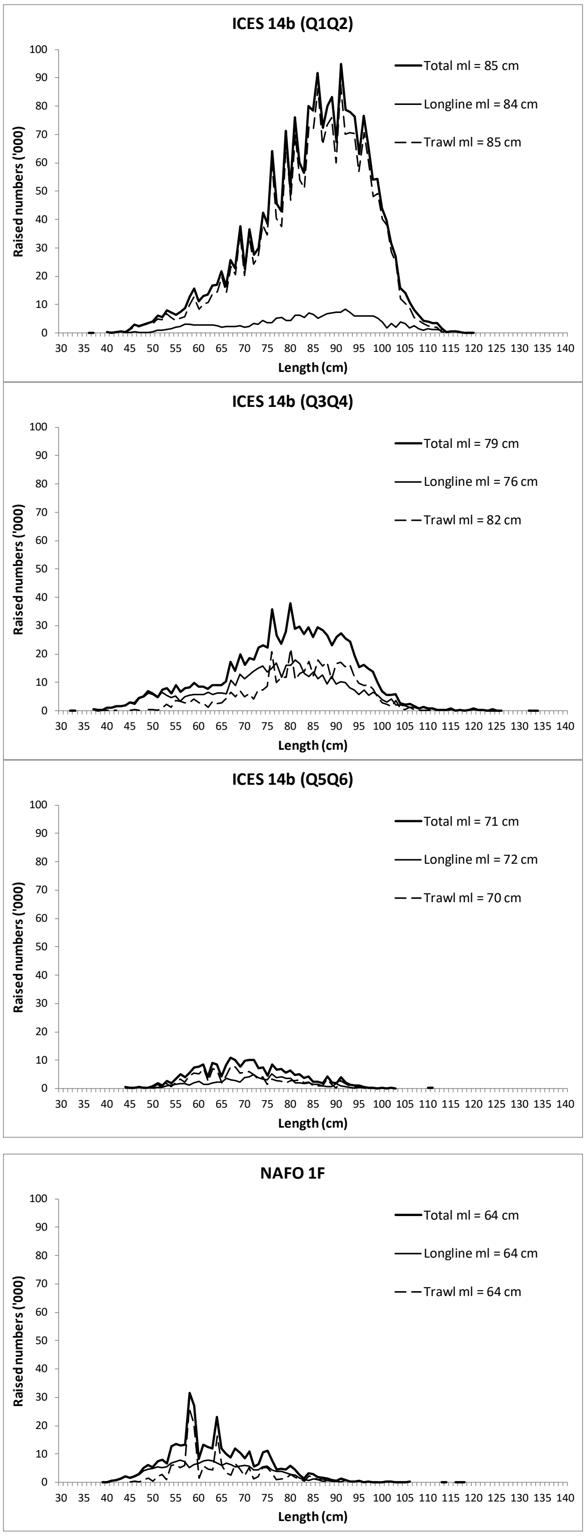
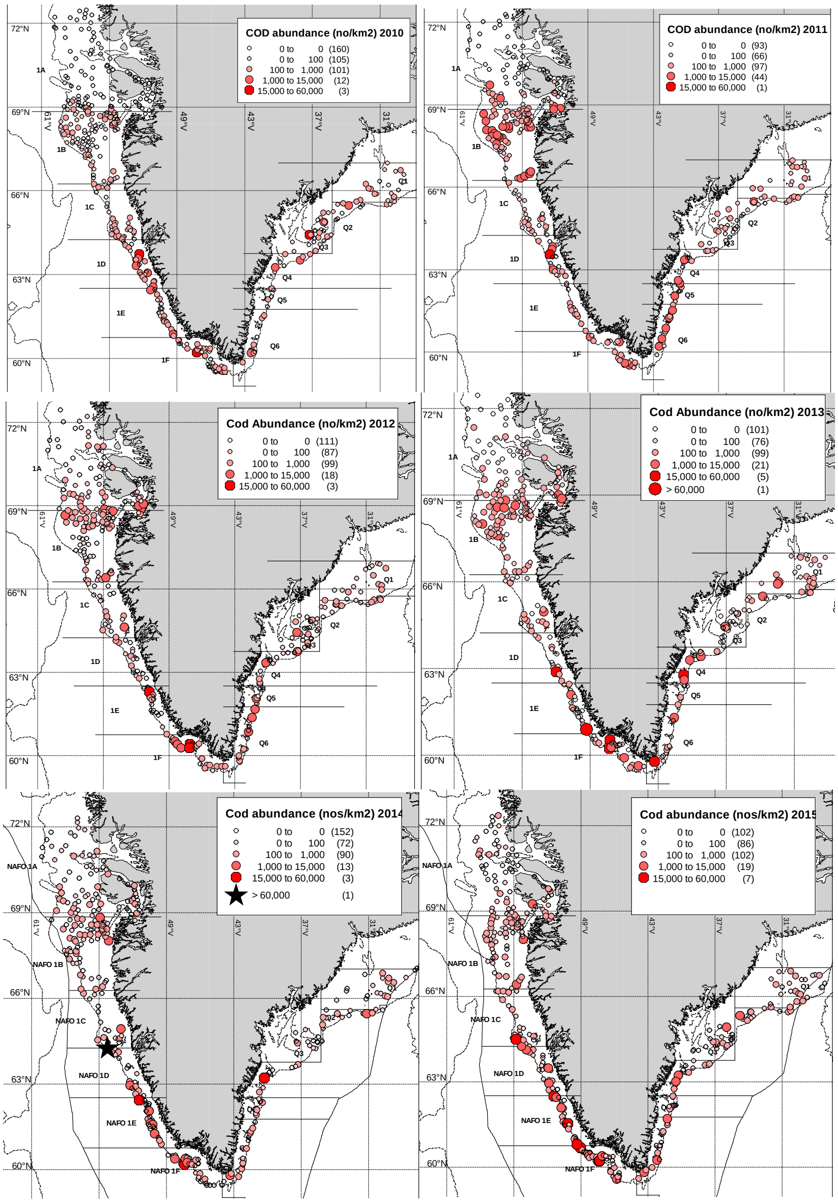


Figure 16.2.5. Length distributions with mean length (ml) of commercial cod catches in three areas in South and East Greenland. Dohrn Bank (Q1Q2) furthest to the north in East Greenland.


COD abundance (no/km2) 2010
0 to 0 (160)
0 to 100 (105)
100 to 1,000 (101)
1,000 to 15,000 (12)
15,000 to 60,000 (3)
COD abundance (no/km2) 2011
0 to 0 (93)
0 to 100 (66)
100 to 1,000 (97)
1,000 to 15,000 (44)
15,000 to 60,000 (1)
Cod Abundance (no/km2) 2012
0 to 0 (111)
0 to 100 (87)
100 to 1,000 (99)
1,000 to 15,000 (18)
15,000 to 60,000 (3)
Cod Abundance (no/km2) 2013
0 to 0 (101)
0 to 100 (76)
100 to 1,000 (99)
1,000 to 15,000 (21)
15,000 to 60,000 (5)
> 60,000 (1)
Cod abundance (nos/km2) 2014
0 to 0 (152)
0 to 100 (72)
100 to 1,000 (90)
1,000 to 15,000 (13)
15,000 to 60,000 (3)
> 60,000 (1)
Cod abundance (nos/km2) 2015
0 to 0 (102)
0 to 100 (86)
100 to 1,000 (102)
1,000 to 15,000 (19)
15,000 to 60,000 (7)
72°N
69°N
66°N
63°N
60°N
1A
1B
1C
1D
1E
1F
NAFO 1A
NAFO 1B
NAFO 1C
NAFO 1D
NAFO 1E
NAFO 1F
Q1
Q2
Q3
Q4
Q5
Q6

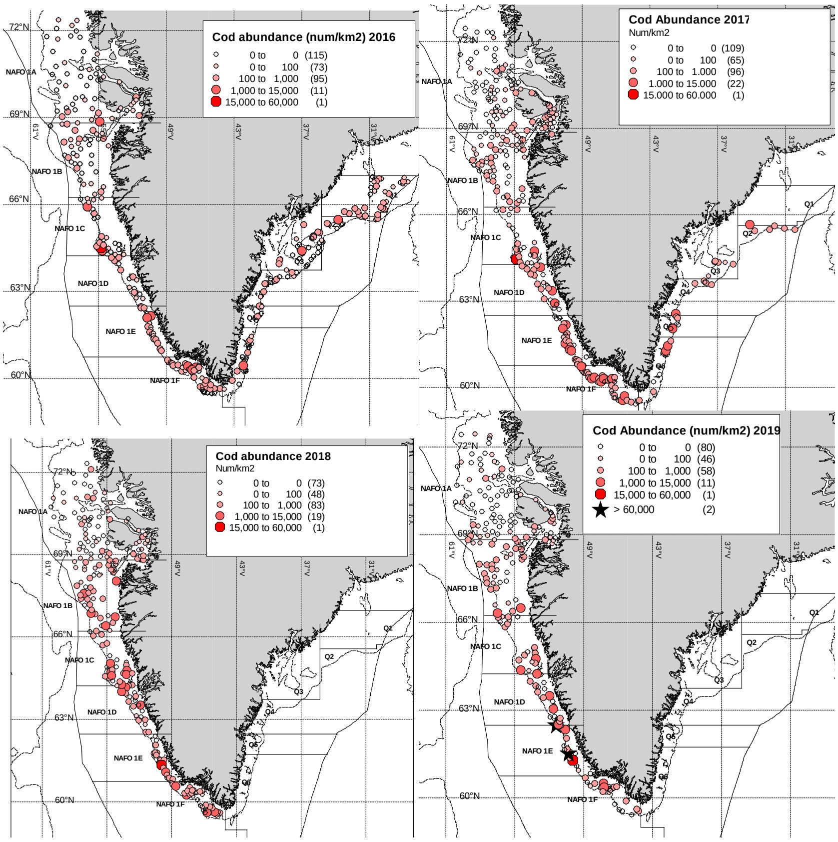
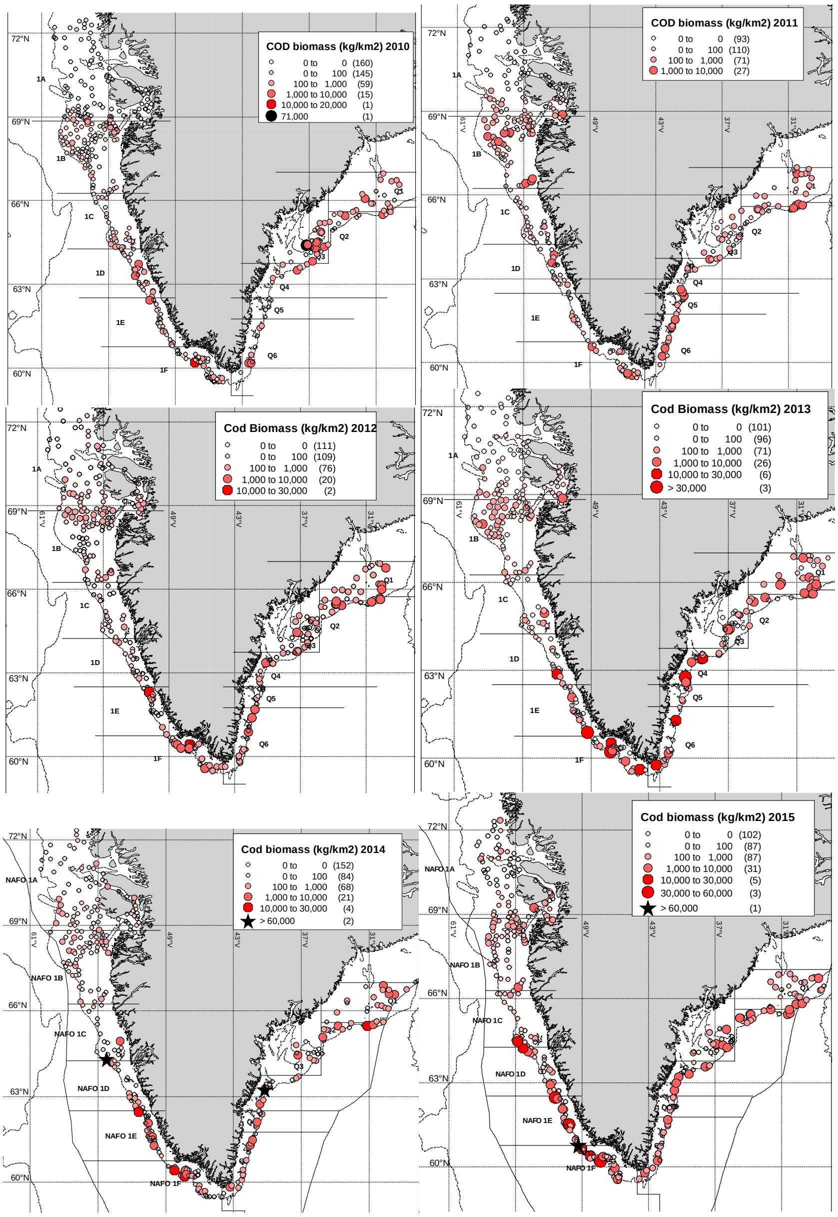


Figure16.2.6. Greenland shrimp and fish survey. Abundance per km².



COD biomass (kg/km2) 2010
0 to 0 (160)
0 to 100 (145)
100 to 1,000 (59)
1,000 to 10,000 (15)
10,000 to 20,000 (1)
71,000 (1)
COD biomass (kg/km2) 2011
0 to 0 (93)
0 to 100 (110)
100 to 1,000 (71)
1,000 to 10,000 (27)
Cod Biomass (kg/km2) 2012
0 to 0 (111)
0 to 100 (109)
100 to 1,000 (76)
1,000 to 10,000 (20)
10,000 to 30,000 (2)
Cod Biomass (kg/km2) 2013
0 to 0 (101)
0 to 100 (96)
100 to 1,000 (71)
1,000 to 10,000 (26)
10,000 to 30,000 (6)
> 30,000 (3)
Cod biomass (kg/km2) 2014
0 to 0 (152)
0 to 100 (84)
100 to 1,000 (68)
1,000 to 10,000 (21)
10,000 to 30,000 (4)
> 60,000 (2)
Cod biomass (kg/km2) 2015
0 to 0 (102)
0 to 100 (87)
100 to 1,000 (87)
1,000 to 10,000 (31)
10,000 to 30,000 (5)
30,000 to 60,000 (3)
> 60,000 (1)
72°N
69°N
66°N
63°N
60°N

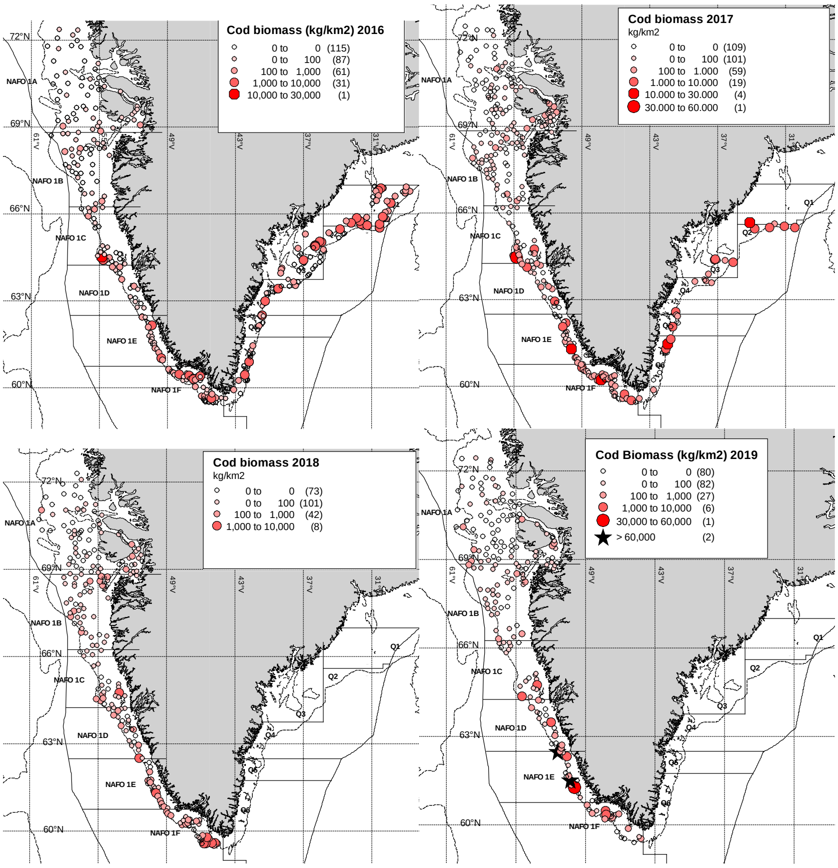


Figure 16.2.7. Greenland shrimp and fish survey. Catch weight kg per km^2

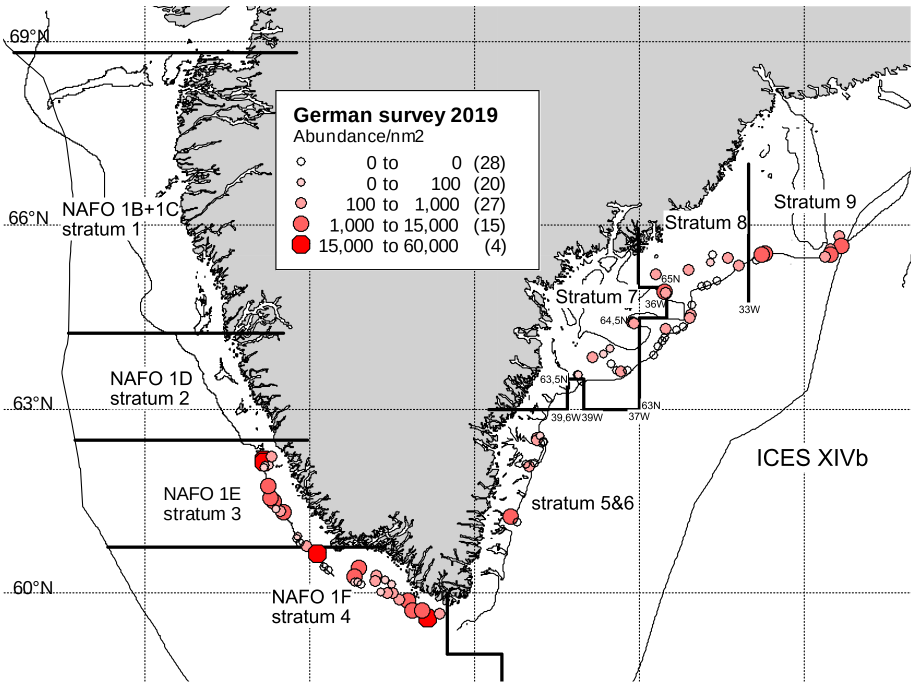


Figure 16.2.8. German ground fish survey. Abundance per nm^2.

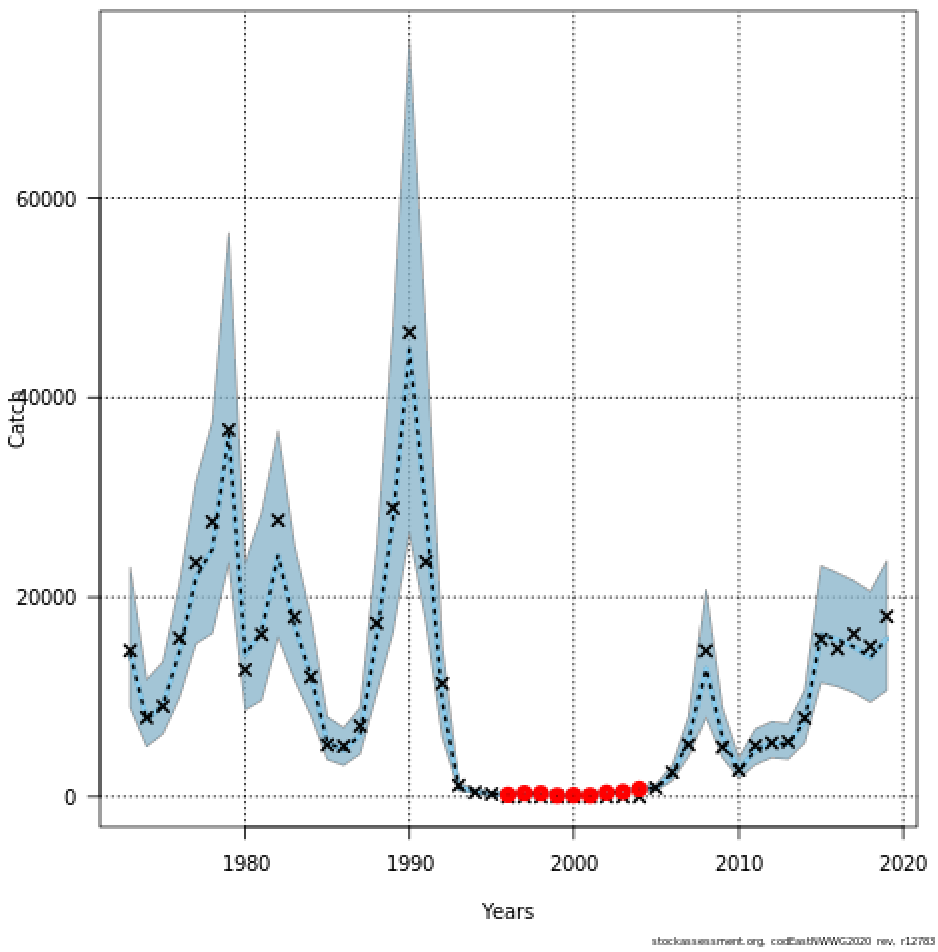


Figure 16.9.1. Estimated catch and with observed catch shown as crosses. Note the period 1996–2004 with near zero catches because no age disaggregated catch data were available.

17 Greenland Halibut in Subareas 5, 6, 12, and 14

Greenland halibut in ICES Subareas 5, 6, 12 and 14 are assessed as one stock unit although precise stock associations are not known.

17.1 Catches, Fisheries, Fleet and Stock Perception

17.1.1 Catches

Total annual catches in Divisions 5.a, 5.b, and Subareas 6, 12 and 14 are presented for the years 1981–2019 in Tables 17.2.1–17.2.6 and since 1961 in Figure 17.2.1. Catches decreased in 2019 by 14% to 23 428 t. Landings in Iceland waters (usually allocated to Division 5a) have historically predominated the total landings in areas 5+14, but since the mid-1990s also fisheries in Subarea 14 and Division 5.b have developed. Total landings have since 1997 been between 20 and 31 kt.

17.1.2 Fisheries and fleets

In 2019 quotas in Greenland EEZ and Iceland EEZ were 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. Catches in 5b decreased in 2019 from 2 917 t to 1986 t.

Most of the fishery for Greenland halibut in Divisions 5.a, 5.b and 14.b is still a directed trawl fishery, but a gillnet fishery has gained importance in Iceland where the proportions of both gillnets and longlines have increased especially in the northern area, where the catches in gillnets are now more than 50% of the catches in 5a. Only minor catches in 5a and 14b are taken as by-catches in a redfish fishery (see section 22 on Greenland slope redfish). No or insignificant discarding has been observed in this fishery.

Spatial distribution of the 2019 fishery and historic effort and catch in the trawl fishery in Subareas 5, 6, 12 and 14 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 deeper than 1000 m at East Greenland (Figure 17.2.6). In recent years and in 2019 the distribution of the fishery covered all areas but bottom trawling has moved towards a more discontinuous distribution (Figure 17.2.2). Catches in gillnets has increased substantially in 5.a, north of Iceland and in 2019 the majority of the landings were from gillnets (Figure 17.2.7).

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 6.b, however, most of these fisheries ceased after 2008. Presently UK, France and Spain have a small fishery in the area. All catches in Subareas 6 and 12 are assumed to derive from the Hatton Bank area (Tables 17.2.5–17.2.6).

17.1.3 By-catch and discard

The Greenland halibut trawl fishery is mostly a clean fishery with little 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 located 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 Iceland since the late 1980s and in Greenland since 2002 was observed to have reduced by-catches considerably. Based on few samplings 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). No information has since been available but the fishery in Division 14b generally report discard rates less than 1% by weight in logbooks.

17.2 Trends in Effort and CPUE

17.2.1 Division 5.a

Indices of CPUE for the Icelandic trawl fleet directed at Greenland halibut for the period 1985–2019 is provided in Table 17.3.1 and Figures 17.3.1–2. The overall CPUE index for the Icelandic fishery is compiled as the average of the standardised indices from four areas.

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 variable with an overall decrease in 2018. The overall tendency is the same for four areas in 5a (Figure 17.3.2) although higher variability is observed in areas north, east and southeast of Iceland.

17.2.2 Division 5.b

Information from logbooks from the Faroese otterboard trawl fleet (>1000 hp) was available for the years 1995-2019 (Table 17.3.1, Figure 17.3.3.). The bulk of the fishery has historically been on the south-east slope of the Faroe Plateau. CPUE has decreased drastically since 2009 coinciding with a significant increase in effort. Catch rates in 2019 are record low at about 50 kg per hour compared to 300 to 400 kg in Divisions 5a and 14b.

17.2.3 Division 14.b

CPUE and effort from logbooks in area 14 are provided in Table 17.3.1 and Figure 17.3.4–5. Following a period with relatively low CPUEs in 1999–2004, catch rates have been variable but increasing and reached in 2016 a record high. Since 2016 CPUE slightly decreased but is maintained at high rates.

CPUE series from Divisions 5a, 5b and 14b show different trends over the time indicating that the populations/areas most likely have different dynamics.

17.2.4 Divisions 6.b and 12.b

Since 2001 a fishery developed in Divisions 6.b and 12.b in the Hatton Bank area by Spain, UK and France. The recent catches are stable but small. Limited fleet information is available from this area (ICES WGDEEP).

17.3 Catch composition

Length compositions of catches from the commercial trawl fishery in Division 5a are rather stable from year to year. In Figure 17.3.1 length distributions are shown since 1996 from Icelandic trawlers. Norwegian length measurements are available for Subarea 14 and France has provided length measurements from Div. 6a.

17.4 Survey information

Three surveys are conducted in the distribution area of the Greenland halibut stock; in East Greenland (14b), in Iceland waters (5a) and in Faroese waters (5b). The total surveyed area in 2019 in Divisions 5.a is provided in Figure 17.4.1. These two surveys in 5.a and 14.b are combined to one index and used as input for the assessment model. Since the Greenland survey in 14b has not been conducted since 2016, the index used for 2016 and onwards are 2016 values. The distribution of the historic catch rates from the two surveys are provided in Figure 17.4.2.

17.4.1 Division 5.a

Since 2006 the total biomass of Greenland halibut has increased significantly in Icelandic waters until 2017 (Figure 17.4.3). In 2018 and 2019 the total biomass has decreased significantly mainly due to lower abundance of smaller fish (less than 40 cm) (Figures 17.4.3 and 17.4.4). Given the continued low abundance of smaller fish, the decrease in total biomass is expected to continue for the next years.

Catch composition data is available from the survey in Icelandic waters are illustrated in Figures 17.4.4 (size) and 17.4.5 (age).

17.4.2 Division 5.b

The catch rates from the available time series of the Faroese survey have declined from a record high level in 2012–13 to about average for the time series in 2019. (Figure 17.4.6). Decreasing catch rates are also seen for the eastern part of Iceland waters adjacent to division 5b indicating a declining stock in this eastern part of its distribution area.

17.4.3 Division 14.b

The Greenland survey have not been conducted since 2016 due to out phasing of old research vessel and lack of ability to get vessel replacement for these years. It is expected that a new research vessel will be in operation in 2021. The text table below provides information for surveys in 5a and 14b on the intended coverage and numbers of stations in 2019.

Survey /Division	No. hauls in 2019 (planned hauls)	Depth range (m)	Coverage (km2)
5.a	203	32 - ~1500	~130 000
14.b	0 (100)	400-1500	29 000

From 1995 to 2016 the total biomass index in 14.b did shown a decreasing trend. The stock annex provides more extensive descriptions of the surveys.

17.5 Stock Assessment

17.5.1 Stock production model

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.

17.5.1.1 Input data

The model synthesizes information from input priors and two independent series of Greenland halibut biomass indices and one series of catches by the fishery (Table 17.5.1). The two series of biomass indices are a revised annually for use in assessment: a standardised series of annual commercial-vessel catch rates in 5a in 1985–2019, $CPUE_t$, and a combined trawl-survey biomass index (5a and 14b) for 1996–2019, $Isur_t$,. In 2017, 2018 and 2019 the survey index is based on the Icelandic survey and the 2016 values from the Greenland survey due to lack Greenland survey data (see section 17.4.3).

Total reported catch or WGs best estimates in ICES Subareas 5, 6, 12 and 14 1961–2019 was used as yield data (Table 17.5.1, 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. The assumed catches for 2019 was 25 000 t based on agreed TACs for 5a and 14b and a continued catch level for 5b.

17.5.1.2 Model performance

The model parameters were estimated (posterior) based on the prior assumptions (Table 17.5.2–3 and Figure 17.5.1). The data could not be expected to carry much information on the parameter P_{1960} – the initial stock size 25 years prior to when the series of stock biomass series start – and the posterior resembled the prior (Figure 17.5.1). The prior for K was updated but similar to previous estimates. However, the posterior still had a wide distribution with an inter-quartile range of 713–1069 kt (Table 17.5.3).

The posterior for MSY was positively skewed with upper and lower quartiles at 26 kt and 40 kt (Table 17.5.3). As mentioned above, MSY was relatively insensitive to changes in prior distributions.

The model was able to produce a reasonable simulation of the observed data (Figure 17.5.2). The probabilities of getting more extreme observations than the realised ones given in the data series on stock size were in the range of 0.03 to 0.94 i.e. the observations did not lie in the extreme tails of their posterior distributions (Table 17.5.4). Exceptions are observed for the survey in 1997 ($p = 0.94$) and in 2019 ($p = 0.03$). The 2019 observations have, however, high residuals for both indices (-12% and 9%) both outside the quartiles of the model estimate (Figure. 17.5.2).

The retrospective runs suggest high consistency for both biomass and fishing mortality within +- 20% (range 0.03 to 0.043, Figure 17.5.3).

17.5.1.3 Assessment results

The time series of estimated median biomass-ratios starts in 1960 as a virgin stock at K (2xBmsy, Figure. 17.5.4–5). The fishery on the stock 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. 48% of B_{MSY} and has in recent years been around 70% of B_{MSY} with a slight increase in 2019. The median fishing mortality ratio (F/F_{MSY}) has exceeded F_{MSY} since the 1990s, but has in recent years decreased and are now close to F_{MSY} (Figures 17.5.4-

5 and Table 17.5.5-6). Relative fishing mortality can only be estimated with large uncertainty and the posteriors therefore also include values below F_{MSY}. However, the probability that F exceed F_{MSY} is high for most of the years.

17.5.2 Short-term forecast and management options

Assuming catches of 25 000 t in 2020, a fishery a F_{MSY} (F / F_{MSY} =1) in 2021 will lead to catches of 23 530 t (Table 17.5.7). Fishing at this level in 2021 will result in a 2% increase in biomass in 2022 and constitute an increase in advice of 10%.

Biomass scenarios at various catch options are provided in Figures 17.5.6–7. Catches below 30 kt is estimated to lead to an increase in biomass, while catches of 30 kt will remain biomass at current level over the next decade (Figure 17.5.7). Only catches of less or equal to 20 kt will lead the biomass to reach BMSY within the next decade (Figure 17.5.6).

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 kt were investigated (Figure 17.5.6.–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 unrealistic.

Scenarios of fixed levels of fishing mortality ratios within the range of 0.3 to 1.7 were conducted and are shown in Figure 17.5.8. Present biomass is above the MSY $B_{trigger}$ (50% of B_{MSY}) and a fishery at F_{MSY} is advised according the ICES MSY advice rule. Fishing at F_{MSY} will result in slowly increasing yield the next decade.

17.5.3 Reference points

Reference points are unchanged from last benchmark in 2013 (WKBUT, ICES 2013)

17.6 Management considerations

Available biological information and information on distribution of the fisheries suggest that Greenland halibut in East Greenland, Iceland and Faroe Islands belong to the same entity and do mix. 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.

A bilateral agreement between Iceland and Greenland since 2014 have limited the overall catches in recent years and assured that fishing pressure is around F_{MSY}. An attempts to include Faroe Islands

17.7 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 common analysis of all CPUE data from the stock area should possibly be utilized for a combined standardised CPUE index for the assessment. Likewise the Faroese survey should be merged into a combined survey index. This lack of optimal usage of available information need to be solved at the next benchmark. Further work should also investigate effects of the changes in effort in 5a as the proportion of landings from and distribution of effort of bottom trawls has been substantially reduced.

17.8 Research needs and recommendations

Stock structure and connectivity between the main fishing areas remains unquantified. Basic biological information on spawning and nursery grounds for the juveniles also remains poorly known. Trends of biomass indices over the entire assessment area are not similar and may suggest different dynamics between areas. Further, 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 are being reviewed. Workshops in 2019 and 2020 with trans-Atlantic participation from major fishery research institutes is presently analysing historic tag-recapture data with the objective to outline stock structure with focus on evaluating present stock entities in the entire North Atlantic. Further, a Nordic project on Greenland halibut structure run by Greenland Institute of Natural Resources has been initiated in 2020 using several methods, eg. genetics, tagging, otolith microstructure and drift modelling. This project is running until 2022.

A number of issues on the quality of the input biomass indices to the present assessment model are questioned. 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 behaviour in relation to the biomass indices. The models use of process error and sensitivity to various priors should be further scrutinized.

At the benchmark in 2013 (WKBUT, ICES 2013) an alternative assessment model, Gadget, was presented. Presently input to the Gadget model is not complete and the approach need further exploration and especially age data from the entire stock distribution area is required.

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 inter-calibration. A new method has been agreed upon and cooperation between institutes has been initiated on age calibration. With respect to the Greenland halibut stock in 5,6,12 and 14 Iceland has now progressed so far that the 5 previous years otolith samplings has been read and the Greenland institute is also in progress. With an ALK some years back and assumptions on constant growth initial exercises with age-based assessment models should be conducted.

17.9 References

ICES. 2013. Report of the Benchmark Workshop on Greenland Halibut Stocks (WKBUT), 26–29 November 2013, Copenhagen, Denmark. ICES CM 2013/ ACOM:44. 367 pp.

ICES. 2017. Report of the Workshop on age reading of Greenland halibut 2 (WKARGH2), 22-26 August 2016, Reykjavik, Iceland. ICES CM 2016/SSGIEOM:16. 40 pp.

Sünksen,K. 2007. Bycatch in the fishery for Greenland halibut. WD 17, NWWG 2007.

17.10 Tables

Table 17.2.1 GREENLAND HALIBUT. Nominal landings (tonnes) by countries, in Sub-areas 5,6,12 and 14 as officially reported to ICES and estimated by WG

Country	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Denmark	-	-	-	-	-	-	6	+	-	-
Faroe Islands	767	1,532	1,146	2,502	1,052	853	1,096	1,378	2,319	1,803
France	8	27	236	489	845	52	19	25	-	-
Germany	3,007	2,581	1,142	936	863	858	565	637	493	336
Greenland	+	1	5	15	81	177	154	37	11	40
Iceland	15,457	28,300	28,360	30,080	29,231	31,044	44,780	49,040	58,330	36,557
Norway	-	-	2	2	3	+	2	1	3	50
Russia	-	-	-	-	-	-	-	-	-	-
UK (Engl. and Wales)	-	-	-	-	-	-	-	-	-	27
UK (Scotland)	-	-	-	-	-	-	-	-	-	-
United Kingdom	-	-	-	-	-	-	-	-	-	
Total	19,239	32,441	30,891	34,024	32,075	32,984	46,622	51,118	61,156	38,813
Working Group estimate	-	-	-	-	-	-	-	-	61,396	39,326

Country	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Denmark	-	-	-	-	-	1	-			0
Faroe Islands	1,566	2,128	4,405	6,241	3,763	6,148	4,971	3,817	3,884	-
France	-	3	2	-	-	29	11	8	-	2
Germany	303	382	415	648	811	3,368	3,342	3,056	3,082	3,265
Greenland	66	437	288	867	533	1,162	1,129	747	200	1,740
Iceland	34,883	31,955	33,987	27,778	27,383	22,055	18,569	10,728	11,180	14,537
Norway	34	221	846	1,173 [1]	1,810	2,164	1,939	1,367	1,187	1,750
Russia	-	5	-	-	10	424	37	52	138	183
Spain								89		779
UK (Engl. and Wales)	38	109	811	513	1,436	386	218	190	261	370
UK (Scotland)	-	19	26	84	232	25	26	43	69	121
United Kingdom									-	166
Total	36,890	35,259	40,780	37,305	36,006	35,762	30,242	20,360	20,226	22,913
Working Group estimate	37,950	35,423	40,817	36,958	36,300	35,825	30,309	20,382	20,371	26,644

Country	2001	2002	2003 [1]	2004 [1]	2005 [1]	2006 [1]	2007 [1]	2008 [1]	2009 [1]	2010 [1]
Denmark	-	-	-	-	-	-	-	-	-	-
Estonia	-	8	-	-	5	3	-	-	-	-
Faroe Islands	121	334	458	338	1,150	855	1,142	-	270	1,408
France	32	290	177	157	-	62	17	114	-	-
Germany	2,800	2,050	2,948	5,169	5,150	4,299	4,930	4,846	427	5,287
Greenland	1,553	1,887	1,459	-	-	-	155	-	2,819	-
Iceland	16,590	19,224	20,366	15,478	13,023	11,798	9,567	11,671	-	13,293
Ireland	56	-	-	-	-	-	-	-	-	-
Lithuania	-	-	2	1	-	2	3	566		-
Norway	2,243	1,998	1,074	1,233	1,124	1,097	78	639	124	233
Poland	2	16	93	207	-	-	-	1,354	988	960
Portugal	6	130	-	-	-	1,094	-	-	-	-
Russia	187	44	-	262	-	552	501	799	762	1,070
Spain	1,698	1,395	3,075	4,721	506	33	-	-	-	-
UK (Engl. and Wales)	227	71	40	49	10	1	-	-	-	-
UK (Scotland)	130	181	367	367	391	1	-	-	-	-
United Kingdom	252	255	841	1,304	220	93	17	422	581	577
Total	25,897	27,609	30,900	29,286	21,579	19,890	16,410	20,411	5,974	22,901
Working Group estimate	20,703	19,714	20,680	27,102	24,978	21,466	21,402	15,379	28,197	25,995

Country	2011 [1]	2012 [1]	2013 [1]	2014	2015 [1]	2016 [1]	2017 [1]	2018 [1]	2019 [1]
Estonia	-	-	-	429	-	-	-	-	-
Faroe Islands	1,705	2,811	2,788	3,393	3,214	4,656	3,999	2,949	1,973
France	150	67	133	-	117	88	51	71	78
Germany	5,782	4,620	3,814	3,701	3,808	4,420	2,994	4,463	4,483
Greenland	3,415	5,239	3,251	1,897	3,642	1,511	2,692	2,970	2,999
Iceland	13,192	13,749	14,859	9,861	12,400	12,652	11,926	15,214	12,390
Ireland	-	-	-	-	-	-	-	-	-
Lithuania	-	99	-	-	-	-	-	-	-
Norway	171	856	614	764	1,126	1,007	1,002	937	995
Poland	-	786	-	-	-	-	-	-	-
Portugal	-	-	-	-	-	-	-	-	-
Russia	1,095	1,168	1,369	587	600	600	599	400	398
Spain	-	-	-		110	2,105	114	125	82
United Kingdom	323	12	95		127	348	90	13	29
Total	25,693	29,407	26,923	20,743	25,145	27,388	23,466	27,142	23,428
Working Group estimate	26,347			21,069	25,677	25,397			

1) Provisional data

Table 17.2.2 GREENLAND HALIBUT. Nominal landings (tonnes) by countries, in Division 5a, 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	26
Germany	13	22	50	31	23	10	6	1	228
Greenland									155
Iceland	11,087	14,507	2,310 [4]	2,277 [4]	20,360	15,478	13,023	11,798	9,567
Norway							100		77
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	10,054
Working Group estimate		14,607	16,752	19,714	20,415	15,477	13,172	11,817	10,054

Country	2008 [1]	2009 [1]	2010 [1]	2011 [1]	2012 [1]	2013 [1]	2014 [1]	2015 [1]	2016 [1]
Faroe Islands	26	93	37	123	585	103	30	18	15
Germany	4	423	797	576	269	386	587	265	
Greenland	224	1285	64	157		92		1	
Iceland	11,671	15,765	13,293	13,192	6,459	14,859	9,859	12,309	12,652
Norway	15		39						
Russia	4								
Poland	3	270							
UK	179								
Total	12,126	17,837	14,230	14,048	7,313	15,440	10,476	12,593	12,667
Working Group estimate	11,859	15,782	14,230	14,048	14,603 [3]	15,440	10,476	12,593	12,667

Country	2017 [1]	2018 [1]	2019 [1]
Faroe Islands	17	31	
Germany	246	552	259
Greenland	3		1
Iceland	11,926	15,214	12,390
Norway			
Russia			
Poland			
UK	15		
Total	12,207	15,797	12,649
Working Group estimate			

1) Provisional data

2) Includes 223 t catch by Norway.

3) Includes 7290 t taken in SA14 in Iceland EEZ

Table 17.2.3 GREENLAND HALIBUT. Nominal landings (tonnes) by countries, in Division 5b 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								
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	0 [2]	5079	3,951	0	265	1,771	892	873	1,060

Country	2008	2009	2010	2011	2012	2013	2014	2015	2016
Denmark									
Faroe Islands			1,037	1,476	2,149	2,560	2,953	3,139	4,633
France	36		35	1	13	20		28	16
Germany									
Iceland								45	
Ireland									
Norway	1	1	5				3	10	8
United Kingdom	32	117	336	11		2	2	9	
Total	69	118	1,413	1,489	2,162	2,582	2,958	3,231	4,658
Working Group estimate	1,759	1,739	1,413	1,489	2,162	2,582	2,958	3,231	4,658

Country	2017 [1]	2018 [1]	2019 [1]
Denmark			
Faroe Islands	3,548	2,903	1,973
France	7	8	7
Germany			
Iceland			
Ireland			
Norway	6	5	1
United Kingdom	15	1	5
Total	3,576	2,917	1,986
Working Group estimate			

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 14 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	0	6958	0 [6]	0 [6]	0	9,854	10,185	8,589	10,261

Country	2008 [1]	2009 [1]	2010 [1]	2011 [1]	2012 [1]	2013 [1]	2014 [1]	2015 [1]	2016 [1]
Estonia							429		
Faroe Islands		270	333		77	125	409	57	7
Germany	4,842	4	4,490	5,206	4,351	3,428	3,114	3,543	4,420
Greenland		2,819		3,258	5,239	3,159	1,897	3,641	1,511
Iceland					7,290		3	46	
Ireland									
Norway	637	29	226	164	853	613	761	1,115	996
Poland	1,354	718	960		786				
Portugal									
Russia	763		1,070	1,095	1,168	1,369	587	600	600
Spain									
United Kingdom	131	452	229	309	1	1			0
Total	7,727	4,292	7,308	10,032	19,765	8,694	7,200	9,002	7,534
Working Group estimate	9,005	9,805	10,402	10,761	12,475		7,526	9,534	7,534

Country	2017 [1]	2018 [1]	2019 [1]
Estonia			
Faroe Islands	434	15	0
Germany	2,747	3,911	4,225
Greenland	2,689	2,970	2,999
Iceland			
Ireland			
Norway	995	931	993
Poland			
Portugal			
Russia	599	400	398
Spain			
United Kingdom	1	1	0
Total	7,466	8,228	8,615
Working Group estimate	0	0	0

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 12, 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]
Faroe Islands							106		
France									
Ireland									
Lithuania		2	3	566				97	
Poland									
Spain [2]	501								
UK	3								
Russia		46	1		762				
Norway					94				
Estonia		2							
Total	504	50	4	566	856	0	106	97	0
WG estimate	504	50	4	566	856	0	106	97	0

Country	2014 [1]	2015 [1]	2016 [1]	2017 [1]	2018 [1]	2019 [1]
Faroe Islands						
France						
Ireland						
Lithuania						
Poland						
Spain [2]	67	91	78	74	95	62
UK						
Russia						
Norway			0			
Estonia						
Total	67	91	78	74	95	62
WG estimate	67	91	78	74	95	62

[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 6, 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]
Estonia	5	1							
Faroe Islands						1			0
France		22	8	114		38	8	54	113
Poland									
Spain [2]	3	33							
UK	217	74	15	80	12	11	3	11	93
Russia		1		32					
Norway		3		1	3	2	7	3	1
Lithuania				968				2	
Total	225	134	23	1195	15	52	18	70	207
WG estimate	225	134	23	1195	15	52	18	70	207

Country	2014 [1]	2015 [1]	2016 [1]	2017 [1]	2018 [1]	2019 [1]
Estonia						
Faroe Islands	1		1			
France		89	72	44	63	71
Poland						
Spain [2]		18	17	39	30	21
UK	42	119	348	58	12	24
Russia						0
Norway	0	1	3	1	0	0
Lithuania						
Total	43	227	440	142	105	117
WG estimate	43	227	440	142	105	117

[1] Provisional data

[2] Based on estimates by observers onboard vessels

Table 17.3.1. CPUE indices from trawl fleets in Division 5.a, 5.b and 14.b as derived from GLM multiplicative models.

area	year	rel. CPUE	% change in CPUE	landings (tonnes)	relative derived	% change in effort
Iceland 5a	1985	1.00		29,197	29	
	1986	0.98	-2	31,027	32	8
	1987	0.93	-5	44,659	48	52
	1988	0.88	-5	49,379	56	17
	1989	0.78	-11	59,272	76	35
	1990	0.75	-4	37,308	50	-34
	1991	0.74	-1	35,413	48	-4
	1992	0.67	-9	31,978	48	0
	1993	0.53	-21	34,134	64	34
	1994	0.44	-18	28,608	65	2
	1995	0.35	-20	27,391	78	19
	1996	0.30	-14	22,073	73	-7
	1997	0.32	6	16,792	52	-28
	1998	0.51	57	10,595	21	-60
	1999	0.57	12	11,138	20	-6
	2000	0.60	6	14,607	24	24
	2001	0.62	2	16,752	27	12
	2002	0.49	-21	19,714	41	49
	2003	0.36	-26	20,415	57	41
	2004	0.30	-17	15,477	52	-9
	2005	0.28	-6	13,172	47	-10
	2006	0.38	34	11,817	31	-33
	2007	0.47	25	10,525	22	-29
	2008	0.40	-13	9,580	24	5
	2009	0.42	4	15,782	37	58
	2010	0.42	-1	13,565	33	-13
	2011	0.44	4	14,048	32	-1
	2012	0.46	5	7,312	16	-50
	2013	0.47	2	15,439	33	107
	2014	0.43	-7	10,475	24	-27
	2015	0.46	8	12,593	27	12
	2016	0.45	-3	12,667	28	4
	2017	0.43	-5	12,207	29	1
	2018	0.41	-4	15,797	39	35
	2019	0.51	24	12,649	25	-36
Greenland 14b	1991	1.0		875	1	
	1992	1.0	-4	1,176	1	40
	1993	2.5	157	2,249	1	-26
	1994	3.2	30	3,125	1	7
	1995	3.2	0	5,077	2	62
	1996	3.1	-2	7,283	2	47
	1997	3.3	4	8,558	3	13
	1998	3.1	-3	5,940	2	-28
	1999	2.3	-28	5,376	2	26
	2000	2.1	-6	6,958	3	37
	2001	2.2	6	7,216	3	-2
	2002	2.4	8	6,621	3	-15
	2003	2.5	1	8,017	3	20
	2004	2.3	-7	9,854	4	32
	2005	3.2	40	10,185	3	-26
	2006	3.3	4	8590	3	-19
	2007	3.1	-6	10261	3	27
	2008	3.1	1	8,952	3	-13
	2009	2.6	-17	10,567	4	41
	2010	2.7	4	10,402	4	-5
	2011	2.7	0	10,761	4	4
	2012	3.2	18	12,475	4	-2
	2013	3.0	-7	12,476	4	8
	2014	3.1	5	7,526	2	-43
	2015	3.4	10	9,534	3	15
	2016	4.3	26	7,534	2	-37
	2017	4.2	-3	7,466	2	2
	2018	4.1	-3	8,228	2	13
	2019	3.9	-3	8,615	2	8
Faroe Islands 5b	1995	1.0		3,832	4	
	1996	0.9	-10	6,469	7	88
	1997	1.0	7	4,870	5	-30
	1998	0.8	-14	3,825	5	-8
	1999	1.0	19	4,057	4	-11
	2000	1.0	-1	5,079	5	26
	2001	0.9	-11	3,951	5	-12
	2002	0.7	-16	209	0	-94
	2003	0.9	27	265	0	0
	2004	0.7	-22	1,771	2	759
	2005	0.8	6	892	1	-52
	2006	0.8	8	873	1	-9
	2007	0.7	-18	1,060	2	48
	2008	0.8	17	1,759	2	42
	2009	0.9	14	1,739	2	-13
	2010	0.8	-10	1,413	2	-10
	2011	1.2	50	1,489	1	-30
	2012	1.1	-7	2,162	2	57
	2013	0.8	-30	2,582	3	71
	2014	1.0	21	2,958	3	-6
	2015	0.8	-17	3,231	4	32
	2016	0.9	10	4,658	5	31
	2017	0.7	-17	3,576	5	-7
	2018	0.5	-30	2,917	6	17
	2019	0.4	-12	1986	5	-22

Table 17.5.1. Assessment 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 combined Icelandic and Greenland 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	1.73	-
1987	46.622	1.64	-
1988	51.118	1.55	-
1989	61.396	1.84	-
1990	39.326	1.32	-
1991	37.950	1.31	-
1992	35.487	1.18	-
1993	41.247	0.94	-
1994	37.190	0.77	-
1995	36.288	0.62	-
1996	35.932	0.54	63.8
1997	30.309	0.57	81.1
1998	20.382	0.89	90.4
1999	20.371	1.00	87.9
2000	26.644	1.06	91.4
2001	27.291	1.09	104.0
2002	29.158	0.86	60.8
2003	30.891	0.63	48.8
2004	27.102	0.53	34.9
2005	24.249	0.49	54.7
2006	21.432	0.66	36.1
2007	20.957	0.83	46.9
2008	22.169	0.72	54.1
2009	27.349	0.74	78.4
2010	25.995	0.73	54.2
2011	26.424	0.77	67.3
2012	29.309	0.81	79.1
2013	27.045	0.82	83.8
2014	21.069	0.76	73.3
2015	25.677	0.82	78.7
2016	25.397	0.79	72.2
2017	23.466	0.75	84.0
2018	27.141	0.72	58.8
2019	23.428	0.89	45.8
2020*	25.000		

*assumed

Table 17.5.2. 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 17.5.3. 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)	32.51	10.06	26.29	32.08	38.05
K (ktons)	897	256	713	885	1069
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}	0.24	0.09	0.18	0.22	0.28
P_{1985}	1559	0.12	1479	1561	1644
P_{2018}	0.67	0.09	0.61	0.67	0.73
σ_{cpue}	0.09	0.02	0.08	0.09	0.11
σ_{Survey}	0.20	0.03	0.18	0.20	0.22
σ_P	0.15	0.03	0.14	0.15	0.17

Table 17.5.4. Model diagnostics: residuals (% of observed value), probability of getting a more extreme observation (p.extreme; see text for explanation).

	CPUE		Survey	
Year	resid (%)	Pr	resid (%)	Pr
1985	-2.04	0.56		-
1986	-0.95	0.53		-
1987	0.84	0.47		-
1988	3.13	0.39		-
1989	-8.93	0.77		-
1990	3.50	0.39		-
1991	-2.11	0.57		-
1992	-3.22	0.60		-
1993	0.37	0.49		-
1994	0.78	0.48		-
1995	5.03	0.35		-
1996	11.81	0.17	-19.15	0.81
1997	14.79	0.11	-34.89	0.94
1998	-2.72	0.60	-18.57	0.80
1999	-1.85	0.56	-3.37	0.56
2000	-1.91	0.56	-1.40	0.52
2001	-4.83	0.66	-15.38	0.76

2002	-4.73	0.65	15.51	0.24
2003	0.61	0.48	11.91	0.29
2004	1.53	0.45	27.06	0.11
2005	8.40	0.24	-16.84	0.78
2006	-8.00	0.75	38.01	0.04
2007	-13.40	0.87	28.06	0.10
2008	-0.14	0.50	12.80	0.28
2009	1.33	0.46	-18.82	0.81
2010	-0.20	0.51	15.26	0.24
2011	0.08	0.50	-0.67	0.51
2012	1.66	0.44	-11.52	0.70
2013	0.92	0.47	-15.43	0.76
2014	4.05	0.37	-6.64	0.62
2015	0.31	0.49	-9.84	0.68
2016	1.16	0.46	-4.08	0.58
2017	3.84	0.37	-21.81	0.84
2018	2.89	0.40	8.82	0.34
2019	-11.69	0.82	8.82	0.03

Table 17.5.5. Stock status for 2019 and predicted to the end of 2020 assuming catches of 25000 t in 2020.

Status	2019	2020
Risk of falling below Blim (0.3BMSY)	0%	0%
Risk of falling below BMSY	100%	88%
Risk of exceeding FMSY	54%	55%
Risk of exceeding Flim (1.7FMSY)	11%	15%
Stock size (B/Bmsy), median	0.73	0.75
Fishing mortality (F/Fmsy),	1.04	1.06
Productivity (% of MSY)	93%	94%

Table 17.5.6. Summary of assessment.

Year	B/Bmsy	high	low	Catch (ktons)	F/Fmsy	high	low
1960	2.000	2.114	1.884	0.000	0.000	0.001	0.000
1961	2.000	2.108	1.889	0.029	0.000	0.001	0.000
1962	2.000	2.105	1.892	3.071	0.048	0.091	0.031
1963	1.992	2.096	1.886	4.275	0.067	0.128	0.043
1964	1.983	2.087	1.878	4.748	0.075	0.142	0.048
1965	1.974	2.078	1.870	7.421	0.118	0.223	0.075
1966	1.959	2.067	1.856	8.030	0.128	0.243	0.082
1967	1.946	2.056	1.843	9.597	0.154	0.291	0.098
1968	1.931	2.042	1.827	8.337	0.135	0.255	0.086
1969	1.922	2.035	1.816	26.200	0.427	0.807	0.271
1970	1.869	1.993	1.756	33.823	0.568	1.067	0.359
1971	1.809	1.943	1.678	28.973	0.505	0.942	0.315
1972	1.768	1.908	1.626	26.473	0.473	0.884	0.293
1973	1.738	1.882	1.590	20.463	0.372	0.697	0.229
1974	1.726	1.870	1.577	36.280	0.664	1.256	0.407
1975	1.678	1.831	1.513	23.494	0.444	0.841	0.269
1976	1.665	1.822	1.499	6.045	0.115	0.220	0.069
1977	1.695	1.844	1.538	16.578	0.308	0.598	0.186
1978	1.697	1.846	1.536	14.349	0.266	0.521	0.161
1979	1.703	1.852	1.540	23.622	0.436	0.861	0.263
1980	1.686	1.838	1.517	31.157	0.581	1.154	0.350
1981	1.651	1.812	1.477	19.239	0.366	0.730	0.219
1982	1.652	1.814	1.472	32.441	0.617	1.242	0.369
1983	1.618	1.791	1.432	30.891	0.601	1.214	0.355
1984	1.592	1.774	1.398	34.024	0.673	1.369	0.395
1985	1.561	1.752	1.358	32.075	0.647	1.325	0.377

1986	1.543	1.893	1.266	32.984	0.673	1.388	0.378
1987	1.490	1.849	1.207	46.622	0.984	2.041	0.553
1988	1.440	1.794	1.165	51.118	1.118	2.311	0.626
1989	1.519	1.899	1.213	61.396	1.278	2.654	0.704
1990	1.231	1.541	0.990	39.326	1.008	2.083	0.561
1991	1.156	1.446	0.929	37.950	1.036	2.146	0.573
1992	1.031	1.287	0.827	35.487	1.088	2.248	0.603
1993	0.849	1.061	0.686	41.247	1.529	3.170	0.852
1994	0.698	0.874	0.565	37.190	1.675	3.462	0.935
1995	0.586	0.737	0.475	36.288	1.943	4.023	1.092
1996	0.546	0.689	0.442	35.932	2.065	4.293	1.166
1997	0.593	0.755	0.479	30.309	1.604	3.309	0.897
1998	0.780	0.978	0.628	20.382	0.826	1.701	0.456
1999	0.884	1.100	0.713	20.371	0.727	1.504	0.404
2000	0.937	1.167	0.756	26.644	0.896	1.856	0.498
2001	0.927	1.157	0.747	27.291	0.930	1.926	0.514
2002	0.739	0.918	0.596	29.158	1.245	2.578	0.693
2003	0.571	0.708	0.462	30.891	1.703	3.530	0.955
2004	0.476	0.590	0.385	27.102	1.792	3.706	1.009
2005	0.479	0.598	0.388	24.249	1.590	3.289	0.895
2006	0.550	0.682	0.440	21.432	1.232	2.550	0.685
2007	0.648	0.809	0.514	20.957	1.024	2.124	0.564
2008	0.639	0.794	0.517	22.169	1.228	2.540	0.688
2009	0.675	0.841	0.547	27.349	1.277	2.640	0.713
2010	0.656	0.815	0.530	25.995	1.249	2.586	0.698
2011	0.694	0.863	0.562	26.424	1.199	2.480	0.669
2012	0.732	0.911	0.593	29.309	1.262	2.608	0.704
2013	0.745	0.930	0.603	27.045	1.145	2.371	0.635
2014	0.712	0.889	0.575	21.069	0.932	1.924	0.520
2015	0.740	0.922	0.599	25.677	1.093	2.259	0.609
2016	0.719	0.896	0.582	25.397	1.112	2.301	0.621
2017	0.701	0.877	0.568	23.466	1.055	2.174	0.587
2018	0.668	0.831	0.540	27.141	1.279	2.659	0.716
2019	0.716	0.900	0.561	23.428	1.034	2.183	0.567
2020	0.729	1.049	0.503				

Table 17.5.7. Catch forecast. Assumptions for 2020 and catch scenarios for 2021.

Variable		Value		Notes	
F (2020) (F/F_{MSY})		1.06		F corresponding to catches of 25 000t	
Biomass (2021) (B/B_{MSY})		0.76		Estimated by the model	
Total catch (2020)		25000 t		Based on TACs of Iceland, Greenland, and assumed catches in 5b.	
Basis	Total catch (2021)	F_{total} (2021) F/F_{MSY}	Biomass (2022) B/B_{MSY}	% Biomass change	% advice change*
ICES advice basis					
MSY approach: F_{MSY}	23530	1.0	0.78	1.6	10.2
Other scenarios					
F = 0	0	0	0.80	5.5	-100
$F = F_{2019}$	24930	1.06	0.76	0.07	16.7
$F = F_{lim}$	40070	1.70	0.72	-5.1	88.6

17.11 Figures

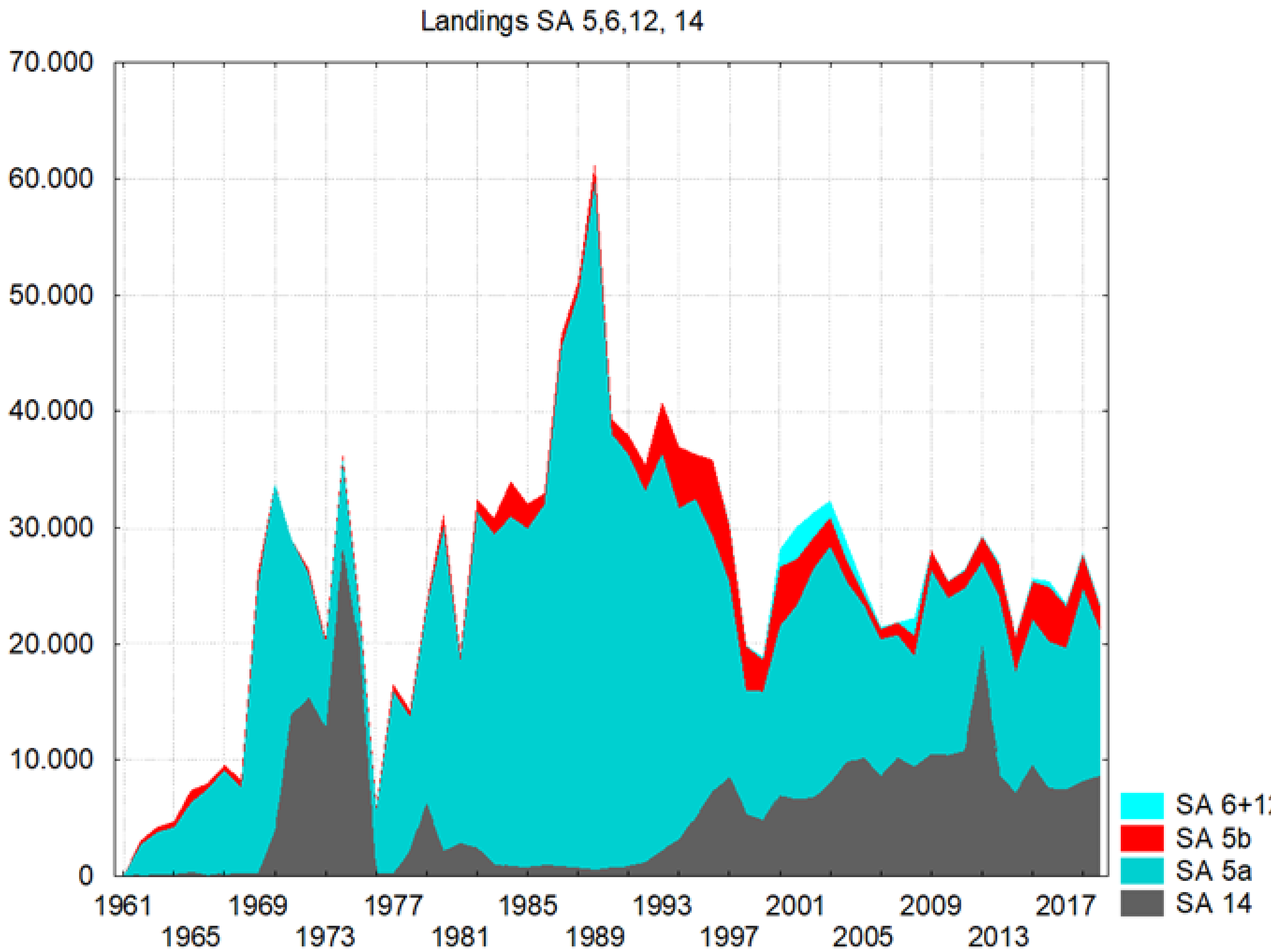


Fig. 17.2.1. Landings of Greenland halibut in Divisions 5, 6, 12 and 14. As the landings within Icelandic waters, since 1976, have not officially been separated and reported according to the defined ICES statistical areas, they are set under area 5a by the NWWG. In 2012 Icelandic landings in Div 14 were only partly recorded in 14, while for remaining years all landings are recorded in 5a.

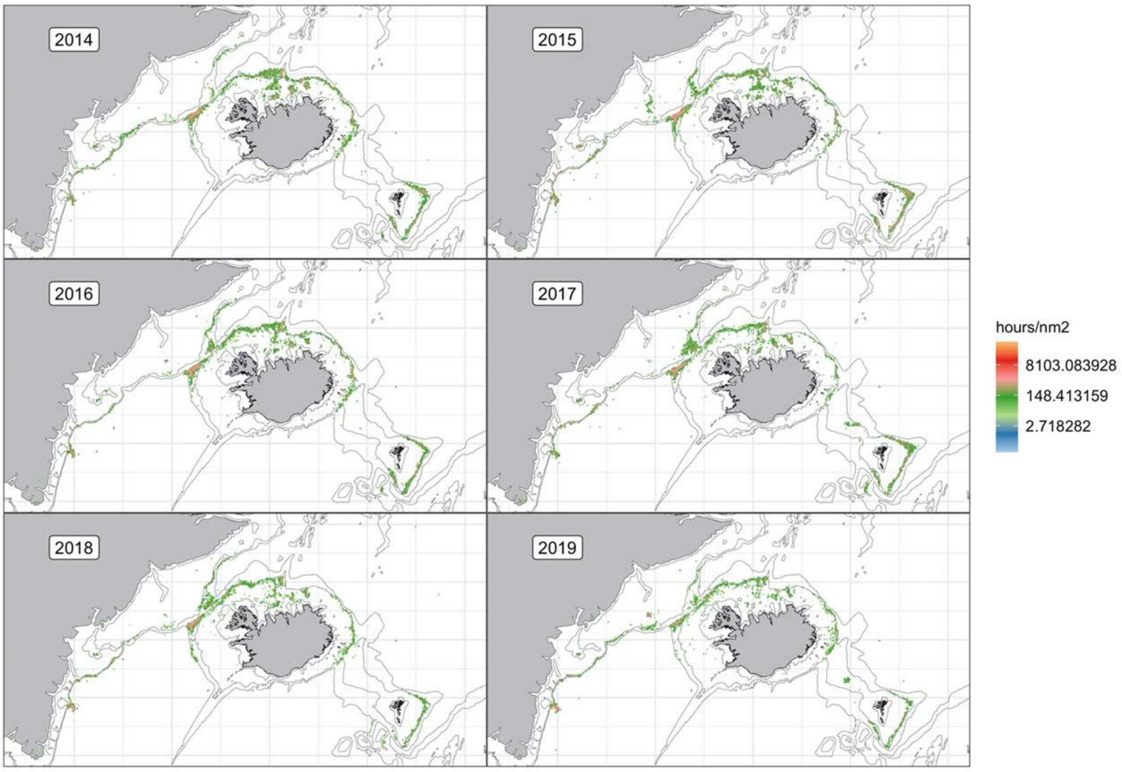


Fig. 17.2.2 Greenland halibut 5+14. Distribution of fishing effort 2014-19. 500m and 1000 m depth contours are shown.

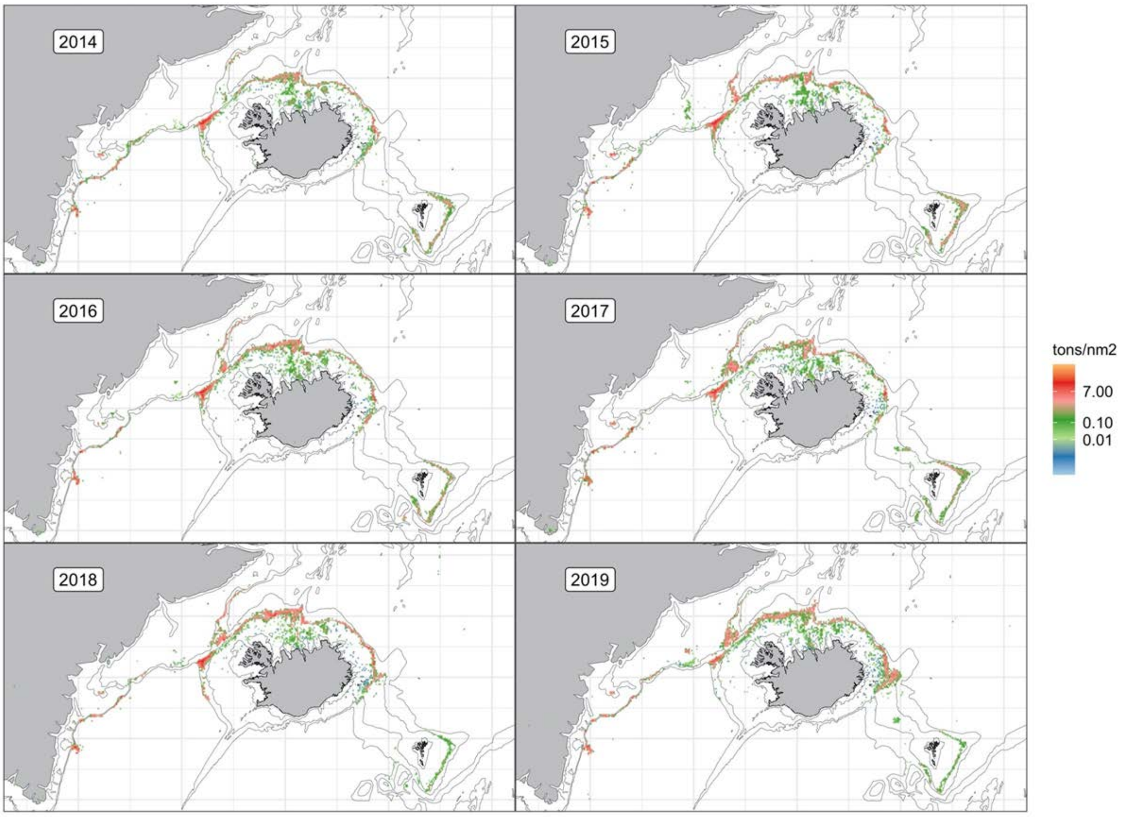


Fig. 17.2.3. Greenland halibut V+XIV. Distribution of catches in the fishery 2014-2019. 500m and 1000 m depth contours are shown.

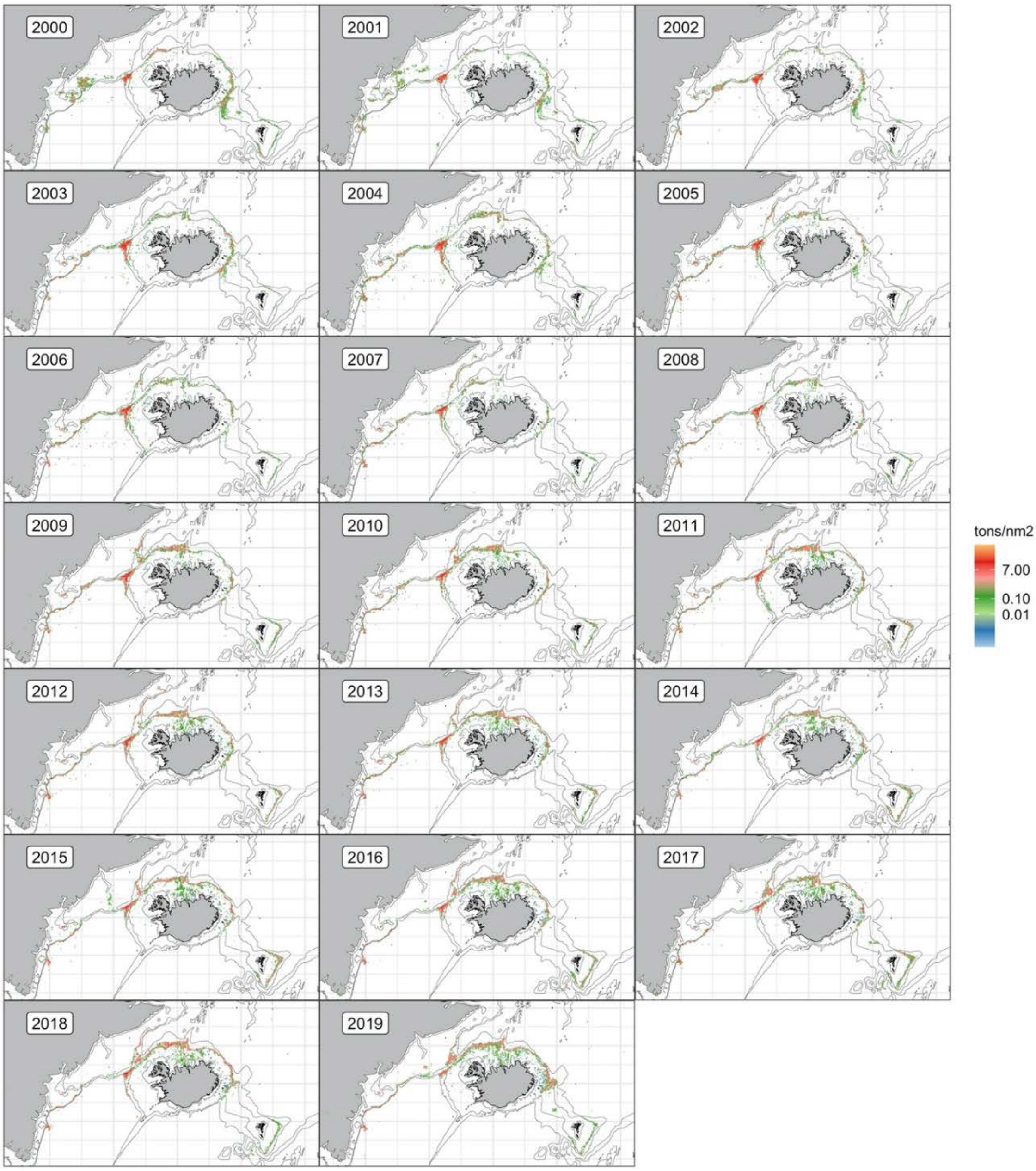


Fig. 17.2.4. Greenland halibut 5+14. Distribution of total fishing effort 2000-2019. The 500m and 1000 m depth contours are shown.

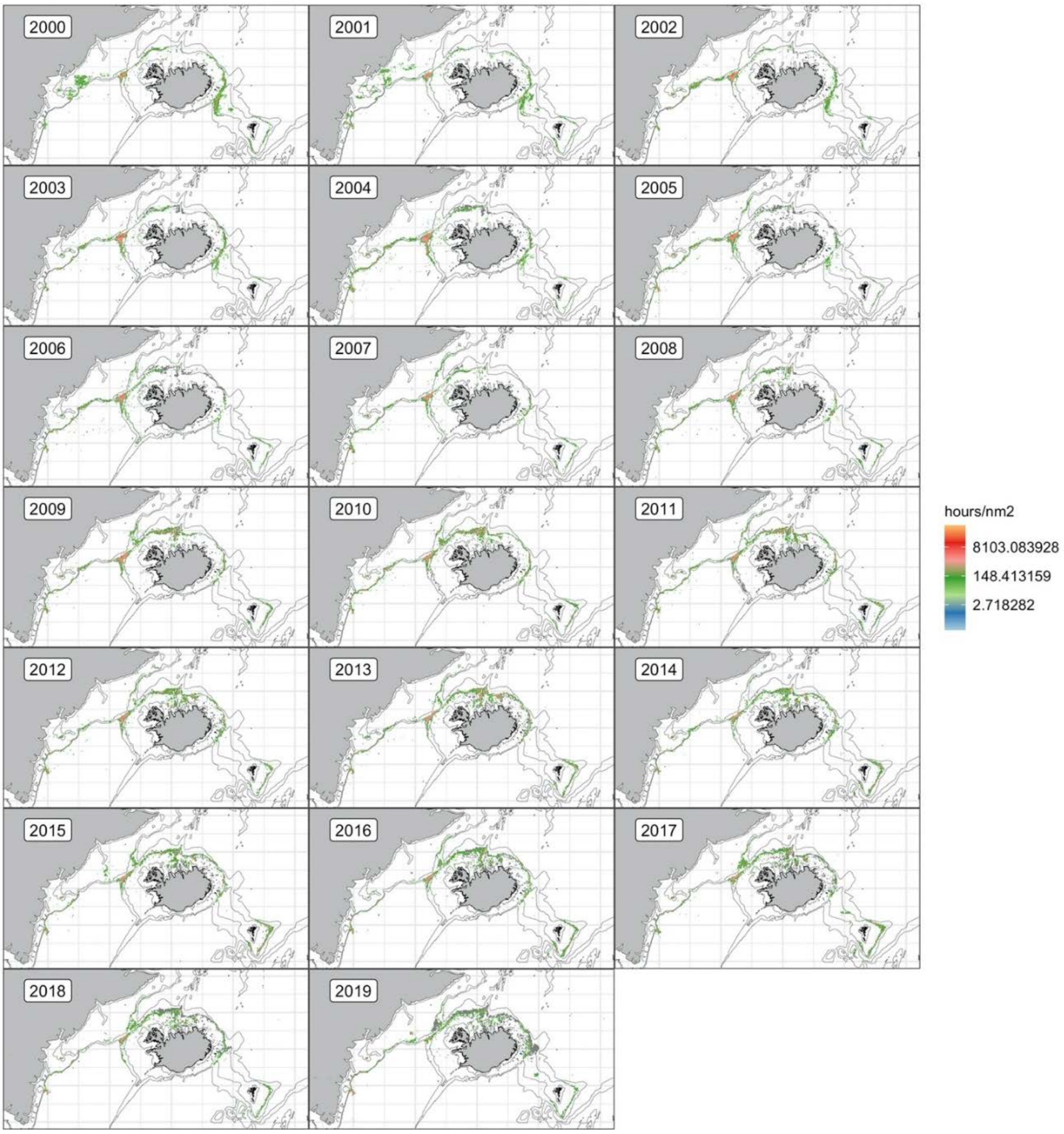


Fig. 17.2.5. Greenland halibut 5+14. Distribution of total catches in the fishery 2000-2019 500m and 1000 m depth contours are shown.

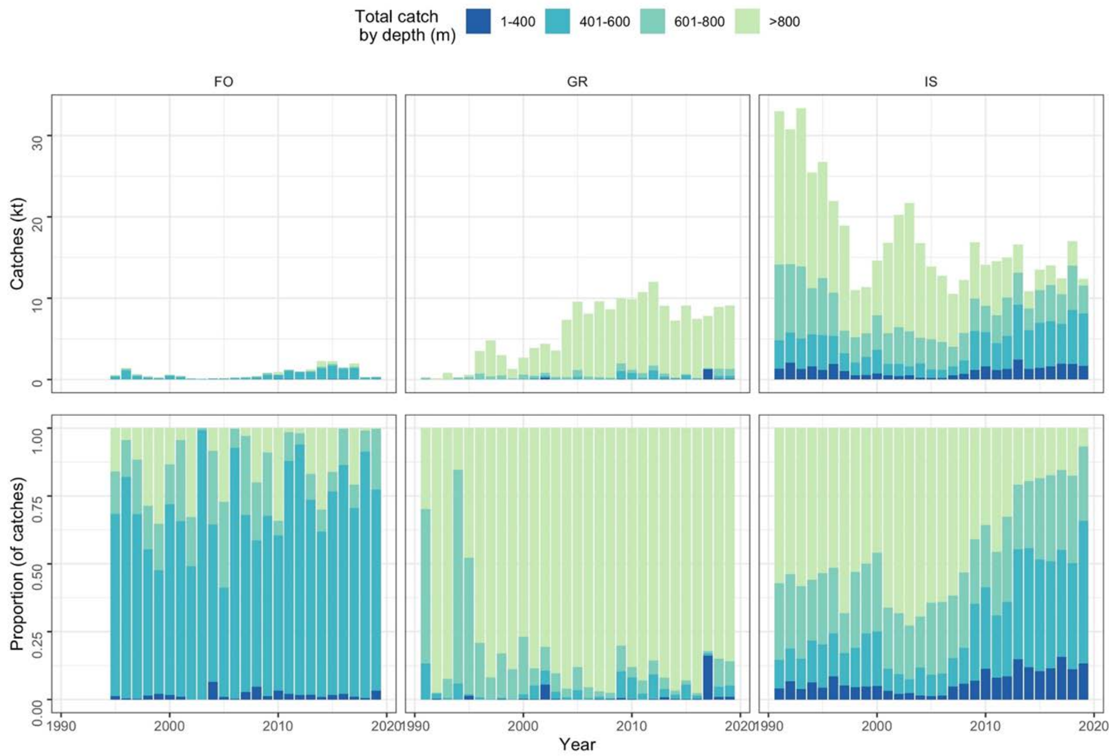


Fig 17.2.6. Greenland halibut 5+14. Depth distribution by EEZ from 1990 to 2019.

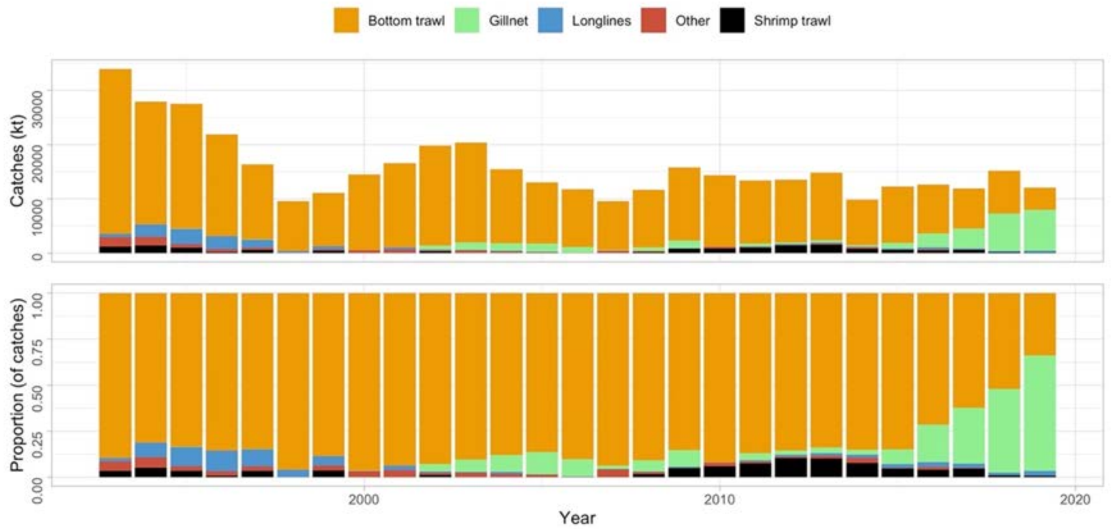


Fig. 17.2.7. Greenland halibut 5+14. Division of landings by gear in 5a.

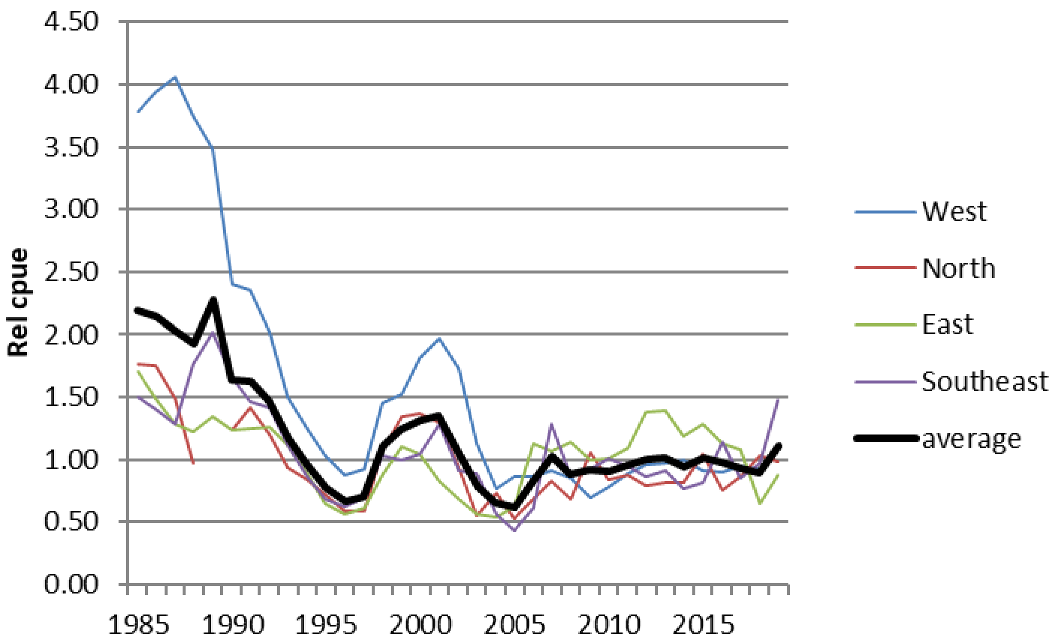


Fig. 17.3.1. Standardised CPUEs from the Icelandic trawler fleet in 5a. Area 1-4 are west, north, east and south-east, respectively. The average index of the four areas is used as biomass indicator in the stock production model.

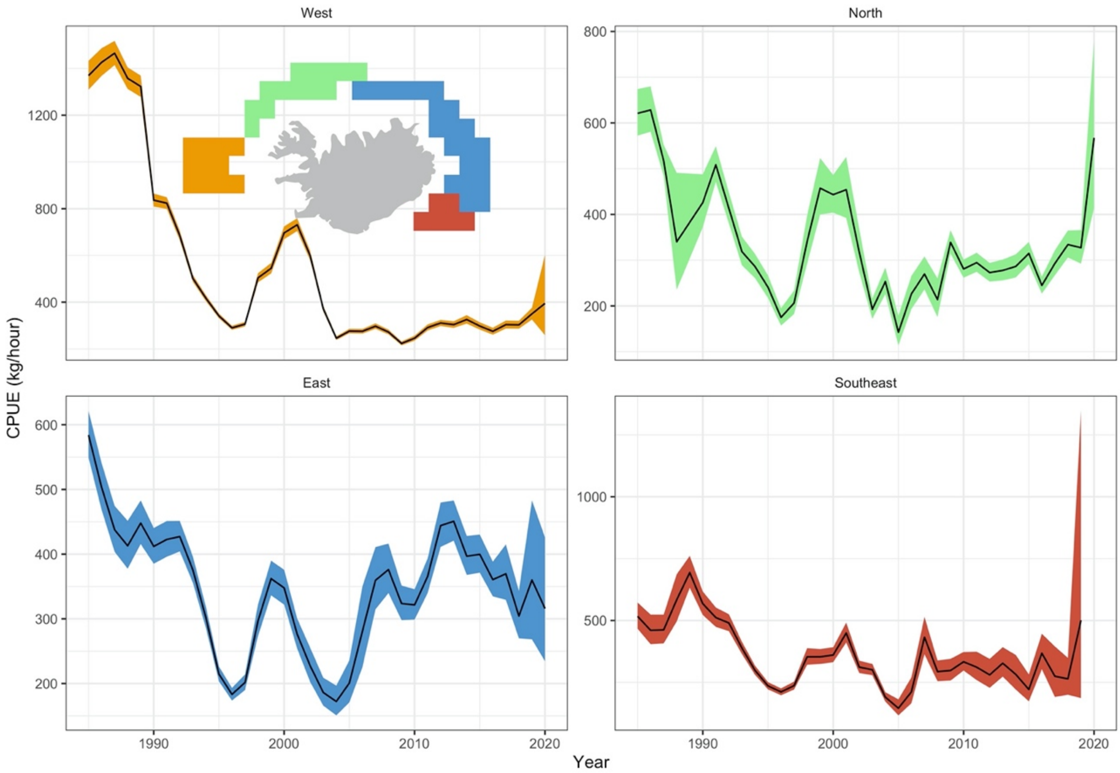


Fig. 17.3.2 Standardised CPUE from the Icelandic trawler fleet in Div 5a by four main fishing areas in 5a. 95% CI indicated. Areas 1-4 are West, North, East and South-east of Iceland, respectively.

Figure 17. 3.3. Standardised CPUE from the Faroese trawler fleet. 95% CI indicated

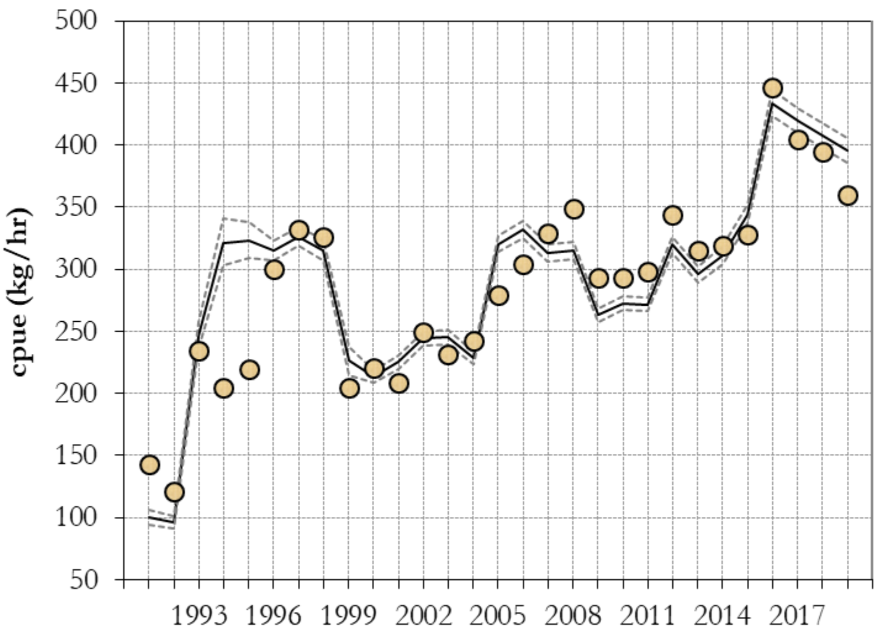


Fig. 17.3.4. Standardised CPUE from trawler fleets in 14b. 95% CI and observed CPUE (avg) indicated.

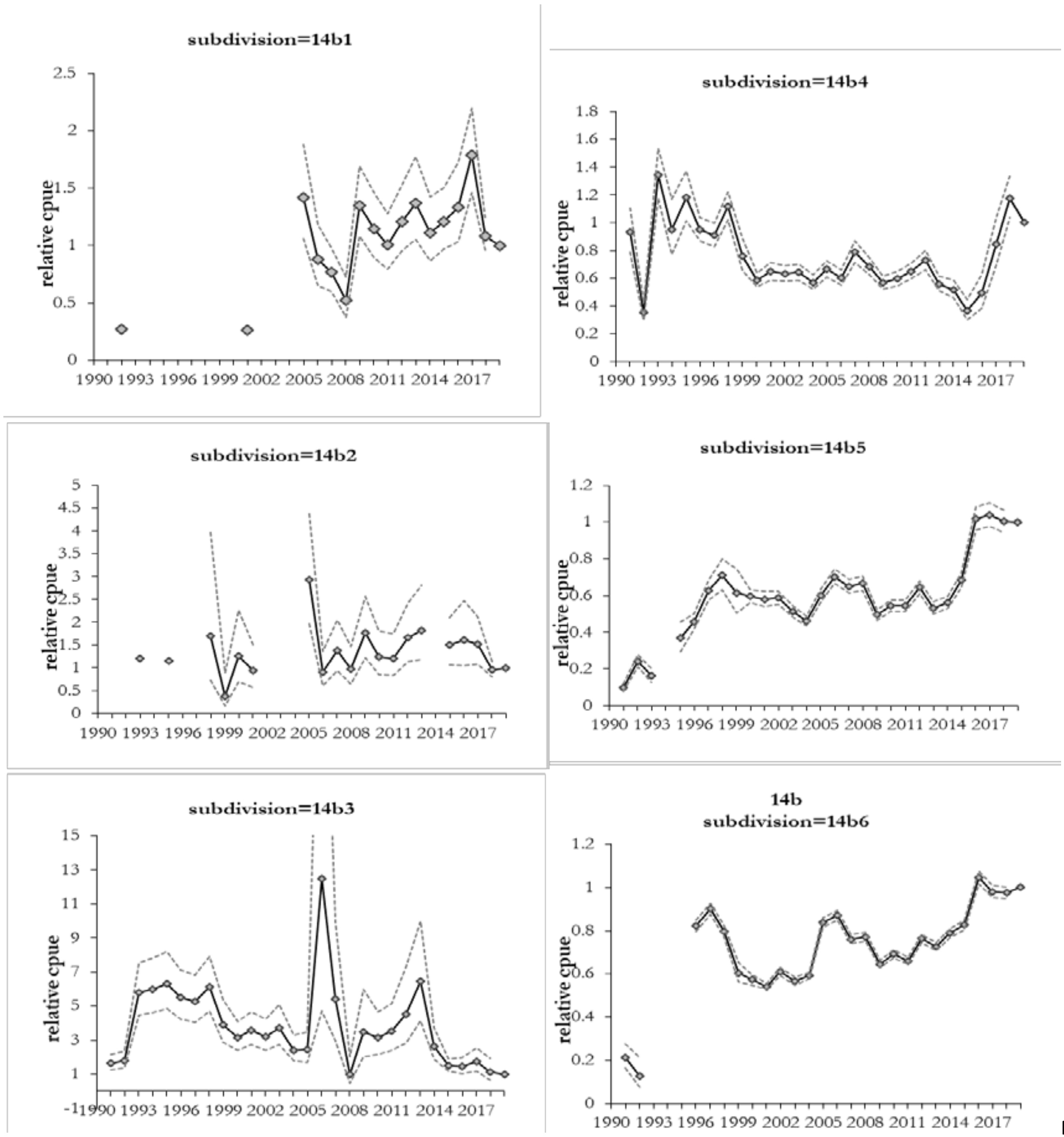


Fig. 17.3.5. Standardised CPUE from trawler fleets in 14b shown by subdivisions in a north-south direction. 95% CI indicated.

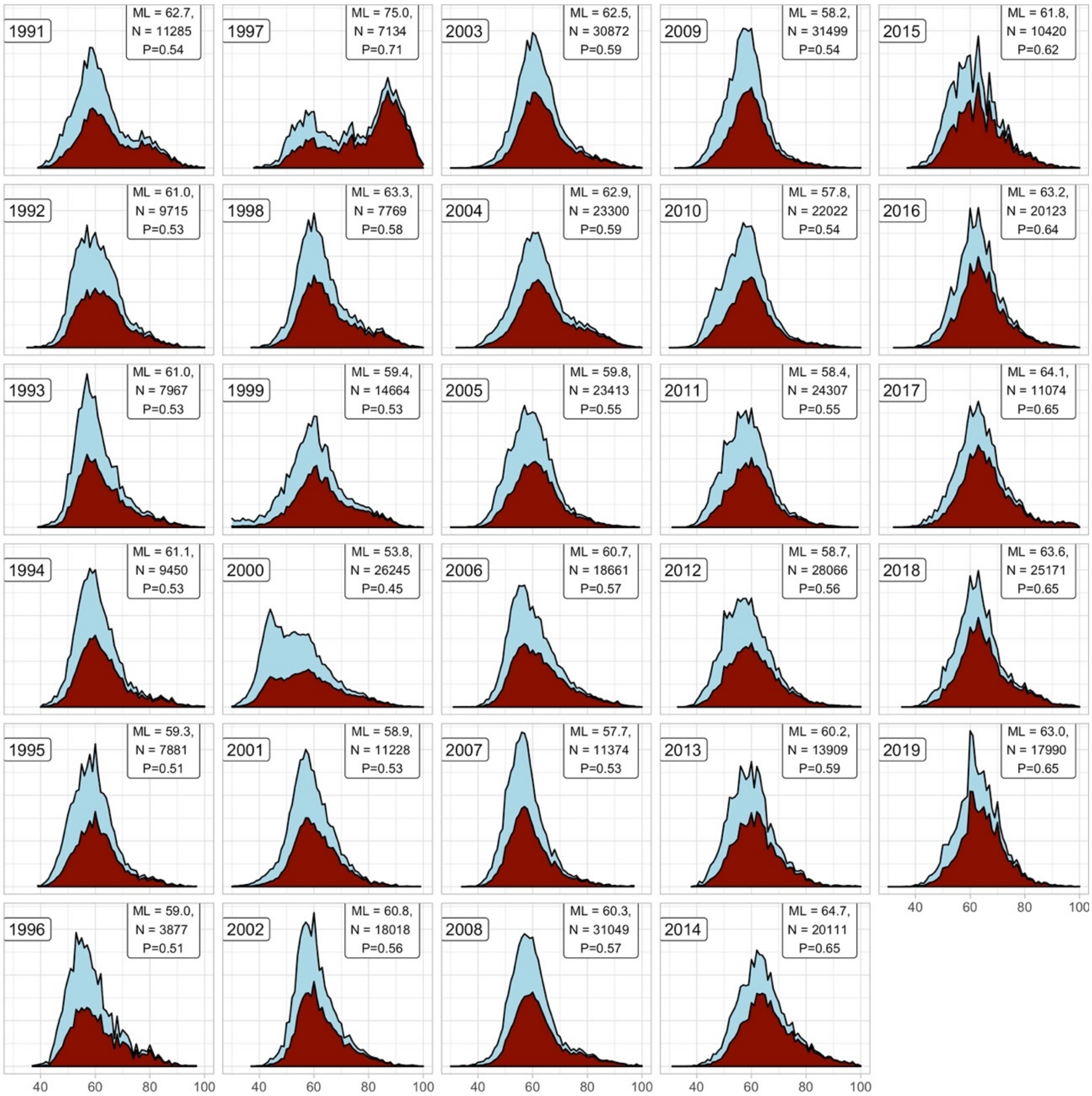


Fig. 17.3.1. Length distributions from the commercial trawl fishery in the western fishing grounds of Iceland (5a) in the years 2002-2019. Blue indicate males and red indicates females.

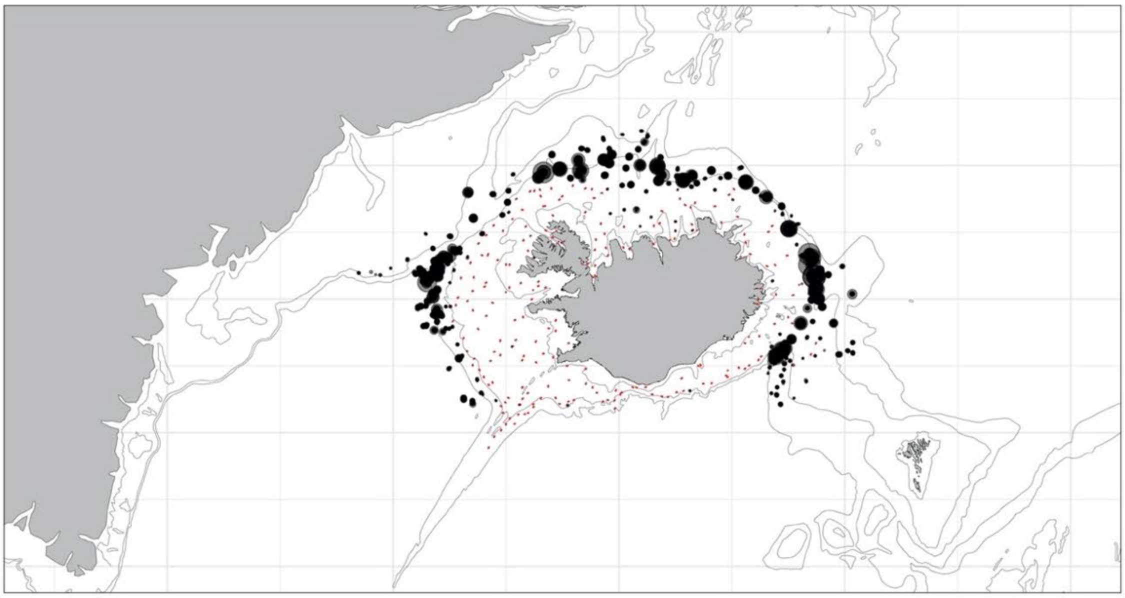


Fig. 17.4.1. Stations covered by scientific surveys in SA 5 and 14 in 2020 by Iceland (n=203). Red dots indicate tows, black circles positions where Greenland halibut was observed. Greenland survey has not been conducted since 2016.

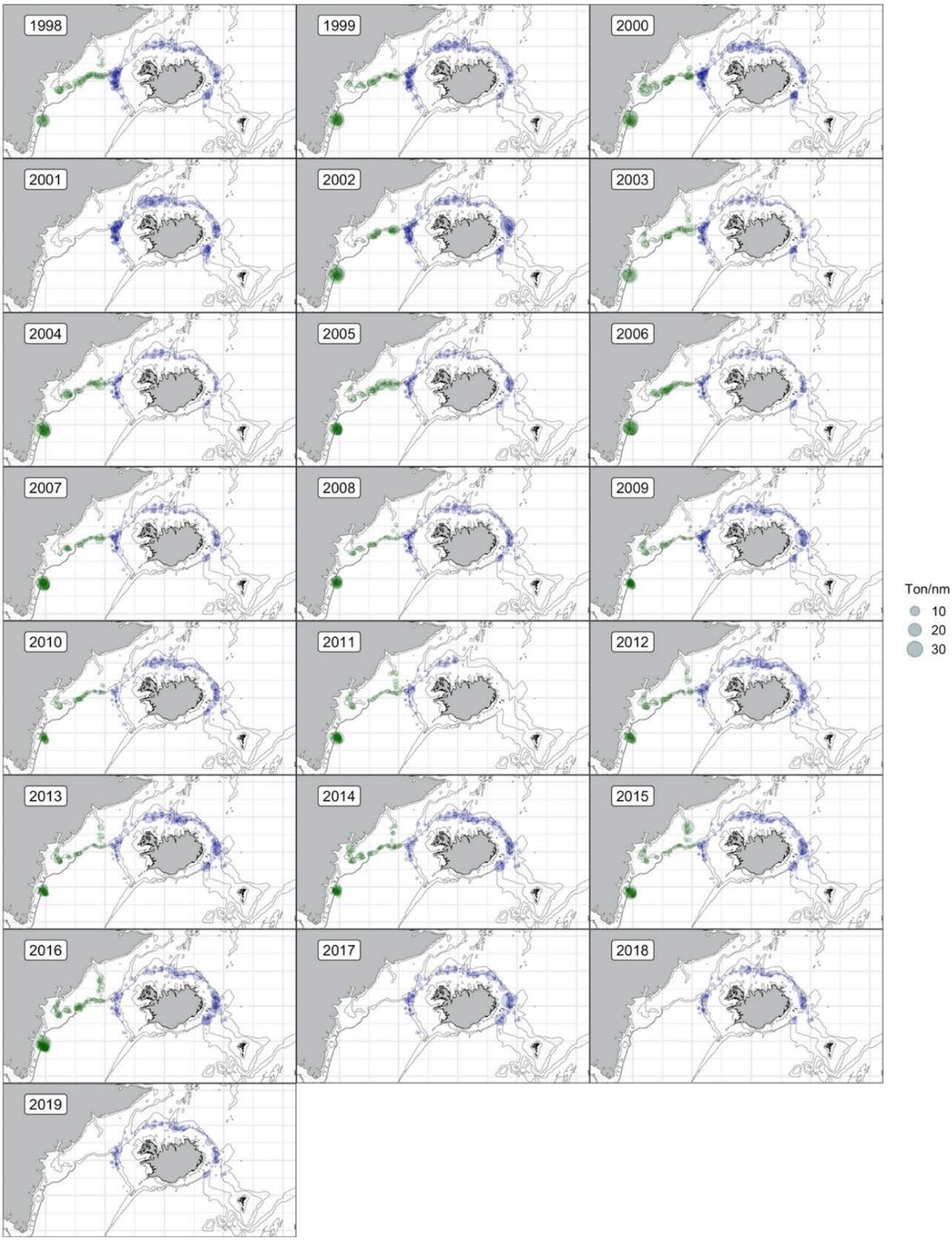


Fig. 17.4.2. Distribution of Greenland halibut catch rates from the combined Greenland-Icelandic fall survey since 1996.

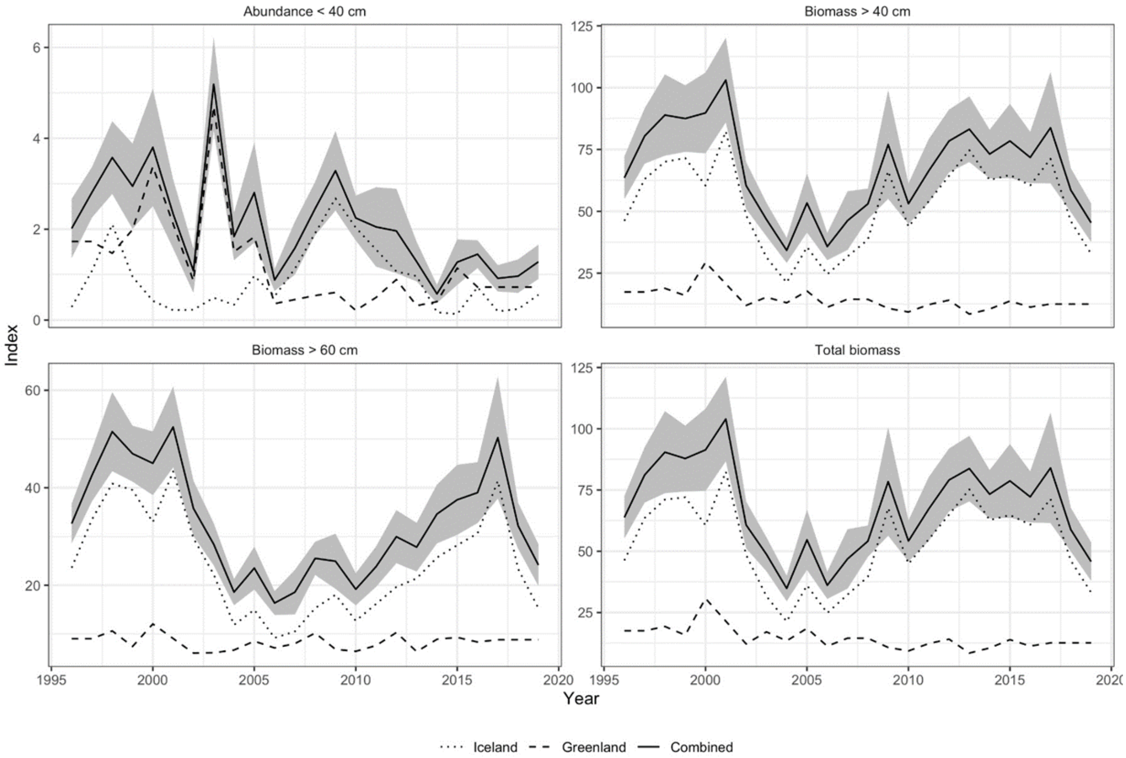


Fig. 17.4.3. Index of Greenland halibut in the Iceland, Greenland and the combined survey. No Iceland survey was conducted in 2011.

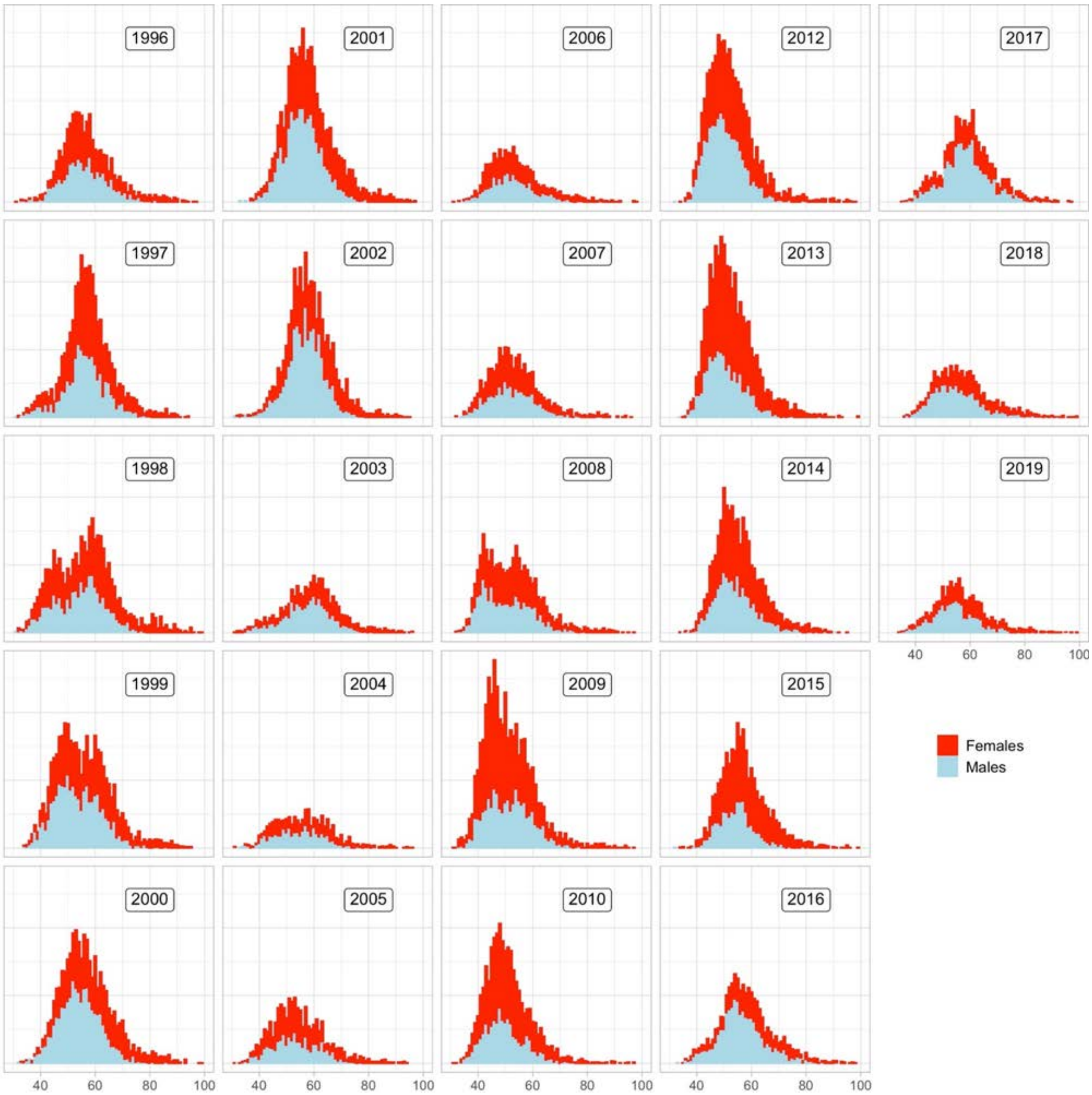


Fig. 17.4.4. Abundance indices by length for the Icelandic fall survey 1996-2019. No survey was conducted in 2011.

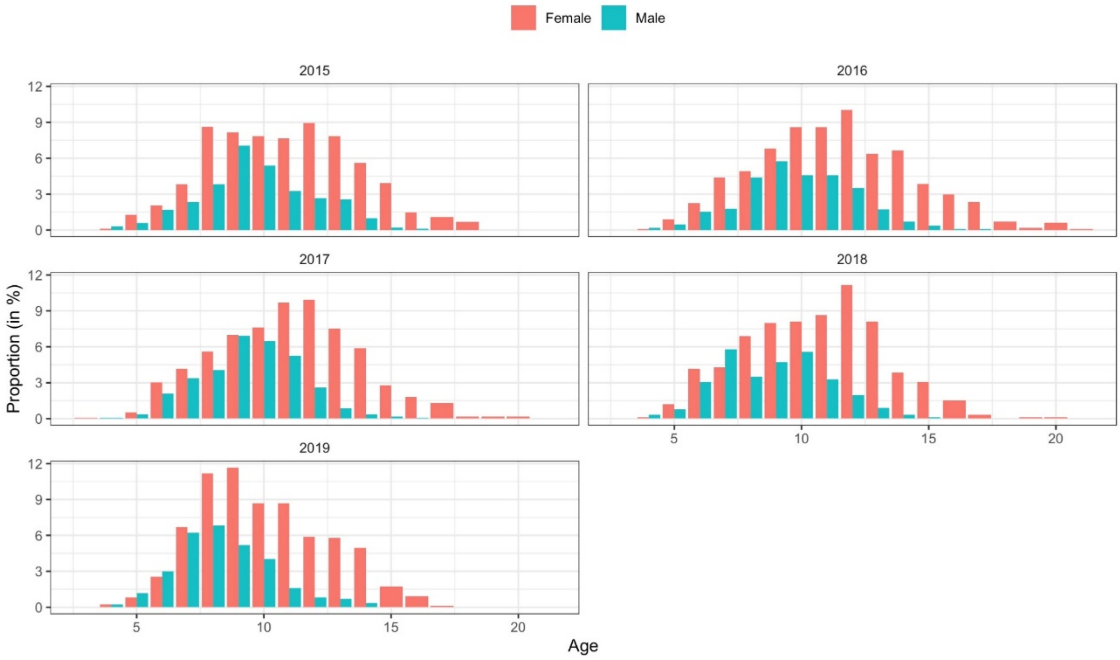


Figure 17.4.5. Age/sex distribution from Icelandic fall survey 2015-2019.

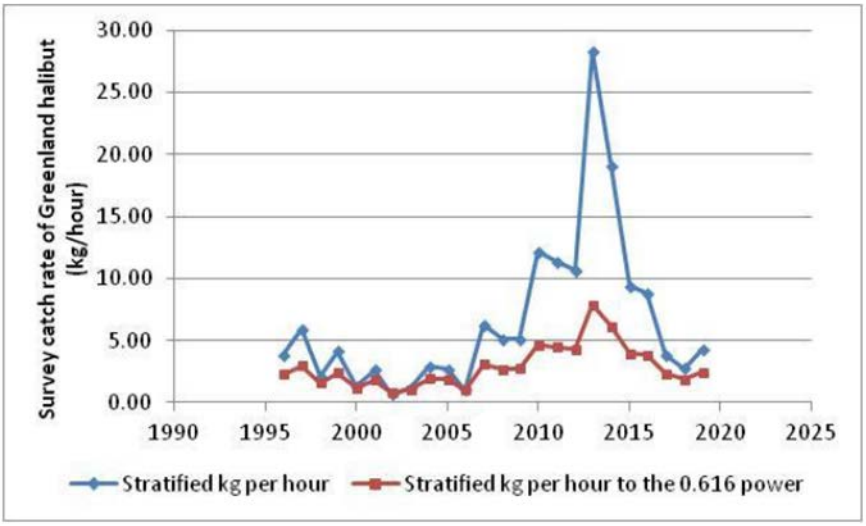


Figure 17.4.6.. Catch rates from a combined survey/fisherman's survey in 5b. Estimates are from a GLM model.

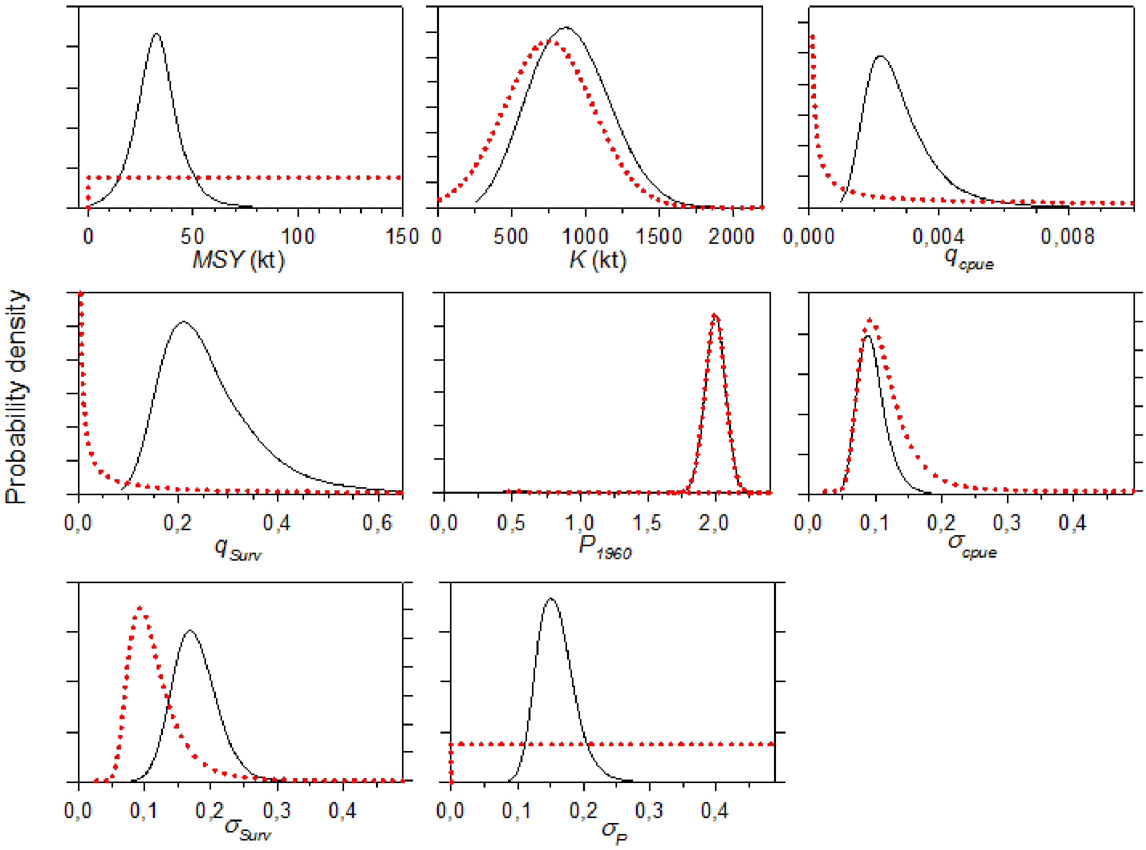


Figure 17.5.1. Probability density distributions of model parameters: estimated posterior (solid line) and prior (broken line) distributions.

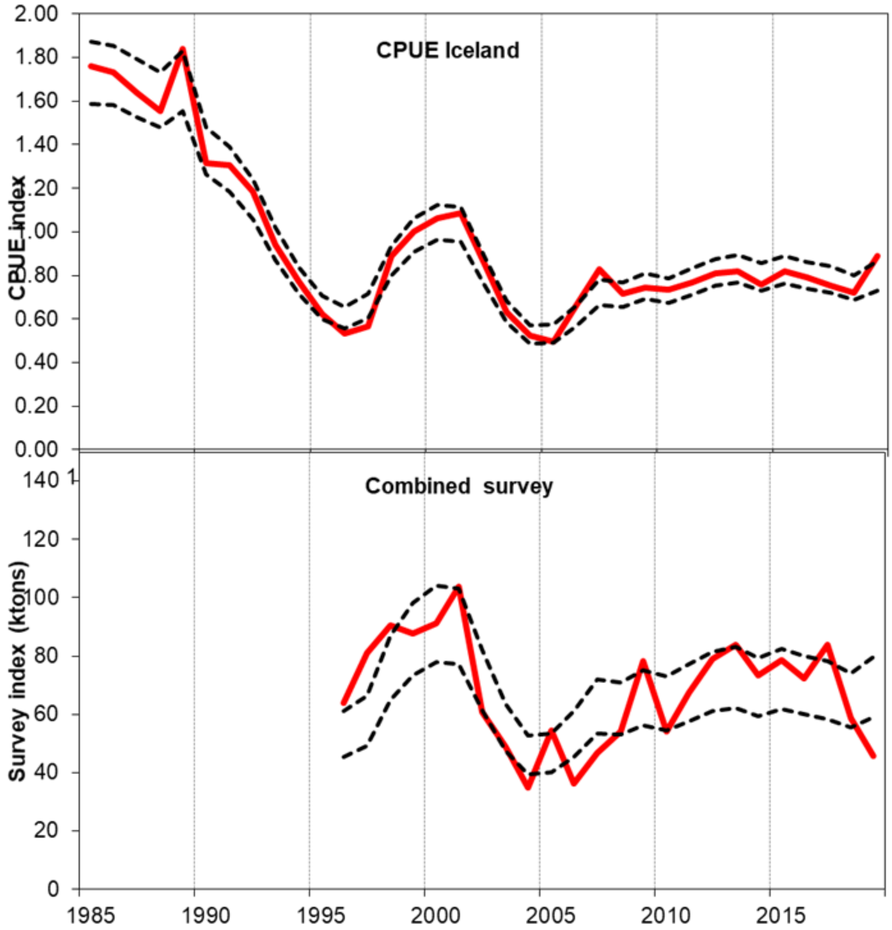


Figure 17.5.2. Observed (red curve) and predicted (dashed lines) series of the two biomass indices input to the model. Dashed lines are inter-quartile range of the model estimates.

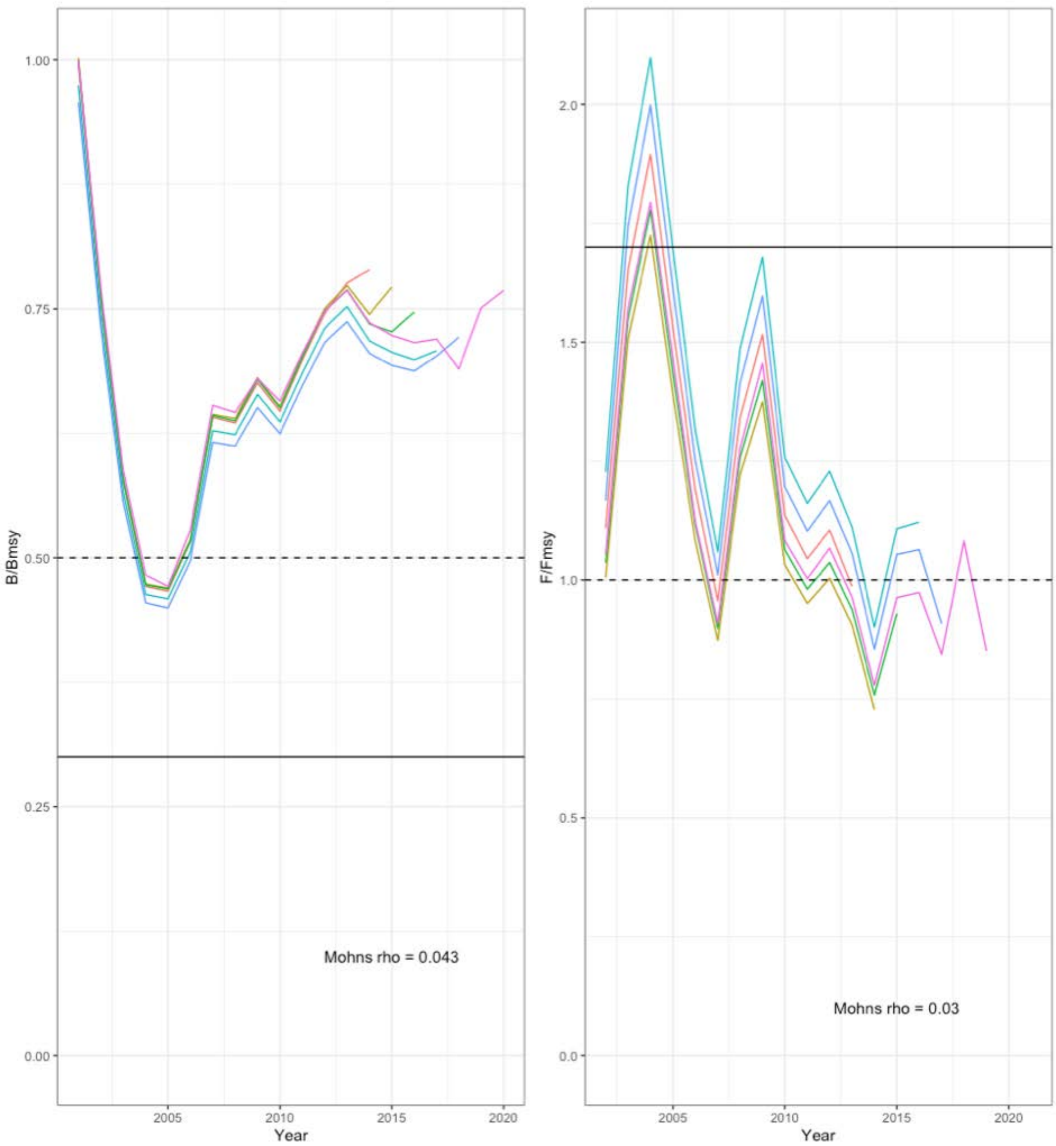


Figure 17.5.3. Retrospective analyses of medians of relative biomass (*B*/*B*$_{msy}$) and fishing mortality (*F/Fmsy*)

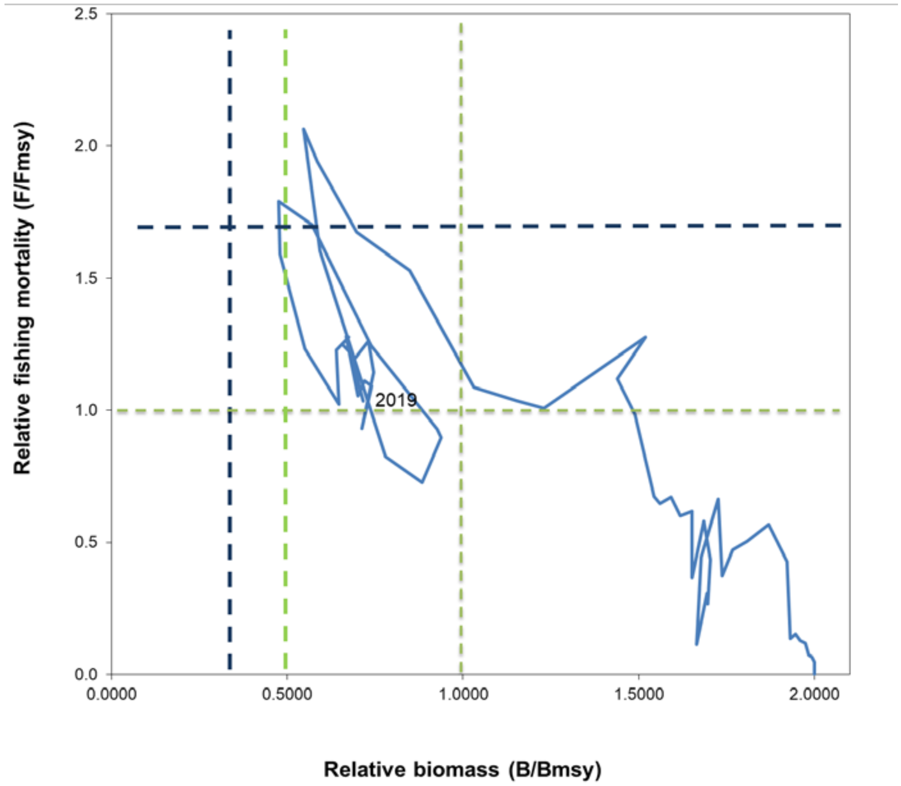
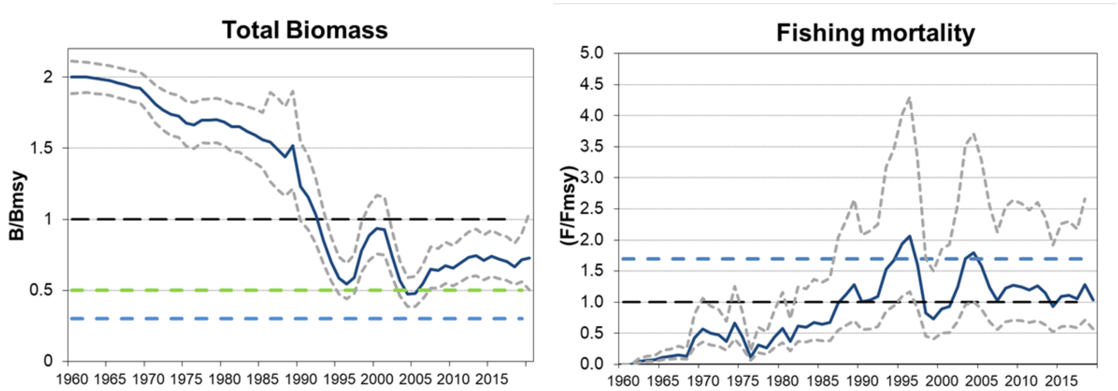


Figure 17.5.4. Stock trajectory 1960-2019. Estimated annual median biomass-ratio (B/BMSY) and fishing mortality-ratio (F/FMSY). B_{lim}, MSY $B_{trigger}$ and F_{lim} are indicated.



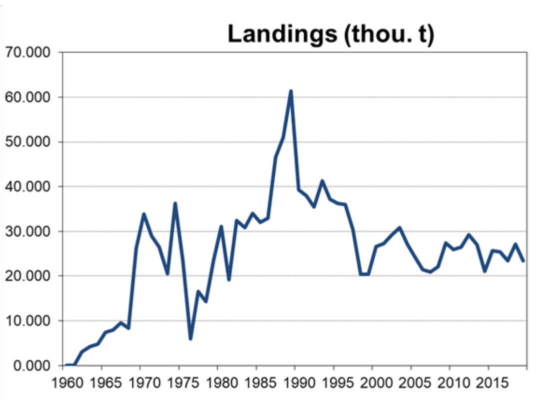


Figure 17.5.5. Stock summary, upper panel right: fishing mortality (F/Fmsy) and 95% conf limits, left: total biomass (B/Bmsy) and 95% conf limits and lower panel is landings since start of the fishery. MSY $B_{trigger}$ (green dashed line), B_{lim} and F_{lim} (blue dashed lines) are indicated.

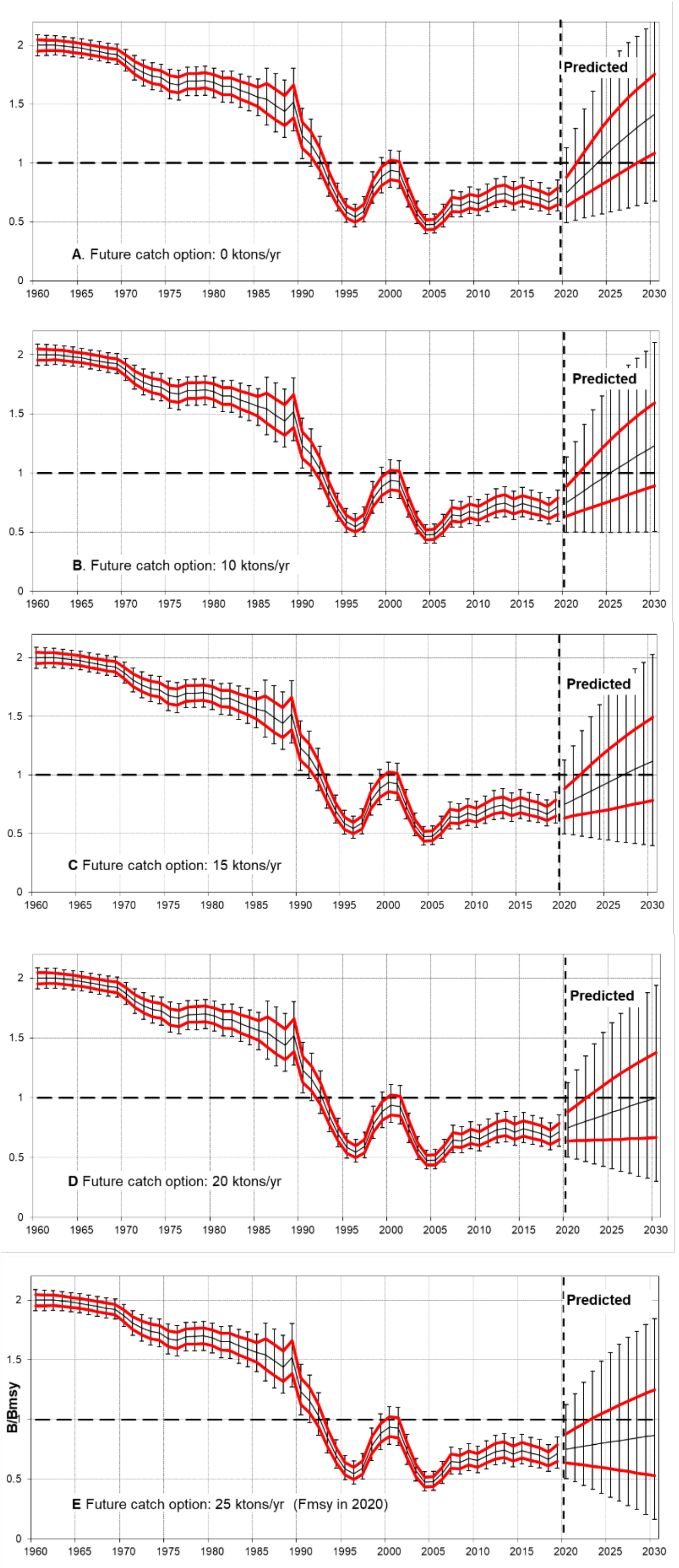


Fig. 17.5.6 Estimated time series of relative biomass (B_t/B_{msy}) under different catch option scenarios: 0, 10, 15, 20 and 25 kt catch from upper to lower panel. Bold red lines are inter-quartile ranges and the solid black line is the median; the error bars extend to cover the central 90 per cent of the distribution.

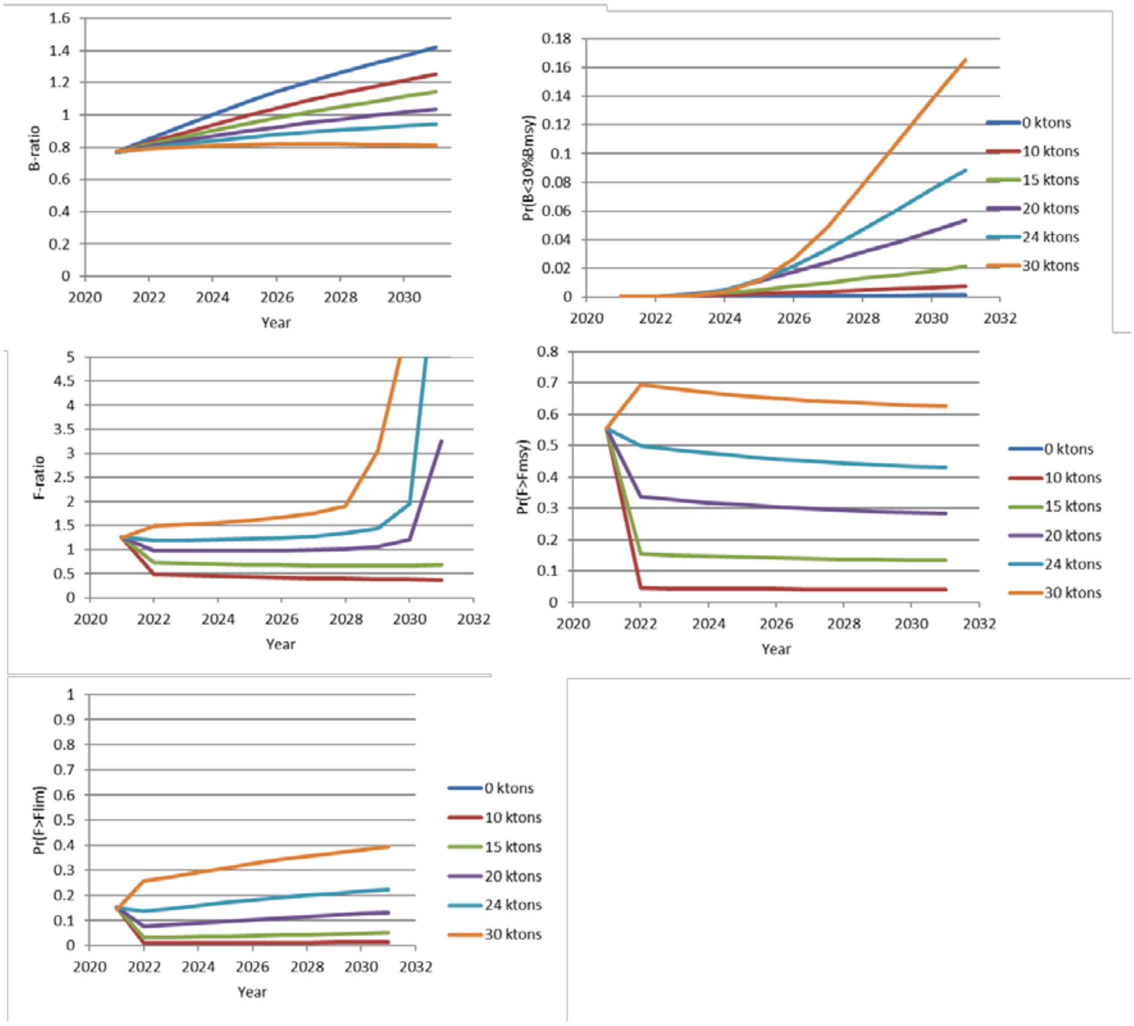


Figure 17.5.7. Projections: Medians of estimated posterior biomass- and fishing mortality ratios; estimated risk of exceeding F_{msy} or going below and $B_{MSYtrigger}$ given catch ranges at 0 -30 ktons.

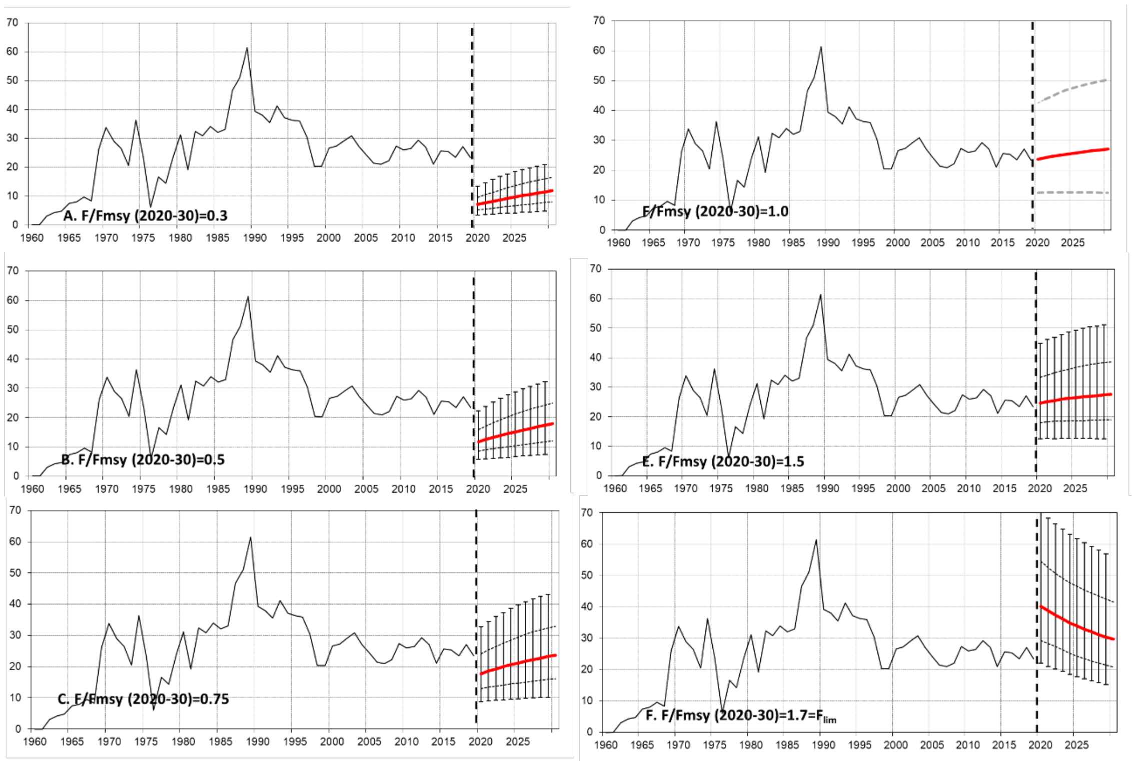


Figure 17.5.8. Historic landings and projected landings 2020-2030 under various F ratio options from 0.3-1.7 F/Fmsy Solid red line is median, quartiles and 90% conf limit indicated.

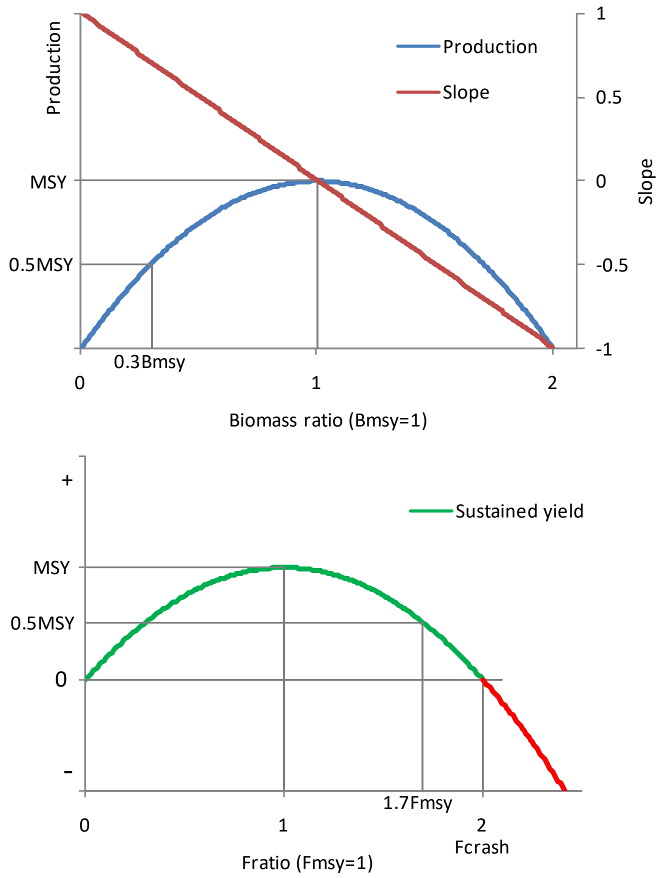


Figure 17.5.9. The logistic production curve in relation to stock biomass (B/Bmsy) (*upper*) and fishing mortality (F/Fmsy) (*lower*). *Upper*: points of maximum sustainable yield (MSY) and corresponding stock size are shown as well as the slope (red line) of the production curve (blue line); *lower*: points of MSY and corresponding fishing mortality and Fcrash (F≥Fcrash do not have stable equilibriums and will drive the stock to zero).

18 Redfish in subareas 5, 6, 12 and 14

This chapter deals with fisheries directed to *Sebastes* species in subareas 5, 6, 12 and 14 (sections 18.4 and 18.7), and the abundance and distribution of juveniles (Section 18.2.1), 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 5, 12, 14 >500 m) – primarily pelagic habitats, and including demersal habitats west of the Faeroe Islands;
- a 'Shallow Pelagic' stock (NAFO 1–2, ICES 5, 12, 14 <500 m) – extends to ICES 1 and 2, but primarily pelagic habitats, and includes demersal habitats east of the Faeroe Islands;
- an 'Icelandic Slope' stock (ICES 5.a, 14) – 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 WD22, WD23 and Annex 7). 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. Recent studies confirm the connectivity between *S. mentella* in East-Greenland and other areas (Saha *et al.*, 2016). Further studies are needed to understand e.g. the connection between the slope stocks in both East-Greenland, Iceland and the Faroe Islands.

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 recommended 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 (Figure 18.1.1):

- Management Unit in the northeast Irminger Sea: ICES subareas 5.a, 12, and 14.
- Management Unit in the southwest Irminger Sea: NAFO Areas 1 and 2, ICES subareas 5.b, 12 and 14.
- Management Unit on the Icelandic slope: ICES subareas 5.a and 14, 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 90%) 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 above mentioned reasons, the group now provides advice for the following *Sebastes* units:

- the *S. norvegicus* on the continental shelves of ICES divisions 5.a, 5.b and subareas 6 and 14 (Section 19);
- the demersal *S. mentella* on the Icelandic slope (Section 20);
- the shallow and deep pelagic *S. mentella* units in the Irminger Sea and adjacent waters (sections 21 and 22, respectively);
- the Greenland shelf *S. mentella* (Section 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 multi-stage 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 58°N, 40°W, 300 m, 34.89 and 4.4°C, 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 (>4.5°C 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. norvegicus* 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. norvegicus* 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. norvegicus* off East Greenland. The nursery areas for *S. norvegicus* 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, 1973–1974, 1985–1991, and in 1995.

There are very few juvenile demersal *S. mentella* in Icelandic waters (see Section 20), 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). The 1999–2006 survey results indicate low abundance and were similar to those observed in the late 1980s. Since 2008, the survey index has been very low and was in 2013–2016 the 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. 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 is given in Section 2, in Icelandic waters in Section 7 and Greenland waters in Section 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.

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; ICES, 2007). 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 (ICES, 2009b).

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, 2013a).

18.4 Description of fisheries

There are three species of commercially exploited redfish in ICES subareas 5, 6, 12, and 14: *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 2600 t, the MRI (now MFRI) advised on a 1500 t TAC for the 2012–2013 fishing year. Annual catches 2012–2015 were about 500 t but have since then decreased and were 117 t in 2018.

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/Icelandic slope *S. mentella*" 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 Icelandic slope *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 a 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 Icelandic slope *S. mentella* fisheries with different gears are presented here, as done previously (see below). Quantitative information on the fractions of the pelagic catches of Icelandic slope *S. mentella* is given in chapter 20. The proportion of the total Icelandic slope *S. mentella* catches taken by pelagic trawls has ranged since 1991 between 0% and 44% (Table 20.3.2), and is on average 15%. With exception of 2007, no Icelandic slope *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 Icelandic slope *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 Icelandic slope *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 Icelandic slope *S. mentella* were mainly taken in the first quarter of the year and during autumn/winter. The length distributions of the Icelandic slope *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. The length distribution also shows that the fish caught in north-east area since 2011 is smaller than during the period 1998–2010 and have now a size similar to that registered in the beginning of the fishery.

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, 2009a; ICES, 2013b; Makhrov *et al*., 2011; Zelenina *et al*., 2011; see also Annex 7 in NWWG 2019 report). 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.

The Russian fishery in 2019 is described in WD09. In 2019 the fishery was conducted from April to September in ICES Subareas 12 and 14 and NAFO Division 1F (Tables 21.2.1, 21.2.2, 22.2.1 and 22.2.2).

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 2019:

Country	Area	No. of samples	No. of fish measured
Russia	14	1100	40 539
Russia	12	200	15 267
Russia	NAFO 1F	55	11 981
Iceland	14 (deep)		

18.7 Demersal *S. mentella* in 5b and 6

18.7.1 Demersal *S. mentella* in 5b

18.7.1.1 Surveys

The Faroese spring and summer surveys in Division 5.b 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 5.b, landings gradually decreased from 15 000 t in 1986 to about 5000 t in 2001 (Table 18.6.1). Between 2002 and 2011 annual landings varied between 1100 and 4000 t. In 2012 landings decreased drastically from 1126 t in 2011 to 263 t but has since then increased and were 646 t in 2019.

Length distributions from the landings in 2001–2018 indicate that the fish caught in 5.b in 2018 are between 35–50 cm and the mode of the distribution is around 42 cm (Figure 18.7.1).

Non-standardized CPUE indices in Division 5.b 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 5b. CPUE decreased from 500 kg/hour in 1991 to 300 kg/hour in 1993 and remained at that level until 2013, when it reached a historical low (Figure 18.7.2). The CPUE has since remained at that level. Data for 2018 was not available.

Fishing effort has decreased since the beginning of the time series and has remained very low since 2008.

18.7.2 Demersal *S. mentella* in 6

18.7.2.1 Fisheries

In Subarea 6, the annual landings varied between 200 t and 1100 t in 1978–2000 (Table 18.6.1). The landings from 6 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 have been 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 19.14 for *S. norvegicus*, Section 20.7 for Icelandic slope *S. mentella*, Section 21.10 for shallow pelagic *S. mentella*, Section 22.10 for deep pelagic *S. mentella*, and Section 23 for Greenland slope *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 18.4).

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*. Detailed descriptions of the fisheries are given in the respective sections: *S. norvegicus* in Section 19.3, Icelandic slope *S. mentella* in Section 20.3, shallow pelagic *S. mentella* in Section 21.2, deep pelagic *S. mentella* in Section 22.2 and Greenland slope *S. mentella* in Section 23.3.

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 5.a, 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. norvegicus* and *S. mentella*.

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18.11 Tables

Table 18.4.1. Landings of *S. viviparus* in Division 5.a 1996–2018.

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
2015	468
2016	234
2017	161
2018	117
2019	143

Table 18.6.1. Nominal landings (tonnes) of demersal *S. mentella* 1978–2019 in ICES divisions 5.b and 6.

Year	5.b	6
1978	7767	18
1979	7869	819
1980	5119	1109
1981	4607	1008
1982	7631	626
1983	5990	396
1984	7704	609
1985	10560	247
1986	15176	242
1987	11395	478
1988	10488	590
1989	10928	424
1990	9330	348
1991	12897	273
1992	12533	134
1993	7801	346
1994	6899	642
1995	5670	536
1996	5337	1048
1997	4558	419
1998	4089	298
1999	5294	243
2000	4841	885
2001	4696	36
2002	2552	20
2003	2114	197
2004	3931	6
2005	1593	111

2006	3421	179
2007	1376	1
2008	750	50
2009	1077	0
2010	1202	0
2011	1126	0
2012	263	0
2013	398	0
2014	370	0
2015	537	0
2016	717	0
2017	372	0
2018	521	0
2019[1)]	646	0

[1)] **Provisional**

18.12 Figures

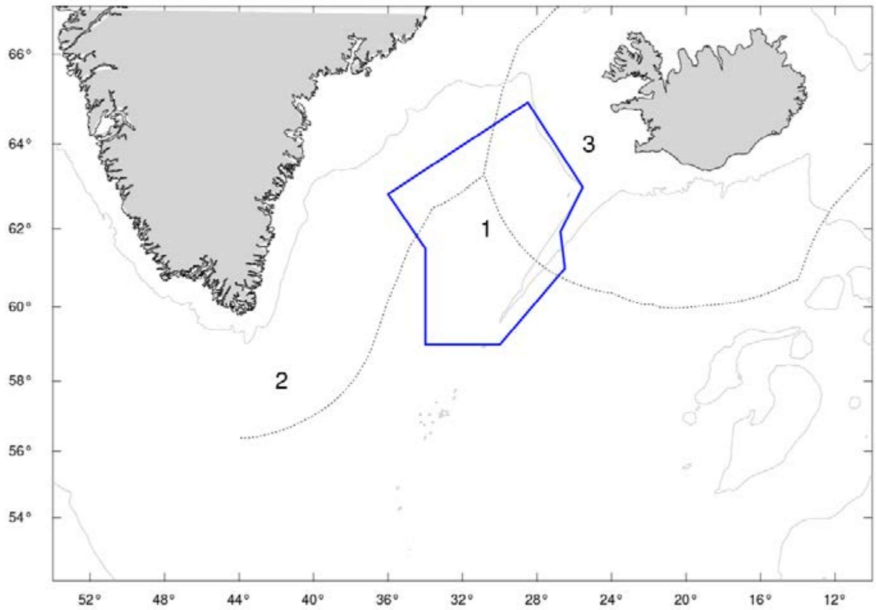


Figure 18.1.1 Potential management unit boundaries. The polygon bounded by blue lines, i.e. 1, indicates the region for the 'deep pelagic' management unit in the northwest Irminger Sea, 2 is the "shallow pelagic" management unit in the southwest Irminger Sea, and 3 is the Icelandic slope management unit.

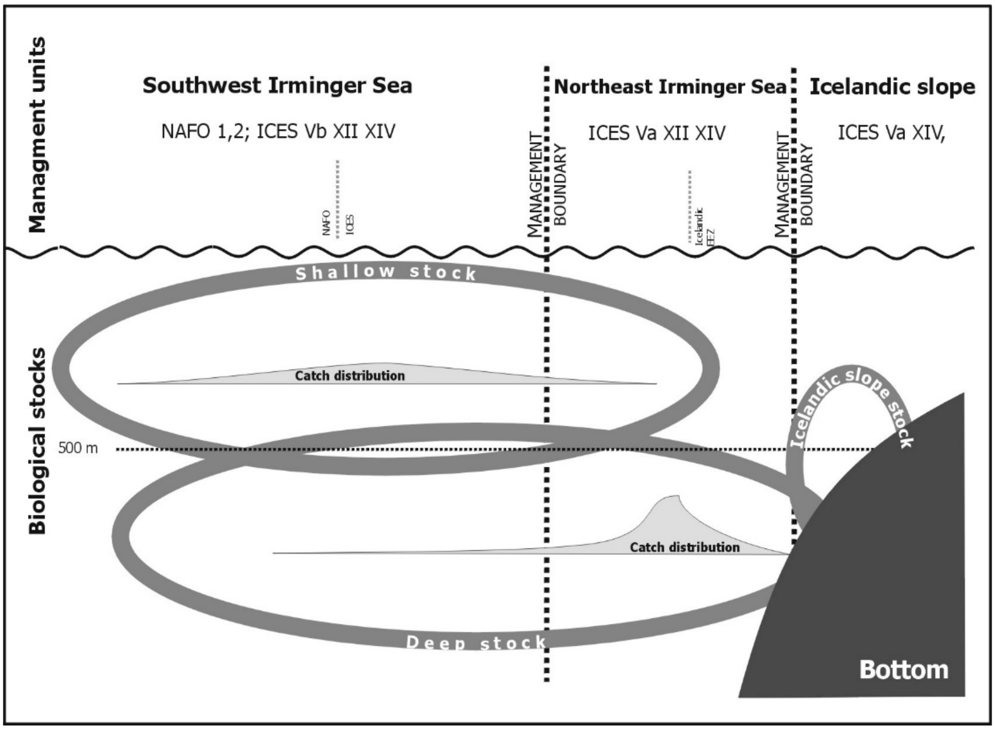


Figure 18.1.2 Schematic representation of biological stocks and potential management units of *S. mentella* in the Irminger Sea and adjacent waters. The management units are shown in Figure 18.1.1. Included is a schematic representation of the geographical catch distribution in recent years. Note that 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.

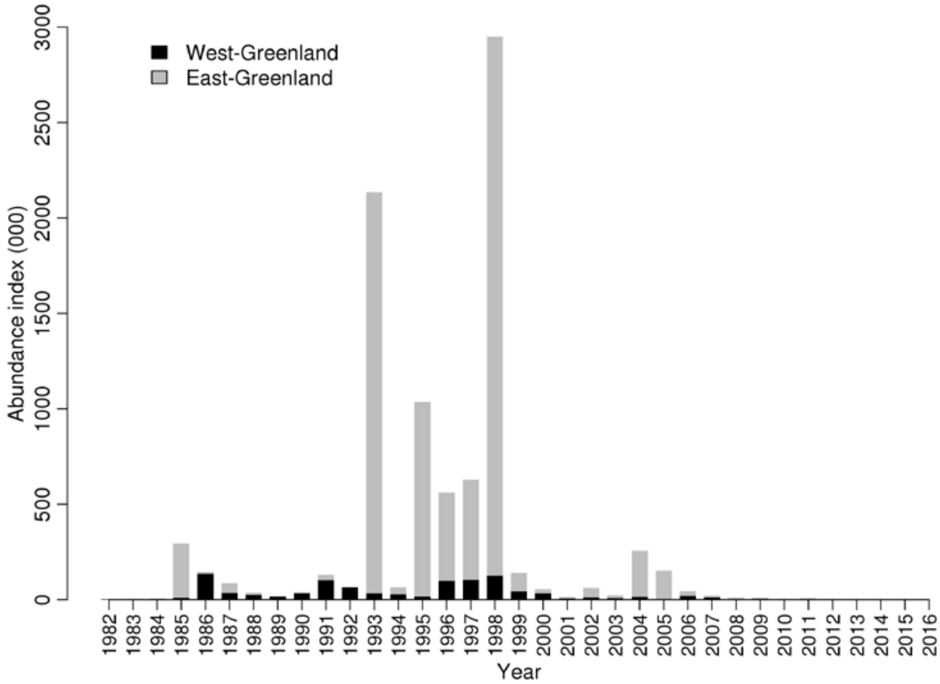


Figure 18.2.1 Survey abundance indices of *Sebastes spp.* (<17 cm) for East and West Greenland from the German ground-fish survey 1982–2016. No data were available in 2017-2019.

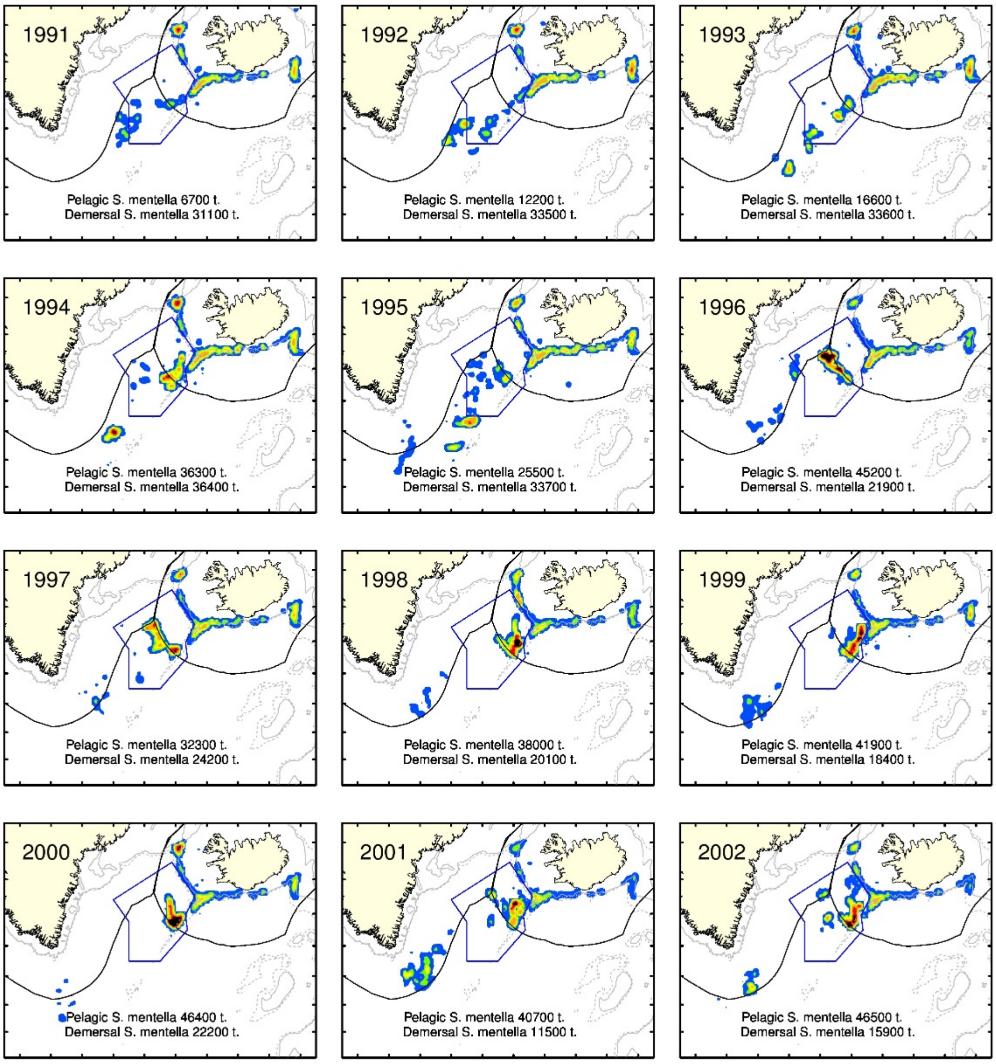


Figure 18.4.1Geographical distribution of the Icelandic catches of S. mentella 1991–2002. The color scale indicates catches (tonnes per NM2). Not updated for 2019.

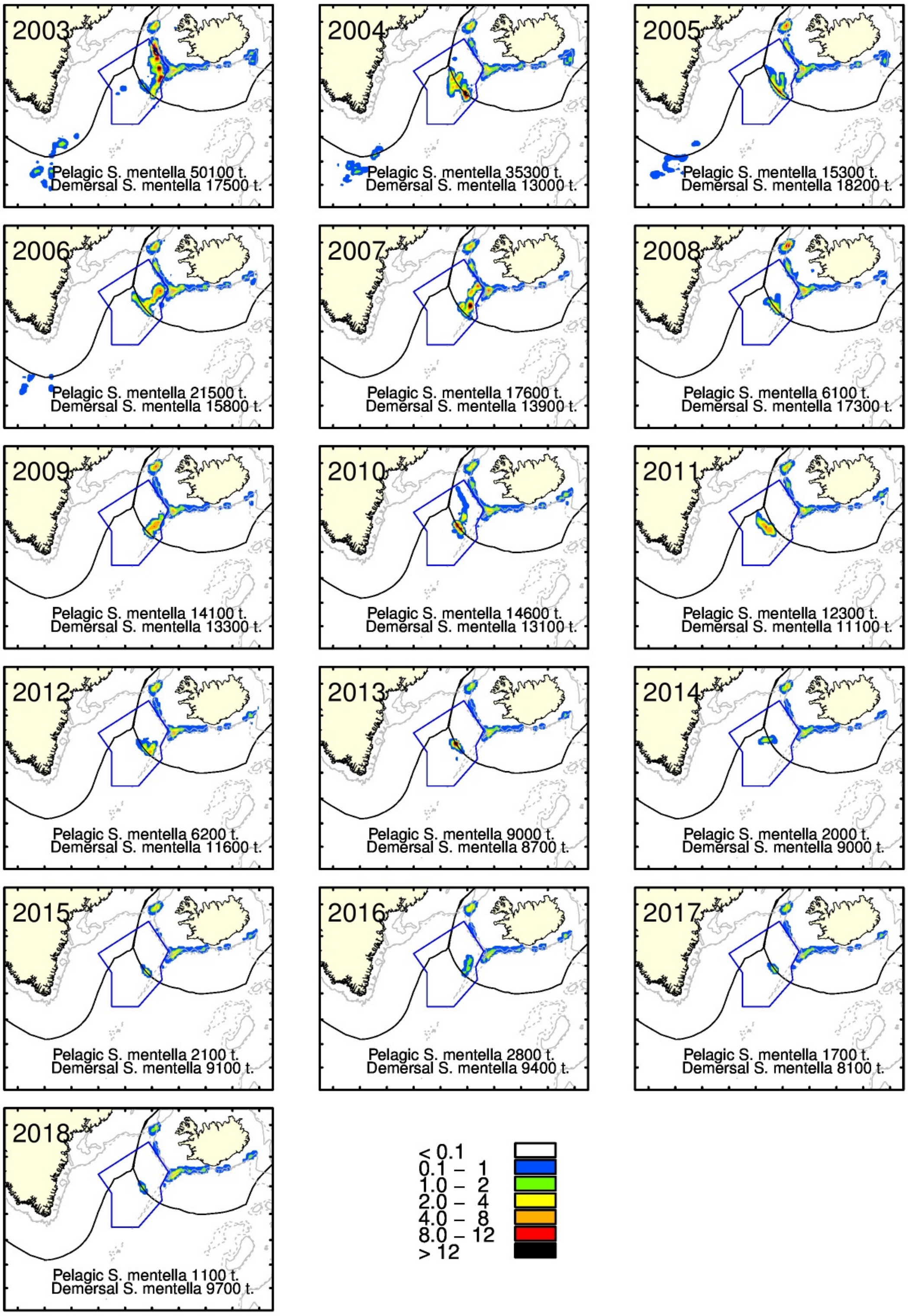


Figure 18.4.1 ***cont.*** **Geographical distribution of the Icelandic catches of** ***S. mentella*** **2003–2018. The colour scale indicates catches (tonnes per NM²). Not updated for 2019.**

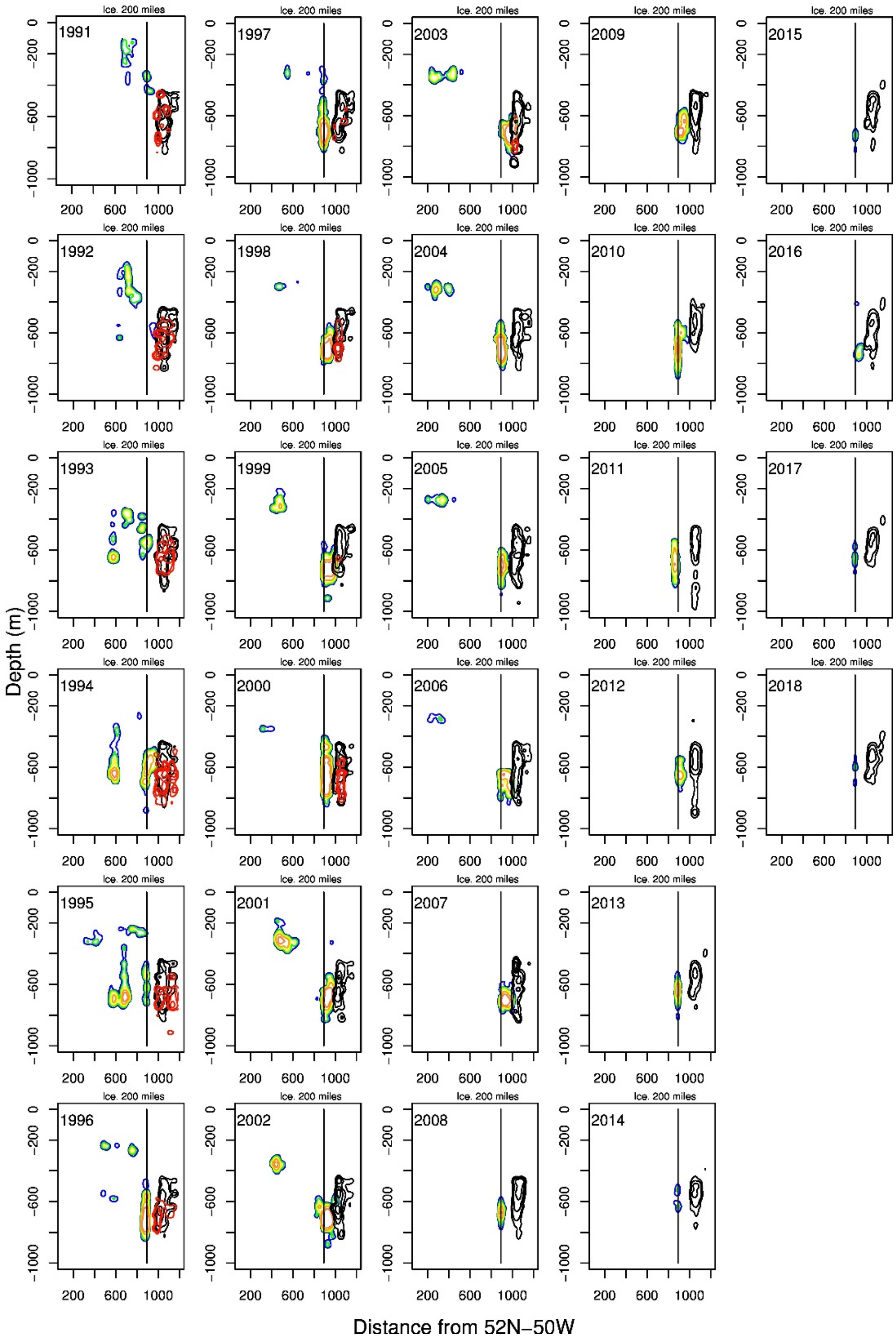


Figure 18.4.2 Distance-depth plot for Icelandic *S. mentella* catches, where distance (in NM) from a fixed position (52°N 50°W) is given. The contour lines indicate catches in a given area and distance. The coloured contours represent the fishery on pelagic *S. mentella*, the black contours indicate bottom trawl catches of demersal *S. mentella*, and the red contours represent catches of demersal *S. mentella* taken with pelagic trawls. Not updated for 2019.

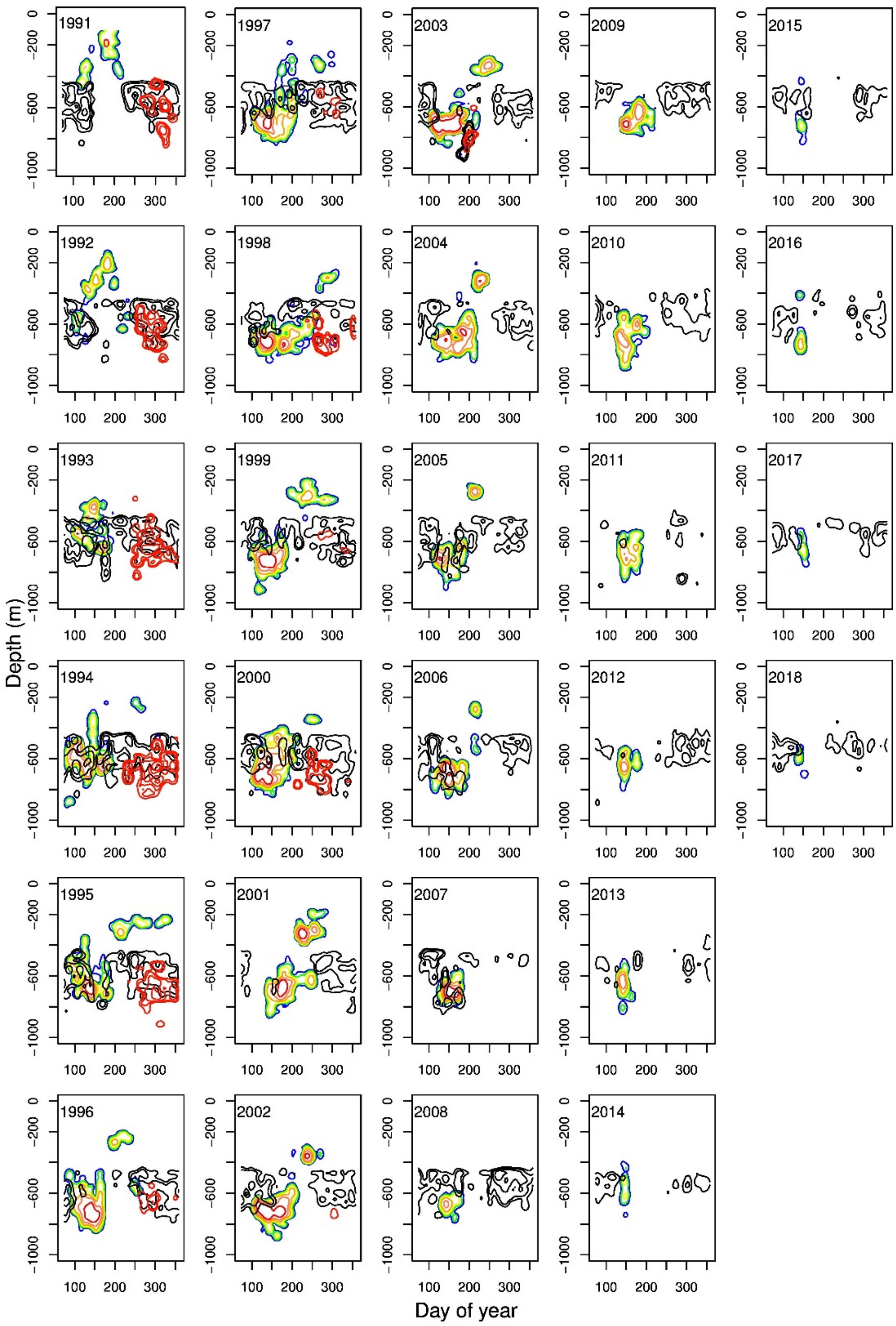


Figure 18.4.3 Depth-time plot for Icelandic *S. mentella* catches 1991–2016 where the y-axis is depth, the x-axis is day of the year and the colour indicates the catches. The coloured contours represent the fishery on pelagic *S. mentella*, the black contours indicate bottom trawl catches of demersal *S. mentella*, and the red contours represent catches of demersal *S. mentella* taken with pelagic trawls. Not updated for 2019.

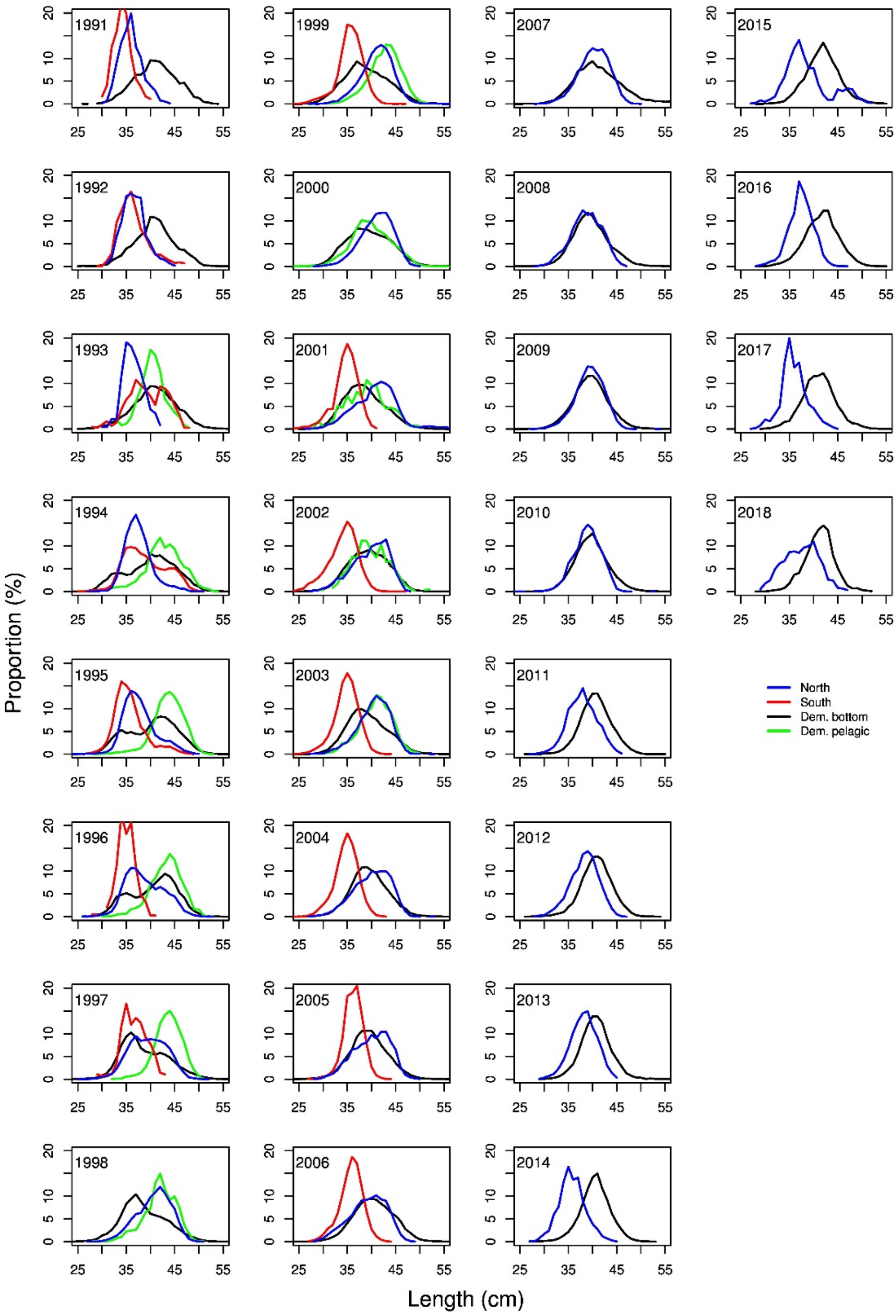


Figure 18.4.4 Length distributions from different Icelandic *S. mentella* fisheries, 1991–2018. The blue lines represent the fishery on pelagic *S. mentella* in the northeastern area, the red lines the pelagic fishery in the southwestern area, the black lines indicate bottom trawl catches of demersal *S. mentella*, and the green lines represent catches of demersal *S. mentella* taken with pelagic trawls. Not updated for 2019.

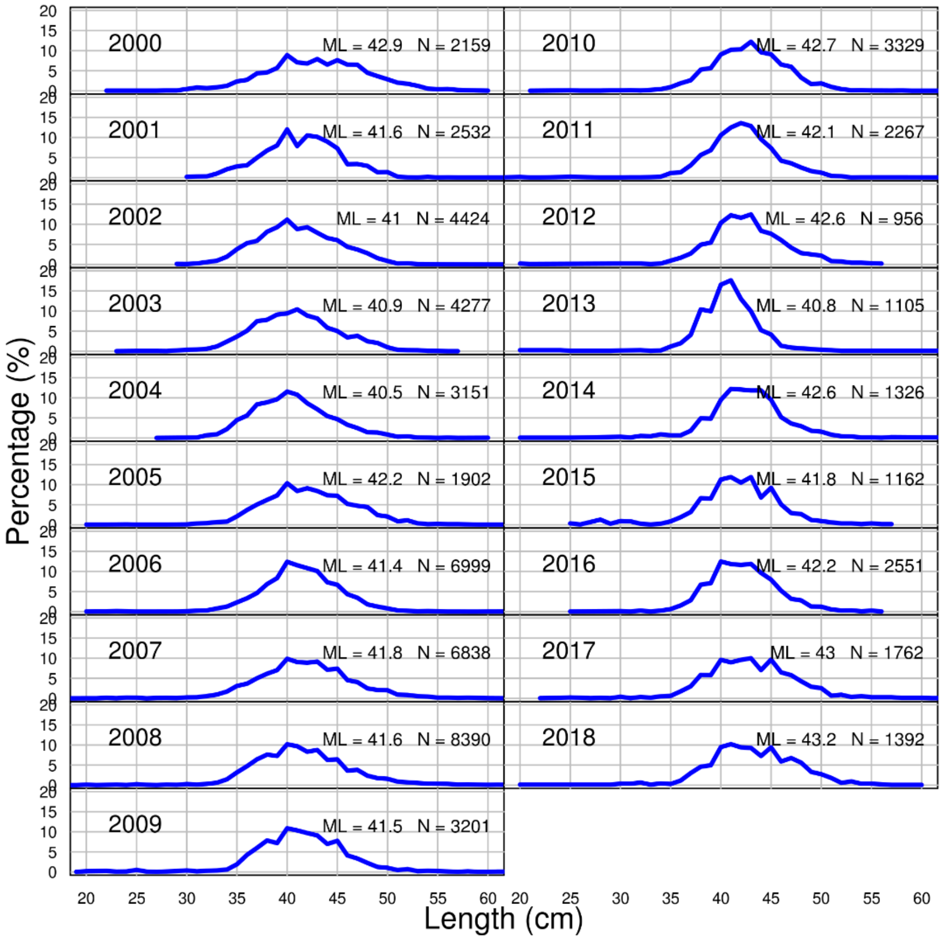


Figure 18.7.1 Length distribution of demersal *S. mentella* from landings of the Faeroese fleet in Division 5.b 2000–2018. Not updated for 2019.

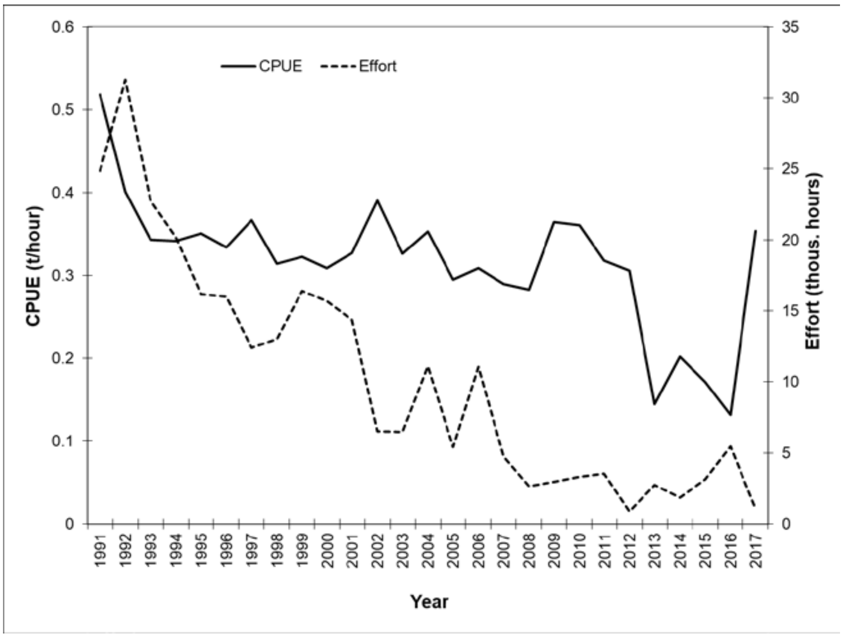


Figure 18.7.2 Demersal *S. mentella*, CPUE (t/hour) and fishing effort (in thousands hours) from the Faeroese CUBA fleet 1991–2017 and where 70% of the total catch was demersal *S. mentella*. Not updated for 2018 and 2019.

19 Golden redfish (*Sebastes norvegicus*) in subareas 5, 6 and 14

19.1 Stock description and management units

Golden redfish (*Sebastes norvegicus*) in ICES subareas 5 and 14 have been considered as one management unit. Catches in ICES Subarea 6 have traditionally been included in this report and the group continues to do so. Data from ICES Subarea 6 is, however, not used in the assessment.

19.2 Scientific data

This section describes results from various surveys conducted annually on the continental shelves and slopes of ICES subareas 5 and 14.

19.2.1 Division 5.a

Two bottom trawl surveys are conducted in Icelandic waters, the Icelandic spring groundfish survey (spring survey) and the Icelandic autumn groundfish survey (autumn survey). The spring survey has been conducted annually in March since 1985 and the autumn survey has been conducted annually in October since 1996. The autumn survey was not conducted in 2011. Description of the Icelandic bottom trawl surveys and the calculation of the survey indices for golden redfish in ICES 5.a. are given in the Stock Annex (smr-5614_SA). The calculation of the survey indices includes length dependent diel vertical migration of the species.

Two survey indices are calculated from these surveys but only the index from the spring survey is used in the assessment of golden redfish. Length disaggregated indices from the spring survey are used in the Gadget model. Age-length keys from the autumn survey in 2 cm length groups are used in the Gadget model.

The total biomass of golden redfish as observed in the spring survey decreased from 1988 to a record low in 1995 (Figure 19.2.1 and Table 19.2.1). From 2000 to 2016 the biomass increased, with some fluctuation, to the highest value in the time-series. Since then the index has decreased and was in 2019 and 2020 similar as in 2014 and 2105. The CV of the measurement error has been considerably higher after 2002.

The total biomass index from the autumn survey shows similar trend as in the spring survey, that is, has gradually increased from 2000 to 2014 when it was the highest in the time-series. The total biomass index has since then been fluctuating around the 2014 level (Figure 19.2.1 and Table 19.2.1).

Length disaggregated indices from the spring survey shows that the peaks in length 4–11 cm, which can be seen first in 1987 (the 1985 year class) and then in 1991–1992 (the 1990 year class), 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 these two strong year classes. During the 1999–2008 period the abundance of small redfish was lower than in 1986–1990, highest in 2000-2003 (Figure 91.2.1). Since 2009 very little of small redfish has been observed in the surveys (Figure 19.2.1). This has been confirmed by age readings (Figure 19.2.4 and Table 19.2.2). In recent years the modes of the length distribution in both surveys has shifted to the right and is narrower. The abundance of golden redfish smaller than 30 cm has decreased since 2006 in both surveys and is now at the lowest level in the time-series (Figures 19.2.1, 19.2.2 and 19.2.3).

Age disaggregated abundance indices from the autumn survey are 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 1996–2007. The year-classes 1996–2002 are gradually disappearing from the stock and the 2003–2008 year-classes are now the most abundant year-classes in the stock. The age disaggregated abundance indices indicate that all year-classes since 2009 are small.

19.2.2 Division 5.b

In Division 5.b, CPUE of golden redfish were available from the Faeroes spring groundfish survey from 1994–2019 and the summer survey 1996–2019 (see smr-5614_SA). Both surveys show similar trends in the indices from 1998 onwards with sharp declines between 1998 and 1999 (Figure 19.2.5). CPUE in the spring survey since 2000 has been stable at low level. The CPUE index in the summer survey shows similar trend as in the spring survey and has gradually decreased and is at the lowest level recorded.

19.2.3 Subarea 14

The German groundfish survey has been conducted annually in the autumn from 1982 to 2017 and in 2019 covering shelf areas and the continental slopes off West and East Greenland. Description of the survey and the re-stratification in 2013 is found in the Stock Annex (smr-5614_SA). In 2017, sampling was only conducted in parts of East Greenland and one spot in NAFO 1F with a total of 46 stations. This is low compared to necessary coverage of 63–75 stations in the respective area as done in the previous years. The survey was not conducted in 2018 because of research vessel breakdown.

Relative abundance and biomass indices for golden redfish (fish >17 cm) from the German groundfish survey are illustrated in Figure 19.2.6. After a severe depletion of the golden redfish stock on the traditional fishing grounds around East Greenland in the early 1990s, the survey estimates showed a significant increase from 2003, both in biomass and abundance (Figure 19.2.6). The survey indices in 2007–2017 were high but fluctuated. The biomass survey index in 2014–2016 were at the highest level in the time-series but decreased in 2017 and 2019 to similar level as in 2010 (Figure 19.2.6a). It should be noted that the CV for the indices are high and the increase is driven by few very large hauls. In 2010–2019, the biomass of pre-fishery recruits (17–30 cm) has decreased gradually compared to previous five years and in 2017 and 2019 very little of 17–30 cm fish was observed (Figure 19.2.6*c*).

Abundance indices of redfish smaller than 18 cm from the German annual groundfish survey show that juveniles were abundant in 1993 and 1995–1998 (see Figure 18.2.1). Since 2008, the survey index has been very low and in recent years at 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 1999–2019 survey results indicate low abundance and are like those observed in the late 1980s. The Greenland shrimp and fish shallow water survey (no survey conducted 2017-2019) also shows no juvenile redfish (<18 cm, not classified to species) were present (see Figure 23.2.6).

19.3 Information from the fishing industry

19.3.1 Landings

Total landings gradually decreased by more than 70% from 130 429 t in 1982 to 43 515 t in 1994 (Table 19.3.1 and Figure 19.3.1). Since then, the total annual landings have varied between 33 451 and 59 698 t. The total landings in 2019 were 48 464 t, which is 4 964 t less than in 2018. Most of the golden redfish catch or 90–98% has been taken in ICES Division 5.a.

Landings of golden redfish in Division 5.a declined from 97 899 t in 1982 to 38 669 t in 1994 (Table 19.3.1). Since then, landings have varied between 31 686 t and 54 041 t, highest in 2016. The landings in 2019 were 44 746 t, 3 268 t less than in 2019. The landings were 14% higher than allocated quota of 39 240 t. The reasons for the implementation errors are related to the management system that allow for transfers of quota share between fishing years and conversion of TAC from one species to another. Detailed description of the Icelandic ITQ system is found in the Stock Annex for the species (smr-5614_SA).

Between 90–95% of the golden redfish catch in Division 5.a 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 bycatch in gillnet, long-line, and lobster fishery. In 2019, as in previous years, most of the catches were taken along the shelf southwest, west and northwest of Iceland (Figure 19.3.2). Higher proportion of the catches is now taken along the shelf northwest of Iceland and less south and southwest.

In Division 5.b, landings decreased from 9194 t in 1985 to 1436 t in 1999 and varied between 1139 and 2484 t from 2000–2005 (Table 19.3.1). In 2006–2016 annual landings were less than 700 t which has not been observed before in the time-series. The landings in 2017 increased substantially compared to previous 11 years and were 1397 t. That is 1232 t more landings than in 2016 and the highest landings since 2005. The landings were 1330 t and 1053 t in 2018 and 2019, respectively. Most of the golden redfish caught in Division 5.b is taken by pair and single trawlers (vessels larger than 1000 HP).

In Subarea 14 (East Greenland waters), the landings of golden redfish reached a record high of 30 962 t in 1982 but decreased drastically within the next three years and to 2117 t in 1985 (Figure 19.3.1 and Table 19.3.1). During the period 1985–1994, the annual landings from Subarea 14 varied between 687 and 4255 t. There was little or no direct fishery for golden redfish from 1995 to 2009 and landings were 200 t or less, mainly taken as bycatch in the shrimp fishery. In 2010, landings of golden redfish increased considerable and were 1650 t. This increase is mainly due to increased *S. mentella* fishery in the area. Annual landings 2010–2015 have been between 1000 t and 2700 t but increased to 5442 t in 2016 which is the highest landings since 1983. The landings in 2019 were 2665 t, about 1339 t less than in 2018.

Annual landings from Subarea 6 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 6 in 2006–2019 and were 101 t in 2019.

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 (Pálsson *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 ICES Division 14.b is currently considered insignificant (see Section 18).

19.3.3 Biological data from commercial fishery

The table below shows the fishery related sampling by gear type and ICES divisions in 2019. No sampling of the commercial catch from Subdivision 6 was carried out.

Area	Nation	Gear	Landings (t)	Samples	No. length measured	No. Age read
5.a	Iceland	Bottom trawl	44 746	161	28 233	1239
5.b	Faroe Islands	Bottom trawl	1053		116	
14	Greenland	Bottom trawl	2665			

19.3.4 Landings by length and age

The length distributions from the Icelandic commercial trawler fleet in 1976–2019 show that most of the fish caught is between 30 and 45 cm (Figure 19.3.3). The modes of the length distributions range between 35 and 40 cm and has over the past decade shifted to the right. The length distributions in 2012–2019 are narrower than previously, with less than average of small fish (<35 cm) caught, and the mean length has increased by almost 3 cm.

Catch-at-age data from the Icelandic fishery in Division 5.a 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. In 2007–2010 the 1996–1999 year-classes dominated in the catches but are now gradually decreasing. The 2003–2008 year-classes (ages 11–16) were the most dominant year classes in the fishery in 2019. There is a substantial decrease of 7–10 year old fish in the catch, compared to recent previous years, an additional indicator of low recruitment in recent year observed in all surveys conducted in East Greenland and Icelandic waters.

The average total mortality (Z), estimated from the 25-year series of catch-at-age data (Figure 19.3.5) is about 0.20 for age 13 years and older.

Length distribution from the Faroese commercial catches 2001–2019 shows 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 14 and 6.

19.3.5 CPUE

The un-standardized CPUE index from the Icelandic bottom trawl fleet was in 2019 the highest in the time-series with sharp increase in recent 19 years. Effort towards golden redfish has since 1986 gradually decreased and is at the lowest level recorded (Figure 19.3.7). 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.

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 5.b. This is because no separation of S. *norvegicus*/*S. mentella* is made in the catches.

19.4 Analytical assessment

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.

19.4.1 Gadget model

19.4.1.1 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 1985–2020 and the German survey in East Greenland 1984–2019. The German survey index in 2018 is based on the average of the 2017 and 2019 values because the survey was not conducted in 2018.
- Survey indices are combined (Figure 19.4.2) and the German survey gets half the weight compared to what is presented in Figure 19.2.6. This was done to avoid extrapolation to areas not surveyed, and hence reduce noise. 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.
- Length distributions from the Icelandic (1972-2020), Faroe Islands (1980-2012) and East Greenland (1975-2004) commercial catches.
- 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 1996–2019.
- Age-length keys and mean length at age from the Icelandic commercial catch 1995–2019.

Model settings:

- The simulation period is from 1970 to 2024 using data until the first half of 2020 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).
- Modelled length ranged between 19-54 cm.
- Commercial catches are split by country and implemented as separate fleets. Survey catch distribution data are modelled as a separate fleet.
- Recruitment was set at age 5.

Estimated parameters are:

- Number of fishes when the simulation starts (8 parameters).
- Recruitment at age 5 each year (48 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 should be noted 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 have an impact on the results. Growth in between March and October is included in the model.

Assumptions done in the predictions:

- Recruitment at age 5 in 2019 and onwards was set as the average of the five smallest estimated year classes 1980–2007 or 41.7 million. The reason is indication of poor recruitment in recent years, but estimated recruitment was even lower.
- Catches in the first time-step in 2020 (first 6 months) were set at the same as in the first time-step of 2019 for all the fleets. In step 2 in 2020 and onwards the model was run at fixed effort corresponding to $F_{9–19}$ = 0.097
- The estimated selection pattern from the Icelandic fleet was used for projections.

19.4.1.2 Results of the assessment model

It should be noted that the SSB, shown in Table 9.4.1, were not calculated correctly in 2015-2019. This error was noted in April 2020 and SSB values were corrected in the 2019 assessment and the NWWG 2019 report corrected accordingly.

The SSB is compiled from the total biomass by length and is based on fixed sized-based maturity ogive:

$$P_L = \frac{1}{1 + e^{-0.3122(L-33.54)}}$$

The error arose that wrong values were used in the function, i.e. 0.1645 instead of 0.3122 and 33.40 instead of 33.54, making the SSB approximately 10% smaller than it is when using the correct values in the logistic function. As the calculation of SSB is done after model run based on total biomass as estimated by the model, this error does not have any effect on advised catch, estimates of fishing mortality and recruitment, nor the perception of SSB being above biomass reference points. Corrected SSB values in the 2019 assessment have been incorporated into the 2019 ICES advice for this stock.

Summary of the assessment is shown in Figure 19.4.3 and Table 19.4.1. The spawning stock increased 1995-2015 but has since then decreased. Fishing mortality has been low since 2010, but since the HCR was adopted in 2014, the fishing mortality has been above the target of 0.097 because the catches has exceeded the advice. Recruitment after 2013 is record low for the time series.

Assumptions about the year-classes after the 2014 one will not have much effect on the advice this year. This is because the average proportion of fish 10 years old and younger in the landings are only about 10%. Later advice will be affected as well as the development of the spawning stock in short and medium term and is expected to decrease.

Although this year's assessment is consistent with previous assessments it shows a downward revision of SSB and an upward revision of fishing mortality compared to last year's assessment (Figures 19.4.4).

19.4.1.3 Mohn's rho

One of the ToR for this year (ToR b)-viii) was to evaluate the retrospective pattern of the assessment (Figure 19.4.5) by calculating the Mohn's rho values. The default five-year peels resulted in the following values:

Variable	Value
F_{bar}	-0.0585
SSB	0.0568
Rec.	-0.0588

19.4.1.4 Diagnostics

Observed and predicted proportion by fleet: Trends in different likelihood components (Figure 19.4.6) shows well how the fit to survey length distributions has deteriorated in recent years. This can also be seen in Figure 9.4.7 where overall fit to the predicted proportional length distributions in the survey is smaller to the observed for medium sized fish (30-40 cm fish).

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 (Figure 19.4.8).

The fit between predicted and observed age distributions is better than for the length distributions (Figures 19.4.9 and 19.4.10). The model uses the data as age-length keys in 2 cm intervals for tuning.

Model fit: An aggregated fit to the survey index (converted to biomass) is presented in Figure 19.4.11. 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 15 years. Residuals by length group show positive residuals in size groups 33–38 cm in recent years but negative for most other size groups, especially for fish smaller than 30 cm, indicating narrower length distributions in the survey than predicted (Figure 19.4.12).

This lack of fit between observed and predicted numbers between 33 and 40 cm is caused by data conflicts with survey indices of larger sizes and compositional data. There appears to be an internal conflict between indices of lengths of 42 cm and above and the large amount of smaller fish that was observed in the survey few years earlier. The model results are therefore a compromise between different data sets, and it is not able to follow the amount of 30–40 cm redfish in recent years. The inability of the model to fit the survey biomass in recent years has some support in the characteristics of the survey. Since 2003 most of the biomass in the Icelandic survey has been observed to be aggregated in very dense schools west of Iceland, caught on 5–10 stations every year. The size distribution in those schools is narrow and fish larger than 40 cm were rare.

In Figure 19.4.13 the length disaggregated indices are plotted against the predicted numbers in the stock as a time-series. As the model converges slowly, predicted indices could change several 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 19.4.12). For 35–42 cm fish, the observed indices have been above predictions for 5-11 years. The indices for 41–50 cm fish do not show such temporal pattern although in recent three years the observed indices have been below prediction. The correlation between observed and predicted is good for 19-34 cm fish. When looking at the temporal patterns, longevity of the fish must be considered.

19.4.2 Advice

The management plan is based on $F_{9–19}$ = 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. The 2019 SSB was estimated at 299 300 t, and according to the management plan the TAC advice for 2020 was 43 600 t.

19.5 Reference points

Harvest control rule (HCR) was evaluated at WKREDMP in January 2014 (ICES, 2014) based on stochastic simulations using the Gadget model. Considering conflicting information by different data continuing for many consequent years (Section 19.4), the simulations were conducted using large assessment error with very high autocorrelation (CV = 0.25, rho = 0.9).

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. 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 autocorrelated assessment error.

At WKREDMP 2014, B_{lim}=B_{loss}=160 000 t was defined as the lowest SSB in the 2012 Gadget run. $B_{trigger}$ = B_{pa} was defined as 220 000 t by adding a precautionary buffer to the proposed B_{lim} of 160 000 t: 160*exp(0.2*1.645). Recruitment in the stochastic simulations was the average of year-classes 1975–2003 but those year-classes were the basis for the simulations at WKREDMP 2014.

The plot of the average spawning stock against fishing mortality show that F_{lim} = 0.226 and F_{pa} is then 0.226/exp(1.645*0.2) = 0.163 (Figure 19.5.1). The spawning stock decreased considerably from early 1980s to mid-1990s or from 400 000 t to 200 000 t. The reduction in SSB was due to heavy fisheries but increased again gradually because of improved recruitment and lower F (Figure 19.5.1).

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 $B_{trigger}$.

Figure 19.5.2 shows the development of $F_{9–19}$ based on $F_{9–19}$ = 0.097. F is expected to be within the range of the fifth and 95th quantile and the 16th and 84th quantile.

19.6 State of the stock

The results from Gadget indicate that fishing mortality has been low since 2009 but above F_{MSY} (Figure 19.4.3). Total biomass and SSB has been decreasing since 2016 (Table 19.4.1) and the absence of any indications of incoming cohorts raises concerns about the future productivity of the stock.

Results from surveys in Iceland and East Greenland indicate that most recent year classes are poor. The accuracy of the surveys as an indicator of recruitment is not known but recruitment is expected to be poor.

19.7 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 five smallest year classes in 1980–2007 (Figure 19.4.3).

The results from the short-term simulations based on $F_{9–19}$ is shown in Figure 19.4.3 and from short term prognosis with varying fishing mortality in 2021 and 2022 in Table 19.4.2.

19.8 Medium term forecast

No medium-term forecast was carried out.

19.9 Uncertainties in assessment and forecast

Various factors regarding the uncertainty and modelling challenges are listed in the WKRED-2012 (ICES, 2012) and WKREDMP-2014 (ICES, 2014) reports. In addition, this subject is discussed in Section 19.4.

19.10 Basis for advice

Harvest control rule accepted at WKREDMP 2014 (ICES, 2014) and implemented by Icelandic and Greenland authorities in 2014.

19.11 Management consideration

In 2009 a fishery targeting redfish was initiated in Subarea 14 with annual catches of between 6000 and 8500 t in 2010–2019, highest in 2015 and lowest in 2018. The fishery does not distinguish between species, but based on survey information, golden redfish is estimated to be between 1000 and 2700 in 2010–2015 but increased to 3000–5400 t in 2016–2019, lowest in 2019.

Subarea 14 is an important nursery area for the entire resource. Measures to protect juvenile in Subarea 14 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 Faroe Islands. However, an agreement was made between Iceland and Greenland in October 2015 on the management of the golden redfish fishery based on the management plan applied in 2014. The agreement was from 2016 to the end of 2018. The agreement states that each year 90% of the TAC is allocated to Iceland and 10% is allocated to Greenland. Furthermore, 350 t are allocated each year to other areas. The plan has not been renewed so no management plan is effective although Iceland and Greenland still follow this plan.

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 more than TACs advised by ICES.

Since 2009, surveys of redfish in the stock area have consistently shown very low abundance of young redfish (< 30 cm). Biomass (SSB and the harvestable biomass) increased from 1995 to 2015 because of recruitment of several strong year-classes to the stock. Since then the biomass has declined. The absence of any indications of any incoming cohorts raises concerns about the future productivity of the stock.

19.12 Ecosystem consideration

Not evaluated for this stock.

19.13 Regulation and their effects

The separation of golden redfish and Icelandic slope *S. mentella* quota was implemented in the 2010/2011 fishing year.

In the late 1980s, Iceland introduced a sorting grid with a bar spacing of 22 mm in the shrimp fishery to reduce the bycatch of juveniles in the shrimp fishery north of Iceland. This was partly done to avoid redfish juveniles as a bycatch 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 1990s, 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 now in 5.b as abundance of small redfish is low and shrimp fisheries limited.

There is no minimum landing size of golden redfish in Division 5.a. However, if more than 20% of a catch observed on board is below 33 cm a small area can be closed temporarily. A large area west and southwest of Iceland is closed for fishing to protect young golden redfish.

There is no regulation of the golden redfish in Division 5.b.

Since 2002 it has been mandatory in the shrimp fishery in Subarea 14 to use sorting grids to reduce bycatches of juvenile redfish in the shrimp fishery.

19.14 Changes in fishing technology and fishing patterns

There have been no changes in the fishing technology and the fishing pattern of golden redfish in ICES subareas 5 and 14.

19.15 Changes in the environment

No information available.

19.16 Benchmark in 2022

Benchmark meeting for golden redfish, scheduled in 2020 was delayed because of lack of resources within the ICES system in 2020. The group proposes that the stock should be benchmarked in 2022. .

The proposed benchmark meeting will explore several issues of current assessment model. These include poor fit to survey indices for fish between 30–40 cm; potential dome-shape in selectivity; uncertainty estimates are not available; investigate the appropriateness of the current growth and maturity model used in the assessment. In addition, the meeting will explore alternative assessment methods. Under-utilized data sources from ICES 5.b and 14.b, mainly relevant survey and commercial samples of age and length. Biological reference points will be redefined depending on the assessment method. Change in form of harvest control rule will also be explored, that is change the rule to proportion of biomass above certain size (i.e. 33 cm and bigger fish) from the F based rule that is used now.

19.17 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.

19.18 Tables

Table 19.2.1 Survey indices and CV of golden redfish from the spring survey 1985–2020 and the autumn survey 1996–2019.

	Spring Survey		Autumn Survey	
Year	Biomass	CV	Biomass	CV
1985	307,926	0.095		
1986	327,765	0.120		
1987	322,081	0.122		
1988	253,763	0.094		
1989	281,117	0.122		
1990	242,450	0.223		
1991	199,128	0.114		
1992	160,545	0.088		
1993	179,275	0.130		
1994	171,080	0.097		
1995	146,100	0.102		
1996	195,630	0.164	199,786	0.248
1997	211,165	0.217	120,628	0.279
1998	206,487	0.136	186,505	0.348
1999	297,060	0.143	262,691	0.310
2000	221,279	0.176	141,335	0.200
2001	192,724	0.176	177,448	0.155
2002	250,420	0.173	192,813	0.150
2003	334,003	0.161	199,450	0.159
2004	326,868	0.236	220,308	0.241
2005	310,635	0.129	229,013	0.240
2006	257,002	0.157	279,333	0.335
2007	339,778	0.224	219,951	0.252
2008	247,887	0.154	288,149	0.244
2009	302,204	0.253	294,028	0.282
2010	383,407	0.245	227,335	0.171

	Spring Survey		Autumn Survey	
Year	**Biomass**	**CV**	**Biomass**	**CV**
2011	401,349	0.235		
2012	461,928	0.204	343,090	0.226
2013	457,448	0.177	312,063	0.158
2014	402,773	0.174	431,369	0.232
2015	406,150	0.281	361,380	0.175
2016	615,712	0.313	401,140	0.279
2017	507,058	0.205	428,351	0.187
2018	497,092	0.210	342,467	0.195
2019	410,550	0.158	383,532	0.233
2020	411,320	0.206		

Table 19.2.2 Golden redfish in 5.a. Age disaggregated indices (in millions) from the autumn groundfish survey 1996–2019. 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	2015	2016	2017	2018	2019
1	0.3	1.0	3.6	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	0.0	0.0	0.0	0.1	0
2	2.4	0.2	1.5	3.3	1.7	1.0	0.9	0.5	0.2	0.1	0.6	1.2	0.3	0.3	0.0		0.0	0.0	0.2	0.1	0.0	0.3	0.2	0.1
3	0.7	2.2	0.9	3.3	1.4	1.9	1.5	1.1	1.0	0.2	0.7	1.2	2.5	0.4	1.7		0.1	0.0	0.3	0.6	0.0	0.3	0.4	0.4
4	1.6	1.6	2.3	1.5	1.6	2.4	6.1	1.1	1.8	1.0	0.5	1.1	2.7	4.4	0.3		1.4	0.2	0.1	0.3	1.8	0.2	0.1	0.8
5	8.3	2.2	0.9	4.7	1.2	5.4	5.8	12.3	3.3	4.2	5.0	2.1	4.1	12.0	4.3		4.1	1.0	0.8	0.1	0.3	1.6	0.2	1.5
6	40.0	6.9	3.5	2.8	7.9	2.1	11.8	17.7	28.6	4.8	6.8	10.4	7.9	11.6	14.2		3.1	4.1	1.8	1.2	0.8	1.3	3.0	0.9
7	11.3	22.5	16.6	10.5	6.7	10.8	3.3	38.2	36.7	39.7	15.6	26.0	39.2	13.9	15.1		23.5	3.0	12.8	7.6	3.9	1.6	2.5	15.3
8	19.1	14.3	58.2	47.2	6.4	10.9	26.9	9.9	65.4	44.9	81.9	35.8	75.1	73.9	23.4		70.3	41.8	24.6	28.3	29.1	10.4	2.0	7.8
9	15.1	13.0	22.4	99.9	26.2	7.1	11.2	48.5	21.0	62.7	81.5	76.6	67.9	96.4	54.4		60.6	84.8	96.9	33.1	63.8	38.1	5.9	7.4
10	28.9	11.1	26.1	43.7	95.0	17.3	16.6	12.7	45.6	24.9	85.7	37.4	106.4	58.7	69.0		62.9	56.3	151.8	86.4	48.1	93.8	36.7	20.3
11	102.7	17.6	18.9	20.7	11.5	111.2	32.0	17.0	19.3	44.2	26.3	36.1	63.2	100.9	32.5		103.8	41.3	90.8	100.7	87.5	56.9	72.1	46.8
12	16.2	67.8	19.1	16.8	14.2	23.6	116.3	39.7	13.4	19.6	37.5	19.0	55.1	45.9	57.4		74.2	68.6	69.7	52.9	97.2	95.7	58.4	91.5
13	10.1	6.2	104.5	20.8	7.9	23.6	20.0	111.3	26.6	15.4	18.0	23.8	13.5	42.9	28.6		43.3	47.5	67.5	47.6	54.3	87.8	65.7	58.7
14	16.8	5.3	10.1	147.1	8.0	7.9	11.5	12.4	103.9	26.8	15.1	8.2	18.2	10.2	19.6		39.1	26.5	50.4	41.7	45.3	41.9	54.9	62.7
15	33.9	7.2	7.6	6.0	51.4	9.2	9.8	10.8	13.6	82.1	18.3	6.8	9.1	18.3	9.1		19.6	31.7	27.0	40.3	35.8	27.4	27.3	45.4
16	16.1	10.0	7.8	9.6	5.3	58.9	10.4	6.1	9.6	9.5	75.4	16.9	7.8	6.9	10.9		16.7	18.7	26.6	21.1	31.9	28.8	20.2	36.1

Year/Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
17	1.9	6.9	14.1	10.9	2.5	4.3	45.4	7.5	6.0	6.7	8.7	49.4	13.1	6.4	4.7		6.1	12.8	17.1	20.0	20.3	35.6	21.9	18.7
18	1.7	3.9	7.6	11.1	2.5	5.0	4.6	32.7	6.1	3.7	4.3	10.4	36.6	7.4	3.1		5.9	7.2	12.3	10.0	22.1	17.8	21.1	21.7
19	4.3	2.0	0.5	8.4	4.6	3.6	3.0	4.5	21.6	5.0	2.8	4.5	6.2	28.4	6.6		3.9	5.2	6.0	10.0	16.1	14.7	12.9	22.1
20	6.6	1.4	3.2	3.9	6.5	4.1	3.2	1.6	3.1	22.0	3.1	1.5	5.7	4.7	22.2		3.9	4.5	5.9	9.9	8.9	16.8	11.3	13.7
21	1.1	0.8	2.3	2.8	1.0	3.7	3.9	1.1	1.8	2.5	17.8	4.0	2.1	2.1	3.1		3.5	4.8	4.8	3.3	3.0	11.5	6.0	14.7
22	5.0	1.5	0.8	1.0	1.6	2.3	3.2	2.7	1.7	2.1	2.0	13.8	2.3	1.3	1.2		18.3	2.4	3.6	2.5	3.9	4.8	10.3	12.3
23	3.9	2.4	2.2	2.1	0.4	0.3	0.8	1.1	2.5	2.4	1.7	1.3	11.0	2.0	1.6		2.9	18.2	3.4	2.1	3.7	6.1	6.9	7.2
24	4.6	0.8	0.4	0.6	1.0	0.5	0.4	0.3	0.0	0.9	1.0	1.3	1.4	10.2	0.7		2.0	2.6	12.7	1.1	2.8	4.8	2.8	3.7
25	3.9	2.7	1.4	2.8	0.8	0.3	0.5	0.3	1.2	1.2	1.7	0.2	0.8	0.8	5.7		1.2	1.2	1.5	13.1	3.4	2.9	2.6	1.3
26	0.9	1.1	0.2	1.2	0.7	0.5	0.6	0.2	0.4	0.3	0.9	0.6	0.9	1.0	0.6		1.7	1.1	0.9	1.5	15.0	2.6	2.9	2.0
27	0.9	0.2	0.9	2.9	0.5	0.8	0.3	0.3	0.0	0.1	0.9	0.3	1.2	1.3	0.4		7.5	0.8	0.9	1.4	1.0	13.9	2.6	1.3
28	0.8	0.4	0.5	1.5	0.7	0.5	0.2	0.0	0.2	0.2	0.2	0.0	0.6	0.2	0.7		0.4	8.7	0.5	1.6	1.0	1.7	11.5	1.7
29	0.1	0.0	0.5	1.2	0.5	0.2	0.7	0.1	0.2	0.0	0.4	0.4	0.8	1.6	0.4		0.4	0.5	3.3	1.0	0.9	1.8	1.5	10.4
30+	0.8	1.4	3.0	1.1	1.3	2.3	1.7	1.5	1.6	2.1	1.0	0.9	1.5	1.7	2.0		2.1	3.5	2.6	6.9	6.7	7.9	7.5	5.3
Total	360.0	214.6	341.6	492.7	271.8	322.1	352.7	393.2	436.4	429.4	515.6	391.3	557.2	565.9	393.5		582.5	499.2	696.9	546.3	608.9	629.0	472.0	531.8

Table 19.3.1 Official landings (in tonnes) of golden redfish, by area, 1978–2019 as officially reported to ICES. Landings statistics for 2019 are provisional.

Year	Area				Total
	5.a	5.b	6	14	
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

Year	Area				Total
	5.a	5.b	6	14	
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
2014	47 769	201	60	2 706	50 736
2015	48 769	270	44	2 562	51 645
2016	54 041	165	50	5 442	59 698
2017	50 119	1 397	93	4 501	56 101
2018	48 014	1 330	80	4 004	53 428
2019[1)]	44 746	1 053	101	2 665	48 464

1) Provisional

Table 19.3.2 Golden redfish in 5.a. Observed catch in weight (tonnes) by age and years in 1995–2019. 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	47	0	32	23	6	38	117	125	189	216	219	175	126	205	101	58	136	69	30	221
8	327	354	219	277	339	62	134	871	199	822	737	995	418	1,019	912	348	546	609	549	448
9	1,452	803	470	584	1,576	830	389	737	1,330	485	1,840	2,113	1,643	2,100	1,649	2,161	1,581	1,598	2,171	1,678
10	8,698	3,654	1,014	1,189	1,237	4,216	1,608	815	1,095	2,059	1,470	3,573	2,345	4,896	3,003	2,663	4,670	3,431	3,846	5,974
11	2,583	9,026	2,641	1,115	1,823	1,861	7,611	3,097	1,178	777	3,052	2,077	3,210	3,923	4,900	2,733	5,604	6,702	5,900	6,574
12	1,284	2,078	11,406	3,215	2,498	2,245	1,786	10,777	3,899	965	1,873	2,774	1,858	4,622	4,423	4,855	4,848	7,316	9,427	5,691
13	3,574	1,313	2,796	12,421	2,428	1,678	1,912	3,021	9,675	2,001	1,349	1,622	3,017	2,283	3,421	3,857	6,209	4,003	6,866	5,732
14	5,718	1,468	1,363	2,073	15,444	2,344	1,235	2,571	2,342	8,548	2,984	1,287	1,039	2,831	1,851	2,720	3,785	4,700	4,027	4,739
15	6,124	4,376	3,125	2,031	1,236	14,675	826	1,823	1,960	2,127	11,727	2,813	946	1,545	2,16	1,372	2,515	2,658	4,478	3,049
16	1,801	5,533	3,648	2,408	1,254	1,753	11,529	2,956	1,212	1,677	2,067	10,126	2,163	1,071	1,252	1,195	1,317	1,518	3,052	2,544
17	889	927	3,016	3,407	1,812	1,172	518	11,787	2,249	809	1,445	2,091	9,370	1,813	686	814	991	814	1,733	1,939
18	384	385	893	2,043	2,641	1,592	780	2,055	6,402	1,380	1,249	1,182	1,340	8,264	1,510	646	607	813	1,222	1,269
19	1,218	266	637	1,015	2,212	2,383	1,043	1,133	756	5,194	1,246	688	748	1,526	6,211	1,082	700	494	766	473
20	1,216	339	943	723	1,259	2,124	1,730	636	411	1,115	6,463	970	732	999	981	5,054	1,004	805	492	1,255
21	559	1,188	453	520	461	535	935	1,392	607	336	391	5,641	893	572	661	910	5,167	626	519	535
22	684	1,034	525	394	214	438	411	1,003	798	489	469	631	4,876	850	584	765	1,085	3,522	789	516

Year/Age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
23	1,574	814	673	424	331	270	411	723	754	618	795	229	753	4,217	348	572	773	474	3,346	504
24	709	0	584	660	216	63	164	372	392	567	619	377	113	392	2,601	670	208	340	234	3,310
25	824	0	734	520	848	392	123	288	300	258	420	472	627	260	100	2,168	143	224	20,	188
26	407	0	275	399	270	337	114	180	74	105	100	73	341	443	97	284	1,406	236	173	203
27	384	0	139	427	615	198	275	80	83	183	279	263	353	343	201	398	79	1,443	110	143
28	808	0	202	357	229	516	189	296	27	141	169	204	205	172	96	132	205	198	937	58
29	0	0	143	53	106	364	146	498	105	138	29	168	37	178	390	187	45	71	38	692
30+	251	0	408	493	768	1,102	1,080	1,333	539	678	1,599	976	1,211	913	449	512	149	424	423	33
Total	41,515	33,558	36,339	36,771	39,823	41,188	35,066	48,569	36,576	31,688	42,591	41,520	38,364	45,537	38,443	36,156	43,773	43,088	51,328	47,768

Year/Age	2015	2016	2017	2018	2019
7	14	47	0	0	210
8	575	723	103	49	142
9	914	2,661	946	210	63
10	3,169	3,668	4,490	2,270	1,215
11	7,128	7,854	3,514	4,689	4,633
12	7,077	9,353	7,063	4,847	6,128
13	5,517	6,657	8,743	6,449	4,003

Year/Age	2015	2016	2017	2018	2019
14	5,628	4,672	5,363	7,620	5,687
15	4,735	4,080	3,785	4,277	5,112
16	2,986	2,663	3,573	3,305	3,992
17	2,685	2,787	3,010	2,737	2,630
18	1,848	2,075	1,865	2,583	2,303
19	775	1,792	1,411	1,310	1,375
20	1,267	668	1,186	1,337	1,520
21	284	560	1,060	1,238	1,148
22	274	365	438	718	511
23	211	230	489	599	584
24	424	251	313	283	161
25	1,829	315	325	343	56
26	243	1,433	148	170	184
27	213	182	1,266	36	352
28	187	30	87	1,730	104
29	87	26	192	26	1,238
30+	700	941	756	1,189	1,398

Year/Age	2015	2016	2017	2018	2019
Total	48,770	54,043	50,117	48,015	44,749

Table 19.4.1 Results from the Gadget model of total biomass, spawning stock biomass, recruitment at age 5 (in millions), catch and fishing mortality, projections are in italic. All weights are in thousand tonnes.

Year	Biomass	SSB	$R_{(age5)}$	Catches	F_{9-19}
1971	616 898	406 553	218.9	67 880	0.092
1972	615 462	394 172	190.3	50 890	0.073
1973	653 758	395 169	445	43 719	0.064
1974	684 178	403 262	209.4	50 598	0.072
1975	701 150	408 546	129.4	61 920	0.086
1976	704 766	401 493	212	94 420	0.133
1977	713 626	404 083	198.2	53 753	0.079
1978	740 311	431468	125.7	48 736	0.066
1979	757 188	452 919	158.2	77 212	0.100
1980	747 291	458 335	104.7	89 143	0.114
1981	718 069	451 678	74.6	101 966	0.136
1982	661 202	423 483	63.2	130 322	0.185
1983	596 006	386 697	67.5	106 050	0.163
1984	543 517	357 778	73.7	95 288	0.155
1985	506 176	334052	131.6	78 531	0.132
1986	475 838	313 003	121.5	76 908	0.140
1987	439 922	288 257	64.9	76 559	0.152
1988	392 501	253 986	41.2	89 804	0.205
1989	351 972	224 740	44.8	56 645	0.145
1990	350 557	204 411	352.7	66 314	0.192
1991	329 588	183 673	58.9	56 015	0.180
1992	311 096	167 354	39.9	55 826	0.198
1993	294 921	154 416	53.5	50 179	0.196
1994	284 727	148 451	63.4	42 520	0.174
1995	302 360	146 627	333.8	44 263	0.184
1996	307 851	148 694	86.8	35 595	0.145
1997	307 687	150 645	40.6	38 996	0.155
1998	309 570	156 488	41.3	39 694	0.155

Year	Biomass	SSB	$R_{(age5)}$	Catches	$F_{9\text{-}19}$
1999	306 724	158 441	81.6	42 463	0.165
2000	301 702	162 123	51.1	42 607	0.161
2001	307 095	166 980	109.2	36 744	0.133
2002	308 950	167 168	119.6	50 730	0.182
2003	321 335	168 373	175.6	38 219	0.138
2004	337 112	178 183	108.4	32 766	0.114
2005	354 561	184 074	166.5	46 619	0.160
2006	376 199	190 673	167.2	42 108	0.147
2007	390 773	200 949	108	39 154	0.132
2008	414 707	218 427	135.3	46 195	0.148
2009	446 058	234 681	211	39 301	0.118
2010	483 606	261 787	169.2	38 504	0.106
2011	507 679	289 267	94.6	45 146	0.115
2012	525 228	308 918	133.7	45 423	0.108
2013	533 968	330 333	68.5	53 223	0.120
2014	523 196	342 322	24.1	50 697	0.109
2015	508 885	353 757	6	51 621	0.107
2016	482 382	353 091	12.2	59 697	0.122
2017	457 732	348 639	30.5	56 334	0.116
2018	419 145	332 059	3.9	53 368	0.114
2019	391 085	315 915	*41.7*	48 484	0.109
2020	364 314	297 105	*41.7*	42 026	*0.101*
2021	*342 818*	*280 100*	*41.7*	*38 343*	*0.097*
2022	*323 071*	*262 557*	*41.7*	*35 667*	*0.097*
2023	*305 468*	*245 670*	*41.7*	*33 100*	*0.097*
2024	*290 075*	*230 158*	*41.7*	*30 785*	*0.097*

Table 19.4.2 Output from short term prognosis. Multiplier is based on reference to the adopted HCR $F_{9–19}$ = 0.097. All weights are in tonnes.

F(2019) = **0.109** C(2019) = **48 484 t**

2020				
Bio 5+	SSB	F_{mult}	$F_{9\text{-}19}$	Landings
364 314	297 105	1.032	0.1	42 026

		2021			2022	
F_{mult}	$F_{9–19}$	Bio 5+	SSB	Landings	Bio 5+	SSB
0.0	0	382 900	316 366	0	400 794	333 959
0.1	0.01	378 779	312 636	4 167	392 359	326 202
0.2	0.019	374 684	308 930	8 259	384 076	318 587
0.3	0.029	370 613	305 246	12 276	375 944	311 112
0.4	0.039	366 568	301 585	16 218	367 960	303 775
0.5	0.049	362 547	297 947	20 088	360 122	296 574
0.6	0.059	358 552	294 332	23 883	352 430	289 508
0.7	0.069	354 581	290 739	27 606	344 880	282 575
0.8	0.079	350 635	287 170	31 257	337 472	275 773
0.9	0.089	346 714	283 623	34 836	330 203	269 101
1.0	0.099	342 818	280 100	38 343	323 071	262 557
1.1	0.109	338 947	276 599	41 779	316 076	256 139
1.2	0.119	335 101	273 121	45 145	309 214	249 846
1.3	0.129	331 280	269 666	48 441	302 485	243 675
1.4	0.140	327 484	266 234	51 667	295 886	237 626
1.5	0.150	323 713	262 824	54 824	289 416	231 696
1.6	0.160	319 967	259 438	57 913	283 073	225 885
1.7	0.171	316 245	256 074	60 933	276 856	220 190
1.8	0.181	312 549	252 734	63 886	270 762	214 610
1.9	0.191	308 878	249 416	66 771	264 790	209 144
2.0	0.202	305 231	246 121	69 590	258 938	203 789

19.19 Figures

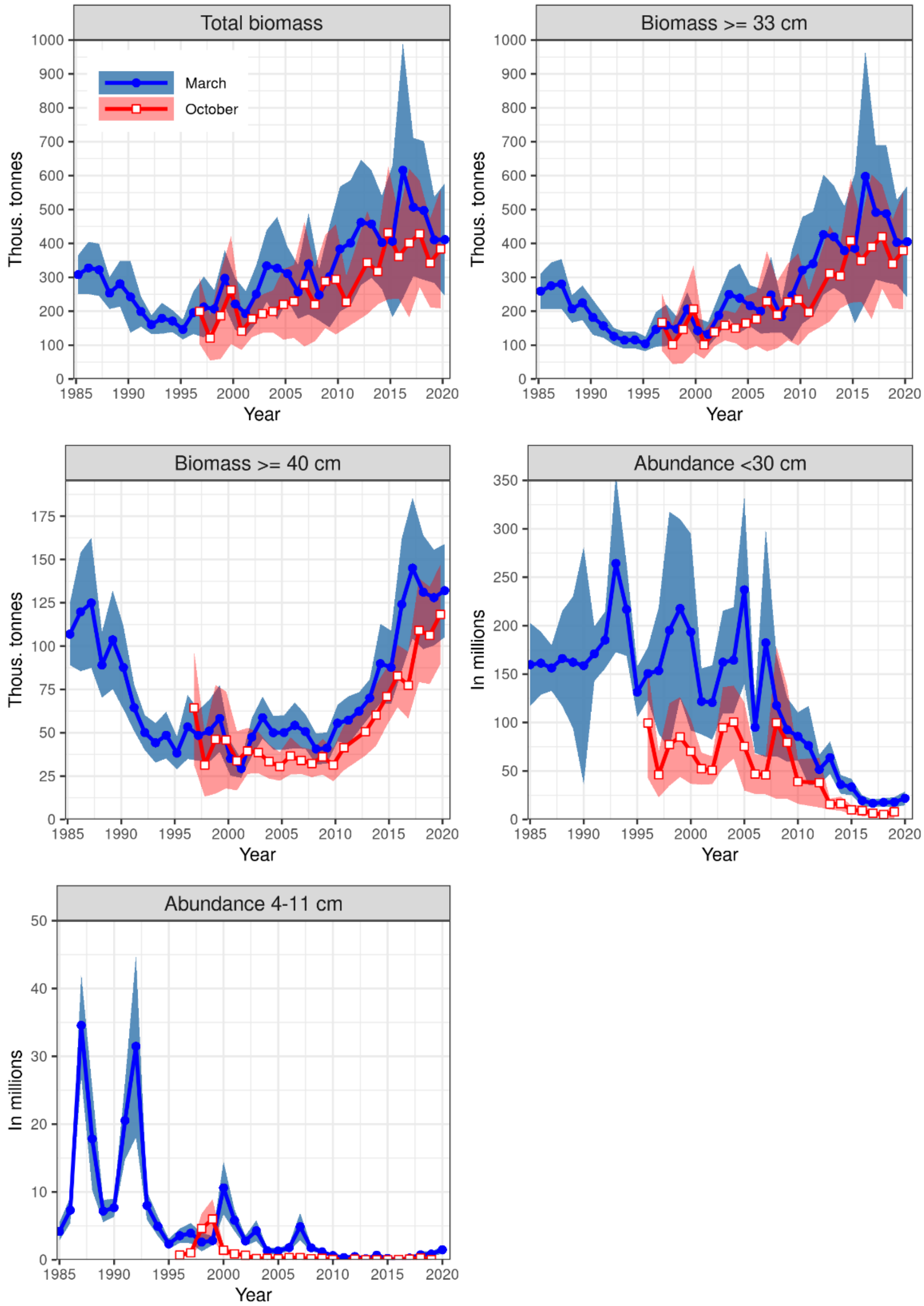


Figure 19.2.1 Indices of golden redfish in ICES Division 5.a (Icelandic waters) from the groundfish surveys in March 1985–2020 (blue line and shaded area) and October 1996–2019 (red lines and shaded areas). The shaded areas represent 95% CI.

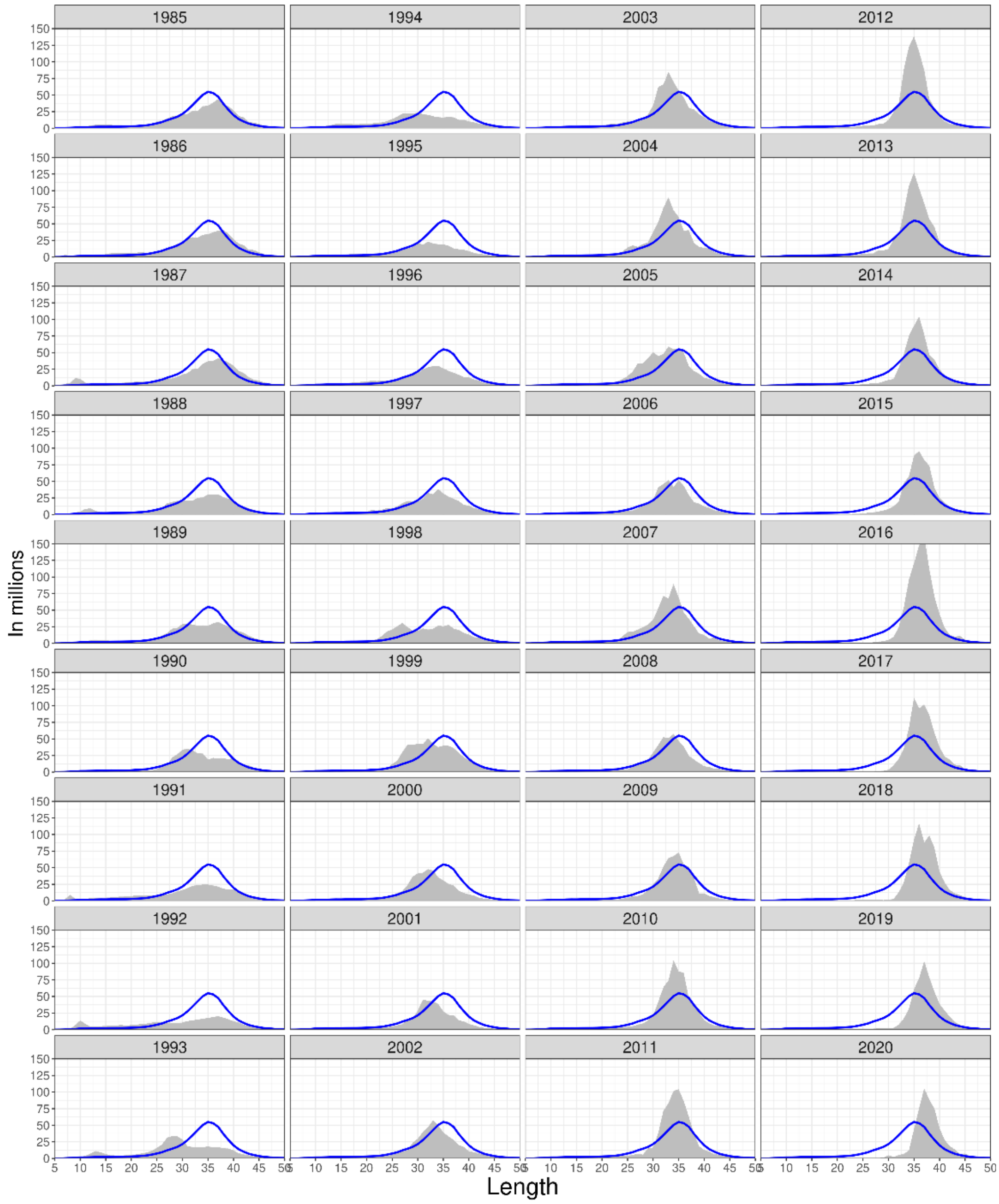


Figure 19.2.2. Length disaggregated abundance indices of golden redfish from the bottom trawl survey in March 1985–2020 conducted in Icelandic waters. The blue line is the mean of total indices 1985–2020.

Figure 19.2.3. Length disaggregated abundance indices of golden redfish from the bottom trawl survey in October 1996–2019 conducted in Icelandic waters. The blue line is the mean of total indices 1996–2019. The survey was not conducted in 2011.

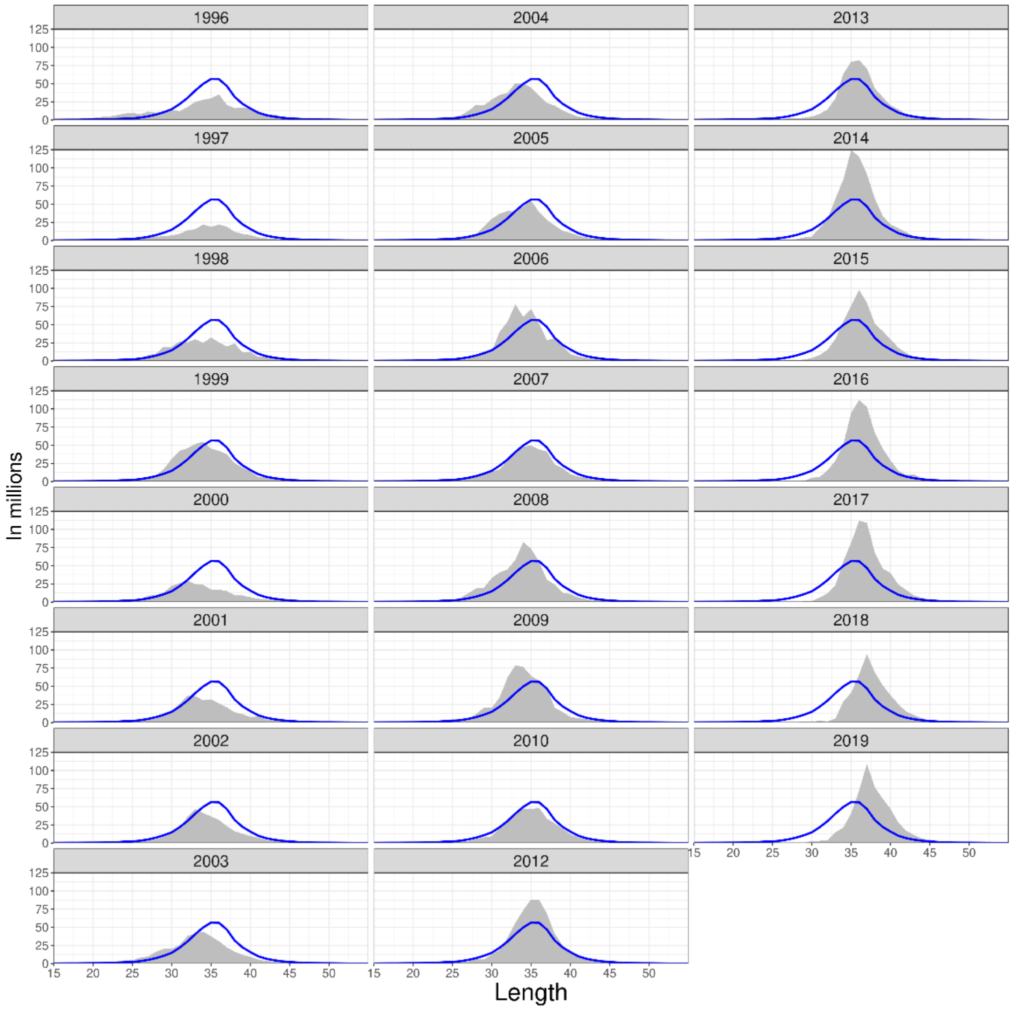


Figure 19.2.3. Length disaggregated abundance indices of golden redfish from the bottom trawl survey in October 1996–2019 conducted in Icelandic waters. The blue line is the mean of total indices 1996–2019. The survey was not conducted in 2011.

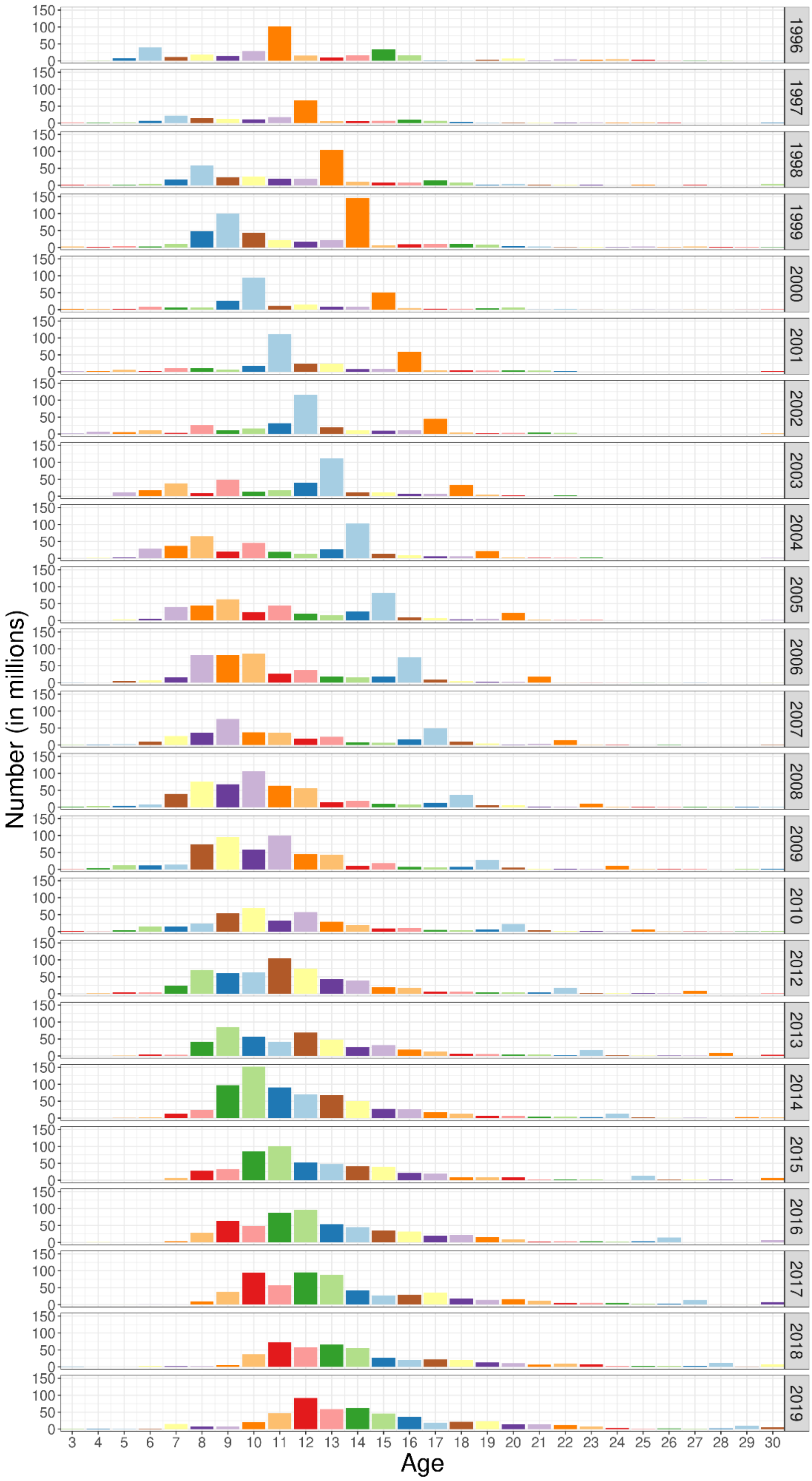


Figure 19.2.4 Age disaggregated abundance indices of golden redfish in the bottom trawl survey in October conducted in Icelandic waters 1996–2019. The survey was not conducted in 2011.

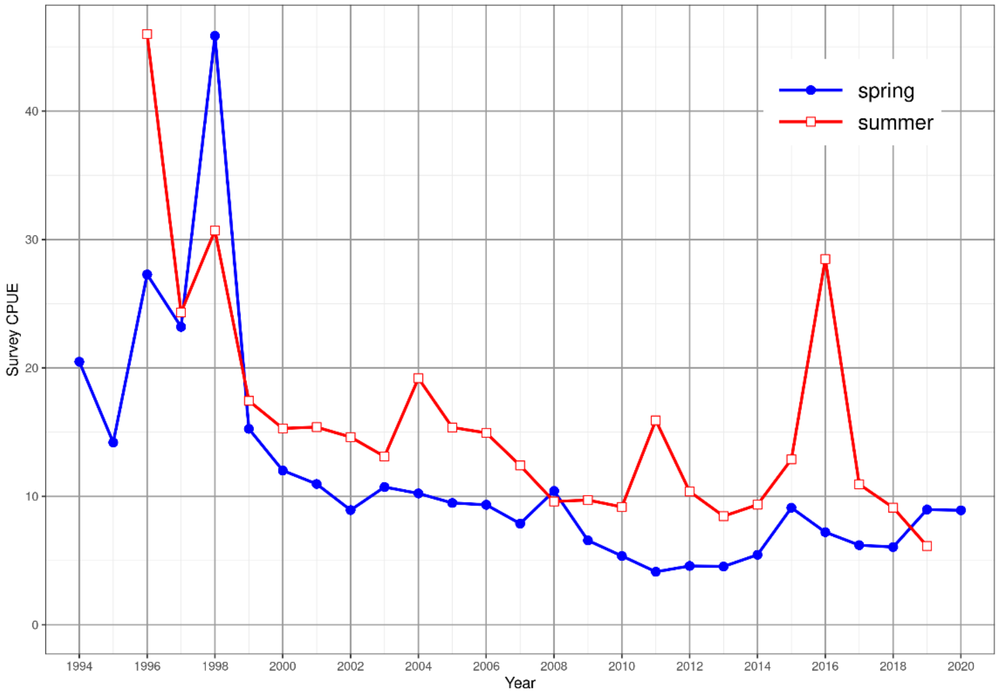
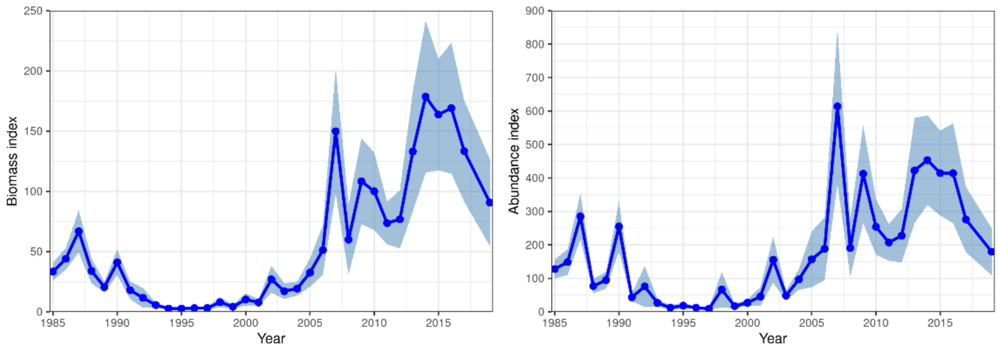


Figure 19.2.5 CPUE of golden redfish in the Faeroes spring groundfish survey 1994–2020 (blue line) and the summer groundfish survey 1996–2019 (red line) in ICES Division 5.b.



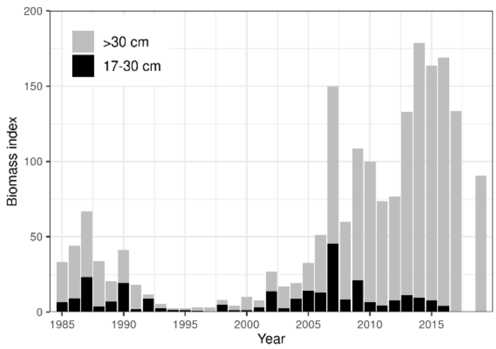


Figure 19.2.6 Golden redfish (> 17 cm). Survey abundance indices for East Greenland (ICES Subarea 14) from the German groundfish survey 1985–2019. a) Total biomass index, b) total abundance index, c) biomass index divided by size classes (17–30 cm and > 30 cm). The survey was not conducted in 2018.

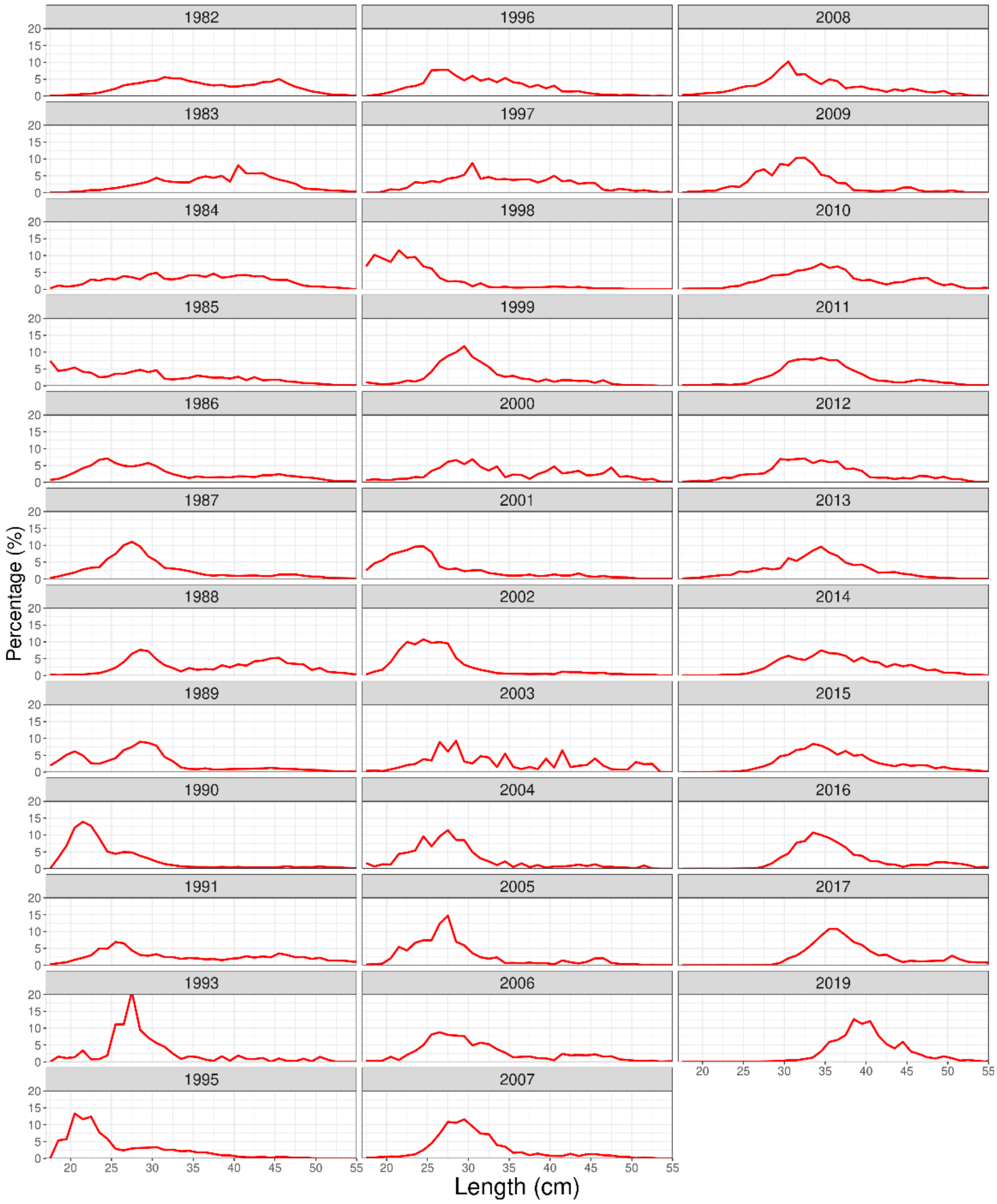


Figure 19.2.7 Golden redfish (>17 cm). Length frequencies for East Greenland (ICES Subarea 14) 1982–2019. The survey was not conducted in 2018.

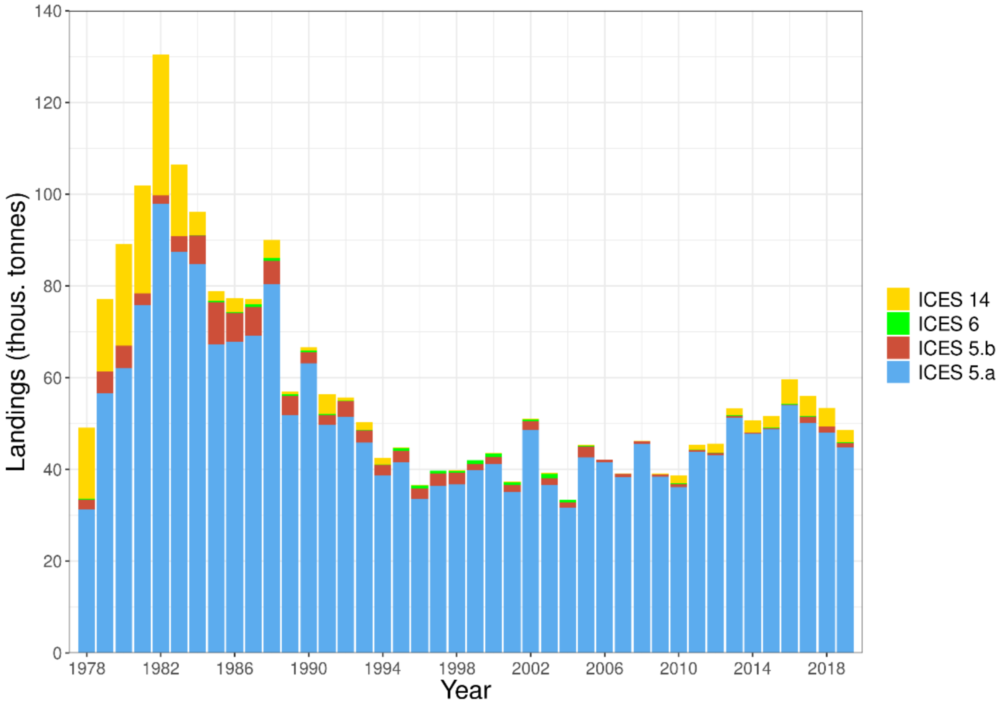


Figure 19.3.1 Nominal landings of golden redfish in tonnes by ICES Divisions 1978–2019. Landings statistics for 2019 are provisional.

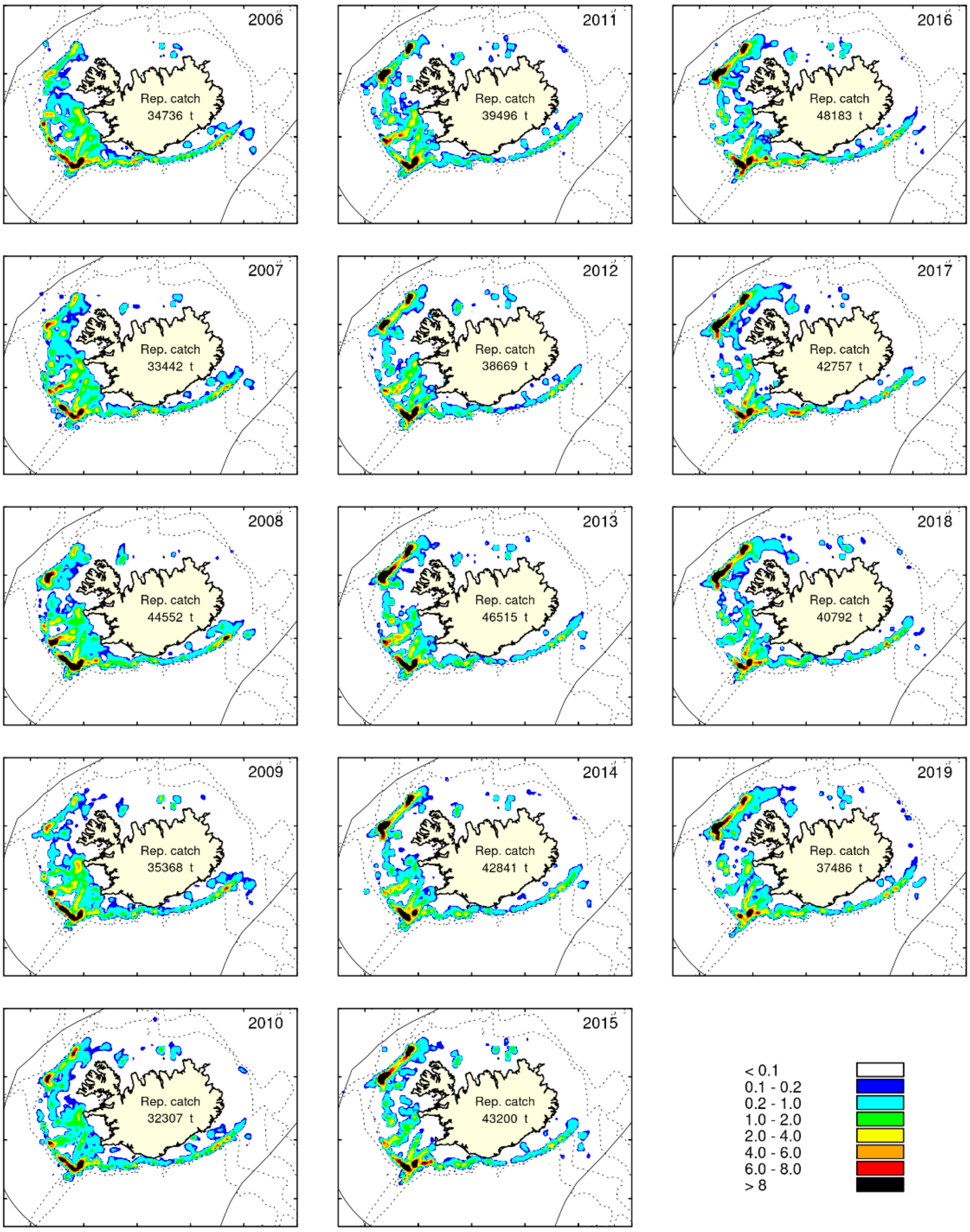


Figure 19.3.2 Geographical distribution of golden redfish bottom trawl catches in Division 5.a 2006–2019.

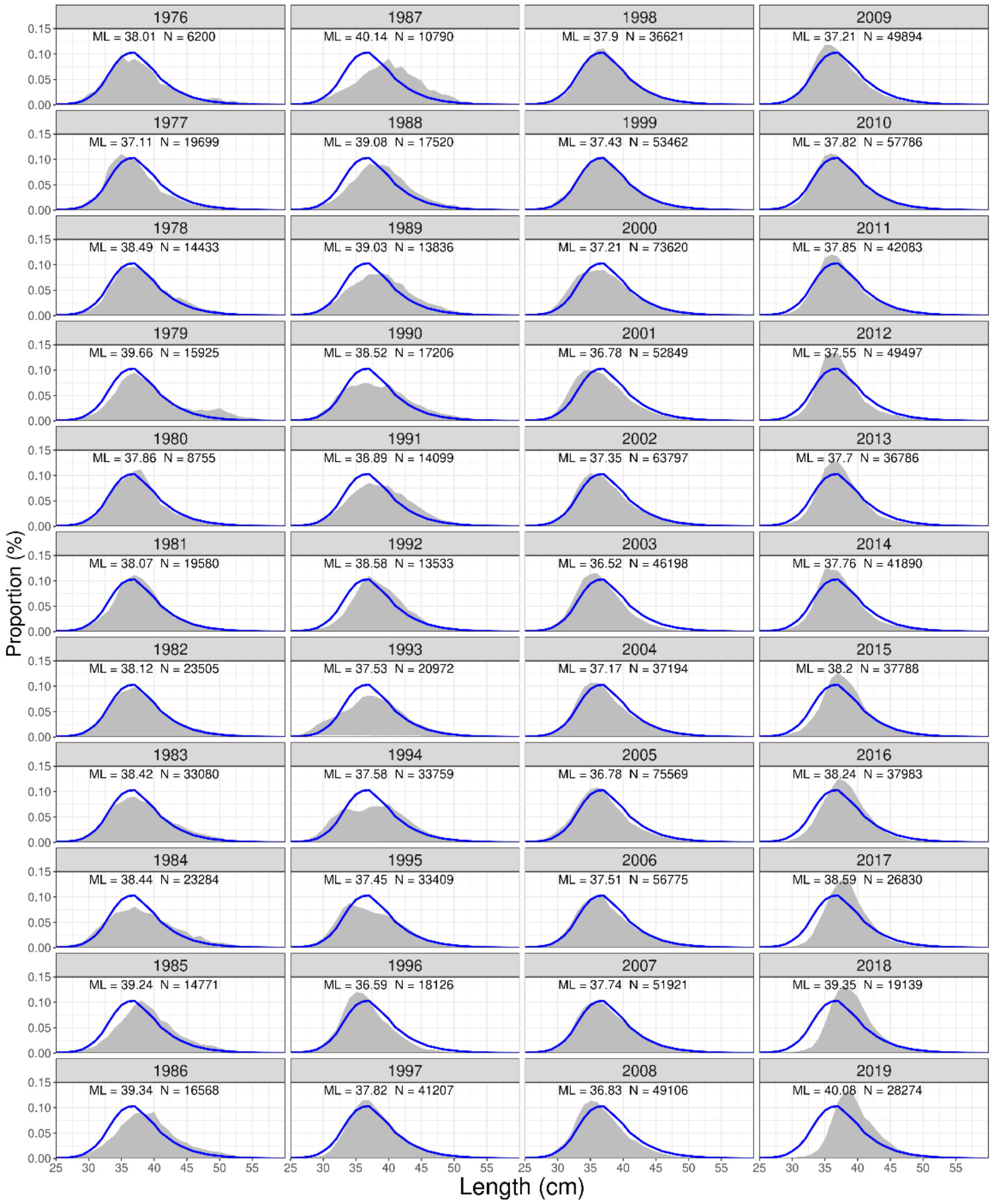


Figure 19.3.3 Length distribution (grey shaded area) of golden redfish in Icelandic waters (ICES Division 5.a) in the commercial landings of the Icelandic bottom trawl fleet 1976–2019. The blue line is the mean of the years 1976–2019.

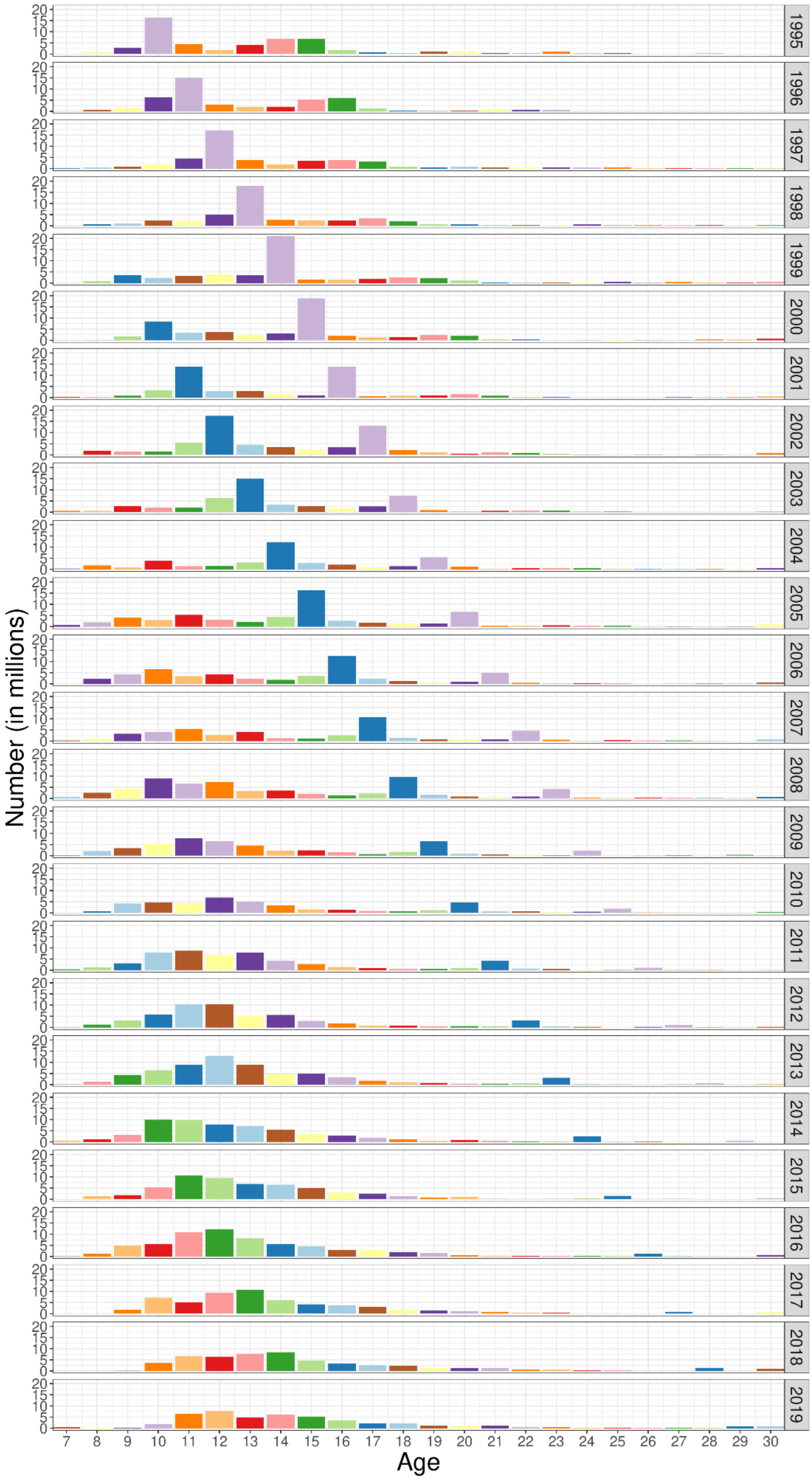


Figure 19.3.4 Catch-at-age of golden redfish in numbers in ICES Division 5.a 1995–2019.

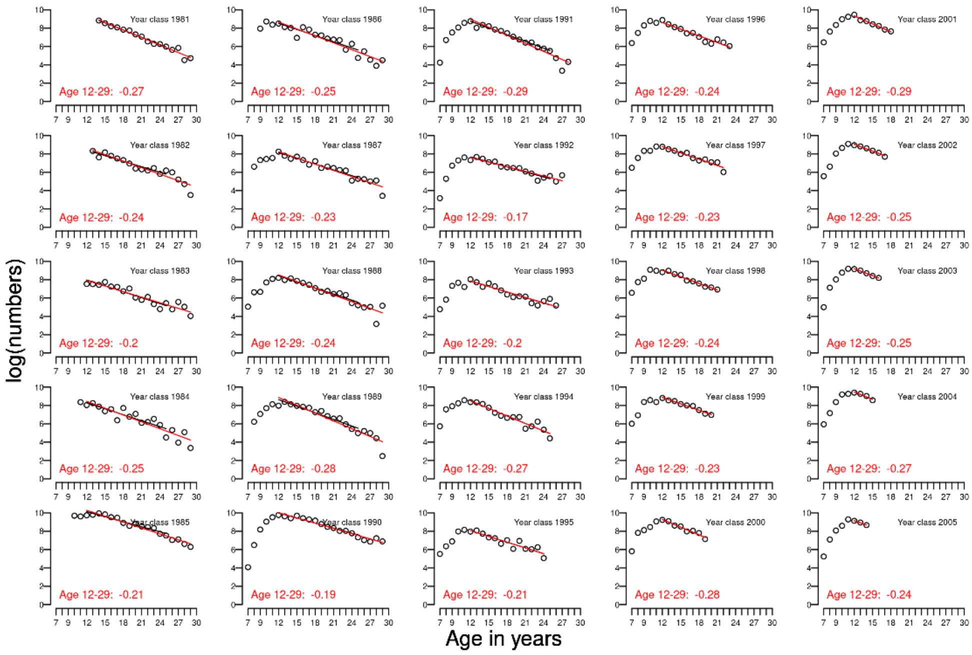


Figure 19.3.5 Catch curve of the 1981–2005 year-classes of golden redfish based on the catch-at-age data in ICES Division 5.a 1995–2019.

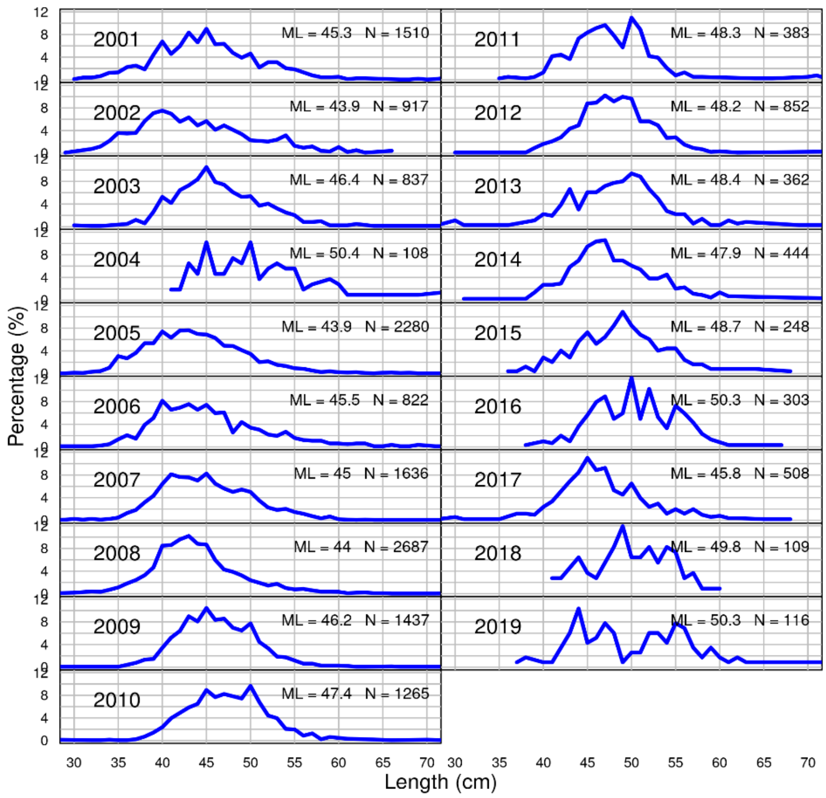


Figure 19.3.6 Length distribution of golden redfish from Faroese catches in ICES Division 5.b in 2001–2019.

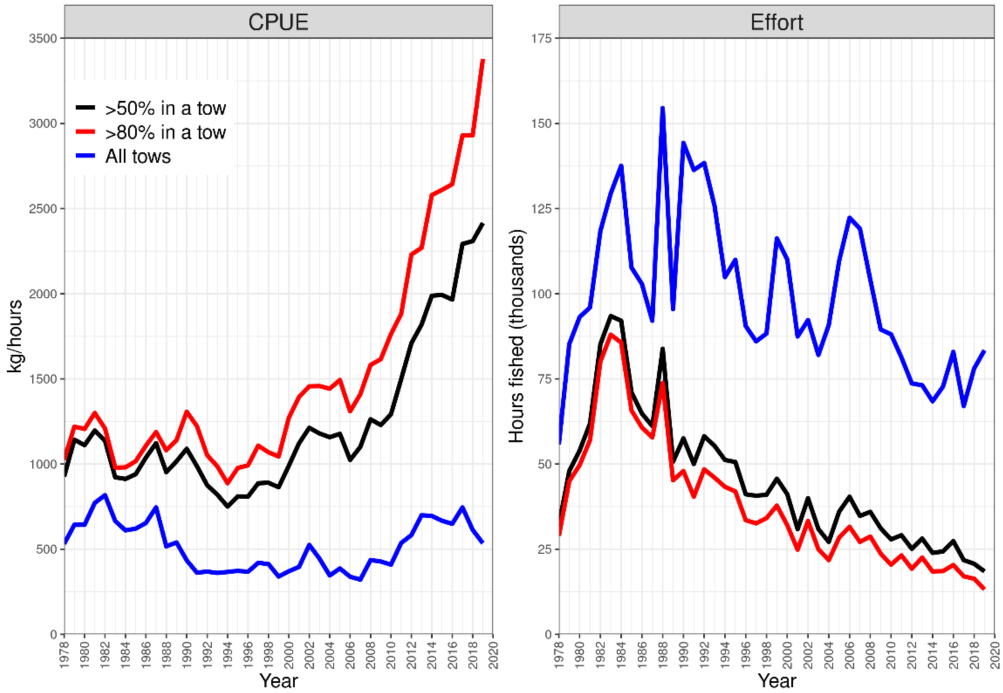


Figure 19.3.7 CPUE of golden redfish from Icelandic trawlers 1978–2019 where golden redfish catch composed at least 50% of the total catch in each haul (black line), 80% of the total catch (red line) and in all tows where golden redfish was caught (blue line). The figure shows the raw CPUE index (sum(yield)/sum(effort)) and effort.

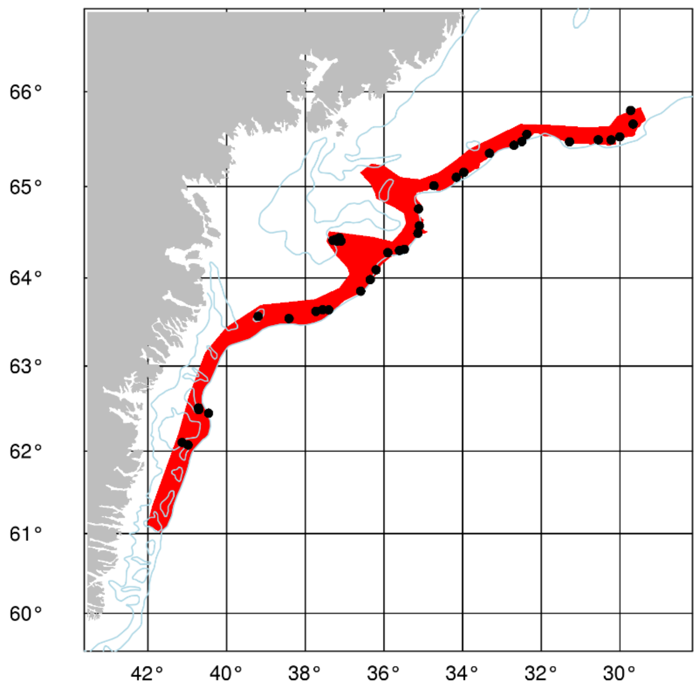


Figure 19.4.1 Stations in the German survey in East Greenland with an area used to compile the indices for Gadget shown. This area corresponds to giving a weight of 0.5 to the results in Figure 19.2.7.

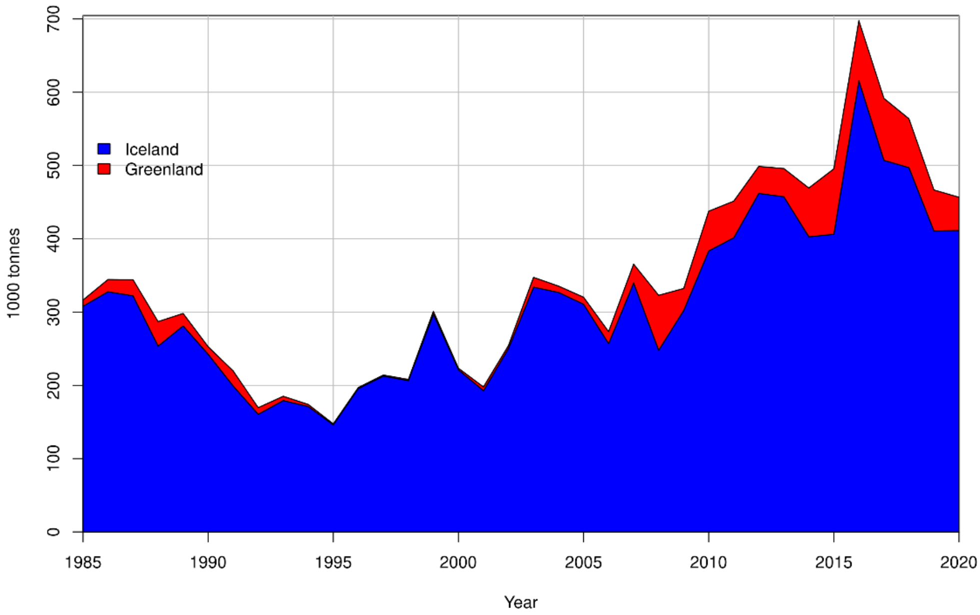


Figure 19.4.2 Biomass index from Iceland (blue) and Greenland (red), based on weighting the German survey data in Figure 19.2.7 by 0.5. In 2019, the survey index is based on the Icelandic survey and the average of the 2017 and 2019 values from the German survey in Greenland because it was not conducted in 2018.

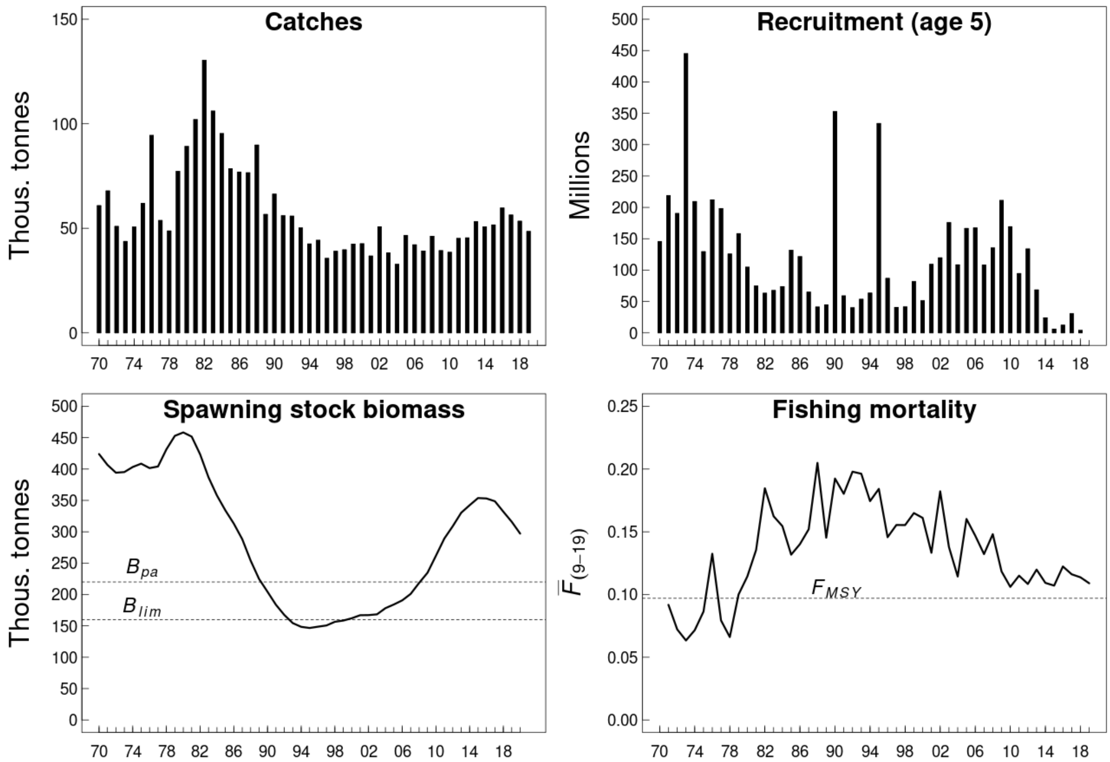


Figure 19.4.3. Summary from the assessment 2020.

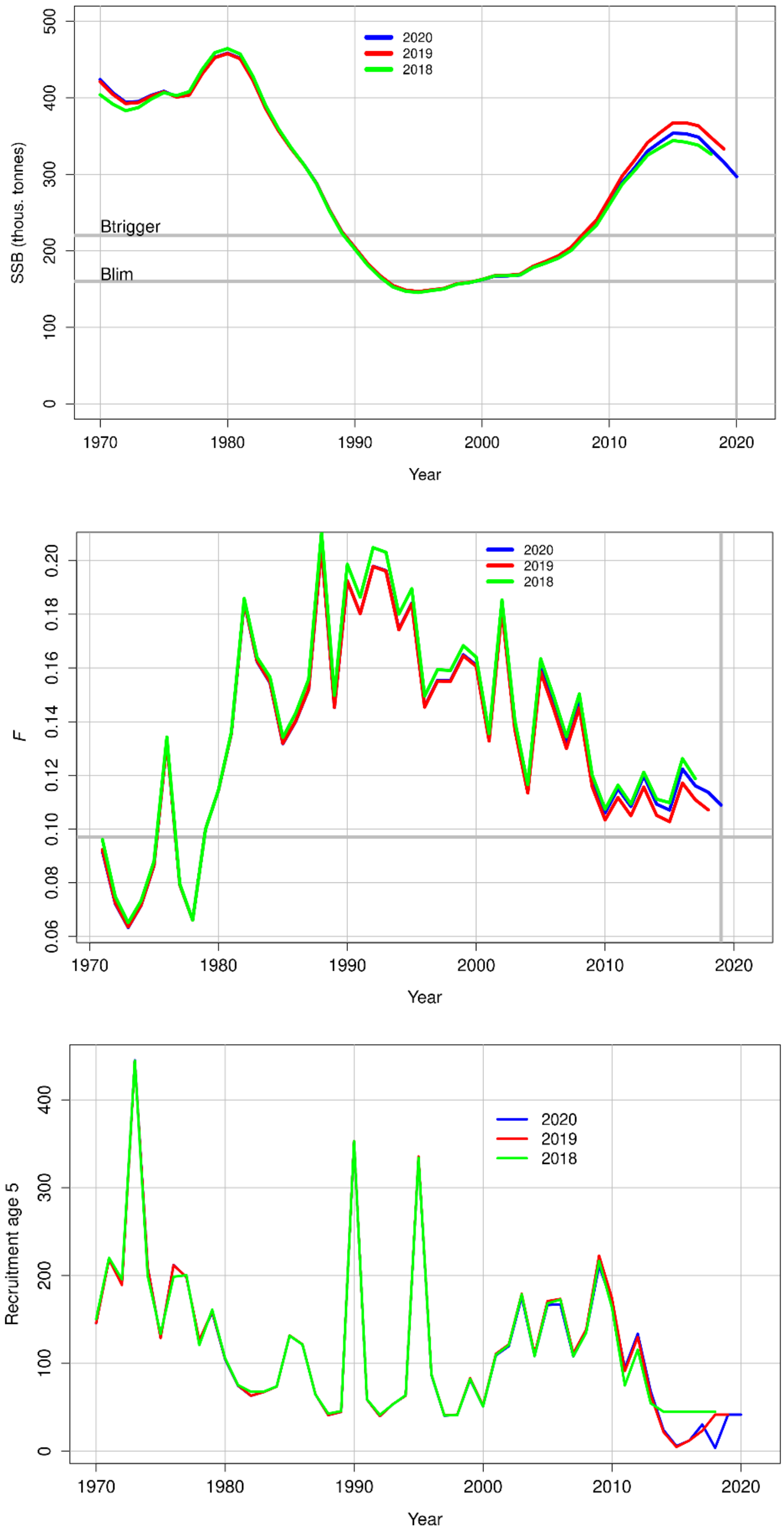


Figure 19.4.4. Comparison of the current assessment (blue line) and the same assessment done in 2018 (red line) and 2019 (green line) for the spawning stock biomass (top), fishing mortality (middle) and recruitment (bottom).

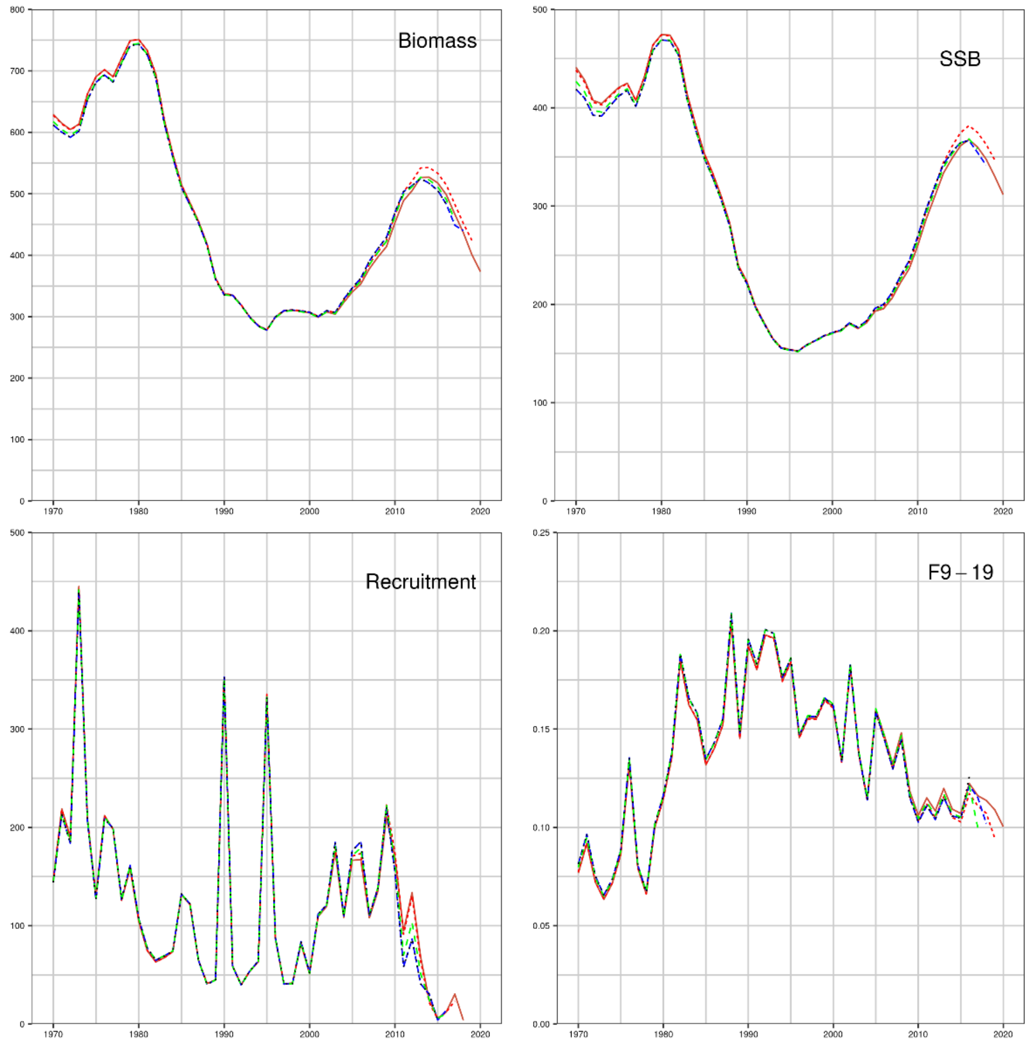


Figure 19.4.5. Analytical retrospective pattern of the base run. Recruitment is at age 5 and F shows the development of ages 9–19.

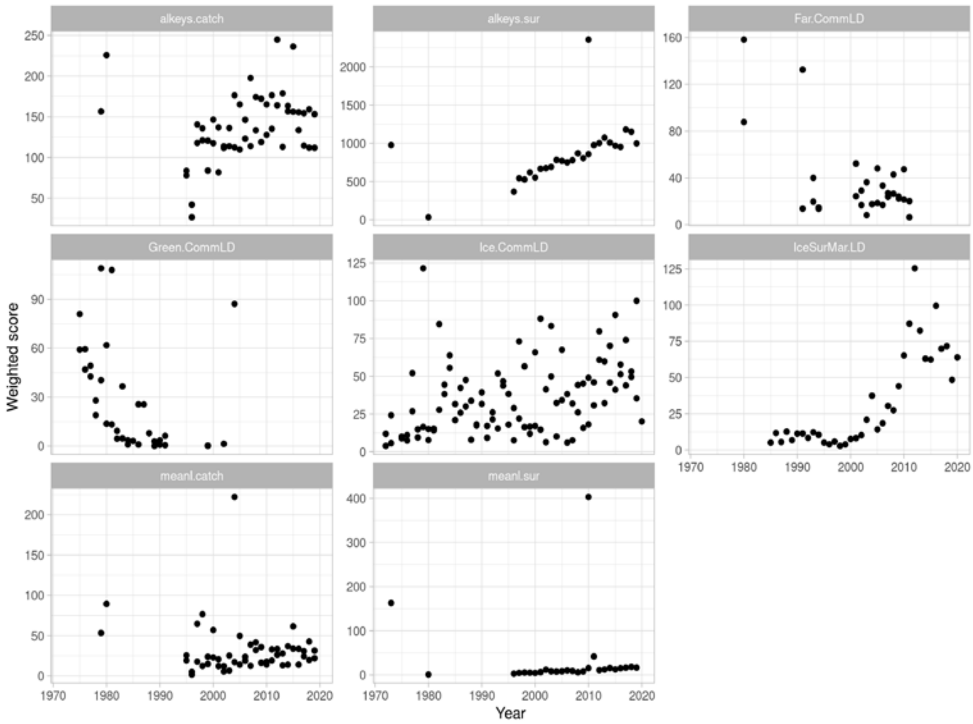


Figure 19.4.6. Development of component of the objective function with time.

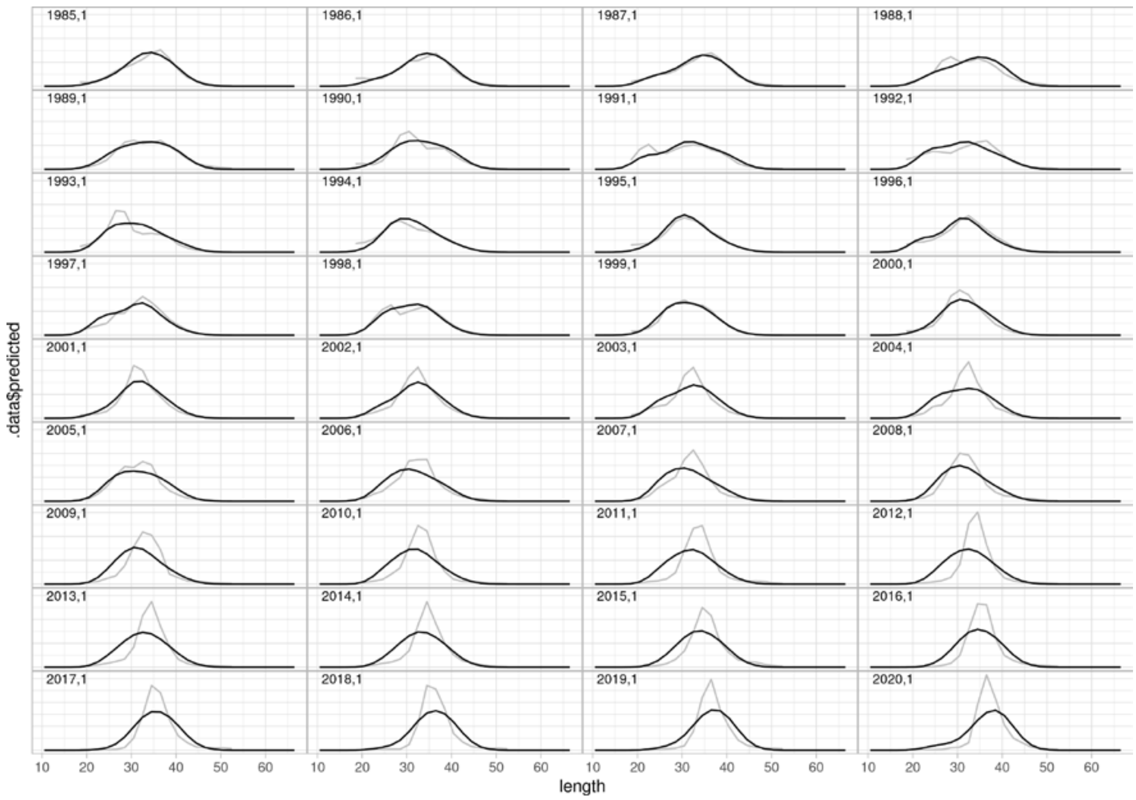


Figure 19.4.7. Fitted proportions-at-length from the Gadget model (black lines) compared to observed proportions in the spring survey (grey lines).

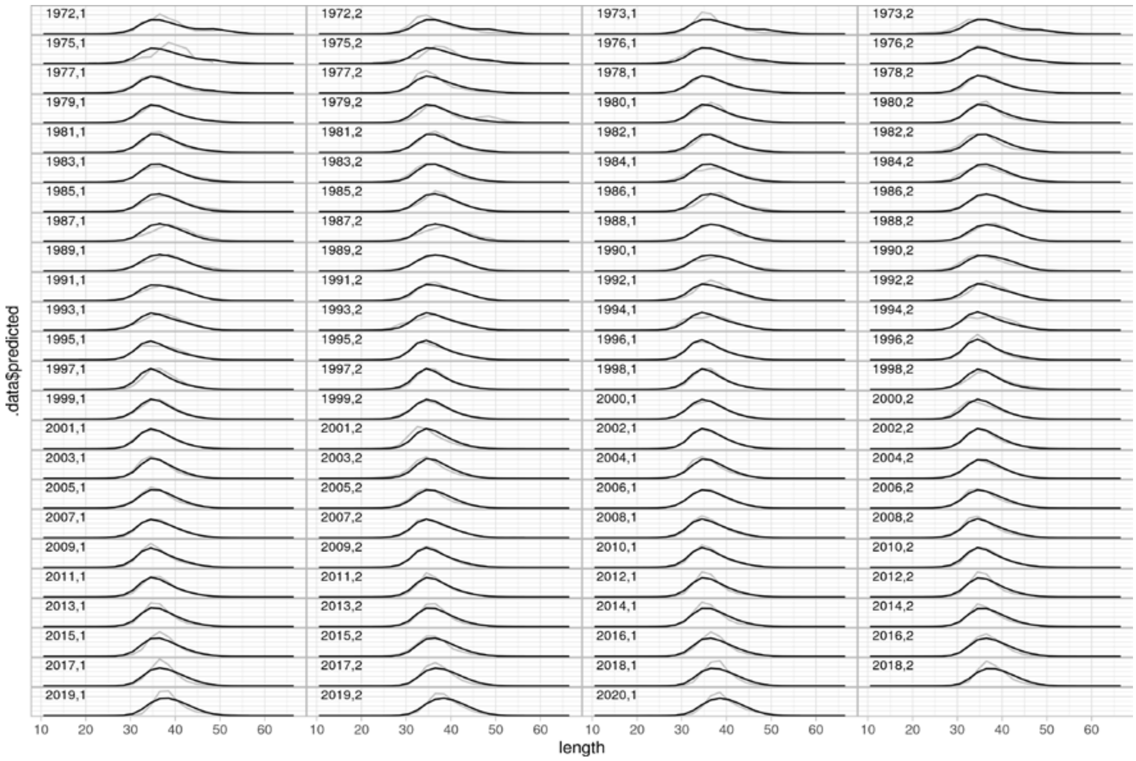


Figure 19.4.8. Fitted proportions-at-length from the Gadget model (black lines) compared to observed proportions from the Icelandic commercial catches (grey lines).

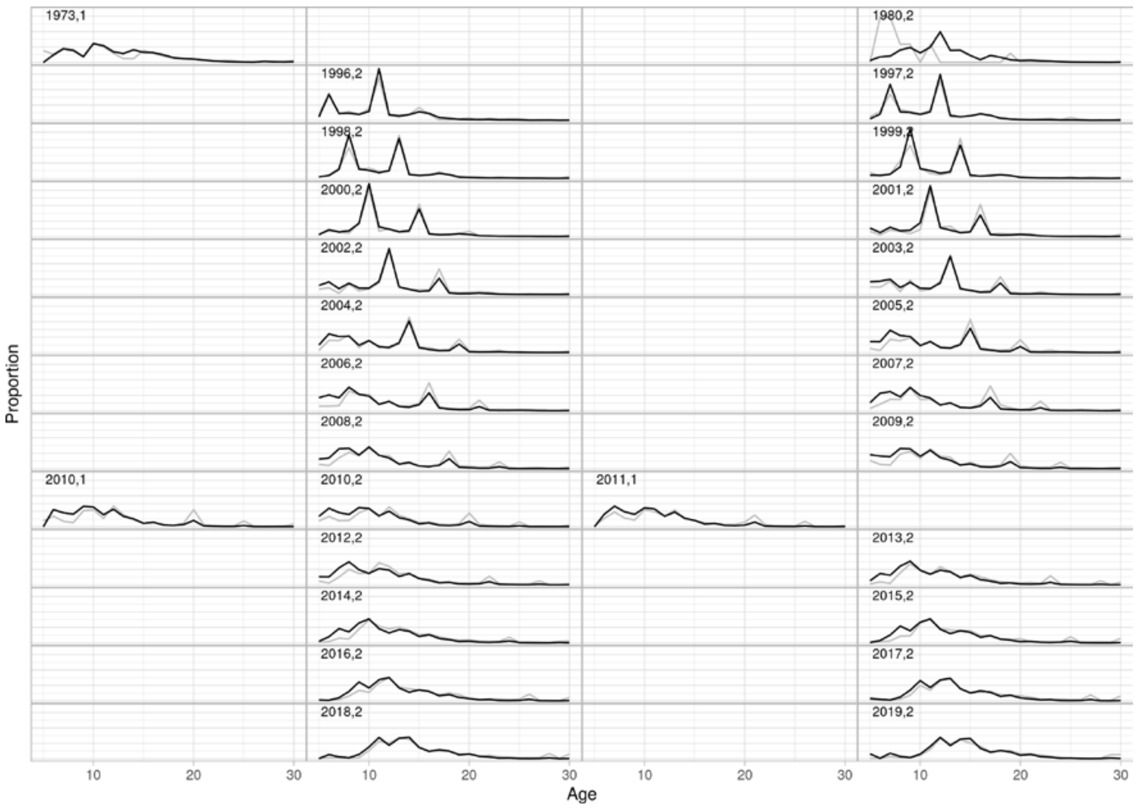


Figure 19.4.9. Fitted proportions-at-age from the Gadget model (black lines) compared to observed proportions in the autumn survey (grey lines).

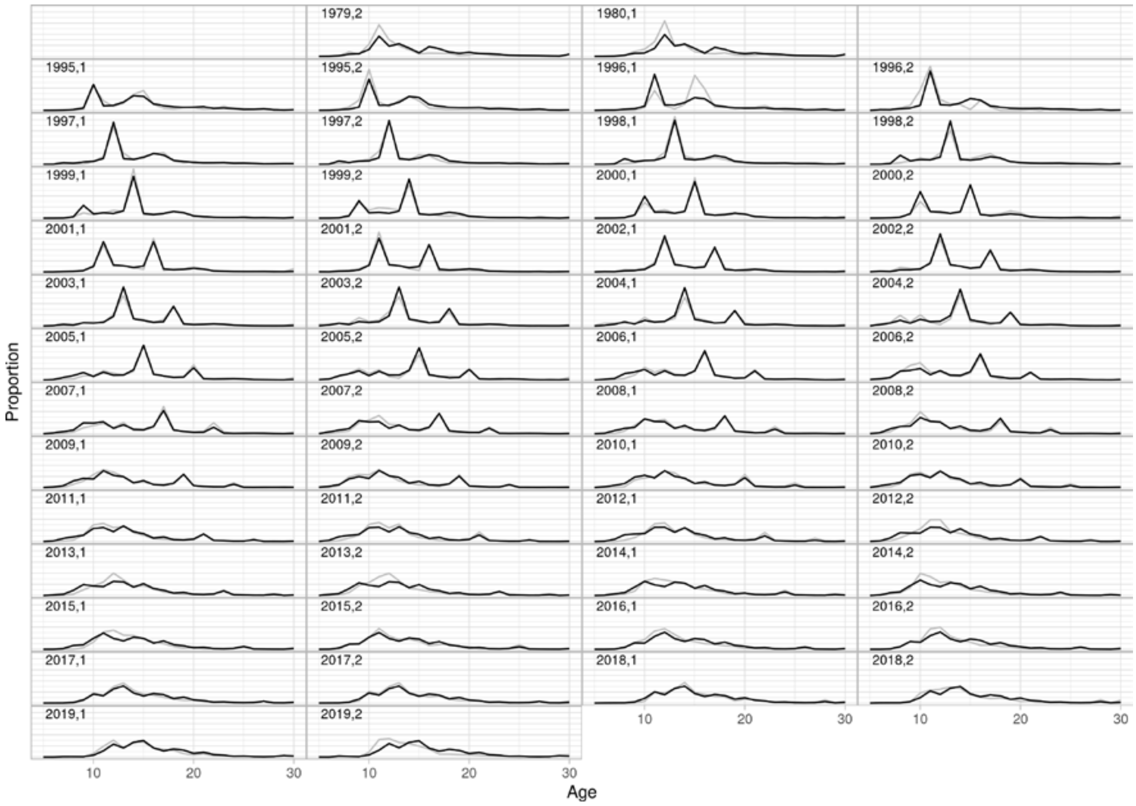


Figure 19.4.10. Fitted proportions-at-age from the Gadget model (black lines) compared to observed proportions from the Icelandic commercial catches (grey lines).

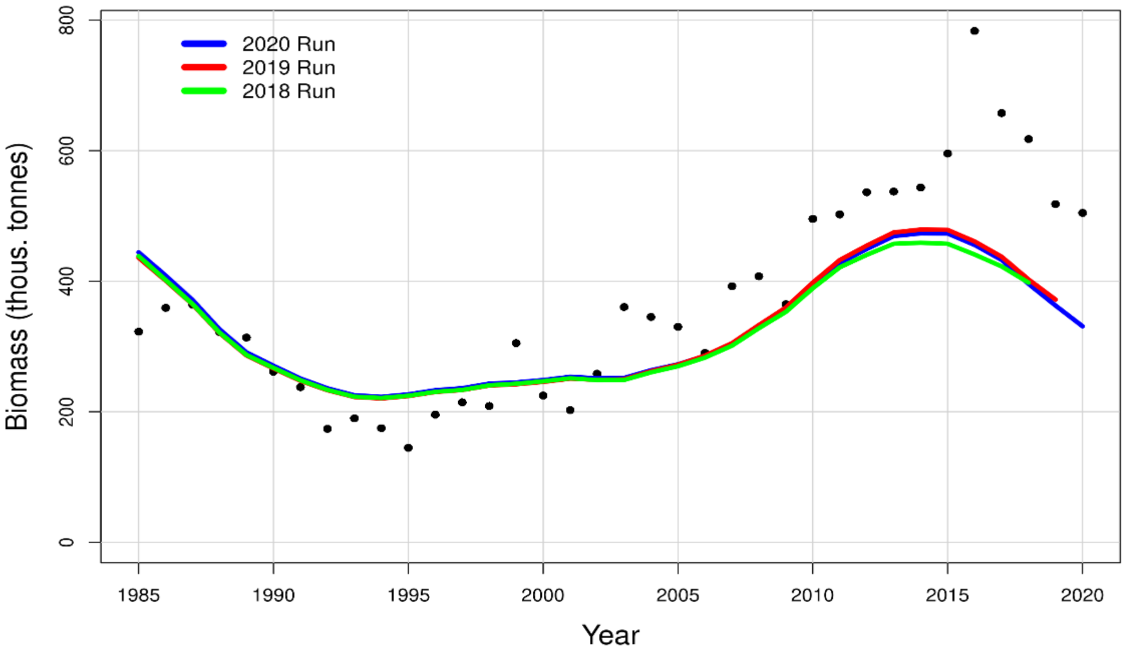


Figure 19.4.11. Comparison of observed and predicted survey biomass from the 2020 (blue line), 2019 (red line) and 2018 (green line) assessment runs.

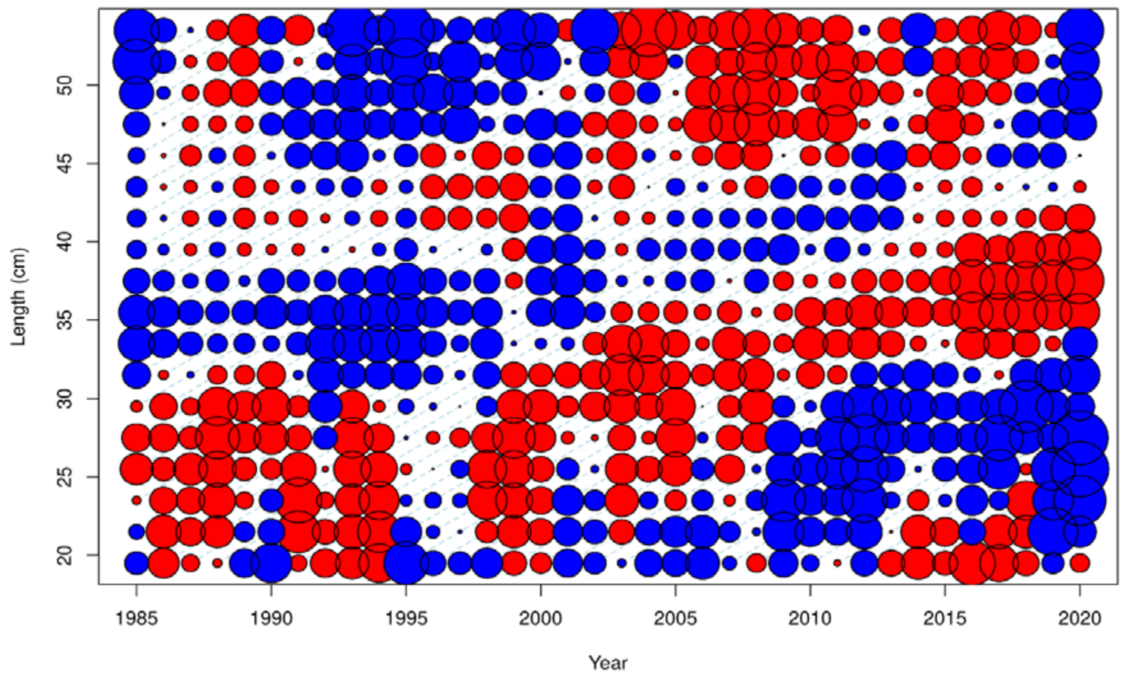


Figure 19.4.12. Residuals from the fit between model and survey indices. The red circles indicate positive residuals (survey results exceed model prediction). Largest residuals correspond to log(obs/mod) = 1

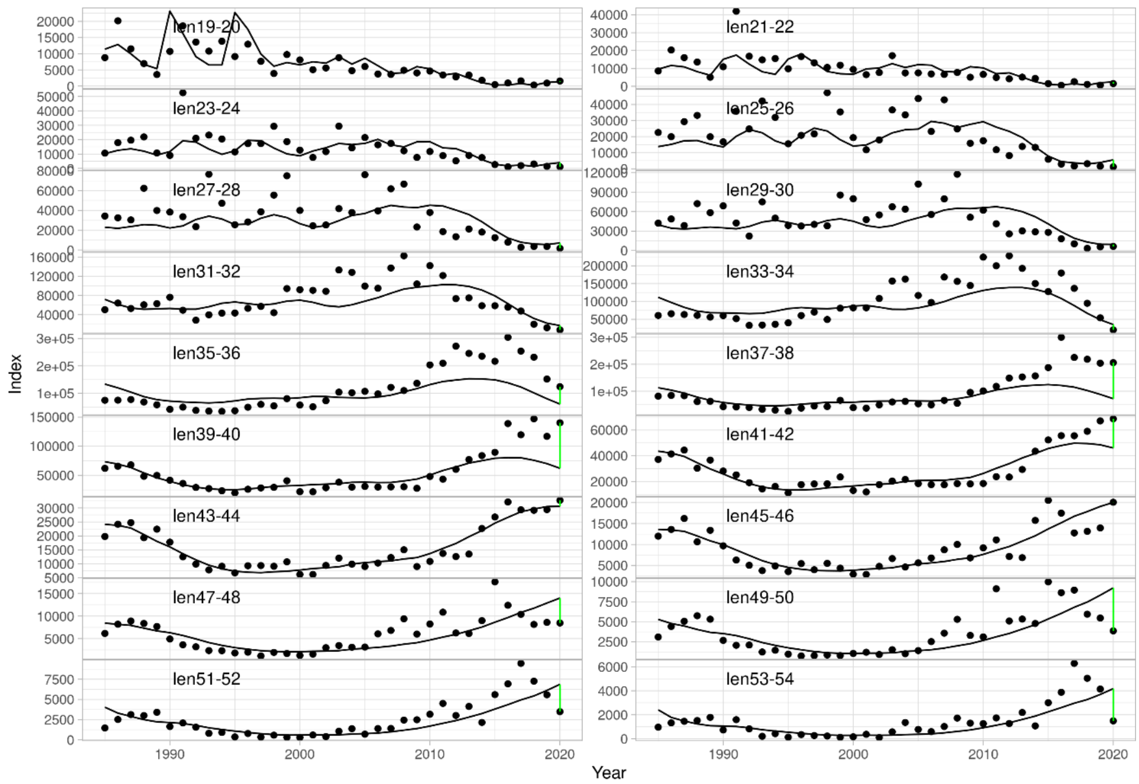


Figure 19.4.13. Gadget fit to indices from disaggregated abundance by length indices from the spring survey.

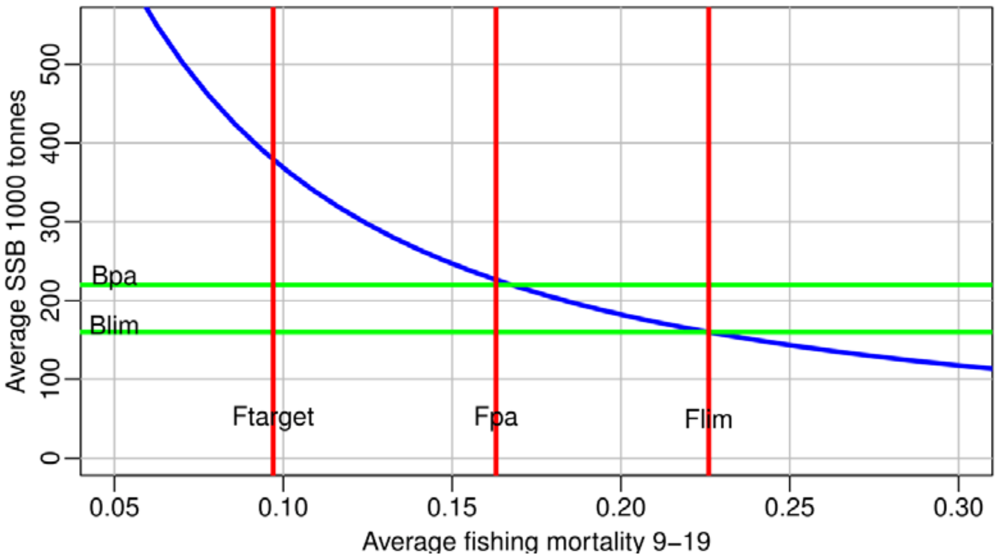


Figure 19.5.1. Average SSB against average fishing mortality and defined reference points.

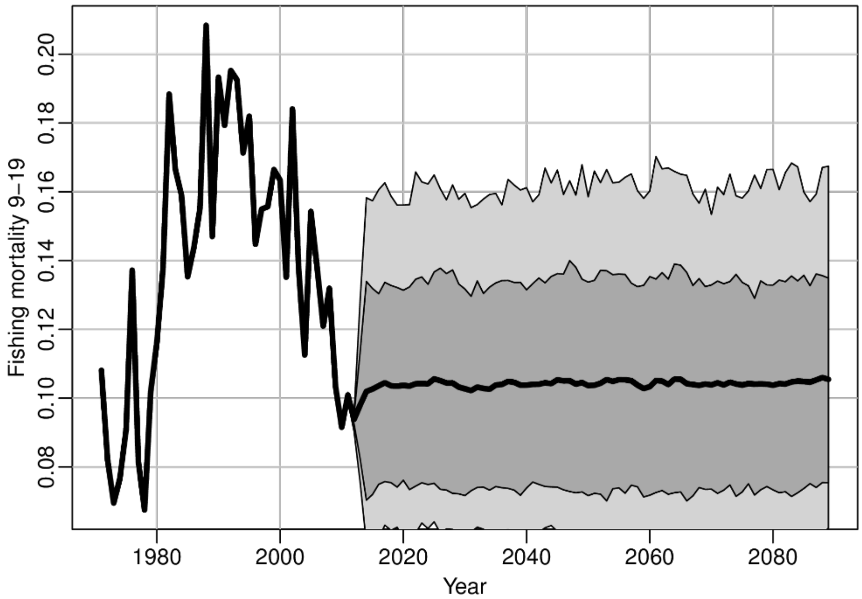


Figure 19.5.2. Development of $F_{9–19}$ based on F_{9-19} = 0.097. The light grey area shows fifth and 95th quantile and the dark areas 16th and 84th quantile.

20 Icelandic slope *Sebastes mentella* in 5.a and 14

Because of the Covid-19 outbreak the Ministry of Industries and Innovation in Iceland does not require advice from ICES for Icelandic slope *Sebastes mentella* for 2021. This is done to reduce travelling of Icelandic experts and the workload of both MRFI and ICES (see letter dated March 12, 2020 in section 1).

The assessment of Icelandic slope *S. mentella* was therefore not presented and discussed during the NWWG in April. Data input tables in the report were updated (catches and survey indices) but not the text and figures. Also, the advice sheet is not updated.

Table 20.2.1 Total biomass index of Icelandic slope *S. mentella* in the Icelandic Autumn Groundfish survey 2000–2019. No survey was conducted in 2011.

Year	Iceland	cv
2000	134 407	0.145
2001	161 733	0.182
2002	95 059	0.140
2003	63 179	0.127
2004	96 465	0.171
2005	109 196	0.250
2006	123 059	0.166
2007	82 062	0.183
2008	80 011	0.141
2009	93 653	0.174
2010	77 852	0.154
2011	-	-
2012	74 604	0.145
2013	70 055	0.156
2014	103 051	0.191
2015	107 423	0.174
2016	80 855	0.123
2017	125 611	0.172
2018	122 292	0.209
2019	85 157	0.142

Table 20.3.1 Nominal landings (in tonnes) of Icelandic slope *S. mentella* 1950–2019 from the Iceland Sea ecoregion (ICES Division 5.a and Subarea 14 within the Icelandic EEZ).

Year	Iceland	Others	Total
1950	1 458	36 269	37 727
1951	1 944	45 825	47 769
1952	885	55 554	56 439
1953	658	86 011	86 669
1954	577	75 972	76 459
1955	654	52 784	53 438
1956	674	40 047	40 721
1957	558	35 993	36 551
1958	409	43 820	44 229
1959	398	40 175	40 573
1960	407	38 428	38 836
1961	307	31 534	31 841
1962	264	35 122	35 386
1963	456	38 338	38 794
1964	362	45 414	45 776
1965	473	55 930	56 403
1966	332	47 491	47 823
1967	357	47 313	47 670
1968	494	50 892	51 386
1969	486	38 358	39 345
1970	500	35 800	36 300
1971	495	34 376	34 871
1972	593	39 874	40 468
1973	794	35 251	36 045
1974	806	32 103	32 909
1975	1 404	29 301	30 705
1976	715	28 632	29 346
1977	590	22 427	23 018

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

Year	Iceland	Others	Total
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
2014	9 500	0	9 500
2015	9 311	0	9 311
2016	9 536	0	9 536
2017	8 371	0	8 371
2018	9 995	0	9 995
2019[1)]	8 716	0	8 716

1) Provisional

Table 20.3.2 Proportion of the landings of Icelandic slope *S. mentella* taken in the Iceland Sea ecoregion (ICES Division 5.a and Subarea 14 within the Icelandic EEZ) by pelagic and bottom trawls 1991–2019.

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%
2008-2019	0%	100%

21 Shallow Pelagic *Sebastes mentella*

Advice for 2020 and 2021 was given in 2019. Because of the Covid-19 outbreak only catch tables were updated.

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	4189	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	9 684	17 037	458	0	0	27 179
1992	106	22 969	39 488	0	0	0	62 564
1993	0	66 461	34 310	0	0	0	100 771
1994	665	77 211	18 992	0	0	0	96 869
1995	77	78 898	21 160	0	0	0	100 136
1996	16	22 544	19 210	0	0	0	41 770
1997	321	18 211	9 213	0	0	0	27 746
1998	284	22 002	1 864	0	0	0	24 150
1999	165	23 713	1 101	534	0	0	25 512
2000	3 375	17 491	1 298	11 052	0	0	33 216
2001	228	32 164	2 383	5 290	1 751	8	41 825
2002	10	24 025	336	15 702	3 143	0	43 216
2003	49	24 211	132	26 594	5 377	325	56 688
2004	10	7 669	1 158	20 336	4 778	0	33 951
2005	0	6 784	281	16 260	4 899	5	28 229
2006	0	2 094	94	12 692	593	260	15 734
2007	71	378	98	2 843	2 561	175	6 126
2008	32	25	422	1 580	0	0	2 059
2009	0	210	2 170	0	0	0	2 380

Year	Va	XII	XIV	NAFO 1F	NAFO 2J	NAFO 2H	Total
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
2015	161	2 281	0	3 119	34	0	5 595
2016	235	1 671	0	61	0	0	1 967
2017	81	10	10	0	0	0	101
2018	0	2 203	0	2 396	0	0	4 599
2019	0	1 799	0	1 385	0	0	3 184

1982–1991 All pelagic catches assumed to be of the shallow pelagic stock

1992–1996 Guesstimates based on different sources (see text)

1997–2019 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. 5a, subareas 12, 14 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	Green-land	Iceland	Japan	Latvia	Lithuania	Nether-lands	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		1510	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		2170	28 314	4 327		2 230	100 136
1996	1 846	343	3 741	2 523		5 696	1866	5 760	219	572	5 618		1 681		476	9 348	1 671	137	273	41 770

Year	Bulgaria	Canada	Estonia	Faroes	France	Germany	Green-land	Iceland	Japan	Latvia	Lithuania	Nether-lands	Norway	Poland	Portugal	Russia*	Spain	UK	Ukraine	Total
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	1161	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	1083	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
2003				1 955		3 579	1047	4 274		1 269	21 629		3 214	917	1926	15 418	1 461			56 688
2004				777		1 126	750	5 728		1 114	3 698		2 721	1018	2133	13 208	1 679			33 951
2005				210		1 152		3 086		919	1 169		624	1170	2780	15 562	1 557			28 229
2006				334		994		1 293		1 803	466		280	663	1372	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				93				5		59	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

Year	Bulgaria	Canada	Estonia	Faroes	France	Germany	Green-land	Iceland	Japan	Latvia	Lithuania	Nether-lands	Norway	Poland	Portugal	Russia*	Spain	UK	Ukraine	Total
2013								72								1 457				1 529
2014								355			287					5 781				6 423
2015								161								5 434				5 595
2016								235								1 732				1 967
2017								91								10				101
2018																4 599				4 599
2019																3184				3184

22 Deep Pelagic *Sebastes mentella*

Advice for 2020 and 2021 was given in 2019. Because of the Covid-19 outbreak only catch tables were updated.

Table 22.2.1 Deep Pelagic *S. mentella* (stock unit >500 m). Catches (in tonnes) by area as used by the Working Group.

Year	5.a	12	14	NAFO 1F	Total
1991	0	7	52	0	59
1992	1862	280	1257	0	3398
1993	2603	6068	6393	0	15064
1994	14807	16977	20036	0	51820
1995	1466	53141	21100	0	75707
1996	4728	20060	113765	0	138552
1997	14980	1615	78485	0	95079
1998	40328	444	52046	0	92818
1999	36359	373	47421	0	84153
2000	41302	0	51811	0	93113
2001	27920	0	59073	0	86993
2002	37269	2	65858	0	103128
2003	46627	21	57648	0	104296
2004	14446	0	77508	0	91954
2005	11726	0	33759	0	45485
2006	16452	51	50531	254	67 288
2007	17769	0	40748	0	58516
2008	4602	0	25443	0	30045
2009	16828	4658	32920	0	54406
2010	8552	0	50736	0	59288
2011	0	7	47326	0	47333
2012	5530	608	26668	0	32806
2013	5274	0	40778	0	46052
2014	603	0	23152	0	23755
2015	1821	0	25612	0	27433
2016	2601	0	26053	0	28654
2017	1639	0	28252	0	29891
2018	711	0	23742	0	24453
2019	236	0	24167	0	24403

Table 22.2.2. Deep pelagic *S. mentella* catches (in tonnes) in ICES Div.5.a, subareas 12, 14 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								3398												3398
1993				310		1135		12741					878							15064
1994						2019		47435					523		377	1465				51820
1995	1140	181	5056	1572	68	8271	1579	25898	396	1501	6868	4	3169		2955	15868	227		956	75707
1996	1654	307	3351	3748		15549	1671	57143	196	512	5031		5161		1903	36400	5558	123	245	138552
1997		9	315	435		11200		36830	3				2849		3307	33237	6895			95079
1998			76	4484		8368	302	46537	1		34		438		4073	25748	2758			92818
1999			53	3466		8218	3271	40261					3337		4240	11419	9885	5		84153
2000			7733	2367		6827	3327	41466			0		3108		3694	14851	9740			93113
2001			878	3377		5914	2360	27727			7515		4275		2488	23810	8649			86993
2002			15	3664		7858	3442	39263			9771		4197		2208	25309	7402			103128
2003				3938		7028	3403	44620			0		5185		2109	28638	9374			104296
2004				4670		2251	2419	31098			0		6277	1889	2286	31067	9996			91954
2005				1800		1836	1431	12919			1027		3950	1240	1088	16323	3871			45485

Year	Bulgaria	Canada	Estonia	Faroes	France	Germany	Greenland	Iceland	Japan	Latvia	Lithuania	Nederland	Norway	Poland	Portugal	Russia	Spain	UK	Ukraine	Total
2006				3498		1830	744	20942			1294		5968	1356	1313	23670	6673			67288
2007				2902		1110	1961	18097		575	1394		4628	636	2067	21337	3810			58516
2008				2632			1170	6723			749		571	219	1733	15106	1142			30045
2009				3206			1519	15125		1355	2613			178	1596	25309	2907			54006
2010				3195			1932	14772		1963	2228		2388	3	2203	22803	7801			59288
2011				2028		1787		11994		845	1348		1066		1540	22364	4361			47333
2012				1438		1523		5912		724	558		3362		250	18377	632			32806
2013				1882		1176		8545		1200	1163		2979			26463	2644			46052
2014				721		890		2081		867	1024		1965			15475	732			23755
2015				779		918		1968			330		1547		202	20214	1475			27433
2016				567		715		2601		549	803		1396			21619	404			28654
2017				559		772		1929			911		970			24355	395			29891
2018				438		357		1138		441	900		868			20113	198			24453
2019						531		236			911		700			21964	61			24403

23 Greenlandic slope *Sebastes mentella* in 14.b

23.1 Stock description and management units

See Section 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 14.b 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 14.b. A German survey directed towards cod in Greenlandic waters (0–400 m) (Fock et al., 2013), the Greenland deep-water survey (400–1500 m) targeting Greenland halibut and the Greenland shrimp and fish survey in shallow water (0–600 m), which has been conducted since 2008 (Christensen and Hedeholm, 2018). The Greenland shrimp and fish survey is used in the assessment. No survey was conducted in 2017,2018 and 2019. The German survey on the slope in 14.b has since 1982 been covering the slopes in East Greenland waters. No survey was conducted in 2018. Cod is the target species in this survey, and it operates at depths of 400 m and shallower. The survey was re-stratified in 2009 (see Stock Annex). From 1993–1998 a large number of Sebastes spp. smaller than 17 cm was found in the German survey (Figure 23.2.1). This coincided with a large in-crease 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 in both biomass and abundance was observed, with 2015 representing the lowest biomass for the last 20 years (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 23.2.1) 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 esti-mates (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. The distribution has become flat with no clearly defined mode in 2013–2019 (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 m 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. In 2015 and 2016, the mode increased slightly (Figure 23.2.4). The survey was aborted in 2017 due to vessel breakdown and in 2018 there was no available research vessel for the survey, why no new data is available since 2016.

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 conjunc-tion 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 cover-age of redfish distribution. The 2016 biomass estimate for S. mentella increased from 61 kt to 164 kt from 2015 to 2016

(Figure 23.2.5). However, the estimate has large uncertainties since one haul accounted for 70% of the total biomass estimate. The haul was taken in area Q2 close to Icelandic waters. Due to the missing survey in 2017, 2018 and, no new data is availa-ble.

The German survey was in 2017 limited due to bad weather and only 46 out of an average of 75 stations were covered on the Greenland East coast. However, the most important Redfish strata were surveyed with a reasonable coverage, why the result is expected to be valid. In 2017 and 2019, the declining trend documented in the earlier years continues. The accuracy of the surveys as an indicator of recruitment is not known but recruitment is expected to be poor, and the abundance of juveniles is at the lowest level in the 30-year time-series. An ex-perimental fishery in 2019 partly focusing on juvenile redfish confirmed that the abundance of juvenile redfish continues to be at a very low level (Christensen, 2020b).

In 2016, there was a difference between the Greenland and the German survey; the Green-land survey had a length mode was 39 cm, while the mode in the German survey was 34 cm. The difference was attributed to the one large haul in the Greenland survey consisting of a high proportion of large S. mentella in the survey area close to Iceland (figures 23.2.2. and 23.2.6). Survey length distributions for the German survey had a mode of 39.5 cm in 2019, which is a notable increase compared to earlier years (figure 23.2.2).Information from the fishing industry.

23.2.1 Landings

From the Greenland and German surveys, we know that the demersal redfish found on the Greenland slope is a mixture of S. norvegicus and S. mentella. In 2019, the species split in the fishery was based on the information from logbooks and is therefore subject to uncertainties due to the fishermen's ability to distinguish between S. norvegicus and S. mentella in the catches. The species split in 2019 was estimated to be 60% S. mentella (3998) and 40% S. norvegicus (2665). Earlier S. mentella dominated the catches, but the proportion started to decline in 2014 (Figure 23.3.1.1). In 2016, the split changed and for the first time S. norvegicus now dominated the catches (Figure 23.3.1.1). In 2019, S. mentella was again dominating the catches. The large change between years is most likely due to the uncertainty of the split. Prior to 1974, all catches were reported as S. norvegicus and the split was determined by working groups on a yearly basis.

Catch depth has in the later years declined compared to earlier. In 2016, the catches were taken at a depth of 300–400 m. In 2017 and 2018 it declined even further and in 2019 an in-creasing part of the catch was taken at down to 300 m. In 2011–2012 were caught at 350–400 m (Figure 23.3.1.2).

Total annual landings of demersal S. mentella from Division 14.b since 1974 are presented in Table 23.3.1.3. From 1976–1994 annual landings were at a relatively high level with landings ranging between 2000 and 20 000 tonnes with a very high peak at nearly 60 000 t in 1976. This fishery was ended abruptly in 1995, due to large amounts of very small redfish in the catches. From 1998–2002 the landings ranged from 1000 to 2000 tonnes and from 2003 to 2008 landings remained at lower levels (< 500 tonnes). In 2009, an exploratory fishery landed 895 tonnes 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 5000 tonnes demersal redfish (mixed S. mentella and S. norvegicus) was initially given and of these, 400 tonnes were allocated to the Norwegian fleet. After this amount was fished, a research quota of 1000 tonnes were given to a Greenland vessel. Since 2010, the catches have been around 8300 tonnes (S. mentella and S. norvegicus combined) (Figure 23.3.1.3). In 2017, total catches decreased to 7568 tonnes and in 2018 the catch de-creased further to 5976 tonnes. However, in 2019 a notable increase in the catches occurred and the total catch was 6663 tonnes (Figure 23.3.1.3). Since 2011 the mixed TAC has been 8500 tonnes until 2017 where the TAC started to decrease. In 2019, the mixed TAC was 5274 tonnes.

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 tonnes) 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).

23.2.2 CPUE and bycatch CPUE

A redfish bycatch CPUE was introduced at the redfish 2012 benchmark (WKRED). This is based on catches from the Greenland halibut directed fishery and include both S. mentella and S. norvegicus (Christensen 2020a), which covers redfish distribution better than data from the red-fish directed fishery and covers a longer period (1999–2019). The Greenland halibut fishery is not as spatially restricted as the redfish fishery; thus it will not be as sensi-tive to local changes as the redfish directed CPUE. The CPUE has very low values in the ini-tial 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. Since 2011, the CPUE have been relatively stable with minor fluctuations (Figure 23.3.2.1). The increase in CPUE in 2016 and the decline in 2017 is reflected in the biomass index estimated based on the shallow water surveys in the same years (German).

The CPUE from the redfish directed fishery showed a decline from 2010 to 2015, while it increases in 2016 (1.7 t/h). in the later years the CPUE have been relatively stable (Figure 23.3.2.2). The 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 (0–600 m) and the German survey (0–400 m) show that the main fishing area coincides with the area of highest overall abundance.

23.2.3 Fisheries and fleets

The fishery for S. mentella on the slopes in 14.b is mainly conducted with bottom trawl, only about 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 (Figure 23.3.3.1). The majority of the catches are taken at depths from 300 m to 400 m.

The directed fishery was stopped in 1995, but in 1998 Germany restarted a directed fishery for redfish with annual landings of approximately 1000 tonnes in 1998–2001 increasing to 2100 tonnes 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 14.b in 2003–2004 (less than 500 tonnes). This continued in 2005–2008 and most S. mentella were caught as bycatch 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 2001–2005 and since 2006 only Greenland, 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 tonnes. 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 ves-sel is not fishing due to processing of the catch.

23.2.4 Bycatch/discard in the shrimp fishery

To minimize bycatch 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 on the amount of bycatch in the shrimp fishery the mean length of the redfish that entered the codend 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 tonnes to a lower level near 100 tonnes. Since 2006, limited shrimp fishery has taken place in ICES 14.b and the current level of bycatch must be considered neg-ligible and have for the last two years been zero (Table 23.3.4.1). From 1999–2009, the fishery started in April–May due to poor winter conditions such as ice and wind that prevents fish-ing. Only in 2000 and 2002, the fishery started already in February (Table 23.3.4.2). Since 2010, the fishery has started already in January and in 2018 February was the month with the highest landings. In 2019, the fishery was relatively high already in March, but most of the catch was fished in May and June. In earlier year, June and July were the most im-portant months today only catches in July are at the same level as earlier in the year (Table 23.3.4.2). The depth distribution of cod and redfish overlap (Figure 23.3.3.2) and therefore the fishery for redfish led to a bycatch of cod on 96 tonnes in 2013. The vessels are allowed a 10% bycatch of cod.

23.3 Methods

No analytical assessment was conducted.

23.4 Reference points

As described in Section 1.3, MSY proxy reference points needs to be defined for the Green-landic S. mentella slope stock. ICES suggested four methods for this purpose, and all methods were tested on the stock. The conclusion was that based on the caveats listed below and the declines seen in surveys, especially on recruitment over the past decade, the determination of the stock status in relation to reference points should not be based solely on any of the indi-cators pre-sented here, but rather a holistic view combining surveys and expert judgment with the results presented in Hedeholm and Christensen (2017).

The caveats to consider in relation to the Greenlandic *S. mentella* slope stock when concluding on the length-based indicators and the SPiCT model.

- If there are few year classes in the fishery, which is current for the present stock, the effect of overfishing the stock is more likely observed on biomass rather than length, especially on a slow growing species. There is no ageing done in this stock, why it is not possible to see if this is the case.
- *Sebastes mentella* is a slow growing species, thus the effect of the fishery on length may be very subtle. The relatively short time-series on length distributions available for this analysis and the limited number of samples per year entails that any effect is eas-ily missed.

- The schooling behavior of *S. mentella* in connection with the points made above means that the fishery can target a diminishing stock in a small area without seeing any effect on the length distribution. Indeed, the fishery is conducted with limited spatial extent.
- Several redfish stocks are present on the East Greenland slope, but in unknown quantities. Any changes in length could just as well be related to migration, timing of sampling, and latitude of sampling as to actual stock changes.
- Based on the three length-based methods the exploitation pattern appears reasonable. However, results from all three methods should be interpreted with some caution due to lack of knowledge of important input parameters (L_{inf}, M and k) for the specific stock (values from Fishbase are used).

23.5 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. In 2016, biomass indices increased but with high uncertainty of the estimate. In 2017-2019, no new biomass index was available from the Greenland survey due to vessel break down and no available research vessel. In both the Greenland and the German surveys there have been a complete absence of small fish since 2013. After a gradual decline from 2010 to 2015, the redfish directed fishery CPUE increased in 2016 to the same level as 2012–2014 but declined again in 2017 and 2018. In 2019, the CPUE increased again. Changes in length distributions also suggests that no new cohorts are present on the slope and that the change in adult biomass is caused by the grad-ual decline of a single/few cohorts. Especially the complete absence of juveniles is cause for concern.

The biomass estimates decline 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. If large redfish aggregations change 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 catcha-bility inferred from the less dense fish aggregations following some years of intense fishing. This is further complicated by the lack of knowledge of the stock's 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 Greenland surveys suggests that the biomass has a decreasing trend. 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.

The advice has until 2019 been based on the Data Limited Stock approach (DLS) including biomass indices from the Greenland shrimp and fish survey . The advice for 2020 was due to the lack of a survey estimate from the Greenland Shallow Water survey in 2017-2019 given based on a category 5 approach. CPUE has remained relatively stable. The advice should however be conservative due to the lack of survey data in 2017-2019, and the biology and dynamics of the species. Furthermore, from the German survey recruitment seems to contin-ue to be at a very low level. In 2018, a precautionary buffer was applied, and the advice is considered precautionary, why the buffer is not applied again this year. The advice for 2021 is 914 tonnes.

23.6 Management considerations

Sebastes mentella is a slow growing, late maturing deep-sea species and is therefore consid-ered vulnerable to overexploitation and advice must be conservative. The fact that the fish-ery is targeting a localized aggregation of fish is cause for concern as is the absence of juve-niles in the area. Given the biology of the species and the uncertainty in the biomass trend, any advice should consider this a hot spot 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 clari-fied.

23.7 References

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23.8 Tables

Table 23.3.1.1 Nominal landings (tonnes) of demersal *S. mentella* 1974–2019 ICES division 14.b.

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

Demersal *S. mentella*	
2013	6 597
2014	4 608
2015	5 977
2016	3 061
2017	3 027
2018	1 972
2019	3 998

Table 23.3.3.2 Landings (tonnes) of demersal redfish (*S. mentella* and *S. norvegicus*) caught in ICES 14.b by nation.

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
2015	1987			74		4979	208	822		469		8539
2016		-	1759	25	2	5859	-	858	-	-	-	8503
2017	1060		537	31		4736		787		418		7568
2018	418		1295	48		3276		489		450		5976
2019	976		1021	5		3410		985		266		6663
Sum	14841	3	4774	1152	536	52812	336	8383	3	1655	856	85350

Table 23.3.4.1 Discarded bycatch (tonnes) of *Sebastes sp*. from the shrimp fishery in ICES 14.b.

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

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Sum
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
2015	0	0	0	0	0	0	0	0	0	0	0	0	0
2016	0	0	0	0	0	0	0	0	0	0	0	0	0
2017	0	0	0	0	0	0	0	0	0	0	0	0	0
2018	0	0	0	0	0	0	0	0	0	0	0	0	0
2019	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 (tonnes) of demersal redfish (*S. mentella* and *S. norvegicus*) caught in ICES 14.b. by month.

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
2015	543	786	1016	451	507	1611	1160	1024	504	393	74	467	8539
2016	306	214	1130	1185	1426	1864	1298	559	466	38	14	1	8501
2017	373	1977	1368	751	308	513	1111	249	38	651	102	124	7568
2018	798	1273	819	779	367	189	1049	22	176	234	225	45	5976
2019	23	211	1102	653	1359	1316	601	520	365	379	36	98	6663
Sum	4198	9711	10105	10087	9730	12284	9172	5411	3360	3694	4211	3368	85347

23.9 Figures

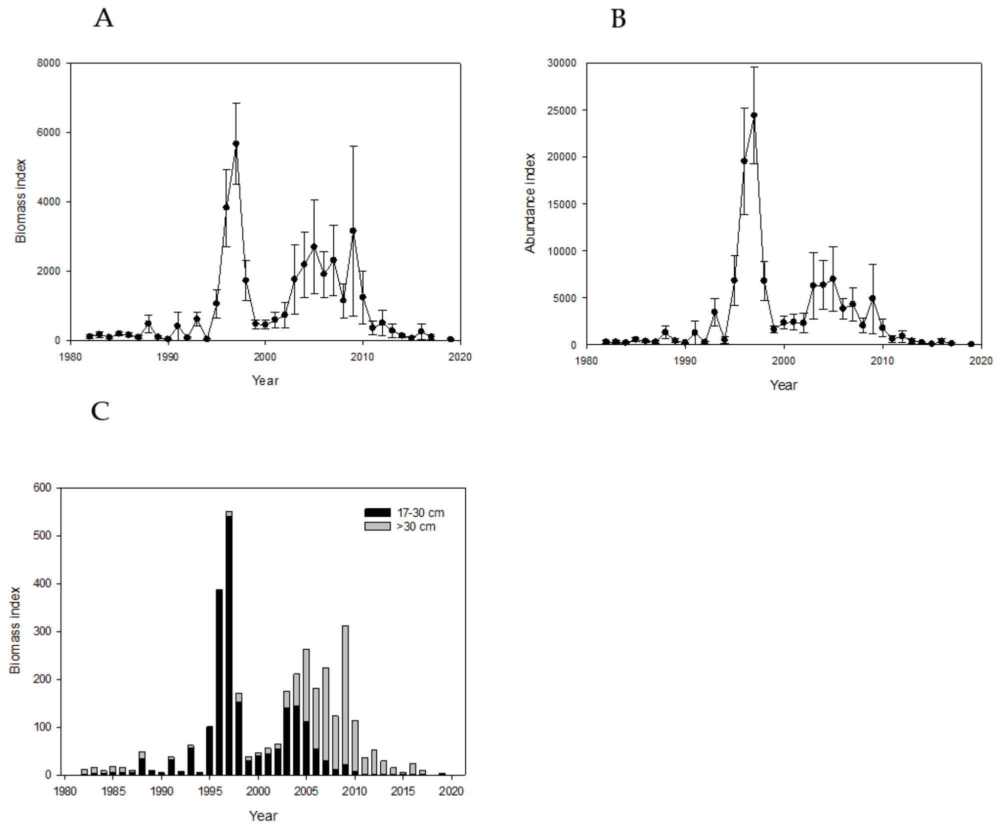

Figure 23.2.1. Indices from the German East Greenland survey of *S. mentella* larger than 17 cm. Biomass (A), abundance (B), and biomass split on length (C). On figure (C) the grey bars represent the biomass of *S. mentella* larger than 30 cm and the light bars biomass in fish from 17–30 cm. No survey was conducted in 2018.

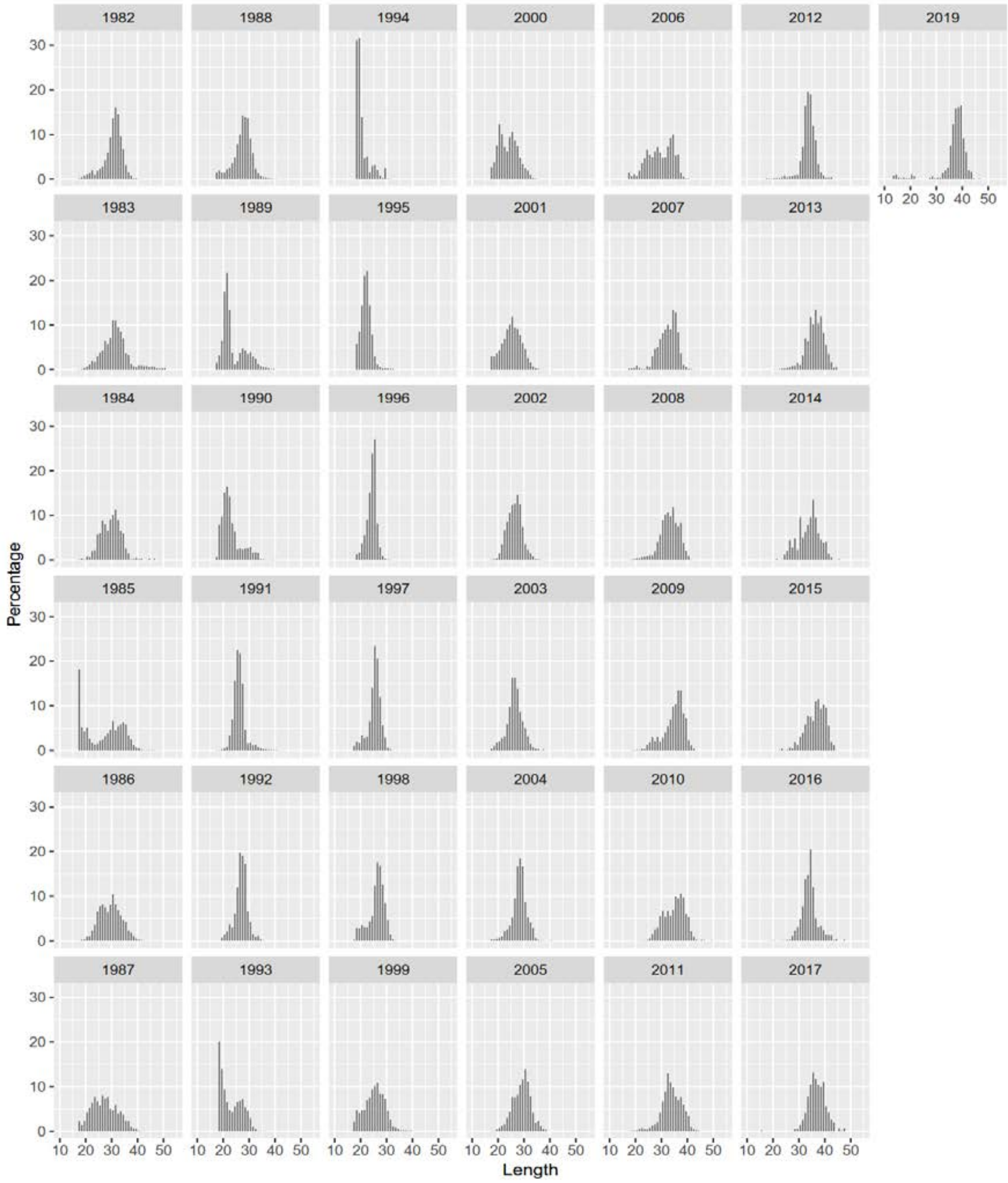

Figure 23.2.2. Length distributions from the German East Greenland survey 1985–2019. In 2018, the survey was not conducted due to break down of the German research vessel.

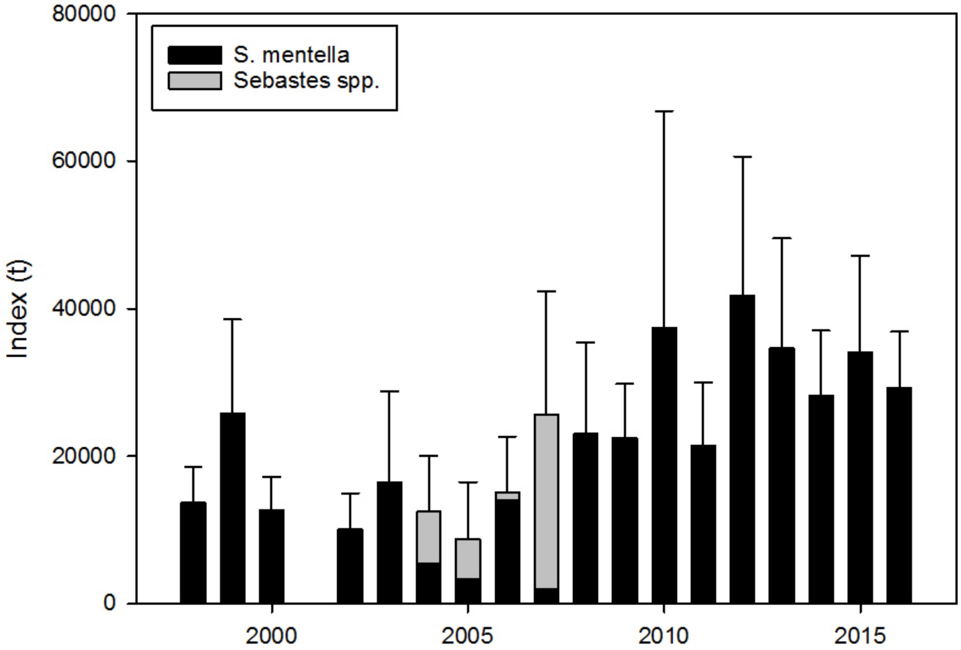

Figure 23.2.3. Biomass of *S. mentella* and *Sebastes* spp. derived from the deep Greenland survey. Bars indicate 2SE of the biomass of *S. mentella* including *Sebastes* spp. No survey in 2001. In 2004, 2005 and 2007 a large proportion of the redfish were not determined to species and only reported as "*Sebastes* spp". It is most likely that the majority of these fish were

***S. mentella.* In 2017, the survey was aborted due to vessel break down. In 2018 and 2019, no research vessel was available.**

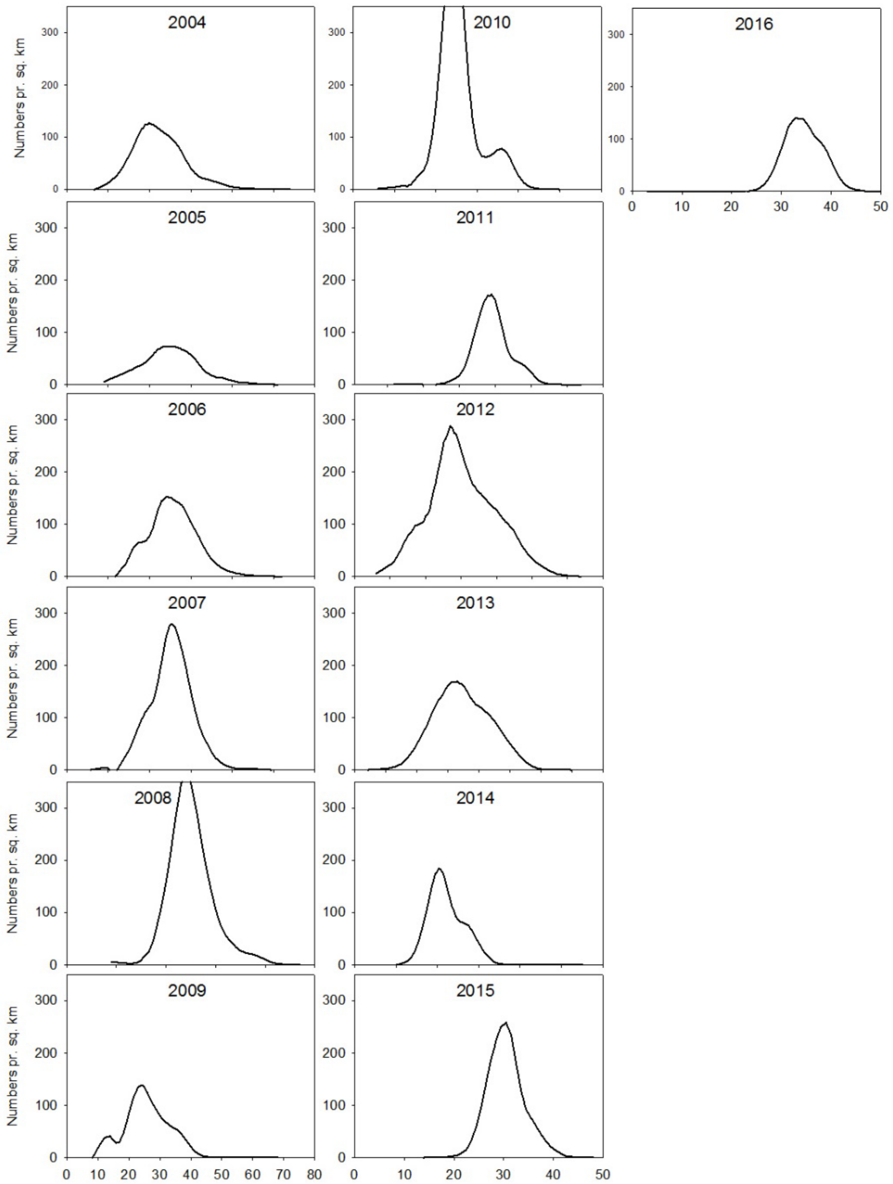

Figure 23.2.4. Overall length distribution of *Sebastes mentella* (number per km²) from the deep Greenland survey. In 2017, the survey was aborted due to vessel break down. In 2018 and 2019, no research vessel was available, therefore no new data is available.

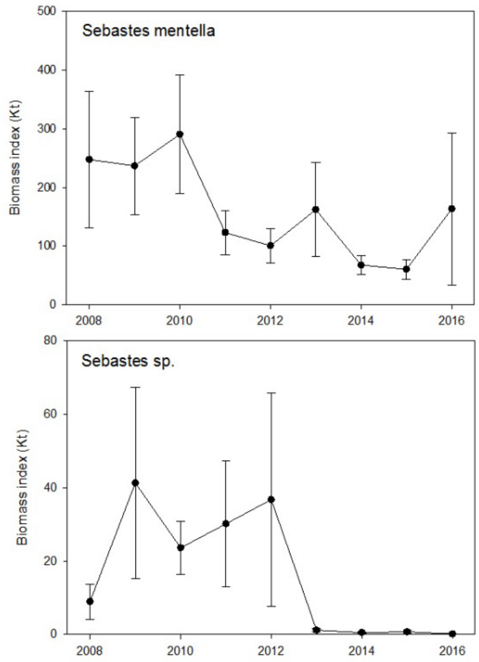

Figure 23.2.5: Biomass (kg*10^6, kt) (±CV%) indices for *S. mentella* (top) and *Sebastes* sp. (< 18 cm) (bottom) off East Greenland in 2008–2016 from the Greenlandic shallow water survey. All surveyed areas are combined (Q1–Q6). In 2017, the survey was aborted due to vessel break down. In 2018 and 2019, no research vessel was available, therefore no new data is available.

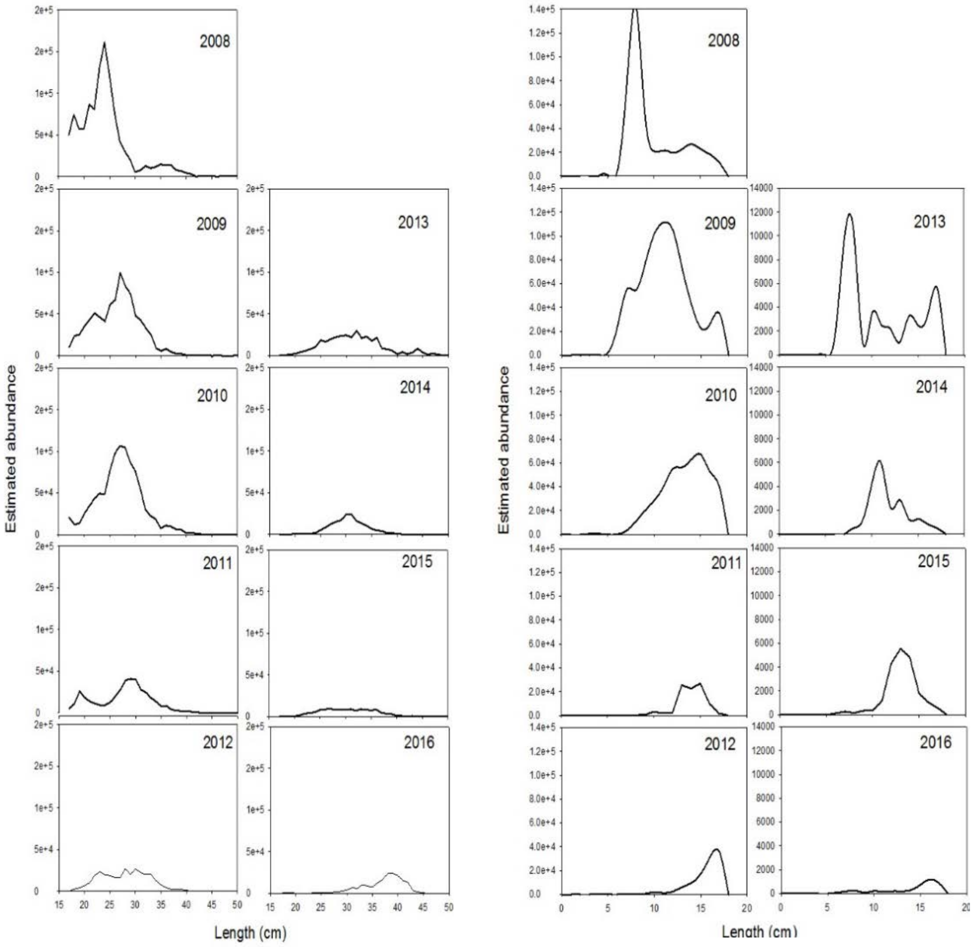

Figure 23.2.6. Overall length distributions for juvenile redfish *S. mentella* (left) and *Sebastes spp.* < 18 cm (right) (note the change in scale from 2013) from the Greenland shallow water survey. All surveyed areas combined (Q1–Q6). In 2017, the survey was aborted due to vessel break down. In 2018 and 2019, no research vessel was available, therefore no new data is available.

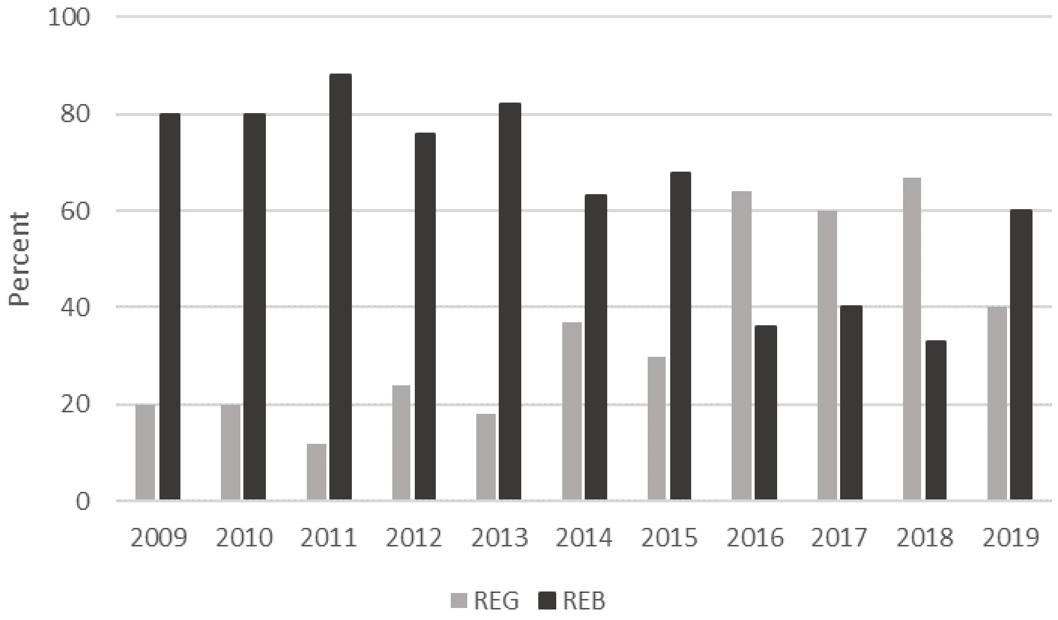

Figure 23.3.1.1. Development in split of *S. mentella* and *S. norvegicus* in the fisheries on the Greenland slope.

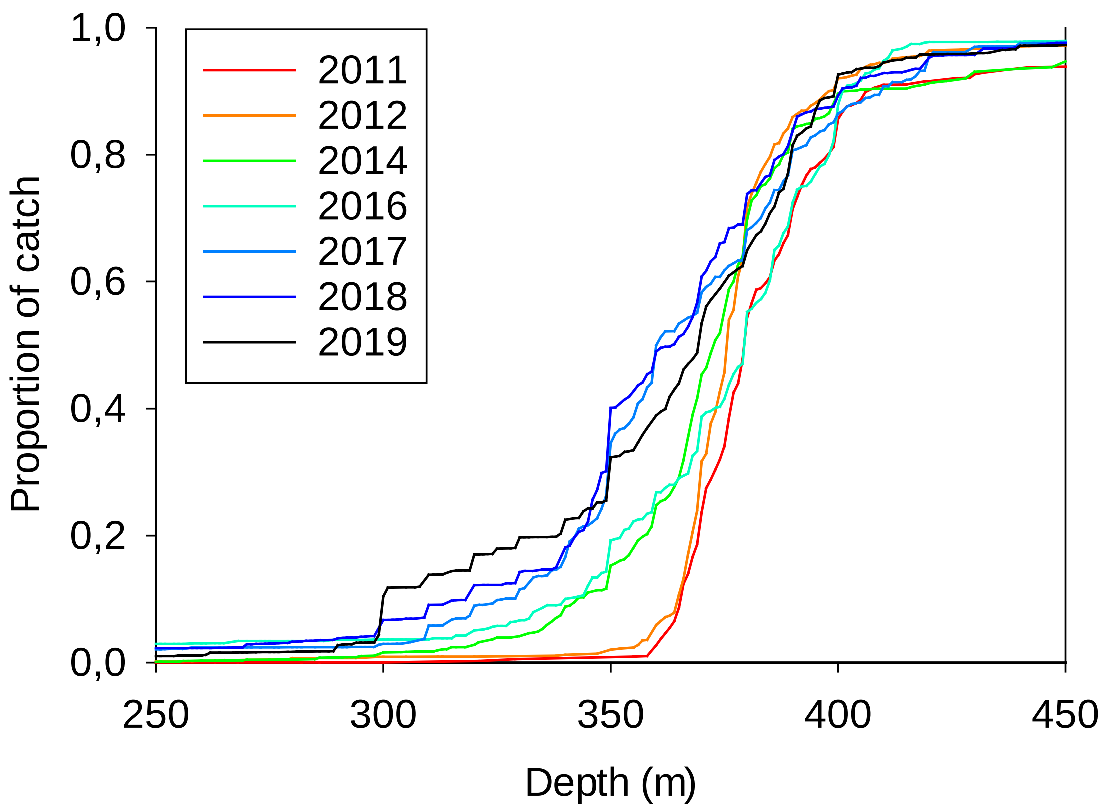

Figure 23.3.1.2 Development in catch depth of *Sebastes* (*S. mentella* and *S. norvegicus* combined).

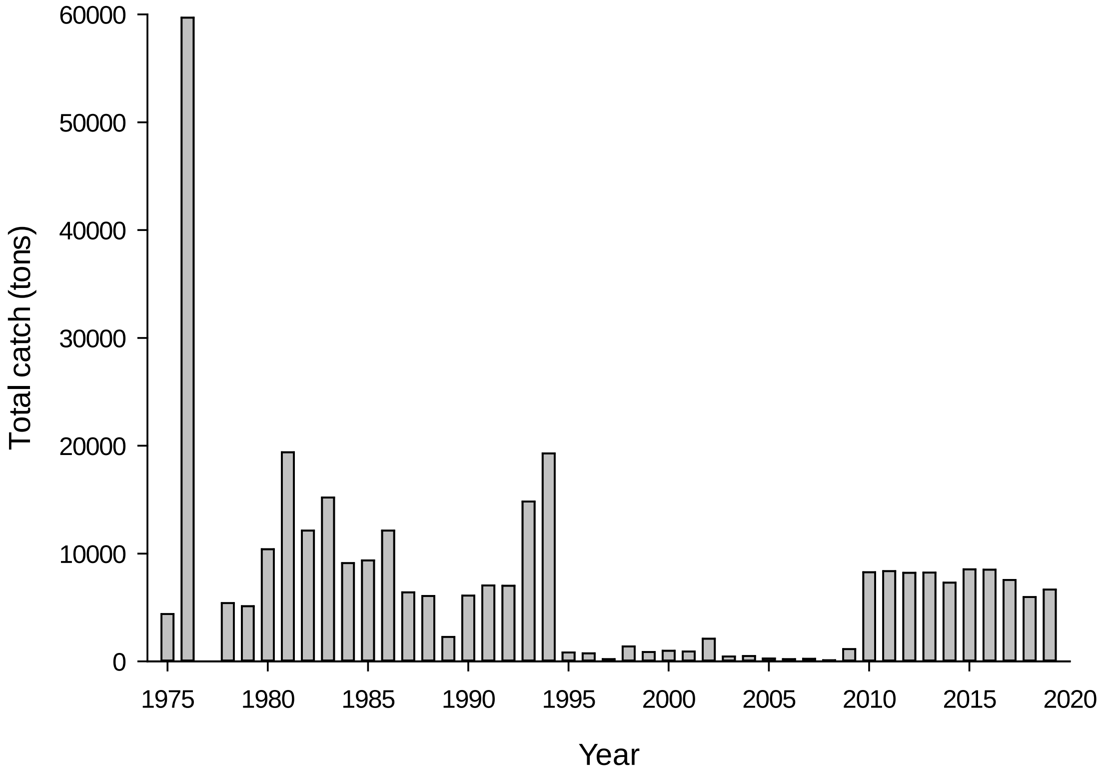

Figure 23.3.1.3 Landings of *S. mentella* in subarea 14.b. Landings of "redfish" have been split based on estimates from survey and commercial catches.

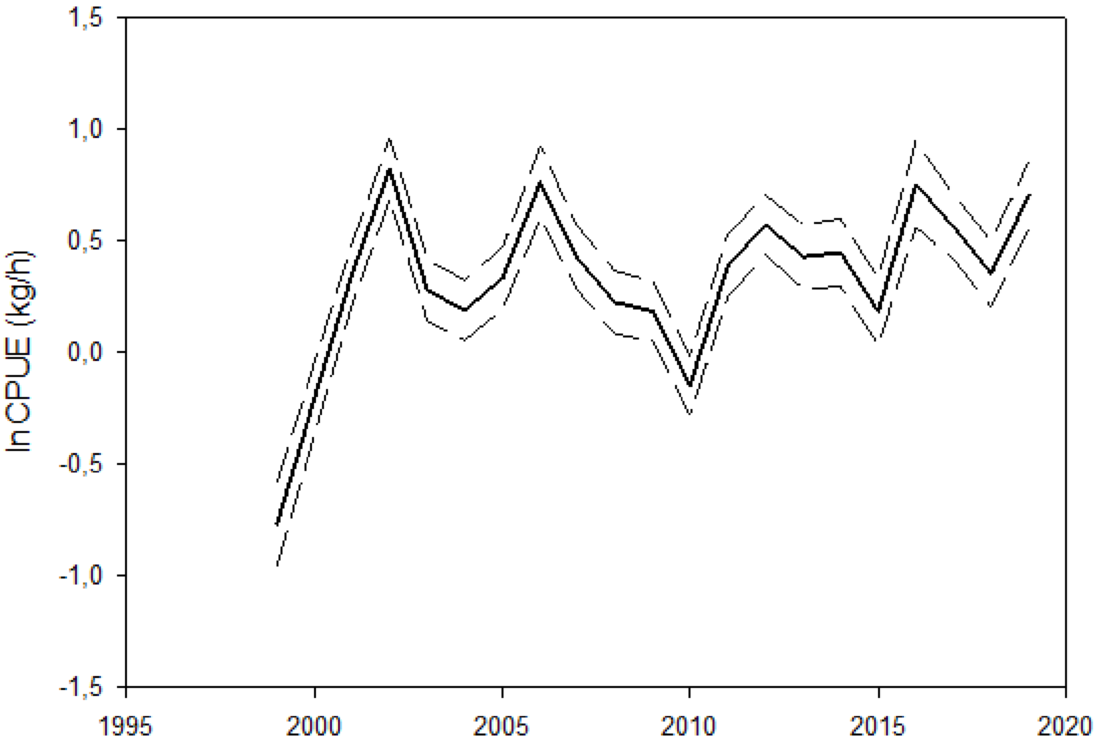

Figure 23.3.2.1 Standardized redfish bycatch CPUE in the directed fishery for Greenland halibut in ICES 14.b as a function of year. CPUE was estimated from the GLM model: lnCPUE = year + ICES Subdivision + depth. Bars represent standard error. Only hauls made below 1000m were used in the analyses.

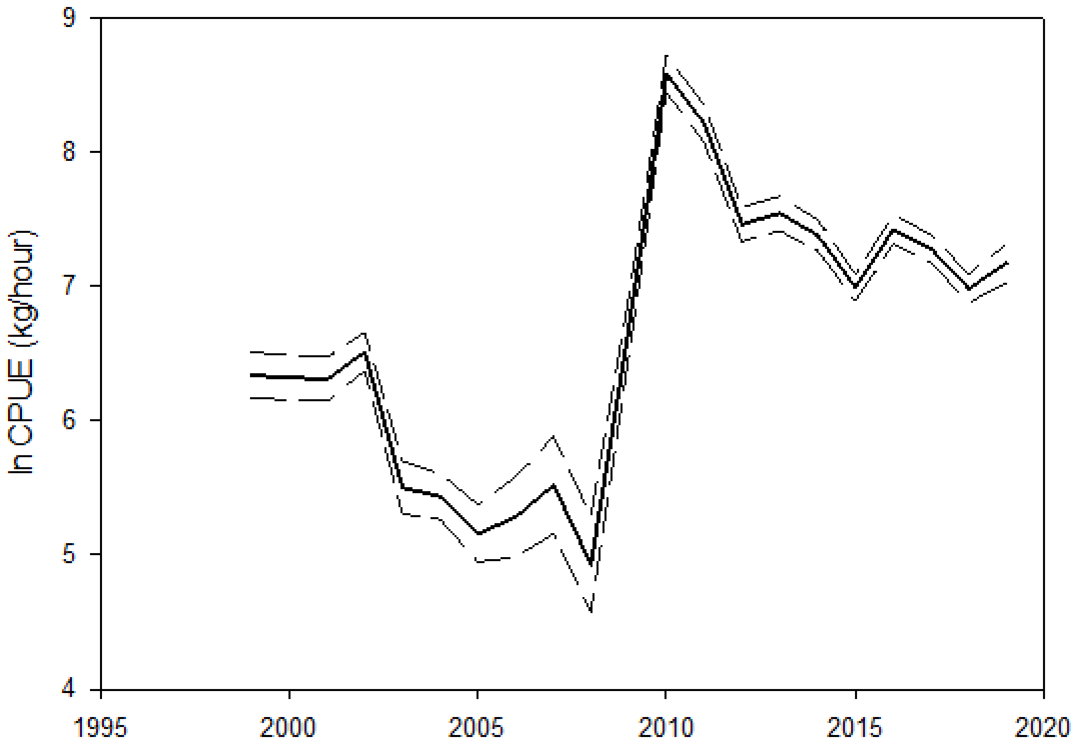

Figure 23.3.2.2 Standardized redfish CPUE in the redfish directed fishery ICES 14.b as a function of year. CPUE was estimated from the GLM model: lnCPUE = year + ICES Subdivision + depth. Dashed lines represent standard error.

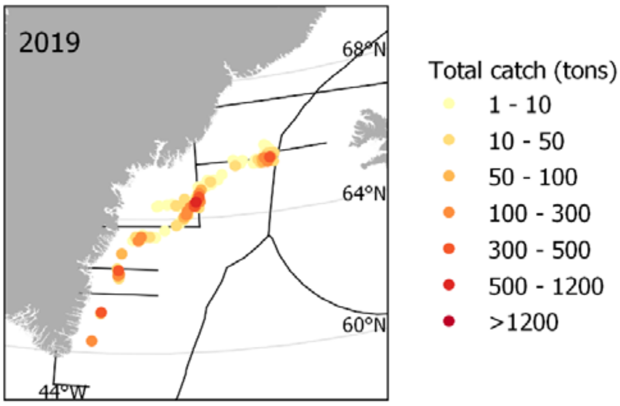

Figure 23.3.3.1 Distribution of catches of demersal redfish (*S. mentella* and *S. norvegicus*) in 2018 in ICES 14.b.

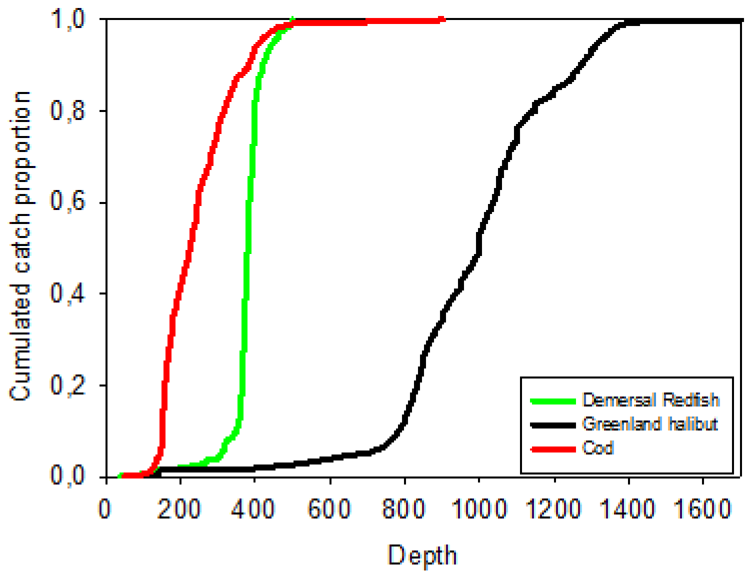

Figure 23.3.3.2. Lines represent the share of the total commercial catch caught at a given depth from 1999–2011 in *G. morhua*, demersal redfish (mixed *S. mentella* and *S. norvegicus)* and *R. hippoglossoides*.

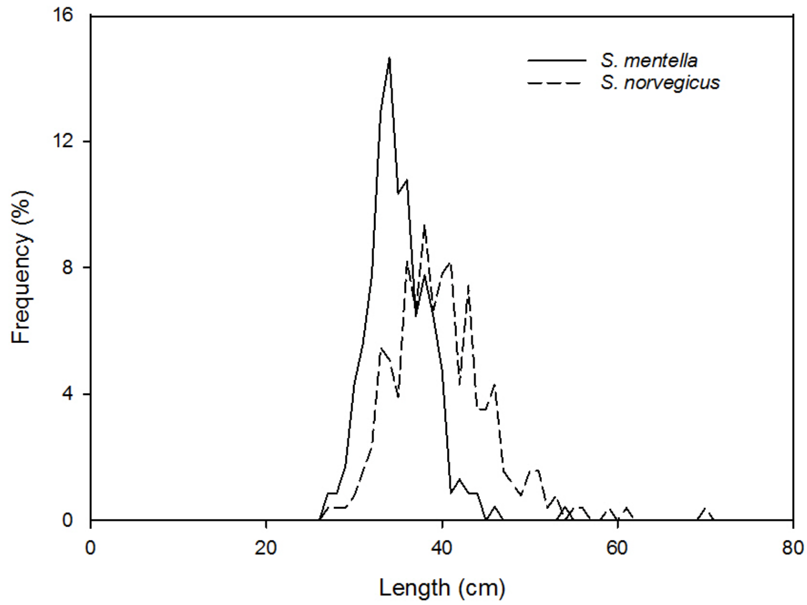

Figure 23.3.5.1: Length distribution of 488 redfish analysed by the Greenland Institute of Natural Resources in 2016 separated into *S. mentella* (N=232) and *S. norvegicus* (N=256). Due to missing samples from the commercial vessels an update of the length distribution was not possible. The missing samples was caused by a change in the license obligations.

Annex 1: List of participants

North-Western Working Group
23 – 28 April 2020

Name	Institute	Country	Email
Alexey Rolskiy	Knipovich Polar Research Institute of Marine Fisheries and Oceanography (PINRO)	Russian Federation	rolskiy@pinro.ru
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Annex 2: Resolution

This resolution was approved 1 October 2019

2019/2/FRSG05 **The North-Western Working Group** (NWWG), chaired by Kristján Kristinsson, Iceland, will work by correspondence 23–28 April 2020 to:

a) Address generic ToRs for Regional and Species Working Groups for all stocks, except stocks mentioned in ToR b).

b) Begin data compilation and explore potential methods to provide advice on plaice in Division 5a.

and during November 2020 by correspondence to:

c) Address generic ToRs for Regional and Species Working Groups for Capelin (*Mallotus villosus*) in subareas 5 and 14 and Division 2.a west of 5°W, Cod (*Gadus morhua*) in Subdivision 5.b.1 (Faroe Plateau), Cod in Subdivision 5.b.2 (Faroe Bank,) Haddock (*Melanogrammus aeglefinus*) in Division 5.b (Faroes grounds) and Saithe (*Pollachius virens*) in Division 5.b (Faroes grounds).

The assessments will be carried out on the basis of the stock annex. The assessments must be available for audit on the first day of the meeting.

Material and data relevant for the meeting must be available to the group on the dates specified in the 2020 ICES data call.

NWWG will report by 13 May and November 2020 for the attention of ACOM.

Only experts appointed by national Delegates or appointed in consultation with the national Delegates of the expert's country can attend this Expert Group

Due to the COVID-19 disruption that started early 2020, ACOM drafted a "spring 2020 approach" for recurring fishing opportunities advice. The generic Terms of Reference have been adjusted as described in the letter to ICES chairs below.

Chairs of Expert Groups

Our Ref: C.4.e/MDC/mo 13 March 2020

Subject: **Spring 2020 approach to advice production**

Dear Expert Group Chair,

I am writing this letter to keep you up to date about the approach of ACOM to the COVID-19 disruption. Many of our institutes now have travel bans and/or working from home policies. ACOM has developed a "spring 2020 approach" to this year's spring advice season. This letter covers the recurrent fishing opportunities advice. Any special request processes and non-fisheries advice will be dealt with separately. The expert groups effected are listed in Annex 1.

ACOM is encouraging all expert groups to keep working, and stick broadly to the time line, but clearly this needs to be through virtual meetings. ICES secretariat will support your efforts and make WebEx available. They will also produce a broad training document on WebEx. We know that the use of virtual meetings will result in an increased burden on the Chairs and members of the expert groups, therefore we have made changes to the generic terms of reference (see Annex 2 below) categorizing them as high, medium and low priority for this year's work. We also suggest that the expert group works virtually through smaller subgroups, and only hold larger virtual meetings when necessary.

The requesters of advice have been informed that there will be disruption/change to the delivery of advice for the spring 2020 season.

ACOM will also change the way that ICES gives advice for the spring 2020 season. There will be three types of advice:

- **Standard advice** sheet (the advice sheet following the January 2020 guidelines)
- **Abbreviated advice** sheet (a shortened advice sheet)
- **Rollover advice** (the same advice as in 2019)

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The choice of which type of advice to apply to a stock is based on criteria determined by ACOM:

a. **Standard advice** - stocks with 2020 benchmarked methods
b. **Abbreviated advice** – most stocks, including management plan and MSY advice stocks, and some Cat 3 stocks. The abbreviated advice will contain the advice of the headline advice, catch scenario tables, plots and automated tables (last years' advice will be added as an annex to each sheet). The guidance for abbreviated advice is being written now and you should receive it in a few days.
c. **Rollover advice** – same as 2019 advice. This will be provided for stocks in the following categories:
    - zero TAC has been advised in recent years and no change likely,
    - category 3 or greater roll over advice, except if due to be reviewed in 2020
    - long lived stable stocks, with no strong trends in dynamics in recent years
    - some non-standard stocks (e.g. North Atlantic salmon)

We need to consult both you and the requesters of advice about which type of advice to apply to each stock. Today the ACOM criteria are being used by the secretariat to allocate advice types to stocks. This is the first version. We would like you to consider this list and comment if you think that the allocation needs changing. Please remember that the abbreviated advice is being developed to help your processes and also the ACOM processes during the disruption. The list of allocated advice type for each stock will hopefully be sent to you today or Monday. Please reply with your comments by 19th March so that we can start the dialogue with requesters. ACOM hopes that we could have a definitive list by 25th March. (This is too late for HAWG, so we suggest that HAWG use the list compiled in cooperation with Secretariat expecting requesters of advice to agree).

ACOM is recommending that for North Sea stocks with re-opening of advice in the autumn, the stock assessments be carried out in the spring but not the forecasts (postponed until early autumn). The advice would be delivered in the autumn of 2020.

You will shortly receive the first version of the **list of advice types allocated to stocks** and the **guidelines for abbreviated advice**. Please respond by 19th March with your comments on the first version of the list.
Your professional officer has been briefed about these changes. The changes are designed to reduce both expert group and ACOM workload. Lotte, your professional officer, the ACOM leadership and the FRSG Chair are available for further explanation.

Best regards

Mark

Mark Dickey-Collas
ACOM Chair

Annex 1. Expert groups associated with 2020 spring advice season

Herring Assessment Working Group for the Area South of 62°N
Working Group on North Atlantic Salmon*
Assessment Working Group on Baltic Salmon and Trout*
Baltic Fisheries Assessment Working Group
Arctic Fisheries Working Group
Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak
North-Western Working Group
Working Group on the Biology and Assessment of Deep-sea Fisheries Resources
Working Group for the Bay of Biscay and the Iberian Waters Ecoregion
Working Group for the Celtic Seas Ecoregion
Working Group on Southern Horse Mackerel, Anchovy, and Sardine
Working Group on Elasmobranch Fishes

* These groups already have different approaches.

Annex 2. Spring 2020 adapted generic terms of reference. [Agreed by ACOM 12 March 2020]

In light of the disruptions caused by COVID-19 in 2020, the generic terms of reference for the FRSG stock assessment groups have been re-prioritised. This applies to expert groups that feed into the spring advice season process[1]. ACOM is encouraging expert groups to use virtual meetings (e.g. WebEx) and subgroups to deliver the high priority terms of reference. See letter from the ACOM Chair to expert groups.

High Priority for spring 2020 advice season

c) Conduct an assessment on the stock(s) to be addressed in 2020 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. **Check the list of the stocks to be done in detail and those to roll over.**
   i) Input data and examination of data quality;
   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 (i.e., all stocks with catches in the NEAFC Regulatory Area) estimate the percentage of the total catch that has been taken in the NEAFC Regulatory Area in 2019.
   v) 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;
   vi) The state of the stocks against relevant reference points;
   vii) Catch scenarios for next year(s) for the stocks for which ICES has been requested to provide advice on fishing opportunities;
   viii) Historical and analytical performance of the assessment and catch options with a succinct description of quality issues with these. For the analytical performance of category 1 and 2 age-structured assessment, report the mean Mohn's rho (assessment retrospective (bias) analysis) values for R, SSB and F. The WG report should include a plot of this retrospective analysis. The values should be calculated in accordance with the "Guidance for completing ToR viii) of the Generic ToRs for Regional and Species Working Groups - Retrospective bias in assessment" and reported using the ICES application for this purpose.

d) Produce a first draft of the advice on the stocks under considerations according to ACOM guidelines. Check list to confirm whether the stock requires a concise advice sheet or a traditional advice sheet.

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

j) Audit all data and methods used to produce stock assessments and projections.

[1] These do not apply to Assessment Working Group on Baltic Salmon and Trout and Working Group on North Atlantic Salmon.

Medium Priority for spring 2020 advice season

a) Consider and comment on Ecosystem and Fisheries overviews where available;

b) For the aim of providing input for the Fisheries Overviews, consider and comment for the fisheries relevant to the working group on:
   i) descriptions of ecosystem impacts of fisheries
   ii) descriptions of developments and recent changes to the fisheries
   iii) mixed fisheries considerations, and
   iv) emerging issues of relevance for the management of the fisheries;

e) Review progress on benchmark processes of relevance to the Expert Group; High for application;

Low Priority for spring 2020 advice season

c iv) Estimate MSY proxy reference points for the category 3 and 4 stocks

g) Identify research needs of relevance for the work of the Expert Group.

h) Review and update information regarding operational issues and research priorities and the Fisheries Resources Steering Group SharePoint site.

i) Take 15 minutes, and fill a line in the audit spread sheet 'Monitor and alert for changes in ecosystem/fisheries productivity'; for stocks with less information that do not fit into this approach (e.g. higher categories >3) briefly note in the report where and how productivity, species interactions, habitat and distributional changes, including those related to climate-change, have been considered in the advice. ACOM would encourage expert groups to carry out this term of reference later in the year through a webex.

Annex 3: Terms of Reference for next meeting

The Terms of Reference for NWWG 2021 will be reviewed in November 2020.

Annex 4: List of Working Documents (NWWG 2020)

Retzel, A. 2020. Greenland commercial data for Atlantic cod in East Greenland offshore waters for 2019. ICES North Western Working Group, 23-28 April 2020, WD 1. 16 pp.

Retzel, A. 2020. Greenland commercial data for Atlantic cod in Greenland inshore waters for 2019. ICES North Western Working Group, 23-28 April 2020, WD 2. 20 pp.

Retzel A. 2020. West Greenland inshore survey results for Atlantic cod in 2019. ICES North Western Working Group, 23-28 April 2020, WD 3. 22 pp.

Retzel, A. 2020. Greenland commercial data for Atlantic cod in West Greenland offshore waters for 2019. ICES North Western Working Group, 23-28 April 2020, WD 4. 15 pp.

Retzel, A. 2020. Greenland Shrimp and Fish survey results for Atlantic cod in NAFO subareas 1A-1E (West Greenland) in 2019. ICES North Western Working Group, 23-28 April 2020, WD 5. 27 pp.

Rigét, F., Retzel, A. and Christensen, H.T. 2020. A SAM assessment of the East Greenland cod stock. ICES North Western Working Group, 23-28 April 2020, WD 6. 24 pp.

Rigét, F., Retzel, A. and Christensen, H.T. 2020. A SAM assessment of the West Greenland Inshore cod stock (cod.21.1). ICES North Western Working Group, 23-28 April 2020, WD 7. 26 pp.

Christensen, H.T. 2020. The fishery for demersal Redfish (*S. mentella*) in ICES Div. 14b in 2019. ICES North Western Working Group, 23-28 April 2020, WD 8. 15 pp.

Rolskii A. and Popov, V. 2020. Information on the results of Russian pelagic fishery for the Irminger Sea redfish in 2019, its stock status and structure. ICES North Western Working Group, 23-28 April 2020, WD 9. 9 pp.

Boje J. 2020. The fishery for Greenland halibut in ICES Div. 14b in 2019. ICES North Western Working Group, 23-28 April 2020, WD 10. 16 pp.

Steingrund, P. 2010. Greenland halibut CPUE for the research vessel operating on the slope on the Faroe Plateau in May-June 1995-2019. ICES North Western Working Group, 23-28 April 2020, WD 11. 10 pp.

Werner, K-M., Fock, H., Stransky, C. and Benreuther, M. 2020. Abundance for *Sebastes norvegicus* L., deep sea *S. mentella* and juvenile redfish (Sebastes spp.) off Greenland based on groundfish surveys 1982-2019. ICES North Western Working Group, 23-28 April 2020, WD 12. 30 pp.

Steingrund, P. 2020. Greenland halibut CPUE for commercial trawlers operating on the slope on the Faroe Plateau 1991-2019. ICES North Western Working Group, 23-28 April 2020, WD 13. 11 pp.

Steingrund, P. 2020. Survey biomass indices of Greenland halibut on the slopes of the Faroe Plateau 1983-2019. ICES North Western Working Group, 23-28 April 2020, WD 14. 8 pp.

Steingrund, P. 2020. A combined biomass index of Greenland halibut on the slopes of the Faroe Plateau 1983-2019. ICES North Western Working Group, 23-28 April 2020, WD 15. 3 pp.

Annex 5: List of stock annexes

The table below provides an overview of the NWWG Stock Annexes. Stock annexes for other stocks are available on the ICES website Library under the Publication Type "Stock Annexes". Use the search facility to find a particular Stock Annex, refining your search in the left-hand column to include the *year*, *ecoregion*, *species*, and *acronym* of the relevant ICES expert group.

Stock ID	Stock name	Last updated	Link
cap 27.2a5.14_SA	Capelin in the Iceland-East Greenland-Jan Mayen area)	January 2015	cap-icel_SA.pdf
cod.21.1_SA	Cod (*Gadus morhua*) in NAFO Subarea 1, inshore (West Greenland cod)	February 2018	cod.21.1_SA.pdf
cod.2127.1f14_SA	Cod (*Gadus morhua*) in ICES Subarea 14 and NAFO Division 1F (East Greenland, South Greenland)	February 2018	cod.2127.1f14_SA.pdf
cod.27.5b2_SA	Cod (*Gadus morhua*) in subdivision 5.b.2 (Faroe Bank)	April 2013	cod-farb_SA.pdf
cod.27.5b1_SA	Cod (*Gadus morhua*) in subdivision 5.b.1 (Faroe Plateau)	May 2017	cod-farp_SA.pdf
cod.27.5a_SA	Icelandic cod	January 2015	cod-iceg_SA.pdf
cod.21.1a-e_SA	Cod (*Gadus morhua*) in NAFO divisions 1A-1E, offshore (West Greenland)	May 2016	cod-wgr_SA.pdf
ghl.27.561214_SA	Greenland halibut *(Reinhardtius hippoglossoides*) in Subareas 5,6,12 and 14 (Iceland and Faroes grounds, West of Scotland, North of Azores, East of Greenland)	December 2013	ghl-grn_SA.pdf
had.27.5b_SA	Haddock (*Melanogrammus aeglefinus*) in Division 5.b (Faroes grounds)	May 2018	had.27.5b_SA.pdf
had.27.5a_SA	Haddock (*Melanogrammus aeglefinus*) in Division 5.a (Iceland)	February 2013	had-iceg_SA.pdf
her.27.5a_SA	Herring (*Clupea harengus*) in Division 5.a, summer-spawning herring (Iceland grounds)	April 2019	her.27.5a_SA.pdf
pok.275b_SA	Saithe (*Pollachius virens*) in Division 5.b (Faroes grounds)	May 2017	pok.27.5b_SA.pdf
pok.275a_SA	Saithe (*Pollachius virens*) in Division 5.a (Iceland grounds)	April 2019	pok.27.5a_SA.pdf
reb.27.14b_SA	Beaked redfish (*Sebastes mentella*) in Division 14.b, demersal (Southeast Greenland)	May 2017	reb 27.14b_SA.pdf
reb.27.5a14_SA	Icelandic slope beaked redfish *(Sebastes mentella)* in Divisions 5.a and 14.b	May 2013	smn-con_SA.pdf
reb.2127.dp_SA	Deep Pelagic beaked redfish *(Sebastes mentella*) in ICES	May 2012	smn-dp_SA.pdf
reb.27.14b_SA	Beaked redfish *(Sebastes mentella*) in Division 14.b (Demersal) (Southest Greenland)	May 2016	smn-grl_SA.pdf

Stock ID	Stock name	Last updated	Link
reb.2127.sp_SA	Shallow pelagic Beaked redfish (*Sebastes mentella*)	May 2012	smn-sp_SA.pdf
reg.27.561214_SA	Golden redfish in Subareas 5,6 12 and 14 (Iceland and Faroes grounds, West of Scotland, North of Azores, East of Greenland)	April 2019	reg.27.561214_SA.pdf

Annex 6: Audit Reports

Audit of West Greenland inshore cod

Date: 28/04/2020
Auditor: Luis Ridao Cruz

To the attention of the ACOM and the 2020 NWWG, this is an audit of the assessment of West Greenland inshore cod.

General

There is no management plan for the West Greenland inshore cod stock.
There are concerns about the mixing of stocks between the inshore and onshore areas as well as migratins to Icelandic waters.
Stock declining in recent years as a consequence of declining recruitment and/or migration to Iceland although F is quite stable since 2010

For single stock summary sheet advice:

1. Same procedure as last year
2. Analytical
3. Presented
4. SAM
5. Data are available, but the use of the survey indices should be revised, because they should be used as one, combined index, instead of two separated indices.
6. Fishing mortality reference points from last years assessment were not accepted and F_{pa} and F_{lim} are excluded this year.
7. Stock size is decreasing, likely due to poor recruitment and high fishing mortality values (approximately 2 times F_{MSY}), but still above MSY $B_{trigger}$.
8. There is no management plan

General comments

The report includes all relevant data. Some editorial changes were included in the report section. There are no references to tables and figures in section 15.6 “State of the stock” but in 15.9 “Uncertainties in the assessment and forecast”. This ought to be corrected. There is also a lack of reference points in figures. Recruitment figure is missing.

Technical comments

No comments.

Conclusions

The assessment has been performed according to the stock annex. Because of the difficult stock separation and mixing of stocks in the area, the assessment is very uncertain.
There is a considerable proportion of fish from the West Greenland offshore stock in inshore catches.

Audit of Cod.2127.1f14

Date: 12/05/2020
Auditor: Einar Hjörleifsson

To the attention of the ACOM and the 2020 NWWG,

General

For single stock summary sheet advice:

1. **Assessment type:** Update
2. **Assessment**: Age-based
3. **Forecast**: Age-based, run internally in the model
4. **Assessment model**: SAM
5. **Data issues:** The Paamiut east (XIVb+1F) survey was not conducted in 2018 and 2019 and WH east (XIVb+1F) survey was not conducted in 2018 adding uncertainty to the assessment.
6. **Consistency**:
7. **Stock status**: Point estimates of F2019 is above Fmsy, otherwise ok.

Management Plan: No explicit harvest control rule

General comments
The assessment is more uncertain in recent years because of missing surveys.

Technical comments
The lack of surveys in 2018 means that there is no initial estimate for the 2017 year class at age 1, the resulting estimates from SAM hence based on a random walk (this was already done so last year). In the 2019 german survey the age groups 1 and 2 were zero. In SAM there is no distinction made between NULL and ZERO, both input entries are treated as missing value. Given that the random walk values are low, it was concluded to proceed with using the random walk values. Using arbitrary low survey value (instead of zero for age 1 and 2 in 2019 in this specific case) when the estimates are zero should be investigated in the next benchmark cycle.

Conclusions
The assessment has been performed, as much as possible, according to the stock annex, although missing survey years were not anticipated at the benchmark.

Audit of Beaked Redfish (*Sebastes mentella*), East Greenland slope (reb.27.14b)

Date: 28 April 2020

Auditor: Kristján Kristinsson

General

This stock was benchmarked in March 2012 and the stock has been assessed in accordance to the benchmark.

For single stock summary sheet advice:

1) **Assessment type:** Category 3 (or 5)
2) **Assessment**: Survey trends, no analytical methods.
3) **Forecast**: No forecast available.
4) **Assessment model**: Survey trend-based assessment from the Greenland Shallow Water survey (GRL-GFS)
5) **Data issues:** There is no data from the Greenland Shallow Water survey (GRL-GFS) 2017-2019.
6) **Consistency**: No new survey data, so consistency cannot be determined.
7) **Stock status**: The biomass index declined from 2010 to 2016. With no new data for three years stock status cannot be determined.
8) **Management Plan**: None

General comments

The assessment is based on survey trends from the Greenland Shallow Water survey (GRL-GFS). The survey was not conducted in 2017-2019 and therefore the status of the stock cannot be determined.
The absence of indications of incoming cohorts raises concerns about the future productivity of the stock.
The split of catches between *S. mentella* and *S. norvegicus* is based on information from log-books. The sharp change in this ration between 2018 and 2019 raises question of the accuracy of the split. Figure 23.3.1.2 show little change in the depth distribution of the commercial redfish catches.

This is a category 3 stock. Since no survey data is available for three years, it should be a category 5 stock.

Technical comments

The report is in accordance with the stock annex.
The advice sheet is consistent with the report.

Conclusions

The assessment has been performed correctly and in accordance with stock annex.

Audit of Greenland halibut

Date: 28.04.2020
Auditor: Karl-Michael Werner

General

- The assessment is carried out well.

- Several people from the working group and different nations provided constructive input for the assessment and although data are limited I believe the assessment is a good job and provides reasonable estimates for biomass and reference points.
- Some concerns exists about stock identification and separation in the large area covered by the assessment and it seems that genetic investigations would be useful.
- In the early 1990s, biomass dropped steeply, but median fishing mortality did not increase as strongly to justify the drop in biomass. Hence, fishing mortality might have truly been above the median but within the presented confidence intervals.

For single stock summary sheet advice:

9) **Assessment type:** update
10) **Assessment**: stock production model
11) **Forecast**: presented
12) **Assessment model**: stochastic version of the logistic production model and Bayesian
13) **Data issues:** Everything looks fine, data were updated in the new report and advice sheet and also retrospectively corrected
14) **Consistency**: Last years assessment accepted
15) **Stock status**: B > MSYBtrigger, F > Fmsy ("Overfishing but not overfished"). After a steep biomass decline in the early 1990s, biomass has been stable and slightly above MSYBtrigger.
16) **Management Plan**: I cannot find indications that a management plan exists. Catches were in the most recent decade sometimes slightly below advice, but more often higher, although not dramatically (for example, 25.000 instead of 22.000 tons).

General comments

No substantial criticism for this assessment or the report. Everything appears to be in place and well structured. For future research I believe it would be useful to evaluate the impact of this fishery on benthic ecosystems, especially because in many regions this fish is caught in deep waters (800-1300 m). As long as there is little known, the ecological sustainability of the fishery remains somewhat uncertain.

Technical comments

No technical comments

Conclusions

The assessment has been performed correctly.

Checklist for audit process

General aspects

- Has the EG answered those TORs relevant to providing advice?
- Is the assessment according to the stock annex description?
- If a management plan is used as the basis of the advice, has been agreed to by the relevant parties and has the plan been evaluated by ICES to be precautionary?
- Have the data been used as specified in the stock annex?
- Has the assessment, recruitment and forecast model been applied as specified in the stock annex?
- Is there any **major** reason to deviate from the standard procedure for this stock?
- Does the update assessment give a valid basis for advice? If not, suggested what other basis should be sought for the advice?

Audit of Golden redfish (*Sebastes norvegicus*) in subareas 5, 6, 12, and 14

Date: 05. May 2020
Auditor: Helle Torp Christensen (htch@natur.gl)

General

The analytical assessment for the golden redfish is based on Gadget, with the main input data deriving from catches and the Icelandic spring-survey and German survey in East Greenland. This is an update assessment with one more year of data. The stock is declining because of poor recruitment (low number of recruits (<30cm) since 2009), which is evident from catches and especially surveys.

This year´s advice sheet is abbreviated due to the Covid 19 disruption. Details on the assessment is still to be found in the assessment report.

For single stock summary sheet advice:

1) **Assessment type:** update
2) **Assessment**: analytical
3) **Forecast**: presented
4) **Assessment model**: Gadget -tuning by 2 surveys
5) **Data issues:** NA
6) **Consistency**: The assessment results are consistent with last year's results, which was accepted for basis of advice.
7) **Stock status**: F is below Flim and Ppa but above FMSY. B is above Blim, Bpa and MGT Btrigger. Recruitment is low and decreasing.

Management Plan: A management plan was agreed between Iceland and Greenland for 2016-2018. The plan has not been renewed; however references points are still followed.

General comments

The advice sheet and the report provide a good and appropriate description on the assessment and the stock status.

Technical comments

Paragraph 19.1 needs an update since it refers to restrictions of the cod fishery in Greenland waters that is no longer applicable. Text on the agreements regarding redfish needs update too.

Conclusions

This update assessment has been performed correctly and give a valid basis for advice. It differed slightly from the Stock Annex in that way that the German Survey in Greenlandic waters from 2017 was repeatedly used in 2018 due to lack of survey that year. It is not expected to have significant impact on the assessment.

Annex 7: Faroe saithe – adjustments of the SAM model configuration

This annex was added to the report in November 2020, and contains two working documents as well as review of these.

- Adjustments of the SAM model configuration for Faroe saithe (5b)-UPDATE 2019
  Luis Ridao Cruz, luisr@hav.fo, Faroe marine resarch institute, FAMRI

- Re-evaluation of biological reference points for Faroe saithe (pok.27.5b)
  Luis Ridao Cruz, luisr@hav.fo, Faroe marine resarch institute, FAMRI

- Review of: Adjustments of the SAM model configuration for Faroe cod and saithe (5b)

Please note: the changes and review refer to cod and saithe while in the end, the model was only changed for saithe

Adjustments of the SAM model configuration for Faroe saithe (5b)-UPDATE 2019

Luis Ridao Cruz, luisr@hav.fo

Faroe marine resarch institute, FAMRI

The SAM model was adopted as the basis of advice for Faroe saithe (5b) in 2017 (WKFAROE, **stock annex**) The present document illustrates the implementation of some adjustments in the SAM model configuration. The motivation for this analysis was to improve the overall fit of the model and reduce the bias associated with the assessment. The configuration options for the SPALY assessment are as follows (some configuration options omitted):

```
##                     minAge                    maxAge
##                          3                        15
##                 fbarRange1                fbarRange2
##                          4                         8
## stockRecruitmentModelCode                   corFlag
##                          0                         2

## $keyLogFsta
##      [,1] [,2] [,3] [,4] [,5] [,6] [,7] [,8] [,9] [,10] [,11] [,12] [,13]
## [1,]    0    1    2    3    4    5    6    7    8     8     8     8     8
## [2,]   -1   -1   -1   -1   -1   -1   -1   -1   -1    -1    -1    -1    -1
## [3,]   -1   -1   -1   -1   -1   -1   -1   -1   -1    -1    -1    -1    -1
##
## $keyLogFpar
##      [,1] [,2] [,3] [,4] [,5] [,6] [,7] [,8] [,9] [,10] [,11] [,12] [,13]
## [1,]   -1   -1   -1   -1   -1   -1   -1   -1   -1    -1    -1    -1    -1
## [2,]    0    1    2    3    4    5    6    6   -1    -1    -1    -1    -1
## [3,]    7    8    9   10   11   12   13   13   -1    -1    -1    -1    -1
##
## $keyVarF
##      [,1] [,2] [,3] [,4] [,5] [,6] [,7] [,8] [,9] [,10] [,11] [,12] [,13]
## [1,]    0    0    0    0    0    0    0    0    0     0     0     0     0
## [2,]   -1   -1   -1   -1   -1   -1   -1   -1   -1    -1    -1    -1    -1
## [3,]   -1   -1   -1   -1   -1   -1   -1   -1   -1    -1    -1    -1    -1
##
## $keyVarObs
##      [,1] [,2] [,3] [,4] [,5] [,6] [,7] [,8] [,9] [,10] [,11] [,12] [,13]
## [1,]    0    0    0    0    0    0    0    0    0     0     0     0     0
## [2,]    1    2    3    3    3    3    3    3   -1    -1    -1    -1    -1
## [3,]    4    5    6    6    6    6    6    6   -1    -1    -1    -1    -1
##
## $obsCorStruct
## [1] ID AR ID
## Levels: ID AR US
##
## $keyCorObs
##      3-4 4-5 5-6 6-7 7-8 8-9 9-10 10-11 11-12 12-13 13-14 14-15
## [1,]  NA  NA  NA  NA  NA  NA   NA    NA    NA    NA    NA    NA
## [2,]   0   0   0   0   0   0    0    -1    -1    -1    -1    -1
## [3,]  NA  NA  NA  NA  NA  NA   NA    -1    -1    -1    -1    -1
```

The options for observation correlation coupling is an AR(1) (observation correlation structure) for the summer survey, i.e., observations are correlated for all age classes (3 -10) whereas for the spring survey there is no correlation coupling between ages (ID). The coupling of observation variances specifies the options for observation noise for both catches and survey indices. For the SPALY run there is one variance component for the catch observations while for both the summer and the spring survey variances are different for ages 3 and 4 and coupled for older age groups.

The changes incorporated to the configuration of the model are as follows.

1. Variance componentse for both surveys will be different for all age groups (3-10)
2. Observation correlation coupling for both surveys is set to an AR(1) process.

The implementation of these changes in the assessment for saithe resulted in better model diagnostics. A visual inspection of the residuals plot in the spring index show the absence of blocks of positive and negative residuals in 1998 and 2007 respectively which were observed in the SPALY model (Figure 1). A measurement of the model improvement can be quantified in terms of AIC (Akaike Information Criterion). The AIC for the adopted assessment is AIC(SPALY)=2115 whereas for the new model configuration is estimated at AIC(MOD0)=2012. Other model configurations were also investigated (Table 1). Model parameter and uncertainty associated to the estimates are illustrated in table 2 (MOD0).

The consistency of the new model configuration evaluated in terms of Mohn's rho, which measures the severity of retrospective patterns is also improved (Table 1, Figures 3 and 4). Retrospetive analysis were run in a five year window. An additional four year retrospective run ("MOD0_rho4" column in table) is also presented as an illustrative example of the sensitivity of Mohn's rho to the time period selected. Bias in SSB and recruitment estimates go down from 33% and 50% (SPALY) to 24% and 40% (MOD0) , respectively.

The leave-one-out analysis (Figures 5 and 6) reflects also the model refinement. The elimination of either survey index in the new model configuration results in both smaller discrepancies than those in the SPALY run and more consistent assessment output, i.e., within the model confidence intervals.
Estimated variability of state variables is illustrated in figure 7. The standard deviation of SSB of all the exploratory models are higher than that of the SPALY run but below 0.20 from 2009 to 2018. Variance of Fbar for all the alternative models is lower than the SPALY assessment from 20109 to 2016 but higher thereafter. For both the MOD0 and SPALY models variablity in Fbar is estimated at 0.21 and 0.18 respectively.

Stock parameters such as spawning stock bimass (SSB), average fishing mortality (F_{bar}), recruitment numbers (age 3) and observed and predicted landings are shown in figure 8 for both the SPALY and the best model run (MOD0). Both agree in the historical perception of the stock but they disagree in the most recent stock dynamics. Thus it's expected that estimates of biological reference points will be very close to current values. Whereas the SPALY assessment suggests that fishing mortality in 2019 is below F_{msy}=0.30 the MOD0 model estimates F at a higher rate and therefore a lower predicted SSB. The recruitment estimates of MOD0 in recent years are below historical average and also lower than the adopted assessment. Model fit to catch and survey at age matrices are illustrated in figures 9-11.

Table 1: Faroe saithe 5b. Mohn's rho for SPALY and alternative model configurations. Calculations based on a 5-year window. Rightmost row shows Mohn's rho on a 4-year period (MOD0_4).

	R(age 3)	SSB	Fbar(4-8)	AIC
SPALY	49.8	32.6	5.9	2114.9
MOD0	39.7	23.8	4.7	2012.4
MOD1	43.2	25.4	2.3	2023.7
MOD2	41.6	23.9	3.1	2036.1
MOD3	46.0	28.9	1.8	2042.4
MOD0_4	34.5	18.4	7.7	2012.4

Table 2: Faroe saithe 5b. Table of selected model parameters (MOD0).

	par	sd(par)	exp(par)	Low	High
logFpar_0	-7.6248898	0.2494171	0.0004881	0.0002964	0.0008039
logFpar_1	-7.0366432	0.1941423	0.0008791	0.0005962	0.0012961
logFpar_2	-6.6775261	0.1822353	0.0012589	0.0008744	0.0018125
logFpar_3	-6.7732568	0.1202054	0.0011440	0.0008995	0.0014549
logFpar_4	-6.9554693	0.1269634	0.0009534	0.0007396	0.0012290
logFpar_5	-6.9987106	0.1166320	0.0009131	0.0007231	0.0011529
logFpar_6	-7.0437632	0.1466969	0.0008728	0.0006509	0.0011704
logFpar_7	-8.4328091	0.2599247	0.0002176	0.0001294	0.0003660
logFpar_8	-7.5506476	0.2046683	0.0005258	0.0003492	0.0007917
logFpar_9	-7.2502588	0.1315865	0.0007100	0.0005457	0.0009237
logFpar_10	-7.1230552	0.0936471	0.0008063	0.0006686	0.0009724
logFpar_11	-7.2988672	0.0915332	0.0006763	0.0005632	0.0008122
logFpar_12	-7.1816729	0.0980355	0.0007604	0.0006250	0.0009251
logFpar_13	-7.0992775	0.1132833	0.0008257	0.0006583	0.0010357
logSdLogFsta_0	-1.4364131	0.1203329	0.2377791	0.1869192	0.3024778
logSdLogN_0	-0.7221061	0.1598354	0.4857282	0.3528272	0.6686896
logSdLogN_1	-1.4015690	0.1108479	0.2462104	0.1972537	0.3073177
logSdLogObs_0	-0.9122594	0.0458611	0.4016158	0.3664176	0.4401951
logSdLogObs_1	0.0750871	0.1517860	1.0779780	0.7957383	1.4603251
logSdLogObs_2	-0.2075604	0.1535134	0.8125642	0.5977473	1.1045813
logSdLogObs_3	-0.2795387	0.1496965	0.7561325	0.5604969	1.0200526
logSdLogObs_4	-0.8439984	0.1615852	0.4299878	0.3112469	0.5940285
logSdLogObs_5	-0.7888165	0.1494388	0.4543822	0.3369926	0.6126638
logSdLogObs_6	-0.9723459	0.1588240	0.3781948	0.2752724	0.5195991
logSdLogObs_7	-0.7022671	0.1558807	0.4954608	0.3627547	0.6767146
logSdLogObs_8	-0.4301396	0.1726447	0.6504183	0.4605062	0.9186499
logSdLogObs_9	0.2149693	0.1437475	1.2398238	0.9300419	1.6527891
logSdLogObs_10	-0.0280598	0.1317771	0.9723302	0.7470568	1.2655342
logSdLogObs_11	-0.5361630	0.1329405	0.5849885	0.4484114	0.7631643
logSdLogObs_12	-1.0068785	0.1407952	0.3653577	0.2756926	0.4841851
logSdLogObs_13	-1.0402628	0.1391296	0.3533618	0.2675304	0.4667303
logSdLogObs_14	-0.9293834	0.1390838	0.3947971	0.2989284	0.5214115
logSdLogObs_15	-0.7298151	0.1680266	0.4819981	0.3444286	0.6745147
logSdLogObs_16	-0.0407215	0.1502164	0.9600965	0.7109491	1.2965558
transfIRARdist_0	-1.4956700	0.2743244	0.2240984	0.1294683	0.3878948
transfIRARdist_1	-0.5236584	0.2051895	0.5923496	0.3929640	0.8929012
itrans_rho_0	1.4421156	0.1572342	4.2296346	3.0883814	5.7926164

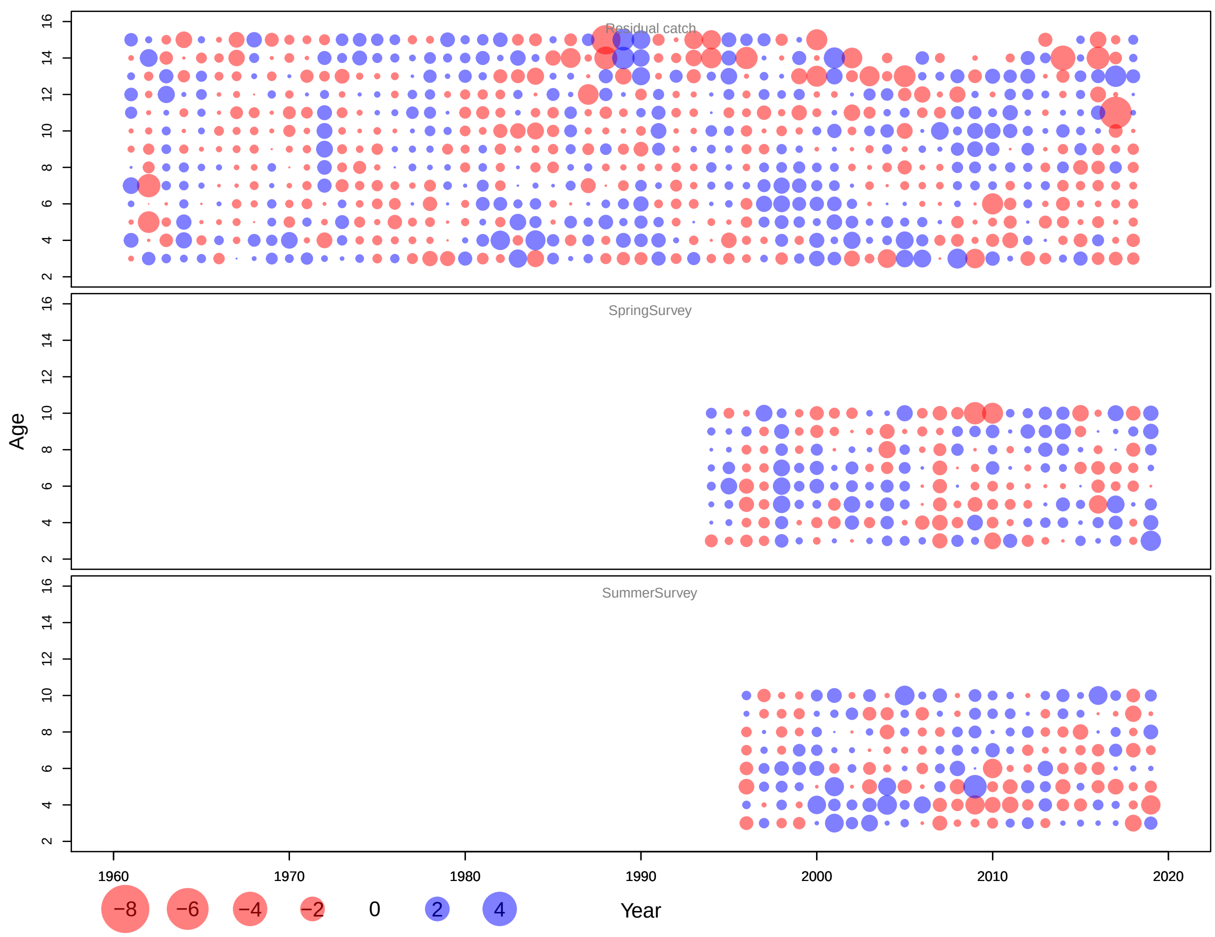

Figure 1: Faroe saithe 5b. Residual plots of the SAM SPALY run

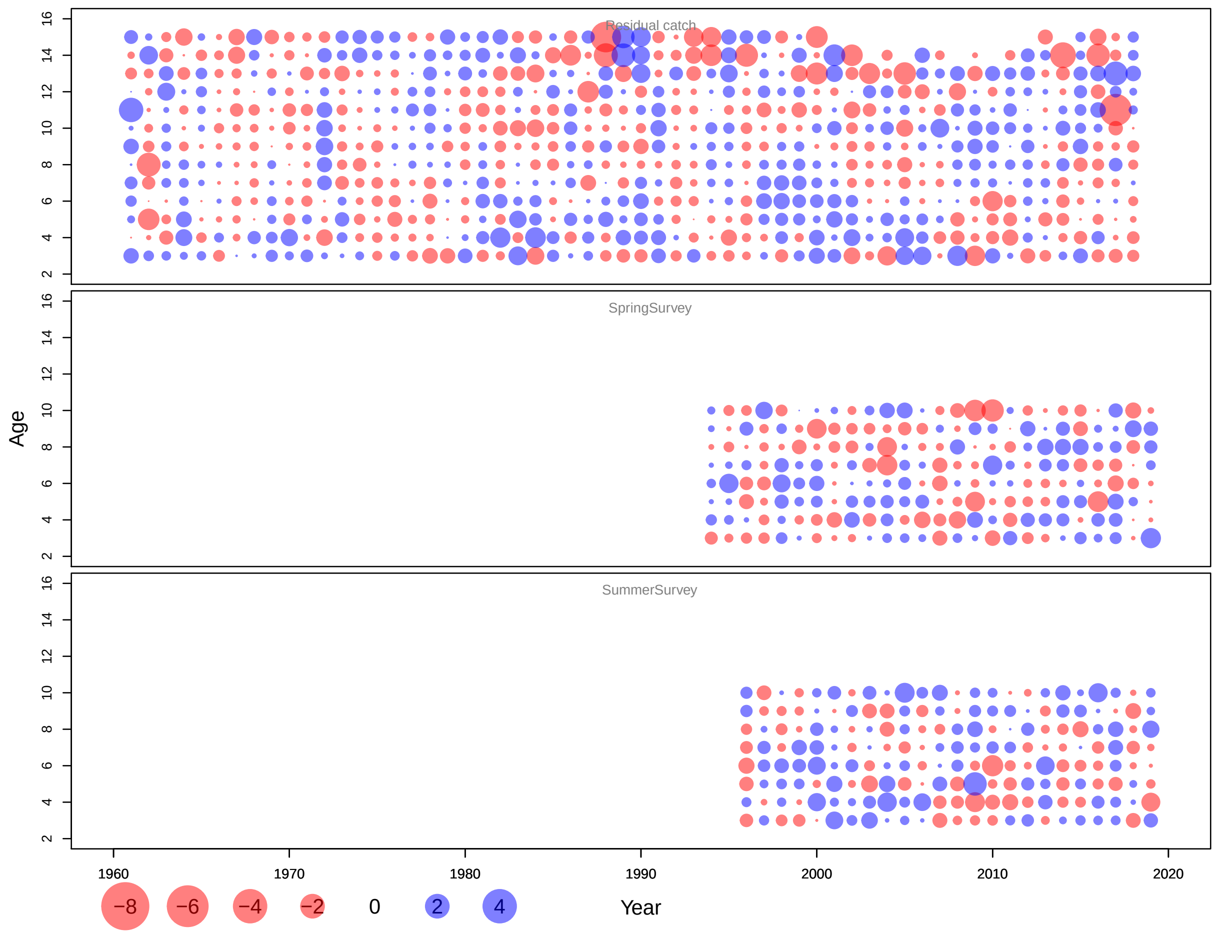

Figure 2: Faroe saithe 5b. Residual plots of the new SAM model configuration (MOD0)

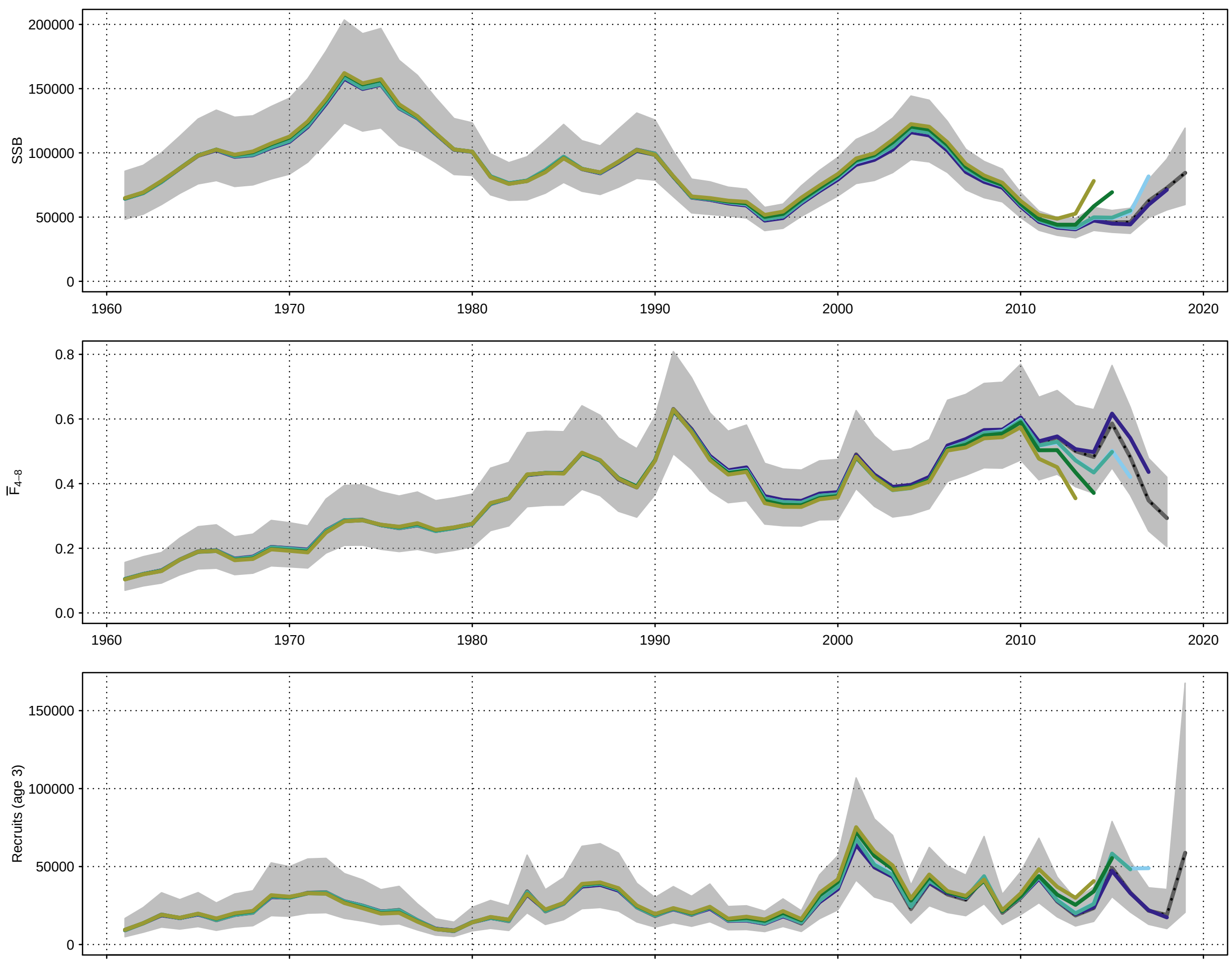

Figure 3: Faroe saithe 5b. Restrospective plots of the SPALY model.

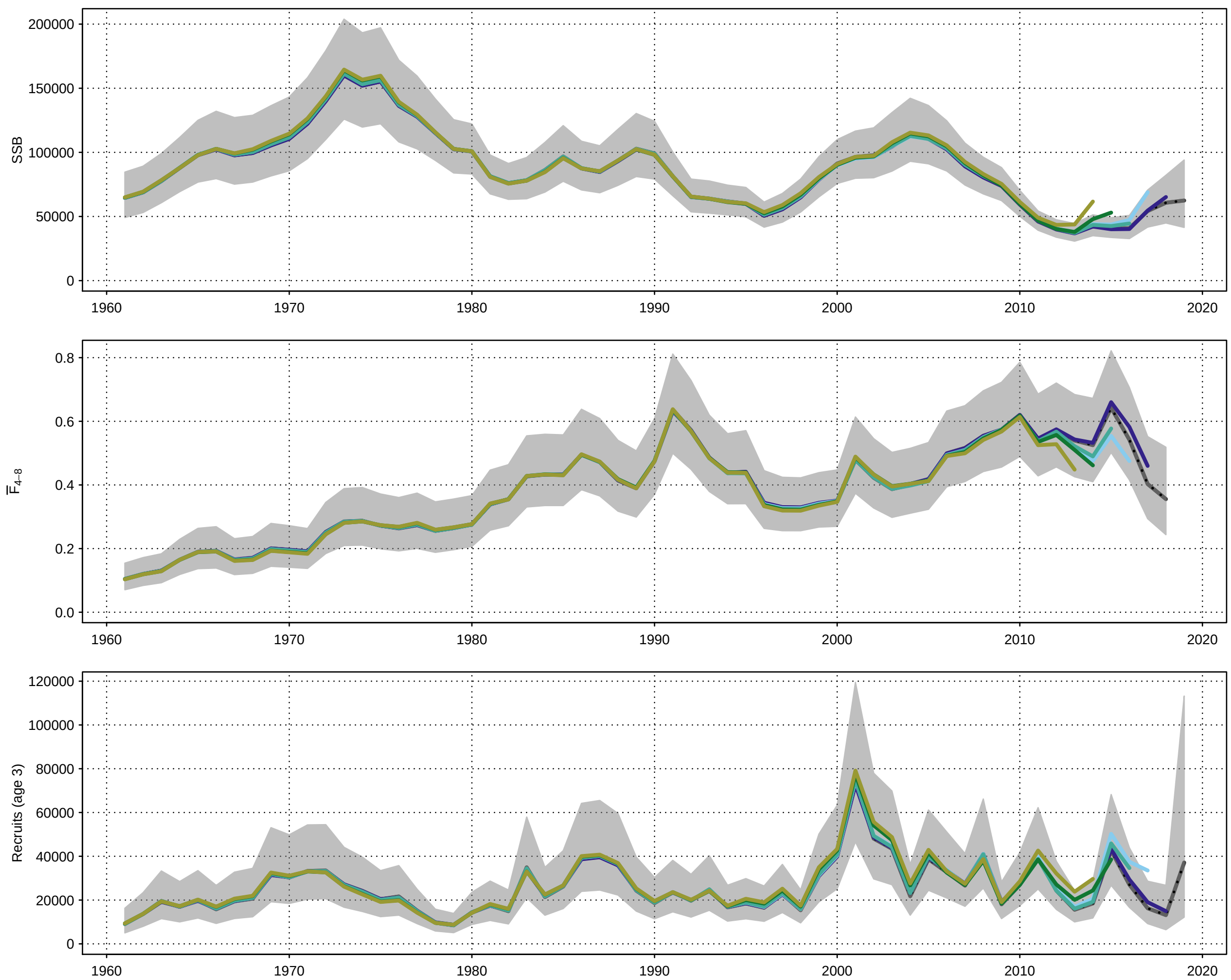

Figure 4: Faroe saithe 5b. Restrospective plots of the new SAM model configuration (MOD0).

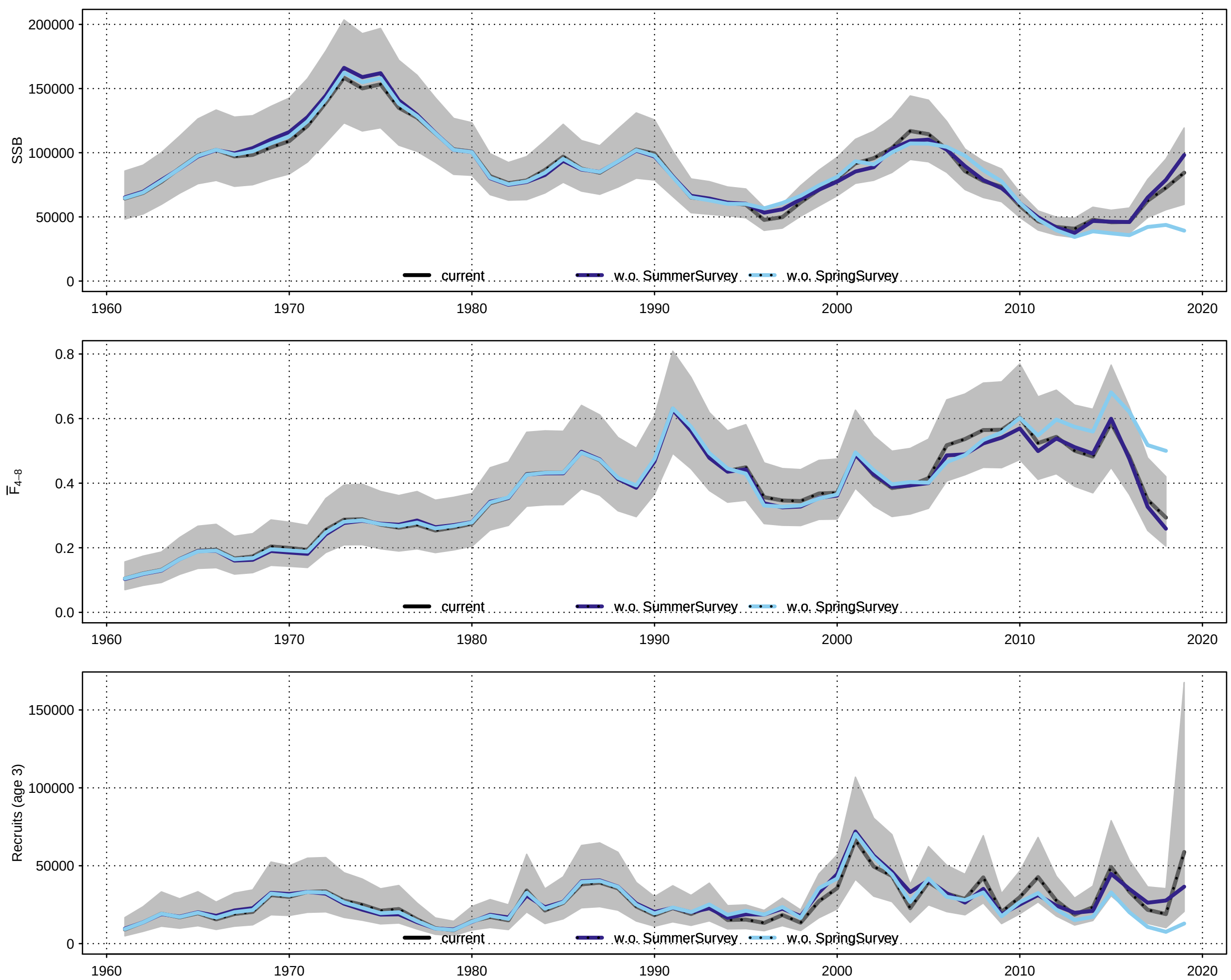

Figure 5: Faroe saithe 5b. Leave-one-ot analysis of the SPALY model.

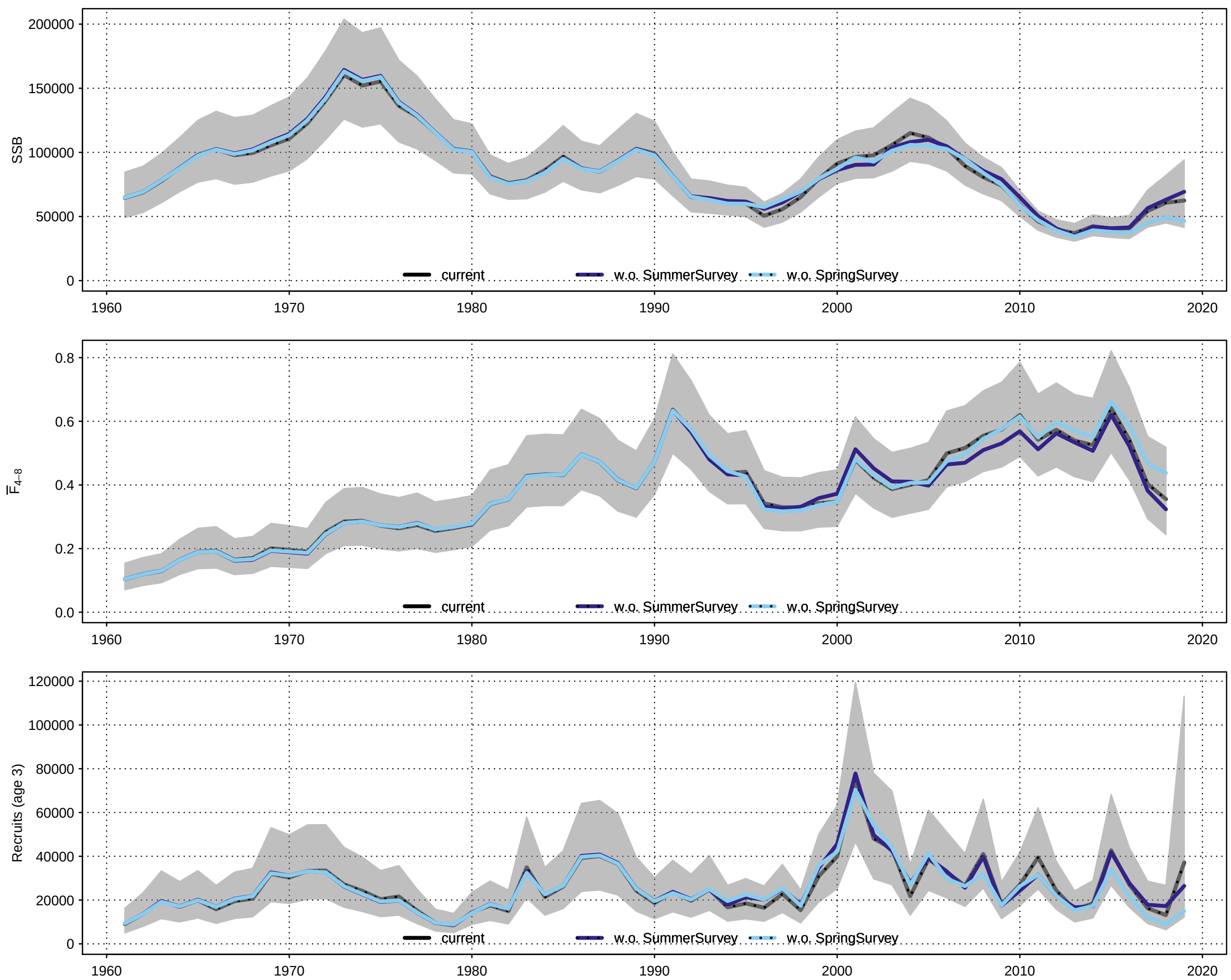

Figure 6: Faroe saithe 5b. Leave-one-ot analysis of the new SAM model configuration (MOD0).

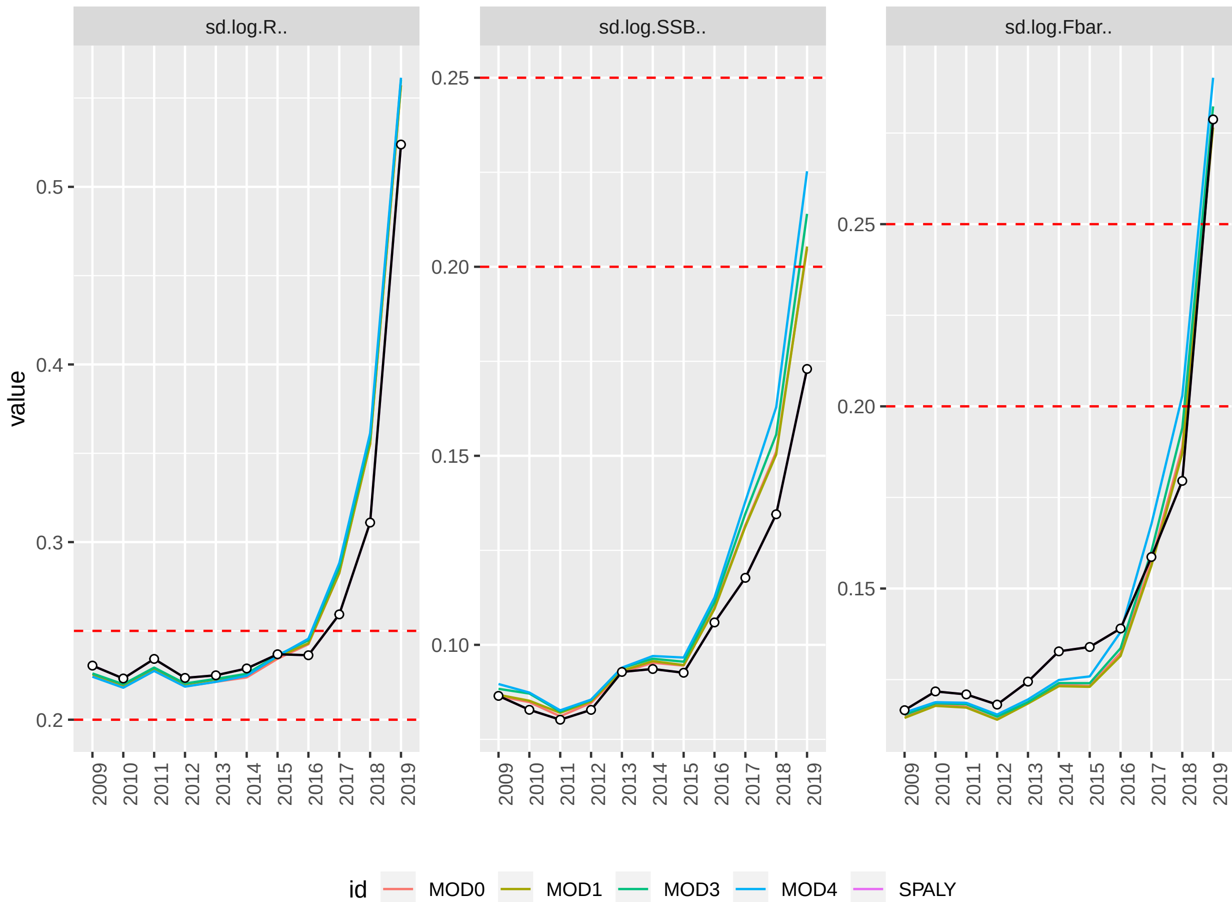

Figure 7: Faroe saithe 5b. Variability in SAM state variables (log-scale) among the models. Recruitment (left), SSB (middle) and Fbar (right). Black circled line represents the SPALY assessment.

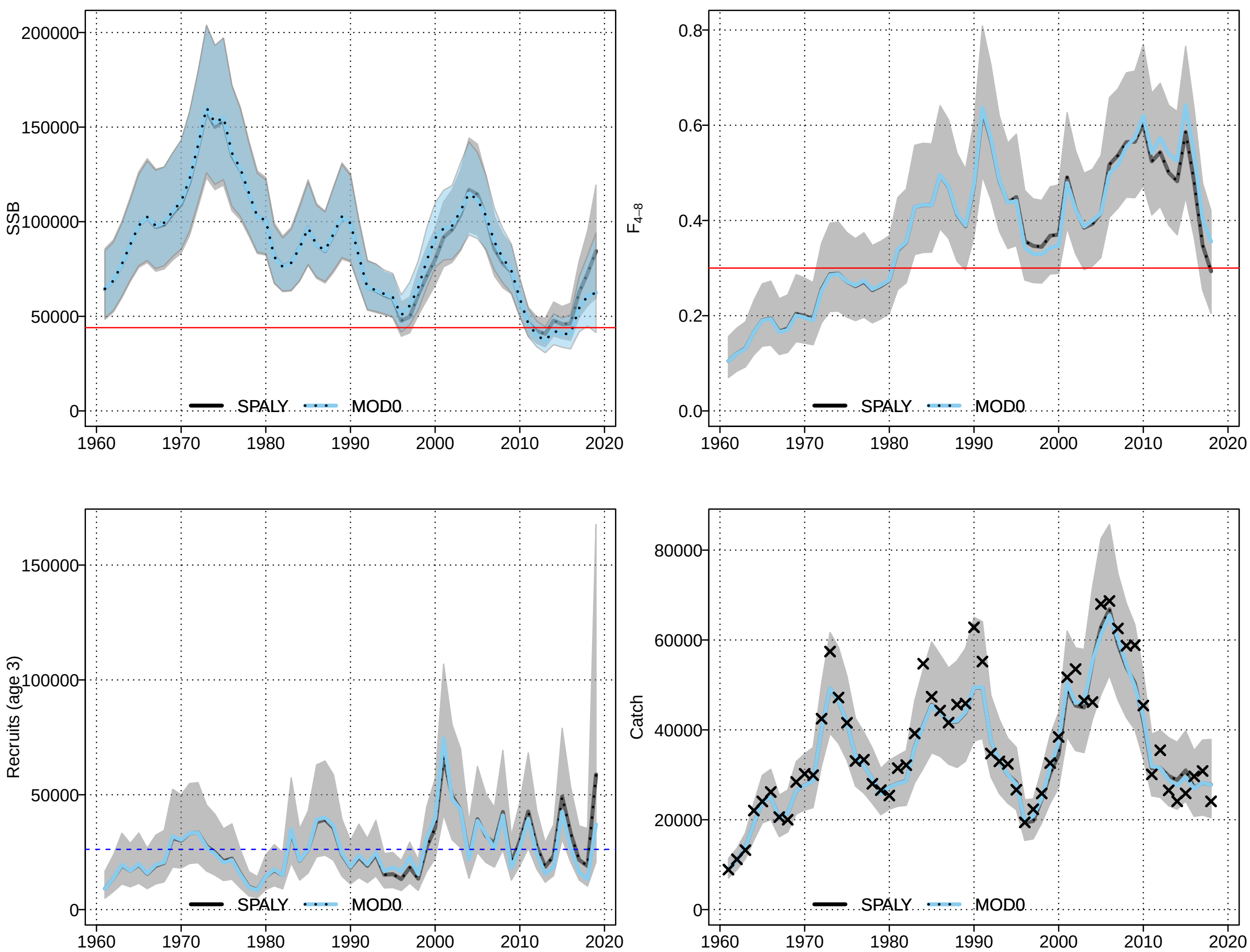

Figure 8: Faroe saithe 5b. SAM model comparison

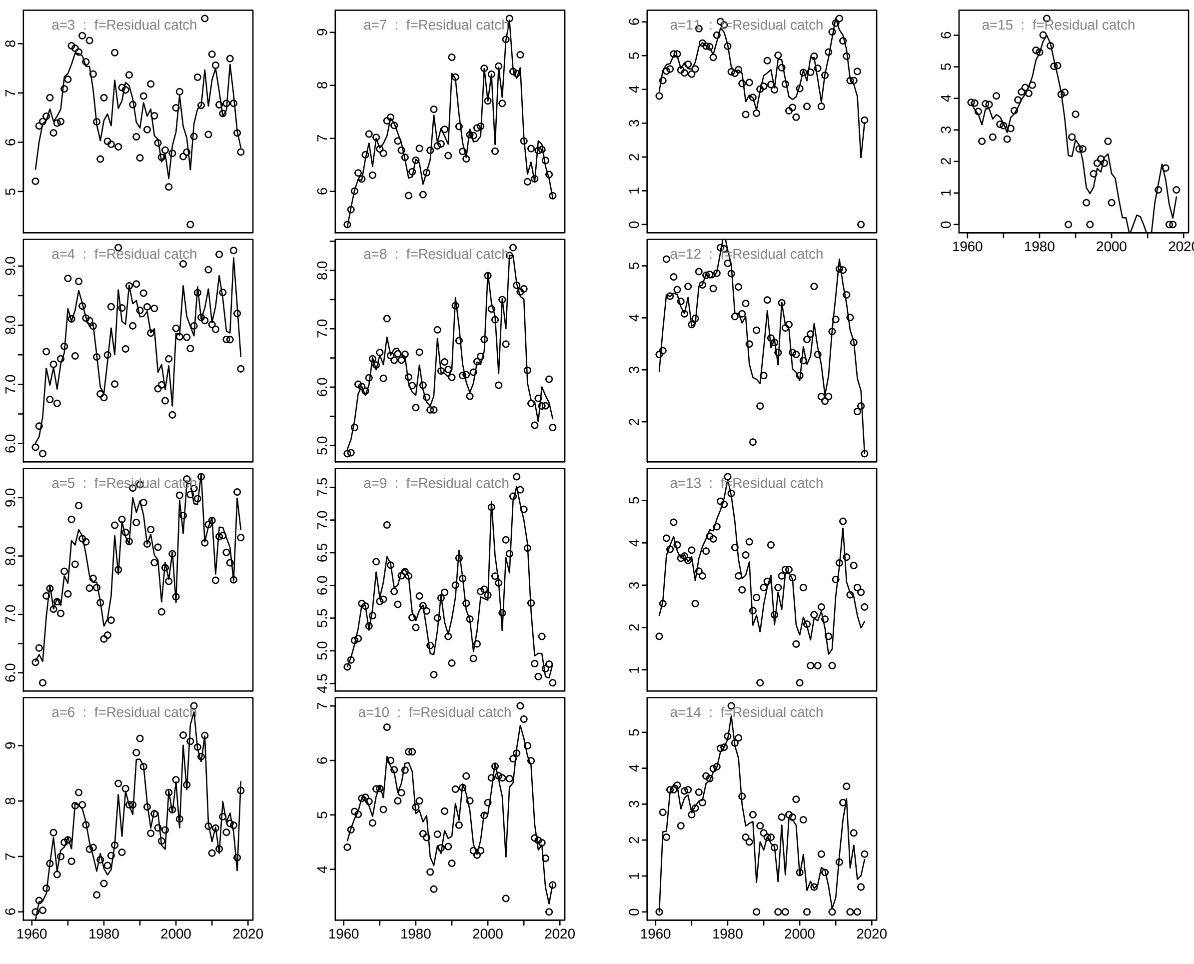

Figure 9: Faroe saithe 5b. SAM model. Fit to catch-at-age matrix.

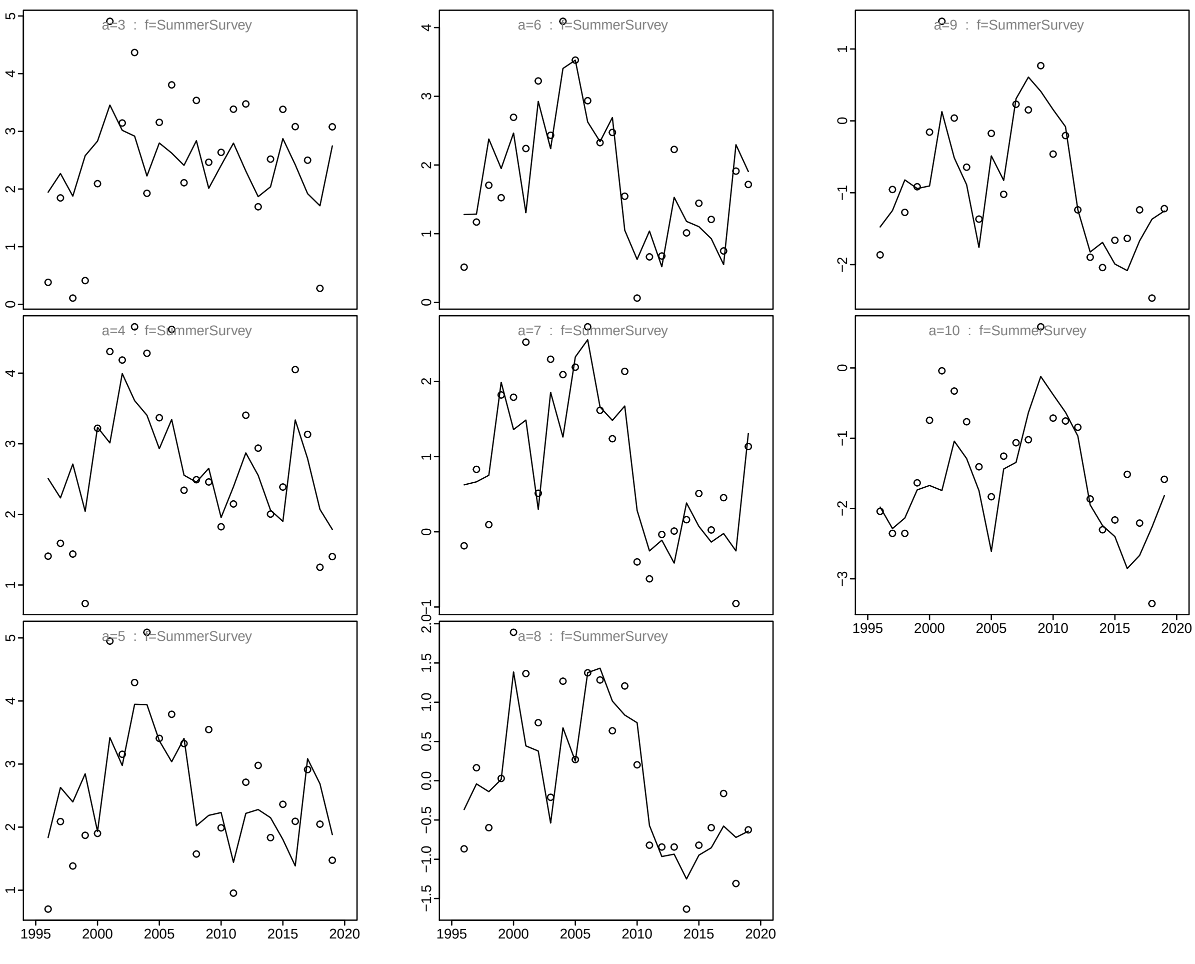

Figure 10: Faroe saithe 5b. SAM model. Fit to summer index catch-at-age matrix.

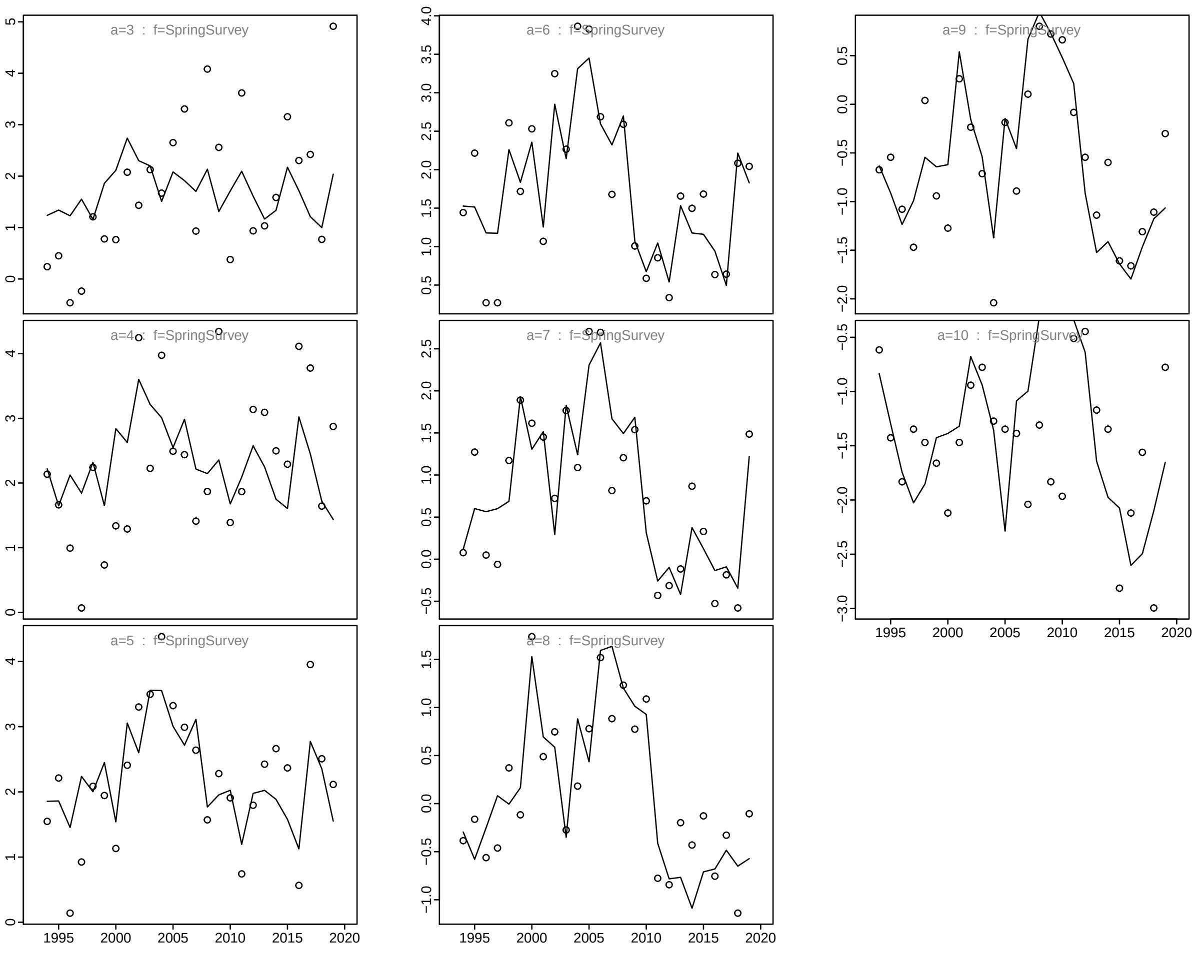

Figure 11: Faroe saithe 5b. SAM model. Fit to spring index catch-at-age matrix.

Re-evaluation of biological reference points for Faroe saithe (pok.27.5b)

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Biological reference points (BRPs) for faroe saithe were evaluated at the North-Western Working group meeting (NWWG) and adopted by ACOM in 2017. This document presents a re-evaluation of the BRPs as a consequence of the changes carried out in the configuration of the adopted SAM assessment model in 2019 (Adjustments of the SAM model configuration for Faroe saithe (5b)-UPDATE 2019). The methodology for the re-calculation of reference points has not been modified and therefore it follows the approach described both in the stock annex and in the NWWG report (see annex at bottom of document)

The recommnendation is to keep the current reference points given the negligible differences observed between the 2017 and 2019 reference points.

Figure 1 and table 1 display the results of the re-evaluation of biological reference points.

Table 1: Biological reference points for faroe saithe.

Ref. Points	2017	2019	Notes
B_{pa}	41 400 t	40 700 t	Based on Bloss
$B_{trigger}$	41 400 t	40 700 t	B_{pa}
B_{lim}	29 571 t	29 071 t	$B_{pa}/1.4$
F_{pa}	0.52	0.52	F_{lim} * exp(-0.18 * 1.645)
F_{msy}	0.30	0.29	Simulations, F that gives P[SSB<B_{lim}]<0.05
F_{lim}	0.70	0.70	Simulations, F that gives P[SSB>B_{lim}]=0.5

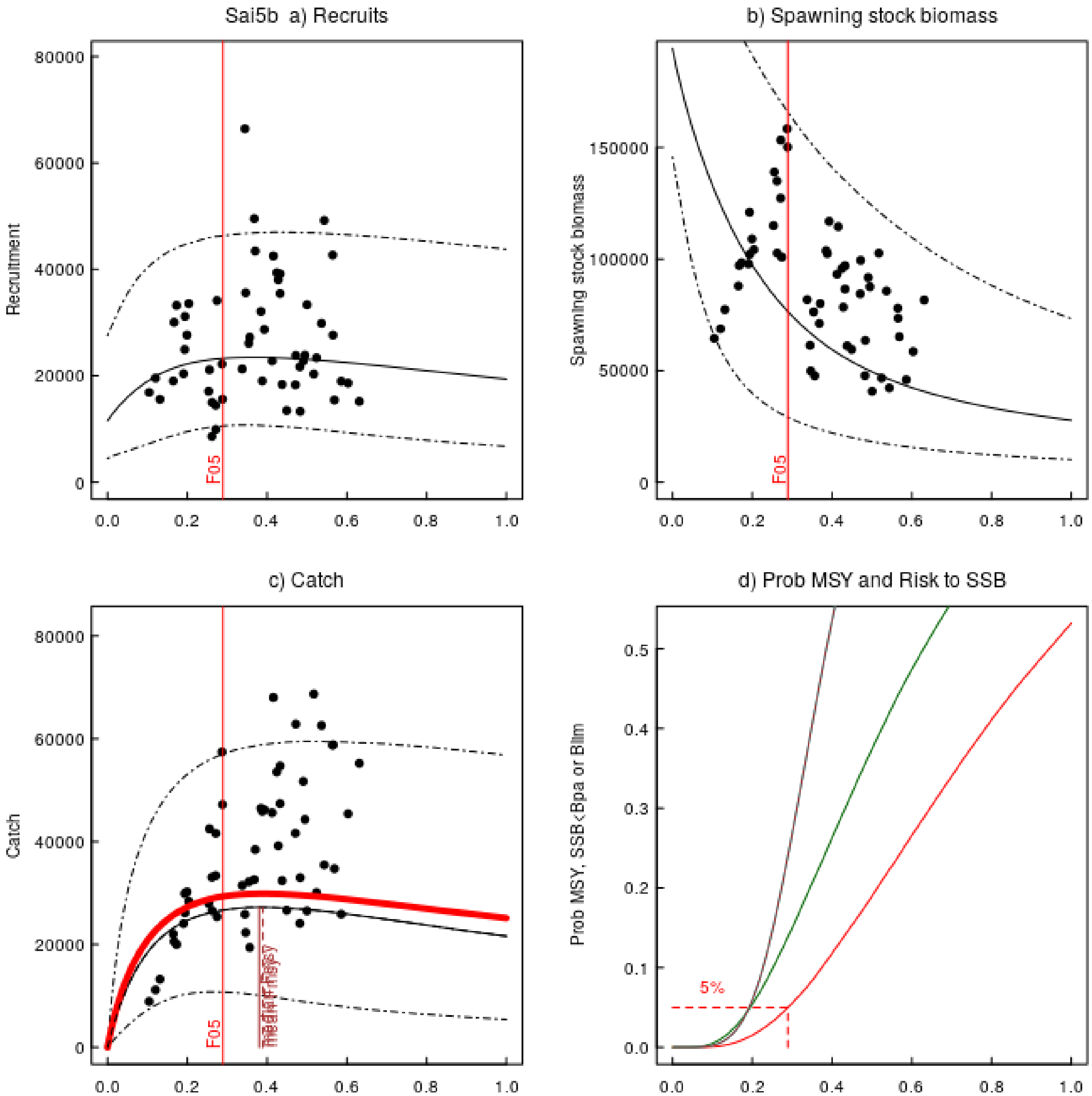

Figure 1: Recruitment, ssb, catch and probability profile from simulations.

Annex

At the NWWG in 2017, reference points were revised according to the ICES guidelines (ICES fisheries management reference points for category 1 and 2 stocks, January 2017) The latest assessment output from 2019 was used as the basis for the simulations. The software to implement the calculations was EqSim. The procedure was as follows:

$B_{pa} = B_{trigger}$ was set to 40 700 t (lowest historical SSB estimated in 2013).

B_{lim} was calculated according the equation: $B_{pa} = B_{lim} \times \exp(\text{sigma} \times 1.645) = 29\,071$ t. where sigma= 0.20 (as suggested by ACOM)

The F_{msy} estimation process consisted of 3 simulations:

1. Simulation 1. Get F_{lim}

F_{lim} is derived from B_{lim} by simulating the stock with segmented regression S-R function with the point of inflection at B_{lim} .

F_{lim} is the F that, in equilibrium, gives a 50% probability of SSB > B_{lim}

The simulation was conducted with:

- fixed F (i.e. without inclusion of a $B_{trigger}$)
- without inclusion of assessment/advice errors.

2. Simulation 2. Get initial F_{msy}

F_{msy} should initially be calculated based on:

- a constant F evaluation
- with the inclusion of stochasticity in population and exploitation as well as assessment/advice error.
- SRRs (using all; Ricker, Beverton-Holt, Segmented)
  Uncertainty parameters used:
  - **Assessment error**
    sigmaF = 0.18
    sigmaSSB = 0.17
  - **Advice error**
    cvF = 0.37
    phiF = 0.83
    cvSSB = 0.29
    phiSSB = 0.82
  - **Biological parameters and selectivity**
    numAvgYrsB = 20 # Number of years for averaging biological parameters
    numAvgYrsS = 20 # Number of years for averaging selectivity

To ensure consistency between the precautionary and MSY frameworks, F_{msy} is not allowed to be above F_{pa} , i.e., F_{msy} is set to F_{pa} if this initial F_{msy} estimate is higher than F_{pa} .

3. Simulation 3. Get final F_{msy}

MSY $B_{trigger}$ should be selected to safeguard against an undesirable or unexpected low SSB when fishing at F_{msy} . The ICES MSY advice rule should be evaluated to check that the F_{msy} and MSY $B_{trigger}$ combination adheres to precautionary considerations; in the long term, P(SSB<B_{lim}) < 5%

The evaluation includes:
- realistic assessment/advice error (see above)
- stochasticity in population biology and fishery exploitation.
- SRRs (using all; Ricker, Beverton-Holt, Segmented)

Review of: Adjustments of the SAM model configuration for Faroe cod and saithe (5b)

Two similar changes are suggested for the Faroe cod and saithe assessments.

- Use AR(1) covariance structure for both surveys.
- Use a separate variance parameter for each of the age groups in the two surveys

It could be interesting to see each of the two suggested model changes applied alone to judge which is more important.

AIC and retrospective summary (Mohn's rho) are listed for 8 models for cod and 5 models for saithe, but only the models SPALLY and MOD0 are described. The remaining models are not mentioned in the text, or even defined. Hence it is impossible to evaluate them.

Using the AR(1) structure for both surveys appears to be an improvement, as the residual diagnostics improves by reducing the yearly systematic residual pattern for the surveys for both cod and saithe — especially for the last year of the spring survey. It also seems consistent to use a similar covariance structure for the two surveys. (Was it attempted for the catches also?) The corresponding correlation parameters (transfIRARdist) are estimated to be similar for the two cod surveys, but different for two saithe surveys, which is a little unexpected, but both estimates corresponds to positive un-transformed correlations (0.86 for the spring survey and 0.65 for the summer survey for neighboring age groups), which are within a previously seen range.

Using a separate variance parameter for every single age group for each survey is a fairly unconventional setting. The normal procedure is to use relatively few variance parameters, and use same variance parameters where possible. Estimating that many variance parameters can make the estimation unstable and the estimates can become very sensitive to outlying observations. It is obvious from the estimates that some of the variance parameters could be shared across age groups (e.g. for cod `logSdLogObs_3`≈-0.67 and `logSdLogObs_4`≈-0.64, both with standard deviations of 0.17). It also seems in great contrast to using only a single variance parameter (per stock) for the catches-at-age. Having more variance parameters than strictly needed is not necessarily a problem, as long as enough data is available to inform the model, but extra care should be taken to ensure that the model is properly identifiable and converging in all runs. A small simulation study could be helpful in accessing if the model is reliably converging. From the diagnostics provided it appears to be converging, but possibly the green retro line for cod, which changes to be far outside the confidence region when all other retro lines are fairly unchanged from the spally run, could indicate convergence issues.

From the residual plot of the cod catches-at-age it appears that the oldest age group have larger variance than the other age groups, and hence a separate variance parameter for this age group could be considered.

The spring index observations for cod age group 1 has a 7 observations (about a third) which are -7 on logarithmic scale. These are clearly outliers and originating from an arbitrary setting a low number (0.001) instead of missing observations. It should be considered if a better solution could be found (e.g. coding as missing or leaving out the age group)

The AIC may indicate a larger than justified difference between the two configurations, because the added variance parameters allow the model to better accommodate the outlying/artificial observations. In terms of model performance and estimated time series of interest the differences compared to the spally assessment are minor.

Overall the model appears to be configured such that the quality of the assessment is sufficient to be the basis for scientific advice.